Draft
Buffer Zone
Sampling and Analysis Plan

July 2001

EXECUTIVE SUMMARY

The Buffer Zone (BZ) Sampling and Analysis Plan (SAP) (BZSAP) describes surface and subsurface soil characterization and remediation confirmation sampling activities for Individual Hazardous Substance Sites (IHSSs), Potential Areas of Concern (PACs), and Under Building Contamination (UBC) Sites, if encountered, at the Rocky Flats Environmental Technology Site (RFETS). It is the Rocky Flats Cleanup Agreement (RFCA) decision document for accelerated action sampling in the BZ.

The objective of the BZSAP is to establish a sampling strategy that includes sampling, data analysis, and analytical methods, and accelerates laboratory and data analysis schedules.

The BZSAP incorporates sampling and analysis methods with a data management approach that enables (1) determination of new sampling locations, (2) generation of near real-time analytical results, (3) verification and validation of field and analytical data, (4) evaluation of analytical results, and (5) integration of analytical results with Geographic Information System (GIS) technology to produce representations of action level (AL) exceedances, hot spots, potential remediation targets, and post-remedial sampling locations.

Methods for determining statistical, geostatistical, and biased characterization and post-remediation sampling location techniques are described. Use of field instrumentation, including high purity germanium detectors and field x-ray diffraction, along with onsite or offsite analytical laboratory support, will result in high quality, near real-time analytical results. These data will be immediately verified and validated so that data analysis and data interpretation will occur within a few days. Data analysis methods, used in accordance with project data quality objectives, provide a consistent and reproducible method for determining AL exceedances and hot spots.

Routine surface and subsurface soil sampling methods are also described. In addition, supporting information, such as data management, health and safety, and quality assurance (QA) requirements are included. Several appendices provide additional analytical and QA information, as well as a summary of existing historical and analytical data at IHSSs and PACs.

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VOLUME 2 – BUFFER ZONE SAMPLING AND ANALYSIS PLAN ADDENDA

ACRONYMS

AOC	Area of Concern
AHA	Activity Hazards Analysis
AL	action level
ALF	Action Levels and Standards Framework for Surface Water, Ground Water, and Soils
AME	Actinide Migration Evaluation
ANOVA	Analysis of Variance
AR	Administrative Record
ASD	Analytical Services Division
AST	Analytical Services Toolkit
bgs	below ground surface
BZ	Buffer Zone
BZSAP	Buffer Zone Sampling and Analysis Plan
CA	contamination area
CAD/ROD	Corrective Action Decision/Record of Decision
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CHWA	Colorado Hazardous Waste Act
cm/sec	centimeters per second
COC	contaminant of concern
CPB	Closure Project Baseline
CRA	Comprehensive Risk Assessment
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DQO	data quality objective
EDD	Electronic Data Deliverable
EDDIE	Environmental Data Dynamic Information Exchange
EMC	Elevated Measurement Comparison
EMWD	environmental-measurement-while-drilling
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
ERA	Ecological Risk Assessment
EU	exposure unit
EZ	exclusion zone
FID	flame ionization detector
FIDLER	Field Instrument for the Detection of Low Energy Radiation
ft	foot
ft^2	square foot

ACRONYMS (continued)

FY	fiscal year
GC/MS	gas chromatography/mass spectrometry
GIS	Geographic Information System
GPR	ground-penetrating radar
GPS	Global Positioning System
GRS	gamma ray spectrometer
Ha	alternative hypothesis
Ho	null hypothesis
H&S	health and safety
HASP	Health and Safety Plan
HDD	horizontal directional drilling
HPGe	high purity germanium
HRR	Historical Release Report
IA	Industrial Area
IASAP	Industrial Area Sampling and Analysis Plan
ICP	inductively coupled plasma
IDW	inverse distance weighting
IGD	Implementation Guidance Document
IHSS	Individual Hazardous Substance Site
IMP	Integrated Monitoring Plan
ISEDS	Integrated Sitewide Environmental Data System
IWCP	Integrated Work Control Program
K-H	Kaiser-Hill Company, L.L.C.
LCS	laboratory control sample
LHSU	lower hydrostratigraphic unit
LIBS	laser-induced breakdown spectroscopy
LRA	Lead Regulatory Agency
m	meter
m^2	square meter
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDL	method detection limit
MS	matrix spike
MSD	matrix-spike duplicate
NFA	no further action
NLR	no longer representative
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
PAC	Potential Area of Concern
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCB	polychlorinated biphenyl
pCi/g	picocuries per gram
PCOC	potential contaminant of concern
PDF	portable document format

ACRONYMS (continued)

PE	performance evaluation
PID	photoionization detector
PMJM	Preble's meadow jumping mouse
PPE	personal protective equipment
QA	quality assurance
QAPjP	Quality Assurance Project Plan
QC	quality control
R^2	correlation coefficient
RADMS	Remedial Action Decision Management System
RBA	radiological buffer area
RCRA	Resource Conservation and Recovery Act
RESRAD	Residual Radioactivity Computer Code
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RFI/RI	RCRA Facility Investigation/Remedial Investigation
RIN	report identification number
RSOP	RFCA Standard Operating Protocol
RSP	Radiological Safety Procedure
RWP	Radiological Work Permit
SAP	Sampling and Analysis Plan
SED	Ecology Database
SEP	Solar Evaporation Ponds
SID	South Interceptor Ditch
Site	Rocky Flats Environmental Technology Site
SME	subject matter expert
SNL	Sandia National Laboratory
SOP	Standard Operating Procedure
SVOC	semivolatile organic compound
SWD	Soil Water Database
UBC	Under Building Contamination
UCL	upper confidence limit
UHSU	upper hydrostratigraphic unit
VOC	volatile organic compound
WEMS	Waste and Environmental Management System
XRF	x-ray fluorescence

1.0 INTRODUCTION

The Buffer Zone (BZ) Sampling and Analysis Plan (SAP) (BZSAP) describes in-process surface and subsurface soil characterization and remediation confirmation sampling and analysis activities for potential contaminant release sites within the Rocky Flats Environmental Technology Site (RFETS or Site) BZ. Numerous Operable Units (OUs) are located within the RFETS BZ including OU 1 881 Hillside Area, OU 5 Woman Creek Priority Drainage, OU 6 Walnut Creek Priority Drainage, OU 7 Present Landfill, OU 11 West Spray Fields, and the BZ Operable Unit. The RFETS BZ contains 66 Individual Hazardous Substance Sites (IHSSs) (all located within the six previously referenced OUs), 29 Potential Areas of Concern (PACs), as well as White Space Areas (areas existing outside current IHSS and PAC boundaries). The Colorado Department of Public Health and Environment (CDPHE) and U.S. Environmental Protection Agency (EPA) have accepted twenty-one of these IHSSs and fifteen of these PACs as requiring no further action (NFA). Fifty-nine (59) of the IHSSs and PACs, as well as new sites that may be identified during closure activities, remain to be dispositioned. Currently, no under-building contamination (UBC) sites have been identified within the RFETS BZ. However, the BZSAP includes UBC scope in the event that sites with UBC are identified in the future.

The BZSAP is the decision document used to guide sampling in the RFETS BZ and streamline the decision process by providing one document for routine soil sampling and analysis activities throughout the BZ. Annual Addenda will supplement the BZSAP, but may be prepared more frequently if circumstances present additional characterization opportunities.

The BZSAP includes innovative sampling, analysis, data evaluation, and data management methods. A key component of the BZSAP is the “in-process” sampling approach that will accelerate characterization and remediation schedules. The in-process approach combines statistical methodologies with field analytical instruments and provides a way to determine, in the field, where and at what levels contamination is present. This results in being able to accomplish the following:

- Define contamination within an IHSS and PAC (or UBC site, if encountered);
- Determine the spatial boundaries of the Area of Concern (AOC) which is defined as the area where an action may be required. The AOC is the area that is evaluated for action through characterization and data aggregation;
- Determine areas that exceed Rocky Flats Cleanup Agreement (RFCA) Action Levels and Standards Framework for Surface Water, Ground Water, and Soil (ALF) action levels (ALs);
- Determine the extent of hot spots; and
- Determine when cleanup objectives are achieved.

The "in-process" sampling approach combines a statistical approach to determine characterization and remediation confirmation sampling locations with the use of field analytical equipment. As samples are taken, they are analyzed with field instrumentation, and a remedial decision is made. If remediation is necessary, soil is excavated. Samples of the remaining soil are taken and analyzed with field instrumentation. Excavation and confirmation sampling continue until remedial objectives are met.

While standard statistical methods will be used to determine sampling locations at many IHSSs and PACs, a geostatistical tool will also be used as appropriate to determine sample locations. Statistical methods incorporate a hot spot identification and analysis methodology, and post-remediation confirmation sampling location methodology based on the size of the remediated area.

Data management methods will ensure that quality data are available to project personnel on an almost real-time basis, while also ensuring that Site data management protocols and requirements are met.

1.1 REGULATORY FRAMEWORK

RFCA, signed by the U.S. Department of Energy (DOE), CDPHE, and EPA (the RFCA Parties), on July 19, 1996, provides the regulatory framework for the cleanup of RFETS (DOE 1996). RFCA streamlines remediation of the Site through accelerated actions that include characterization, remediation, and closure of IHSSs and PACs in the RFETS BZ.

RFCA provides the regulatory framework for DOE response obligations under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and corrective action obligations under the Resource Conservation and Recovery Act (RCRA). The RFCA accelerated action process incorporates the requirements of both CERCLA and RCRA characterization, remediation, and closure. The accelerated action process includes development of a SAP, characterization, remediation (if necessary), and development of a Closeout Report. This process also serves to provide the documentation for the closure of IHSSs and PACs in the BZ that are also RCRA units.

Environmental Restoration (ER) will accelerate all BZ remedial activities to meet the Site goal of 2006 closure. To streamline schedules, using the in-process approach and by reducing document preparation and review cycles, the BZSAP combines the sampling and analysis requirements for the entire RFETS BZ into one document. After accelerated actions are complete, DOE will develop a RCRA Facility Investigation/Remedial Investigation (RFI/RI) to describe the accelerated actions and a Comprehensive Risk Assessment (CRA) to verify that potential contamination remaining at RFETS is within acceptable risk levels as defined by CERCLA and implemented through RFCA. The final Corrective Action Decision/Record of Decision (CAD/ROD) will include, as necessary, post-closure monitoring and operation requirements, including 5-year requirements for Site reviews to evaluate whether the remedies, including any institutional controls, are effective.

1.2 PURPOSE AND OBJECTIVES

The purpose of the BZSAP is to provide sampling and analysis methods and protocols for surface and subsurface soil characterization and post-remediation confirmation sampling and analysis within the RFETS BZ. The BZSAP addresses the following:

1. Characterization sampling for IHSSs and PACs in the RFETS BZ;
2. Post-remediation confirmation sampling at IHSSs and PACs within the RFETS BZ; and
3. Characterization sampling in White Space (areas outside of IHSSs and PACs) in the RFETS BZ for the CRA.

The BZSAP approaches characterization of the RFETS BZ as a single sampling project implemented over the period required to complete remediation of the BZ. It includes grouping of the remaining 59 IHSSs and PACs requiring disposition and is based on similar disposal methods, common contaminants of concern, and mutual proximity. Table 1 provides a list of IHSS and PACs as BZ Characterization Groups.

Table 1 Buffer Zone Characterization Groups

Group	OU	ID	Description
000-5		NW-1502	Disposal of diesel contaminated material at Landfill (formerly NW-177)
		NW-1503	Disposal of Fuel Contaminated Material at Landfill
		NW-1504	Disposal of Thorosilane Contaminated Material at Landfill
	6	166.1	Landfill Trench A
	6	166.2	Landfill Trench B
	6	166.3	Landfill Trench C
	6	167.2	Landfill Pond Spray Area
	6	167.3	Landfill Pond Spray Area
	7	114	Present Landfill
900-11		900-1316	Elevated Chromium Identified During Geotechnical Drilling
		SE-1602	East Firing Range
	BZ	109	Ryan's Pit (Trench 2)
	BZ	112	903 Pad
	BZ	140	Hazardous Disposal Area
	BZ	155	903 Lip Area
	BZ	183	Gas Detoxification Area
900-12	BZ	108	Trench T-1
	BZ	110	Trench T-3
	BZ	111.2	Trench T-5
	BZ	111.3	Trench T-6
	BZ	111.5	Trench T-8
	BZ	111.6	Trench T-9
	BZ	111.7	Trench T-10

Group	OU	ID	Description
	BZ	111.8	Trench T-11
900-2	BZ	153	Oil Burn Pit No. 2
	BZ	154	Pallet Burn Site
	BZ	216.2	East Spray Field-Center Area
	BZ	216.3	East Spray Field-South Area
	6	216.1	East Spray Field-North Area
NE-1	6	142.1	Pond A-1
	6	142.2	Pond A-2
	6	142.3	Pond A-3
	6	142.4	Pond A-4
	6	142.12	Pond A-5
	6	142.5	Pond B-1
	6	142.6	Pond B-2
		NE-1404	Diesel Spill at Pond B-2 Spillway
	6	142.7	Pond B-3
	6	142.8	Pond B-4
	6	142.9	Pond B-5
	5	142.10	Pond C-1
	5	142.11	Pond C-2
NE-2	BZ	111.4	Trench 7
NE/NW		NE-1407	OU2 Treatment Facility
		NE-1409	Modular Tanks and 910 Treatment Sys Spill (formerly 000-503)
		NE-1410	Diesel fuel Spill at field Treatability Unit
		NE-1411	Diesel Fuel Overflowed from Tanker @ OU2
		NE-1412	Trench T-12 Located @ OU2 East Trenches
		NE-1413	Trench T-13 Located @ OU2 East Trenches
	BZ	170	PU&D Storage Yard
	BZ	174a	PU&D Yard - Drum Storage
SW-1		SW-1701	Recently Identified Ash Pit
		SW-1702	Recently Identified Ash Pit
	5	133.1	Ash Pit 1
	5	133.2	Ash Pit 2
	5	133.3	Ash Pit 3
	5	133.4	Ash Pit 4
	5	133.5	Incinerator
	5	133.6	Concrete Wash Pad

In addition to enhancing efficiency of the characterization and remediation effort, grouping acknowledges that IHSS designations represent the characterization starting points but do not necessarily represent the actual boundaries of areas of contamination. By removing the constraint of the IHSS boundary, it enables characterization and

remediation to proceed unencumbered by issues such as overlapping IHSSs and contaminant depth. Specific objectives of the BZSAP include the following:

- Optimize resources by conducting sampling programs that support all appropriate decisions, including whether remediation is required, remedial objectives have been achieved, or a NFA recommendation can be justified;
- Define data quality objectives (DQOs) for characterization, post-remediation confirmation sampling, and document the decisions and uses for which data are needed;
- Define a sampling strategy that supports DQO criteria for characterization, post-remediation confirmation sampling, and CRA sampling and analysis requirements so that each area will only be sampled once for characterization, as needed for in-process characterization, and once for post-remediation confirmation;
- Define sampling, data analysis and analytical methods;
- Ensure data are of the appropriate quality to support remedial decisions and CRA requirements;
- Define a sampling strategy that accelerates laboratory and data analysis schedules; and
- Define a sampling strategy for IHSSs and PACs coordinated with the Decommissioning schedule.

The BZSAP will be the current and complete decision document guiding characterization, confirmation sampling, and sampling for the CRA. Modifications to sampling methodologies, DQOs, and other elements that effect sampling strategies will be proposed to CDPHE and EPA for their approval. Modifications to the initial BZSAP will be designated sequentially beginning with “Modification 1” and will be documented in Appendix A.

The BZSAP is designed to promote maximum sampling efficiency and quality at all suspected contaminant release sites, some of which have little or no starting-point data. Guided by the DQOs (Section 3), and the data acquisition and analysis process (Section 5), the sampling approach will adapt to changing conditions as new information is acquired. The anticipated frequent adjustments to the sampling approach will be implemented using the field modification process described in RFCA (¶ 130) (DOE 1996). Points of contact for implementing the field modification process will be the Lead Regulatory Agency (LRA) Project Manager and the DOE Contractor Project Manager assigned to the sampling project.

1.3 BZSAP ADDENDUM

While the BZSAP approaches characterization of the RFETS BZ as a single project, all IHSSs and PACs must be administratively dispositioned to achieve Site closure. The

BZSAP Addendum enables the BZSAP to accommodate this obligation over the period required to complete remediation of the BZ. The Addendum identifies the specific sites that will be characterized during a given interval such as a fiscal year (FY) and serves as the beginning reference point to track all IHSSs and PACs from characterization through remediation and ultimately to Site closure.

Addenda will be developed prior to the beginning of each FY and may be prepared more frequently if additional remediation opportunities arise. The Addendum scope will include:

- Project organization;
- BZ Group-specific potential contaminants of concern (PCOCs);
- BZ Group-specific maps showing existing qualified data points (DOE 2001a);
- Starting-point sampling locations based on approved BZSAP methodologies; and
- Sampling methodology for each IHSS or PAC.

CDPHE and EPA will have 14 calendar days for review and approval of the Addendum. The regulatory agencies can approve all or part of the Addendum. This will allow work to continue if specific issues require resolution. No response from the regulatory agencies during the 14-day period implies approval. Appendix B provides an example of the BZSAP Addendum format. Volume 2 of the BZSAP will contain the addenda. Table 2 lists the planned FY when each BZ Group Addendum will be prepared based on the current Closure Project Baseline (CPB). Changes to the baseline schedule or circumstances that provide accelerated characterization opportunities will result in changes to the schedule.

Table 2
Buffer Zone - Addendum Preparation Schedule

FY01		**FY04**	
BZ Group	**Description**	**BZ Group**	**Description**
900-2	Oil Burn Pit, Pallet Burn Pit, East Spray Fields – North, -Center, -South	900-12	Trench 5,6,8,9,10
NE/NW	Trenches T-12 and T-13	NE-1	Ponds B-1, B-2, B-3
SW-1	Incinerator, Concrete Wash Pad		
FY02		**FY05**	
BZ Group	**Description**	**BZ Group**	**Description**
900-11	903 Pad, 903 Lip Area, Hazardous Waste Disposal Area, East Firing Range and Target Area		To Be Determined
NE-2	Trench T-7		
FY03		**FY06**	
BZ Group	**Description**	**BZ Group**	**Description**
	To Be Determined		To Be Determined, if required

Table 2 presents descriptions of IHSS and PACs baselined for characterization activities. Table 1 provides a complete list of IHSS and PACs not accepted as NFA (potential requiring characterization) as of the 2000 Annual Update to the Historical Release Report (DOE 2000a).

