# 5.0 REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROCESS

This chapter describes the RI/FS (assessment) process for the 200-SW-1 and 200-SW-2 OUs. The development of, and rationale for, this process are provided in the Implementation Plan (DOE/RL-98-28). The process follows the CERCLA format, with modifications to concurrently satisfy the requirements specific to RPP waste sites and RCRA TSD units undergoing closure. A summary of the integrated regulatory process is provided in Section 5.1.

Section 5.2 outlines the tasks to be completed during the RI phase, including planning and conducting field sampling activities and preparing the RI report. These tasks are designed to effectively manage the work, satisfy the DQOs (identified in Chapter 4.0), document the results of the RI, and manage the waste generated during field activities. The general purpose of the RI is to characterize the nature, extent, concentration, and potential transport of contaminants and to provide data to determine the need for and type of remediation. The detailed information that will be collected to carry out these tasks is presented in the SAP (Appendix A).

Tasks to be completed following the RI include an FS/closure plan (Section 5.3), a proposed plan, and proposed WA7890008967, *Hanford Facility RCRA Permit*, modification for RCRA TSD units, followed by a ROD and a RCRA permit modification for RCRA TSD units (Section 5.4).

Project management occurs throughout the RI/FS process. Project management is used to direct and document project activities (so that the objectives of the work plan are met) and to ensure that the project is kept within budget and on schedule. The initial project management activity will be to assign individuals to roles established in Section 7.2 of the Implementation Plan (DOE/RL-98-28). Project management activities also include the following:

- Day-to-day supervision of and communication with project staff and support personnel
- Meetings
- Control of cost, schedule, and work
- Records management
- Progress and final reports
- Quality assurance
- Health and safety
- Community relations.

Appendix A of the Implementation Plan (DOE/RL-98-28) provides the overall quality assurance framework that was used to prepare an OU-specific quality assurance project plan for the 200-SW-1 and 200-SW-2 RI (Appendix A, Section A2.0). Appendix C of the Implementation Plan reviews data management activities that are applicable to the 200-SW-1 and 200-SW-2 OU RI/FS and describes the process for the collection/control of data, records, documents, correspondence, and other information associated with OU activities.

## 5.1 INTEGRATED REGULATORY PROCESS

Ecology has jurisdiction through RCW 70.105, "Hazardous Waste Management Act," over waste with chemical constituents (in particular, dangerous waste and dangerous waste constituents) and the chemical constituents in mixed wastes (i.e., mixtures of dangerous waste and radioactive contaminants) that exceed regulated concentrations under RCRA or WAC 173-303, "Dangerous

Waste Regulations." RCRA and the "Hazardous Waste Management Act" do not provide jurisdiction over waste with radioactive contaminants only. CERCLA authority, however, encompasses not only hazardous/dangerous chemical wastes and mixtures, but also radionuclides. By applying CERCLA authority concurrently with RCRA closure and corrective action requirements, clean-up will be addressing all regulatory and environmental obligations at these OUs as effectively and efficiently as possible. By applying CERCLA authority jointly with that of RCRA, additional options for disposal of closure, corrective action, and remedial action wastes at the Environmental Restoration Disposal Facility (ERDF) are possible. By allowing flexibility in final disposal options, the DOE, Ecology, and EPA intend to minimize disposal costs as much as possible while remaining fully protective of human health and the environment.

The integrated process for characterization of the 200-SW-1 and 200-SW-2 OUs uses this RI/FS work plan in combination with the Implementation Plan (DOE/RL-98-28) to satisfy the requirements for both an RI/FS work plan and a RCRA field investigation/corrective measures study (RFI/CMS) work plan. General facility background information, potential ARARs, preliminary RAOs, and preliminary remedial technologies developed in the Implementation Plan are incorporated by reference into this work plan. The work plan and subsequent CERCLA documentation and processes that are developed for an individual OU refine the basic information provided in the Implementation Plan to meet the site-specific needs for each OU. This work plan also provides RCRA TSD unit closure plan information addressing facility description, location and process information (Sections 2.1 and 2.2), waste characteristics (Section 3.1), and groundwater monitoring (Section 3.4). Following the completion of the work plan, an RI will be performed that will satisfy the requirements for an RFI and will provide the data needed to support the implementation of the closure strategy for the RCRA TSD units. The RI will include the concurrent investigation of the historical waste sites (Bin 1, 2, and 3B) and RCRA TSD units undergoing closure (Bin 3A). A report summarizing the results of the RI then will be prepared that will satisfy the requirements for an RFI report. The report also will contain the characterization information required in a RCRA TSD unit closure plan. The RI and FS will build on the basic information provided in the Implementation Plan to identify and evaluate remedial technologies and ARARs.

After the RI is complete, remedial alternatives/closure strategies will be developed and evaluated against WAC 173-303-610(2), "Closure Performance Standards," performance standards and evaluation criteria. The integration process for the evaluation of remedial alternatives includes the preparation of an FS/closure plan that will satisfy the requirements for a CMS report. Both documents are required to include identification and development of corrective measure/remedial alternatives and an evaluation of those alternatives. The CMS generally also includes a recommended alternative, which typically is the purpose of the proposed plan under CERCLA. The FS will include a section that provides corrective action recommendations for RPPs, and closure plans will address the RCRA TSD units in the OUs. The FS also will include further evaluation and refinement of potential ARARs that were identified in the Implementation Plan (DOE/RL-98-28).

The RCRA TSD unit closure plan currently calls for placement of a cover over the trenches, although the cover design has not been identified (DOE/RL-88-20). The construction of an engineered barrier over the units equates to what is typically termed as a "containment

alternative" under CERCLA. Areas within specific TSD units that never were used for waste disposal will be delineated as requiring no further action.

The decision-making process for the 200-SW-1 and 200-SW-2 OUs will be based on the use of a proposed plan, a ROD, and a *Hanford Facility RCRA Permit* modification. Based on the FS/closure plan, a proposed plan will be prepared that identifies the preferred remedial alternative for waste sites within the OUs. The proposed plan will include a draft permit modification with unit-specific permit conditions for RPP waste sites and the RCRA TSD units within these OUs for incorporation into the *Hanford Facility RCRA Permit* (WA7890008967). The CERCLA ROD will document the RCRA TSD unit closure and RCRA corrective action decisions for these units; currently, no corrective action is anticipated. The lead regulatory agency (Ecology) will prepare the CERCLA ROD following completion of the public involvement process for the proposed plan, which, after signature by the EPA, Ecology, and the DOE (Tri-Parties), will authorize the selected remedial action. The remedy selected under CERCLA will be incorporated into the *Hanford Facility RCRA Permit* as the RCRA closure/corrective action after completion of the public involvement process.

The technical and procedural elements of RCRA and CERCLA each are addressed in full in this process. The CERCLA public involvement process, including public notice and opportunity to comment, will be enhanced, as necessary, to concurrently satisfy the public involvement requirements for the RCRA closure and RPP processes. The public will be given an opportunity to review and comment on the FS/closure plan and the proposed permit conditions that will be contained in the proposed plan. The proposed plan with a draft permit modification will be issued for a minimum 45-day public review and comment period. Supporting documents, including the FS/closure plan, also will be made available to the public for review at this time. A combined public meeting/public hearing may be held during the comment period to provide information on the proposed action and permit modification and to solicit public comment.

## 5.2 REMEDIAL INVESTIGATION ACTIVITIES

This section summarizes the planned tasks that will be performed during the RI phase for the 200-SW-1 and 200-SW-2 OUs, including the following:

- Records review
- Planning
- Field investigation
- Site surveys
- Data integration and modeling (Bin 3B)
- Laboratory analysis and data validation
- Preparing an RI report.

These tasks and subtasks reflect the work breakdown structure that will be used to manage the work and to develop the project schedule discussed in Chapter 6.0. In addition, concurrent with the RI activities describe above, the project will identify or develop the appropriate models to support an evaluation of the personnel exposure levels (ALARA) associated with the various remedial alternatives, and the cost for implementing those alternatives.

### 5.2.1 Records Review

Existing information varies significantly in terms of completeness for the 200-SW-1 and 200-SW-2 OU sites. The initial step for all sites will be to reassess the available documentation of site history to establish a basis for investigative needs. This documentation was reviewed before this work plan was developed. This step in the RI will be to familiarize the field personnel with the particulars of each site. The first step in this process will be to review the WIDS record for a site to get a sense of the areal extent of the site, the nature of contamination present, and source documentation that was used to establish the WIDS record. If WIDS records for Bin 1 and 2 sites appear to be adequate to support site characterization, the project will proceed to planning the field characterization. If records for Bin 1 or 2 sites do not appear sufficient, the supporting document(s) referenced in WIDS will be reviewed and an attempt will be made to identify additional clarifying documentation before commencing the planning subtask. Records review for the Bin 3 sites will include WIDS data, waste inventory records for the Bin 3A sites and, when available, for Bin 3B sites, and information that has been compiled in sources such as, e.g., WHC-EP-0912, radiological survey reports (e.g., HNF-SP-0665-53, *Quarterly Environmental Radiological Survey Summary, Second Quarter 2004 100, 200, 300, And 600 Areas*), and ARH-2762. These documents will be used to improve the understanding of the inventory at the burial grounds, to the extent practical using existing knowledge. Once readily available sources of information have been exhausted, the project will commence planning for the field characterization.

### 5.2.2 Planning

The planning subtask includes activities and documentation that need to be completed before field activities can begin. Planning activities will be more, or less, complex depending on the completeness of available records reviewed, the nature and extent of site contamination, and the anticipated remedial path forward. Activities include the preparation of a job hazard analysis and a site-specific health and safety plan (HASP), radiation work permits, excavation permits and supporting surveys (e.g., cultural, radiological, wildlife, and utilities), work instructions, personnel training, and the procurement of materials and services (e.g., laboratory support, drilling, and geophysical logging services).

Appendix B of the Implementation Plan (DOE/RL-98-28) provides a general HASP that outlines health and safety requirements for RI activities. Site-specific HASPs will be prepared. Initial surface radiological surveys will be performed to document any radiological surface contamination and the background levels[1] in and around the sampling locations. This information will be used to document initial site conditions and prepare HASPs and radiation work permits.

Some of the burial grounds have access restrictions because of the potential for subsidence (see HNF-2030, *Subsidence Potential in the Burial Grounds*). These burial grounds should be identified early in the planning process to determine possible restrictions on access for field characterization and to develop a strategy to work around the restrictions, if possible.

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[1]Background levels in this instance are determined for purposes of the HASP and are not to be used to determine background levels for screening against limits as prescribed in various sections of WAC 173-340.

### 5.2.3 Field Investigation

The field investigation task involves data-gathering activities performed in the field that are required to satisfy the project DQOs. The field characterization approach is summarized in Section 4.2 and detailed in the SAP (Appendix A). The scope includes site surveys with field instruments, and soil sampling and analysis to characterize the surface and/or vadose zone soils at the waste sites to verify close-out decisions. Other activities include work zone setup, mobilization and demobilization of equipment, equipment decontamination, and field analyses.

Major subtasks associated with the field investigation include the following:

1. Collection of data from chemical and radioactive contamination surveys
2. Soil sampling
3. Preparation of a field report.

#### 5.2.3.1 Collection of Data from Chemical and Radioactive Contamination Surveys

Planned field analyses include radioactive contamination field screening. An initial step in the investigations will be to perform a field screening to determine the exposure potential at sites and to establish areas with concentrations of radionuclides significantly above background. Radiological data will be used to establish radiation control measures, and to ensure worker health and safety. Radioactive contamination screening surveys will be used to locate sites and to gather in situ radioactive contamination data as specified in the SAP. Field techniques also will be used to screen sites for the presence and extent of chemical contamination. If initial screening shows the presence of contamination at Bin 2 sites, excavated soil at RTD sites will be field screened to provide additional characterization data used in decisions and identification of hot spots at the site.

#### 5.2.3.2 Soil Sampling

Soil samples will be collected to verify the absence of contamination at Bin 1 sites, or at Bin 2 sites if initial survey data indicate that there are no contaminants present above levels of concern. Soil samples also will be required for Bin 3B sites to characterize conditions from specific waste locations. Soil samples may be collected from surface locations, backhoe buckets, test pits, or shallow shovel excavations depending on the size of the site and the depth of contamination. Bin 3B soil samples generally will be collected using a push-probe technique. The samples will be packaged for shipment to a laboratory.

#### 5.2.3.3 Data Integration and Modeling

For Bin 3B sites, the project will screen the list of COCs developed for these OUs against the anticipated inventories at the burial grounds to determine which sites have the highest potential for releases to the environment or personnel exposure. Samples will be collected from locations that show the highest concentrations of wastes and contamination, based on surface geophysics and non intrusive evaluations of radionuclide and chemical inventories. The resulting data will be used as input to model the exposure potential, using accepted models commonly used to assess exposure at the Hanford Site.

#### 5.2.3.4 Preparation of a Field Report

At the completion of the field investigation, a field report will be prepared to summarize activities performed and information collected in the field. The report will include radioactive

contamination survey data collection locations, the number and types of samples collected and associated HEIS numbers, and any chemical field-screening results.

### 5.2.4 Laboratory Analysis and Data Validation

Soil samples collected will be analyzed for a suite of radioactive and nonradioactive constituents identified as COCs during the DQO and defined in the SAP. The SAP lists the analytes, methods, and associated target detection limits. This task includes the laboratory analysis of samples, the compilation of laboratory results into data packages, and the validation of a representative number of laboratory data packages.

Laboratory data will be generated to support site closeout, in the case of Bin 1 sites, and, potentially, some Bin 2 sites. Laboratory data also will be used to verify site conditions at Bin 3B burial grounds. This task will include evaluating the information collected during the investigation. Radionuclide and nonradionuclide data will be compiled, tabulated, and statistically evaluated. If contaminants not identified as COCs are detected during laboratory analysis, the data will be evaluated against regulatory standards, or risk-based levels.

### 5.2.5 Remedial Investigation Report

This section summarizes data evaluation and interpretation subtasks leading to the production of an RI report. The primary activities include a data quality assessment; evaluating the nature, extent, and concentration of contaminants based on sampling results; assessing contaminant fate and transport; refining the conceptual site model; and evaluating risks through a risk assessment. These activities will be performed as part of the RI report preparation task.

#### 5.2.5.1 Data Quality Assessment

A data quality assessment will be performed on the analytical data to determine if the data are the right type, quality, and quantity to support the intended use. The data quality assessment completes the data life cycle of planning, implementation, and assessment that began with the DQO process. For this task, the data will be examined to determine if they meet the analytical quality criteria outlined in the DQO and to determine if the data are adequate to evaluate the decision rules in the DQO.

#### 5.2.5.2 Data Evaluation and Conceptual Model Refinement

This task will include evaluating the information collected during the investigation. The chemical and radionuclide data obtained from samples will be compiled, tabulated, and statistically evaluated to gain as much information as possible to satisfy the data needs. For RCRA TSD units, the data collected during the RI will be evaluated against WAC 173-303-610 performance standards.

If contaminants not identified as contaminants of potential concern are detected during laboratory analysis, the data will be evaluated against regulatory standards (or risk-based levels if exposure data are available) and existing process knowledge in support of remedial action decision making.

#### 5.2.5.3 Risk Assessment

The Tri-Parties recently undertook the task of developing a risk framework to support risk assessments in the Central Plateau. This included a series of workshops with representatives from the Tri-Parties, the Hanford Advisory Board (HAB), the Tribal Nations, the State of Oregon, and other interested stakeholders. The workshops focused on the different programs involved in activities in the Central Plateau and the need for a consistent application of risk assessment assumptions and goals. The results of the risk framework are documented in HAB Advice #132 (HAB 132, "Exposure Scenarios Task Force on the 200 Area"), in the Tri-Parties response to the HAB advice (Klein et al. 2002, "Consensus Advice #132: Exposure Scenarios Task Force on the 200 Area"), and in the *Report of the Exposure Scenarios Task Force* (HAB 2002). The following items, which summarize the risk framework description from the Tri-Parties response to the HAB (Klein et al. 2002), will help guide the OU risk assessments to be conducted in the RI and FS reports:

1. The Core Zone (200 Areas including B Pond [main pond] and S Ponds) will have an industrial scenario for the foreseeable future.
2. The Core Zone will be remediated and closed allowing for "other uses" consistent with an industrial scenario (environmental industries) that will maintain active human presence in this area, which in turn will enhance the ability to maintain the institutional knowledge of waste left in place for future generations. Exposure scenarios used for this zone should include a reasonable maximum exposure to a worker/day user, to possible Native American users, and to intruders. An assumption of industrial land use will be used to set clean-up levels.
3. The DOE will follow the required regulatory processes for groundwater remediation (including public participation) to establish the points of compliance and remedial action objectives. It is anticipated that groundwater contamination under the Core Zone will preclude beneficial use for the foreseeable future, which is at least the period of waste management and institutional controls (150 yr). It is assumed that the tritium and I-129 plumes beyond the Core Zone boundary will exceed the drinking water standards for the period of the next 150 to 300 yr (less for the tritium plume). It is expected that other groundwater contaminants will remain below, or be restored to, drinking water levels outside the Core Zone.
4. No drilling for water use or otherwise will be allowed in the Core Zone. An intruder scenario will be calculated for in assessing the risk to human health and environment.
5. Waste sites outside the Core Zone but within the Central Plateau (200 North Area, Gable Mountain Pond, BC Crib Controlled Area) will be remediated and closed based on an evaluation of multiple land-use scenarios to optimize land use, institutional control cost, and long-term stewardship.
6. Other land use scenarios (e.g., residential, recreational) may be used for comparison purposes to support decision making, especially for the following:
   - The post-institutional controls period (>150 yr)
   - Sites near the Core Zone perimeter to analyze opportunities to "shrink the site"
   - Early (precedent-setting) closure/remediation decisions.

7. This framework does not deal with the tank retrieval decision.

#### 5.2.5.3.1 Human Health Risk Assessment

For the 200-SW-1 and 200-SW-2 OUs, a quantitative, baseline human health risk assessment for the sites will be prepared, as part of the RI report, to evaluate risk to human receptors from potential exposure to contaminants in accessible surface sediments and shallow subsurface soils. The risk assessment also will evaluate the potential for contaminants currently in the vadose zone beneath the waste sites to impact groundwater in the future. Risks from current groundwater contamination will not be evaluated; this evaluation will be conducted as part of the RI/FS process for the groundwater OUs.

The following DOE and EPA guidance documents may be used to support the human health risk assessment process:

- DOE/RL-91-45, *Hanford Site Risk Assessment Methodology*
- EPA/540/1-89/002, *Risk Assessment Guidance for Superfund (RAGS), Volume I -- Human Health Evaluation Manual, Part A (Interim Final)*
- EPA 1991, OSWER Directive 9285.6-03, *Risk Assessment Guidance for Superfund, Vol. I Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors, (Interim Final)*
- EPA/600/P-95/002Fa, *Exposure Factors Handbook*
- EPA/540/R/99/005, *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim*
- EPA/600/P-92/003C, *Proposed Guidelines for Carcinogen Risk Assessment*
- EPA 1992, OSWER Directive 9285.7-081, *Supplemental Guidance to RAGS: Calculating the Concentration Term.*

Risks initially will be evaluated by comparison to risk-based standards such as WAC 173-340-745. Contaminants present at concentrations exceeding these risk-based standards will be considered further in the risk assessment process. Risks from nonradiological noncarcinogens will be evaluated by calculating hazard quotients for individual constituents and a hazard index for cumulative risk. Risks from nonradiological carcinogens and radionuclides will be evaluated by calculating incremental cancer risks for individual constituents and a cumulative cancer risk.

The computer program RESRAD (ANL, 2002, *RESRAD for Windows*, Version 6.21) will be used to obtain risk and dose estimates from direct-contact exposure to radiological constituents present in the shallow zone of the waste sites. The RESidual RADioactivity (RESRAD) model also will be used to obtain risk and dose estimates for the protection of the groundwater pathway. The results obtained from the RESRAD model for the groundwater protection model are limited to screening purposes only. Once risks and dose are evaluated, a follow-up assessment will be made to determine whether additional modeling will provide substantive new information. For example, previous modeling in the Central Plateau has indicated that constituents with zero $K_d$ reach groundwater. Thus, no added information may be obtained from this assessment. Should additional fate and transport modeling be required, appropriate models (e.g., STOMP

[PNNL-12034, *STOMP, Subsurface Transport Over Multiple Phases, Version 2.0, User's Guide*] will be used to assess the impact of chemicals and radionuclides to groundwater. The project also will evaluate the use of the model(s) used to conduct the performance assessments for the 200 East and 200 West Area burial ground sites to assess impact potential associated with individual burial grounds (WHC-SD-WM-TI-730 and WHC-EP-0645).

The risk evaluation for the 200-SW-1 and 200-SW-2 OUs will be based on this risk framework as well as applicable regulation and guidance. Radiological and nonradiological constituents in surface and near-surface soil are to be evaluated for potential human health impacts using an industrial land-use scenario. Other land-use scenarios also may be considered to provide additional information to decision makers for the sites outside the Core Zone, per item 6 in the Tri-Parties' response (Klein et al. 2002). The risk evaluation also will include an assessment of the potential impacts to groundwater related to soil contamination. Hypothetical human health risk is to be assessed using inputs developed from other Hanford Site OUs, site-specific data, and EPA and state guidance documents. Risk evaluations for possible Native American users and intruder scenarios may be considered in the FS for informational purposes.

In addition, the waste inventories at the 200-SW-1 and 200-SW-2 OUs will be evaluated to determine the risks to workers associated with remedial alternatives. These risks include, for example, dose related to direct exposure to gamma-emitting radionuclides and inhalation risk from alpha and beta emitting particles.

#### 5.2.5.3.2 Ecological Risk Assessment

The screening-level ecological risk assessment in DOE/RL-2001-54 is meant to be a conservative evaluation of risk to ecological receptors from stressors, in this case, introduction of contaminants and habitat elimination. The screening-level ecological risk assessment identifies pathways for ecological receptors to be exposed to the contamination and evaluates potential risk from those exposures. The following discussion describes the information found in specific sections of DOE/RL-2001-54.

Chapter 2.0 of DOE/RL-2001-54 describes the physical and ecological setting of the Central Plateau and identifies important aspects of the ecology and the condition of the waste sites to consider during the ecological risk assessment. For instance, while most waste sites are in a disturbed habitat with little vegetation to support wildlife, the nearby shrub-steppe offers a more suitable location for wildlife and needs protection in this region because of encroachment and elimination of this habitat in other parts of eastern Washington. Individual species whose populations are limited and are designated as sensitive species also must be protected. Recent surveys of the biological diversity on the Hanford Site have identified a number of new-to-science species and the protection status of these species has not yet been determined. More information is needed to help with this determination.

Most of the waste in the waste sites has been stabilized, thereby limiting ecological access. The decisions to stabilize and remediate waste sites must balance the potential disruption to the ecosystem both at and adjacent to the waste sites as well as from a distant location (e.g., borrow source sites).

The conceptual site model in DOE/RL-2001-54, Chapter 3.0, provides an understanding of the ecological resources and the ways that receptors may be exposed. It shows where chemicals and radionuclides from the waste sites are likely to come into contact with receptors in the

environment. The exposure pathways that are expected to be complete at most waste sites include the following:

- Direct contact with, or ingestion of, soil by invertebrates (e.g., beetles, ants) and burrowing mammals
- Uptake of contaminants in soil by vegetation
- Bioaccumulation through ingestion of food items (e.g., food chain effects) consumed by wildlife that may forage at the waste sites.

Chapter 4.0 of DOE/RL-2001-54 discusses the toxicity values that are available for contaminants believed to be present in the Central Plateau. Contaminants were identified from preliminary sampling data available from a subset of waste sites. These contaminants then were screened, primarily with respect to the likelihood to be present in the environment (i.e., half-life and persistence). A literature search for bird and mammalian toxicity values was performed; toxicity values are not available for some contaminants. A risk management decision will be needed to determine how contaminants that do not have toxicity values will be handled during the risk assessment for each OU.

Chapter 5.0 of DOE/RL-2001-54 presents the exposure parameters used for estimating the exposure in a quantitative manner. In a screening-level ecological risk assessment, most exposure parameters are set conservatively at 100 percent. The only organism-specific factor necessary will be body weight and these data are available in the literature. This section further evaluated the exposure pathways and constructed a food chain exposure model for wildlife specific to the Central Plateau. The wildlife are listed in the food chain and habitat model in DOE/RL-2001-54.

Chapter 6.0 of DOE/RL-2001-54 is the screening-level risk calculation for the Central Plateau. The state and the DOE provide contaminant-specific numerical values (WAC 173-340-900 and biota concentration guides) to potential risks. These are conservative numbers designed to address all possibilities without leaving potential risks out of consideration. Data are available for a subset of the Central Plateau waste sites. These maximum concentrations of contaminants detected at the waste sites were compared with the state and DOE screening-level values. For chemicals, 12 metals, pentachlorophenol, and 4-dinitrophenol were detected at a maximum concentration above the screening level. The high number of metals presenting a risk requires closer examination. Site-specific bioavailability data would be helpful for understanding whether this is a reflection of the conservative nature of the screening assessment or an actual risk to the ecosystems at the waste sites. For radionuclides, Cs-137, Ra-226, Ra-228, and Sr-90 were above acceptable limits in the soil samples. It is important to recognize the limitations and uncertainty associated with risks identified by screening-level assessments. The risk calculations are useful for determining relative risks between waste sites, not site-specific risk. The information should be considered carefully along with actual biological evidence from the waste site area to determine if a hazard exists. Data are available for hundreds of wastes sites in the Central Plateau (see Appendix C of DOE/RL-2001-54). These data include soil from the waste site, vegetation, and soil invertebrates. As each OU quantifies its risk using the exposure models available, these data will be useful in verifying the mathematical estimates.

The screening-level ecological risk assessment in DOE/RL-2001-54 leads to the problem formulation stage of a baseline ecological risk assessment. During problem formulation, the risk managers and others consider the toxicity evaluation, conceptual model exposure pathways, and

assessment endpoints to support cleanup decisions. As a result, they then are able to better define the initial risks and determine direction for the DQO process, if needed.

Ecological risk will be evaluated using the EPA eight-step process as outlined in DOE/RL-2001-54. DOE/RL-2001-54 serves as the screening-level assessment for the Central Plateau. For the 200-SW-1 and 200-SW-2 OUs, DOE/RL-2001-54 provides the starting point for OU-specific ecological evaluations that will include a screening-level evaluation based on the data collected during the RI and other existing data as available, which will be compared to screening-level concentrations protective of wildlife. Because the waste sites in these OUs are all within the Core Zone, only terrestrial wildlife risks will be evaluated. Consistent with this approach, WAC 173-340-7490 (3)(b), "Terrestrial Ecological Evaluation Procedures," "Goal," specifies that for industrial or commercial properties, current or potential for exposure to soil contamination need only be evaluated for terrestrial wildlife protection. Plants and biota need not be considered unless the species is protected under the federal *Endangered Species Act of 1973*. Currently, no federally listed threatened or endangered species are known to exist on the waste sites.

For radionuclides, screening levels have been developed in DOE/STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*. The international community has been involved for more than 20 yr in evaluating the effects of ionizing radiation on plants and animals. In 1992, the International Atomic Energy Agency (IAEA) issued a study (IAEA 332) endorsing the 1977 International Commission on Radiological Protection (ICRP) reports *Recommendations of the International Commission on Radiological Protection* (ICRP Publication 26 and ICRP Publication 60) and stating that chronic radiation dose rates below 0.1 rad/day will not harm plant and animal populations and that radiation standards for human protection also will protect populations of nonhuman biota. The report implies that dose limits of 0.1 rad/day for animals and 1.0 rad/day for plants will protect populations, but additional evaluation of effects may be needed if sensitive species are present.

*Effects of Ionizing Radiation on Terrestrial Plants and Animals: A Workshop Report* (ORNL/TM-13141, *Effects of Ionizing Radiation on Terrestrial Plants and Animals: A Workshop Report*) presents information from a DOE-sponsored workshop held in 1995. The workshop was attended by 12 experts in radioecology and ecological risk assessment. The goal of the workshop was to evaluate the adequacy of current approaches to radiological protection, as exemplified by the IAEA report. The attendees reviewed DOE's perspective and responsibilities, rationales underlying the IAEA conclusions, and a summary of ecological data from the former Soviet Union. The consensus of the workshop participants was that the 0.1 rad/day limit for animals and the 1.0 rad/day limit for plants recommended by the IAEA are adequately supported by the available scientific information. However, they concluded that guidance on implementing the limits is needed and that the existing data support application of the recommended limits for populations of terrestrial and aquatic organisms to representative rather than maximally exposed individuals.

In response to the workshop findings, the DOE produced DOE/STD-1153-2002, which provides a graded approach to ecological risk assessment for radionuclides and screening-level biota concentration guides. For radiological constituents, no promulgated screening or cleanup levels are available. The biota concentration guides from DOE/STD-1153-2002 will be used in the ecological evaluation of radiological constituents.

DOE/RL-2001-54 is foundational to the Central Plateau ecological evaluation DQO process, which is to be conducted in three phases, the first of which was completed in FY 2004. Phase II is to be completed in FY 2005, and Phase III is to be completed by the end of FY 2006. This DQO process will further develop data gaps identified in DOE/RL-2001-54 and identify data needs for the Central Plateau to support remedial decision making. An ecological evaluation SAP is prepared and implemented for the Central Plateau, either on an area-wide basis or by OU, depending on the actual data needs.

Based on the results of the DQO and the screening-level evaluation, additional risk assessment activities, including a baseline ecological risk assessment, may be conducted using the eight-step process. The evaluation will be conducted based on soil data collected during the RI, existing soil and ecological data, and if identified during the Central Plateau ecological evaluation DQO, newly collected ecological data.

## 5.3 FEASIBILITY STUDY/RCRA TREATMENT, STORAGE, AND/OR DISPOSAL UNIT CLOSURE PLAN

After the RI is complete, remedial alternatives/closure strategies will be developed and evaluated against CERCLA performance standards and evaluation criteria in the FS/closure plan. Closure and corrective actions for RCRA TSD units will be evaluated against the appropriate dangerous waste performance standards. The FS process consists of several steps:

1. Defining RAO and RCRA closure and RCRA corrective action performance standards
2. Identifying general response actions to satisfy RAOs
3. Identifying potential technologies and process options associated with each general response action
4. Screening process options to select a representative process for each type of technology based on its effectiveness, implementability, and cost
5. Assembling viable technologies or process options into alternatives representing a range of treatment and containment plus the no-action alternative
6. Evaluating alternatives and presenting information needed to support remedy selection and RCRA closure of the unit as a landfill pursuant to *Hanford Facility RCRA Permit* Condition II.K (WA7890008967).

Appendix D of the Implementation Plan (DOE/RL-98-28) identifies the following remedial action alternatives as potentially applicable to the 200-SW-1 and 200-SW-2 OUs:

- No-action alternative
- Engineered multimedia surface barriers
- Excavation and disposal with or without soil treatment
- Excavation, ex situ treatment, and geologic disposal of transuranic soil
- In situ grouting or stabilization
- Monitored natural attenuation (with institutional controls).

A number of technologies associated with these alternatives have been fully developed and implemented in the DOE complex or have undergone treatability testing. The 200-SW-1 and

SW-2 OU RI/FS will use the treatment evaluations and results from a number of Hanford Site RI/FS activities, as well as from similar studies being conducted at other DOE facilities. Treatment evaluations completed or being conducted that are relevant for the SW-1 and SW-2 OU RI/FS are described below.

- **Natural Attenuation**

  Natural attenuation is retained in the 200-CW-5 OU FS (DOE/RL-2004-24, Draft A), the 200-TW-1 OU, 200-TW-2 OU, and 200-PW-5 OU FS (DOE/RL-2003-64, Draft A), the 200-CW-1 OU, 200-CW-3 OU, and 200 North Area waste sites FS (DOE/RL-2002-69, Draft A), and the FFS for the 200-UW-1 Operable Unit (DOE/RL-2003-23, Draft B), because it is a natural component of all of the potential alternatives. Natural attenuation is most effective at sites with nonradionuclides that readily degrade in the environment and at sites with radionuclides that have short half-lives, such as Cs-137. It may be the only feasible and cost-effective technology for sites that have deep contamination, because other technologies (e.g., retrieval, in situ treatment) are difficult to implement, ineffective, and potentially cost prohibitive.

- **Soil Mixing**

  Ex-situ treatment processes retained in the Implementation Plan include thermal desorption, vapor extraction, mechanical separation, soil washing, ex-situ vitrification, solidification/ stabilization, and soil mixing. Some soil mixing (blending) may be required to meet health and safety standards and waste acceptance criteria before the soils are disposed of at the ERDF. Soil mixing is retained as an option for the 200-CW-5 OU FS (DOE/RL-2004-24, Draft A). Soil mixing is commonly used in construction and is a well-developed technology.

- **In Situ Vitrification**

  In situ vitrification (ISV) applies an electrical current to melt contaminated soil and forms a stable, vitrified mass when cooled. The stable mass chemically incorporates most inorganics (including heavy metals and radionuclides) and destroys or removes organic contaminants.

  This technology is being considered in several DOE CERCLA evaluations, including the Pit 9 site at LANL (DOE 2004, *Screening-Level Evaluation of Remedial Alternatives for Pit 9 TRU Waste at Los Alamos National Laboratory*) and 200-CW-5 OU at Hanford (DOE/RL-2004-24, Draft A). Australia used ISV on transuranic-contaminated sites, as reported in ANSTO/C453, *A Report to the Parliamentary Standing Committee on Public Works on Mixing and Encapsulation of Plutonium in In Situ Vitrification Trials at Maralinga*. ANSTO/C453 reports that concentrations of transuranics up to 100 g per melt were successfully processed.

  ISV is the technology selected for processing TRU-contaminated soil as reported in EPA/541/R-02/100, *Record of Decision (ROD) for Waste Area Group 7, Trenches 5 and 7 in Melton Valley at Oak Ridge National Laboratory*.

- **In Situ Grouting**

  Grout injection, commonly referred to as jet grouting or in situ grouting, is a process that entails injecting a slurry-like mixture of cements, chemical polymers, or petroleum-based waxes into contaminated media. Grouts are specially formulated to encapsulate contaminants, isolating them from the surrounding environment.

  Grout injection, as a standalone action, was rejected for the 200-CW-5 OU because of the size and depth of the waste sites and its unproven effectiveness on large-scale sites having radioactive and chemical hazards. However, the technology was retained for further evaluation at the 200-CW-5 OU (DOE/RL-2004-24, Draft A) and 200-CW-1 OU, 200-CW-3 OU, and 200 North Area waste sites FS (DOE/RL-2002-69, Draft A) as being potentially applicable to remedial alternatives to fill voids in pipelines, voids in cribs, and voids in tanks that will remain in place after contamination is removed. The technology may have similar utility on a case-by-case basis for equipment and/or waste packages at 200-SW-2 OU sites.

  This technology is also evaluated in INEEL/EXT-02-01258, *Preliminary Evaluation of Remedial Alternatives for the Subsurface Disposal Area*, and DOE 2004.

  In situ grouting is commonly used in construction and has been demonstrated at the Hanford Site to fill voids and pipelines. Design testing may be needed to confirm appropriate grout.

- **Special Studies (618-10/618-11 Burial Grounds)**

  The "In Situ TRU Delineation and Waste Removal of Radioactive Waste at Hanford 618-10 and 618-11 Burial Grounds" project is being funded by DOE-Headquarters to demonstrate technologies in support of remediation of the 618-10 and 618-11 Burial Grounds in the 600 Area. Beginning in FY 2005, three technologies are planned to be demonstrated in the 218-W-4A Burial Ground, 200-SW-2 OU, where a set of six vertical pipe units (VPU) similar to those found in the 618-10 and 618-11 Burial Grounds are located (Figure 2-27). These VPUs received 300 Area laboratory waste during the same time period that waste was being placed in the 618-11 Burial Ground. During the technology demonstration at the 218-W-4A Burial Ground, one or more contractor teams will apply the following technologies to a VPU to collect data supporting future deployment at the 618-10 and/or 618-11 Burial Grounds:

  1. Demonstrate characterization and delineation technologies that include geophysical methods, soil-gas sampling techniques, large area radiological survey measurements, and other radiological measurement techniques for neutron and gamma detection using a cone penetrometer subsurface delivery system
  2. Demonstrate technologies for the in situ location, identification, and vitrification of TRU waste materials. This includes demonstration of the planar in situ vitrification technique to melt a VPU, its contents, and the surrounding soils into a vitrified mass. Following cooling of the block, characterization of the melt will be performed as will sampling of the soils underneath the block
  3. Demonstrate technologies and approaches for in situ delineation and retrieval of a VPU, characterization of the soils below the VPU, and packaging and loading of the VPU in accordance with Hanford Site requirements. Retrieval of the VPU

will use an over-drilling technique to place a large-diameter drill casing over a VPU and extract the unit in a single mass from the ground. Once extracted, the VPU will be stored pending a final disposition decision.

A treatability test plan will be provided to the regulatory agencies for review before intrusive tests are conducted at the 218-W-4A Burial Ground. The tests will be conducted and documented by the 618-10 and 618-11 Burial Grounds project.

- **Dynamic Compaction**

Dynamic compaction is used to increase the soil density, compact the buried solid waste, and/or reduce void spaces by dropping a heavy weight onto the ground surface. The compaction process can reduce the hydraulic conductivity of subsurface soils and, correspondingly, the mobility of contaminants. Because the compactive energy attenuates with depth, dynamic compaction is limited to shallow applications typically less than 3 m (10 ft). This technology frequently is used to prepare a waste site for cap construction. Dynamic compaction also is carried forward in the 200-CW-1 OU, 200-CW-3 OU, and 200 North Area waste sites FS (DOE/RL-2002-69, Draft A).

The Idaho National Engineering and Environmental Laboratory has retained dynamic compaction as an alternative being evaluated in DOE/ID-11039, *Second Addendum to the Work Plan for the OU 7-13/14 Waste Area Group 7 Comprehensive Remedial Investigation/Feasibility Study*, as a means of pretreatment to mitigate subsidence.

Dynamic compaction is a well-developed technology that has been used at the Hanford Site to address subsidence.

- **Surface Barriers (Capping)**

Evapotranspiration barriers are considered to be an appropriate process option for the waste sites in the 200-CW-5 OU FS (DOE/RL-2004-24, Draft A), the 200-CW-1 OU, 200-CW-3 OU, and 200 North Area waste sites FS (DOE/RL-2002-69, Draft A), and the FFS for the 200-UW-1 OU (DOE/RL-2003-23, Draft B), based on the level of supporting documentation and Hanford Site-specific field data that demonstrate that these barriers perform well (DOE/RL-99-11; PNNL-13033, *Recharge Data Package for the Immobilized Low-Activity Waste 2001 Performance Assessment*). This process option forms the basis for evaluating capping alternatives at soil waste sites not contaminated with transuranic constituents.

The performance and design parameters for barriers would be determined during remedial design. Evapotranspiration barriers have been shown to be equivalent to or to exceed the performance of the standard RCRA Subtitle C barrier design and have been approved or planned for use in several western states as documented in DOE/RL-93-33, *Focused Feasibility Study of Engineered Barriers for Waste Management Units in the 200 Areas*.

The evapotranspiration barriers have been and continue to be evaluated within the DOE complex (Sandia National Laboratory, Los Alamos National Laboratory, Idaho National Engineering and Environmental Laboratory, Nevada Test Site, Hanford Site) and by the U.S. Environmental Protection Agency. The Alternative Cover Assessment Program, sponsored by the EPA, is evaluating a number of field-scale test covers throughout the United States. Results to date indicate that alternative barrier designs at semiarid and arid

sites generally exhibit little percolation (Albright et al., 2003, "Examining the Alternatives").

During the detailed analysis, each alternative will be evaluated against the following criteria:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost
- State acceptance.

One additional modifying criterion, community acceptance, will be applied following the FS at the proposed plan and ROD phase.

NEPA values also will be evaluated as part of the DOE's responsibility under this authority. These values include impacts to natural, cultural, and historical resources; socioeconomic aspects; and irreversible and irretrievable commitments of resources.

The RCRA closure performance standards (WAC 173-303-610[2]) also will be used to evaluate the ability of alternatives to comply with RCRA closure requirements. In addition, RCRA corrective action performance standards (WAC 173-303-646[2], "Corrective Action," "Requirements") will be used to evaluate alternative compliance with RCRA corrective action requirements.

The FS also will include supporting information needed to complete the detailed analysis and meet regulatory integration needs, including the following:

- Summarize the RI, including the nature and extent of contamination, the contaminant distribution models, and an assessment of the risks to help establish the need for remediation and to estimate the volume of contaminated media.
- Refine the conceptual exposure pathway model to identify pathways that may need to be addressed by remedial action.
- Quantify the dose to workers associated with various alternatives.
- Provide a detailed evaluation of ARARs, beginning with potential ARARs identified in the Implementation Plan (Section 4.0, DOE/RL-98-28).
- Refine potential RAOs and PRGs identified in the Implementation Plan (Chapter 5.0, DOE/RL-98-28) based on the results of the RI, ARAR evaluation, and current land-use considerations.
- Refine the list of remedial alternatives identified in the Implementation Plan (Appendix D, DOE/RL-98-28) and in this section, based on the RI.
- Provide corrective action recommendations for RPPs to fulfill the requirements for a CMS report.

- Include closure plan information, in accordance with WAC 173-303-610(3), "Closure Plan; Amendment of Plan," to address RCRA TSD units in the OUs. The information will incorporate, by reference, specific sections of the work plan or RI report containing specific closure plan information. The information will include closure performance standards, a closure strategy, general closure activities including verification sampling, and general post-closure information.

Additional RCRA integration guidance for preparing an FS/closure plan is provided in Section 2.4 of the Implementation Plan (DOE/RL-98-28).

## 5.4 PROPOSED PLAN AND PROPOSED RCRA PERMIT MODIFICATION

The decision-making process for the 200-SW-1 and 200-SW-2 OUs will be based on the use of a proposed plan, ROD, and modification to the *Hanford Facility RCRA Permit* (WA7890008967). The proposed plan also will include a draft permit modification with unit-specific permit conditions for RPPs and the RCRA TSD units for incorporation into the *Hanford Facility RCRA Permit.*

During the RI/FS process, a number of options for development of proposed plans and RODs will be evaluated. Remedial decisions may proceed on an OU-by-OU basis, but it also is likely that alternative site groupings will be considered for waste sites in the Central Plateau. Several alternatives currently are under consideration, some of which may be used for the waste sites addressed in this work plan.

Three alternatives to the OU-by-OU remediation approach have been identified to provide flexibility in the decision-making process, facilitate early action, and remediate and close specific areas or zones. Examples of these alternatives are presented below.

### 5.4.1 High-Risk Waste Sites Identified for Early Action

This alternative accelerates the start of remedial actions and closure of waste sites that present an ongoing or expected future threat to groundwater. Some high-risk sites already have been identified for early actions within the BC Controlled Area, and near U Plant, PUREX, and PFP. These sites will be included in a proposed plan and ROD that promotes early action. None of the waste sites from the 200-SW-1 and 200-SW-2 OUs have been identified as high-risk sites, and it is not anticipated that any findings from this RI/FS process will change their status in this regard.

### 5.4.2 Regional Site Closure

Waste site remedial decision making may be realigned under a regional closure strategy that aligns wastes sites into groups defined by geographical zones.

### 5.4.3 Waste Site Grouping by Characteristics or Hazards

A third example of remedial decision-making strategies would be based on a specific characteristic or hazard that mandates additional requirements, such as supplemental ARARs, or more robust remedial alternatives. Grouping waste sites with other similarly contaminated soil

sites in other OUs could streamline the decision-making process and tailor the requirements and alternatives to these specific hazards.

Following the completion of the FS/closure plan, a proposed plan will be prepared that identifies the preferred remedial alternative for the OUs (which will include RCRA closure and corrective action requirements). In addition to identifying the preferred alternative, the proposed plan will also serve the following purposes.

- Provide a summary of the completed RI/FS.
- Provide criteria by which analogous waste sites within the OUs not previously characterized will be evaluated after the ROD is issued to confirm that the contaminant distribution model for the site is consistent with the preferred alternative. Contingencies also will be developed to move a waste site to a more appropriate waste group.
- Identify performance standards and ARARs applicable to the OUs.

The proposed plan also will include a draft permit modification with unit-specific permit conditions for RPPs and the RCRA TSD units for incorporation into the *Hanford Facility RCRA Permit* (WA7890008967). After the public review process is complete, Ecology (as the lead regulatory agency), in concert with the DOE and EPA, will make a final decision on the remedial action to be taken, which is documented in a ROD. The *Hanford Facility RCRA Permit*, subsequently, will be modified by Ecology to incorporate the ROD (and subsequent amendments) by reference, authorizing the RCRA actions. If alternative decision-making strategies are employed, lead agency realignments may be considered in consultations between EPA and Ecology.

## 5.5 POST-RECORD OF DECISION ACTIVITIES

After the ROD and modification to the *Hanford Facility RCRA Permit* (WA7890008967) have been issued, a remedial design report (RDR) and remedial action work plan (RAWP) will be prepared to detail the scope of the remedial action (which will include RCRA closure and corrective action requirements). As part of this activity, DQOs will be established and SAPs will be prepared to direct confirmatory and verification sampling and analysis efforts. Before remediation begins, confirmation sampling will be performed to ensure that sufficient characterization data are available to confirm that the selected remedy is appropriate for all waste sites within the OUs, to collect data necessary for the remedial design, and to support final cumulative risk assessments for the 200 Area National Priorities List site. Verification sampling will be performed after the remedial action is complete to determine if ROD requirements have been met and if the remedy was protective of human health and the environment. Additional guidance for confirmatory and verification sampling is provided in Section 6.2 of the Implementation Plan (DOE/RL-98-28).

The RDR/RAWP will include an integrated schedule of remediation activities for the OUs, including the schedule for RCRA TSD unit closure, and will satisfy the requirements for an RPP corrective measures implementation work plan and corrective measures design report. The available options for remedy implementation throughout the 200 Area will be explored during the course of the RI/FS process and may be reflected in the RAWP. Following the completion of the remediation effort, closeout activities will be performed as specified in the ROD, RDR/RAWP, and the Permit.

The RCRA closure activities and schedules will be defined in the FS/closure plan and will be consistent with those identified in the RDR/RAWP. Enforceable sections of the FS/closure plan will be stated in the modification to the *Hanford Facility RCRA Permit* (WA7890008967). Certification of closure in accordance with WAC 173-303-610(6), "Certification of Closure," will be performed after completion of cleanup actions. The site will be restored as appropriate for future land use. If clean closure is not attained at a TSD unit, post-closure care requirements will be met. These requirements will include final status groundwater monitoring, maintenance and monitoring of institutional controls and/or surface barriers, and certification of post-closure at the completion of the post-closure period.

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# 6.0 PROJECT SCHEDULE

Figure 6-1 illustrates the overall schedule for the implementation of the work plan, SAP, and RI/FS for the 200-SW-1 and 200-SW-2 OUs.

The comprehensive strategy for the 200 Area radioactive landfills includes elements that will contribute to the RI and the remediation of the 200-SW-2 OU waste sites, but are not currently within the scope of the CERCLA RI/FS activities or integrated RCRA closure activities, included in this work plan. The following additional activities are related to characterization or remediation of solid waste burial grounds.

- As noted in Section 1.3, the 218-E-12B, 218-W-3A, 218-W-4B, and 218-W-4C Burial Grounds contain retrievably stored suspect TRU waste. The suspect TRU waste includes both CH suspect TRU waste and RH suspect TRU waste. The CH suspect TRU waste was stored in drums, boxes, and large containers; the RH suspect TRU waste was stored in drums, boxes, and caissons. Activities associated with this scope of work that will contribute to the remedial investigation of these burial grounds include:
- CH suspect TRU waste is being retrieved from four burial grounds in the LLBG TSD unit in accordance with Tri-Party Agreement Interim Milestone M-91-40, Requirement 1.
- As retrieval of CH suspect TRU waste proceeds, trench substrates will be sampled and analyzed in accordance with Tri-Party Agreement Interim Milestone M-91-40, Requirement 2. The purpose of the sampling is to evaluate whether contaminants have been released to the environment and, if so, the nature and extent of the contamination. A separate DQO report and SAP will be developed for substrate sampling at each of the four burial grounds.
- RH suspect TRU waste will be retrieved from four burial grounds in accordance with Tri-Party Agreement Interim Milestone M-91-41, Requirement 1.

DOE-Headquarters has funded demonstrations of technologies for in situ characterization and remediation of TRU wastes to support remediation of the 618-10 and 618-11 Burial Grounds in the 600 Area. Before deployment in the 618-10 and 618-11 Burial Ground waste sites, selected technologies will be demonstrated at the 218-W-4A Burial Ground in FY 2005. Implementation of these technologies in the 218-W-4A Burial Ground is expected to result in characterization and/or remediation of selected structures in the burial ground (e.g., vertical pipe units). Perhaps more importantly, lessons learned from the demonstration and implementation of these technologies will provide input to selection and use of characterization and remediation technologies in the 200-SW-2 OU waste sites.

The RI for the 200-PW-1 OU in the 200 West Area includes characterization of the dispersed carbon tetrachloride vadose zone plume, which extends beyond the known 200-PW-1 OU waste site boundaries (DOE/RL-2001-01, *Plutonium/Organic-Rich Process Condensate/Process Waste Group Operable Unit RI/FS Work Plan: Includes the 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units*). The investigation is being conducted in two steps. The Step I investigation (completed) focused on the shallow vadose zone overlying the highest concentration portion of the carbon tetrachloride groundwater plume. The Step II investigation includes the vadose zone overlying the entire carbon tetrachloride groundwater plume. The Step I DQO process identified

seven potential modes by which carbon tetrachloride could be released to the vadose zone. One of these modes was releases from materials in burial grounds.

During Step I, soil-gas sampling was conducted in the shallow vadose zone in the 218-W-4C Burial Ground (Section 3.1.4.6). During Step II, soil-gas sampling will be conducted in the deeper vadose zone in the 218-W-4C Burial Ground. Soil-gas sampling also is planned for the 218-W-3A Burial Ground.

The anticipated schedule for these additional activities, which is provided for reference only, is shown on Figure 6-2.

Figure 6-1. Project Schedule for the Consolidated 200-SW-1 and 200-SW-2 Operable Units RI/FS Process. (2 Pages)

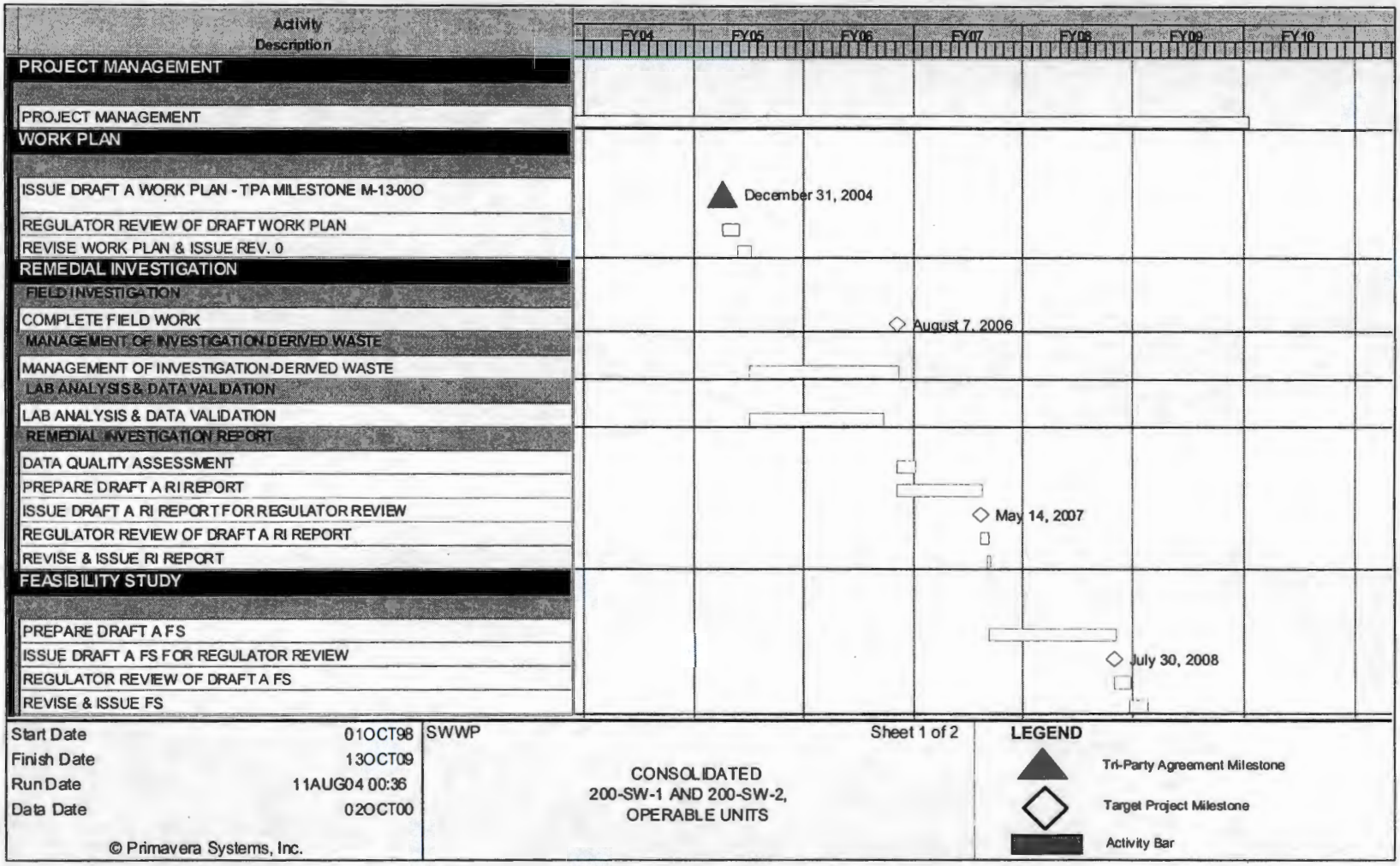


Figure 6-1. Project Schedule for the Consolidated 200-SW-1 and 200-SW-2 Operable Units RI/FS Process. (2 Pages)

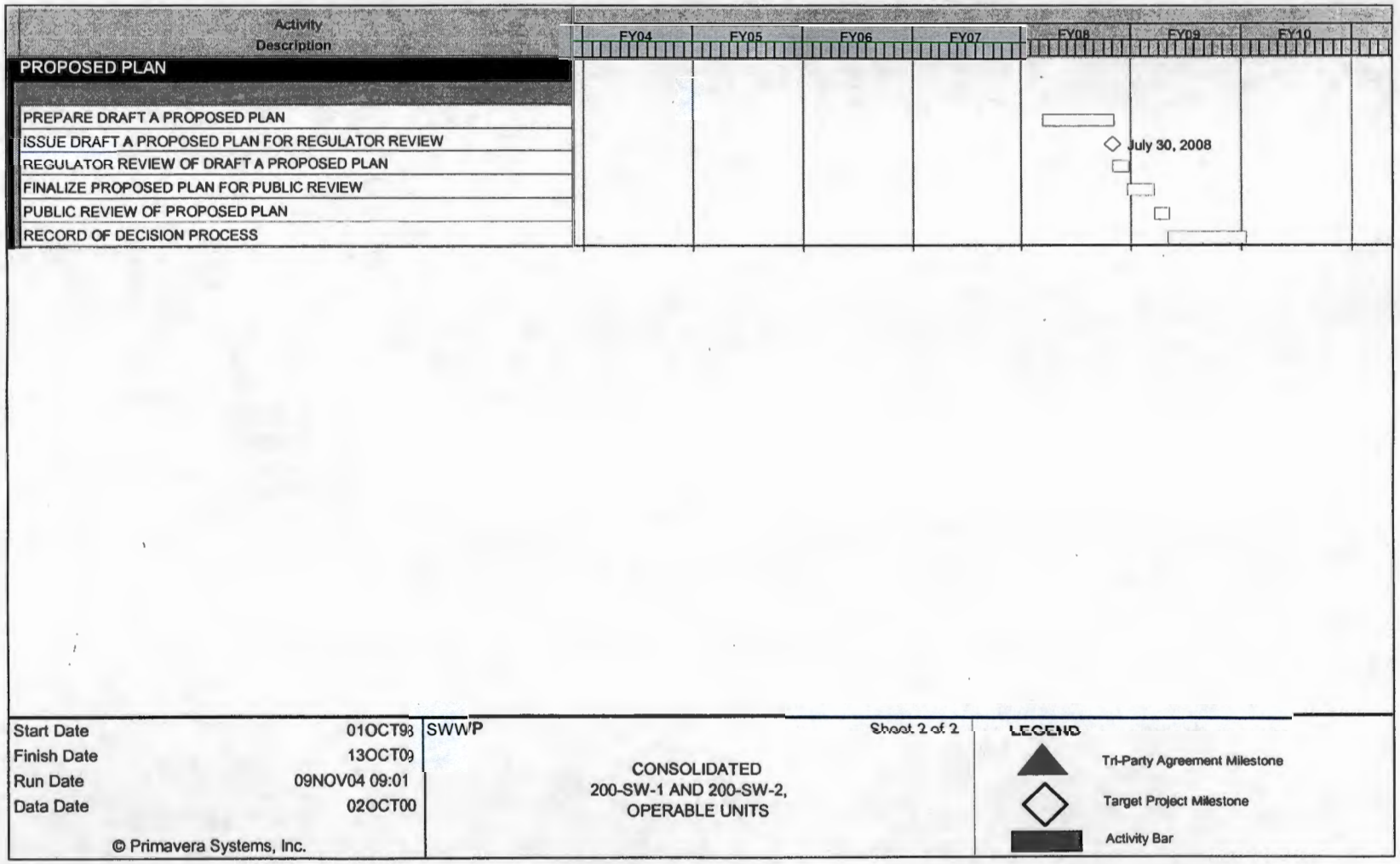
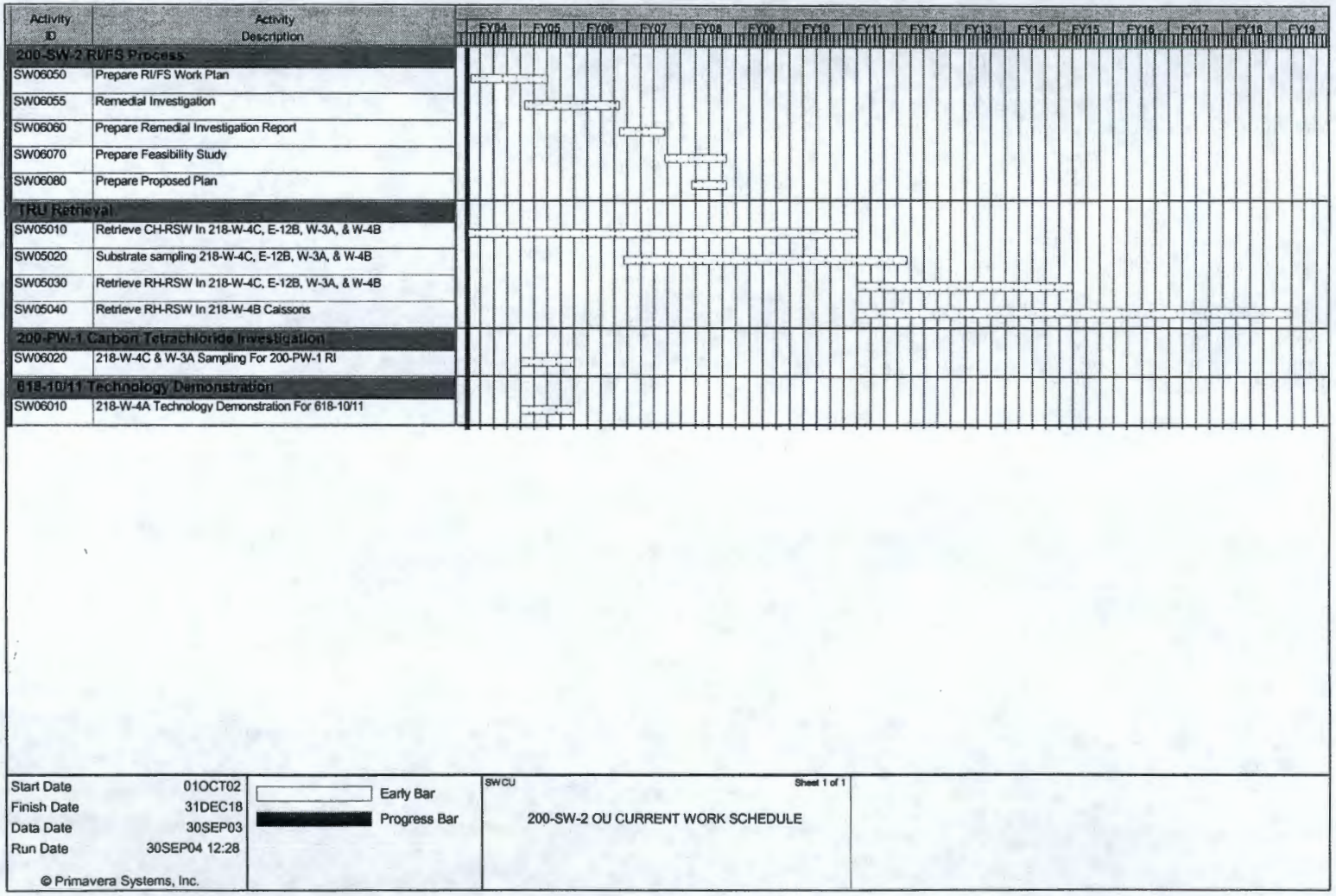


Figure 6-2. Schedule for Related Activities at the 200-SW-1 and 200-SW-2 Operable Units.



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# APPENDIX A

# SAMPLING AND ANALYSIS PLAN TO SUPPORT THE 200-SW-1 NONRADIOACTIVE LANDFILLS AND DUMPS GROUP OPERABLE UNIT AND 200-SW-2 RADIOACTIVE LANDFILLS AND DUMPS GROUP OPERABLE UNIT REMEDIAL INVESTIGATION/FEASIBILITY STUDY

# CONCURRENCE PAGE

**Title:** *Sampling and Analysis Plan to Support the 200-SW-1 Nonradioactive Landfills and Dumps Group Operable Unit and 200-SW-2 Radioactive Landfills and Dumps Group Operable Unit Remedial Investigation/Feasibility Study*

| | |
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| _____ DOE-RL Manager | _____ Date |
| _____, Unit Manager<br>Washington State Department of Ecology | _____ Date |
| _____, Director<br>Fluor Hanford Groundwater Remediation Project | _____ Date |
| _____, Manager<br>Fluor Hanford Groundwater Remediation Engineering | _____ Date |
| _____, Manager<br>Fluor Hanford Waste Site Remedial Actions | _____ Date |
| _____, Manager<br>Fluor Hanford Operations Management | _____ Date |
| _____, Manager<br>Fluor Hanford Environmental/Science Assurance | _____ Date |
| _____, QA Engineer<br>Fluor Hanford Groundwater Remediation Project | _____ Date |
| _____, Environmental Compliance<br>Fluor Hanford Groundwater Remediation Project | _____ Date |

(NOTE: To be completed following regulatory review and during incorporation of regulatory comments into Rev. 0 of the sampling and analysis plan.)