2.0 SITE DESCRIPTION

2.1 PHYSICAL SETTING

RFETS is located approximately 16 miles northwest of Denver, Colorado, in northern Jefferson County. The site occupies approximately 10 square miles. Boundaries and major features are illustrated on Figure 1. Most of the buildings are located within an industrial complex of approximately 350 acres (the IA) surrounded by a BZ of approximately 6,150 acres. RFETS is a government-owned, contractor-operated facility that has been in operation since 1952.

The BZ surrounds the IA where the bulk of RFETS mission activities took place between 1951 and 1989 (DOE 1996). Most of the buildings and associated structures were used for historic processing activities associated with weapons production.

Materials defined as hazardous substances by CERCLA, and materials defined as hazardous constituents by RCRA and/or the Colorado Hazardous Waste Act (CHWA) may have been released to the environment at various locations at RFETS. In the BZ, releases were identified at 96 IHSSs and PACs as illustrated on Figure 1. Of these 96 IHSS and PACs, 36 have been approved for no further action. Fifty-nine IHSS and PACs in the Buffer Zone have not been approved as NFAs and may required additional characterization under this SAP.

2.2 CONCEPTUAL MODEL

2.2.1 Geology and Hydrogeology

In the pediment area of the BZ, relatively flat-lying Quaternary surficial deposits overlie Cretaceous bedrock. The surficial deposits consist primarily of the Rocky Flats Alluvium and artificial fill materials (EG&G 1992). The alluvium ranges from over 100 feet thick at the western edge of the BZ (OU11) to 10 feet thick at the eastern edge of the IA. The Rocky Flats Alluvium is truncated by erosion immediately east of the IA. The Rocky Flats Alluvium consists of unconsolidated, poorly sorted coarse gravels, coarse sands, and gravelly clays with discontinuous lenses of clay, silt, and sand.

The alluvium unconformably overlies weathered claystone bedrock consisting of the Upper Cretaceous Arapahoe and Laramie Formations. The Arapahoe Formation is less than 50 feet thick in the central portion of the BZ and consists of siltstones and claystones with sandstone lenses. In some areas, such as near the Solar Evaporation Ponds (SEP), well sorted and coarser grained sandstone is present. This sandstone and may provide a preferential pathway; however, it is interrupted by erosion and does not provide an offsite pathway for groundwater and contaminant migration. The Laramie Formation unconformably underlies the Arapahoe Formation. Beneath the BZ, the Laramie Formation is 600 to 800 feet thick and consists primarily of claystone with siltstone; fine-grained sandstone and coal lenses are also present (EG&G 1995a).

2.2.2 Surface Water Hydrology

Three intermittent streams drain RFETS: Rock Creek, Walnut Creek, and Woman Creek. The northwestern corner of RFETS is drained by Rock Creek, which flows northeast

through the BZ to its offsite confluence with Coal Creek. Rock Creek, North and South Walnut Creeks, and an unnamed tributary drain the northern part of the BZ. The confluence of North and South Walnut Creeks is below Ponds A-4 and B-5. The South Interceptor Ditch (SID), located between the BZ and Woman Creek, collects runoff from the southern part of RFETS and ultimately diverts the water to Pond C-2. Water from Pond C-2 is monitored and discharged. Woman Creek is diverted under the SID, flows around Pond C-2, and then flows offsite into the Woman Creek Reservoir.

2.2.3 Hydrogeologic Setting

Two hydrostratigraphic units are present within the BZ: the upper hydrostratigraphic unit (UHSU), and the lower hydrostratigraphic unit (LHSU). The UHSU consists of the unconfined saturated Rocky Flats Alluvium and weathered Arapahoe and Laramie Formation bedrock, including sandstone lenses. This hydrostratigraphic unit contains most of the groundwater impacted by Site activities. The LHSU consists of the unweathered Arapahoe and Laramie Formations. These claystones and silty claystones act as an aquitard, inhibiting downward groundwater movement. The geometric mean of measured hydraulic conductivity values in the Rocky Flats Alluvium is approximately 10^{-4} centimeters per second (cm/sec). The LHSU hydraulic conductivity is generally lower than those of the overlying UHSU because of the higher percentage of fine-grained material (EG&G 1995b).

Groundwater within the UHSU primarily flows from west to east along the bedrock contact with the underlying Arapahoe and Laramie Formation claystones. Groundwater elevations are highest in the spring and early summer when precipitation is highest and evapotransporation is low. Groundwater elevations decline during the remainder of the year, and some areas of the UHSU in the BZ are seasonally dry. Groundwater from the UHSU discharges at springs and seeps on the hillsides of the BZ at the contact between the alluvium and bedrock, and where sandstone lenses subcrop in drainages (EG&G 1995b).

To the west, where the alluvium is thickest, the average depth to the water table is 70 feet below ground surface. Depth to water generally decreases from west to east as the surficial material thins. Depth to water in the BZ ranges from discharging as springs (Antelope Springs) to greater that 70 feet (OU 11). Engineered structures cause variations in water levels and saturated thickness. The impact of building footing drains, utility corridors, and other structures has not been fully evaluated; however, these structures are believed to impact groundwater flow (EG&G 1995b).

3.0 DATA QUALITY OBJECTIVES

The RFETS quality assurance (QA) staff and risk assessment working group developed preliminary DQOs for the Industical Area Sampling and Analsis Plan (IASAP)(DOE, 2001b). The working group consisted of DOE, the Kaiser-Hill Company, L.L.C. (K-H) Team, CDPHE, and EPA representatives. These DQOs will also be applied to data collected for decisionmaking purposes within the RFETS BZ. This section details sampling, analytical, and data analysis DQOs for BZ activities. BZ Group-specific DQOs will be presented in the appropriate BZSAP Addenda, if required.

3.1 DATA QUALITY OBJECTIVE PROCESS FOR THE BZSAP

The DQO process is a series of planning steps designed to ensure that the type, quantity, and quality of environmental data used in decisionmaking are appropriate for the intended purpose. EPA has issued guidelines to help data users develop site- and project-specific DQOs (EPA 1994). The DQO process is intended to:

- Clarify the study objective;
- Define the most appropriate types of data to collect;
- Determine the most appropriate conditions under which to collect the data; and
- Specify acceptable levels of decision errors that will be used as the basis for establishing the quantity and quality of data needed to support decisions.

The DQO process specifies project decisions, the data quality required to support those decisions, specific data types needed, data collection requirements, and analytical techniques necessary to generate the specified data quality. The DQO process consists of seven steps. Each step influences choices that will be made later in the process. These steps are as follows:

Step 1 State the Problem
Step 2 Identify the Decision
Step 3 Identify the Inputs to the Decision
Step 4 Define the Study Boundaries
Step 5 Develop a Decision Rule
Step 6 Specify Tolerable Limits on Decision Errors
Step 7 Optimize the Design

During the first six steps of the DQO process, the planning team develops decision performance criteria (i.e., DQOs) for the data collection design. DQOs for the BZSAP provide key BZ characterization decision rules. All decision rules need to be considered, as appropriate. The final step of the process involves developing the data collection design based on the DQOs. The data collection design is presented in Section 4.0. These DQOs are based on EPA Guidance for the Data Quality Objective Process (EPA 1994). Data developed under these DQOs will be used to:

1. Establish the nature and extent of contamination within IHSS, PACs, UBC Sites (if encountered) and White Space Areas in the BZ, including areas where RFCA ALs are exceeded;
2. Confirm that remediation within IHSSs and PACs was successful;
3. Determine whether selected final remedies are protective, based on the CRA, for post-closure uses; and
4. Support final remedy selection analysis.

The BZSAP DQOs apply to surface and subsurface soil encountered during characterization and post-remediation confirmation sampling. CRA DQOs in the BZSAP are specific to soil sampling; more detailed CRA DQOs are presented in the CRA Methodology (Appendix D).

The BZSAP DQOs complement those used in the RFETS Integrated Monitoring Plan (IMP) (DOE 1999). The IMP and associated DQOs focus on air, surface water, groundwater, and ecology, and will be used to support remediation decisions and the CRA. Project-specific air, surface water, and groundwater performance monitoring data from stations surrounding remediation project locations will be used to identify additional areas that may require evaluation.

3.1.1 Characterization of IHSSs and PACs

The Problem

The nature and extent of contamination must be known with adequate confidence to make remedial decisions. Data of sufficient quality and quantity must be available to conduct an AL comparison, as specified in the RFCA Implementation Guidance Document (IGD), and assess whether an IHSS or PAC requires remediation or management.

Identification of Decisions

The decisions that will be made are as follows:

1. Determine whether the nature and extent of PCOCs in an IHSS or PAC are known with adequate confidence;
2. Characterize an IHSS or PAC to determine whether sampling and analysis results are greater than RFCA Tier I ALs; and
3. Characterize an IHSS or PAC to determine whether sampling and analysis results are greater than RFCA Tier II ALs.

Inputs to the Decisions

Information needed to make the characterization decisions specified above include the following:

1. PCOCs

   PCOCs include all analytes detected during previous studies in the BZ and generally include the following analytical suites:

   - Target Compound List (Organics)
     Volatile organic compounds (VOCs)
     semi-volatile organic compounds (SVOCs)
     Pesticides

Arochlors (PCBs)
Herbicides

- Target Analyte List
  Metals
  Cyanide

- Radionuclides (RFETS-specific)

PCOCs will be evaluated for each BZ Group during preparation of the BZSAP Addenda. At that time, the PCOC list may be expanded or abbreviated depending on site-specific analytical data and process knowledge;

2. Method detection limits (MDLs)

   MDLs for BZ PCOCs and analytical methods are presented in Appendix E. Analytical methods are organized in tables by general analytical suite. The tables present the minimum required analytes within each respective suite, as well as the required analytical sensitivity for each analyte. Sensitivities are expressed as MDLs, and are specific to the measurement systems used for BZ sample analysis. The RFCA ALs are the lowest values stipulated in RFCA for any exposure scenario. These conservative values are provided to ensure that method sensitivities, for each and every PCOC, are adequate for making project decisions.

   Accuracy and precision tolerances are also provided in each table. Accuracy specifications apply to methods only, whereas precision specifications are presented relative to both laboratory and instrument performance and the overall project, which includes sampling error;

3. Background levels for each inorganic and radionuclide PCOC, included in Appendix F;

4. RFCA Tier I and Tier II ALs for surface and subsurface soil as listed in the ALF (Attachment 5, RFCA). Comparison criteria include the following:

   a) Soil data values for inorganics will be compared to the background mean plus two standard deviations. Soil data values for organics will be compared to detection limits.

   b) Each soil data value will be compared to the appropriate AL.

   c) RCFA Tier I exceedance is defined as:

      – Ratio of each soil data value to the Tier I AL is > 1, or

      – Sum of the ratios for either nonradionuclides or radionuclides is > 1.

   d) RCFA Tier II exceedance is defined as:

      – Ratio of each soil data value to the Tier II AL is > 1, or

      – Sum of the ratios for either nonradionuclides or radionuclides is > 1.

e) Below Tier II is defined as:

- Ratio of each soil data value to the Tier II AL is < 1, or
- Sum of the ratios for either nonradionuclides or radionuclides is < 1.

f) For sites with soil data values exceeding Tier II ALs, the spatial extent of the AOC will be established by delineating PCOC values above the background mean plus two standard deviations for inorganics and radionuclides, and PCOC values above detection limits for organics. PCOC values above Tier I ALs and PCOC values above Tier II ALs will be delineated. There is no lower limit on the size of an AOC; however, no single AOC will exceed 10 acres or an approved exposure unit (EU).

The process for determining the extent of the AOC is shown on Figure 2 and described below:

- Compare data for inorganics and radionuclides to the background mean plus two standard deviations; compare data for organics to detection limits.
- Establish AOCs based on the spatial distribution of data.
- Aggregate data over the AOC, according to decision rules.
- Compare the 95% upper confidence limit (UCL) of the mean for each PCOC to the Tier I and Tier II ALs.
- When evaluation of a Tier I exceedance indicates an area of very limited extent (i.e., a hot spot), data aggregation may not be appropriate. The methodology for determining potential hot spots is described in Section 4.3.

5. Process knowledge and historical data, including information and data contained in technical memoranda, RFI/RI reports, remedial action reports, IMP reports, the Historical Release Report (HRR) (DOE 1992), and other relevant documents; and

6. Existing and BZSAP-generated characterization data, which meet usability criteria and pass the Data Quality Filter (DOE 2001a) (Figure 3) will be used to assess the variability of PCOC and contaminant of concern (COC) concentrations.

Study Boundaries

Characterization decision boundaries that define when and where data will be collected are listed below.

1. IHSSs and PACs are listed in Table 2 and shown on Figure 1. The actual boundary of an AOC will be determined from the spatial distribution of the sampling data. White Space Areas will be addressed after IHSS and PAC remediation.

2. The decisions will be applied to each IHSS and PAC located in the BZ.

3. Soil will be considered from the land surface to the top of the saturated zone or top of bedrock, as appropriate.

4. Temporal boundaries will be consistent with BZ project schedules. These boundaries will be refined in the BZSAP Addenda.

Decision Rules

The characterization decision rules that describe how the data will be aggregated and evaluated are listed below. Decision rules are complex and must be applied in a systematic way. Figure 4 illustrates the decision sequence and Figure 5 illustrates how PCOCs become COCs. The decision rules are as follows:

1. If each PCOC has been adequately documented with respect to concentrations and three-dimensional locations for IHSSs and PACs, the nature and extent are adequately defined. Otherwise, PCOCs have not been adequately characterized, and additional sampling and analysis are necessary.

2. If all analytical results are nondetections, a PCOC will be disqualified from further consideration; otherwise, the PCOC will be retained. AOCs will be determined based on PCOC concentrations above detection limits.

3. If all data values are below the background mean plus two standard deviations, the PCOC will be disqualified from further consideration. Some inorganic and radionuclide concentrations may be below background levels but above Tier II ALs. Data values below background will not be carried over for further evaluation. AOCs will be determined based on PCOC concentrations detected above background.

4. If a single maximum PCOC data point is below the Tier II AL, and the sum of the maximum ratios of the concentrations of each PCOC across the AOC to their respective Tier II AL for both nonradionuclides and radionuclides, considered separately, is below 1, then no evaluation, management, or remediation of the AOC is necessary in accordance with RFCA requirements.

5. If a single maximum PCOC data point is equal to or above the Tier II AL, aggregation and evaluation as described in decision rules 7, 8, and 9 are necessary in accordance with RFCA requirements. If the sum of the ratios of the maximum concentrations for each PCOC across the AOC to its respective Tier II AL for either nonradionuclides or radionuclides is greater than or equal to 1, aggregation and evaluation as described in decision rules 7, 8, and 9 are necessary in accordance with RFCA requirements.

6. If a single maximum PCOC data point is above the Tier I AL, or the sum of the ratios of the maximum concentrations for each PCOC to its respective Tier I AL for either nonradionuclides or radionuclides is greater than or equal to 1, additional data evaluation as a potential hot spot may be necessary and the data will be aggregated as described in decision rules 7, 8, and 9.

7. If the ratio of the 95% UCL of the mean concentration for a single PCOC to its Tier I AL across the AOC is greater than or equal to 1, the PCOC is then considered a COC and a remedial action decision will be made in accordance with RFCA requirements. If the sum of the ratios of the 95% UCL of the mean concentrations for all PCOCs to their respective Tier I ALs for both radionuclides and nonradionuclides across the AOC is greater than or equal to 1, the PCOCs are then considered COCs and a remedial action decision will be made in accordance with RFCA requirements.

8. If the ratio of the 95% UCL of the mean concentration for a single PCOC to its respective AL, or the sum of the ratios of the 95% UCL of the mean concentrations for all PCOCs across the AOC to their respective ALs for either radionuclides or nonradionuclides is greater than or equal to 1 for Tier II ALs and below 1 for Tier I ALs, the PCOCs are considered COCs and further evaluation of the site is required in accordance with RFCA requirements.

9. If the ratio of the 95% UCL of the mean concentration for a single COC to its Tier II AL, and the sum of the ratios of the 95% UCL of the mean concentrations for all PCOCs across the AOC to their respective Tier II ALs for either radionuclides or nonradionuclides are below 1, then the soil does not need to be further evaluated or managed in accordance with RFCA requirements.

Tolerable Limits on Decision Errors

Sample data requirements will be based on uncertainties of 10 percent or less for alpha (false positive) errors and 20 percent or less for beta (false negative) errors. The null hypothesis (Ho) is that the AOC is contaminated. The null and alternative hypotheses (Ha) are stated as follows:

Ho = AOC concentrations $\geq$ ALs
Ha = AOC concentrations < ALs

Characterization of data, including the minimum detectable relative differences and data variability, will be evaluated for each AOC.

Optimization of Plan Design

The BZSAP sampling design will be optimized through the BZSAP Addenda. Sampling locations, sampling depth, and PCOCs will be described in the BZSAP Addenda for each IHSS and PAC. Optimization will be conducted in consultation with CDPHE and EPA through a shared access data and mapping system (Section 6.2). This will allow RFETS and regulatory agency staffs to communicate and view data and maps concurrently so that potential sampling design issues are resolved.

Existing data and process knowledge will be reviewed and analyzed to determine:

- Type of statistical sampling methods (geostatistical, standard, biased, or a combination of methods) appropriate for each site;

- Specific PCOC lists for each IHSS and PAC through comparison to background for metals and radionuclides, and detection limits for organics; and

- Sampling depth.

Consistent with the iterative approach of the DQO process, decisions without adequate confidence will be revisited until enough data are gathered to make a decision. Existing data sets may be checked for sampling adequacy based on comparison with the EPA G-4 model (EPA 1994) or Gilbert's methods (Gilbert 1987). Sampling requirements and densities will be based on the AOC. The following documents will be used as guidance in optimizing sampling and analysis requirements:

- EPA, 1989, Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A), EPA/540/1-89/002, December.

- EPA, 1992, Guidance for Data Usability in Risk Assessment (Parts A&B), EPA Publication 9285.7-09A&B, April/May.

- EPA, 1994, Guidance for the Data Quality Objective Process, QA/G-4 EPA/600/R-96/055, September.

- EPA, 1996, Soil Screening Guidance: Technical Background Document, EPA/540/R-95/128, May.

- EPA, 1997, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG-1575, EPA 402-R-97-016, December.

- EPA, 1998, Guidance for the Data Quality Assessment Process: Practical Methods for Data Analysis, QA/G-9 EPA/600/R-96/084, January.

- EPA, 1999, Guidance on Environmental Data Verification and Validation, Peer Review Draft, QA/G-8, August.

- EPA, 2000, Data Quality Objectives Process for Hazardous Waste Site Investigations, EPA QA/G-4HW, EPA/600/R-00/007, January.

3.1.2 Confirmation Sampling and Analysis

The Problem

Following remediation of any contaminated area, the concentrations of remaining contaminants, if any, are not known with adequate confidence to conclude that remediation was complete and successful.