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## TERMS

| | |
|---|---|
| 600 CL | 600 Area Central Landfill (Solid Waste Landfill) |
| 600 OCL | 600 Area Original Central Landfill |
| AEA | alpha energy analysis |
| ALARA | as low as reasonably achievable |
| bgs | below ground surface |
| CERCLA | *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* |
| CL | Central Landfill |
| CLARC | *Cleanup Levels and Risk Calculations under the Model Toxics Control Act Regulation* (CLARC Version 3.1) (Ecology 94-145) |
| COC | contaminant of concern |
| COPC | contaminant of potential concern |
| CV | cold vapor |
| DL | detection limit |
| DOE | U.S. Department of Energy |
| DQO | data quality objective |
| DR | decision rule |
| DS | decision statement |
| Ecology | Washington State Department of Ecology |
| EPA | U.S. Environmental Protection Agency |
| FS | feasibility study |
| GeLi | germanium-lithium |
| GRP | Groundwater Remediation Project |
| GW | groundwater |
| HEIS | *Hanford Environmental Information System* |
| HPGe | high-purity germanium |
| IC | ion chromatography |
| ICP | inductively coupled plasma |
| LARADS | Laser-Assisted Ranging and Data System |
| LLBG | low-level burial ground |
| LLW | low-level waste |
| MW | mixed waste |
| N/A | not applicable |
| NaI | sodium iodide |
| NEPA | *National Environmental Policy Act of 1969* |
| NEPA solid waste ROD | 69 FR 39449 |
| NRDWL | Nonradioactive Dangerous Waste Landfill |
| OCSA | Old Central Shop Area |
| OSWER | Office of Solid Waste and Emergency Response |
| OU | operable unit |
| PCB | polychlorinated biphenyl |
| PRG | preliminary remediation goal |
| QA | quality assurance |
| QAPjP | quality assurance project plan |

| | |
|---|---|
| QC | quality control |
| RCRA | *Resource Conservation and Recovery Act of 1976* |
| REDOX | Reduction-Oxidation |
| RESRAD | RESidual RADioactivity (dose model) (ANL 2002) |
| RI | remedial investigation |
| ROD | record of decision |
| RR | railroad |
| RTD | remove/treat/dispose |
| SAP | sampling and analysis plan |
| solid waste EIS | *Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement, Richland, Washington* (DOE/EIS-0286F) |
| SVOA | semivolatile organic analyte |
| TBD | to be determined |
| TLD | thermoluminescent dosimeter |
| Tri-Party Agreement | *Hanford Federal Facility Agreement and Consent Order* |
| TRU | transuranic (waste materials contaminated with more than 100 nCi/g of transuranic materials having half-lives longer than 20 years) |
| TSD | treatment, storage, and/or disposal (unit) |
| UCL | upper confidence limit |
| USG | unsegregated (waste type) |
| VOA | volatile organic analyte |
| VOC | volatile organic compound |
| WAC | *Washington Administrative Code* |
| WIDS | *Waste Information Data System* |
| XRF | X-ray fluorescence |

# APPENDIX A

# SAMPLING AND ANALYSIS PLAN

## A1.0 INTRODUCTION

The activities described in this sampling and analysis plan (SAP) are to support the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) remedial investigation (RI) of the 200-SW-1 Nonradioactive Landfills and Dumps Operable Unit (200-SW-1 OU) and the 200-SW-2 Radioactive Landfills and Dumps Operable Unit (200-SW-2 OU). The purpose of the sampling and analysis activities described in the SAP is to provide data to refine the preliminary conceptual contaminant distribution models, support an assessment of risk, and evaluate remedial alternatives for the waste sites in the OUs. Characterization activities described in this plan are based on the implementation of the data quality objective (DQO) process as documented in WMP-22210, *Remedial Investigation Data Quality Objectives Summary Report for the 200-SW-1 and 200-SW-2 Operable Unit Waste Sites.*

This chapter provides general background information about the OUs, contaminants of concern (COC), and potential preliminary remediation goals (PRG), and a summary of DQOs identified for the waste sites. Subsequent chapters of this SAP present the quality assurance project plan (QAPjP), the field-sampling plan, and the health and safety and waste management requirements.

## A1.1 BACKGROUND

Seventy-seven sites within the consolidated 200-SW-1 and 200-SW-2 OUs, located mainly within the Central Plateau Core Zone in the Hanford Site's 200 East and 200 West Areas, will be investigated as part of this CERCLA action (Table A-1). The 200-SW-1 OU includes 41 solid waste sites that received, for example, power plant ash, construction debris, burned materials, and miscellaneous nonradioactive waste; the 200-SW-1 OU sites were not intentionally used for the disposal of radioactive wastes. The 200-SW-1 OU also includes the inactive Central Landfill complex, which is composed of the Nonradioactive Dangerous Waste Landfill (NRDWL) and the Solid Waste Landfill (600 CL). The 200-SW-2 OU includes 36 solid waste sites that received radioactive and/or mixed (radioactive and chemical) wastes. The major constructed/excavated burial grounds ("218" prefix burial grounds) consist of multiple individual trenches that received dry contaminated equipment, solid laboratory waste, clothing, and tightly packed/sealed liquid wastes in radiological vessels. Before 1970, low-level wastes (LLW), including LLW with transuranic (TRU) constituents, were disposed of in common burial trenches. Post-1970 wastes were segregated according to their LLW or TRU[1] designation. At some post-1970 sites, wastes with significant inventories of TRU were placed into underground concrete caissons. Because of the various disposal options (e.g., cribs, trenches,

[1]Waste materials contaminated with more than 100 nCi/g of transuranic materials having half-lives longer than 20 years.

ponds) available for bulk liquids, it is believed that the burial grounds were not used for bulk disposal of liquids. Some 200-SW-2 sites are known to have received limited amounts of packaged liquid wastes. The majority of waste disposed to the burial grounds originated from processes in the 200 East and 200 West Areas of the Hanford Site. The burial grounds also contain wastes that were received from the 100 and 300 Areas of the Hanford Site, as well as waste received from offsite sources.

There are two *Resource Conservation and Recovery Act of 1976* (RCRA) treatment, storage, and/or disposal (TSD) units within these OUs. The low-level burial ground (LLBG) TSD contains eight burial grounds within its boundaries. The 218-W-6 Burial Ground was reserved for future use and never has received waste. The remaining seven burial grounds, 218-W-3A, 218-W-3AE, 218-W-4B, 218-W-4C, 218-W-5, 218-E-12B, and 218-E-10, were used for radioactive solid waste disposal. The second TSD unit, the NRDWL, was used for nonradioactive waste disposal.

Aside from designated burial grounds, the remaining sites within the 200-SW-2 OU consist of historical disposal sites and unplanned releases. The unplanned releases generally consist of small volume spills to the ground surface, disseminated radioactive particulates, and/or facility materials.

Because of the wide variety of waste sites in the 200-SW-1 and 200-SW-2 OUs, the initial scoping for this project included an assessment of the possible remedial approaches that could be applied to the different waste site configurations. Based on conceptual models developed during the DQO process, the waste sites were sorted into categories/bins to align the waste sites with the anticipated, appropriate remedial paths. The remedial approaches identified for the 200-SW-1 and 200-SW-2 OU waste sites include the following:

- Bin 1 – The anticipated remedial alternatives for Bin 1 sites are no action or maintain existing soil cover while allowing for monitored natural attenuation. Most (17) of the 20 sites in this bin are nonradioactive (i.e., in the 200-SW-1 OU). The sites are predominantly burn pits, ash disposal sites, and locations of random contamination from miscellaneous site activities. The sites likely are minimally contaminated; however, any contamination that is present is believed to be lower than action levels and will not require remediation. The records are sufficiently ambiguous that the contamination status must be confirmed. The objective of sampling is to determine whether the sites require remediation. The characterization approach will include screening of sites with survey techniques to establish locations for samples. Sample results will be used to establish a basis for no action, to maintain existing soil cover and allow monitored natural attenuation, or to reassign a site to Bin 2.

- Bin 2 – The anticipated remedial alternative for Bin 2 sites is removal, treatment, and disposal using the observational approach during site remediation as a streamlining strategy for characterization. Two-thirds (20) of these 30 sites are nonradioactive (i.e., in the 200-SW-1 OU). All of the sites in Bin 2 are anticipated to contain some amount of contaminated material that will require removal. Most of the sites consist of material disposed to the surface and should not present significant challenges to remediation. In

many cases, the cost associated with removal of the waste may be less than the cost of characterization.

These sites generally are suited to a remove/treat/dispose (RTD) approach with the application of standard remediation techniques that would be applied to a commercial waste disposal site. This bin contains several sites that may need to be treated on a special-case basis because they have different characteristics than the majority of Bin 2 sites. These sites are the three laboratory vaults (218-E-7, 218-W-7, and 218-W-8), the burial grounds at 218-E-2 and 218-E-4, and the 600 Area Original Central Landfill (600 OCL). The project will apply lessons learned from the remediation of other, similar sites at the Hanford Site when developing the RTD approach for these sites.

- Bin 3 – All but 2 of the 24 sites in this bin are radioactive (i.e., in the 200-SW-2 OU). Bin 3 includes most of the 200 Areas solid waste burial grounds, which typically contain multiple engineered trenches. This bin includes the LLBG and NRDWL TSD units, as well as older (pre-1960) burial trenches and burial grounds whose inventories and burial practices are not as well documented as those for newer burial grounds. The TSD units are placed in sub-Bin 3A. The LLBG and NRDWL TSD units are slated to be closed with caps. The closure pathway for the LLBG sites was established through the record of decision for the Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement (69 FR 39449, "Record of Decision for the Solid Waste Program, Hanford Site, Richland WA; Storage and Treatment of Low-Level Waste and Mixed Low-Level Waste; Disposal of Low-Level Waste and Mixed Low-Level Waste, and Storage, Processing, and Certification of Transuranic Waste for Shipment to the Waste Isolation Pilot Plant"; and DOE/EIS-0286F, *Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement, Richland, Washington*). DOE/RL-90-17, *Nonradioactive Dangerous Waste Landfill Closure/Postclosure Plan*, documented capping as the closure pathway for the NRDWL; however, there has been no final resolution of deficiencies identified in this closure plan. The 600 CL also is contained in Bin 3A because of its proximity to the NRDWL and the assumption that the two sites will be remediated as one. The two TSD units will be characterized for the parameters required to support cap design and to determine whether site conditions may require interim remedial measures before the cap is placed.

  The remaining sites are candidates for the RI/feasibility study (FS) process, and have been placed in sub-Bin 3B. An unplanned release site, UPR-200-E-95, also has been placed in the Bin 3B category because of its proximity to burial grounds, and due to the assumption that it will be remediated along with the burial grounds. These sites will be characterized to generate the data required to evaluate various remedial alternatives.

The binning provides the basis for decision-making activities; sites within each bin are identified in Table A-1. This SAP specifies the field characterization techniques for each bin, including the following:

- Sampling and analyses required to establish site conditions for Bin 1 sites
- Supporting the observational approach for Bin 2 sites

- Data collection specifications for sites that will be assessed as part of the RI/FS process for Bin 3.

## A1.2 200-SW-1 AND 200-SW-2 OPERABLE UNIT WASTE SITE LOCATIONS

The 200-SW-1 and 200-SW-2 OU waste sites are located in south-central Washington State within and adjacent to the Hanford Site's 200 Areas. Most of the sites are located within the Central Plateau Core Zone. Figure A-1 is a map of the Hanford Site that shows the location of the 200 Areas and indicates the additional detailed map coverage for the 200-SW-1 and 200-SW-2 OU waste sites (Plates 1 through 3 are included in Appendix C, in pocket). Plate 1 shows the 200 Areas, the location of the Core Zone, and the 200-SW-1 and 200-SW-2 OU waste site locations outside the 200 Areas and the Core Zone. Plate 2 shows the 200-SW-1 and 200-SW-2 OU waste site locations that are part of the 200 West Area. Plate 3 identifies the 200-SW-1 and 200-SW-2 OU waste sites located within the 200 East Area. Section 2.2 of the Work Plan and Appendix B provide descriptive information regarding each waste site.

## A1.3 CONTAMINANTS OF CONCERN

Step 1 of the DQO process identifies the need to develop a list of COCs for the 200-SW-1 and 200-SW-2 OU waste sites. Development of the list of COCs is an essential step toward refining the conceptual site models. For the 200-SW-1 and 200-SW-2 OU waste sites, a list of the potential radioactive, organic, and inorganic COCs that were, or could have been, placed in the waste sites was compiled. The compilation was based on the following DQO documents for the 200 Areas OUs and those COCs identified in DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program*) (Implementation Plan).

| | | | |
|---|---|---|---|
| 200-CW-1 | BHI-01239 | *200-CW-1 Gable/B-Pond and Ditches Cooling Water Waste Group Remedial Investigation DQO Summary Report* | 1999 |
| 200-CS-1 | CP-13196, Draft A | *Data Quality Objectives Summary Report for Designation of the 200-CS-1 Investigation Derived Wastes* | 2001 |
| 200-CW-5 | BHI-01591 | *Data Quality Objectives Summary Report for Designation of the 200-CW-5 Investigation Derived Wastes* | 2002 |
| 200-LW-1 and LW-2 | WMP-18098 | *Data Quality Objectives Summary Report for the Designation of the 200-LW-1 and 200-LW-2 Operable Unit Investigation-Derived Wastes*, 2003 | 2003 |
| 200-MW-1 | WMP-20380 | *Data Quality Objectives Summary Report for the Designation of the 200-MW-1 Operable Unit Investigation-Derived Wastes* | 2004 |
| 200-PW-1 | BHI-01608 | *Data Quality Objectives Summary Report for Designation of 200-PW-1 Investigation-Derived Wastes* | 2002 |
| 200-PW-2 and PW-4 | CP-14682 | *Data Quality Objectives Summary Report for the Designation of the 200-PW-2 and 200-PW-4 Investigation-Derived Wastes* | 2003 |
| 200-TW-1 and TW-2 | BHI-01492 | *Data Quality Objectives Summary Report for 200-TW-1 and 200-TW-2 Waste Designation* | 2001 |

The logic for the inclusion and exclusion of specific COCs is included in the DQO reports that support the activities at those OUs and will not be repeated in this document. In general, the majority of the waste disposed to the 200-SW-1 and 200-SW-2 OU waste sites consisted of solid wastes in the form of construction and building debris, maintenance wastes, process equipment, materials and wastes, and limited amounts of liquid wastes, generally stabilized.

Table A-2 lists the COCs for the 200-SW-1 and 200-SW-2 OUs that were identified through the DQO process.

### A1.3.1 Direct Exposure Preliminary Remediation Goals

The contaminants in the 200-SW-1 and 200-SW-2 OUs are expected to be located within 4.6 to 10 m (15 to 33 ft) of the ground surface or at or near the bottom of the disposal unit and are not anticipated to pose a threat to groundwater. The exception to this preliminary contaminant distribution model is the 600 CL, which received liquid sewage and other bulk liquid wastes until 1987 and may have leached contaminants to groundwater.

#### A1.3.1.1 Chemical Constituent Preliminary Remediation Goals

Soil screening levels for direct exposure for nonradionuclides based on human health risk were obtained from Washington State Department of Ecology (Ecology) 94-145, *Cleanup Levels and Risk Calculations under the Model Toxics Control Act Cleanup Regulation; CLARC, Version 3.1*, for nonradioactive analytes regulated under WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties," and WAC 173-340-747, "Deriving Soil Concentrations for Ground Water Protection." To support the potential evaluation of other exposure scenarios for sites outside the core zone, WAC 173-340-740, "Unrestricted Land Use Soil Cleanup Standards," screening levels were identified to ensure that appropriate detection limits were established. Screening levels pertaining to soil for protection of groundwater were developed based on the WAC 173-340-747(4), "Fixed Parameter Three-Phase Partitioning Model," fixed-parameter (default values) variant of the three-phase equilibrium model. Soil-screening levels for protection of ecological receptors for nonradionuclides were obtained from Table 749-3 in WAC 173-340-900, "Tables."

#### A1.3.1.2 Radionuclide Constituent Preliminary Remediation Goals

For radioactive constituents, EPA 1997, *Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination*, OSWER Directive 9200.4-18, limits radiation doses from contaminated sites to 15 mrem/yr above natural background for 1,000 yr following the completion of cleanup. To determine if a site meets the 15 mrem/yr above background level, soil radionuclide concentrations (picocurie/gram) must be converted to a dose rate (millirem/year) using a dose assessment model. Screening levels for direct exposure to radionuclides were developed using RESidual RADioactivity (RESRAD) modeling for radionuclides (ANL 2002, *RESRAD for Windows*, Version 6.21).

Table A-3 identifies the approach that will be used to establish the PRGs to support determination of detection limits.

## A1.4 DATA QUALITY OBJECTIVES

EPA/600/R-96/055, *Guidance for the Data Quality Objectives Process*, was used to support the development of this SAP. The DQO process is a strategic planning approach that provides a systematic method for defining the criteria that a data collection design should satisfy. Using the DQO process ensures that the type, quantity, and quality of environmental data used in decision making will be appropriate for the intended application.

This section summarizes the key outputs resulting from the implementation of the seven-step DQO process. Additional details are provided in WMP-22210.

### A1.4.1 Statement of the Problem

Because of the wide variety of waste sites in the 200-SW-1 and 200-SW-2 OUs, the initial scoping for the DQO process included evaluating the conceptual site models for possible remedial approaches that could be applied to the different waste site configurations. The problem was described as determining appropriate remediation pathways for the 200-SW-1 and 200-SW-2 OU waste sites. The waste sites were divided into three bins, Bin 1 (potentially no remediation necessary), Bin 2 (candidate for waste to be RTD with observational approach for characterization), and Bin 3 (candidate for full RI/FS process). The goals were to efficiently confirm no further action for minor waste sites (Bin 1), efficiently clean up moderately complex waste sites where waste geometry and site characteristics lend themselves to RTD (Bin 2), and establish the most appropriate method to address potentially high-dose radioactive waste within the large burial grounds (Bin 3B). The remedial path for the LLBG TSD sites within Bin 3A was established in 69 FR 39449. The NRDWL TSD site in Bin 3A also has been identified as a candidate for closure with a cover (DOE/RL-90-17). Supplemental data to support closure with an engineered barrier will be collected in accordance with this SAP. Data are required to support analyses of the proposed remedial strategies.

The conceptual models described Bin 1 sites as containing few or no regulated constituents, with no impact to groundwater, ecosystems, or human health. Bin 2 sites were described as containing waste that is limited in areal extent, whose nature is fairly well described, and which do not pose undue personnel risk to remediate. The waste in Bin 2 sites is primarily dry waste; most of it is expected to contain only low levels of contamination, shallowly buried in a dry landscape. Contamination is very unlikely to have spread into the vadose zone below the waste sites. Bin 3 sites were described as containing waste buried in large (1 to 475 acre) sites, some of which pre-date RCRA regulations and whose contents are not as well defined. Some are covered under WA7890008967, *Hanford Facility RCRA Permit* (Bin 3A) and are slated to be closed with an engineered barrier (cap); others require additional characterization to establish the most appropriate remedial options (Bin 3B). Some of the sites contain large inventories of plutonium (1 to 400 kg) and uranium (100 to 400,000 kg), and/or dangerous/hazardous wastes. Because the waste is dry and is buried in shallow trenches in a dry landscape, and the sites did not receive bulk liquids, it is unlikely that contamination has spread into the vadose zone. It is likely that some of the buried waste containers have been breached and potentially have contaminated surrounding soil.

The binning described above provided the basis for the DQO decision-making activities. The sampling design developed through the DQO process specified the field characterization techniques for each bin, including sampling and analyses required to establish site conditions for Bin 1 sites, to support the RTD for Bin 2 sites, as well as data collection specifications for sites that will be assessed as part of the RI/FS process for Bin 3B.

Ecology 94-49, *Guidance on Sampling and Data Analysis Methods*, was considered during the DQO process to support the selection of appropriate sampling methods. This guidance indicates that a focused sampling approach may be used to investigate a site that is known to be contaminated, and the contaminated regions may be identified for sampling and analysis.

### A1.4.2 Decision Rules

Decision rules (DR) are developed from the combined results of DQO Steps 2, 3, and 4. These results include the principal study questions, decision statements, remedial action alternatives, data needs, COC action levels, analytical requirements, and the scale of the decisions. The DRs generally are structured as "IF…THEN" statements that indicate what action will be taken when a prescribed condition is met. The DRs incorporate the parameters of interest (e.g., COCs), the scale of the decision (e.g., location), the action level (e.g., COC concentration), and the actions that would result. The 200-SW-1 and 200-SW-2 OU DRs are summarized in Table A-4. Potential PRGs for radionuclides and for chemical constituents specified in the DRs, which will be used for verification sampling, are provided in Tables A-5 and A-6, respectively.

### A1.4.3 Error Tolerance and Decision Consequences

In general, two types of decision errors are associated with the decisions for this project. The first type of decision error involves mistakenly concluding that the site is "clean" (i.e., mistakenly concluding that cleanup thresholds are met). The second type of decision error involves mistakenly concluding that the site is not clean (i.e., mistakenly concluding that one or more of the thresholds are not met). To mitigate the potential consequences of these decision errors, the tolerable decision errors to be used for this project are shown in Table A-7.

The 95 percent upper confidence limit corresponds to a 5 percent tolerable error rate for mistakenly concluding that the action level is not exceeded and forms the basis for no-action decisions. The tolerable error rate for mistakenly concluding that the action level is exceeded (and the site requires remedial action) was set at 20 percent. These decision errors are based on the DQO decision errors most commonly accepted at the Hanford Site.

### A1.4.4 Sample Design Summary

As part of the characterization process, radioactive and chemical contamination screening and surveys will be conducted to support the following data needs.

- Determine the current extent, magnitude, and variability (as surface and depth profiles) of the contamination.
- Provide information on the radioactive and chemical contaminant distributions and concentrations.
- Identify hard-to-detect radionuclides.
- Develop surrogate ratios.
- Assign the sigma, characterizing the variability of the contamination, when determining the number of samples needed.

Radioactive contamination screening may include field measurements and sample collection with laboratory analysis to identify the specific radionuclides that are present and their radiation characteristics. Examples of field methods include gamma measurements with sodium iodide detectors, gross alpha measurements with field instrumentation (portable alpha monitor), gross beta/gamma field instrumentation, and other passive gamma measurements (e.g., thermoluminescent dosimeter [TLD] readings).

The following sections provide an overview of the sampling approach for the 200-SW-1 and 200-SW-2 OU sites. Details of field sampling are provided in Chapter A3.0.

#### A1.4.4.1 Bin 1 Sampling Approach

The Bin 1 sites are generally believed to be not or only minimally contaminated; however, the records are sufficiently ambiguous that the contamination status must be confirmed. Any contamination that is present should be at or near the surface. The characterization objective for Bin 1 will be to verify that the sites do not require any remedial activity.

A walk down of each site will be conducted to observe and record the presence of waste materials and any significant site conditions. Records will be reassessed to determine whether significant changes have occurred such that the initial sampling approach should be modified. Bin 1 sites will be screened for radioactive contamination using surface-based survey techniques. If the walk down and pre-sampling reviews for an individual site indicate that organic constituents potentially have been disposed of, a systematic passive soil-gas survey will be used. Individual waste sites within this bin may require additional screening, using techniques such as X-ray fluorescence (XRF) for metals, test pits, or direct push technologies.

If the results from the previous steps show that chemical contamination is present above detection levels or that radioactive contamination is present above background levels, targeted sampling may be needed to define the extent of the soil contamination at these sites. Sites that

are potentially contaminated will be considered candidates for the RTD approach and reassigned as Bin 2 sites.

If contamination is below detection or background levels, variance estimated from the field-screening measurements will be used to develop a statistically based sampling program with samples submitted for laboratory analysis. The results will be applied to confirm site conditions. Samples taken during this process also will be evaluated at the 0 to 0.3 m (0 to 1 ft) depth to support an ecological risk evaluation. If the results of the characterization do not indicate the presence of contamination above PRGs, the site will be proposed for "No Further Action" under CERCLA.

#### A1.4.4.2 Bin 2 Sampling Approach

Most of the waste sites in Bin 2 are presumed to be contaminated. The sampling approach is intended to confirm the presence and location of contamination before initiating the RTD process.

A walk down of each site will be conducted to observe and record the presence of waste materials and any significant site conditions. Records will be reassessed to determine whether significant changes have occurred such that the initial sampling approach should be modified. This review also will consider the results from other Hanford Site remedial activities at analogous waste sites (e.g., 118 and 618 Burial Grounds) to determine whether approaches used at those locations can be applied to the Bin 2 sites (e.g., 600 OCL). Based on this review, if site characteristics or contamination appear more complex than initially assumed, it may be appropriate to reassign some of the Bin 2 sites to Bin 3 in order to conduct a more extensive evaluation of site conditions or alternative approaches before entering into an RTD process for specific sites.

The presence of contamination will be confirmed with field-screening methods. Field screening methods for radioactive contamination will be used to establish the boundaries of contamination (area and depth) and provide data to support an as low as reasonably achievable (ALARA) evaluation for subsequent RTD work. Field-screening methods also will be used to determine if chemical contamination is present above detection levels, using the same approach as described for the Bin 1 sites. The data will be used to identify the extent of contamination and to identify health and safety concerns.

If contamination is below the detection or background levels, variance estimated from the field-screening measurements will be used to develop a statistically-based sampling approach. Samples will be submitted for laboratory analysis, which in turn will be applied to verify the site conditions. Samples taken during this process also will be evaluated at the 0 to 0.3 m (0 to 1 ft) depth to support an ecological risk evaluation. If characterization does not indicate the presence of contamination above PRGs, the site will be proposed for "No Further Action" under CERCLA.

If laboratory samples indicate contamination is present above PRGs, a cost-benefit analysis will be conducted during the FS process before recommending an RTD pathway.

### A1.4.4.3 Bin 3 Sampling Approach

#### A1.4.4.3.1 Bin 3A Approach

As noted previously, the Bin 3A sites are TSD units regulated under the site RCRA program. Waste disposal is managed and the sites are environmentally monitored. The NEPA solid waste ROD determined that the LLBG TSD sites would be placed under an engineered cover (69 FR 39449). A closure plan also has been submitted for the NRDWL, which indicates that a cap is to be constructed over that site. Although this closure plan has not been finalized, closure with a cap would be consistent with *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989) (Tri-Party Agreement) Section 5.3 and WAC 173-303-665(6), "Dangerous Waste Regulations," "Landfills," "Closure and Post-Closure Care," which require a cover over landfills. Available monitoring information, site characterization studies, and waste inventory records adequately address radioactive and inorganic constituents in the LLBG sites. Passive soil-gas surveys will be performed to obtain data regarding the presence of volatile organics in the LLBG sites. Results from the soil-gas surveys will be evaluated to determine the need for collection of soil samples to establish the nature and extent of any contamination that may be present. Samples will be evaluated to determine whether site conditions require the implementation of interim measures before a cap is placed. Soil-gas surveys previously have been conducted at the NRDWL site (BHI-01115, *Evaluation of the Soil-Gas Survey at the Nonradioactive Dangerous Waste Landfill*).

#### A1.4.4.3.2 Bin 3B Approach

Bin 3B sites include industrial and dry waste burial grounds, most of which operated for many years with little or no records of waste disposal practices or inventory to allow any form of detailed determinations of waste type, dose, or volume within specific trenches. At the industrial burial grounds, which received large pieces of failed or obsolete equipment, geophysical surveys and radioactive contamination surveys will be used to identify anomalies for further screening and confirmational sampling. At each of the dry waste burial grounds, which received all types of miscellaneous wastes, discrete trenches containing wastes that represent disposal activities at each burial ground were selected for characterization. At each of these selected trenches, geophysical and radioactive contamination surveys will guide the selection of locations for further field screening and targeted soil sampling.

Results from the characterization of Bin 3A and 3B sites will be used in the FS, including the development of cost and ALARA models.

# A2.0 QUALITY ASSURANCE PROJECT PLAN

The QAPjP establishes the quality requirements for environmental data collection, including sampling, field measurements, and laboratory analysis. The overall QAPjP for environmental restoration waste sites in the 200 Areas is included in Appendix A of the Implementation Plan (DOE/RL-98-28). The QAPjP complies with the requirements of the following guidance materials:

- DOE O 414.1A, *Quality Assurance*
- 10 CFR 830.120, "Quality Assurance Requirements"
- EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans*
- DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Documents.*

The Implementation Plan provides the general framework of technical and administrative requirements that apply to the 200-SW-1, 200-SW-2, and other OUs in the 200 Areas.

The following sections describe the supplemental quality requirements and the procedural controls applicable to this characterization activity. The 200 Areas QAPjP (Appendix A of the Implementation Plan) and this chapter will serve as the QAPjP for the 200-SW-1 and 200-SW-2 OU data acquisition activities. Table A-8 illustrates the correlation between EPA/240/B-01/003 requirements and information provided in the 200 Areas QAPjP and/or this document.

## A2.1 FIELD QUALITY CONTROL

Field quality control (QC) samples will be collected to evaluate the potential for cross-contamination and laboratory performance. Field QC for sampling in the 200-SW-1 and 200-SW-2 OUs will require the collection of duplicates, field splits, equipment rinsate blanks, and trip blank samples. The QC samples and the required frequency for collection are described in this section. QC samples will be collected as part of the verification sampling activities.

QC samples will not be collected from zones that are expected to contain TRU-contaminated soils because of the extreme cost and handling requirements associated with TRU materials.

### A2.1.1 Duplicates

Duplicates are used to evaluate the precision of field-sampling methods, and are defined as independent samples collected as close as possible to the same point in space and time, taken from the same source, stored in separate containers, and analyzed independently (i.e., not homogenized). Duplicate samples will be analyzed for the same constituents that are analyzed for in the primary samples. The duplicates will be collected at a minimum frequency of

5 percent of total collected samples, or one field duplicate for every 20 samples, whichever is greater. Duplicate samples also shall be collected for samples being analyzed using field screening techniques at the same frequency as laboratory-analyzed samples. The duplicates generally should be collected from an area that is expected to have some contamination, so that valid comparisons between the samples can be made (i.e., at least some of the COCs will be above detection limit).

For active soil-gas samples, duplicates are defined as samples collected with enough volume to permit two separate analyses performed sequentially by the same analyzer. These samples will be collected to evaluate performance of the analytical methodology by comparing two analyses of the vapor concentrations in one sample container. A minimum of 5 percent of the total collected vapor samples will be duplicated (i.e., 1 field duplicate will be analyzed for every 20 samples). The duplicate samples will be designated during the field analyses. Where feasible, duplicates will be selected after an initial volume is analyzed and shown to contain detectable concentrations of volatile contaminants, so that valid comparisons between the samples can be made (i.e., concentrations will be above the detection limit).

The following strategy will be used to analyze duplicate active soil-gas samples. One sample in every 20 will be analyzed sequentially as a sample and then as a duplicate sample. The first sample in the 20-sample group with detectable contamination will provide the duplicate sample for that 20-sample group. If a second sample in the 20-sample group has a significantly higher contaminant concentration, it also may be analyzed as a duplicate sample. If the first 19 samples in the 20-sample group have no detectable contamination, the 20th sample will provide the duplicate.

Physical property samples, if required, will not require duplicates.

### A2.1.2 Field Splits

Field split samples are used to verify the performance of the primary laboratory. Field split samples will be collected for soil samples only. One soil split sample shall be collected for every 20 soil samples during the field characterization program. Split samples will be retrieved from the same sample interval using the same equipment (e.g., collected from one split spoon). Samples shall be homogenized, split into two separate aliquots in the field, and sent to two independent laboratories. The split will be used to verify the performance of the primary laboratory.

The split sample will be obtained from sample media suitable for analysis at an offsite laboratory and shall be analyzed for all of the analytes listed in Tables A-9 and A-10.

### A2.1.3 Equipment Rinsate Blanks

Equipment blanks will be collected from a minimum of 5 percent of the total number of collected soil samples, or one equipment blank for every 20 samples (whichever is greater) and will be used to verify the adequacy of sampling equipment decontamination procedures. The field geologist may request that additional equipment blanks be taken. Equipment blanks will consist

of pure deionized water washed through decontaminated sampling equipment and placed in containers, as identified on the project Sampling Authorization Form. Note that the bottle and preservation requirements for water may differ from the requirements for soil.

Equipment rinsate blanks shall be analyzed for the following:

- When characterization analysis is for radionuclides only:
  - Gamma emitters
  - Gross alpha
  - Gross beta.
- When characterization analysis is for radionuclides and chemical constituents:
  - Gamma emitters
  - Gross alpha
  - Gross beta
  - Metals (excluding hexavalent chromium and mercury)
  - Anions
  - Semivolatile organic analytes
  - Volatile organic analytes.

### A2.1.4 Trip Blanks

The volatile organic trip blanks will constitute approximately 5 percent of all samples designated for analysis of volatile organic compounds (VOC), or approximately one in every sixth batch (cooler) that contains samples requiring VOC analyses. The trip blank shall consist of pure deionized water added to clean sample containers in the Fluor Hanford Sample Storage and Shipping Facility. These containers will be transported to the field with their associated bottle set(s) and will be returned unopened to the laboratory with these samples. Trip blanks are prepared as a check for possible contamination originating from container preparation methods, shipment, handling, storage, or site conditions. The trip blank shall be analyzed only for VOCs.

### A2.1.5 Prevention of Cross-Contamination

Special care shall be taken to prevent cross-contamination of soil samples. Particular care will be exercised to avoid the following common ways in which cross-contamination or background contamination may compromise the samples:

- Improperly storing or transporting sampling equipment and sample containers
- Contaminating the equipment or sample bottles by setting the equipment/sample bottle on or near potential contamination sources (e.g., uncovered ground)
- Handling bottles or equipment with dirty hands
- Improperly decontaminating equipment before sampling or between sampling events.