Due to the nature of some remediation technologies, such as soil excavation and hauling with heavy equipment, the possibility exists that limited contaminated media could be released outside the remediation boundaries during field activities.

Identification of Decisions

The confirmation sampling and analysis questions that will be resolved include the following:

1. Has contamination within an AOC been successfully remediated based on RFCA ALs and other mutually agreed-upon cleanup criteria?

2. Did any releases of contamination occur outside the remediation activity boundaries during the remediation activity (based on compliance and project-specific performance monitoring)?

Inputs to the Decisions

Information needed to resolve the confirmation sampling and analysis questions are as follows:

1. COCs as determined by the AL screen;

2. Post-remediation sampling locations based on RFCA and CRA requirements;

3. Compliance monitoring results concurrent with remediation;

4. MDLs

   MDLs for BZ COCs and field analytical equipment are presented in Appendix E. Analytical methods are organized in tables by general analytical suite. The tables present the minimum required analytes within each respective suite, as well as the required sensitivity for each analyte. Sensitivities are expressed as MDLs, and are specific to the measurement systems used for BZ sample analysis. The RFCA ALs are the lowest values stipulated in RFCA for any exposure scenario. These conservative values are provided to ensure that method sensitivities, for each and every COC, are adequate for making project decisions.

   Accuracy and precision tolerances are also provided in each table. Accuracy specifications apply to methods only, whereas precision specifications are presented relative to both laboratory and instrument performance and the overall project, which includes sampling error.

   MDLs for offsite analytical laboratories are those established by Analytical Services Division (ASD) and are listed in Appendix E;

5. Confirmation sample results (post-remediation concentrations);

6. RFCA Tier I and Tier II ALs for surface and subsurface soil as listed in the ALF (Attachment 5, RFCA). Comparison criteria include the following:

   a) Each soil data value will be compared to the background mean plus two standard deviations.

   b) Each soil data value will be compared to the appropriate AL.

c) RFCA Tier I exceedance is defined as:

- Ratio of each soil data value to the Tier I AL is > 1, or
- Sum of the ratios for either nonradionuclides or radionuclides is > 1.

d) RFCA Tier II exceedance is defined as:

- Ratio of each soil data value to the Tier II AL is > 1, or
- Sum of the ratios for either nonradionuclides or radionuclides is > 1.

e) Below RFCA Tier II is defined as:

- Ratio of each soil data value to the Tier II AL is < 1, or
- Sum of the ratios for either nonradionuclides or radionuclides is < 1.

7. Other mutually agreed-upon cleanup criteria.

Data will be reviewed and evaluated against usability criteria and must pass the Data Quality Filter (DOE 2001a).

Study Boundaries

Decision boundaries that determine when and where data will be collected are listed below.

1. Identified IHSS and PAC are listed in Table 2 and shown on Figure 1. The actual boundary of an AOC will be determined from the spatial distribution of the sampling data, as specified in the IGD. The AOCs determined will be used as areas for confirmation sampling and analysis immediately after remediation.

2. White Space Areas will be sampled and addressed when monitoring data indicate contamination was spread during remediation of adjacent sites. Otherwise, White Space Areas will be addressed as part of the CRA.

3. COCs determined for each AOC in accordance with Section 3.1.1 will be compared to ALs or other mutually agreed-upon cleanup criteria.

4. Confirmation sampling will cover the area remediated.

5. Soil will be considered from the land surface to the top of the saturated zone or top of bedrock, as appropriate.

6. Temporal boundaries will be consistent with BZ project schedules. These boundaries will be refined as the BZSAP is developed and BZ remediation proceeds. Confirmation sampling will be conducted after remediation. Data from confirmation sampling will be used to support the CRA.

Decision Rules

The confirmation sampling and analysis decision rules that describe how the data will be aggregated and evaluated are illustrated on Figure 6 and listed below.

1. The concentration and distribution of each COC, after the remedial action has been performed, must be adequately documented within the AOC boundaries of interest to evaluate the remediation using the following decision rules. Otherwise, post-remediation COCs have not been adequately characterized, and additional sampling and analysis are necessary.

2. If all COC data values are below the background mean plus two standard deviations, the COC will be disqualified from further consideration. Some inorganic and radionuclide concentrations may be below background but above Tier II ALs. Data values that are below background will not be carried over for further evaluation.

3. If a single maximum COC data point is below the Tier II AL, and the sum of the ratios of the maximum concentrations for each COC across the AOC to its respective Tier II AL for both nonradionuclides and radionuclides is below 1, no action is necessary in accordance with RFCA requirements.

4. If a single maximum COC data point is above the Tier II AL, or the sum of the ratios of the maximum concentrations for each COC across the AOC to its respective Tier II AL for either nonradionuclides or radionuclides is greater than or equal to 1, then aggregation and evaluation as described in decision rules 6, 7, and 8 are necessary in accordance with RFCA requirements.

5. If a single maximum COC data point is above the Tier I AL, or the sum of the ratios of the concentrations for each COC across the AOC to its respective Tier I AL for either nonradionuclides or radionuclides is greater than or equal to 1, then additional evaluation as a potential hot spot may be necessary and the data will be aggregated as described in decision rules 6, 7, and 8.

6. If the ratio of the 95% UCL of the mean concentration for a single COC to its Tier I AL, and the sum of ratios of the 95% UCL of the mean concentrations for all COCs to their respective Tier I ALs for both nonradionuclides and radionuclides across the AOC are greater than or equal to 1, then a remedial decision will be made in accordance with RFCA requirements.

7. If the ratio of the 95% UCL of the mean concentration for a single COC to its respective AL, or the sum of the ratios of the 95% UCL of the mean concentration for all COCs across the AOC to their respective ALs is greater than or equal to 1 for Tier II ALs and below 1 for Tier I ALs, a remedial decision will be made in accordance with RFCA requirements.

8. If the ratio of the 95% UCL of the mean concentration for a single COC to its respective Tier II AL, and the sum of the ratios of the 95% UCL of the mean concentration for all COCs across the AOC to their respective Tier II ALs are below 1, then no further action is required in accordance with RFCA requirements.

9. If compliance or project-specific performance monitoring (e.g., air or surface water monitoring) corresponding with the BZ remediation activity produces results that exceed ALs stated in RFCA, then the potential release of contaminants resulting from the respective remediation activity will be evaluated. Otherwise, the

remediation activity was adequately controlled to prevent release of contaminants outside the immediate remediation boundaries.

Tolerable Limits on Decision Errors

Areas and associated COCs disqualified from further characterization or remediation based on process knowledge have no associated quantifiable decision error. Sample data requirements will be based on uncertainties of 10 percent or less for alpha errors and 20 percent or less for beta errors. The null hypothesis is that the AOC is contaminated. Characterization of data, including the minimum detectable relative differences and data variability, will be evaluated for each AOC.

Optimization of Plan Design

Optimization of the post-remediation data collection process will be based on statistical or geostatistical analysis where possible. Consistent with the iterative approach of the DQO process, decisions without adequate confidence will be revisited until enough data are gathered to make a decision. Existing data sets may be checked for sampling adequacy by comparison with the EPA G-4 model, Gilbert's methods (Gilbert 1987), or MARSSIM (EPA 1997). Sampling requirements and densities will be based on the remediation area considerations.

The following documents will be used as guidance to optimize sampling and analysis requirements in support of remediation activities:

- EPA, 1989, Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A), EPA/540/1-89/002, December.
- EPA, 1992, Guidance for Data Usability in Risk Assessment (Parts A&B), EPA Publication 9285.7-09A&B, April/May.
- EPA, 1994, Guidance for the Data Quality Objective Process, QA/G-4 EPA/600/R-96/055, September.
- EPA, 1996, Soil Screening Guidance: Technical Background Document, EPA/540/R-95/128, May.
- EPA, 1997, MARSSIM, NUREG-1575, EPA 402-R-97-016, December.
- EPA, 1998, Guidance for the Data Quality Assessment Process: Practical Methods for Data Analysis, QA/G-9 EPA/600/R-96/084, January.
- EPA, 1999, Guidance on Environmental Data Verification and Validation, Peer Review Draft, QA/G-8, August.
- EPA, 2000, Data Quality Objectives Process for Hazardous Waste Site Investigations, EPA QA/G-4-HW, EPA/600/R-00/007, January.

3.1.3 Final Characterization of the Buffer Zone for the Comprehensive Risk Assessment

The BZ must be assessed to ensure that the post-remediation state is protective of human health and the environment based on post-closure uses. Data will be collected to ensure that the nature and extent of any remaining contamination are known, so that a CRA can be performed to ensure post-closure uses are protective. The CRA will address direct surface soil, surface water, and air exposure pathways and offsite exposures; however, the BZSAP DQOs only address soil. Other media will be sampled and evaluated as part of the compliance monitoring or other RFETS programs.

The nature and extent of soil characterization and remediation within the BZ AOCs will have been determined; however, nature and extent of soil contamination in most White Space Areas will be unknown. The concentrations of COCs in soil in all areas within the BZ must be determined with adequate confidence to be protective of post-closure uses.

Data used in the CRA will be evaluated based on EUs. The extent of the EUs will be determined in the CRA Methodology (Appendix D), and will not depend on the size of the AOCs. CRA DQOs for the BZSAP provide information for data collection. Detailed CRA DQOs are presented in the CRA Methodology (Appendix D).

The Problem

Human and ecological receptors can be expected to randomly contact soil from any or all parts of the BZ. The previous DQOs address select areas of known contamination; however, there are areas within the BZ for which no data are available. The post-remediation state of the BZ must be assessed to determine whether it is adequately protective of the post-closure uses.

Identification of Decisions

The CRA questions that will be resolved are listed below:

1. Has each COC and its nature and extent within IHSSs, PACs, AOCs, and White Space Areas been identified with adequate confidence, based on process knowledge and analytical data?

2. Are long-term risks to receptors in an EU acceptable, based on post-closure uses?

3. Are long-term risks to onsite and offsite receptors via the air and surface water pathways acceptable, based on post-closure uses?

4. Does residual contamination within an Ecological Risk Assessment (ERA) EU represent an acceptable ecological risk due to direct contact with abiotic media?

Inputs to the Decisions

The information needed to resolve the CRA questions above are listed below.

1. Characterization data from RIs, RFI/RI reports, CMSs/FSs, remedial action reports, IMP reports, predemolition survey reports, and other projects and data sets, including BZSAP-generated, historical, and compliance monitoring data (e.g., concentrations of COCs in surface and subsurface soil, surface water, groundwater, air, and biota), as described in the CRA Methodology (Appendix D), will be used as inputs to the decisions. BZSAP data will include data collected for pre- and post-remediation AL comparisons. Data used in the CRA will be screened through the Data Quality Filter (DOE 2001a);

2. All available historical information, sampling data, and risk assessment requirements, as documented in the CRA Methodology (Appendix D), will be used to determine sampling locations and densities for White Space Areas to support CRA decisions. Data used in the CRA will be screened through the Data Quality Filter (DOE 2001a).

3. These data will be processed using one or more numerical methods to provide a decision context. These methods may include:

   - PCOC filter (algorithm);
   - Monte Carlo methods;
   - Air dispersion modeling;
   - Surface water, groundwater, or erosion modeling;
   - CRA modeling; and
   - ALF comparisons on an EU basis;

4. COCs as determined from sampling and remediation efforts;

5. Pre- and post-remediation sampling locations;

6. MDLs

   MDLs for BZ COCs and field analytical equipment are presented in Appendix E. Analytical methods are organized in tables by general analytical suite. The tables present the minimum required analytes within each respective suite, as well as the required sensitivity for each analyte. Sensitivities are expressed as MDLs, and are specific to the measurement systems used for BZ sample analysis. The RFCA ALs are the lowest values stipulated in RFCA for any exposure scenario. These conservative values are provided to ensure that method sensitivities, for each and every COC, are adequate for making project decisions.

   Accuracy and precision tolerances are also presented in each table. Accuracy specifications apply to methods only, whereas precision specifications are presented

relative to both laboratory and instrument performance and the overall project, which includes sampling error.

MDLs for offsite analytical laboratories are established by ASD and are listed in Appendix E; and

7. Acceptable human health and ecological risk levels for post-closure uses

   All characterization (unless remediated) and confirmation data for environmental media in the BZ that pass the Data Quality Filter (DOE 2001a) will be used in the CRA. This will include data from historical investigations and actions, BZ characterization, remediation confirmation, compliance monitoring, and additional samples to complete the nature and extent determination. All appropriate modeling results will be used in the assessment.

   CRA data will meet at least one of the following criteria:

   - Data must pass the Data Quality Filter (DOE 2001a).
   - Data must meet compliance monitoring DQO requirements.
   - Data used for CRA modeling must meet Actinide Migration Evaluation (AME) DQO modeling criteria.

   Data will be stratified using appropriate statistical methods to account for possible higher density sampling and higher levels of contamination in AOCs than in White Space Areas.

Study Boundaries

Decision boundaries to determine when and where data will be collected are listed below.

1. The data associated with IHSSs, PACs, AOCs, and White Space Areas will be incorporated into EUs as designated in the CRA Methodology (Appendix D).
2. EU sizes and factors will be documented in the CRA Methodology (Appendix D). The size of the EUs will be based on the potential land uses identified on Figure 1 of RFCA Attachment 5. The EUs will contain IHSSs, PACs, AOCs, and White Space Areas, as appropriate.
3. For ecological characterization, the minimum grid spacing for selecting random samples within an ERA EU will be based on the average home range of the Prebles meadow jumping mouse (PMJM) (3.5 hectares in a linear-ovate configuration). Other grid spacing will be used in habitats not frequented by the PMJM.
4. AL comparisons will be performed on aggregated data for COCs contained in an EU to account for direct exposure, including contact with multiple contaminants.

5. Aggregate human health risks and doses, and ecological risks, will be assessed for projected land uses in accordance with RFCA, and for adjacent areas including those downwind and downstream, as specified in the CRA Methodology (Appendix D).

6. Soil will be considered from the land surface to the top of the saturated zone or top of bedrock, as appropriate.

7. Temporal boundaries will be consistent with BZ project schedules. These boundaries will be refined as the BZSAP is developed and BZ remediation proceeds (e.g., to consider the optimal season for various sample types).

8. The CRA modeling effort will include several out-year land use scenarios as defined in the CRA Methodology (Appendix D).

9. The CRA will use characterization and confirmation data as appropriate from IHSSs, PACs, AOCs, and White Space Areas.

Decision Rules

The decision rules that describe how the data will be evaluated are illustrated on Figure 7 and listed below.

1. If the nature and extent of chemicals, metals, and radionuclides are known for an EU with sufficient certainty so that human health risks and doses and ecological risks can be adequately quantified, then additional sampling and analysis will not be performed. Otherwise, additional sampling and analysis will be performed.

Tolerable Limits on Decision Errors

Sample data requirements will be based on uncertainties of 10 percent or less for alpha errors and 20 percent or less for beta errors. Characterization of data, including the minimum detectable relative differences and data variability, will be evaluated for each EU. Sources of uncertainties in the risk assessments will be identified and minimized.

Optimization of Plan Design

Optimization of the post-remediation data collection and sampling requirements will be based on the EU for the appropriate land use, in consultation with CDPHE and EPA during development of the CRA Methodology (Appendix D).

The following documents will be used as guidance in defining the sampling and analysis requirements for the CRA:

- EPA, 1989, Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A), EPA/540/1-89/002, December.

- EPA, 1992, Guidance for Data Usability in Risk Assessment (Parts A&B), 9285.7-09A&B, April/May.

- EPA, 1996, Soil Screening Guidance: Technical Background Document, EPA/540/R-95/128, May.

- EPA, 1997, MARSSIM, NUREG-1575, EPA 402-R-97-016, December.

4.0 SAMPLING STRATEGY

The BZ sampling strategy specifies surface and subsurface soil sampling and analysis methodologies that will streamline characterization and remediation processes and maintain appropriate QA. The sampling strategy will:

- Provide a consistent process for characterizing IHSSs and PACs;

- Provide characterization focused on identifying areas that require remediation;

- Diminish reliance on offsite analytical laboratories to reduce cost and accelerate schedules; and

- Provide defensible quality data for the CRA.

The BZ sampling strategy includes the following key elements:

- In-process characterization and remediation sampling at IHSSs and PACs;

- Post-remediation confirmation sampling at IHSSs and PACs; and

- Sampling in White Space Areas for the CRA.

4.1 IN-PROCESS SAMPLING

The K-H characterization team will implement an in-process sampling approach that combines a statistical approach to determine sampling locations and remediation areas with the use of field analytical equipment. Existing data and historical process information will be used to determine the statistical approach needed to determine characterization sampling locations in IHSSs, PACs, and White Space Areas. After the sampling locations have been identified, samples will be collected and analyzed using field analytical instrumentation. The data will be evaluated using a geostatistical or standard statistical approach to delineate the AOC and areas that require remediation.

After the areas have been remediated, samples will be collected and analyzed using field analytical instrumentation to immediately determine whether remediation goals have been achieved. Soil will be removed in “lifts.” After a lift is removed, the remaining soil will be analyzed with field instrumentation. This process will continue until remedial objectives have been achieved. When field analytical results indicate remediation has been achieved, post-remediation confirmation samples will be collected and analyzed on site, if appropriate data quality can be demonstrated, or sent to an offsite laboratory for analysis. Offsite laboratory results will be validated according to ASD requirements.

If remediation is not required at specific IHSSs or PACs based on the results of field analysis, confirmation samples will be collected to support an NFA recommendation and the CRA. An offsite or onsite laboratory will perform the confirmation sample analysis. Field analytical instrument data will be used for the CRA if appropriate data quality can be demonstrated. Offsite laboratory results will be validated according to DQO requirements. Figure 8 illustrates the overall in-process sampling technique for IHSSs and PACs.

4.2 STATISTICAL APPROACHES

Characterization sampling locations will be determined for each IHSS, and PAC using geostatistical, standard statistical, or biased sample selection methods. Table 3 generally describes when each method will be used. Using existing data, a decision as to whether the data define a contaminant distribution (apply geostatistical approach) or a localized hot spot (apply standard or biased approach) will be made. The method for determining sampling locations will be specified in the appropriate BZSAP Addenda. In some cases, a combination of techniques may be used. For example, if process knowledge or existing data indicate discrete spill areas in a large IHSS, both standard statistical and biased sampling may be appropriate.

Table 3
Sampling Decision Matrix for IHSSs and PACs

Method	Condition
Geostatistical	• Existing analytical data • Existing data indicate a contaminant distribution
Standard Statistical	• No existing analytical data • Limited analytical data • Process knowledge
Biased Sampling	• Process knowledge • Limited analytical data • Analytical data indicate localized contamination or point sources

In-process sampling will use a variety of statistical error management approaches to meet the decision error limits specified in the DQOs. The specific approach will be customized to meet the uncertainty, time, and health and safety (H&S) constraints of each IHSS and PAC characterization.

Each component of the sampling design is based on the project DQOs presented in Section 3.0. The sampling strategies described in this section are the basis for IHSS and PAC characterization. However, these strategies are flexible and will be modified, as needed, to fit actual field conditions. Statistical methods are described in the following sections.

4.2.1 Geostatistical Approach

SmartSampling, a geostatistical approach developed at Sandia National Laboratory (SNL) and used at several DOE sites is the basis for the geostatistical approach that will

be used to determine the optimum number and location of samples needed to characterize IHSSs and PACs for remediation.

The geostatistical approach will be used to:

- Optimize the number and locations of characterization samples;
- Develop maps of the areas with concentrations or activities exceeding RFCA ALs at a given level of probability;
- Optimize the number and location of post-remediation confirmation samples;
- Achieve DQO-specified limits on decision errors; and
- Link onsite analysis with sampling to allow near real-time remediation decisions.

Geostatistics uses an iterative process based on remediating a site to required ALs at a specified level of confidence. Geostatistics will be applied using existing data to generate maps showing the probability of exceeding RFCA ALs in IHSSs, PACs, and White Space Areas. Based on the probability of exceedance maps, two types of maps can be developed:

1. Maps showing areas requiring additional sampling; and
2. Maps showing both Tier I and Tier II AL exceedances at a specified level of reliability.

Existing data will be analyzed, and a decision to collect more samples will be based on an analysis of sampling locations, analytical results, and the chosen reliability level. After characterization of individual IHSSs and PACs, geostatistical or standard statistical techniques will be used to define AOCs and areas above RFCA ALs. Sampling necessary to define the extent of contamination will be iterative: as sample data are received, they will be evaluated using geostatistics. The results will be used to determine the optimal number and locations of samples to be collected in the next iteration, if necessary. This iterative updating will be conducted in near real-time (on the order of several hours turnaround for incorporating the new sample information).

Geostatistics are not designed for developing a characterization plan around a single hot spot. Sampling to identify hot spots will generally be more focused on defining contaminants in a single location, and may not provide the necessary areal coverage to define the extent of contamination across an entire IHSS. However, depending on the size of the IHSS, the same sampling grid spacing used for finding a hot spot may provide the necessary information for the geostatistical approach.

Figure 9 illustrates how geostatistics will be used at the IHSSs and PACs. A more detailed description of geostatistical procedures is provided in Section 5.2.4.

4.2.2 Standard Statistical Approach

The geostatistical approach is not suitable for IHSSs or PACs that have relatively few or no observations. Therefore, a separate sampling methodology is necessary to adequately characterize soil contamination in these areas. An efficient sampling strategy for delineating the spatial distribution and total amount of contamination encompassing "poorly" defined areas is a statistical grid design. This type of design is best suited for detecting potential hot spots of unknown spatial distribution(s).

Appropriate grid designs will be developed based on project DQOs and may include, but not be limited to, triangular and random stratified grids. Sampling IHSSs and PACs on a triangular grid will result in a spatial configuration of data that can be used for geostatistical analysis. This approach is conducive to determining the spatial correlation structure of the data set, which can be used in the geostatistical analysis to define areas above Tier I and Tier II ALs.

A systematic sampling scheme will be used to identify and delineate hot spots within the areas of interest following procedures outlined in Gilbert (1987). Sampling locations will be positioned into equilateral grids, such as triangular grids, following the methods presented in Gilbert (1987), Gilbert and Simpson (1992), and Section 4.3. Triangular grid sampling provides uniform coverage of a sampling area and increases the chances of identifying an elliptical or circular hot spot (Gilbert 1987). The following assumptions apply to the proposed sampling design:

- Samples will be collected on a statistical grid.
- The sampled area is much smaller than the grid spacing.
- Hot spots are circular or elliptical.

Hot spots will be defined.

After the grid interval is calculated for the specified area, a random-start grid overlay will be superimposed on a map of the IHSS or PAC. In some cases, biased sampling will supplement the grid interval. This methodology provides grid coverage with a 90% confidence of finding a radionuclide hot spot, as well as provides statistical confidence for other constituents consistent with DQO error rates of 10% (alpha) and 20% (beta) for both radionuclides and nonradionuclides. Confidence limits are also consistent with EPA specifications (EPA 1992).

Soil samples will be collected at the intersection of each grid according to the sample collection methods described in Section 4.8. Additional samples will be collected, as needed, to determine the size of the AOC. Sampling methods for each IHSS and PAC will be specified in the appropriate BZSAP Addendum.

In summary, standard statistical techniques, outlined in Gilbert (1987) (and incorporated in a number of available software programs [e.g., Visual Sampling Plan]) will be used to determine sampling locations in areas where:

- No existing analytical data are available;
- Limited analytical data are available;
- Process knowledge does not indicate biased sampling is appropriate; and
- Uniform contamination is indicated.

A hot spot methodology (Section 4.3) augments the standard statistical approach used to define grid spacing in IHSSs and PACs.

Figures 10 and 11 illustrate how standard statistical techniques, and standard statistical techniques combined with a biased sampling approach, respectively, will be used at IHSSs and PACs.

4.2.3 Biased Sampling Approach

In addition to the systematic sampling design, some areas may require judgment or biased sampling where process knowledge or analytical data suggest there is a high probability

of contamination in a limited area. This approach will provide targeted sampling of potential problem areas and result in the following:

- Additional sampling between the standard grid, if necessary; and
- Limited sampling of some IHSSs and PACs.

Biased sampling locations might include areas of deposition where contaminants have a tendency to accumulate. Other physical features that may warrant biased sampling include confluences, outfall points, and apparent discoloration of the soil, sediment, or vegetation. These features and the applicability of biased locations will be assessed during characterization planning. Figure 12 illustrates how biased sampling will be used at IHSSs and PACs.

In summary, a biased sampling approach will be used when:

- Process knowledge indicates discrete spills or releases; or
- Limited analytical data indicate hot spots or other discrete areas of interest.

4.3 HOT SPOT METHODOLOGY

Hot spot is a relative term used to denote an area that has a significantly higher contaminant concentration than the surrounding area. Hot spots are quantified by their size and contaminant concentration. A method for measuring hot spots is needed to:

- Determine areas of limited extent that require remediation;
- Statistically evaluate the extent of contamination in localized areas; and

- Determine the size of the sampling grid.

Hot spot size drives the grid density and number of samples for a given area of interest. To determine grid density for BZ and CRA sampling, the Site has been divided into three areas based on the following criteria:

- Potentially Contaminated Areas - IHSSs, PACS, and UBC Sites in the IA and BZ are areas of known contamination or have a potential for contamination (based on process knowledge or analytical data).

- Areas Not Expected To Exceed Action Levels - White Space Areas in the IA and inner BZ are considered areas that have a potential for contamination or known contamination but the contamination is not expected to exceed RFCA ALs.

- Outer Buffer Zone – Areas outside of IHSSs and PACs within the outer BZ are not expected to contain significantly higher contamination than the surrounding area. The outer BZ White Space will not require sampling activites for hot spots.

4.3.1 Potentially Contaminated Areas

IHSSs and PACs will be sampled based on the requirements of standard statistics and/or geostatistics depending on site-specific circumstances. These statistical approaches are used to assess the concentration/activity of an analyte across an IHSSs and PACs for comparison with RFCA Tier I and Tier II ALs. This AL comparison must also include a hot spot analysis to ensure that small, localized areas with elevated sample results comply with health-based requirements.

A two-step process will be used to define hot spots in potentially contaminated areas.

1. The first step is to evaluate existing analytical data to determine whether there are data to constrain the size of a potential hot spot in an IHSS or PAC. If data exist that provide information on potential hot spot size (or sizes), these data will be used. For example, knowledge of the size of hazardous waste storage units such as drum pallets, storage tanks, and crates, or the size of spills, will dictate the likely hot spot dimension(s) in a given area. If there is more than one potential hot spot in a given area, an average hot spot size will be determined. The grid size used for sampling and number of samples required will be based on the defined hot spot size and level of probability (90 percent) of finding a hot spot (Gilbert 1987). Biased sampling may also be used to augment the grid design.

2. If there are no data available that can constrain the size of a hot spot, two options will be considered.

    a) The hot spot size in IHSSs and PACs will be based on the sampling grid used to characterize radiologically contaminated surface soil within the 903 Pad Area. The 903 Pad Area was characterized using high-purity germanium (HPGe) instrumentation on an 11-meter (m) (36-foot[ft]) triangular grid. Based on this grid dimension, there is a 90 percent probability of detecting a hot spot using Gilbert's (1987) methodology. The hot spot size is assumed to be circular with a

diameter of 36 ft. (The field of view of the HPGe was 10 meters [m] [or 33 ft], which was based on the instrumentation, not a specified hot spot size.) The 36-ft triangular grid spacing is conservative for characterizing nonradionuclides, and provides a consistent approach for both radionuclides and nonradionuclides.

This methodology will provide a consistent sample density for most IHSSs and PACs in the BZ, and is small enough to detect most hot spots. Additionally, sampling at this grid size will provide data for subsequent geostatistical analysis, if needed.

(b) There are IHSSs and PACs that are smaller than the proposed grid size of 10 m across. If there are no data available to constrain a hot spot size in these IHSSs and PACs, a minimum of five samples will be collected in a triangular, square, or random stratified grid pattern. This methodology will provide the minimum number of samples that can be used for statistical analysis. Additional samples will be collected as needed based on the in-process sampling results.

Areas with concentrations above RFCA Tier I and Tier II ALs will be evaluated, according to BZSAP DQOs and methods described in Section 5.0, to determine whether a hot spot is present. Hot spot size, along with grid spacing and number of samples required for individual IHSSs and PACs in the BZ, will be described in the BZSAP Addenda.

4.3.2 Areas Not Expected To Exceed Action Levels

White Space and inner BZ is not expected to have contamination above ALs and will be sampled to support CRA analyses. Surface soil in the inner BZ White Space and inner BZ will be sampled at grid points located based on Gilbert's methods and the probability of finding an area of elevated contamination. The area of the IA White Space and inner BZ is approximately 1,027 acres and a grid size of 2.5 acres has been chosen for the following reasons:

- There is very little precedence in existing literature for determining grid size at DOE Superfund sites. However, provides guidance on the evaluation of land areas at radionuclide sites. MARSSIM defines land areas that have a potential for contamination as not greater than 10,000 square meters (m^2) in size. The IA White Space Areas and inner BZ are considerably larger (approximately 1,027 acres, 45 million ft^2, or 4 million m^2) than a MARSSIM area of 10,000 m2 (2.5 acres or 107,639 ft^2). A grid size of 2.5 acres in the IA White Space and inner BZ would be approximately 0.2 percent of the area and provides a conservative method for determining contaminant distribution.

- The grid design based on the 2.5-acre gird will augment geostatistical analysis by filling in data gaps between IHSSs and PACs..

- The grid size of 2.5 acres will provide appropriate sampling frequency and information for geostatistical analysis of White Space Areas in the IA and inner BZ.

Areas with concentrations above RFCA Tier I and Tier II ALs will be evaluated, according to BZSAP DQOs and methods described in Section 5.0, to determine whether contamination is present. Figure 13 illustrates the extent of the inner and outer BZ areas at RFETS.

4.3.3 Elevated Measurement Comparison

In AOCs that contain RFCA Tier I and Tier II AL exceedances, remedial and management decisions can be based on the Elevated Measurement Comparison (EMC) (MYAPC 1999). The EMC defines significantly high measurements relative to the size of a hot spot, magnitude of the AL, and mean of the surrounding measurements. The EMC depends on several variables: AL, measured value, size of the hot spot, and size of the AOC. The EMC is applicable to all sample results or hot spots with concentrations above RFCA Tier I or Tier II ALs. In AOCs where all sample results are less than ALs, the EMC is not required.

The decision whether a hot spot requires remediation is not part of the BZ characterization or post-remedial sampling effort. The EMC is presented in the BZSAP because the EMC is consistent with BZSAP DQOs for data aggregation and evaluation.

Results of the EMC equation (Section 5.3) greater than 1 indicate action is necessary, and results less than 1 indicate action is not necessary. Because the EMC includes an area-weighting component, results for very small hot spots may indicate action is not necessary for very high contaminant concentrations. To reduce this effect, when the concentration of a contaminant at a hot spot is three times the Tier I AL, action is indicated. The “three times the AL” concept will not apply to ALs that are based on acute toxicity. Using a value of three times the AL as an upper limit for reevaluation is consistent with the Residual Radioactivity Computer Code (RESRAD) release criteria. If the hot spot is remediated, the confirmation sample values will be used in the equation.

The EMC equation is discussed in Section 5.3 and several examples of how the equation works are presented in Appendix G.

4.4 CHARACTERIZATION SAMPLING STRATEGY FOR IHSSS AND PACS

Existing analytical and historical information will be evaluated for each IHSS and PAC to establish the appropriate statistical method (Section 4.2) for determining characterization sampling locations, PCOCs, and sampling methods for the site. A list of IHSSs and PACs, and a preliminary assessment of the statistical method that will be used, is provided in Table 4. PCOCs for the BZ are listed in Section 3.0. Sampling locations for IHSSs and PACs will be detailed in the appropriate BZSAP Addendum.

4.4.1 Surface and Subsurface Soil Sampling

The characterization team will sample surface soil in accordance with Standard Operating Procedure (SOP)-OPS-GT-08 and as described in Section 4.8. Surface soil samples will be analyzed with field instruments for radionuclides, metals, SVOCs, and, if existing historical or analytical data suggest, other analytes (pesticides, PCBs, etc.). In some

cases where existing data suggest a restricted COC list, soil samples will be analyzed for the specific COCs only. A list of PCOCs will be included in the BZSAP Addenda.

Subsurface soil will be sampled where historical information and analytical data suggest contamination may be present below a depth of 6 inches. The characterization team will collect subsurface soil samples with a Geoprobe® (or other appropriate method) to the top of the saturated zone or top of bedrock. The characterization team will use concrete drills,drills (for concrete slabs, and other foundation areas) where necessary. The types of Geoprobe® and other sampling methods that may be used are described in Section 4.8. Sample Collection and COCs for each IHSS and PAC will be specified in the appropriate BZSAP Addendum.

Table 4
Preliminary Sample Location Statistical Technique

IHSS Group	Description	ID	NFA Status[1]	Area (ft2)	Number of Existing Sample Locations						Historical Notes	Preliminary Sampling Methodology
					Rads	Metals	PCBs	Pesticides	SVOCs	VOCs		
000-5	Disposal of Diesel Contaminated Material at Landfill (formerly NW-177)	NW-1502	P	356							Disposal of 50 lbs of soil and oil absorbent contaminated with diesel fuel.	Biased/Stratified Statistical Grid
	Disposal of Fuel Contaminated Material at Landfill	NW-1503	P	356							Empty motor oil containers, used oil filters and oil stained debris were removed.	Biased/Stratified Statistical Grid
	Disposal of Thorosilane Contaminated Material at Landfill	NW-1504	P	356							Release of thorosilane and disposal of contaminated absorbent.	Biased/Stratified Statistical Grid
	Landfill Trench A	166.1	P	13,959	8	7		7		7	Disposal of sanitary sewage sludge and liquids. Potential radiological contamination.	Biased/Stratified Statistical Grid
	Landfill Trench B	166.2	P	17,208	6	6		6		6	Disposal of sanitary sewage sludge and liquids. Potential radiological contamination.	Biased/Stratified Statistical Grid
	Landfill Trench C	166.3	P	15,820	6	6		6		6	Disposal of sanitary sewage sludge and liquids. Potential radiological contamination.	Biased/Stratified Statistical Grid
	Landfill Pond Spray Area	167.2	P	10,875	4	4					Sparay evaporation of landfill leachate	Biased/Stratified Statistical Grid
	Landfill Pond Spray Area	167.3	P	10,875	3	3					Sparay evaporation of landfill leachate	Biased/Stratified Statistical Grid
	Present Landfill	114	P	1,644,510	188	196	41	19	34	28	Disposal of uncontaminated solid waste	Geostatistical/Biased
900-11	Elevated Chromium Identified During Geotechnical Drilling	900-1316	P	4,586							Potential chromium release	Biased/Stratified Statistical Grid

IHSS Group	Description	ID	NFA Status[1]	Area (ft2)	Number of Existing Sample Locations						Historical Notes	Preliminary Sampling Methodology
					Rads	Metals	PCBs	Pesticides	SVOCs	VOCs		
	East Firing Range & Target Area	SE-1602		465,173							Lead bullets in Firing Range berm. Armor piercing bullet fragments made of depleted uranium in Target Area	Biased/Stratified Statistical Grid
	Ryan's Pit (Trench 2)	109		261	2	2		2	2	2	Disposal of VOCs and drum carcasses.	Biased/Stratified Statistical Grid
	903 Pad	112		146,727	52	12	7	17	22	27	Leaks and spills from Drum Storage	Geostatistical/Biased
	Haz Disposal Area	140	R	65,498	14	12	6	16	10	16	Reactive metal destruction and disposal site.	Biased/Stratified Statistical Grid
	903 Lip Area	155		1,009,572	1173	16	11	25	12	25	Wind dispersal contamination from the 903 Pad.	Geostatistical/Biased
	Gas Detox Area	183	S	354							Toxic gas storage and gas detoxification/neutralization area.	Biased/Stratified Statistical Grid
900-12	Trench T-1	108	S	6,286	1	1	1	1	1	1	Disposal of sanitary waste sludge and debris.	Biased/Stratified Statistical Grid
	Trench T-3	110	S	7,823	12	12	1	15	11	15	Disposal of sanitary waste sludge and debris.	Geostatistical/Biased
	Trench T-5	111.2		19,235	5	5	2	6	5	6	Disposal of sanitary waste sludge	Biased/Stratified Statistical Grid
	Trench T-6	111.3		4,089	2	2	1	2	2	2	Disposal of sanitary waste sludge	Biased/Stratified Statistical Grid
	Trench T-8	111.5		7,297	1	1	1	1	1	1	Disposal of sanitary waste sludge	Biased/Stratified Statistical Grid
	Trench T-9	111.6		14,705	4	4	1	4	4	4	Disposal of sanitary waste sludge, scrap metal, and junk	Biased/Stratified Statistical Grid
	Trench T-10	111.7		4,271	4	4	1	4	4	4	Disposal of sanitary waste sludge	Biased/Stratified Statistical Grid
	Trench T-11	111.8		5,776	4	4		4	2	4	Disposal of sanitary waste sludge and asphalt planking	Biased/Stratified Statistical Grid
900-2	Oil Burn Pit No. 2	153		6,403							Disposal and burning of uranium contaminated coolant and waste oils	Biased/Stratified Statistical Grid
	Pallet Burn Site	154		3,152							Burning of wooden pallets	Biased/Stratified Statistical Grid
	East Spray Field-North Area	216.1	P	149,481	12	12		6		6	Spray evaporation of B-Series	Biased/Stratified Statistical Grid