## A2.2 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

Quality objectives and criteria for soil measurement data are presented in Table A-9 for radionuclides and Table A-10 for chemical analytes. Analysis of soil physical properties will be performed according to applicable American Society for Testing and Materials procedures, where required. Quality objectives and criteria for soil-vapor measurement data are presented in Table A-11.

## A2.3 SAMPLE PRESERVATION, CONTAINERS, AND HOLDING TIMES

Soil sample preservation, containers, and holding times for chemical and radioactive analytes of interest are presented in Table A-12. Final sample collection requirements will be identified on the Sampling Authorization Form.

## A2.4 ONSITE MEASUREMENTS QUALITY CONTROL

Field-screening instrumentation will be calibrated and controlled according to the procedures identified in Section A2.7. Onsite XRF measurements will use method blanks and appropriate matrix matching during calibration as defined by U.S. Environmental Protection Agency (EPA) Method 6200 (SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update III-A*).

## A2.5 DATA MANAGEMENT

Data and records resulting from the implementation of this QAPjP shall be managed and stored by the Fluor Hanford Groundwater Remediation Project (GRP) organization responsible for sampling and characterization, in accordance with CP-GPP-EE-01-2.0, *Environmental Information Systems – Sample Event Coordination* and CP-GPP-EE-01-2.1, *Environmental Information Systems – Sampling Documentation Processing*. At the direction of the task lead, all analytical data packages shall be subject to final technical review by qualified personnel before the results are submitted to the regulatory agencies or before inclusion in published reports. Electronic data access, when appropriate, shall be via a database (e.g., *Hanford Environmental Information System* [HEIS] or a project-specific database). Where electronic data are not available, hard copies shall be provided in accordance with Section 9.6 of the Tri-Party Agreement (Ecology et al. 1989).

## A2.6 VALIDATION AND VERIFICATION REQUIREMENT

Validation shall be performed on completed data packages by qualified GRP Sample Management personnel or by a qualified independent contractor. Validation shall consist of

verifying required deliverables, requested versus reported analyses, and transcription errors. Validation also shall include the evaluation and qualification of results based on holding time, method blanks, matrix spikes, laboratory control samples, laboratory duplicates, and chemical and tracer recoveries, as appropriate, to the methods used. No other validation or calculation checks will be performed. At least 5 percent of all data shall be validated. Validation requirements identified in this section are consistent with Level C validation, as defined in CP-GPP-EE-01-2.5, *Environmental Information Systems – Data Package Validation Process*. Validation will be performed in accordance with the procedures identified in the next section. No formal validation will be performed for field screening or physical test data.

## A2.7 TECHNICAL PROCEDURES AND SPECIFICATIONS

Soil sampling and onsite environmental measurements will be performed according to Fluor Hanford procedures and the appropriate Waste Disposal/GRP procedures. Administrative, data management, personnel training, health and safety, and other applicable procedures also will be followed in conjunction with the acquisition of environmental data. Individual procedures that will be used during performance of this SAP include, but are not limited to, the following:

- Training/certifications
  - HNF-PRO-459, *Environmental Training*
  - HNF-RD-11061, *Training Requirements.*
- Documents and records
  - HNF-PRO-10863, *Notebooks and Logbooks*
  - HNF-RD-210, *Records Management Program.*
- General sampling and sample management
  - CP-GPP-EE-01-2.0, *Environmental Information Systems – Sample Event Coordination*
  - CP-GPP-EE-01-2.1, *Environmental Information Systems – Sampling Documentation Processing*
  - GRP-EE-01-3.0, *Chain of Custody*
  - GRP-EE-01-3.1, *Sample Packaging and Shipping*
  - GRP-EE-01-3.2, *Field Decontamination of Sampling Equipment*
  - GRP-EE-05-1.0, *Routine Field Screening*
  - GRP-EE-01-1.6, *Environmental Information Systems – Survey Requirements and Techniques*

- TBD: XRF Field Screening of Soils (e.g., EPA Method 6200 [SW-846]).

- Soil and soil-vapor sampling
  - GRP-EE-01-4.0, *Soil and Sediment Sampling*
  - GRP-EE-01-4.2, *Sample Storage and Shipping Facility*
  - GRP-EE-01-4.5, *Sample Compositing*
  - GRP-EE-05-3.2, *Field Screening Tedlar Bag Sampling*
  - GRP-EE-05-4.0, *Analysis of Volatile Organic Compounds in Vapor Samples Using the Brüel and Kjær 1302 and Innova 1312 Multi-Gas Analyzers*
  - Passive soil-gas surveys (e.g., EMFLUX[1] or GORE-SORBER[2] surveys) will be conducted in accordance with written field procedures provided by the vendor.

- Geophysical Investigations
  - TBD: ground-penetrating radar, electromagnetic, and magnetic field surveys (e.g., ASTM D6639-01, *Standard Guide for Using the Frequency Domain Electromagnetic Method for Subsurface Investigations*)
  - TBD: Borehole geophysical survey procedures.

- Instrument/equipment calibration and testing
  - HNF-PRO-490, *Calibration Management Program*
  - GRP-PRO-8377, *Instrument Accuracy and Reliability (Calibration).*

- Supplies and consumables
  - HNF-PRO-268, *Control of Purchased/Acquired Items and Services*
  - HNF-PRO-123, *Requesting Materials and Services.*

- Subsurface access
  - GRP-EE-01-5.2, *Test Pit Excavation in Contaminated Areas.*

- Radiological surveys, protection, and control
  - HNF-13536, *PHMC Radiological Control Procedures*

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[1]EMFLUX is a registered trademark of Beacon Environmental Services, Inc., Bel Air, Maryland.

[2]GORE-SORBER is a registered trademark of W. L. Gore and Associates, San Francisco, California.

- HNF-5173, *PHMC Radiological Control Manual*
- HNF-12494, *Environmental Radiological Measurement Plan for the Central Plateau Remediation Project*
- HNF-IP-1277, *D & D Radiation Protection Procedures*
- HNF-PRO-1623, *Radiological Work Planning Process*
- RCP 4.5.1, *Portable Environmental Survey Instrument Operation*
- RCP 4.5.2, *Performance of Environmental Radiological Measurements*
- RCP 4.5.3, *MDA and Scan Speed Determination for Environmental Radiological Surveys*
- RCP 4.5.7, *Preparation of Environmental Radiological Survey Task Instructions (ERSTIs)*
- RCP 4.5.8, *Background Measurements for Environmental Radiological Surveys*
- RCP 4.5.9, *Documenting Environmental Radiological Measurements*
- RCP 5.6.15, *Operation of Mobile Surface Contamination Monitor II*
- HNF-13536, Procedure 3.1.2, *Evaluation of Outdoor Contamination Areas*
- TBD: Thermoluminescent Dosimeter Screening

• Waste Management

- GRP-OP-0001, *Handle and Package Transuranic Solid Waste in 55 Gallon Drums and Standard Waste Boxes*
- GRP-OP-0002, *Packaging and Storage of Low Level Waste*
- GRP-OP-0003, *Packaging and Storage of Low Level Mixed Waste*
- GRP-OP-0004, *Packaging and Storage of Dangerous Waste*
- GRP-OP-0005, *Handling, Packaging and Storage of Non-Radioactive, Non-Regulated Waste*
- Fluor Hanford waste management procedures as required
- HNF-PRO-462, *Pollution Prevention*
- HNF-PRO-15333, *Environmental Protection Processes*

- HNF-PRO-15334, *Effluent and Environmental Monitoring*
- HNF-PRO-15335, *Environmental Permitting and Documentation Preparation*
- HNF-EP-0063, *Hanford Site Solid Waste Acceptance Criteria.*

Work also shall be performed in accordance with the following:

- Quality assurance
  - HNF-20635, *Groundwater Remediation Project Quality Assurance Project Plan (GRP-QA-001).*
- Quality improvement
  - HNF-PRO-052, *Corrective Action Management*
  - HNF-PRO-298, *Nonconforming Items.*
- Management assessment
  - HNF-PRO-246, *Management Assessment.*
- Data management
  - CP-GPP-EE-01-2.4, *Environmental Information Systems – Data Package Technical Verification*
  - HNF-20433, *Data Validation Procedure for Chemical Analyses*
  - HNF-20434, *Data Validation Procedure for Radiochemical Analyses.*
- Health and safety
  - HNF-PRO-121, *Heat Stress Control*
  - HNF-PRO-175, *Training Program Descriptions*
  - HNF-RD-10743, *Safety Communications*
  - HNF-RD-11812, *Occupational Noise Exposure and Hearing Conservation.*
- Site-specific plans, as applicable
  - Health and safety plans
  - Radiological evaluation and/or radiation work permits
  - Activity hazard analysis and/or job safety analysis.

### A2.7.1 Sample Location

Sample locations (e.g., sample grid nodes) shall be staked and labeled before starting the activity. The locations shall be staked at the direction of the technical lead or the field team leader

assigned by the project manager. After the sample locations have been staked, minor adjustments to the location may be made to mitigate unsafe conditions, avoid structural interferences, or bypass utilities. Sample locations shall be identified during or after sampling in accordance with GRP-EE-01-1.6. Changes in sample locations that do not impact the DQOs will require approval of the project manager; however, changes to sample locations that result in impacts to the DQOs will require Washington State Department of Ecology (Ecology) concurrence.

### A2.7.2 Sample Identification

The GRP Sample and Data Tracking database will be used to track the samples from the point of collection and through the laboratory analysis process. The HEIS database is the repository for the laboratory analytical results. The HEIS sample numbers will be issued to the sampling organization for this project in accordance with CP-GPP-EE-01-2.0. Each chemical/radionuclide and physical property sample will be identified and labeled with a unique HEIS sample number. The sample location, depth, and corresponding HEIS numbers will be documented in the sampler's field logbook.

Each sample container will be labeled with the following information using a waterproof marker on firmly affixed, water-resistant labels:

- HEIS number
- Sample collection date/time
- Name of person collecting the sample
- Analysis required
- Preservation method (if applicable).

### A2.7.3 Field-Sampling Log

All information pertinent to field sampling and analysis will be recorded in bound logbooks in accordance with HNF-PRO-10863. The sampling team will be responsible for recording all relevant sampling information including, but not limited to, the information listed in HNF-PRO-10863. Entries made in the logbook will be dated and signed by the individual who made the entry.

### A2.7.4 Sample Custody

A chain-of-custody record will be initiated in the field at the time of sampling and will accompany each set of samples shipped to the laboratory(ies) in accordance with GRP-EE-01-3.0. The analyses requested for each sample will be indicated on the accompanying Chain-of-Custody Form. Chain-of-custody procedures will be followed throughout sample collection, transfer, analysis, and disposal to ensure that sample integrity is maintained. Each time responsibility for custody of the sample changes, the new and previous custodians will sign the record and note the date and time. The sampler will make a copy of the signed record before

sample shipment and transmit it to GRP Sample Management within 24 hours of shipping, as detailed in CP-GPP-EE-01-2.1.

A custody seal (i.e., evidence tape) shall be used for each sample jar to demonstrate that tampering has not occurred. The container seal will be inscribed with the sampler's initials and the date sealed.

### A2.7.5 Sample Containers and Preservatives

Level I EPA pre-cleaned sample containers will be used for soil samples that are collected for chemical and radionuclide analysis. Container sizes may vary depending on laboratory-specific volumes/requirements for meeting analytical detection limits. If, however, the dose rate on the outside of a sample jar or the curie content exceeds levels acceptable by the laboratory, the sampling lead and task lead can send smaller volumes to the laboratory after consultation with GRP Sample Management to determine acceptable volumes. Preliminary container types and volumes are identified in Table A-12. The final types and volumes will be indicated on the Sampling Authorization Form.

### A2.7.6 Sample Shipping

The radiological control technician will survey the outside of each sample jar to verify that the container is free of smearable surface contamination. The radiological control technician also shall measure the radiological activity on the outside of the sample container (through the container) and will mark the container with the highest contact radiological reading in either disintegrations per minute or millirem per hour, as applicable. All samples that are shipped will be packaged, marked, and labeled in accordance with U.S. Department of Transportation regulations (49 CFR, "Transportation"), and the requirements of GRP-EE-01-3.1 and/or other technical procedures as listed in Section A2.7.

### A2.7.7 Documents and Records

The characterization activities described in this SAP will be implemented in accordance with the most current, approved version of this QAPjP, which will be provided to appropriate project personnel. In the event that the QAPjP is changed and approved before the characterization activities have been completed, the project manager, or the field team leader at the discretion of the project manager, will provide the updated version of the QAPjP to appropriate project personnel.

Final disposition of records, including location and length of retention, will be in accordance with the requirements in the following procedures:

- HNF-PRO-10863, *Notebooks and Logbooks*
- HNF-RD-210, *Records Management Program.*

## A2.8 ANALYTICAL METHODS

Samples collected during implementation of this SAP will be analyzed using the methods specified in Tables A-9 and A-10 for soil samples and Table A-11 for soil vapor samples. All sampling, field analytical, and laboratory analytical services required by this SAP will be performed in accordance with DOE/RL-96-68. Issues dealing with sampling, sample handling, analytical support, data validation, and sample management services are managed in accordance with CP-GPP-EE-01-2.7, *Environmental Information Systems – Sample Disposition Records*.

# A3.0 FIELD-SAMPLING PLAN

This chapter describes the approach that will be used to characterize sites in the 200-SW-1 and 200-SW-2 OUs, based on the remediation bins. Sections A3.1 through A3.4 provide the sampling designs for the remediation bins; Section A3.5 describes the field screening methods.

## A3.1 BIN 1 SITES

Bin 1 contains 22 sites, 18 of which are from the 200-SW-1 OU (nonradioactively contaminated). The sites are predominantly burn pits, ash disposal sites, and known locations of random waste disposal from miscellaneous site activities. The sites are generally believed to be uncontaminated or only minimally contaminated; however, the records are sufficiently ambiguous that the contamination status must be confirmed. Any contamination that is present should be at or near the surface. The objective for Bin 1 sampling will be to verify that the sites do not require any remedial activity.

### A3.1.1 Sampling Approach

Figure A-2 illustrates the decision logic and characterization steps for the Bin 1 sites, as described in the following paragraphs:

- Records Review: The historical data and available records for the waste sites within Bin 1 will be reassessed prior to sampling to evaluate the available information regarding conditions at these sites. In addition, new or revised details regarding site history, location, size, disposal records, waste inventory, etc., will be reviewed. This information will be used to guide the field characterization program.

- Site Walk Down/Define Boundaries: Waste and contamination at the Bin 1 sites are anticipated to be present primarily at or near the surface. As a first step in the field activities, the project will conduct a walk down of each site, observing and recording the presence of waste materials and any significant site conditions. If records or site conditions indicate the potential for buried waste, ground-penetrating radar or other appropriate non-intrusive techniques will be used to define the boundaries of the waste disposal area.

- Radioactive Contamination Screening: The 200-SW-2 OU Bin 1 waste sites will be screened for radioactive contamination using the most appropriate screening methodology to detect contaminants identified during the records review. If the screening indicates the presence of radionuclides above background levels, the site will be reassigned to Bin 2 for management under the strategy described below for those sites.

- Soil-Gas Survey: If the information for an individual site indicates the potential for organic constituents to have been disposed of, a systematic sampling approach will be applied to evaluate the presence of contamination. Sites will be screened for volatile organic chemicals using passive soil-gas surveys (e.g., EMFLUX or GORE-SORBER) with follow-up confirmatory soil samples if screening indicates the presence of contamination.

- Site-Specific Sampling: In addition to the screening methodologies described above, individual waste sites within the Bin 1 category may have a specific contaminant issue that needs to be addressed through a targeted sampling approach. XRF technologies will be applied in a systematic manner appropriate to each site to evaluate for the presence of regulated metals. Shallow soil samples will be collected and analyzed for polychlorinated biphenyls or other constituents if site records indicate the potential presence of specific constituents. Soil sampling may require shallow, surface-based collection methods and shallow, subsurface-based methods (e.g., test pits or direct push technologies such as GeoProbe[1]).

- Follow-up Targeted Sampling: If any results from the previous steps show that contamination potentially is present above levels of concern, follow-up targeted sampling may be needed to define the lateral and/or vertical extent of the soil contamination at these sites. These sites will be considered candidates for the RTD approach and reassigned as Bin 2 sites. Targeted sampling is used to further define the nature and extent of contamination, and is necessary in the event that further data are needed to support cost estimates and planning for RTD activities.

- Verification Sampling: If contamination is below levels of concern, variance estimated from the field-screening measurements will be used to develop a statistically- based sampling and laboratory analysis process, which in turn will be applied to confirm site conditions. Samples taken during this process also will be evaluated at the 0 to 0.3 m (0 to 1 ft) depth, if needed to support an ecological risk evaluation. If characterization does not indicate the presence of contamination above PRGs, the site will be proposed for "No Further Action" under CERCLA.

### A3.1.2 Bin 1 Sampling Design

Bin 1 sites are expected to have zero to low contamination levels, but actual levels are uncertain. Because the objective of the sample design will be to close out these sites without further action,

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[1]GeoProbe is a registered trademark of GeoProbe Systems, Salina, Kansas.

and there is a lack of sample data to support a statistical sample design, systematic grid sampling will be used to ensure spatial coverage of the sites. To supplement this activity and address the fact that waste is not uniformly distributed at these sites, field teams may take judgmental measurements, using field-screening techniques, at locations within a site that may be contaminated. Because the sites are assumed to have very low contamination levels, a grid-spacing of one set of measurements per 1,000 $m^2$ was chosen with a minimum of three sets of measurements per site. This design is based on professional judgment, and represents a preliminary screening of the site to estimate a variance on which a statistical sampling and laboratory analysis scheme may be based. (NOTE: The proposed grid size in this document is preliminary and may change based on field observations.)

Table A-13 gives the dimensions (if available) of the Bin 1 sites, along with the estimated number (where possible) of measurement locations for the systematic-grid portion of the design. Data in Table A-13 were derived from *Waste Information Data System* (WIDS) records; dimensions are not provided for all sites in WIDS. Site dimensions and grid size will be verified as part of the site walk-down process. The numbers reflect the locations where survey techniques will be used to screen for radioactive and organic or other nonradioactive contamination (e.g., toxicity characteristic metals).

Figure A-3 presents an example of the Bin 1 systematic-grid design for measurement locations using the 200 CP (200 Central Plateau) site. The grid is triangular with an approximate spacing of one measurement location per 1,000 $m^2$. Survey/screening measurements will be collected at each grid node within the grid unit. Other Bin 1 sites greater than 3,000 $m^2$ will have a similar pattern for measurement locations. Sites less than 3,000 $m^2$ in size will have three equally spaced (spatially) measurement locations. Additional samples may be collected on a judgmental basis based on conditions observed at the site. The example map in Figure A-3 does not indicate any potential judgmental measurement locations.

If screening activities do not indicate the presence of contamination, the results from the screening activity will be used to determine a statistically based sampling scheme to collect a limited number of laboratory-based samples to confirm site conditions. If laboratory samples confirm the absence of contamination above PRGs, the site will be proposed for "No Further Action" under CERCLA. If laboratory samples indicate contamination above PRGs, the site will be evaluated for remediation under the approach presented for Bin 2, using the results from the screening and samples already collected to support characterization.

## A3.2 BIN 2 SITES

Twenty-one of the 31 sites in Bin 2 are from the 200-SW-1 OU, indicating that they belong to the nonradioactive group and are anticipated to not contain radioactively contaminated wastes. All of the sites that are included in Bin 2 are assumed to contain some amount of contaminated material.

In general, the inventory for these sites consists of materials disposed of at the surface. The notable exceptions are as follows:

- Three vault sites (218-E-7, 218-W-7, and 218-W-8)
- Burial grounds at 218-E-2 and 218-E-4
- 600 OCL.

The inventory generally has been well defined and should not present a significant challenge for remediation through an RTD process. Although some of the Bin 2 sites encompass a relatively large geographic area, the records and site inspections indicate that the waste at these sites is, for the most part, not spread over the entire site.

### A3.2.1 Sampling Approach

Figure A-4 illustrates the decision logic and characterization steps for the Bin 2 sites, as described in the following paragraphs.

- Records/Site Review: The historical data and available records for the waste sites within Bin 2 will be reassessed before sampling to evaluate the available information regarding waste disposal and contamination at these sites. This review also will consider the results from Hanford Site remedial activities at other burial grounds (e.g., 618 and 118 Burial Grounds) to determine whether approaches used at those locations can be applied to the Bin 2 sites (e.g., 600 OCL). The results from this review will be used to guide the survey activities to follow.

- Field Screening: The presumption is that most of the waste sites in Bin 2 are contaminated. The intention for this step will be to confirm the presence of contamination through the following approach before proposing a removal action.

  - A site walkdown will be performed to establish the grid for field screening (discussed below) and to observe any unusual conditions at the site that may require targeted characterization. If there is evidence of buried material (either through records review or the walkdown), a ground-penetrating radar survey may be performed.

  - Radioactive Contamination Screening: The 200-SW-2 OU Bin 2 waste sites will be screened for radioactive contamination using the most appropriate screening methodology to detect contaminants that were identified during the records review. Radioactive contamination screening results will be used to support radionuclide inventory estimates and an ALARA evaluation for subsequent RTD work.

  - Soil-Gas Survey: If the information for an individual site indicates the potential for organic constituents to have been disposed of, a systematic approach will be applied to evaluate the presence of contamination. Sites will be screened for volatile organic chemicals using passive soil-gas surveys (e.g., EMFLUX or

GORE-SORBER) with confirmatory samples where screening indicates the presence of contamination.

- Site-Specific Sampling: In addition to the above screening methodologies, individual waste sites within this bin may have a specific contaminant issue that needs to be addressed through a targeted sampling approach. XRF technologies will be applied in a systematic manner appropriate to each site to evaluate for the presence of regulated metals. Shallow soil samples will be collected and analyzed for polychlorinated biphenyls or other constituents if site records indicate the potential presence of specific constituents. Soil sampling may require shallow, surface-based collection methods and shallow, subsurface-based methods (e.g., test pits or direct push technologies such as GeoProbe).

- Follow-up Targeted Sampling: If any results from the previous steps show that contamination is potentially present above levels of concern, follow-up targeted sampling may be needed to define the lateral and/or vertical extent of the soil contamination at these sites to support RTD activities. A cost-benefit analysis will be conducted in the FS before recommending an RTD process, subsequent to approval of the ROD. This analysis will include the development of cost estimates for RTD, and post-RTD sampling.

- Verification Sampling: If contamination is below levels of concern, variance estimated from the field-screening measurements will be used to develop a statistically based sampling and laboratory analysis process, which will be applied to confirm site conditions. Samples taken during this process also will be evaluated at the 0 to 0.3 m (0 to 1 ft) depth, if needed to support an ecological risk evaluation. If laboratory samples confirm the absence of contamination above PRGs, the site will be proposed for "No Further Action" under CERCLA.

- RTD Approach: The presumptive remedy for contaminated media and materials at the Bin 2 sites is RTD. Excavators, front-end loaders, and other equipment, as appropriate, will be used to excavate and remove the waste at these locations after approval of the ROD. Field-screening techniques for radionuclides, volatile organic chemicals, and selected metals (e.g., lead, chromium) will be used to determine the lateral and vertical extent of contaminated media, as well as the contaminant concentrations, during waste removal actions at these sites using the observational approach. Waste will be segregated, as appropriate, for treatment and repackaging for disposal to an approved waste disposal facility. Following removal actions, the variance, calculated using field-screening data, will be used to establish a statistically based soil sampling location scheme to verify cleanup, using results from laboratory analysis as a basis for site closure.

### A3.2.2 Bin 2 Sampling Design

Contamination is anticipated at Bin 2 sites. The objective of the characterization program will be to confirm the presence and extent of contamination requiring action, as well as evaluate the cost

of RTD activities. Because contamination in Bin 2 sites is likely to be at low to moderate levels, a sampling scheme similar to Bin 1 sites will be implemented. That is, screening/survey locations will consist of systematic-grid locations (due to the lack of existing data on which to base a statistical plan) combined with judgmental samples as deemed necessary.

More specifically, for nonradioactive sites, screening/survey locations will be along a systematic grid and data collection points will be one per 1,000 $m^2$ with a minimum of three per site. (NOTE: The proposed grid size in this document is preliminary and may change based on field observations.) Survey/screening measurements will be collected at each grid node within the grid unit. If screening activities do not indicate the presence of contamination, the results from the screening activity will be used to determine a statistically based sampling scheme to collect a limited number of laboratory-based samples to confirm site conditions. If laboratory samples confirm the absence of contamination above PRGs, the site will be proposed for "No Further Action" under CERCLA. If average contamination in the laboratory samples is found to be above the PRGs, then the recommended remedial action will be RTD using the observational approach, if determined to be cost-effective in the FS.

For contaminated sites, measurements will be collected from a systematic grid. In addition, judgmental measurements will be collected to address concerns identified in the field. If contamination is located, additional measurements will be taken to determine the boundaries (depth and area) of the contamination. The assumed remedial action for sites is RTD using the observational approach as discussed in Section A3.2.3. Discussion of the RTD approach is included in this Work Plan to provide the reader with a context for the planned pathway for these sites. Remediation will take place subsequent to the approval of the ROD.

Upon completion of the remedial activity, the results from the systematic screening approach will be used to develop a statistically based sampling plan to collect laboratory verification samples for analysis.

Table A-14 gives the dimensions (if available) of the Bin 2 sites along with estimated number (where possible) of measurement locations for the systematic-grid portion of the design. Site dimensions were taken from records in the WIDS database; dimensions are not provided for all sites in WIDS. Site dimensions and grid spacing will be confirmed during the site walkdown. The numbers reflect the locations where field techniques will be used to screen for radioactive and organic or other nonradioactive contamination (e.g., metals).

### A3.2.3 Use of the Observational Approach for Removal/Treatment/Disposal Sites

After the ROD for the 200-SW-1 and 200-SW-2 OUs has been approved, the observational approach will be used to characterize the Bin 2 sites that were selected for RTD through the ROD. Under the observational approach, the cleanup process is streamlined such that characterization and remediation of a site will include the following:

- Verifying site boundaries
- Establishing a radionuclide/chemical contamination survey and sampling grid

- Removal and radioactive contamination field screening of soil cover materials (if present) to expose the waste site materials
- Performing radioactive contamination surveys of the exposed surface to determine the extent of contamination (if any) under the soil cover and locating the area with the highest level of contamination
- Evaluating soil screening analysis results, at the location with the high contamination levels, for waste characterization and designation
- Excavation of the contaminated media (soil, waste materials, wood, concrete, asphalt, etc.)
- Performing a verification radionuclide/chemical contamination survey, which includes subsequent laboratory analysis of soil samples to document the successful removal of contaminated media to levels below remedial action levels.

Site conditions may be encountered where targeted monitoring and sample collection are required to meet additional project needs. Examples of these situations include the following.

- If action levels for health and safety are approached that require increased environmental and worker protection, a sampling activity may be initiated. Action levels are defined in the appropriate documents (i.e., radiation work permit, health and safety plan) and will be referenced in the instruction guide.
- If visual anomalies are encountered during the site inspection or excavation, a sampling activity may be initiated. Visual anomalies include discoloration of soils, appearance of a sheen on soil particles, obvious changes in soil textural characteristics, unexpected waste materials being uncovered, or other unexpected changes in site conditions.
- If the waste profile, as indicated by onsite measurement, approaches the Environmental Restoration Disposal Facility waste acceptance criteria (BHI-00139, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*), a sampling activity will be initiated to support waste characterization and designation.
- Increases in contaminant levels, as determined by onsite measurements that indicate the presence of unexpected levels of contamination, may require a sampling activity.
- Other field conditions may be encountered in which additional sampling may be required. All sampling activities will be evaluated by project and/or technical personnel to ensure that sampling and analysis activities are performed to specifically address the field condition in a cost-effective manner.

## A3.3 BIN 3A SITES

The Bin 3A site grouping includes the LLBG TSD sites slated to be closed with a cap (69 FR 39449). Bin 3A also includes the NRDWL TSD site, anticipated to be closed with a cap

(DOE/RL-90-17), and the 600 CL, which is adjacent to the NRDWL and will be closed in conjunction with that site. The inventory for the trenches at these sites that received waste post-1986 is well defined. Trenches that received waste before 1986 generally have good records, but did not keep detailed inventory of the nonradioactive wastes. The sites have been operated under WA7890008967 and monitored through a system of groundwater monitoring wells. All of the TSD units will be characterized, based on the available monitoring information, site characterization studies, and waste inventory records. Because these burial grounds have been operating as regulated facilities and the monitoring program does not indicate any releases, only limited additional characterization will be performed in order to more fully address the potential for volatile organics contamination.

### A3.3.1 Sampling Approach

As noted above, portions of some of these burial grounds received waste before 1986, during a period when detailed records were not maintained for the nonradioactive waste constituents. This results in a concern that some trenches may have been used for disposal of containerized liquid organic waste after 1973, when disposal of liquid organic waste to the soil column ceased, and before 1986. Passive soil-gas surveys (using GORE-SORBER or EMFLUX) will be conducted at specific trenches that could have received waste from 1973 to 1986 at each of the Bin 3A burial grounds, using a survey grid with 20 m spacing. Table A-15 illustrates the operations periods for the various burial grounds and trenches. The table illustrates those trenches that could have accepted containerized liquid organic wastes during the timeframe of concern (1973-1986). In addition, although the majority of the waste in the Bin 3A burial grounds was disposed of before Ecology began to regulate the hazardous component of mixed waste (August 19, 1987), engineering drawings for the burial grounds identify waste in trenches using the following codes:

- A LLW Low-Level Waste
- B LLW-MW Low-Level Waste and Mixed Waste
- C LLW-MW-L Low-Level Waste and Mixed Waste with Liquid
- D TRU Transuranic
- E TRU-MW Transuranic and Mixed Waste
- F TRU-MW-L Transuranic and Mixed Waste with Liquid
- U USG U in front of map symbols indicates an unsegregated waste type.

Trenches were selected for soil-gas evaluation based first on their potential to have received waste during the time period of 1973 to 1986 and second on an indication from the drawings that they may have received liquid waste. If the records do not suggest that trenches within a burial ground received liquid waste, then trenches were selected based on records indicating that they received what would now be considered mixed waste or unsegregated waste or could be considered to be representative of the 1973-1986 timeframe.

1. Burial ground 218-E-10 is shown on Drawing H-2-92004, *Industrial Burial Ground 218-E10 Site-Plan and Details*. The drawing does not indicate that the site has received liquid wastes. Trench #12 is shown on the drawing as having received LLW and mixed

waste. Trench #11 and #16 were selected to represent the burial ground trenches from the period of concern.

2. An engineering drawing that illustrates the waste codes disposed to specific trenches was not available to review for Burial Ground 218-E-12B. Trenches 19, 26, and 31 were selected as sites for investigation, based on their operating dates potentially straddling the time of concern.

3. Burial Ground 218-W-3A is shown on Drawing H-2-34880, *Dry Waste Burial Ground 218-W-3A*. Trench 3S was selected for investigation, based on the waste code "C" being assigned to the full length of that trench. Trenches 12 and 20 also were selected because sections of those trenches were coded as having liquids disposed to them.

4. Burial Ground 218-W-3AE is shown on Drawing H-2-75351, *Dry Waste Burial Ground 218-W-3AE*. Trenches 5 and 10 were selected based on sections of those trenches being shown as having received liquid wastes. Trench 2 also was selected as representative of the disposal time frame.

5. Burial Ground 218-W-4B is shown on Drawing H-2-33055, *Dry Waste Burial Ground 218-W-4B*. Trenches 7 and 11 were selected for investigation. Both of these trenches are coded as having received liquid wastes. All other trenches in this burial ground did not receive waste after 1973. Trench 7 was constructed with vent risers, which may be sampled in lieu of passive soil-vapor sampling.

6. Burial Ground 218-W-4C is shown on Drawing H-2-37437, *Dry Waste Burial Ground 218-W-4C*. Trenches 4, 7, 19, and 23 were selected based on sections of those trenches being shown as having received liquid wastes. Trench 28 also was selected to represent the operating period of this site. Trenches 4 and 7 were constructed with vent risers, which were sampled for volatile organic compounds in 2002 in support of the 200-PW-1 OU RI (DOE/RL-2001-01, *Plutonium/Organic-Rich Process Condensate/Process Waste Group Operable Unit RI/FS Work Plan, Includes: 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units*) and in 2003 in support of TRU retrieval operations (DOE/RL-2003-48, *218-W-4C Sampling and Analysis Plan*). These results also will be used to support the 200-SW-2 OU characterization, and no passive soil-vapor sampling will be conducted at these two trenches.

7. Burial Ground 218-W-5 began operation in 1986. As a result, the trenches in this burial ground were not receiving waste during the 1973-1986 time frame and will not be investigated for VOC contamination.

The number of sampling locations within each trench is listed in Table A-16. The passive samplers will be placed, if possible, in the soil covering the buried waste in the selected trenches. However, if this area cannot be accessed at a trench because of safety concerns, the samplers will be placed along the perimeter of that trench.

The results of the passive soil-vapor surveys will be evaluated to identify any areas of elevated VOC concentrations. At locations of elevated VOC concentrations, additional samplers may be

placed, using a refined spacing of 10 m, both along and perpendicular to the survey line, to evaluate the source and extent of contamination.

Soil-vapor samples will be collected from the vadose zone at up to three areas of elevated VOC concentrations within each burial ground using a direct push technology (e.g., cone penetrometer) for subsurface access. Two locations, one on either side of the trench at the location of the "hot spot," will be sampled at each area of elevated VOC concentrations. As the cone penetrometer is advanced, active soil-gas samples will be collected every 1.5 m (5 ft). Cone penetrometer pushes will be conducted to a depth of 2.5 times waste burial depth or refusal, whichever comes first. All pushes must exceed 1.5 times waste burial depth to be acceptable. If contamination is measured at 1.5 times waste burial depth, then the penetrations must continue until either the contamination ends or 2.5 times the waste burial depth is reached. The active soil-gas samples will be analyzed for VOCs using a field screening technique (Table A-11).

All of the passive and active soil-gas data will be evaluated to determine areas that appear to define a VOC plume in the vadose zone. At the location in an apparent plume with the highest VOC concentrations based on field screening, a soil-vapor sample will be collected in a container (e.g., SUMMA canister[1]) for laboratory analysis (Table A-11). If no VOC plumes are apparent at a given trench, laboratory samples will not be collected.

If feasible, a soil sample will be collected at locations where the concentration of a VOC in a laboratory-analyzed vapor sample exceeds 1 percent of its theoretical saturated vapor concentration. The soil samples will be analyzed for VOCs (Table A-10).

As noted in Section 2.2.6.1.7 of the work plan, a heavy snowfall and rapid melting in the 1979-1980 winter caused flooding in the 218-W-4C Burial Ground. Drums were observed floating in Trench 4 and were recovered undamaged (WHC-EP-0225, *Contact-Handled Transuranic Waste Characterization Based on Existing Records*). Volatile organic contaminants were detected in the vadose zone at the east end of trench 4 in 2002 (CP-13514, *200-PW-1 Operable Unit Report on Step I Sampling and Analysis of the Dispersed Carbon Tetrachloride Vadose Zone Plume*). An additional soil probe will be advanced at a location adjacent to trench 4 in Burial Ground 218-W-4C to determine whether any contamination was carried into the subsurface from flooding associated with historical snowmelt at this site.

If trucks are not allowed adjacent to burial ground trenches (e.g., insufficient space between trenches), hand-augering equipment will be needed to penetrate into the vadose zone.

Four of the LLBG TSD sites include trenches that contain retrievably stored suspect TRU wastes. The TRU retrieval program will characterize the substrate soils underlying the locations of retrievably stored waste in accordance with Tri-Party Agreement Interim Milestone M-91-40 to evaluate whether contaminants have been released to the environment.

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[1]SUMMA is a trademark of Moletrics, Inc., Cleveland, Ohio.

Active soil-vapor sampling using a direct-push technology for subsurface access was conducted at the NRDWL in 1997 (BHI-01115). The 600 CL site has been monitored quarterly for VOCs since 1997.

Remedial options for VOC contamination found in these investigations will be evaluated as part of the FS.

### A3.3.2 Bin 3A Sampling Design

The LLBG sites are slated to be capped, based on the NEPA Solid Waste ROD (69 FR 39449). Landfill closure with a cap is anticipated for the NRDWL (and adjacent 600 CL) site. The objective of the characterization program is to determine whether the sites have the potential for volatile organic contamination that may require interim remedial measures before the caps are placed. Passive soil-gas surveys will be used at trenches identified as having the highest potential to have received containerized liquid organic waste. Results of the passive soil-gas surveys will be used to focus vadose zone investigations in the burial grounds. Data collected during these investigations will be used to support evaluations of interim remedial options during the FS.

## A3.4 BIN 3B SITES

Bin 3B includes those historical, radioactive burial grounds that are not as well defined in terms of inventory or waste disposal practices. The majority of these sites received some or all of their wastes in the 1944 to mid-1960s timeframe, when records of waste inventory and waste disposal practices were incomplete. Bin 3B burial grounds can be subdivided to include industrial and dry waste burial grounds, most of which operated for many years with limited information on waste disposal practices or inventory. An unplanned release site, UPR-200-E-95, also has been placed in the Bin 3B category because of its proximity to some of the burial grounds (e.g., 218-E-2A, 218-E-5) included in this bin.

### A3.4.1 Industrial Waste Burial Grounds Sampling Approach

Industrial waste burial grounds received large pieces of failed or obsolete equipment. At each of the eight industrial waste burial grounds, grids with 10 m spacing will be established over the extent of the burial ground (Table A-17). Geophysical surveys will be performed at the grid nodes to identify the extent of the burial grounds and to locate anomalies indicative of buried waste and equipment. Geophysical surveys will be conducted using magnetic and electromagnetic methods. Ground-penetrating radar may be used if needed to confirm correlations between the first two methods. Additional investigations will be conducted at locations of identified anomalies using nonintrusive passive gamma surveys (e.g., using TLDs) and passive soil-gas samplers placed at grid nodes. It is expected that this grid will be triangular, with a spacing of approximately 10 m. However, because the size and density of the anomalies may very significantly, it may be necessary to adjust the grid spacing. (NOTE: The proposed

grid size in this document is preliminary and may change based on field observations.) Field screening methods are described in more detail in Section A3.5.

The results of the passive gamma survey will be used to evaluate the amount of radioactive material at depth (Section A.3.5.3). The results of the passive soil-vapor surveys will be evaluated to identify any areas of elevated VOC concentrations. At locations of elevated radioactivity or VOC concentrations, additional samplers may be deployed to provide better resolution of the anomaly.

The three areas within each burial ground with the highest results from these screening surveys will be probed with a single push advanced using a direct-push technology (e.g., cone penetrometer). As the cone penetrometer is advanced, radioactive contamination screening will be performed using NaI or other appropriate detectors. Soil moisture measurements using a cone penetrometer-deployed soil moisture probe will be made during advancement at locations in 218-C-9 to determine if any residual moisture remains from past liquid disposal activities. Depending on results from the passive soil-gas survey, active soil-gas samples may be collected and analyzed using a field screening technique (Table A-11). Each push will be advanced to 2.5 times the maximum depth of waste burial, or refusal, whichever comes first, to collect samples from soils beneath the waste disposal locations. All pushes must exceed 1.5 times waste burial depth to be acceptable. If contamination is measured at 1.5 times waste burial depth, then the penetrations must continue until either the contamination ends or is 2.5 times the waste burial depth.

At each push location, soil samples will be collected at the depth of the highest contamination in the vertical profile and at refusal. The samples will be analyzed in the laboratory for the potential contaminants listed on Tables A-9 and A-10.

As noted in the discussion for Bin 3A, during the period from 1973 to 1986, operating practices at the Hanford Site resulted in a condition that could have caused containerized organic liquid wastes to be disposed to burial grounds. Burial Ground 218-W-2A is the only industrial waste burial ground that operated during this timeframe. Trenches 25, 26, and 27 may have received waste during this period. Soil-gas surveys will be performed over these trenches in the same manner as that described for Bin 3A trenches to evaluate the presence of VOC contamination.

The characterization logic for the Bin 3B industrial waste burial grounds is provided on Figure A-5.

### A3.4.2 Dry Waste Burial Grounds Sampling Approach

Dry waste burial grounds received all types of miscellaneous solid waste. For the dry waste burial grounds, trenches were selected for characterization by evaluating the available historical data and drawings (Table A-18). These trenches are expected to contain a cross section of the full range of wastes that were disposed to the dry waste burial grounds. Geophysical surveys using magnetic and electromagnetic methods will be conducted along the centerline of each of the selected trenches using a 20 m interval. If a trench in a dry waste burial ground cannot be located, three survey lines (evenly spaced across the width of the burial ground) will be conducted at right angles to the expected trench direction (i.e., if the trenches are expected to run

east-west, the survey passes will run north-south). Ground-penetrating radar may be used if needed to confirm correlations between the first two geophysical methods. The geophysical surveys will be used to identify anomalies indicative of buried waste and containers.

Passive gamma surveys (e.g., using TLDs) and passive soil-vapor surveys will be deployed along the centerline of each selected trench at 20 m intervals. However, because the size and density of the anomalies may very significantly, it may be necessary to adjust the sample spacing. The results of the passive soil-vapor surveys will be evaluated to identify any areas of elevated VOC concentrations. At locations of elevated radioactivity or VOC concentrations, additional samplers may be deployed along and/or perpendicular to the survey line to provide better resolution of the anomaly.

The three areas within each burial ground with the highest results from these screening surveys will be probed with a single push by a direct-push technology (e.g., cone penetrometer). As the cone penetrometer is advanced, radioactive contamination screening will be performed using NaI or other appropriate detectors. Depending on results from the passive soil-gas survey, active soil-gas samples may be collected and analyzed using a field screening technique (Table A-11). Each push will be advanced to 2.5 times the maximum depth of waste burial or refusal, whichever comes first, to characterize soil conditions beneath the waste locations. All pushes must exceed 1.5 times the waste burial depth to be acceptable. If contamination is measured at 1.5 times waste burial depth, then the penetrations must continue until either the contamination ends or is 2.5 times the waste burial depth.

At each push location, soil samples will be collected at the depth of the highest contamination in the vertical profile and at refusal. The samples will be analyzed in the laboratory for the potential contaminants listed on Tables A-9 and A-10.

The characterization logic for the Bin 3B dry waste burial grounds is provided on Figure A-6.

### A3.4.3 Bin 3B Sampling Design

Bin 3B sites include industrial and dry waste burial grounds. The objective of the RI is to evaluate the nature and extent of the radioactive and chemical contamination to support evaluation of remedial alternatives in the FS. Nonintrusive surface-based surveys using geophysical, radioactive, and passive soil-vapor sampling methods will be used to identify anomalies for further screening and targeted soil sampling. The radioactive contamination screening and analysis of soil samples will be used during the FS to develop ALARA models.

## A3.5 FIELD SCREENING METHODS

The following section discusses the use of field techniques to evaluate the nature and extent of contamination at the 200-SW-1 and 200-SW-2 OUs.

### A3.5.1 Geophysical Surveys

Geophysical surveys will be performed using magnetic and electromagnetic methods. Ground-penetrating radar may be used to confirm correlations between the first two methods. For the industrial waste sites, a survey grid with a 10 m spacing will be used to perform walking surveys over the entire waste site. The dry waste burial grounds will be surveyed making a survey pass down the centerline of each selected trench. If a trench in a dry waste burial ground cannot be located, three survey lines (evenly spaced across the width of the burial ground) will be conducted at right angles to the expected trench direction (i.e., if the trenches are expected to run east-west, the survey lines will run north-south).

Magnetometer/gradiometer surveys will be used to identify the locations of buried ferromagnetic objects, such as drums and metal debris, which will help determine the boundaries of individual trenches and waste sites. Electromagnetic surveys (such as Geonics EM-31[1]) also will be used to map changes in the geo-electrical characteristics of the subsurface. The terrain-apparent conductivity resulting from the survey can detect changes in clay content, water content, water conductivity, and buried conductive metal debris, which also will help determine the boundaries of individual trenches and waste sites, as well as any significant liquid releases.

Ground-penetrating radar surveys also may be used at selected geophysical anomalies (defined by the magnetometer/gradiometer and/or electromagnetic surveys) to help confirm the subsurface limits and depth of the buried object(s).

### A3.5.2 Radioactive Contamination Field Screening

Potential radioactive contamination field-screening instrumentation and applications are summarized in Table A-19. These techniques may be used during site characterization activities, as described below.

For sites with radioactive COCs, identification of areas of contamination will be guided by field screening measurements. The same techniques ultimately may be used to guide excavation at RTD sites. Sodium iodide detectors with the ability to discriminate the specific energy of the limiting action levels will be used to provide isotope-specific count rate information. Other detectors may be used on a case-by-case or site-specific basis.

Sodium iodide detectors will be used as a screening method to determine whether contamination levels are within allowable limits, or that contamination significantly exceeds background. If the onsite radioactive contamination measurements indicate acceptable levels of contamination for release of the site, soil samples will be collected for high-purity germanium analysis in a laboratory. If the NaI and high-purity germanium analyses agree, the verification release process will be initiated.

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[1]Geonics and EM-61 are trademarks of Geonics Limited, Mississauga, Ontario Canada.

If the surface radiation surveys indicate that concentrations in the area being characterized exceed release levels, samples will not be collected, because additional excavation is required. If, however, the general area contamination levels are deemed acceptable, but discrete hot spots are noted, samples will be collected from the hot spots for high-purity germanium analysis.

The surveys will be used to identify existing surface contamination. Qualified radiological control technicians shall conduct surface radiation surveys in accordance with applicable approved radiological procedures (see Section A2.7). A post-sampling survey also will be performed to document changes to the surface contamination levels as a result of sampling activities.

Radioactive contamination survey information will be used to make a decision concerning no action and/or completeness of soil removal actions. Gridded surveys will provide an estimate of the spatial variability of the radioactive contamination. The surveys will be a combination of static counting, sequential static counting, and scanning counts, depending on the identity and level of contamination to be detected. Because of the unique sizes and contaminant distributions, each site will require a slightly different design. In addition to identifying any areas of elevated residual radioactivity that can aid in the selection of focused samples, the data can be used to evaluate spatial variability for representative statistical sampling designs. The minimum detectable activity and scan speed determinations for survey instrumentation will be determined based on the instrumentation selected, the matrix of the media under consideration, and the counting times used, as appropriate.

### A3.5.3 Passive Gamma Surveys

Passive gamma surveys will be used as a screening method at Bin 3B sites. For example, thermoluminescent dosimeters (TLD), which are specially calibrated aluminum oxide dosimeters, will be placed throughout the trench to be characterized. To accurately gauge the amount of radioactive material at depth, TLDs will be strategically placed over anomalies discovered during the geophysical surveys in the industrial waste burial grounds, and down a grid along the centerline of the trenches selected for characterization in each dry waste burial ground. As part of the survey process, a grid will be set up over each trench that will be characterized. The grids will pinpoint where real-time radioactive contamination readings will need to be taken and where TLDs will be placed. A process similar to what will be implemented is described in HNF-13536, Section 3.1.2, "Evaluation of Outdoor Contamination Areas," Appendix C. The survey and grid spacing will be one of the first steps as part of the characterization process. The TLDs may be placed in a shielded enclosure on all sites except the few that would be in contact with the ground surface, as needed.

### A3.5.4 Consideration of Trench-Specific Ambient Gamma Levels

The background used to determine surface radioactive contamination levels in each trench will be determined on a site-by-site basis, as appropriate, depending on the sample matrix and the instrumentation utilized. Ambient gamma readings will be considered as part of the

characterization activities. Using real-time instrumentation, gamma readings will be evaluated over each trench. This information will be used as part of the TLD placement.

### A3.5.5 Chemical-Screening Measurements

Table A-20 lists the chemical field-screening methods that may be used at RTD sites during soil removal operations. Where field screening can be used to detect and quantify contaminant concentrations at the site, a relative percent difference or ($s$) and ($\bar{x}$) can be computed. Non-detect results should be considered at half the detection limit for such computations (*Statistical Guidance for Ecology Site Managers* [Ecology 1992]). If more than 50 percent of the results are below detection, the field measurements are not suitable for computing a relative percent difference or ($s$) and ($\bar{x}$).

Chemical field screening may be employed to determine anomalous conditions, assess site contaminant variability, and confirm the need for remediation. The potential nonradioactive COCs will be evaluated against potential screening technologies to determine if field screening offers an advantage. Censored data (non-detect results) are not likely usable when the practical quantitation limit of the field-screening method is equal to or above the level of concern.

Chemical field screening will be completed using the most practical techniques appropriate under expected sampling constraints. COC fate and transport, constituent location, and environmental impacts (such as degradation) must be considered in determining target compounds for field screening.

Field-screening instruments will be used, maintained, and calibrated in accordance with the manufacturer's specifications and other approved procedures. The field geologist will record field-screening results in the field log.

## A4.0 HEALTH AND SAFETY

All field operations will be performed in accordance with Fluor Hanford health and safety requirements and the appropriate Waste Disposal/GRP procedures. In addition, a work control package will be prepared, in accordance with procedures that will further control site operations. This package will include an activity hazard analysis, a site-specific health and safety plan, and applicable radiological work permits. Work shall be performed in accordance with site-specific health and safety plans and applicable radiological work permits.

The sampling procedures and associated activities will take into consideration exposure reduction and contamination control techniques that will minimize the radiation exposure to the sampling team as required by the procedures mentioned above.

Health and safety personnel will use data collected during the response action as input to determine exposure levels to workers and to conduct health and safety assessments in accordance with the health and safety plan.

## A5.0 MANAGEMENT OF INVESTIGATION-DERIVED WASTE

The waste generated during excavation or characterization activities will be managed in accordance with the "Strategy for Management of Investigation Derived Waste" (Ecology et al. 1995) and as directed in the 200-SW-1 and 200-SW-2 OU waste control plan (to be prepared). Guidance will be provided on the management of investigation-derived waste, waste minimization practices, and waste types applicable to the 200-SW-1 and 200-SW-2 OU sampling and analysis activities.

Unused samples and associated laboratory waste from analyses will be dispositioned in accordance with the laboratory contract, which in most cases will require the laboratory to dispose of this material. The approval of the remedial project manager is required before returning unused samples or waste from offsite laboratories.

Investigation-derived waste is defined as potentially contaminated waste materials that result from field characterization activities and may pose a risk to human health and the environment. This waste may include soil and other materials from the collection of samples, residues from the testing of treatment technologies, contaminated personal protective equipment, decontamination fluids (aqueous or otherwise), and disposable sampling equipment (*Guide to the Management of Investigation-Derived Wastes*, Publication 9345.3FS [EPA 1992]).

## A6.0 REFERENCES

10 CFR 830.120, "Quality Assurance Requirements," Title 10, *Code of Federal Regulations*, Part 830.120, as amended.

49 CFR, "Transportation," Title 49, *Code of Federal Regulations*, as amended.

69 FR 39449, "Record of Decision for the Solid Waste Program, Hanford Site, Richland WA; Storage and Treatment of Low-Level Waste and Mixed Low-Level Waste; Disposal of Low-Level Waste and Mixed Low-Level Waste, and Storage, Processing, and Certification of Transuranic Waste for Shipment to the Waste Isolation Pilot Plant," *Federal Register*, Vol. 69, No. 125, pp. 39449-39455, June 30, 2004.

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Figure A-1. Location of the Hanford Site and Map Coverage Provided for 200-SW-1 and 200-SW-2 Operable Unit Sites.

NOTE: Plates 1 through 3 are included in Appendix C, in pocket.

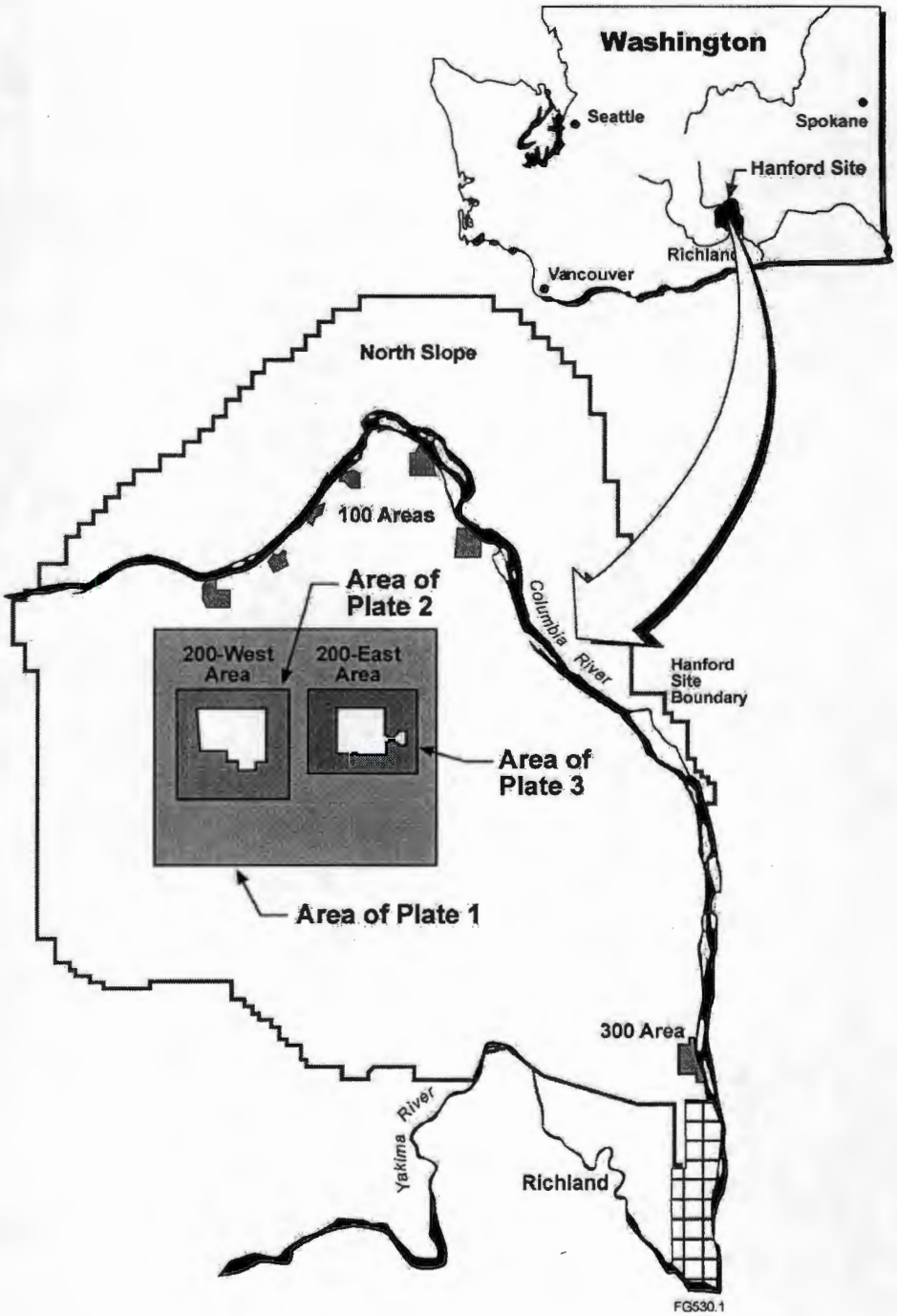
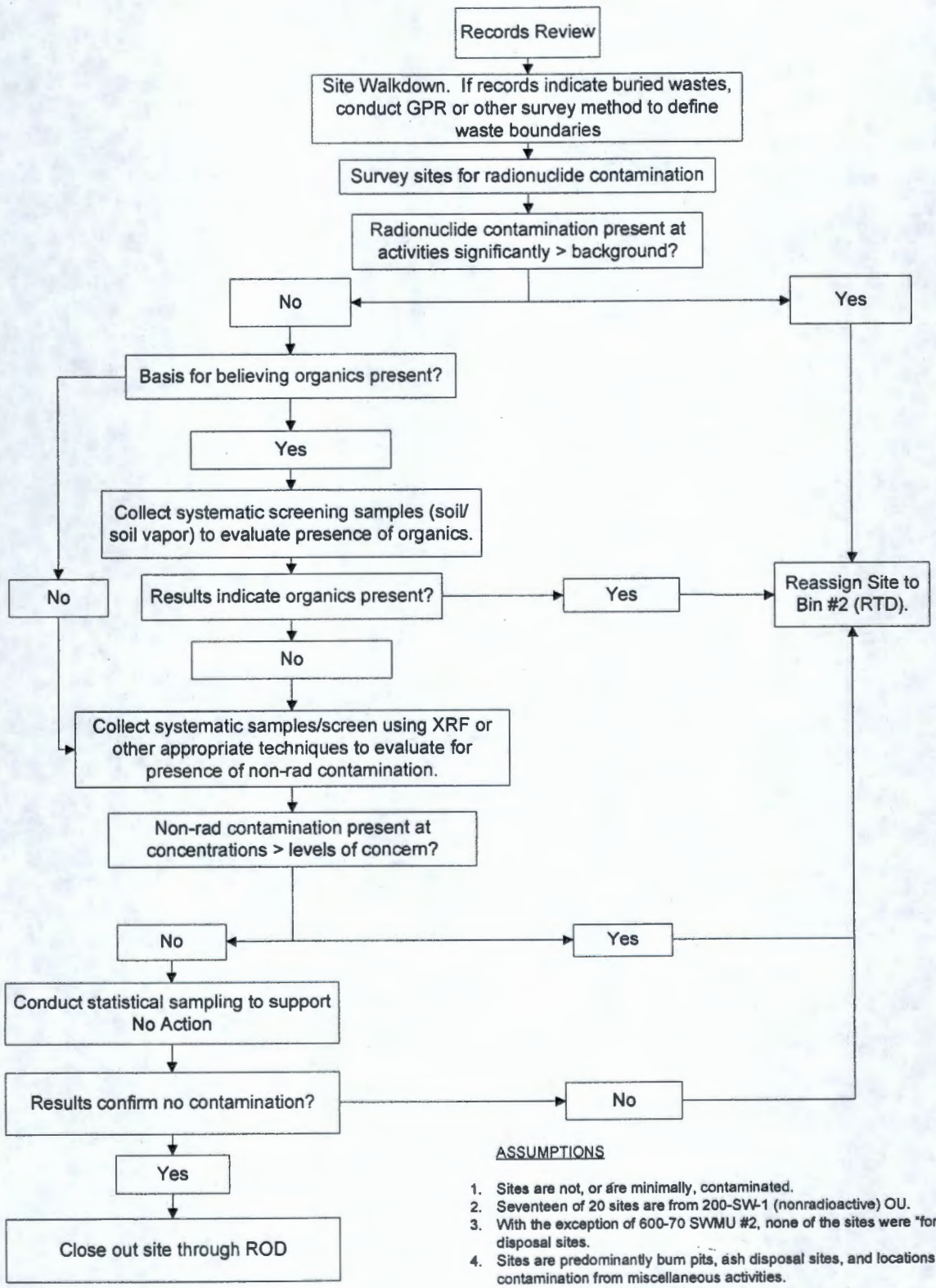


Figure A-2. Bin 1 Characterization Logic.




ASSUMPTIONS

1. Sites are not, or are minimally, contaminated.
2. Seventeen of 20 sites are from 200-SW-1 (nonradioactive) OU.
3. With the exception of 600-70 SWMU #2, none of the sites were "formal" waste disposal sites.
4. Sites are predominantly burn pits, ash disposal sites, and locations of random contamination from miscellaneous activities.
5. Most contamination thought to be surface or near surface.

Figure A-3. Possible Systematic-Grid Field Measurement Locations for Bin 1 Site, Central Plateau.

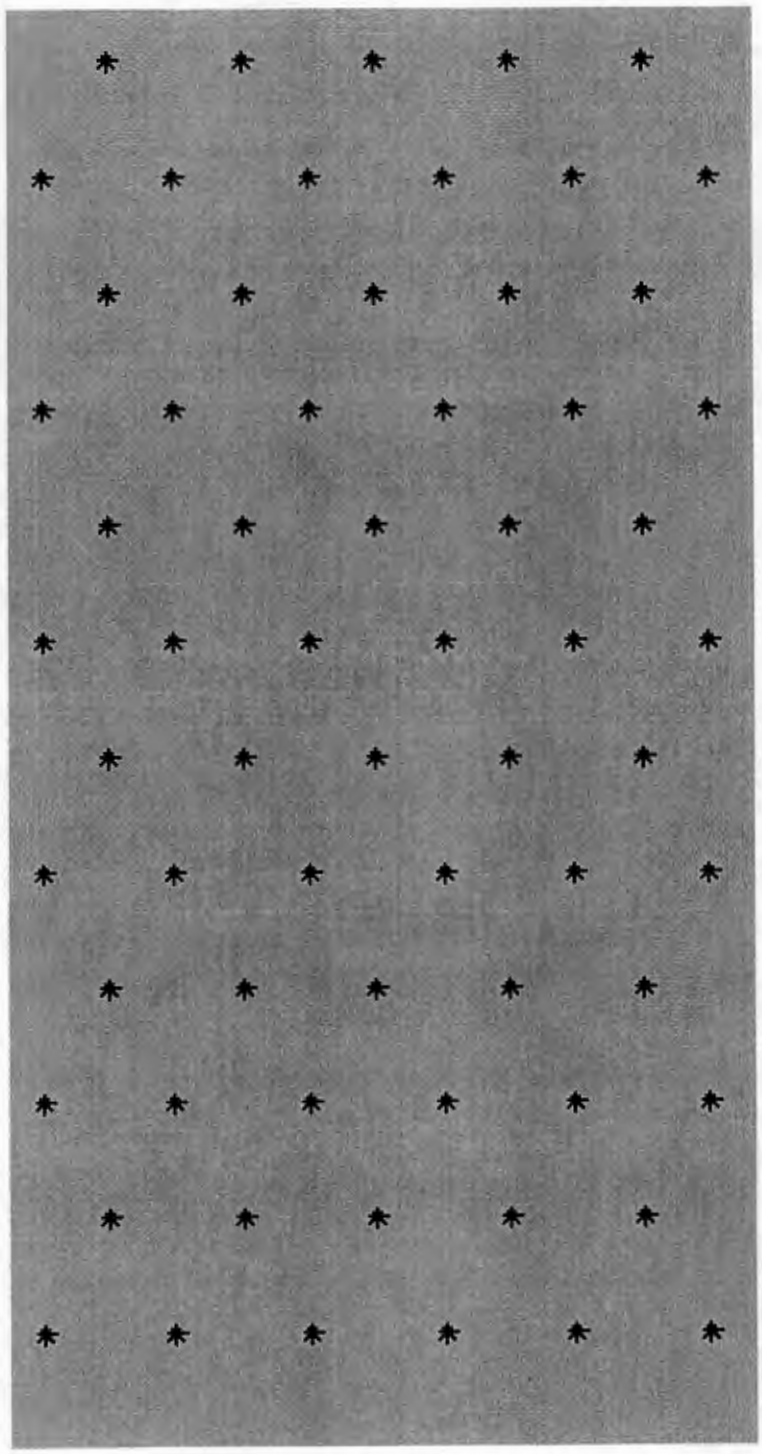
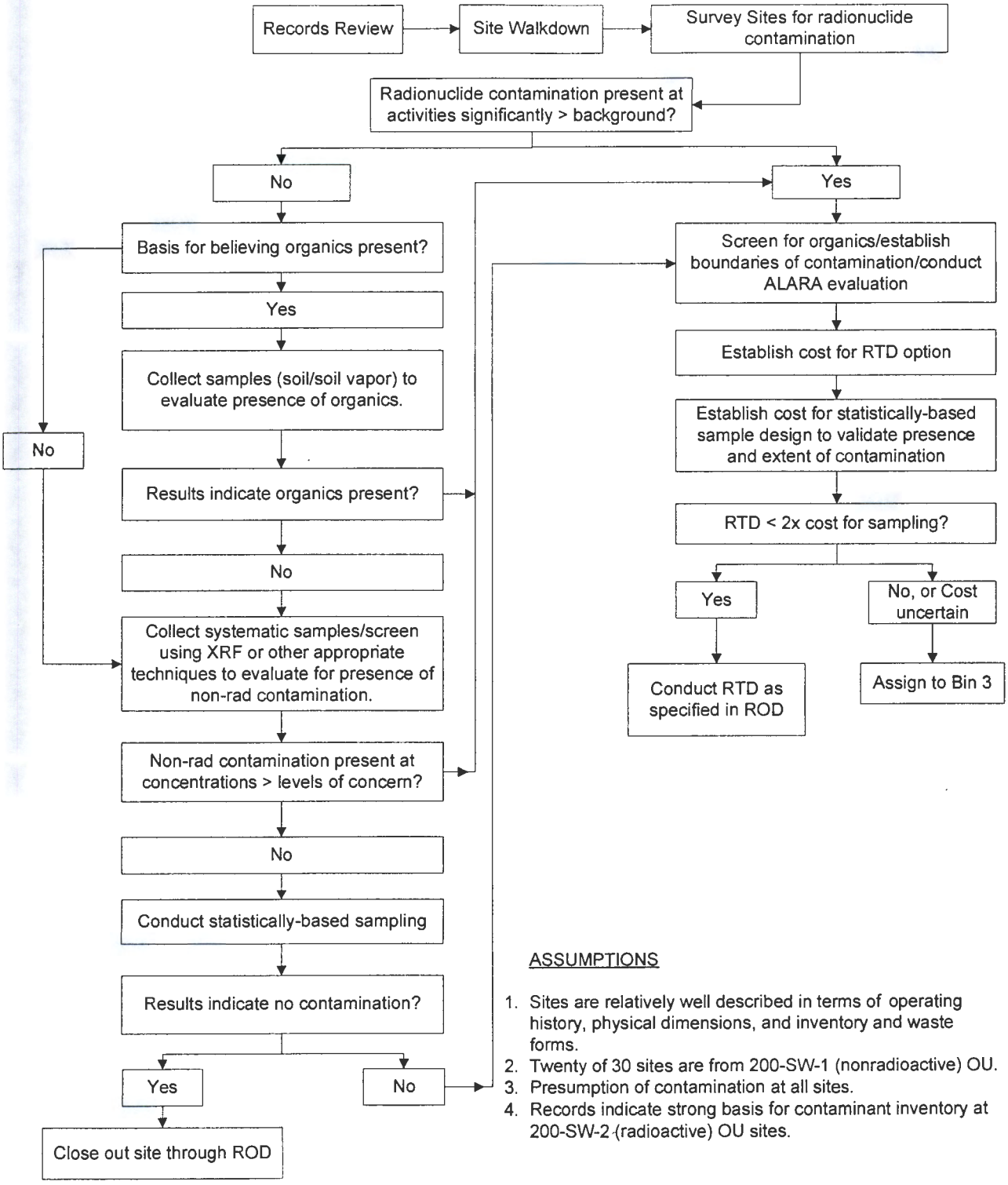


Figure A-4. Bin 2 Characterization Logic.