IHSS Group	Description	ID	NFA Status[1]	Area (ft2)	Number of Existing Sample Locations						Historical Notes	Preliminary Sampling Methodology
					Rads	Metals	PCBs	Pesticides	SVOCs	VOCs		
											pond water	
	East Spray Field-Center Area	216.2	D	73,458	1	1	1	3	1	3	Spray irrigation from Pond B-3	Biased/Stratified Statistical Grid
	East Spray Field-South Area	216.3	D	651,580	10	13	3	13	4	13	Spray irrigation from Pond B-3	Biased/Stratified Statistical Grid
NE-1	Pond C-1	142.10	R	33,975	2	2	1	1	2	2	Retention and monitoring pond. Received sanitary sewage discharge and runoff from the 903 Pad Area.	Biased/Stratified Statistical Grid
	Pond C-2	142.11	R	168,524	3	4	3	3	3	4	Received discharge from the South Interceptor Ditch.	Biased/Stratified Statistical Grid
	Pond A-1	142.1	R	39,294	4	4	4	4	4	4	Received wastewater effluent from the Industrial Area. Spill control.	Biased/Stratified Statistical Grid
	Pond A-5	142.12	R	12,256	5	5	5	5	5	5	Received wastewater effluent from the Industrial Area.	Biased/Stratified Statistical Grid
	Pond A-2	142.2	R	61,373	1	4	4	4	4	4	Received wastewater effluent from the Industrial Area. Spill control.	Biased/Stratified Statistical Grid
	Pond A-3	142.3	R	122,909	4	5	4	4	4	4	Received wastewater effluent from the Industrial Area.	Biased/Stratified Statistical Grid
	Pond A-4	142.4	R	254,102	4	4	4	4	4	4	Received wastewater effluent from the Industrial Area.	Biased/Stratified Statistical Grid
	Pond B-1	142.5		11,396	5	4	5	5	5	5	Flow-through retention pond. Received treated sanitary effluent and process waste.	Biased/Stratified Statistical Grid
	Pond B-2	142.6		33,761	5	5	5	5	5	5	Flow-through retention pond. Received treated sanitary effluent and process waste.	Biased/Stratified Statistical Grid
	Pond B-3	142.7		18,422	4	4	4	4	4	4	Flow-through retention pond. Received treated sanitary wastewater effluent discharge.	Biased/Stratified Statistical Grid
	Pond B-4	142.8	R	11,731	5	5	5	5	5	5	Flow-through retention pond. Received treated sanitary effluent and process waste.	Biased/Stratified Statistical Grid
	Pond B-5	142.9	R	129,515	5	5	5	7	5	7	Flow-through retention pond. Received treated sanitary effluent and process waste.	Biased/Stratified Statistical Grid
	Diesel Spill at Pond B-2 Spillway	NE-1404	D	356							18 gallons of diesel released	Biased/Stratified Statistical Grid

IHSS Group	Description	ID	NFA Status[1]	Area (ft2)	Number of Existing Sample Locations						Historical Notes	Preliminary Sampling Methodology
					Rads	Metals	PCBs	Pesticides	SVOCs	VOCs		
											on the shore	
NE-2	Trench T-7	111.4		15,565	9	9	1	9	8	9	Disposal of sanitary waste sludge and debris.	Biased/Stratified Statistical Grid
NE/NW	OU2 Treatment Facility	NE-1407		356							Leaks and spills from process operations.	Biased/Stratified Statistical Grid
	Modular Tanks and 910 Treatment Sys Spill (formerly 000-503)	NE-1409	S	68							Release of 4,700 gallons of RCRA F-listed water.	Biased/Stratified Statistical Grid
	Diesel fuel Spill at field Treatability Unit	NE-1410	P	356							Release of 2-4 gallons of diesel fuel followed by removal action.	Biased/Stratified Statistical Grid
	Diesel Fuel Overflowed from Tanker @ OU2	NE-1411	P	356							Release of 20 gallons of diesel fuel followed by removal action.	Biased/Stratified Statistical Grid
	PU&D Storage Yard	170	D	221,304		37	37	39	39	39	Drum and dumpster storage	Geostatistical/Biased
	Trench T-12 Located @ OU2 East Trenches	NE-1412		7,449							Disposal of sanitary waste sludge and flattened drums.	Biased/Stratified Statistical Grid
	Trench T-13 Located @ OU2 East Trenches	NE-1413		5,090							Disposal of sanitary waste sludge and flattened drums.	Biased/Stratified Statistical Grid
	PU&D Yard - Drum Storage	174a		4,342		21	21	24	24	24	Leaks and spills from RCRA drum storage.	Geostatistical/Biased
SW-1	Recently Identified Ash Pit	SW-1701	D	11,066							Disposal of combustible waste ash, depleted uranium and metallic debris.	Biased/Stratified Statistical Grid
	Recently Identified Ash Pit	SW-1702		5,588							Disposal of combustible waste ash, depleted uranium and metallic debris.	Biased/Stratified Statistical Grid
	Ash Pit 1	133.1		13,960	4	4					Disposal of combustible waste ash and noncombustible trash.	Biased/Stratified Statistical Grid
	Ash Pit 2	133.2		26,624	7	7					Disposal of combustible waste ash and noncombustible trash.	Biased/Stratified Statistical Grid
	Ash Pit 3	133.3		13,023	3	3					Disposal of combustible waste ash and noncombustible trash.	Biased/Stratified Statistical Grid
	Ash Pit 4	133.4		10,749	3	3					Disposal of combustible waste ash and noncombustible trash.	Biased/Stratified Statistical Grid

IHSS Group	Description	ID	NFA Status[1]	Area (ft2)	Number of Existing Sample Locations						Historical Notes	Preliminary Sampling Methodology
					Rads	Metals	PCBs	Pesticides	SVOCs	VOCs		
	Incinerator	133.5	D	45,495	2	2			1		Area backfilled with ash potentially contaminated with depleted uranium	Biased/Stratified Statistical Grid
	Concrete Wash Pad	133.6	D	35,274	1	1	1	1	1	1	Deposition of potentially contaminated ash	Biased/Stratified Statistical Grid

[1] No Further Action Status based on Annual Update for the Historical Release Report (DOE 2000a) IHSS and PACs with NFA status identified as Proposed (P) or Resubmitted (S) or Request Additional Data (D) approved by regulators. If approved as NFAs these IHSSs and PACs are excluded from the BZSAP scope.

Surface and subsurface soil sample analytical results will be compared to RFCA Tier I and Tier II ALs. Data from each IHSS and PACwill be evaluated according to DQOs (Section 3.0).

4.5 POST-REMEDIATION CONFIRMATION SAMPLING

Post-remediation confirmation sampling will be conducted at AOCs associated with IHSSs and PACs in the BZ. In-process confirmation soil samples will be collected and analyzed during remediation to verify cleanup below remediation goals. In-process samples will be analyzed with field analytical instruments. Post-remediation confirmation samples will also be collected and analyzed. The combination of in-process and confirmation samples will ensure that residual contamination levels are below remediation goals.

4.5.1 Confirmation Sampling and Analysis

Confirmation samples are defined as those samples acquired following a remedial action. The characterization team will conduct confirmation sampling and analysis on remediated areas to verify that the site has met remedial objectives. The confirmation sampling and analysis will provide a representative assessment of the magnitude and spatial configuration of the COC(s) after remediation. The number and distribution of confirmation samples will be based on the probability of detecting residual contamination (90 percent) and the size and spatial variability of the remediated site. Statistical sampling strategies will ensure that the appropriate numbers of samples are collected from unbiased locations.

The characterization team will collect soil from the remediated areas before the areas are covered with clean fill. Confirmation sampling locations will be determined using geostatistical methods or the approach described in Section 4.5.2. Soil samples will be analyzed onsite if appropriate data quality is achieved, or sent to offsite analytical laboratories for analysis, and analytical data will be validated in accordance with ASD requirements. If adequate correlation is demonstrated between field analytical and laboratory analysis data, field instrumentation may also be used for confirmation analysis.

The characterization team will conduct confirmation sampling at all BZ Group remediations during FY02. They will compile and evaluate confirmation sampling data generated during that time to determine whether field analytical data are of sufficient quality to be used for CRA analyses. If the regulatory agencies concur that the field analytical data are of sufficient quality, remediation confirmation samples will be analyzed with field analytical instruments rather than sent to offsite laboratories.

4.5.2 Sampling Locations

A triangular sampling grid, based on the size of an excavation, will be used for the selection of confirmation sampling points. Three grid densities will be used to verify remediation. The origin of the grid will be determined using a randomizing technique to minimize sampling bias.

1. For remediated areas that were contaminated with radionuclides, 90 percent of the area will be scanned using in-situ HPGe techniques within a triangular grid system. Considering an HPGe 11-m diameter field of view with the detector placed 1 m above the soil surface, a grid interval of 11 m (36 ft) will be used to achieve 90 percent coverage. This grid spacing is consistent with the characterization sampling approach.

2. The second approach for defining a grid density will be applicable to areas where nonradiological-contaminated soil was remediated. The grid density for confirmation sampling in nonradiological-contaminated areas will be based on the size of the remediated area (Michigan DNR 1994). This approach is based on a 95% confidence level of determining any hot spot concentrations on a site. Incorporating confirmation sampling will allow for a reduction in the Type I error rate from 0.1 to 0.05, which will reduce the probability of residual contamination after remediation. This approach is designed to delineate nonuniform areas of residual contamination, and is therefore appropriate for reliable characterization of the entire remedial area. Grid density is proportional to the size of the area and can be determined using one of the following equations (Michigan DNR 1994):

Small Remediation Site (0.06 to 0.25 acre): $$GI = \frac{\sqrt{A/\pi}}{2}$$ (Equation 4-1)

Medium Remediation Site (0.25 to 3.0 acres): $$GI = \frac{\sqrt{A/\pi}}{4}$$ (Equation 4-2)

Large Remediation Site (> 3.0 acres): $$GI = \sqrt{(A*\pi)/SF}$$ (Equation 4-3)

Where

GI = grid size
A = size of area of interest
SF = site factor, length of grid area [dimensionless]

As shown above, the grid equations apply to three different size areas. The grid densities vary according to the size of the area of interest.

Table 5 presents several examples of the calculations.

Table 5
Calculation of Confirmation Sampling Location Grids

Equation 4-1	**Area (ft^2)**	**A/π**	**Sq Root**	**Grid Size (ft^2)**
Small Site - 0.06 to 0.25 acre (2,614 to 10,890 ft^2)	2,614	832	28	14
	5,000	1,592	39	20
	10,890	3,468	58	29
Equation 4-2				
Medium Site - 0.25 to 3.0 acres (10,890 to 130,680 ft^2)	10,890	3,468	58	15
	50,000	15,923	126	32
	100,000	31,847	178	45
	130,680	41,617	204	51
Equation 4-3	**Area (ft^2)**	**A*π**	**SF**	**Grid Size (ft^2)**
Large Site - >3.0 acres (130,680 ft^2)	1,000,000	3,140,000	1,000	56

After the grid size is calculated for a specified area, a randomly located grid overlay will be superimposed on a map of the remediated area. Some grid adjustment may be necessary for unusually shaped areas. For excavations, both the sidewalls and bottom areas will be included in the determination of the area size. A minimum of one sample for each sidewall is required. Sidewall samples will be located in biased areas, if possible.

The systematic grid sampling will be augmented with biased sampling as necessary. Exact locations of biased sampling points will be based on site-specific information (e.g., location of leaks in an underground storage tank or its piping) and physical characteristics of the soil. Some characteristics that may require biased sampling may include, but are not limited to, the following:

- Preferential migration pathways (e.g., burrows, fractures, bedding planes, and sandstone lenses);
- Source areas (e.g., outfalls, storage areas, and historical spill sites);
- Stained soil;
- Changes in soil characteristics (e.g., sand/clay interfaces); and
- Depressions and ditches.

3. At remediated areas smaller than 0.06 acre (2,614 ft^2), a minimum of five locations will be sampled. Locations will include the walls and floor of the remediated area.

4.6 CHARACTERIZATION SAMPLING STRATEGY FOR SURFACE SOIL IN THE OUTER BUFFER ZONE WHITE SPACE AREAS

Surface soil in outer BZ White Space Areas will be sampled and analyzed to provide data for the CRA. The sum of ratio data for COCs from existing and BZ characterization data will be compared to RFCA Tier I and Tier II ALs.

Sampling grid spacing and the number of required samples will be on the EU defined in the CRA Methodology. Specific sampling locations will be described in the appropriate BZSAP Addendum.

Surface soil samples will be collected at the specified locations and depths according to the sample collection methods described in Section 4.8. These samples will be analyzed at an offsite analytical laboratory or with field instruments for radionuclides, metals, and SVOCs. Areas with concentrations above RFCA Tier I and Tier II ALs will be evaluated, according to DQOs (Section 3.0) and methods described in Section 5.0, to determine whether contamination is present.

4.7 FIELD ANALYTICAL APPROACH

The characterization team will use field analytical instruments to detect COCs above RFCA Tier I and Tier II ALs in surface and subsurface soil samples. All analytical instruments will have detection limits below RFCA ALs. Field analytical instruments will be coupled with computer software so that analytical results can be uploaded into statistical and geostatistical programs and the Site database. Field analytical instruments will be field portable where possible or available in an onsite mobile laboratory. For compounds that cannot be analyzed for using field analytical instruments, samples may be sent to offsite laboratories.

All field analytical instruments will be calibrated to determine their relationship with standard laboratory procedures. The sample size (support) investigated with field analytical techniques will be made as close as possible to the support investigated by the laboratory analytical techniques. This calibration and consistency in sample supports will ensure a valid relationship between the concentration/activity values determined by the field analytical techniques and the concentration/activity values determined in the final confirmation sample analyses (Myers 1997, Pitard 1993).

Field analytical instruments, either portable or in a mobile laboratory, may include, but are not limited to, the following:

- Multielement x-ray fluorescence (XRF) spectrum analyzer, laser-induced breakdown spectroscopy (LIBS), and inductively coupled plasma (ICP) spectrometer analysis for metals;
- HPGe for radionuclides; and
- Gas chromatography/mass spectrometry (GC/MS) for VOCs, SVOCs, pesticides, herbicides, and PCBs.

Other field screening analytical instruments, including organic vapor analyzers, Field Instruments for the Detection of Low Energy Radiation (FIDLERs), flame ionization detectors (FIDs), or photoionization detectors (PIDs) may be chosen based on analytical requirements. Additionally, offsite analytical laboratories will be used as necessary for specific analytes or groups of analytes.

4.7.1 Radionuclides

Gamma spectroscopy using an HPGe is the primary means by which the type and quantity of radionuclides in soil will be determined. In general, gamma spectroscopy will be used in lieu of alpha spectroscopy, because gamma spectroscopy provides data of comparable quality and sensitivity in a shorter time. Limited alpha spectroscopy analyses may be performed for verification and validation of gamma spectroscopy methods.

Soil samples will be screened with HPGe to detect areas with radionuclides elevated above Tier II ALs. Gamma spectroscopy methods may be used in at least two ways: in situ and field laboratory. In-situ methods provide field data for two-dimensional measurements (areal), or three-dimensional measurements with very limited depth. Field-of-view depths are typically limited to several centimeters within the soil. Use of in-situ gamma spectrometry to investigate “soils at depth” for confirmation sampling will be based on remediation lifts (i.e., exposed soil surfaces as the lift moves downward or laterally). The exposed soil surfaces will have relatively flat surface geometries that can be accommodated by the gamma-spectrometry measurement system. Where counting times for radionuclides are long and for subsurface samples, samples may be analyzed in the field laboratory. Quality control (QC) specifications for both techniques are presented in the Quality Assurance Project Plan (QAPjP), which is included in Appendix H. These controls will be contractually required of the gamma spectrometry vendor. Detection limits and counting times for radionuclides are specified in the DQOs and Appendices E and H.

4.7.2 Metals

Soil samples will be analyzed to detect the presence of metals using EPA Method 6200, *Field Portable XRF Spectrometry*, or SW 7090 or 7091 or equivalent. Quality controls required for this method are summarized in the QAPjP. Field analytical equipment may include field-portable XRF or LIBS. Specific manufacturers and models will be chosen by the analytical subcontractor, but will be approved by K-H QA personnel. The selected instruments will have detection limits below RFCA ALs as specified in the DQOs. Mobile laboratory and offsite laboratory analyses will use standard fixed-laboratory methods (e.g., SW846).

4.7.3 Organic Compounds

Concentrations of VOCs, SVOCs, pesticides, herbicides, PCBs, and other organics will be measured using a mobile GC or GC/MS in a field or offsite analytical laboratory. Organic analyses will be preceded by an appropriate extraction/digestion method. Preparation and analysis will consist of SW846 methodologies, and will be consistent with existing ASD contractual requirements, with variances listed in the QAPjP. Examples of variances might include abbreviated analytical suites based on the final BZ

PCOC list, as well as abbreviated reporting requirements, where data packages and Electronic Data Deliverables (EDDs) will be streamlined to accelerate decisionmaking in the field. Instrumentation will have detection limits below RFCA ALs as specified in the DQOs.

4.8 SAMPLE COLLECTION

Sample collection requirements and procedures are described in this section. If conditions are encountered during sampling activities that may result in unsafe or inappropriate use of the sampling technique, procedures may be modified or replaced. Modifications or replacements will be justified and detailed in the sampling records, and the resulting data will be comparable and adequate to meet the project DQOs.

4.8.1 Presampling Activities

In preparation for sampling and associated field activities, contamination area (CA), radiological buffer area (RBA), and exclusion zone (EZ) support zones, and all related radiological and H&S postings will be established and identified at each work site in accordance with project-specific H&S protocols and Radiological Safety Procedures (RSPs), as required.

All H&S protocols will be followed in accordance with the requirements specified in the Health and Safety Plan (HASP) for each BZ Group. Drilling and sampling subcontractors will provide a HASP specific to their scope. Each HASP will be developed under the guidance of, and in accordance with, applicable federal, state, local, and Site policies and procedures. Each HASP will identify all personal protective equipment (PPE), training, and air monitoring requirements, as well as all other hazard assessments and controls specific to the work scope and the Site.

Nonintrusive Surveys

Nonintrusive surveys will be conducted to detect structures and debris beneath the soil and building surfaces. These surveys may include ground-penetrating radar (GPR). RFETS Excavation Specialists routinely use GPR and other survey instruments to locate subsurface utilities and structures prior to drilling and in preparation for an Activity Hazards Analysis (AHA).

4.8.2 Surface Soil Sampling

The characterization team will collect surface soil samples in accordance with DQOs and at locations specified in the BZSAP Addenda. Modifications to sampling procedures will be made as field conditions warrant. All modifications will be documented and justified in the final report.

Where required, pre-work radiological surveys will be conducted. Sampling locations will be marked in accordance with OPS-PRO.947, *Location/Surveying*. Location numbers will correspond with sample numbers assigned by ASD (Section 6.0).

The characterization team will collect soil samples from the 0- to 6-inch horizon using grab or hand auger methods. Each sample will be collected using a clean, stainless steel or disposable scoop/trowel or hand auger depending on the sampling location and soil types present. If surface vegetation is present, it will be removed from the sampling location with a decontaminated, stainless steel shovel or appropriate hand tool prior to soil collection. All sample material recovered will be placed into individual sample jars according to OPS-PRO.069, *Containerizing, Preserving, Handling and Shipping of Soil and Water Samples*. The samples will be analyzed, in the field, with field analytical instruments for characterization or in-process post-remediation sampling, or sent to an offsite laboratory for confirmation sampling. Duplicate and equipment rinsate QC samples will represent 5 percent of the samples to provide adequate information on sample variability, as defined in Guidance for Data Quality Objective Process (EPA 1994).

All reusable sampling equipment will be decontaminated prior to and between each sampling location with a Liquinox (or Alconox) solution, and rinsed with deionized or distilled water in accordance with 4-S01-ENV-OPS-FO.03, *Field Decontamination Operations* and the project-specific HASP. Other sampling equipment and materials will include standard items such as chain-of-custody seals, forms, and logbooks. Soil descriptions will be recorded in the field, as appropriate.

In areas where the ground surface is covered with pavement or concrete, the characterization team will collect soil samples using grab sampling or hand augering methods. The characterization team will access the soil by removing surface obstructions using a concrete corer, rotary hammer, or other appropriate equipment. Samples will be collected from the soil substrate underlying whatever base materials are beneath the pavement. Samples will then be collected to a depth of 6 inches from the top of the collection zone.

Asphalt and concrete samples will also be collected. These samples will consist of one or more small-diameter (approximately 1- to 2-inch) core plugs. The cores will be collected in sufficient quantities with respect to the required field and/or laboratory analyses. The characterization team will collect core plugs using a rotary-type, concrete coring drill. Wet coring techniques will be used where radiological contamination is suspected to prevent airborne contamination. Residual concrete and drilling water will be handled in accordance with 1-PRO-079-WGI-001, *Waste Characterization, Generation, and Packaging*. Wastes will be managed in accordance with the Draft RFCA Standard Operating Protocol (RSOP) for Asphalt and Soil Management (DOE 2001c), whichever is current.

4.8.3 Subsurface Soil Sampling

The characterization team may use several types of Geoprobes® (Table 7) to collect vertical profile soil samples in areas of interest. Geoprobes® will be used in accordance with Site procedure OPS-PRO.124, *Push Subsurface Soil Sampling*. Soil cores will be recovered continuously to the desired depth in 2-ft increments using a core barrel as specified in this procedure. If the characterization team encounters probe refusal before reaching the target borehole depth, they will abandon the boring using procedure

OPS-PRO.117, *Plugging and Abandonment of Boreholes*, and attempt an offset boring within 3 ft of the original boring. If probe refusal occurs repeatedly, or a much greater depth is required, a truck-mounted, hollow-stem auger drill may be used to complete the boring. Detailed hollow-stem auger drilling and sampling procedures are presented in OPS-PRO.114, *Drilling and Sampling Using Hollow-Stem Auger and Rotary Drilling and Rock Coring Techniques*.

Before advancing boreholes, all locations will be cleared in accordance with OPS-PRO.102, *Borehole Clearing*, and marked in accordance with OPS-PRO.124, *Push Subsurface Soil Sampling*. A prework radiological survey will be conducted.

Soil cores will be recovered continuously (when possible) in 2-ft increments using a 2-inch-diameter (or 2.125-inch-diameter for the dual-wall system) by 24- to 48-inch-long

Table 7
Potential Geoprobe® Models for BZ Characterization

5400
- Standard Geoprobe® unit
- Attaches to the back of most vehicles (vans, pickup trucks, etc.)
- Hydraulics powered by hooking up to vehicle engine

54LT
- Track-mounted, compact, and designed to maneuver within building structures
- 34.5 inches wide, fits through standard 3-foot doorway
- Slightly more powerful than the 5400 model: 20,000 lbs down-force, 27,000 lbs up-force
- Diesel engine

54DT
- Track-mounted
- Designed to maneuver over rough terrain, mud, and tight congested areas; 48 inches wide
- Can maneuver through 10 to 12 inches of standing water
- Angle probing capabilities
- Diesel engine

66DT
- Track-mounted, most powerful model: 34,000 lbs down-force, 46,000 lbs up-force
- 48 inches wide
- Sufficiently powered to probe to deeper depths or through denser materials
- Can also be used to concrete drill and soil auger
- Able to use larger downhole tooling for increased sample volume recoveries
- Diesel engine

All units can collect groundwater samples and use Geoprobe® instrumentation if desired (e.g., soil conductivity and membrane interface probes for logging VOCs in subsurface).

stainless steel- or lexon-lined core barrel. Cores will be monitored following recovery for H&S purposes with a FID or PID, as appropriate, in accordance with OPS-PRO.121, *Soil Gas Sampling and Field Analysis*, and with a FIDLER, in accordance with 3-PRO-112-RSP-02.01.

Samples will be collected from the core in 2-ft increments. The characterization team will analyze the lowest 6 inches of a 2-ft increment using field instrumentation. VOC grab samples from the same interval will be containerized to minimize the amount of headspace within the sample container as actual field and sample recovery conditions permit. Due to the unconsolidated nature of the local soil, gravel recovered with the core may be removed prior to sampling.

For sampling locations beneath building slabs, a rotary-type, wet coring system will be used to initiate boreholes through the slabs. This type of system is useful in containing contamination that may be present within the paint and/or concrete. The corer is held to the floor surface by vacuum pressure supplied by a vacuum pump. The slurry produced by coring will be contained by a slurry collection system used in conjunction with a wet/dry vacuum. Little or no airborne emissions will be produced during coring activities.

Upon the completion of each boring, the characterization team will abandon the borehole in accordance with OPS-PRO.117, *Plugging and Abandonment of Boreholes*.

Equipment will be monitored for radiological contamination during and after sampling activities. All sampling equipment will be decontaminated with a Liquinox (or Alconox) solution, and rinsed with deionized or distilled water, in accordance with 4-S01-ENV-OPS-FO.03, *Field Decontamination Operations.* All other sampling equipment will include standard items such as chain-of-custody seals, forms, and logbooks. Field duplicates will represent 5 percent of the samples to provide adequate information on sample variability, as defined in Guidance for Data Quality Objective Process (EPA 1994), and in accordance with Appendix H.

4.8.4 Horizontal Drilling

The characterization team may elect to use horizontal directional drilling (HDD) and environmental-measurement-while-drilling (EMWD) for characterization of soil beneath buildings. They may use HDD instead of, or with, Geoprobe® drilling to sample soil beneath buildings and building slabs, if UBC is encountered. Drilling and sampling will be conducted in accordance with operating procedures, if the techniques are demonstrated at UBC 123 and Building 886.

HDD sample intervals will be reached using an appropriately sized and equipped horizontal drilling rig in accordance with the subcontractor drilling procedure. The characterization team will collect soil samples at the depths and intervals specified in the appropriate BZSAP Addenda. Every effort will be made to collect an undisturbed sample from the borehole to obtain accurate and representative data from each sampling event.

If EMWD is successfully demonstrated at Building 886 and UBC 123, the levels of gamma-emitting radionuclides within subsurface soil will be continuously monitored and

recorded every 20 seconds with a gamma ray spectrometer (GRS) providing real-time data to operations at the surface. Additional samples may be collected if the downhole GRS indicates elevated radiological conditions, or if visible evidence (staining, odors, etc.) of contamination is present in drill cuttings.

4.8.5 Surveying

The locations of all surface soil sampling and boreholes will be surveyed using a Global Positioning System (GPS) or other surveying instruments. Sampling locations will be surveyed for northing and easting in state planar coordinates and elevation, and will be entered into the BZ database and Soil Water Database (SWD). Using GPS is not possible inside buildings; manual measurements will be collected instead. Sampling location surveying will be conducted in accordance with OPS-PRO.947, *Location/Surveying.*

4.8.6 Equipment Decontamination and Waste Handling

Reusable sampling equipment will be decontaminated in accordance with OPS-FO.03, *Field Decontamination Operations*. Decontamination water generated during sampling will be managed according to OPS-PRO.112, *Handling of Field Decontamination Water*. Horizontal drilling and Geoprobe® rigs and equipment will be decontaminated between locations, and following project completion at the Decontamination Pad in accordance with OPS-PRO.070, *Equipment Decontamination at Decontamination Facilities.*

PPE will be disposed of in accordance with 1-PRO-573-SWODP, *Sanitary Waste Offsite Disposal Procedure.* Residual soil will be handled in accordance with 1-PRO-079-WGI-001, *Wastes Characterization, Generation, and Packaging*. Returned sample media will be managed in accordance with 1-PRO-079-WGI-001, *Waste Characterization, Generation, and Packaging*. In the event that hazardous, low-level, or mixed wastes are generated, project waste generators will package and manage the waste containers in accordance with Site procedures OPS-FO.23, *Management of Soil and Sediment Investigative Derived Materials* or the Asphalt and Soil Management RSOP, whichever is current.

4.9 GROUNDWATER AND INCIDENTAL WATER SAMPLING

4.9.1 Groundwater

Several groundwater contaminant plumes were identified during previous RFI/RIs and Sitewide programs. Groundwater wells, installed to monitor plume extent, are being sampled as part of the compliance monitoring program. When active groundwater wells are located in IHSSs, PACs, or areas being characterized, compliance staff may direct or perform groundwater sampling.

4.9.2 Incidental Water

Incidental water is defined in the IMP as “precipitation, surface water, groundwater, utility water, process water, or wastewater collected in one or more of the following areas:

- Excavation sites, pits, or trenches;

- Secondary containments or berms;
- Valve vaults;
- Electrical vaults;
- Steam pits and other utility pits;
- Utility manholes;
- Other natural or manmade depressions that must be dewatered; or
- Discharges from a fire suppression system that has been breached within a radiological buffer area or a contamination area" (DOE 1999).

If incidental water is encountered during characterization, dewatering of the area may be necessary to maintain a safe working environment. If dewatering of the area is necessary, a temporary sump will be installed to transfer the water into a temporary storage container(s). The water will then be sampled and managed in accordance with the Site's Incidental Water Program, 1-C91-EPR-SW.01, *Control and Disposition of Incidental Water*.

Incidental water is sampled to determine whether it may be discharged to the environment, or treatment is required. Process knowledge, field pH, appearance, field nitrate, and field conductivity are the initial screening criteria. Compliance staff may direct or perform additional sampling and analysis, when known or suspected contamination is present.

5.0 DATA ANALYSIS PROCEDURES

The characterization team will aggregate and evaluate data generated as part of BZSAP activities in accordance with the BZSAP DQOs. This will include the following:

- Aggregation according to BZSAP DQOs for comparison to RFCA Tier I and Tier II ALs;
- Use of geostatistical or standard statistical techniques to determine whether additional sampling is required to reach specified confidence levels that an IHSS andPAC has been adequately characterized;
- Use of verification sampling techniques to ensure the accuracy of data generated from field instrumentation;
- Use of geostatistical or standard statistical techniques to determine whether RFCA ALs have been exceeded;

- Aggregation of remediation confirmation data according to BZSAP DQOs for comparison to RFCA Tier I and Tier II ALs to determine whether remediation was successful; and
- Aggregation and evaluation according to BZSAP DQOs for use in the CRA.

5.1 VERIFICATION OF FIELD ANALYTICAL DATA

Data generated from field instrumentation will be correlated with analytical laboratory data. The following techniques will verify the accuracy of field analytical data:

1. Evaluation of linear regression based on data developed during the 903 Pad characterization for HPGe correlation (Appendix I);
2. Initial verification study to compare new field analytical instruments to laboratory analytical data;
3. Ongoing verification sampling of field analytical results at a rate of 5 to 10 percent (i.e., 5 to 10 laboratory analytical samples for every 100 field analytical samples); and
4. Confirmation sampling.

5.1.1 Linear Regression Analysis

The QA staff will evaluate the accuracy of HPGe, and other field instrument methods, not only through standard, periodic QC specifications (such as daily source checks and annual full-scale calibrations), but also by regressing field measurements against associated laboratory measurements. Regression analysis provides a means of "normalizing," or standardizing, field measurements to laboratory measurements. The general linear model that relates a response to a set of indefinite variables will be used.

Successful regression analyses of HPGe data have been performed at RFETS, and other DOE sites (DOE 2000b). Regression analysis has also been successfully used in the quantification of metals (Sackett and Martin 1998), and is recommended by EPA to correct for low biases inherent in the field methods.

Optimization of sample homogeneity is a key factor in producing usable field/laboratory correlations (Sackett and Martin 1998), where relatively large and variable grain sizes are thought to cause a low bias (in field methods). Samples will be homogenized and sieved, and each sample will be split for field and laboratory analysis.

A general linear model (Equation 5-1) that relates a response to a set of indefinite variables may be used.

$$y = B_0 + B_1 x_1 + B_2 x_2 + \ldots B_k x_k + E \qquad \text{(Equation 5-1)}$$

Where:

$x_1, x_2 \ldots x_k$ = independent variables

$B_1, B_2 ... B_k$ = unknown parameters
E = random error term

Consistent with calibration curves constructed for laboratory analytical methodologies (EPA SW846), where full-range curves are constituted by four (e.g., metals, SW6010) to five (e.g., VOCs, SW8260) sequentially increasing values, regression analyses will be initiated with a minimum of five values through the measurement range of interest. Additional values will be added to the curves as the project progresses.

Based on previous experience and related publications (Sackett and Martin 1998), a linear relationship is expected between field and laboratory results. Acceptability of a linear regression will be based on a correlation coefficient (R^2) of greater than 0.90, and use of an Analysis of Variance (ANOVA) and corresponding F Test to determine both "goodness-of-fit" and appropriateness of the model. The regression will be rejected if the measurements are too variable or the model is incorrect. If a linear model is inappropriate, a curvilinear regression may be evaluated (including confidence intervals or limits), and if used, will be evaluated using an ANOVA to determine the significance of adding terms to the regression. Polynomial expansion beyond a quadratic is not anticipated for correlating field results with laboratory results.

5.1.2 Initial Verification Study

An initial verification study will be conducted to confirm the accuracy of field analytical equipment. Soil samples will be collocated with field analytical readings and sent to an offsite analytical laboratory for analysis.

The underlying assumption for the verification study is that a linear relationship exists between the laboratory analytical data and field analytical data. The field analytical data may be standardized using the following equation (Gilbert 1987):

$$\bar{x}_{lr} = \bar{x}_A + b(\bar{x}_{n'} - \bar{x}_F) \qquad \text{(Equation 5-2)}$$

Where

$\bar{x}_{lr}$ = standardized estimate of μ
$\bar{x}_A$ = mean of the n laboratory measurements
b = slope of the estimated linear regression
$\bar{x}_{n'}$ = mean of the n' field measurements
$\bar{x}_F$ = mean of the n field measurements

5.1.3 Ongoing Verification

As stated previously, accuracy of several field methods will be evaluated, not only through standard, periodic QC specifications (such as daily source checks and annual full-scale calibrations), but also by regressing field measurements against associated

laboratory measurements. Regression analysis provides a means of normalizing, or standardizing, field measurements to laboratory measurements.

Verification of field analytical methods will continue throughout BZ characterization and remediation activities. The frequency of split samples for the ongoing field analytical equipment verification sampling will be based on the following:

- Initial verification study;
- Results of previous verification; and
- Field duplicate frequency (5 to 10 percent) as discussed in Section 5.1.4.

5.1.4 Verification Sampling

Environmental projects may use a variety of QC samples, depending on the needs and goals of the project. The QC samples could include blanks (e.g., preparation blanks and trip blanks), duplicates, splits, blind performance evaluation (PE) samples, etc. Typically, each type of QC sample has only one use; for example, field duplicates are used to evaluate sampling precision. The QC samples required for the BZ sampling and analysis effort are presented in Appendix H.

To increase efficiency and reliability of the project, one type of QC sample, the duplicate, will serve several purposes:

1. To evaluate sampling precision (its typical use);
2. To confirm that methods are sufficiently comparable with laboratory methods; and
3. As “confirmation samples” to confirm the results in the AOC.

This approach will eliminate the time and cost of performing a separate phase of verification sampling and will be performed in parallel with field sampling and analysis. This approach will be implemented by sending a duplicate sample, after it is analyzed for its first purpose, to the laboratory for verification analysis. The duplicate sample, initially used for field precision purposes, effectively becomes a replicate when used for verification purposes. Acceptable verification will be determined through use of a percent difference value; specifically, this is the laboratory value compared with the normalized field value (i.e., field value based on the regression analysis).

In certain cases where field analytical methods (or onsite laboratories) do not provide adequate quality, such as unacceptable detection limits or field/laboratory correlations, verification sampling must be more aggressive than described above. More rigor could include the original grid spacing and number of samples used for characterization purposes, which consider hot spot size and contaminant boundaries. The term “verification sample,” in the context of the BZSAP, is reserved for those specific samples whose sole purpose is to confirm (or contradict) results of samples already collected. Because of this narrow purpose, the number of samples needed is much less than the previous number of samples required to characterize the site of interest. If an aggressive

design for verification sampling is required, it indicates that characterization sampling (and field analysis), relative to a specific COC and applicable ALs, was inadequate for cleanup decisions.

5.2 TIER I AND TIER II ACTION LEVELS AND DATA EVALUATION

In accordance with the BZSAP DQOs, the extent of contamination must be delineated to RFCA Tier I and Tier II ALs. Designation of hot spots and subsequent remediation and/or closure decisions will be based on comparisons to RFCA Tier I and Tier II ALs. A phased statistical evaluation will be conducted that consists of the following steps:

1. Data aggregation;
2. Comparison of data to Tier I and Tier II ALs;
3. Geostatistical analyses, if appropriate data are available; and
4. EMC (if necessary).

The flow chart presented on Figure 14 displays the steps and decision points used for this phased statistical evaluation. The null (Ho) and alternative (Ha) hypotheses used during the statistical analyses are as follows:

Ho: Analyte concentrations/activities within the AOC are significantly greater than the Tier I and Tier II ALs.

Ha: Analyte concentrations/activities within the AOC are not significantly greater than the Tier I and Tier II ALs.