ASSUMPTIONS

1. Sites are relatively well described in terms of operating history, physical dimensions, and inventory and waste forms.
2. Twenty of 30 sites are from 200-SW-1 (nonradioactive) OU.
3. Presumption of contamination at all sites.
4. Records indicate strong basis for contaminant inventory at 200-SW-2 (radioactive) OU sites.

Figure A-5. Bin 3B Industrial Waste Characterization Concept.

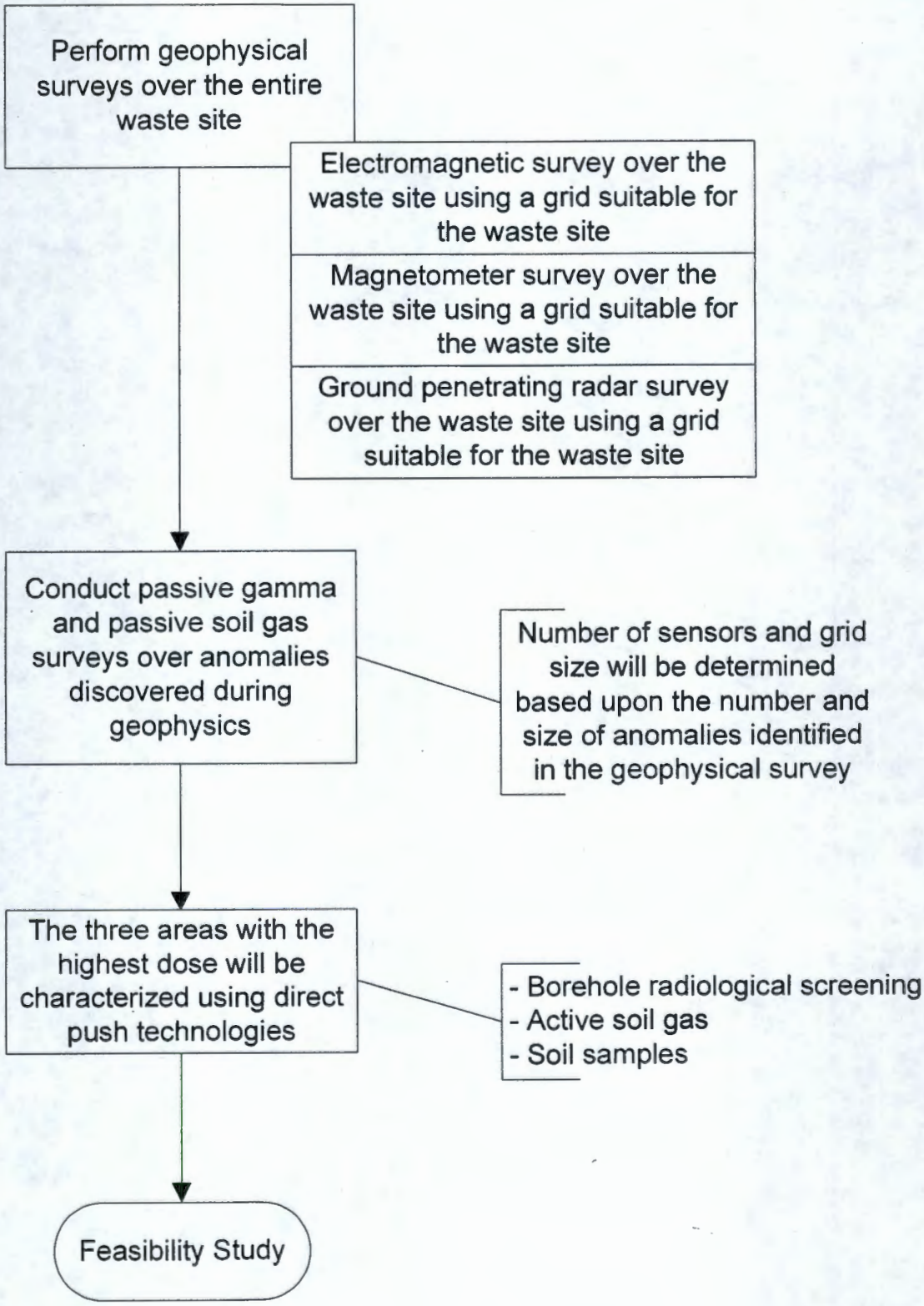


Figure A-6. Bin 3B Dry Waste Characterization Concept.

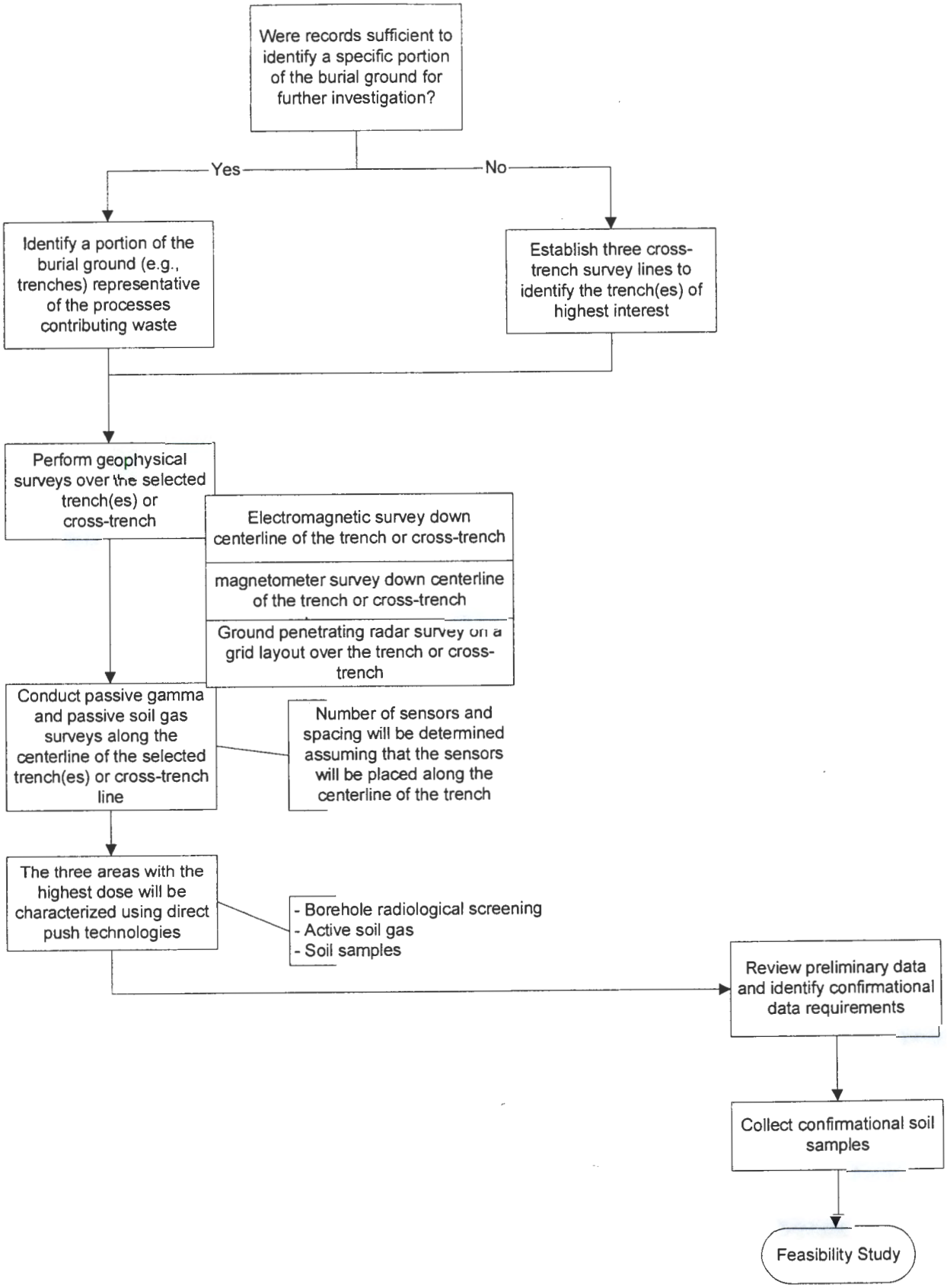


Table A-1. 200 SW-1 and 200-SW-2 Remediation Bins. (4 Pages)

| Site ID (Operable Unit) | Site Name | WIDS Reclassification Status |
|---|---|---|
| **Bin 1 (20 Sites) – No Remediation Planned – Samples Required to Confirm** | | |
| 200 CP (200-SW-1) | 200 Area Construction Pit | Accepted |
| 200-E BP (200-SW-1) | 200-E Burn Pit | Accepted |
| 200-E-1 (200-SW-1) | 284-E Landfill | Accepted |
| 200-E-2 (200-SW-1) | Soil Stains at the 2101M SW Parking Lot, MO-234 Parking Lot | Accepted |
| 200-N-3 (200-SW-1) | 200-N-3 Ballast Pits | Accepted |
| 200-W ADB (200-SW-1) | 200-W Ash Disposal Basin | Accepted |
| 200-W BP (200-SW-1) | 200-W Burn Pit | Accepted |
| 200-W-1 (200-SW-1) | REDOX Mud Pit West | Accepted |
| 200-W-12 (200-SW-1) | 201-W Soil Mound and Plastic Pipe | Accepted |
| 200-W-2 (200-SW-1) | REDOX Berms West | Accepted |
| 200-W-3 (200-SW-1) | 2713-W North Parking Lot, 220-W-1 | Accepted |
| 200-W-6 (200-SW-1) | 200-W Painter shop paint solvent disposal area | Accepted |
| 218-E-9 (200-SW-2) | 200E Regulated Equipment Storage Site No. 009, Burial Vault (HISS) | Accepted |
| 291-C-1 (200-SW-2) | 291C Stack Burial Trench | Accepted |
| 600-146 (200-SW-1) | Steel Structure NW of Gable Mt | Accepted |
| 600-228 (200-SW-1) | H-40 Gun Site | Accepted |
| 600-70 (200-SW-1) | Solid Waste Management Unit #2 | Accepted |
| 628-2 (200-SW-1) | 100 Fire Station Burn Pit | Accepted |
| UPR-200-W-63 (200-SW-2) | Contamination S. Shoulder 23rd St. | Accepted |
| UPR-200-W-70 (200-SW-1) | Contamination Found at the 200 West Burning Ground East of Beloit Ave. | Accepted |

Table A-1. 200 SW-1 and 200-SW-2 Remediation Bins. (4 Pages)

| Site ID (Operable Unit) | Site Name | WIDS Reclassification Status |
|---|---|---|
| **Bin 2 (30 Sites) – Remove/Treat/Dispose Using Observational Approach** | | |
| 200-E-122 (200-SW-1) | Construction Forces Bullpen | Accepted |
| 200-E-13 (200-SW-1) | Rubble Piles | Accepted |
| 200-E-46 (200-SW-1) | Solid Debris | Accepted |
| 200-W-101 (200-SW-2) | Contaminated Material W of 216-S-12 Crib | Accepted |
| 200-W-11 (200-SW-1) | S Farm Concrete Foundation | Accepted |
| 200-W-33 (200-SW-1) | Solid Waste Dumping Area | Accepted |
| 200-W-55 (200-SW-1) | Dump N of 231Z | Accepted |
| 200-W-75 (200-SW-2) | Rad Logging System Silos | Accepted |
| 200-W-92 (200-SW-2) | Soil Mound W of TY Farm | Accepted |
| 218-E-2 (200-SW-2) | Equip Burial #2 | Accepted |
| 218-E-4 (200-SW-2) | Equip Burial #4 | Accepted |
| 218-E-7 (200-SW-2) | 222B Vaults | Accepted |
| 218-W-7 (200-SW-2) | 222S Vaults | Accepted |
| 218-W-8 (200-SW-2) | 222T Vaults | Accepted |
| 218-W-9 (200-SW-2) | Dry Waste Burial #9 | Accepted |
| 600 OCL (200-SW-1) | 600 Original Central Landfill | Accepted |
| 600-218 (200-SW-1) | H-61 Anti-Aircraft Dump | Accepted |
| 600-220 (200-SW-1) | H-51 Anti-Aircraft Dump | Accepted |
| 600-222 (200-SW-1) | H-60 Gun Site | Accepted |
| 600-226 (200-SW-1) | H-42 Gun Site | Accepted |
| 600-281 (200-SW-1) | Scattered Debris South of Army Loop Road | Accepted |

Table A-1. 200 SW-1 and 200-SW-2 Remediation Bins. (4 Pages)

| Site ID (Operable Unit) | Site Name | WIDS Reclassification Status |
|---|---|---|
| 600-36 (200-SW-1) | Ethel RR Siding Burn Pit | Accepted |
| 600-38 (200-SW-1) | Susie Junction | Accepted |
| 600-40 (200-SW-1) | W of W Lake Dumping Area | Accepted |
| 600-51 (200-SW-1) | Chemical Dump | Accepted |
| 600-65 (200-SW-1) | 607 Batch Plant Drum Site | Accepted |
| 600-66 (200-SW-1) | 607 Batch Plant Orphan Drums | Accepted |
| 600-71 (200-SW-1) | 607 Batch Plant Burn Pit | Accepted |
| OCSA (200-SW-1) | Old Central Shop Area | Accepted |
| UPR-200-E-35 (200-SW-2) | Buried Pipe, Contaminated | Accepted |
| **Bin 3A (9 Sites) – Characterize to Support Landfill Closure** | | |
| 218-E-10[a, b] (200-SW-2) | Equip Burial #10 | Accepted |
| 218-E-12B[a, b, c] (200-SW-2) | Dry Waste #12B | Accepted |
| 218-W-3A[a, b, c] (200-SW-2) | Dry Waste #3A | Accepted |
| 218-W-3AE[a, b] (200-SW-2) | Dry Waste #3AE | Accepted |
| 218-W-4B[a, b, c] (200-SW-2) | Dry Waste #4B | Accepted |
| 218-W-4C[a, b, c] (200-SW-2) | Dry Waste #4C | Accepted |
| 218-W-5[a, b] (200-SW-2) | Low Level Radioactive Mixed Waste Burial Ground | Accepted |
| 600 CL[d] (200-SW-1) | 600 Area Central Landfill | Accepted |
| 600 NRDWL[a] (200-SW-1) | 600 Area Non Radioactive Dangerous Waste Landfill | Accepted |
| **Bin 3B (15 Sites) – Characterize to Support Remedial Investigation/Feasibility Study** | | |
| 218-C-9 (200-SW-2) | Dry Waste & 216-C-9 Pond | Accepted |
| 218-E-1 (200-SW-2) | Dry Waste #1 | Accepted |

Table A-1. 200 SW-1 and 200-SW-2 Remediation Bins. (4 Pages)

| Site ID (Operable Unit) | Site Name | WIDS Reclassification Status |
|---|---|---|
| 218-E-12A (200-SW-2) | Dry Waste #12A | Accepted |
| 218-E-2A (200-SW-2) | Regulated Equip Storage | Accepted |
| 218-E-5 (200-SW-2) | Equip Burial #5 | Accepted |
| 218-E-5A (200-SW-2) | Equip Burial #5A | Accepted |
| 218-E-8 (200-SW-2) | 200E Construction Burial | Accepted |
| 218-W-1 (200-SW-2) | Solid Waste Burial #1 | Accepted |
| 218-W-11 (200-SW-2) | Regulated Storage Site | Accepted |
| 218-W-1A (200-SW-2) | Equip Burial #1 | Accepted |
| 218-W-2 (200-SW-2) | Dry Waste #2 | Accepted |
| 218-W-2A (200-SW-2) | Equip Burial #2 | Accepted |
| 218-W-3 (200-SW-2) | Dry Waste #3 | Accepted |
| 218-W-4A (200-SW-2) | Dry Waste #4A | Accepted |
| UPR-200-E-95 (200-SW-2) | Ground Contamination on RR Spur Between 218-E2A and 216-E5 | Accepted |

[a]Sites that are within a TSD unit boundary.

[b]Sites that are currently within the boundary depicted on DOE/RL-88-20, *Hanford Facility Dangerous Waste Permit Application, Low-Level Burial Grounds.*

[c]Sites that contain retrievably stored waste.

[d]The 600 CL waste site is not a TSD unit but will be closed in conjunction with the adjacent TSD unit, NRDWL.

CL = Central Landfill.
NRDWL = Nonradioactive Dangerous Waste Landfill.
REDOX = Reduction-Oxidation.
RR = railroad.
TSD = treatment, storage and/or disposal (unit).
WIDS = *Waste Information Data System.*

Table A-2. 200-SW-1 and 200-SW-2 Operable Unit Contaminants of Concern. (2 Pages)

| Radioactive Constituents (200-SW-2 OU Sites Only) | |
|---|---|
| Americium-241 | Nickel-63 |
| Antimony-125 | Plutonium-238 |
| Carbon-14 | Plutonium-239/240 |
| Cesium-137 | Radium-226 |

Table A-2. 200-SW-1 and 200-SW-2 Operable Unit Contaminants of Concern. (2 Pages)

| | |
|---|---|
| Cobalt-60 | Radium-228 |
| Europium-152 | Strontium-90 |
| Europium-154 | Technetium-99 |
| Europium-155 | Thorium-232 |
| Hydrogen-3 (Tritium) | Uranium-234 |
| Iodine-129 | Uranium-235 |
| Neptunium-237 | Uranium-238 |
| **Chemical Constituents – Metals (200-SW-1 and 200-SW-2 OU Sites)** | |
| Antimony | Manganese |
| Arsenic (Total) | Mercury |
| Barium | Molybdenum |
| Beryllium | Nickel |
| Cadmium | Selenium |
| Chromium (Total) | Silver |
| Hexavalent Chromium | Strontium |
| Cobalt | Tin |
| Copper | Uranium |
| Lead | Vanadium |
| Lithium | Zinc |
| **Chemical Constituents – Other Inorganics (200-SW-1 and 200-SW-2 OU Sites)** | |
| Ammonia/ammonium | pH |
| Asbestos | Iodine |
| Chloride | Nitrate/Nitrite |
| Cyanide | Phosphate |
| Fluoride | Sulfate/Sulfite |
| **Chemical Constituents – Volatile Organics (200-SW-1 and 200-SW-2 OU Sites)** | |
| 1,1-dichloroethane (DCA) | 4-methylphenol (p-cresol) |
| 1,1-dichloroethene | Carbon Tetrachloride |
| 1,1,1-trichloroethane (TCA) | Chlorobenzene |
| 1,1,2-trichloroethane | Chloroform |
| 1,1,2,2-trichloroethane | Cis-1,2-dichloroethylene |
| 1,2-dichlorobenzene | Dichloromethane (Methylene Chloride) |
| 1,2-dichloroethane (DCA) | Ethylbenzene |
| 1,3-dichlorobenzene | Naphthalene |
| 2,4-dinitrotoluene | n-butyl Benzene |
| 2-butanone (Methyl Ethyl Ketone/MEK) | Tetrachloroethylene (PCE) |
| 2-hexanone (Methyl Isobutyl Ketone/MIBK) | Toluene |
| 2-methylphenol (o-cresol) | Trans-1,2-dichlorotheylene |
| Benzene | Trichloroethylene (TCE) |
| Butanol | Xylene |
| **Chemical Constituents – Semivolatile Organics (200-SW-1 and 200-SW-2 OU Sites)** | |
| Normal paraffin hydrocarbon* | Phenol |
| Tributyl Phosphate | Polychlorinated biphenyls (PCB) |
| Creosote | |
| **Petroleum (200-SW-1 and 200-SW-2 OU Sites)** | |
| Gasoline range organics | Diesel range organics |

*Analyzed as kerosene total petroleum hydrocarbons.
OU = operable unit.

Table A-3. Preliminary Remediation Goals to Support Determination of Detection Limits.

| Subsurface Depths | Preliminary Criteria | Preliminary Remediation Goals |
|---|---|---|
| **Radionuclides Inside the Central Plateau Industrial Land Use (Core Zone) Boundary** | | |
| Shallow Zone<br>0 to 4.6 m (0 to 15 ft) bgs | 15 mrem/yr above background via industrial Core Zone scenario while under DOE control; 15 mrem/yr above background at the end of the exclusive-use period if DOE control is relinquished.[a] | Contaminant-specific; RESRAD modeling[b] |
| Deep Zone<br>(0 m bgs to groundwater) | 4 mrem/yr above background dose from groundwater, or no additional groundwater degradation. | Contaminant-specific; RESRAD modeling[b] |
| **Nonradioactive Constituents Inside the Central Plateau Core Zone Boundary** | | |
| Shallow Zone<br>0 to 4.6 m (0 to 15 ft) bgs | Direct exposure WAC 173-340-745 in Ecology 94-145; and for comparison WAC 173-340-740[c] | Chemical-specific |
| Deep Zone<br>(4.6 m bgs to groundwater) | Soil-screening values for protection of groundwater WAC 173-340-747(4) three-phase equilibrium model in Ecology 94-145 | Chemical-specific |

[a]Radicnuclide standards are not final and will be agreed upon in the ROD.

[b]The RESRAD dose model (ANL 2002, *RESRAD for Windows*, Version 6.21) has been used for similar waste sites and will be used as a minimum for direct exposure. If more appropriate models are developed, they will be evaluated for use.

[c]WAC 173-340-740 standards may be considered for waste sites outside the Core Zone as part of a range of exposure scenarios to provide additional information to decision makers.

Ecology 94-145, *Cleanup Levels and Risk Calculations under the Model Toxics Control Act Cleanup Regulation; CLARC, Version 3.1.*

WAC 173-340-740, "Unrestricted Land Use Soil Cleanup Standards."

WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties."

WAC 173-340-747(4), "Deriving Soil Concentrations for Ground Water Protection," "Overview of Methods," "Fixed Parameter Three-Phase Partitioning Model."

bgs = below ground surface.
DOE = U.S. Department of Energy.
RESRAD = RESidual RADioactivity.
ROD = record of decision.

Table A-4. Decision Rules.

| DS # | DR # | Application | Decision Rule |
|---|---|---|---|
| 1 | 1 | Field Screening for Bin 1 & 2 Sites | If field screening indicates concentrations of chemical contaminants within the soil that are below the compound-specific detection limits[a] for the analytical equipment, and the detected radioactivity is less than the background radiation detected by the field detector, proceed with verification sampling for laboratory analysis. Otherwise, evaluate the site for RTD of waste to an approved disposal facility. |
| 1 | 2 | Verification Sampling for Bin 1 & 2 Sites | If the true mean (as estimated by the 95% UCL on sample mean) of radionuclide or chemical contaminants in a verification sample at a Bin 1 or Bin 2 site is greater than the associated PRG[b] value in Tables A-5 and A-6, then evaluate for RTD of waste to an approved disposal facility. Otherwise, initiate waste site closeout. |
| 2 | 3 | Characterization (Bin 3A) | If the true mean concentration of volatile chemical contaminants (as estimated by the maximum detected value, mean, or 95% UCL on sample mean, as appropriate) in soil samples is greater than the associated PRG[b] value in Table A-6, then evaluate the need for interim action alternatives in an FS. Otherwise, do not evaluate the need for interim action alternatives. |
| 2 | 4 | Characterization (Bin 3B) | If the true mean activity of radionuclides and concentration of chemical contaminants (as estimated by the maximum detected value, mean, or 95% UCL on sample mean, as appropriate) in soil samples is greater than the associated PRG[b] value in Tables A-5 and A-6, or the activity of radionuclide concentrations exceeds background levels, then evaluate remedial alternatives in an FS. Otherwise, initiate waste site closeout. |

[a]Limits are presented in Table A-11 of this sampling and analysis plan.

[b]The PRGs may be modified by site background levels or detection limits as detailed in the data quality objectives document (WMP-22210, *Remedial Investigation Data Quality Objectives Summary Report for the 200-SW-1 and 200-SW-2 Operable Unit Waste Sites*).

DR = decision rule.
DS = decision statement.
FS = feasibility study.
PRG = preliminary remediation goal.
RTD = remove/treat/dispose.
UCL = upper confidence limit.

Table A-5. Summary of Radionuclide Soil-Screening Levels for Protection of Human Health.

| Contaminant | Protection from Direct Exposure | | | |
|---|---|---|---|---|
| | Screening Levels for Radionuclides (Inside Core Zone) | | Screening Levels for Radionuclides (Outside Core Zone)[a] | |
| | pCi/g | Year of Maximum Exposure[b] | pCi/g | Year of Maximum Exposure[b] |
| Americium 241 | 320 | 0 | 41 | 0 |
| Antimony-125 | 35 | 0 | 10 | 0 |
| Carbon-14 | 81,000 | 0 | 4.2 | 0 |
| Cesium-137 | 23 | 0 | 5.7 | 0 |
| Cobalt-60 | 5 | 0 | 1.4 | 0 |
| Europium-152 | 11 | 0 | 3.3 | 0 |
| Europium-154 | 10 | 0 | 3.0 | 0 |
| Europium-155 | 440 | 0 | 130 | 0 |
| Iodine-129 | 3,100 | 0 | 17 | 0 |
| Neptunium-237 | 57 | 0 | 2.4 | 0 |
| Nickel-63 | 3,100,000 | 0 | 2,600 | 0 |
| Plutonium-238 | 450 | 0 | 50 | 0 |
| Plutonium-239/240 | 410 | 0 | 45 | 0 |
| Radium-226 | 6.8 | 10 | 1.0 | 90 |
| Radium-228 | 7.9 | 2 | 1.6 | 1 |
| Strontium-90 | 2,500 | 0 | 3.8 | 0 |
| Technetium-99 | 400,000 | 0 | 33 | 0 |
| Thorium-232 | 4.6 | 120 | 1.0 | 130 |
| Tritium | 98,000 | 0 | 280 | 0 |
| Uranium-234 | 1,800 | 1,000 | 160 | 1,000 |
| Uranium-235 | 97 | 1,000 | 18 | 1,000 |
| Uranium-238 | 440 | 0 | 90 | 0 |

[a]Most restrictive standards based on an unrestricted surface land-use; provides a bounding condition to support a range of exposure scenarios outside the Core Zone for comparative purposes.

[b]Number of years in the future in which the maximum dose from the radionuclide is predicted to occur.

Table A-6. Summary of Nonradionuclide Soil-Screening Levels. (3 Pages)

| Contaminant | Protection from Direct Exposure | |
|---|---|---|
| | Screening Levels for Nonradionuclides (mg/kg) (Inside Core Zone)[a] | Screening Levels for Nonradionuclides (mg/kg) (Outside Core Zone)[b] |
| **Inorganic Chemical Constituents (mg/kg)** | | |
| Antimony | 1,400 | 32 |
| Arsenic (total) | 87.5 | 0.667 |
| Barium | 245,000 | 5,600 |
| Beryllium | 7,000 | 160 |
| Cadmium | 3,500 | 80 |
| Chromium | No Limit | 120,000 |
| Hexavalent chromium | 10,500 | 240 |
| Cobalt | N/A | N/A |
| Copper | 130,000 | 2,960 |
| Lead | No Limit | 250 |
| Lithium | 20,000[c] | 1,600[c] |
| Manganese | 490,000 | 11,200 |
| Mercury | 1,050 | 24 |
| Molybdenum | 17,500 | 400 |
| Nickel | 70,000 | 1,600 |
| Selenium | 17,500 | 400 |
| Silver | 17,500 | 400 |
| Strontium | No Limit | 48,000 |
| Tin | No Limit | 48,000 |
| Uranium | 10,500 | 240 |
| Vanadium | 24,500 | 560 |
| Zinc | No Limit | 24,000 |
| **Other Inorganics – Chemical Constituents (mg/kg)** | | |
| Ammonia/ammonium | Not regulated under WAC 173-340 | Not regulated under WAC 173-340 |
| Chloride | N/A | N/A |
| Cyanide | 70,000 | 1,600 |
| Fluoride | N/A | N/A |
| Nitrate as N | 350,000 | 8,000 |
| Nitrite as N | 350,000 | 8,000 |
| Phosphate | Not regulated under WAC 173-340 | Not regulated under WAC 173-340 |
| Sulfate | N/A | N/A |
| **Organic Chemical Constituents (mg/kg)** | | |
| Benzene | 2,390 | 18.2 |
| n-butyl alcohol (1-butanol) | 350,000 | 8,000 |

Table A-6. Summary of Nonradionuclide Soil-Screening Levels. (3 Pages)

| Contaminant | Protection from Direct Exposure | |
|---|---|---|
| | Screening Levels for Nonradionuclides (mg/kg) (Inside Core Zone)[a] | Screening Levels for Nonradionuclides (mg/kg) (Outside Core Zone)[b] |
| Carbon tetrachloride | 1,010 | 7.69 |
| Chlorobenzene | 70,000 | 1,600 |
| Chloroform (trichloromethane) | 21,500 | 164 |
| Cis/Trans-1,2-Dichloroethylene | 35,000 | 800 |
| 1,2-Dichlorobenzene | 315,000 | 7,200 |
| 1,3-Dichlorobenzene[d] | 70,000 | 1,600 |
| 1,1-Dichloroethane | 350,000 | 8,000 |
| 1,2-Dichloroethane | 1,444 | 11 |
| 1,1-Dichloroethene | 219 | 1.67 |
| Dichloromethane (methylene chloride) | 17,500 | 133 |
| 2,4-Dinitrotoluene | 7000 | 160 |
| Ethyl benzene | 350,000 | 8,000 |
| 2-butanone (Methyl ethyl ketone) | No Limit | 48,000 |
| Methyl isobutyl ketone (MIBK) | 280,000 | 6,400 |
| 2-methylphenol (o-cresol) | 175,000 | 4,000 |
| 4-methylphenol (p-cresol) | 17,500 | 400 |
| Naphthalene | 70,000 | 1,600 |
| n-butyl Benzene[c] | 140,000 | 3,200 |
| Phenol | No Limit | 24,000 |
| Toluene | 700,000 | 16,000 |
| 1,1,1-Trichloroethane (TCA) | No Limit | 72,000 |
| 1,1,2-Trichloroethane | 2,300 | 17.5 |
| 1,1,2,2-Tetrachloroethane | 656 | 5 |
| Tetrachloroethylene (PCE) | 2,570 | 19.6 |
| Trichloroethylene (TCE) | 11,900 | 90.9 |
| Xylene | 700,000 | 16,000 |
| **Other Constituents (mg/kg)** | | |
| Total Petroleum Hydrocarbon-diesel range | 2,000[e] | 2,000[e] |
| Total Petroleum Hydrocarbon-gasoline range | 100[e] | 100[e] |
| Polychlorinated biphenyls (Total Aroclors) | 10[e,f] | 0.5[f] |
| Hydraulic Fluids (greases) | 2,000[e] | 2,000[e] |

Table A-6. Summary of Nonradionuclide Soil-Screening Levels. (3 Pages)

| Contaminant | Protection from Direct Exposure | |
|---|---|---|
| | Screening Levels for Nonradionuclides (mg/kg) (Inside Core Zone)[a] | Screening Levels for Nonradionuclides (mg/kg) (Outside Core Zone)[b] |
| **Polychlorinated Biphenyls** | | |
| Aroclor-1016 | 1,880[g] | 0.143[g] |
| Aroclor-1254 | 65.6[g] | 0.5[g] |
| Aroclor-1260 | 65.6[g] | 0.5[g] |

Aroclor is an expired trademark.