5.2.1 Data Aggregation

Data aggregation will be based on media type (e.g., surface or subsurface soil), AOC, and purpose of evaluation (e.g., characterization, confirmation, or CRA). To perform a valid statistical evaluation, data must meet the criteria that all observations are independent but comparable (i.e., collected and analyzed using similar methods). Furthermore, data from various soil horizons need to be aggregated by subgroups before conducting statistical comparisons. These aggregated subgroups must represent a single population characterized by a fixed population mean and variance. Table 8 summarizes the data aggregation and appropriate subdivisions of each group.

Table 8
Data Aggregation Framework

Soil Horizon	Depth Interval[1] (ft)	Subgroups		
		Characterization[2]	Confirmation (Excavation Remedy)	CRA
Surface Soil	0.0 to 0.5	Area of Concern	Floor and Sidewalls	Exposure Unit
Subsurface Soil	0.5 to 2.5	Area of Concern		
	2.5 to 4.5	Area of Concern		
	4.5 to 6.5	Area of Concern		
	6.5 to 8.5	Area of Concern		
	8.5 to Bedrock	Area of Concern		

[1] Actual depth intervals will be based on the depth to bedrock contact or depth to water.

[2] The AOC is based on IHSS, PAC, UBC Site, and White Space Area boundaries as defined by the project team.

The first step in the data evaluation process is to group the data by soil horizons. For example, surface soil samples collected from 0 to 6 inches below ground surface (bgs) will be grouped as a single soil horizon, and subsurface soil samples from 6 to 30 and 30 to 54 inches bgs will be grouped into second and third horizons, respectively, so that each depth interval is grouped as a unique sample population. Although different subsurface soil horizons may have similar geologic and physical properties, the aggregation of distinct soil horizons will conform to remediation excavation techniques. Subsurface soil samples with similar geologic properties may be aggregated into a single group for the CRA.

Data aggregation for remediation confirmation will be based on samples collected within the excavated or remediated area. For excavations, samples from the floor and sidewalls of the excavation will be consolidated into a single subgroup. Data aggregation for the CRA will be based on the size of the EUs (DOE 2000c).

5.2.2 Elevated Measurement Test

Individual measurement values will be compared to corresponding Tier I and Tier II ALs for delineating hot spot areas and making remediation decisions. This elevated measurement test identifies measurements that may normally be overlooked using more robust inferential statistical test procedures. Measurements of a given analyte that are greater than or equal to the elevated measurement value (Tier I or Tier II AL) may indicate potential contamination. However, some Tier I and Tier II ALs may be less than mean background concentrations or activities. Therefore, data will be prescreened to filter out those that are below background levels (mean plus two standard deviations) and MDLs.

5.2.3 Confirmation Samples

The characterization team will evaluate confirmation sampling measurements to determine whether residual soil is clean with respect to remediation goals. Measurements of a given analyte that exceed remediation goals may require additional evaluation.

Flexibility in the decision process includes statistically comparing means of populations to the corresponding ALs.

5.2.4 Spatial Evaluation – Geostatistics

In addition to defining optimal sampling locations for characterization purposes, the characterization team will also use geostatistical analysis to define areas above RFCA ALs. The geostatistical approach incorporates probabilistic and risk-based outcomes relative to the AL thresholds and decision error rates. The geostatistical methodology is an unbiased geostatistical tool that will be used to optimize characterization and remediation within the BZ. Specifically, geostatistical analysis will be used to:

- Optimize the number and locations of characterization samples;
- Develop maps of the areas with concentrations above RFCA ALs at a given level of probability;
- Optimize the number and locations of confirmation samples; and
- Link onsite analysis with sampling to allow near real-time remedial decisions.

Geostatistical Procedures

Geostatistical analysis is a spatial correlation modeling approach that uses several evaluative steps. Descriptions and applications of the SmartSampling geostatistical technique are presented in reports published by SNL (1998), Rautman (1996), and McKenna (1997). The following describes the ordered process of the geostatistical approach:

1. *Exploratory Analysis* - The first step in the geostatistical evaluation is to determine the distribution of the data set by evaluating descriptive statistics and plotting the data on a histogram. Data found to depart from the normal distribution function should be normalized prior to performing the geostatistical evaluation.
2. *Structural Analysis* - Variograms (Myers 1997), which describe the geostatistical spatial correlation between samples, are generated. This procedure defines the spatial variance between data points. Three important parameters defined by the variogram include (1) the range (distance at which samples are spatially correlated), (2) sill (similar to the variance of the data set), and (3) nugget effect (departure from the origin, which indicates microscale sampling variability or imprecision of the data set).
3. *Kriging* - The spatial correlation model derived from the variogram analysis is used in the kriging simulation. Kriging is the process of simulating predicted values in unsampled areas by calculating a weighted least-squares mean of the surrounding data points. The weighted values account for not only the distance between known observations and points of predicted values, but also the correlation of clustered observations. For example, clustered data may provide redundancy and are weighted less than a single observation at an equal distance in a different direction. The kriging

simulations are processed to produce maps defining the spatial distribution of the contaminants and uncertainty in the spatial distribution.

4. *Probability Kriging* - Probability maps that describe the likelihood a contaminant value at any unsampled location exceeds the AL are generated. Probability kriging is based on multiple simulations of the contaminant concentration. The outcome of each simulation reflects the actual observations within the area. The multiple simulations of the concentrations provide the basis for determining the relative uncertainty so that the probability of exceeding a specified threshold value (e.g., RCFA ALs) at any point within the area can be estimated. The simulations are processed to produce maps defining the spatial distribution of the contaminants and the inherent uncertainty in spatial distribution.

5. *Probability Calculation* - The probabilities are calculated from the estimated value from each realization and a cumulative distribution function at each point of estimation is developed. For example, assume 100 realizations are performed for the area of interest. If the threshold value is 10 picocuries per gram (pCi/g) and 20 of the 100 realizations exceed the threshold value at a given point, the probability of exceedance is 20 percent at that point.

6. *Uncertainty Mapping* - A map with optimal locations for additional sampling is developed. These locations are optimized to produce the greatest decrease in the spatial uncertainty of the contaminant distribution with respect to ALs. That is, areas with the greatest uncertainty of exceeding the ALs are identified and targeted for additional sampling and analysis.

7. *Sample Optimization* - Data are collected and added to the geostatistical program.

8. Steps 2 through 5 are repeated as necessary.

9. *Excavation Mapping* - Excavation maps are developed from the probability kriging. These maps are based on the probability of exceeding a specified AL as described in Step 4. An excavation map requires that an acceptable reliability of remediation is determined. This is similar to the process of specifying an acceptable level of false positive errors in the traditional DQO procedure. For example, if the Type I error rate is specified at 10 percent, then all remediation units exceeding 10 percent would be targeted for remediation.

5.3 ELEVATED MEASUREMENT COMPARISON

The EMC (MYAPC 1999) comparison, illustrated on Figure 15, includes an equation that depends on several variables: AL, measured value, size of the hot spot, and size of the AOC. The EMC is applicable to all sample results or hot spots that are above RFCA Tier I or Tier II ALs. In AOCs where all sample results are less than ALs, the EMC is not required. The EMC for nonradionuclides is shown in Equation 5-3. If the EMC is greater than or equal to 1, action is indicated.

(Equation 5-3)

$$\text{If}: \sum_{i=1}^{n}\left[\frac{95\%\text{UCL}_{\text{AOC}}}{\text{AL}}\right]_i + \sum_{j=1}^{n}\left[\frac{\left(\text{SampleResult}_{\text{hs}} - 95\%\text{UCL}_{\text{AOC}}\right)}{\left(\frac{\text{AL} * \text{Area}_{\text{AOC}}}{\text{Area}_{\text{hs}}}\right)}\right]_j \geq 1 \text{ Then}: \text{Action is Indicated}$$

Where

(95%UCL)$_{AOC}$	=	95% UCL of the mean concentration in the AOC
AL	=	Tier I or Tier II soil AL
(Sample Result)$_{hs}$	=	hot spot sample result
(Area)$_{AOC}$	=	area of the AOC
(Area)$_{hs}$	=	hot spot area (based on the area surrounding the elevated sample result)
i	=	number of COCs
j	=	number of hot spots for a particular COC

The first term "i" of Equation 5-3 will be applied to each COC separately. This term will be used for all observations less than Tier I or Tier II ALs within the AOC. As shown in Equation 5-3, the first term is defined as the ratio of the 95% UCL of the mean to the RFCA Tier I or Tier II AL for the AOC. Observations greater than the ALs will be excluded from the 95% UCL calculations, because this type of censorship will ensure the data set complies with normality assumptions required for calculating the 95% UCL.

The second term "j" of Equation 5-3 will be applied to each sample result that exceeds the RFCA Tier I or Tier II AL separately, so that these results can be evaluated as a function of the hot spot size relative to the AOC and magnitude of the AL. Because human health risks are based on an individual's exposure across an area, the incremental risk due to a small, elevated COC sample result (hot spot) needs to be determined. The second term of Equation 5-3 is defined as the difference between the 95% UCL of the mean concentration and the sample result divided by the RFCA Tier I or Tier II AL for a given COC. The AL is area-weighted, which is appropriate because exposure to contamination is random across an area.

For radionuclides, an area factor consistent with MARSSIM (EPA 1997) guidance is applied to the AL as shown in Equation 5-4. Radionuclide-specific area factors are based on exposure pathway models, which can be estimated from RESRAD simulations.

(Equation 5-4)

$$\text{If}: \sum_{i=1}^{n}\left[\frac{95\%\text{UCL}_{\text{AOC}}}{\text{AL}}\right]_i + \sum_{j=1}^{n}\left[\frac{\left(\text{SampleResult}_{\text{hs}} - 95\%\text{UCL}_{\text{AOC}}\right)}{\left(\text{AL} * \text{AF}\right)}\right]_j \geq 1 \text{ Then}: \text{Action is Indicated}$$

Where

(95%UCL)$_{AOC}$	=	95% UCL of the mean concentration in the AOC
AL	=	Tier I or Tier II soil AL
(Sample Result)$_{hs}$	=	hot spot sample result
AF	=	area factor (for radionuclides)

i	=	number of COCs
j	=	number of hot spots for a particular COC

The product of Equations 5-3 and 5-4 is the summation of EMCs for all COCs and each hot spot within a given AOC. Results of the equation greater than 1 indicate action may be necessary and results less than 1 indicate action is not necessary. Because the EMC includes an area-weighting component, results for very small hot spots may indicate action is not necessary for very high contaminant concentrations. To reduce this effect, when the concentration of the contaminant at a hot spot is three times the Tier I AL, action is indicated. If the hot spot is remediated, the confirmation sample values will be used in the equation. Using a value of three times the AL as an upper limit for re-evaluation is consistent with RESRAD's release criteria. An example data set (Appendix J) shows how the EMC is applied.

6.0 DATA MANAGEMENT

A variety of data types will be generated during BZ characterization and remediation to support data analysis and reporting requirements. ER will manage in-process field analytical data so that the characterization staff can evaluate these data on a daily basis. All field analytical data will be transferred to ASD for long-term data management. All offsite analytical data will be managed by ASD.

Data generated during BZ characterization and remediation will include, but not be limited to, the following:

- Sampling location data;
- Field parameters (depth, sample interval, field instrument readings, etc);
- Surface and subsurface soil analytical data; and
- Investigative-derived materials data (e.g., stockpiles and drill cuttings).

All data collected during these activities will meet RFETS data quality requirements and project DQOs. BZ investigation data will be used for the following purposes:

- Document BZ investigation activities and decisions;
- Provide final characterization of all residuals left in the BZ;
- Provide data for the CRA; and
- Support the CAD/ROD and post-closure monitoring.

A generalized overview of the BZ investigation environmental data management process is shown on Figure 16. This diagram also identifies where electronic and hard copy data may be located. The majority of data collected will be available electronically and stored in shared data systems accessible to all project team members. Current environmental

data systems are summarized in Table 9. The data systems used to support the BZ investigation are in common RFETS standard platforms to facilitate integration of data and information among media and make data easily available to users.

Table 9
Current Environmental Data Systems at RFETS

Environmental Data System	Software Platform in FY00	Typical Data
Air Database (AIR)	Oracle V8.0	Effluent air, ambient air, meteorology
Soil Water Database (SWD)	Oracle V8.0	Laboratory analytical data for soil, groundwater, surface water, non-WIPP waste, sediment, and miscellaneous media; field parameters for environmental sampling; sampling locations (x/y)
Flow	Oracle V8.0	Surface water flow measurements
Ecology Database (SED)	Access	Ecological species, ecological sampling locations
Administrative Record (AR)	Oracle V8.0	Index of AR documents
Industrial Area Data Analysis Database	Access	Database for IA characterization and remediation data
Waste Environmental Management System	Oracle V.8	Waste drum tracking
Analytical Services Toolkit (AST)/EDDProPlus(BIG EDD)	Access/Oracle V8.0	Laboratory analyses tracking, electronic laboratory analyses (EDD) processing
Geographic Information System (GIS)	ArcInfo V.8	Spatial data coverages for base features (topography, roads, buildings, etc.) and interpreted spatial data for extent of chemical contamination
Integrated Sitewide Environmental Data System (ISEDS)	Internet (regulatory agency access only)	Uninterpreted analytical data (all media), electronic field measurements, interpreted data sets, “residual” data sets
Environmental Data Dynamic Information Exchange (EDDIE)	Internet	Final environmental reports, photos, data summaries, and update information on environmental programs

6.1 DATA MANAGEMENT REQUIREMENTS

Surface and subsurface soil data collected as part of the BZ investigations will be stored in the applicable database listed in Table 9. All data collected and/or information generated as part of the BZ investigation will be managed in accordance with the requirements presented below.

6.1.1 Sample Tracking Information

Laboratory Analytical Sample Tracking

All offsite laboratory analytical samples will be tracked using the Analytical Services Toolkit (AST) or equivalent system, which tracks the entire lifecycle of a sample request and provides a chain-of-custody. Samples will be numbered in accordance with ASD-003, *Identification System for Reports and Samples.*

Field Analytical Sample Tracking

All field analytical samples will be given an AST tracking number that will be used for the entire life cycle of the sample request. The AST tracking number will ensure that data generated during BZ characterization activities will be consistent with AST requirements and formats for transfer to SWD. Samples will be numbered in accordance with ASD-003, *Identification System for Reports and Samples.* Field analytical data will be tracked in the BZ data analysis system and transferred to SWD.

6.1.2 Sampling Locations

Sampling Location Codes and Names

Sampling location codes and names used to support data analysis and Geographic Information System (GIS) analysis will be created following requirements specified in PRO-1058-ASD-005, *Environmental Data Management Procedure.*

Location Spatial Coordinates

Spatial coordinates will be collected at all sampling locations in accordance with OPS-PRO-947, *Location/Surveying.* Final approved coordinates will be stored in the SWD Master Location Table.

6.1.3 Analytical Laboratory Data

Electronic Analytical Data

Offsite laboratory analytical data collected during BZ sampling activities will be processed, subjected to QC review and tracked through EDDPRo Plus, and entered into SWD. Electronic analytical data packages in a portable document format (PDF) file will be managed by K-H ASD according to PRO-1058-ASD-005, *Environmental Data Management Procedure.*

Field Analytical Data

Field analytical data generated from instrument-specific software will be controlled, and data will be backed up daily on an RFETS server to ensure no loss of data occurs prior to transfer to ASD.

Hard Copy Analytical Data

Hard copy laboratory analytical data will be managed according to PRO-1058-ASD-005, *Environmental Data Management Procedure.*

6.1.4 Nonanalytical Field Data

Field Parameter Data

Field parameter data will be entered into the AST Field Event Data Module and stored in SWD in accordance with PRO-1058-ASD-005, *Environmental Data Management Procedure*.

6.1.5 Maps

Geographic Information System Maps

GIS maps will be created using the RFETS GIS. All GIS files will be labeled and stored in the GIS tracking system following GIS Department SOPs. Map presentation will adhere to PRO-1130-ASD-006, *Spatial Data Map Control*.

6.1.6 Samples/Data of Special Significance

Confirmation Soil Sampling/Excavation Boundary Samples

Confirmation/excavation boundary soil samples collected to demonstrate performance will be labeled in SWD in accordance with PRO-1058-ASD-005, *Environmental Data Management Procedure*. Any excavation boundary samples representing material removed from the site will be labeled as no longer representative (NLR) in SWD within 10 days of determination.

No Longer Representative Data

If during BZ activities, data are determined to be NLR of site conditions (i.e., source material has been removed and shipped from the site, or otherwise made not representative), they will be coded NLR in SWD within 10 days of determination in accordance with PRO-1058-ASD-005, *Environmental Data Management Procedure*.

Stockpile Sampling

Where treated or untreated soil has been stockpiled and sampled prior to returning it to an excavated location (put back), any sample results representative of the stockpile and thus the returned soil, will be labeled with the appropriate final location in SWD.

Waste

All waste sample analyses and waste drums are tracked through the Waste and Environmental Management System (WEMS).

6.1.7 Final Decision Documents, Reports, and Data Sets

Final Reports – Electronic Version

All final reports and/or decision documents will be provided in electronic format to the RFETS Environmental Data Dynamic Information Exchange (EDDIE) Web site for dissemination to the public.

Final Reports – Hard Copy

All final reports and/or decision documents will be provided in hard copy to the CERCLA Administrative Record (AR) staff for inclusion into the RFETS AR.

Interpreted Report Data

The BZ investigation will generate sets of subject matter expert (SME)-interpreted data to document decisions. These data sets will be created using RFETS standard software (such as Microsoft Excel, ArcInfo, or Microsoft Access) and will be stored electronically on the Integrated Sitewide Environmental Data System (ISEDS) Web site. Files will be clearly labeled to identify project and data set, and a text file describing the data set will be created and stored on the ISEDS site. Interpreted data sets will be provided to ISEDS within 10 days of submission of final approved report or decision document.

6.1.8 Field Analytical Data Management

Field analytical data generated during BZ sampling activities will be managed so that data are easily configured and transferred to the appropriate Site databases. Field analytical data will be generated by several field instruments (Section 4.7). All field instrumentation will be equipped with instrument-specific software that will record and report all relevant environmental and QC data generated. Field measurements will be downloaded daily, or at the end of the sampling event if it is less than 1 day. Data will be configured for the following uses:

- ER data evaluation according to DQOs;
- Geostatistical analysis;
- AST; and
- SWD.

6.1.9 Environmental Restoration Data Evaluation

The ER data evaluation will include the following information for samples collected in each IHSS and PAC:

- Location code;
- Project identification;

- Sample date;
- X-coordinate (latitude);
- Y-coordinate (longitude);
- Elevation;
- Depth interval;
- Soil horizon;
- Sample type;
- Analyte;
- Results;
- Result units;
- Detection limit;
- Dilution factor (if applicable); and
- QC partners.