[a]Calculated in accordance with WAC 173-340-745(5)(b)(iii)(B), , "Soil Cleanup Standards for Industrial Properties," "Method C Industrial Soil Cleanup Levels," "Standard Method C Industrial Soil Cleanup Levels," "Human Health Protection," "Soil Direct Contact."

[b]Most restrictive standards based on an unrestricted surface land-use; provides a bounding condition to support a range of exposure scenarios outside the Core Zone for comparative purposes.

[c]No WAC value, value from EPA 2002, *Region 9 Preliminary Remediation Goals (PRG) 2002 Tables.*

[d]No WAC value, value from EPA 2004, *EPA Region 3 Risk Based Concentration (RBC) Tables*, October 2004 Update.

[e]Based on WAC 173-340, "Model Toxics Control Act -- Cleanup," Method A values from Tables 740-1 and 745-1 of WAC 173-340-900, "Tables," amended February 12, 2001.

[f]Compliance is based on the sum of all Aroclors detected.

[g]No WAC value as a carcinogen, value calculated using cancer slope factor from EPA Region 3.

EPA = U.S. Environmental Protection Agency.
N/A = not applicable.
WAC = *Washington Administrative Code.*

Table A-7. Tolerable Decision Errors.

| DS # | Media | COPCs | Parameter of Interest | Statistic of Interest[a] | Tolerable Decision Error | |
|---|---|---|---|---|---|---|
| | | | | | False Positives (%) | False Negatives (%) |
| 1 | Varies[b] | Radionuclides and chemicals | Population mean concentration | Single-tailed 95% UCL of sample results | 5 | 20 |
| 2 | Soil | Radionuclides and chemicals | Population mean concentration | Single-tailed 95% UCL of sample results | 5 | 20 |

[a]For any judgmental samples, the maximum sample concentration value is used rather than the 95% UCL.

[b]Assumed to be soil, gravel, or debris.

COPC = contaminant of potential concern.
DS = decision statement.
UCL = upper confidence limit.

Table A-8. Correlation Table.

| EPA QA/R-5[a] Criteria | EPA QA/R-5[a] Title | Reference Section |
|---|---|---|
| Project Management | Project/Task Organization | (DOE/RL-98-28[b]), Figure 1 (HNF-20635[c]) |
| | Problem Definition and Background | A1.4.1, A1.1 |
| | Project Task Description | A1.0, A2.0 |
| | Quality Objectives and Criteria | A1.4, A2.2 |
| | Special Training/Certification | A2.7 |
| | Documents and Records | A2.7 |
| Data Generation and Acquisition | Sample Process Design | A3.0, A1.4.4 |
| | Sampling Methods | A2.7 |
| | Sample Handling and Custody | A2.7.4, A2.7.5, A2.7.6 |
| | Analytical Methods | A2.2, Tables A-9, A-10, and A-11, A2.8 |
| | Quality Control | A2.1, A2.2 |
| | Instrument/Equipment Testing, Inspection, and Maintenance | A2.7 |
| | Instrument/Equipment Calibration and Frequency | A2.7 |
| | Inspection and Acceptance of Supplies and Consumables | A2.7 |
| | Non Direct Measurement | A1.1, 5.2.1 and 4.2 (Work Plan) |
| | Data Management | A2.5 |
| Assessment and Oversight | Assessment and Response Actions | A2.7 |
| | Reports to Management | A2.7 |
| Data Validation and Usability | Data Review, Verification, and Validation | A2.6 |
| | Verification and Validation Methods | A2.6 |
| | Reconciliation with User Requirements | A2.5 (DOE/RL-98-28) |

[a]EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R-5.

[b]DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program.*

[c]HNF-20635, *Groundwater Remediation Project Quality Assurance Project Plan (GRP-QA-001).*

EPA = U.S. Environmental Protection Agency.
QA = quality assurance.

Table A-9. Radionuclide Analytical Performance Requirements for Soil Samples. (2 Pages)

| Chemical Abstracts Service # | Analyte | Survey or Analytical Method | Human Health Action Levels | | Ecological Protection | Required Target Quantitation Limits[f] | | Precision Required (%)[c] | Accuracy Required (%)[c] |
|---|---|---|---|---|---|---|---|---|---|
| | | | 15 mrem/yr Industrial (pCi/g) | 15 mrem/yr (Outside Core Zone)[i] (pCi/g) | Ecological Soil-Screening Values (pCi/g) | Water[g] (pCi/mL) | Soil (pCi/g[a]) | | |
| **Field Screening Measurements** | | | | | | | | | |
| N/A | Am-241 | PG-2 NaI detector | N/A | N/A | N/A | N/A | 5 | ±20 | 80-120 |
| N/A | Gamma-emitting radionuclides | Portable NaI detector | N/A | N/A | N/A | N/A | 6.2 | ±20 | 80-120 |
| N/A | Gross alpha | SHP380-A/B Probe<br>DP6DB Probe | N/A | N/A | N/A | N/A | 90 dpm/ 100 $cm^2$ (fixed)<br>20 dpm/ 100 $cm^2$ (remov-able) | ±20 | 80-120 |
| **Laboratory Measurements** | | | | | | | | | |
| 14596-10-2 | Americium-241 | AmAEA[b] | 320 | 41 | 3,890 | -- | 1 | ±35 | 65-135 |
| 14234-35-6 | Antimony-125 | HPGe/GeLi | 35 | 10 | 3,520 | -- | 0.05 | ±35 | 65-135 |
| 14762-75-5 | Carbon-14 (low-level) | Liquid scintillation | 81,000 | 4.2 | 19,000,000 | 200 | 1 | ±35 | 65-135 |
| 10045-97-3 | Cesium-137 | HPGe/GeLi | 23 | 5.7 | 21 | 15 | 0.1 | ±35 | 65-135<br>80-120[h] |
| 10198-40-0 | Cobalt-60 | HPGe/GeLi | 5 | 1.4 | 692 | 25 | 0.05 | ±35 | 65-135<br>80-120[h] |
| 14683-23-9 | Europium-152 | HPGe/GeLi | 11 | 3.3 | 1,520 | -- | 0.1 | ±35 | 65-135 |
| 15585-10-1 | Europium-154 | HPGe/GeLi | 10 | 3.0 | 1,290 | -- | 0.1 | ±35 | 65-135 |
| 14391-16-3 | Europium-155 | HPGe/GeLi | 440 | 130 | 15,800 | -- | 0.1 | ±35 | 65-135 |
| 15046-84-1 | Iodine-129 | Low Energy Photon Spectroscopy | 3,100 | 17 | 5,670 | 0.5 | 0.2 | ±35 | 65-135 |
| 13994-20-2 | Neptunium-237 | NpAEA[b] | 57 | 2.4 | 1,900 | 1 | 1 | ±35 | 65-135 |

Table A-9. Radionuclide Analytical Performance Requirements for Soil Samples. (2 Pages)

| Chemical Abstracts Service # | Analyte | Survey or Analytical Method | Human Health Action Levels | | Ecological Protection | Required Target Quantitation Limits[f] | | Precision Required (%)[c] | Accuracy Required (%)[c] |
|---|---|---|---|---|---|---|---|---|---|
| | | | 15 mrem/yr Industrial (pCi/g) | 15 mrem/yr (Outside Core Zone)[i] (pCi/g) | Ecological Soil-Screening Values (pCi/g) | Water[g] (pCi/mL) | Soil (pCi/g[a]) | | |
| 13981-37-8 | Nickel-63 | Liquid scintillation | 3,100,000 | 2,600 | 22,000,000 | -- | 30 | ±35 | 65-135 |
| 13981-16-3 | Plutonium-238 | PuAEA[b] | 450 | 50 | 5,400 | -- | 1 | ±35 | 65-135 |
| Pu-239/240 | Plutonium-239/240 | PuAEA[b] | 410 | 45 | 6,110[d] | -- | 1 | ±35 | 65-135 |
| 13982-63-3 | Radium-226 | HPGe/GeLi | 6.8 | 1.0 | 51 | -- | 0.2 | ±35 | 65-135 |
| 15262-20-1 | Radium-228 | HPGe/GeLi | 7.9 | 1.6 | 44 | -- | 0.1 | ±35 | 65-135 |
| 10098-97-2 | Strontium-90 | Rad Sr | 2,500 | 3.8 | 22 | 2 | 1 | ±35 | 65-135 |
| 14133-76-7 | Technetium-99 | Liquid scintillation | 400,000 | 33 | 4,490 | 20 | 15 | ±35 | 65-135 |
| 7440-29-1 | Thorium-232 | ThAEA[b] | 4.6 | 1.0 | 1,510 | -- | 0.1 | ±35 | 65-135 |
| 10028-17-8 | Tritium (mid-level) | Liquid separation | 98,000 | 280 | 174,000 | 400 | 30 | ±35 | 65-135 |
| 13966-29-5 | Uranium-234 | UAEA[b] | 1,800 | 160 | 4,830 | -- | 1 | ±35 | 65-135 |
| 15117-96-1 | Uranium-235 | | 97 | 18 | 2,770[e] | -- | 1 | ±35 | 65-135 |
| 7440-61-1 | Uranium-238 | | 440 | 90 | 1,580 | -- | 1 | ±35 | 65-135 |

[a]Units are in pCi/g unless otherwise specified.

[b]AmAEA, NpAEA, PuAEA, ThAEA, UAEA = chemical separation, electro/microprecipitation deposition, alpha energy analysis via Si barrier detector.

[c]Accuracy criteria for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional analysis-specific evaluations also performed for matrix spikes, tracers, and carriers as appropriate to the method. Precision criteria for batch laboratory replicate sample analyses.

[d]Plutonium-239.

[e]Uranium-235.

[f]Detection limits are based on optimal conditions in a standard fixed laboratory. Interferences and matrix effects may degrade the values shown.

[g]Water detection limits are for quality control samples (e.g., trip blanks).

[h]Accuracy for water measurements.

[i] Most restrictive standards based on an unrestricted surface land-use; provides a bounding condition to support a range of exposure scenarios outside the Core Zone for comparative purposes.

DP6DB, PG-2, and SHP380-A/B are trademarks of Eberline Instruments, a subsidiary of Thermo Electron Corporation, Waltham, Massachusetts

AEA = alpha energy analysis.
GeLi = germanium-lithium.
N/A = not applicable.
NaI = sodium iodide.
HPGe = high-purity germanium.

Table A-10. Nonradionuclide Analytical Performance Requirements for Soil Samples. (6 Pages)

| Chemical Abstracts Service # | Analyte | Survey or Analytical Method[a] | Human Health Action Levels | | | Ecological Protection | | Required Detection Limits[b] | | Precision Required (%) | Accuracy Required (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | WAC 173-340-740 (Outside Core Zone)[m] (mg/kg) | WAC 173-340-745 Industrial (Inside Core Zone) (mg/kg) | WAC 173-340-747 Protection of Groundwater (mg/kg) | WAC 173-340-900 Table 749-2 (Outside Core Zone)[c] (mg/kg) | WAC 173-340-900 Table 749-3 (Inside Core Zone)[c] (mg/kg) | Water (µg/L) | Soil (mg/kg) | | |
| **Metal Constituents** | | | | | | | | | | | |
| 7440-36-0 | Antimony | EPA Method 6010 or 200.8 | 32 | 1,400 | 5.4 | 5[f] | 5[f] | 10 | 5 | ±30[d] ±25[k] | 70-130[d] ±25[k] |
| 7440-38-2 | Arsenic | EPA Method 6010 or 200.8 (Trace ICP) | 0.667 | 87.5 | 0.03 | 7[i] | 7[i] | 10 | 0.6 | ±30[d] ±25[k] | 70-130[d] ±25[k] |
| 7440-39-3 | Barium | EPA Method 6010 or 200.8 | 5,600 | 245,000 | 923 | 102 | 102 | -- | 20 | ±30[d] | 70-130[d] |
| 7440-41-7 | Beryllium | EPA Method 6010 or 200.8 | 160 | 7,000 | 63.2 | 10 | 35[g] | -- | 0.5 | ±30[d] | 70-130[d] |
| 7440-43-9 | Cadmium | EPA Method 6010 or 200.8 | 80 | 3,500 | 0.69 | 4 | 14 | 5 | 0.5 | ±30[d] ±25[k] | 70-130[d] ±25[k] |
| 7440-47-3 | Chromium (III) | EPA Method 6010 or 200.8 | 120,000 | No limit | 2000 | 42 | 67 | 10 | 1 | ±30[d] ±25[k] | 70-130[d] ±25[k] |
| 18540-29-9 | Hexavalent Chromium | EPA Method 7196 | 240 | 10,500 | 18.4 | -- | -- | 10 | 0.5 | ±30[d] ±25[k] | 70-130[d] ±25[k] |
| 7440-48-4 | Cobalt | EPA Method 6010 or 200.8 | -- | -- | -- | 20[f] | 20[f] | 20 | 1 | ±30[d] ±25[k] | 70-130[d] ±25[k] |
| 7440-50-8 | Copper | EPA Method 6010 or 200.8 | 2,960 | 130,000 | 263 | 50 | 217 | -- | 2.5 | ±30[d] | 70-130[d] |
| 7439-92-1 | Lead | EPA Method 6010 or 200.8 | 250 | No Limit | 3000 | 50 | 118 | 10 | 10 | ±30[d] ±25[k] | 70-130[d] ±25[k] |
| 7439-93-2 | Lithium | EPA Method 6010 or 200.8 | 1,600 | 20,000 | 17.5[e] | 35 | 35 | 25 | 2 | ±30[d] ±25[k] | 70-130[d] ±25[k] |
| 7439-95-4 | Manganese | EPA Method 6010 or 200.8 | 11,200 | 490,000 | 50 | 1,100 | 1,500 | 5 | 0.7 | ±30[d] ±25[k] | 70-130[d] ±25[k] |
| 7439-97-6 | Mercury (inorganic) | EPA Method 7471 or 200.8 | 24 | 1,050 | 2.09 | 0.1 | 5.5 | 0.5 | 0.1 | ±30[d] ±25[k] | 70-130[d] ±25[k] |
| 7439-98-7 | Molybdenum | EPA Method 6010 or 200.8 | 400 | 17,500 | 16.3 | 2 | 7 | -- | 2 | ±30[d] | 70-130[d] |

Table A-10. Nonradionuclide Analytical Performance Requirements for Soil Samples. (6 Pages)

| Chemical Abstracts Service # | Analyte | Survey or Analytical Method[a] | Human Health Action Levels | | | Ecological Protection | | Required Detection Limits[b] | | Precision Required (%) | Accuracy Required (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | WAC 173-340-740 (Outside Core Zone)[m] (mg/kg) | WAC 173-340-745 Industrial (Inside Core Zone) (mg/kg) | WAC 173-340-747 Protection of Groundwater (mg/kg) | WAC 173-340-900 Table 749-2 (Outside Core Zone)[e] (mg/kg) | WAC 173-340-900 Table 749-3 (Inside Core Zone)[c] (mg/kg) | Water (µg/L) | Soil (mg/kg) | | |
| 7440-02-0 | Nickel | EPA Method 6010 or 200.8 | 1,600 | 70,000 | 130 | 30 | 980 | -- | 4 | ±30[d] | 70-130[d] |
| 7782-49-2 | Selenium | EPA Method 6010 (Trace ICP) | 400 | 17,500 | 5.2 | 0.3 | 0.3 | -- | 0.3 | ±30[d] | 70-130[d] |
| 7440-22-4 | Silver | EPA Method 6010 | 400 | 17,500 | 13.6 | 2[f] | 2[f] | -- | 2 | ±30[d] | 70-130[d] |
| 7440-24-6 | Strontium | EPA Method 6010 | 48,000 | No Limit | 2920 | -- | -- | -- | 0.7 | ±30[d] | 70-130[d] |
| 7440-31-5 | Tin | EPA Method 6010 | 48,000 | No Limit | 25,000 | 50[f] | 50[f] | -- | 5 | ±30[d] | 70-130[d] |
| 7440-61-1 | Uranium | KPA | 240 | 10,500 | 1.32 | 5[f] | 5[f] | -- | 0.2 | ±30[d] | 70-130[d] |
| 7440-62-2 | Vanadium | EPA Method 6010 | 560 | 24,500 | 2240 | 2[f] | 2[f] | 50 | 2 | ±30[d] ±25[k] | 70-130[d] ±25[k] |
| 7440-66-6 | Zinc | EPA Method 6010 or 200.8 | 24,000 | No Limit | 5970 | 86 | 360 | -- | 2 | ±30[d] | 70-130[d] |
| **Inorganic Constituents** | | | | | | | | | | | |
| 7664-41-7 | Ammonia/ ammonium | EPA Method 350.3 | Not regulated under WAC 173-340 | Not regulated under WAC 173-340 | Not regulated under WAC 173-340 | -- | -- | 50 | 0.5 | ±30[d] ±25[k] | 70-130[d] ±25[k] |
| 16887-00-6 | Chloride | EPA Method 9056 or 300.7 | -- | -- | 1000 | -- | -- | -- | 0.2 | ±30[d] | 70-130[d] |
| 57-12-5 | Cyanide | EPA Method 9010 total cyanide | 1,600 | 70,000 | 0.8 | -- | -- | 5 | 0.8 | ±30[d] ±25[k] | 70-130[d] ±25[k] |
| 16984-48-8 | Fluoride | EPA Method 9056 | -- | -- | 16 | -- | -- | -- | 0.2 | ±30[d] | 70-130[d] |
| NO3-N | Nitrate as N | IC 300 Modified and 353.1 | 8,000 | 350,000 | 40 | -- | -- | 75 | 0.75 | ±30[d] ±25[k] | 70-130[d] ±25[k] |
| NO2-N | Nitrite as N | IC 300 Modified and 353.1 | 8,000 | 350,000 | 4 | -- | -- | 75 | 0.75 | ±30[d] ±25[k] | 70-130[d] ±25[k] |
| 14265-44-2 | Phosphate | EPA Method 9056 | Not regulated under WAC 173-340 | Not regulated under WAC 173-340 | Not regulated under WAC 173-340 | -- | -- | -- | 5 | ±30[d] | 70-130[d] |

Table A-10. Nonradionuclide Analytical Performance Requirements for Soil Samples. (6 Pages)

| Chemical Abstracts Service # | Analyte | Survey or Analytical Method[a] | Human Health Action Levels | | | Ecological Protection | | Required Detection Limits[b] | | Precision Required (%) | Accuracy Required (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | WAC 173-340-740 (Outside Core Zone)[m] (mg/kg) | WAC 173-340-745 Industrial (Inside Core Zone) (mg/kg) | WAC 173-340-747 Protection of Groundwater (mg/kg) | WAC 173-340-900 Table 749-2 (Outside Core Zone)[e] (mg/kg) | WAC 173-340-900 Table 749-3 (Inside Core Zone)[c] (mg/kg) | Water (µg/L) | Soil (mg/kg) | | |
| 14808-79-8 | Sulfate | EPA Method 9056 | -- | -- | 1000 | -- | -- | -- | 2 | ±30[d] | 70-130[d] |
| **Organic Constituents** | | | | | | | | | | | |
| 71-43-2 | Benzene | EPA Method 8260 | 18.2 | 2,390 | 0.004 | -- | -- | 5 | 0.004 | j | j |
| 71-36-3 | n-butyl alcohol (1-butanol) | EPA Method 8015 | 8,000 | 350,000 | 6.62 | -- | -- | 100 | 5 | j | j |
| 56-23-5 | Carbon tetrachloride | EPA Method 8260 | 7.69 | 1,010 | 0.0031 | -- | -- | 3 | 0.003 | j | j |
| 108-90-7 | Chlorobenzene | EPA Method 8260 | 1,600 | 70,000 | 0.874 | 40[f] | 40[f] | 5 | 0.005 | j | j |
| 67-66-3 | Chloroform (trichloromethane) | EPA Method 8260 | 164 | 21,500 | 0.0381 | -- | -- | 5 | 0.005 | j | j |
| 156-59-2/ 156-60-5 | Cis/Trans-1,2-Dichloroethylene | EPA Method 8260 | 800 | 35,000 | 0.36 | -- | -- | 5 | 0.005 | j | j |
| 95-50-1 | 1,2-Dichlorobenzene | EPA Method 8260 | 7,200 | 315,000 | 7.03 | -- | -- | 5 | 0.001 | j | j |
| 541-73-1 | 1,3-Dichlorobenzene | EPA Method 8260 | 1,600 | 70,000 | -- | -- | -- | 5 | 0.001 | j | j |
| 75-34-3 | 1,1-Dichloroethane | EPA Method 8260 | 8,000 | 350,000 | 4.37 | -- | -- | 5 | 0.01 | j | j |
| 107-06-2 | 1,2-Dichloroethane | EPA Method 8260 | 11 | 1,444 | 0.0023 | -- | -- | 5 | 0.001 | j | j |
| 75-35-4 | 1,1-Dichloroethene | EPA Method 8260 | 1.67 | 219 | 0.00052 | -- | -- | 5 | 0.001 | j | j |
| 75-09-2 | Dichloromethane (methylene chloride) | EPA Method 8260 | 133 | 17,500 | 0.0254 | -- | -- | 1 | 0.005 | j | j |
| 121-14-2 | 2,4-Dinitrotoluene | EPA Method 8270 | 160 | 7,000 | 0.189 | -- | -- | 5 | 0.18 | j | j |

Table A-10. Nonradionuclide Analytical Performance Requirements for Soil Samples. (6 Pages)

| Chemical Abstracts Service # | Analyte | Survey or Analytical Method[a] | Human Health Action Levels | | | Ecological Protection | | Required Detection Limits[b] | | Precision Required (%) | Accuracy Required (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | WAC 173-340-740 (Outside Core Zone)[m] (mg/kg) | WAC 173-340-745 Industrial (Inside Core Zone) (mg/kg) | WAC 173-340-747 Protection of Groundwater (mg/kg) | WAC 173-340-900 Table 749-2 (Outside Core Zone)[e] (mg/kg) | WAC 173-340-900 Table 749-3 (Inside Core Zone)[c] (mg/kg) | Water (µg/L) | Soil (mg/kg) | | |
| 100-41-4 | Ethyl benzene | EPA Method 8260 | 8,000 | 350,000 | 6.05 | -- | -- | 5 | 0.005 | j | j |
| 78-93-3 | Methyl ethyl ketone (MEK) | EPA Method 8260 | 48,000 | No limit | 21.8 | -- | -- | 10 | 0.01 | j | j |
| 108-10-1 | Hexone (Methyl isobutyl ketone - MIBK) | EPA Method 8260 | 6,400 | 280,000 | 12.8 | -- | -- | 10 | 0.01 | j | j |
| 95-48-7 | 2-methyl-phenol (o-cresol) | EPA Method 8270 | 4,000 | 175,000 | 4.66 | -- | -- | 5 | 0.1 | j | j |
| 105-67-9 | 4-methyl-phenol (p-cresol) | EPA Method 8270 | 400 | 17,500 | 140 | -- | -- | 5 | 0.1 | j | j |
| 91-20-3 | Naphthalene | EPA Method 8270 | 1,600 | 70,000 | 4.46 | -- | -- | 5 | 0.1 | j | j |
| 104-51-8 | n-butyl Benzene | EPA Method 8270 | 3,200 | 140,000 | 110 | -- | -- | 5 | 0.1 | j | j |
| 108-95-2 | Phenol | EPA Method 8270 | 24,000 | No limits | 22 | -- | -- | 10 | 0.33 | j | j |
| 108-88-3 | Toluene | EPA Method 8260 | 16,000 | 700,000 | 7.27 | 200[f] | 200[f] | 5 | 0.005 | j | j |
| 71-55-6 | 1,1,1-Tri-chloroethane (TCA) | EPA Method 8260 | 72,000 | No limit | 1.58 | -- | -- | 5 | 0.005 | j | j |
| 79-00-5 | 1,1,2-Tri-chloroethane | EPA Method 8260 | 17.5 | 2,300 | 0.0043 | -- | -- | 5 | 0.004 | j | j |
| 79-34-5 | 1,1,2,2-Tetra-chloroethane | EPA Method 8260 | 5 | 656 | 0.0012 | -- | -- | 5 | 0.005 | j | j |
| 127-18-4 | Tetrachloro-ethylene (PCE) | EPA Method 8260 | 19.6 | 2,570 | 0.0091 | -- | -- | 5 | 0.005 | j | j |

Table A-10. Nonradionuclide Analytical Performance Requirements for Soil Samples. (6 Pages)

| Chemical Abstracts Service # | Analyte | Survey or Analytical Method[a] | Human Health Action Levels | | | Ecological Protection | | Required Detection Limits[b] | | Precision Required (%) | Accuracy Required (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | WAC 173-340-740 (Outside Core Zone)[m] (mg/kg) | WAC 173-340-745 Industrial (Inside Core Zone) (mg/kg) | WAC 173-340-747 Protection of Groundwater (mg/kg) | WAC 173-340-900 Table 749-2 (Outside Core Zone)[e] (mg/kg) | WAC 173-340-900 Table 749-3 (Inside Core Zone)[c] (mg/kg) | Water (µg/L) | Soil (mg/kg) | | |
| 79-01-6 | Trichloro-ethylene (TCE) | EPA Method 8260 | 90.9 | 11,900 | 0.026 | -- | -- | 5 | 0.005 | j | j |
| 1330-20-7 | Xylenes | EPA Method 8260 | 16,000 | 700,000 | 14.6 | -- | -- | 10 | 0.01 | j | j |
| **Other Constituents** | | | | | | | | | | | |
| N/A | Total petroleum hydrocarbon - Diesel Range | EPA Method 8015 | 2,000 | 2,000 | -- | 200 | 6,000[h] | 100 | 5 | j | j |
| N/A | Total petroleum hydrocarbon - Gasoline Range | EPA Method 8015 | 100 | 100 | -- | 100 | 5,000[h] | 100 | 5 | j | j |
| N/A | Polychlorinat-ed biphenyls | EPA Method 8082 | 0.5 | 10 | -- | 0.65 | 0.65 | 100 | 0.02 | j | j |
| N/A | Hydraulic fluids (greases) | Oil & Grease – 413.N or 1664 modified for soil | 2,000 | 2,000 | -- | -- | -- | -- | 200 | ±30[d] | 70-130[d] |

Table A-10. Nonradionuclide Analytical Performance Requirements for Soil Samples. (6 Pages)

| Chemical Abstracts Service # | Analyte | Survey or Analytical Method[a] | Human Health Action Levels | | | Ecological Protection | | Required Detection Limits[b] | | Precision Required (%) | Accuracy Required (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | WAC 173-340-900 | | | | | |
| | | | WAC 173-340-740 (Outside Core Zone)[m] (mg/kg) | WAC 173-340-745 Industrial (Inside Core Zone) (mg/kg) | WAC 173-340-747 Protection of Groundwater (mg/kg) | Table 749-2 (Outside Core Zone)[c] (mg/kg) | Table 749-3 (Inside Core Zone)[c] (mg/kg) | Water (µg/L) | Soil (mg/kg) | | |

[a]For 4-digit EPA methods, see SW-846. For EPA Methods 350.3, 353.1, and 413.N, see EPA/600/4-79/020. For EPA Method 200.8, see EPA/600/R-94/111. For EPA Method 300.7, see EPA/600/4-86/024. For EPA Method 1664, see EPA/821/B-94/004b. The laboratory may substitute 6020 for 6010.

[b]Detection limits are based on optimal conditions in a standard fixed laboratory. Interferences and matrix effects may degrade the values shown.

[c]Based on screening level for wildlife receptor following WAC 173-340-7490(3)(b) and WAC 173-340-900, Table 749-3.

[d]Accuracy criteria are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based controls if more stringent. Additional analyte-specific evaluations also performed for matrix spikes and surrogates as appropriate to the method. Precision criteria for batch laboratory replicate matrix spike analyses.

[e]Based on WAC 173-340-900, Table 749-3, screening level for lowest of wildlife, soil biota, and plant.

[f]No terrestrial wildlife value available, screening value is lowest of soil values for plants and biota (WAC-173-340-900, Table 749-3).

[g]No terrestrial wildlife value available, screening value is soil-screening level for wildlife from EPA OSWER Directive 9285.7-55.

[h]Cannot exceed residual saturation as defined by WAC 173-340-747.

[i]WAC 173-340-900, Table 749-2 provides different values for Arsenic III and Arsenic V. The laboratories used cannot make these isomer distinctions; therefore, the most conservative value (20 mg/kg for Arsenic III) has been adopted.

[j]Organic detection limits and precision/accuracy may vary by matrix and laboratory. SW-846 allows the laboratory to establish statistical limits, which will be used to evaluate data.

[k]Second value, if present, is for water sample analysis.

The letter "l" was not used as a footnote.

[m]Most restrictive standards based on an unrestricted surface land-use; provides a bounding condition to support a range of exposure scenarios outside the Core Zone for comparative purposes.

EPA/600/R-94/111, *Methods for the Determination of Metals in Environmental Samples, Supplement I.*

EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes.*

EPA/600/4-86/024, *Development of Standard Methods for the Collection and Analysis of Precipitation.*

EPA/821/B-94/004b, *Method 1664: N-Hexane Extractable Material (HEM) and Silica Gel Treated N-Hexane Extractable Material (SGT-HEM) by Extraction and Gravimetry (Oil and Grease and Total Petroleum Hydrocarbons).*

EPA 2003, *Guidance for Developing Ecological Soil Screening Levels*, OSWER Directive 9285.7-55.

SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update III-A.*

WAC 173-340, "Model Toxics Control Act -- Cleanup."

WAC 173-340-740, "Unrestricted Land Use Soil Cleanup Standards."

WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties."

WAC 173-340-747, "Deriving Soil Concentrations for Ground Water Protection."

WAC 173-340-900, "Tables."

WAC 173-340-7490(3), "Terrestrial Ecological Evaluation Procedures," "Goal."

-- = no value is given in the pertinent WAC citation for the indicated constituent.
EPA = U.S. Environmental Protection Agency.
IC = ion chromatography.
ICP = inductively coupled plasma.
N/A = not applicable.
OSWER = Office of Solid Waste and Emergency Response.
WAC = *Washington Administrative Code.*

Table A-11. Analytical Performance Requirements for Soil-Vapor Samples. (3 Pages)

| Contaminant of Concern | Chemical Abstracts Service # | Preliminary Action Level[a] | | Name/Analytical Technology | Target Required Quantitation Limits | Precision Vapor[f] (%) | Accuracy Vapor (%) |
|---|---|---|---|---|---|---|---|
| | | TBC Industrial (mg/kg) | GW Protection (mg/kg) | | Vapor (ppmv) | | |
| **Field Screening Measurements** | | | | | | | |
| Total VOCs | N/A | N/A | N/A | Organic vapor monitor[b] | 10 | +/- 25 | 75 - 125 |
| Carbon tetrachloride | 56-23-5 | N/A | N/A | Innova[c] analyzer | 1 | +/- 25 | 75 - 125 |
| | 56-23-5 | N/A | N/A | Photovac 10S Plus[d] gas chromatograph | 0.20 | +/- 25 | 75 - 125 |
| | 56-23-5 | N/A | N/A | MIRAN SapphiIRe Ambient Air Analyzer[e] | 0.05 | +/- 25 | 75 - 125 |
| Chloroform | 67-66-3 | N/A | N/A | Innova multigas analyzer | 1 | +/- 25 | 75 - 125 |
| | 67-66-3 | N/A | N/A | Photovac 10S Plus gas chromatograph | 0.20 | +/- 25 | 75 - 125 |
| | 67-66-3 | N/A | N/A | MIRAN SapphiIRe Ambient Air Analyzer | 0.07 | +/- 25 | 75 - 125 |
| 1,1-dichloroethane | 75-34-3 | N/A | N/A | Photovac 10S Plus gas chromatograph | 0.25 | +/- 25 | 75 - 125 |
| | 75-34-3 | N/A | N/A | MIRAN SapphiIRe Ambient Air Analyzer | 0.4 | +/- 25 | 75 - 125 |
| Tetrachloroethene | 127-18-4 | N/A | N/A | Photovac 10S Plus gas chromatograph | 0.25 | +/- 25 | 75 - 125 |
| | 127-18-4 | N/A | N/A | MIRAN SapphiIRe Ambient Air Analyzer | 0.09 | +/- 25 | 75 - 125 |
| 1,1,1-trichloroethane | 71-55-6 | N/A | N/A | Photovac 10S Plus gas chromatograph | 0.15 | +/- 25 | 75 - 125 |
| Methylene chloride | 75-09-2 | N/A | N/A | Photovac 10S Plus gas chromatograph | 0.10 | +/- 25 | 75 - 125 |
| | 75-09-2 | N/A | N/A | MIRAN SapphiIRe Ambient Air Analyzer | 4 | +/- 25 | 75 - 125 |
| Trichloroethene | 79-01-6 | N/A | N/A | Photovac 10S Plus gas chromatograph | 0.10 | +/- 25 | 75 - 125 |
| | 79-01-6 | N/A | N/A | MIRAN SapphiIRe Ambient Air Analyzer | 4 | +/- 25 | 75 - 125 |
| 1,1,2-trichloroethane | 79-00-5 | N/A | N/A | Photovac 10S Plus gas chromatograph | 0.10 | +/- 25 | 75 - 125 |
| | 79-00-5 | N/A | N/A | MIRAN SapphiIRe Ambient Air Analyzer | 0.25 | +/- 25 | 75 - 125 |
| Acetone | 67-64-1 | N/A | N/A | MIRAN SapphiIRe Ambient Air Analyzer | 5 | +/- 25 | 75 - 125 |
| Ammonia | 7664-41-7 | | | | 0.07 | | |
| Benzene | 71-43-2 | | | | 2 | | |
| n-butyl alcohol | 71-36-3 | | | | 0.25 | | |
| Carbon dioxide absolute | 124-38-9 | | | | 1 | | |
| Carbon dioxide differential | 124-38-9 | | | | 1.5 | | |
| Carbon disulfide | 75-15-0 | | | | 1 | | |
| Chlorobenzene | 108-90-7 | | | | 0.4 | | |
| p-dichlorobenzene | 106-46-7 | | | | 0.25 | | |
| 1,2-dichloroethene | 540-59-0 | | | | 0.6 | | |
| Ethyl benzene | 100-41-4 | | | | 1.2 | | |
| Ethyl chloride | 75-00-3 | | | | 1 | | |
| Ethylene dichloride | 107-06-2 | | | | 0.7 | | |

Table A-11. Analytical Performance Requirements for Soil-Vapor Samples. (3 Pages)

| Contaminant of Concern | Chemical Abstracts Service # | Preliminary Action Level[a] | | Name/Analytical Technology | Target Required Quantitation Limits | Precision Vapor[f] (%) | Accuracy Vapor (%) |
|---|---|---|---|---|---|---|---|
| | | TBC Industrial (mg/kg) | GW Protection (mg/kg) | | Vapor (ppmv) | | |
| Methane | 74-82-8 | N/A | N/A | MIRAN SapphiIRe Ambient Air Analyzer | 1.5 | +/- 25 | 75 - 125 |
| Methyl chloride | 74-87-3 | | | | 1.7 | | |
| Methyl chloroform | 71-55-6 | | | | 0.15 | | |
| Methyl ethyl ketone | 78-93-3 | | | | 1.6 | | |
| Methyl isobutyl ketone | 108-10-1 | | | | 0.35 | | |
| Styrene | 100-42-5 | | | | 0.6 | | |
| Toluene | 108-88-3 | | | | 1 | | |
| 1,1,2,2-tetrachloroethane | 79-34-5 | | | | 0.25 | | |
| Vinyl chloride | 75-01-4 | | | | 0.6 | | |
| Vinylidene chloride | 75-35-4 | | | | 0.2 | | |
| Xylene | 1330-20-7 | | | | 1.3 | | |
| **Laboratory Measurements** | | | | | | | |
| 1,1-dichloroethane | 75-34-3 | N/A | N/A | Passive soil-vapor analysis using SW-846 Methods 5041A and 8260B[g] | 2 to 5 ng/volume of absorbent[g] | +/- 25 | 70 - 130 |
| 1,2-dichloroethane | 107-06-2 | | | | | | |
| Benzene | 71-43-2 | | | | | | |
| Carbon tetrachloride | 56-23-5 | | | | | | |
| Chlorobenzene | 108-90-7 | | | | | | |
| Chloroform | 67-66-3 | | | | | | |
| cis-1,2-dichloroethene | 156-59-2 | | | | | | |
| Ethylbenzene | 100-41-4 | | | | | | |
| Toluene | 108-88-3 | | | | | | |
| Tetrachloroethene | 127-18-4 | | | | | | |
| trans-1,2-dichloroethene | 156-60-5 | | | | | | |
| Trichloroethene | 79-01-6 | | | | | | |
| Xylene | 1330-20-7 | | | | | | |
| Full Suite of VOCs | Compound -specific | N/A | N/A | Active soil-vapor analysis using Method TO-14 (EPA 600/4-89/017), TO-15 (EPA 625/R-96-010b), or SW-846 Method 8260B | 2 to 5 ppbv | +/- 25 | 70 - 130 |

Table A-11. Analytical Performance Requirements for Soil-Vapor Samples. (3 Pages)

| Contaminant of Concern | Chemical Abstracts Service # | Preliminary Action Level[a] | | Name/Analytical Technology | Target Required Quantitation Limits | Precision Vapor[f] (%) | Accuracy Vapor (%) |
|---|---|---|---|---|---|---|---|
| | | TBC Industrial (mg/kg) | GW Protection (mg/kg) | | Vapor (ppmv) | | |

[a]The preliminary action levels are not applicable for field screening.

[b]The organic vapor monitor will include an 11.8 eV lamp. The lamp will ionize and measure compounds with lower ionization potentials, such as carbon tetrachloride (ionization potential of 11.47 eV). However, the total concentration measured may include other volatile organic compounds with ionization potentials less than 11.8 eV.

[c]Innova is a trademark of Innova AirTech Instruments A/S, Ballerup, Denmark.

[d]Photovac 10S Plus is a trademark of Potovac, Inc., Waltham, Massachusetts.

[e]MIRAN and the SapphIRe Ambient Air Analyzer are registered trademarks of Thermo Electron Corporation, Franklin, Massachusetts.

[f]The precision of the analyses using the MIRAN will be confirmed during calibration of the instrument.

[g]Based on EMFLUX technology. EMFLUX is a registered trademark of Beacon Environmental Services, Inc., Bel Air, Maryland.

EPA 600/4-89/017, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air.*
EPA 625/R-96/010b, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition.*
SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update III-A.*

GW = groundwater.
N/A = not applicable.
TBC = to be considered.
VOC = volatile organic compound.

Table A-12. Sample Preservation, Container, and Holding Time Guidelines. (2 Pages)

| Analytes/Methods[a] | Analytical Priority | Bottle | | Volume[b] | Preservation | Packing Requirements | Soil Holding Time | Water Holding Time |
|---|---|---|---|---|---|---|---|---|
| | | Number | Type | | | | | |
| **Radionuclides** | | | | | | | | |
| Americium AEA | 2 | 1 | G/P | 10 g | None | None | 6 months | 6 months |
| Gamma spectroscopy | 4 | 1 | G/P | 1,500 g | None | None | 6 months | 6 months |
| Carbon-14 | 10 | 1 | G/P | 10g | None | None | 6 months | 6 months |
| Isotopic plutonium | 1 | 1 | G/P | 10 g | None | None | 6 months | 6 months |
| Isotopic thorium | 8 | 1 | G/P | 6 g | None | None | 6 months | 6 months |
| Isotopic uranium | 7 | 1 | G/P | 10 g | None | None | 6 months | 6 months |
| Neptunium-237 | 4 | 1 | G/P | 10 g | None | None | 6 months | 6 months |
| Nickel-63 | 10 | 1 | G/P | 6 g | None | None | 6 months | 6 months |
| Strontium-90 | 6 | 1 | G/P | 10 g | None | None | 6 months | 6 months |
| Technetium-99 | 10 | 1 | G/P | 6 g | None | None | 6 months | 6 months |
| Tritium – H-3 | 15 | 1 | G | 100 g | None | None | 6 months | 6 months |
| **Chemicals** | | | | | | | | |
| Alcohols, glycols, and ketones – 8015 | 11 | 3 | G | 40 mL | None | Cool 4 °C | 14 days | 7 days |
| IC anions – 300.0 | 17 | 1 | G/P | 250 g | None | Cool 4 °C | 28 days/ 48 hours | 28 days/ 48 hours |
| ICP metals – 6010A or 6020 | 3 | 1 | G/P | 125 g | None | None | 6 months | 6 months |
| Hexavalent chromium – 7196 | 13 | 1 | G/P | 60 g | None | Cool 4 °C | 30 days | 24 hours |
| Mercury – 7471 – (CV) | 12 | 1 | G | 125 g | None | None | 28 days | 28 days |
| PCBs – 8082 | 5 | 1 | G | 250 g | None | Cool 4 °C | 14/40 days | 7/40 days |
| SVOA – 8270A | 10 | 1 | G | 250 g | None | Cool 4 °C | 14/40 days | 7/40 days |
| Sulfides – 9030 | 14 | 1 | G | 40 g | None | Cool 4 °C | 7 days | 7 days |
| Total petroleum hydrocarbons – kerosene range – 8015 | 9 | 1 | G | 200 g | None | Cool 4 °C | 14 days | 7 days |

Table A-12. Sample Preservation, Container, and Holding Time Guidelines. (2 Pages)

| Analytes/Methods[a] | Analytical Priority | Bottle | | Volume[b] | Preservation | Packing Requirements | Soil Holding Time | Water Holding Time |
|---|---|---|---|---|---|---|---|---|
| | | Number | Type | | | | | |
| Methanol – VOA – 8015 | 19 | 1 | G | 50 g | None | Cool 4 °C | 14 days | 7 days |
| VOA – 8260A | 16 | 1 | G | 50 g | None | Cool 4 °C | 14 days | 7 days |

[a]For 4-digit U.S. Environmental Protection Agency methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update III-A*. For U.S. Environmental Protection Agency Method 300.0, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*.

[b]Optimal volumes, which may be adjusted downward to accommodate the possibility of low mass recoveries from soil sampling. Minimum sample size will be defined on the Sampling Authorization Form.

AEA = alpha energy analysis.
CV = cold vapor.
G = glass.
IC = ion chromatography.
ICP = inductively coupled plasma.
P = plastic.
PCB = polychlorinated biphenyl.
SVOA = semivolatile organic analyte.
VOA = volatile organic analyte.

Table A-13. Bin 1 Site Dimensions and Estimated Systematic-Grid Measurement Locations.

| Site | Length (m) | Width (m) | Area (acres) | Number of Systematic Measurement Locations |
|---|---|---|---|---|
| 200 CP | 457 | 152 | 17.16 | 70 |
| 200-E BP | 120 | 6 | 0.18 | 3 |
| 200-E-1 | -- | -- | -- | 3 |
| 200-E-2 | 51 | 29 | 0.37 | 3 |
| 200-N-3 | -- | -- | -- | 3 |
| 200-W ADB | 243 | 183 | 10.99 | 44 |
| 200-W BP | 61 | 61 | 0.92 | 4 |
| 200-W-1 | 30 | 15 | 0.11 | 3 |
| 200-W-12 | 4 | 15 | 0.01 | 3 |
| 200-W-2 | -- | -- | -- | 3 |
| 200-W-3 | 91 | 152 | 3.42 | 14 |
| 200-W-6 | -- | -- | -- | 3 |
| 218-E-9 | 130 | 30 | 0.96 | 4 |
| 291-C-1 | 60 | 7 | 0.10 | 3 |
| 600-146 | 10 | 4 | 0.01 | 3 |
| 600-228 | 12 | 12 | 0.04 | 3 |
| 600-70 | 425 | 280 | 29.41 | 118 |
| 628-2 | 42 | 37 | 0.38 | 3 |
| UPR-200-W-63 | -- | -- | -- | 3 |
| UPR-200-W-70 | -- | -- | -- | 3 |
| Total | | | | 296 |

Table A-14. Bin 2 Site Dimensions and Estimated Systematic-Grid Measurement Locations. (2 Pages)

| Site | Length (m) | Width (m) | Area (acres) | Number of Systematic Measurement Locations |
|---|---|---|---|---|
| 200-E-122 | 44 | 20 | 0.22 | 3 |
| 200-E-13 | N/A | N/A | N/A | 3 |
| 200-E-46 | 150 | 50 | 1.85 | 8 |
| 200-W-101 | 12 | 6 | 0.018 | 3 |
| 200-W-11 | N/A | N/A | N/A | 3 |
| 200-W-33 | 245 | 215 | 0.013 | 3 |
| 200-W-55 | N/A | N/A | N/A | 3 |
| 200-W-75 | 2.4 | 1.2 | 0.0007 each of 4 silos<br>0.0028 total | 4 (1 each silo) |
| 200-W-92 | 24 | 9 | 0.053 | 3 |
| 218-E-2 | 165 | 134 | 5.46 | 22 |
| 218-E-4 | 238 | 61 | 3.50 | 14 |
| 218-E-7 | N/A | N/A | 0.0033 | 3 |
| 218-W-7 | N/A | N/A | 0.002 each for 2 wooden boxes, 0.0011 for 1 concrete box<br>0.0056 total | 3 (1 each box) |
| 218-W-8 | 25 | 13 | 0.08 | 3 |
| 218-W-9 | 43 | 30 | 0.32 | 3 |
| 600 OCL | 91 | 15 | 0.34 | 3 |
| 600-218 | 74 | 20 | 0.37 | 3 |
| 600-220 | 200 | 166 | 8.2 | 33 |
| 600-222 | 212 | 167 | 8.7 | 35 |
| 600-226 | N/A | N/A | N/A | 3 |
| 600-281 | N/A | N/A | N/A | 3 |
| 600-36 | 18 | 91 | 0.084 | 3 |
| 600-38 | N/A | N/A | N/A | 3 |
| 600-40 | N/A | N/A | 0.12 | 3 |
| 600-51 | 1 | 1.5 | 0.0004 | 3 |
| 600-65 | 3 | 3 | 0.002 | 3 |
| 600-66 | 1.5 | 1.5 | 0.0006 | 3 |
| 600-71 | 30 | 24 | 0.18 | 3 |

Table A-14. Bin 2 Site Dimensions and Estimated Systematic-Grid Measurement Locations. (2 Pages)

| Site | Length (m) | Width (m) | Area (acres) | Number of Systematic Measurement Locations |
|---|---|---|---|---|
| OCSA | N/A | N/A | N/A | 3 |
| UPR-200-E-35 | 14 | 12 | 0.04 | 3 |
| Total | | | | 188 |

600 OCL = 600 Area Original Central Landfill.
N/A = not available (no dimensions given in the *Waste Information Data System* database).
OCSA = Old Central Shop Area.

Table A-15. Operating Dates of Individual Trenches in the Low-Level Burial Grounds (Bin 3A Waste Sites), with Shading Indicating Trenches Active or Potentially Active from 1973-1986. (3 Pages)

| Trench Number | LLBG Name and Beginning Date | | | | | | |
|---|---|---|---|---|---|---|---|
| | 218-E-10 1960 | 218-E-12B 1967 | 218-W-3A 1970 | 218-W-3AE 1981 | 218-W-4B 1967 | 218-W-4C 1978 | 218-W-5 1986 |
| | Date by Which Trench was Filled | | | | | | |
| 1 | 1967 | 1967* | 1985 | -- | 1967 | 1983 | -- |
| 2 | 1969 | -- | 1980 | 1987 | 1968 | -- | -- |
| 3 | 1967 | 1969 | 1973 | 1996 | 1969 | -- | 1990 |
| 4 | 1971 | -- | 1974 | -- | 1969 | 1981 | -- |
| 5 | 1971 | -- | 1986 | 1989 | 1967 | -- | -- |
| 6 | 1979 | -- | 1971 | -- | 1971 | -- | -- |
| 7 | 1983 | ? | -- | -- | 1973-1983 | 1987 | -- |
| 8 | 1979 | 1969 | 1990 | 2004 | 1970 | -- | 1995 |
| 9 | 1999 | 1973 | 1985 | -- | 1969 | -- | 1988 |
| 10 | -- | 1967 | 1975 | 1986 | 1968 | -- | -- |
| 11 | 1986 | 1977 | 1978 | -- | 1972-1978 | -- | -- |
| 12 | 1984 | 1970 | 1976 | -- | 1969 | -- | -- |
| 13 | -- | 1968 | 1979 | 2003 | 1968 | -- | 1989 |
| 14 | 2000 | 1975 | 1975 | -- | 1969-1990 | 2004 | 1989 |
| 15 | -- | 1972 | 1985 | -- | -- | -- | -- |
| 16 | 1984 | 1969 | 1985 | 2004 | -- | -- | -- |
| 17 | -- | 1974 | 1983 | -- | -- | -- | -- |
| 18 | -- | 1976 | -- | -- | -- | -- | -- |
| 19 | -- | 1978 | 1990 | -- | -- | 1981 | -- |
| 20 | -- | 1981 | 1985 | -- | -- | 1996 | -- |
| 21 | -- | 1985 | 1975 | -- | -- | -- | 1987 |
| 22 | -- | 1972 | 1978 | -- | -- | -- | 1994 |
| 23 | -- | 1978 | 1976 | -- | -- | 1981 | -- |

Table A-15. Operating Dates of Individual Trenches in the Low-Level Burial Grounds (Bin 3A Waste Sites), with Shading Indicating Trenches Active or Potentially Active from 1973-1986. (3 Pages)

| Trench Number | LLBG Name and Beginning Date | | | | | | |
|---|---|---|---|---|---|---|---|
| | 218-E-10 1960 | 218-E-12B 1967 | 218-W-3A 1970 | 218-W-3AE 1981 | 218-W-4B 1967 | 218-W-4C 1978 | 218-W-5 1986 |
| | Date by Which Trench was Filled | | | | | | |
| 24 | -- | 1983 | 1979 | -- | -- | 1997 | 1988 |
| 25 | -- | 1974 | 1975 | -- | -- | -- | -- |
| 26 | -- | 1986 | 1977 | 1996 | -- | -- | -- |
| 27 | -- | 1972 | 1978 | -- | -- | -- | 1994 |
| 28 | -- | 1973 | 1978 | -- | -- | 1982 | -- |
| 29 | -- | 1983 | 1985 | -- | -- | 1985 | 2003 |
| 30 | -- | 1980 | 1976 | -- | -- | -- | -- |
| 31 | -- | 1985 | 1981 | -- | -- | -- | IS |
| 32 | -- | 2002 | 1977 | -- | -- | -- | -- |
| 33 | -- | -- | 1979 | -- | -- | 1998 | 2004 |
| 34 | -- | 1983 | 1976 | -- | -- | -- | IS |
| 35 | -- | -- | 1978 | -- | -- | -- | -- |
| 36 | -- | 2004 | 1982 | -- | -- | -- | -- |
| 37 | -- | 1986 | 1983 | -- | -- | -- | -- |
| 38 | -- | 1990 | 1984 | -- | -- | -- | -- |
| 39 | -- | -- | 1985 | -- | -- | -- | -- |
| 40 | -- | -- | 1981 | -- | -- | -- | -- |
| 41 | -- | -- | 1983 | -- | -- | -- | -- |
| 42 | -- | 2000 | 1986 | -- | -- | -- | -- |
| 43 | -- | 1987 | 1984 | -- | -- | -- | -- |
| 44 | -- | -- | 1984 | -- | -- | -- | -- |
| 45 | -- | -- | 1985 | -- | -- | -- | -- |
| 46 | -- | -- | 1986 | -- | -- | -- | -- |
| 47 | -- | -- | 1983 | -- | -- | -- | -- |
| 48 | -- | 1989 | 1982 | -- | -- | 1997 | -- |
| 49 | -- | -- | 1988 | -- | -- | -- | -- |
| 50 | -- | -- | 1980 | -- | -- | -- | -- |
| 51 | -- | -- | 1980 | -- | -- | -- | -- |
| 53 | -- | 1991 | -- | -- | -- | 1997 | -- |
| 58 | -- | -- | -- | -- | -- | 1989 | -- |
| 1S | -- | -- | 1980 | -- | -- | -- | -- |
| 2S | -- | -- | 1980 | -- | -- | -- | -- |
| 3S | -- | -- | 1993 | -- | -- | -- | -- |

Table A-15. Operating Dates of Individual Trenches in the Low-Level Burial Grounds (Bin 3A Waste Sites), with Shading Indicating Trenches Active or Potentially Active from 1973-1986. (3 Pages)

| Trench Number | LLBG Name and Beginning Date | | | | | | |
|---|---|---|---|---|---|---|---|
| | 218-E-10 1960 | 218-E-12B 1967 | 218-W-3A 1970 | 218-W-3AE 1981 | 218-W-4B 1967 | 218-W-4C 1978 | 218-W-5 1986 |
| | Date by Which Trench was Filled | | | | | | |
| 4S | -- | -- | 1981 | -- | -- | -- | -- |
| 5S | -- | -- | -- | -- | -- | -- | -- |
| 6S | -- | -- | 1993 | -- | -- | -- | -- |
| 7S | -- | -- | 1985 | -- | -- | -- | -- |
| 8S | -- | -- | 1981 | -- | -- | -- | -- |
| 9S | -- | -- | 1980 | -- | -- | -- | -- |
| Unnamed East-West Trench | 1967 | -- | -- | -- | -- | -- | -- |
| 94 | -- | out of scope | -- | -- | -- | -- | -- |
| NC | -- | -- | -- | -- | -- | 1995 | -- |

Data obtained from LLBG Figures 2-11, 2-12, 2-13, 2-14, 2-15, 2-16, and 2-17 in the Work Plan.

Pale shading indicates trenches that have had waste placed in them between 1973 and 1986. Dark shading indicates trenches that may have had waste placed in them between 1973 and 1986, but the data on the LLBG figures are insufficient to determine this with certainty.

*Trench 1 is divided into four parts, 1A-1D, and all have the same filled date of 1967.

LLBG = Low-Level Burial Ground.

? = date not given on the LLBG figure, or the date given is uncertain.

-- = trench does not exist in this LLBG.

Table A-16. Number of Passive Soil-Gas Sampling Locations in Low-Level Burial Ground Trenches. (2 Pages)

| Low-Level Burial Ground Trench Number | Approximate Trench Length (m) | Number of Passive Soil-Gas Sampling Locations |
|---|---|---|
| **218-E-10 Burial Ground** | | |
| Trench 11 | 300 | 15 |
| Trench 12 | 300 | 15 |
| Trench 16 | 250 | 13 |
| **218-E-12B Burial Ground** | | |
| Trench 19 | 300 | 15 |
| Trench 26 | 300 | 15 |
| Trench 31 | 300 | 15 |
| **218-W-3A Burial Ground** | | |
| Trench 3S | 150 | 8 |
| Trench 12 | 270 | 16 |
| Trench 20 | 270 | 16 |

Table A-16. Number of Passive Soil-Gas Sampling Locations in Low-Level Burial Ground Trenches. (2 Pages)

| Low-Level Burial Ground Trench Number | Approximate Trench Length (m) | Number of Passive Soil-Gas Sampling Locations |
|---|---|---|
| **218-W-3AE Burial Ground** | | |
| Trench 2 | 370 | 19 |
| Trench 5 | 380 | 19 |
| Trench 10 | 410 | 21 |
| **218-W-4C Burial Ground** | | |
| Trench 19 | 180 | 9 |
| Trench 23 | 180 | 9 |
| Trench 28 | 180 | 9 |
| **Total** | | 214 |

Table A-17. Bin 3B Industrial Waste Burial Ground Site Dimensions.

| Site | Length (m) | Width (m) | Area (acres) | Number of Measurement Locations on Initial Grid |
|---|---|---|---|---|
| 218-C-9 | 76 | 66 | 1.2 | 42 |
| 218-E-2A | 98 | 14 | 0.3 | 9 |
| 218-E-5 | 102 | 63 | 1.6 | 60 |
| 218-E-5A | 102 | 40 | 1.0 | 40 |
| 218-E-8 | 122 | 35 | 1.1 | 36 |
| 218-W-1A | 184 | 251 | 11.4 | 450 |
| 218-W-2A* | 536 | 340 | 45.0 | 1,802 |
| 218-W-11 | 152 | 61 | 2.3 | 90 |
| Total | | | 63.9 | 2,529 |

*Three 218-W-2A trenches also will be investigated using passive soil-vapor surveys. The trenches are included in Table A-18.

Table A-18. Trenches Selected for Characterization in the Dry Waste Burial Grounds. (2 Pages)

| Burial Ground | Trenches Selected | Approximate Trench Length (m) | Basis for Selection |
|---|---|---|---|
| 218-E-1 | 1 | 60 | Trench 1 was selected to represent waste received from B Plant operations. Trench 14 was selected to represent waste received at the site from later process activities. |
| | 14 | 60 | |
| 218-E-12A | 3 | 275 | Trench 28 was selected to represent the acid-soaked waste trenches and Trench 3 was selected to represent trenches receiving dry wastes. |
| | 28 | 275 | |
| 218-W-1 | 6A | 73 | Trench 6A and Trench 7 were selected to represent different methods of disposal and waste received at the site. |
| | 7 | 149 | |
| 218-W-2 | 12 | 144 | Trench 12 was selected to represent waste from the generating processes associated with this burial ground. |

Table A-18. Trenches Selected for Characterization in the Dry Waste Burial Grounds. (2 Pages)

| Burial Ground | Trenches Selected | Approximate Trench Length (m) | Basis for Selection |
|---|---|---|---|
| 218-W-3 | 13 | 145 | Trench 17 was selected because of the depleted uranium scrap and Trench 13 was selected to represent the cellblock disposal areas. |
| | 17 | 145 | |
| 218-W-4A | 2 | 192 | Trench 2 was selected to represent earlier disposal activities. Trench 16 was selected because of the drywells and plutonium disposal. Trench 20, which also received plutonium and unsegregated waste, was selected to represent the waste placed in this burial ground. |
| | 16 | 260 | |
| | 20 | 297 | |
| 218-W-2A | 25 | 230 | Trenches 25, 26, and 27 had the potential to have received containerized liquid organic waste between 1973 and 1986. These trenches will be investigated using passive soil-gas surveys as described for Bin 3A trenches. |
| | 26 | 256 | |
| | 27 | 287 | |

Table A-19. Potential Radioactive Contamination Field-Screening Methods.

| Contaminant of Potential Concern | Waste Site Contaminant of Potential Concern Profiles | Potential Field-Screening Method | Applications/Potential Limitations |
|---|---|---|---|
| Gross Cs-137 counts | Potentially all sites with radioactive contamination | Portable NaI detector | Field surveys; very sensitive gamma detector. |
| Gross alpha | | Portable contamination detector | Health and safety uses/limited detection capability, alpha particles are readily shielded; contamination may be missed during surveys. |
| Gross beta/ gamma | | Portable contamination detector | Health and safety uses/limited detection capability, beta particles may be shielded by soil/concrete; contamination may be missed during surveys. |
| | | Laser-Assisted Ranging and Data System (LARADS) | Data logging system that allows use of multiple types of radioactive contamination detectors and stores radioactive contamination and physical (geographic) location data. Requires establishment of two benchmarks to provide geographic position correlation. |
| Gross beta/ gamma | All Bin 3B sites with radioactive contamination. | Thermoluminescent dosimeter (i.e., aluminum oxide type dosimeters or similar) or equivalent technology | Screening technique that provides a higher resolution detection capability and is better able to detect radioactive material at depth. |

LARADS is a trademark of Eberline Services, Santa Fe, New Mexico.

NaI = sodium iodide.

Table A-20. Potential Chemical Field-Screening Measurement Methods. (2 Pages)

| Variable | Potentially Appropriate Measurement Method[a] | Possible Limitations or Reservations |
|---|---|---|
| Arsenic | X-ray fluorescence[b] | DL (75 mg/kg) |
| Barium | X-ray fluorescence[b] | DL (300 mg/kg) |
| Cadmium | X-ray fluorescence[b] | DL (75 mg/kg) |
| Chlorine (chlorinated compounds) | X-ray fluorescence[b] | Calibration and correlation to compound of interest; DL is unknown |
| Chromium (total) | X-ray fluorescence[b] | DL (400 mg/kg) |
| Chromium (VI) | Water extraction and colorimetric analysis | Interferences (iron) and soil alkalinity. DL (2 to 5 mg/kg) |
| Lead | X-ray fluorescence[b] | DL (100 mg/kg) |
| Mercury | Mercury vapor monitor | DL associated with soil concentrations well above the remedial action goal |
| Mercury | Immunoassay | DL (0.5 mg/kg). Results reported within a pre-specified range. Analysis takes 15 to 30 minutes. |
| Mercury | X-ray fluorescence[b] | DL (100 mg/kg) |
| Selenium | X-ray fluorescence[b] | DL (200 mg/kg) |
| Silver | X-ray fluorescence[b] | DL (100 mg/kg) |
| Zinc | X-ray fluorescence[b] | DL (400 mg/kg) |
| Sulfate | X-ray fluorescence[b] | Calibration and correlation to elemental sulfur required |
| Polyaromatic hydrocarbons | Immunoassay | DL (1 to 5 mg/kg). Results reported within a pre-specified range. Analysis takes 15 to 30 minutes. |
| Polychlorinated biphenyls | Immunoassay | DL (0.1 to 0.3 mg/kg). Results reported within a pre-specified range. Analysis takes 15 to 30 minutes. |
| Pesticides | Immunoassay | DL approximately 10 mg/kg. Need to know specific pesticide of interest. Results reported within a pre-specified range. Analysis takes 15 to 30 minutes. |
| Total petroleum hydrocarbons | Immunoassay | DL (5 to 10 mg/kg). Results reported within a pre-specified range. Need to know if gasoline or diesel products. Analysis takes 15 to 30 minutes. |
| VOCs | Colorimetric tube | Tube capability must be compared to the site-specific need to determine if field detection limits would be sufficient for the VOC of interest. Need to know specific VOCs of interest. |
| VOCs | Flame ionization detector (e.g., Foxboro OVA 128)[c] | DL (1 to 5 mg/kg, methane-equivalent). Instrument capability must be compared to the site-specific need to determine if field detection limits would be sufficient for the VOC of interest. Need to know specific VOCs of interest. Limited to hydrogen containing compounds. |
| VOCs | Photoacoustic infrared analyzer (e.g., B&K 1302)[d] | Instrument capability must be compared to the site-specific need to determine if field detection limits would be sufficient for the VOC of interest. Need to know specific VOCs of interest. |

Table A-20. Potential Chemical Field-Screening Measurement Methods. (2 Pages)

| Variable | Potentially Appropriate Measurement Method[a] | Possible Limitations or Reservations |
|---|---|---|
| VOCs | Photo-ionization detector (e.g., thermo analytical organic vapor monitor) | DL (1 to 5 mg/kg, isobutylene-equivalent). Instrument capability must be compared to the site-specific need to determine if field detection limits would be sufficient for the VOC of interest. Need to know specific VOCs of interest. Limited to photo-ionizing compounds at 10.6 eV. |
| VOCs | Portable gas chromatograph with photo-ionization detector (e.g., Photovac 10S Plus)[e] | DL (sub-mL/m$^3$ levels depending on VOC of interest). Instrument capability must be compared to the site-specific need to determine if field detection limits would be sufficient for the VOC of interest. Need to know specific VOCs of interest. Limited to photo-ionizing compounds at 11.7 eV. |
| VOCs | Transportable mass spectrometer | Instrument use requires extensive training. Capital cost and setup are high; operational cost is moderate. |

[a]Other methods may be identified and implemented in conjunction with technology development.

[b]Metals by X-ray fluorescence require calibration using site-specific soils spiked with known concentrations of reference metals.

[c]Foxboro and OVA 128 are trademarks of The Foxboro Company, Foxboro, Massachusetts.

[d]B&K 1302 is a trademark of Brüel and Kjær, Nærum, Denmark.

[e]Photovac 10S Plus is a trademark of Photovac, Inc., Waltham, Massachusetts.

DL = detection limit.
VOC = volatile organic compound.

# APPENDIX B

# SUMMARY DESCRIPTIONS OF WASTE SITES IN THE 200-SW-1 AND 200-SW-2 NONRADIOACTIVE AND RADIOACTIVE LANDFILLS AND DUMPS OPERABLE UNITS