Geostatistical Evaluation

Geostatistical evaluation will include the following information:

- Location code;
- X-coordinate (latitude);
- Y-coordinate (longitude);
- Elevation;
- Depth interval;
- Soil horizon;
- Sample type; and
- Sum of ratios per location code for radionuclides and nonradionuclides relative to Tier I and Tier II ALs.

6.1.10 Field Instrument Data Definition

EDDs will be produced for all field sampling events through the Remedial Action Decision Management System (RADMS). EDDs will be consistent with ASD EDDs, but may include additional fields relevant only to the BZSAP DQOs. If these additional fields are of archival value for future Site needs, SWD will be modified to accommodate the additional information.

Files will be in space delimited text format that is easily portable to Microsoft Access or Microsoft Excel. The format may vary from the template displayed below; however, all records will include, at a minimum, the fields specified in Table 10.

6.1.11 Sample Handling and Documentation

Soil samples will be handled and containerized according to OPS-PRO.069, *Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples.* Transferring and shipping samples will be performed according to PRO-908-ASD-004, *On-Site Transfer and Off-Site Shipment of Samples.*

Samples sent offsite for analysis will require evaluation under 49 Code of Federal Regulations (CFR) 173, the U.S. Department of Transportation (DOT) radioactive materials criteria of 2,000 pCi/g total radioactivity. If radiological screening indicates levels above this threshold, samples may be analyzed onsite or transported to offsite laboratories in accordance with hazardous materials transportation shipping requirements. DOT radiological screening samples will be collected and assigned a unique sample designation as described in Section 6.1.12. In addition, radiological screening samples collected under the BZSAP will be sufficient to support DOT shipping and offsite laboratory license requirements.

6.1.12 Sample Numbering

Unique sample numbers will be generated for each BZ Group sampling effort. A report identification number (RIN) will be generated through the AST system. The unique sample number consists of the RIN, event number, and, if necessary, a bottle number. The event number is the sampling event at a given location and time. The bottle number is the numbers for bottles for multiple analyses from the same event.

Table 10
Electronic Digital Data Format

Field Type	Field Name	Description	Definition
general lab	LAB_CODE	Laboratory Code	Coded value identifying the analytical laboratory
project-specific	PROJECT_ID	Project Name	Project description/unique identification
project-specific	CUST_SAMP_NUM	Customer Sample Number	Text field used by the sample team that identifies the sample
general lab	LAB_SAMPLE_NUM	Laboratory Sample Number	Laboratory's unique sample identifier, assigned by the laboratory
general lab	LAB_SAMPLE_RECEIPT_DATE	Laboratory Sample Receipt Date	Date laboratory received the sample
general lab	LAB_BATCH_ID	Laboratory Batch ID	Laboratory's unique numerical identifier relating a group of samples to a given laboratory batch
general lab	SAMPLE_VOLUME	Sample Volume	Volumetric amount of sample for analysis
general lab	SAMPLE_VOLUME_UNIT_CODE	Sample Volume Unit Code	Coded value representing the volumetric units
general lab	ALIQUOT	Aliquot Size	Volume or mass of aliquot analyzed
general lab	ALIQUOT_UNITS	Units of Measure for the Aliquot	Units of measure for the volume or mass of the aliquot
general lab	EXTR_METH_CODE	Code Denoting an Approved Sample preparation/extraction method	Specific laboratory preparation or extraction procedure used to digest the sample prior to analysis
general lab	ANAL_METH_NAME	Name of the approved test method	Specific laboratory test methods used to analyze the sample
general lab	% MOISTURE	Percent moisture	Mass percentage of moisture in the sample; allows correction of result to dry weight basis
general lab	LAB_EXTRACTION_DATE	Laboratory Extraction Date	Date the sample was extracted
general lab	LAB_EXTRACTION_TIME	Laboratory Extraction Time	Time the sample was extracted
general lab	LAB_ANALYSIS_DATE	Laboratory Analysis Date	Date of analysis
general lab	LAB_ANALYSIS_TIME	Laboratory Analysis Time	Time of analysis
general lab	INSTRUMENT_ID	Identification of Instrument	Unique ID number of the measurement system used to measure the sample
general lab	CAS_NO	CAS Number	Code that identifies the analyte tested
general lab	ANALYTE_NAME	Analyte Name	Name of the analyte
general lab	RESULT	The measured numerical analytical result	Analytical numeric result
general lab	SIG_FIGS	Significant Figures	Number of significant figures for the result
general lab	UNIT_CODE	Unit Code	Units used at the laboratory
general lab	RESULT_TYPE_CODE	Result Type	Coded value identifying the type of sample, including all QC types (target, matrix spike, etc.)

Field Type	Field Name	Description	Definition
general lab	DETECTION_LIMIT	Detection Limit	Numeric value representing the MDL or minimum detectable activity with same units as result
general lab	DETECTION_LIMIT_TYPE_CODE	Detection Limit Type Code	Coded value indicating which detection limit was used (MDL, instrument detection, etc.)
general lab	BASIS	Wet or Dry Basis	Mass basis for reported concentration of a solid sample; typically, results are reported on a dry basis
general lab	DILUTION_FACTOR	Serial Dilution Factor	Numeric factor when a sample was diluted prior to analysis
general lab	RESULT_SEQUENCE_ID	Result Sequence Identifier	Unique record-level sequential identifier for the datum
general lab	COMMENTS	Comment	Any comment that relates to the record
QC	SPIKE_AMOUNT	Amount of spike concentration or reference standard value	Spike concentration of analyte or activity value for radioactive standards
QC	%_RECOVERY	Percent recovery	Measured recovery, expressed as percentage, of a spike or reference standard value
QC	LCL	Lower Control Limit	Lower control limit on a measurement relative to a spike or reference standard amount
QC	UCL	Upper Control Limit	Upper control limit on a measurement relative to a spike or reference standard amount
QC	RPD	Relative Percent Difference	Relative percent difference between an original sample and its corresponding duplicate or replicate sample
QC	LAB_RESULT_QUALIFIER_CODES	Laboratory Result Qualifier Codes	Coded value indicating a laboratory qualifier or flag
QC	VALIDATION_QUALIFIER_CODE	Validation Qualifier Code	Coded value representing the validation qualifier or flag
QC	VALIDATION_REASON_CODES	Validation Reason Codes	Numeric value describing the reason for the validation qualifier
QC	VALIDATION_DATE	Validation Date	Date validation was performed on the laboratory batch
QC- RAD-specific	COUNT_TIME	Counting time for radioactivity	Amount of time, in minutes, that sample was counted; for radiological measurements only
QC- RAD-specific	DETECTOR_EFF	Detector Efficiency	Efficiency of the detector used for radiological measurement of the sample; unitless
QC- RAD-specific	BACKGROUND	Radiological Background	Numerical background value
QC- RAD-specific	CHEM_YIELD	Chemical Yield	Chemical yield of the tracer (radiometric) or carrier (gravimetric)
QC- RAD-specific	BKGRD_UNITS	Background Units of Measure	Unit of measure for radiological background values, typically in pCi/g
QC- RAD-specific	DUPLICATE_EQUIVALENCY	Duplicate Equivalency	Measure of precision using duplicate samples
QC- RAD-specific	COUNT_ERROR	Counting Error	Measure of random error in the measurement based on the stochastic nature of radioactive decay
QC- RAD-specific	TOTAL_ERROR	Total Error	Total error of the measurement, which includes random (e.g., counting) and systematic error

Note: All parameter fields are left-justified and padded to the right with blanks. File Name field may be omitted if all records are provided as one file.

The unique sample number format is presented below.

Format: YYNXXXX-EVT.BOT
RIN, seven digits, three parts YYNXXXX
YY= FY
N= use code
XXXX = sequential number

Each sample will be assigned a unique number in accordance with procedure, ASD-003, *Identification System for Reports and Samples*. The RIN is used by ASD to track and file analytical data and will be designated by ASD prior to sampling activities. The unique sample number is broken down into the following three parts:

- RIN;
- Event number; and
- Bottle number.

As presented above, the RIN is a seven-digit alphanumeric code starting with the FY (e.g., "00" for the year 2000). The RIN is followed by a dash, and then by the event number. The event number is a three-digit code, starting with "001" under the RIN, and is sequential. Each typical sampling location will have a unique event number under the RIN. QC samples will have unique event numbers to support a "blind" submittal to the analytical laboratories. The event number will be followed by a period, and then by the sequential bottle number. The bottle number is a three-digit sequential code, starting with "001," and is used to identify individual sample containers collected at the same location and same event number.

In addition to the sample numbering scheme above, additional information will be collected with respect to each sample and recorded on the project logsheets. This includes:

- Sample type; and
- QC code.

QC codes will include the following, as appropriate:

- REAL: regular sample; and
- DUP: duplicate sample.

A sample number will also be assigned to each sample collected for internal sample tracking. The block of sample numbers will be of sufficient size to include the entire number of possible samples (including QA samples) and location codes. In preparation for the final report, the ASD and project sample numbers will be cross-referenced with location codes.

6.2 REMEDIAL ACTION DECISION MANAGEMENT SYSTEM

The ER RADMS is a system that generates, verifies, validates, and delivers environmental data products to ER staff in complete and timely maps and reports in conformance with requirements described in Section 6.1. The ER RADMS is a tool for accessing and evaluating environmental data produced within 24 to 48 hours of sample analysis (coupled with historical data as needed), during both characterization and remediation activities. Figure 17 illustrates the general data flow and system configuration.

Detailed specifications of the ER RADMS are described in the data management plan, which describes data generation, aggregation, QC, archival, and access policies. Field and analytical data is organized in Microsoft Access and linked with a GIS, specifically ArcView, to provide users with contaminant data by geographic location and the ability to perform spatial analyses as needed. The ER RADMS will interface with existing site databases, including ASD and SWD, to ensure data consistency and retrievability.

The ER staff will use RADMS to:

- Evaluate analytical data;
- Track environmental samples and maintain chain-of-custody;
- Assess the quality of analytical results;
- Determine characterization sampling locations;
- Determine remediation areas;
- Determine confirmation sampling locations;
- Estimate risk from residual contamination;
- Track closure of RCRA units;
- Track waste volumes and composition; and,
- Produce reports.

Additionally, RADMS will be available to CDPHE and EPA. ER staff will work interactively with the regulatory agencies to:

- View existing data;
- Determine proposed characterization sampling locations;
- Determine remediation areas;
- Determine confirmation sampling locations; and,

- Accelerate the review and approval process by working with virtual data and graphics prior to submittal of Closeout Reports.

The RADMS includes several modules customized for ER program requirements. The modules include the following:

- Sample tracking;
- Data analysis
  - Data verification and validation
  - Spatial analysis (contaminant-concentration isopleths)
  - Risk screen;
- RCRA closure;
- Waste management; and
- Reporting.

6.2.1 Sample Tracking

All characterization and remediation samples will be tracked through the RADMS field data collection management module. Sample tracking will be keyed to the ASD sample numbering system, and will include a variety of field parameters (e.g., those currently required by ASD, as well as sample depth, test method, collection time, and field QC information). Chain-of-custody forms and sample labels may also be printed from this module.

6.2.2 Data Analysis

Data will be analyzed through several different modules as described below. Routine statistical, verification and validation, and spatial analysis will be automated. The algorithms and data analysis sequences are consistent with project DQOs (Section 3.1.1 and data evaluation (Section 5.0). Data analysis will be performed with verified and validated data after characterization sampling is complete, and again after remediation confirmation sampling.

6.2.3 Verification and Validation

All data collected during ER characterization and remediation sampling will be verified and validated according to QA requirements. Verification will consist of ensuring that all data received from the analytical vendor(s) are complete and correctly formatted. Validation will consist of a systematic comparison of all QC requirements with results reported by the vendor (e.g., relative to laboratory control samples [LCSs], matrix spikes [MSs], matrix-spike duplicates [MSDs], and blanks). The verification and validation

process will establish usability of the data by determining, reporting, and archiving the following criteria relative to each measurement set or batch:

- Precision;
- Accuracy;
- Bias;
- Sensitivity; and,
- Completeness.

6.2.4 Spatial Analysis

Several data aggregation and evaluation options will be available in the spatial analysis module, including inverse distance weighting (IDW), kriging, Monte Carlo simulations, and other geostatistical techniques. Spatial analysis will allow determination of contaminant-concentration boundaries as defined by RFCA Tier I, Tier II, and background values. This analysis will also be used to determine additional sampling locations, remediation areas, and associated confidences in the values/decisions.

6.2.5 Risk Screen

The risk screening module is used to determine whether human health risks are acceptable in remediated areas. Algorithms in the risk screening module are consistent with DQOs in the Draft CRA (DOE 2000c) and the BZSAP. The risk screening module includes estimation of external and internal exposures on an BZ Group basis

6.2.6 RCRA Closure

The RCRA closure module allows a user to archive all pertinent location, analytical, and remediation information about RCRA units. This will be used to track closure of sections of the OPWL and NPWL.

6.2.7 Waste Management

Location, volume, characteristics, classification, and container type will be tracked for all ER remediation waste, and will allow links with other RFETS waste management databases.

6.2.8 Reporting

RADMS is configured to produce reports from all of the customized modules. Hardcopy reports will typically consist of data tables (queries), isopleth maps (e.g., Tier I, Tier II, and background concentration boundaries, and risk), and combinations of tables and maps tailored to specific needs. Hardcopy reports will be minimized through the routine use of desktop “workstations” dedicated to specific locations and/or personnel within the project, DOE, EPA, and CDPHE.

7.0 PROJECT ORGANIZATION

The overall BZ project organization is shown on Figure 18 and the general BZ Group characterization project organization is shown on Figure 19.

The overall BZ project organization is designed to provide support to the project manager by ensuring the various support functions are consistent across the BZ characterization program and available to the project. These support functions will include, but not necessarily be limited to, the following:

- H&S;
- QA;
- Field instrumentation and mobile laboratory services;
- Data configuration;
- Data analysis procedures;

  Interactions with ASD and SWD;
- Data management; and
- Reporting procedures.

The BZ Group characterization organization shown on Figure 19 illustrates the characterization team functions. Individuals assigned to each specific BZ Group characterization will be identified in the appropriate BZSAP Addenda.

8.0 QUALITY ASSURANCE AND QUALITY CONTROL

QA requirements defined in this BZSAP are consistent with quality requirements as defined in DOE (Order 414.1A, *Quality Assurance*) and EPA (QA/R-5, EPA *Requirements for Quality Assurance Project Plans*) (EPA 1999b). These requirements are also consistent with RFETS-specific quality requirements as described in the Kaiser-Hill Team *Quality Assurance Program*, PADC-1996-00051 (K-H 1999).

The applicable QC categories include the following:

Management

- Quality Program;
- Training;
- Quality Improvement;
- Documents/Records;

Performance

- Work Processes;
- Design;
- Procurement;
- Inspection/Acceptance Testing;

Assessments

- Management Assessments; and
- Independent Assessments.

The QAPjP (Appendix H) discusses in detail how these criteria will be implemented. The project manager will be in direct contact with the QA manager to identify and correct potential quality-affecting issues. Oversight of field sampling and analysis will be conducted to ensure data comply with quality requirements. The confidence levels of the data will be maintained by the collection of QC samples and implementation of the DQO process.

Data verification and validation will be performed according to ASD procedures. Analytical laboratories supporting this task undergo annual technical and QA audits performed by ASD.

Data quality will be measured in terms of the precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters. Data collected during BZ sampling activities will be evaluated using the PARCC parameters (Appendix H). Measurement sensitivity and bias will also be addressed.

9.0 HEALTH AND SAFETY

All necessary H&S protocols will be followed in accordance with the specifications in the BZSAP Addenda and Integrated Work Control Program (IWCP), as appropriate. In addition, work will be conducted under Radiological Work Permits (RWPs), as applicable. A readiness review will be conducted before the start of fieldwork for all BZ Groups. The BZSAP Addenda will include H&S requirements for the specific PCOCs, hazards, and emergency response protocols associated with the BZ activities.

The Occupational Safety and Health Administration (OSHA) construction standard for Hazardous Waste Operations and Emergency Response, 29 CFR 1926.65, is followed at RFETS. Under this standard, a H&S plan that addresses the safety and health hazards of each phase of the project and specifies the requirements and procedures for employee protection will be developed. In addition, the DOE Order for Construction Project Safety and Health Management, 5480.9A, applies to this project. This order requires the preparation of AHAs to identify each task, hazards associated with each task, and

cautions necessary to mitigate the hazards. These requirements will be integrated wherever appropriate.

BZSAP activities could expose workers to physical, chemical, and low levels of radiological hazards. Physical hazards include those associated with excavation activities, drilling, use of heavy equipment, noise, heat stress, cold stress, and work on uneven surfaces. Physical hazards will be mitigated by appropriate use of PPE, engineering, and administrative controls. Chemical hazards will be mitigated by use of PPE and administrative controls. Appropriate skin and respiratory PPE will be worn throughout the project.

VOC monitoring will be conducted with an organic vapor monitor for any employees who must work near suspected VOC-contaminated soil (e.g., soil sampling or excavation personnel). Based on employee exposure evaluations, the Site H&S officer may downgrade PPE requirements, if appropriate.

H&S data and controls will be continually evaluated. Field radiological screening will be conducted using radiological instruments appropriate to detect surface contamination and airborne radioactivity. As stated in 10 CFR 835, Radiation Protection of Occupational Workers, all applicable implementing procedures will be followed to ensure protection of workers. Dust minimization techniques will be used to minimize suspension of contaminated soil.

10.0 SCHEDULE

The schedule for characterization of the BZ Groups is shown on Figure 20. This figure illustrates the 2005 Working Schedule for RFETS Closure, but may change based on the decommissioning schedule and characterization acceleration opportunities.

11.0 REFERENCES

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LIST OF APPLICABLE STANDARD OPERATING PROCEDURES

Identification Number	Procedure Title
1-C91-EPR-SW.01	*Control and Disposition of Incidental Waters*
1-PRO-079-WGI-001	*Waste Characterization, Generation, and Packaging*
1-PRO-573-SWODP	*Sanitary Waste Offsite Disposal Procedure*
3-PRO-112-RSP-02.01	*Radiological Instrumentation*
4-S01-ENV-OPS-FO.03	*Field Decontamination Operations*
ASD-003	*Identification System for Reports and Samples*
OPS-PRO.069	*Containerizing, Preserving, Handling and Shipping of Soil and Water Samples*
OPS-PRO.070	*Equipment Decontamination at Decontamination Facilities*
OPS-PRO.102	*Borehole Clearing*
OPS-PRO.112	*Handling of Field Decontamination Water*
OPS-PRO.114	*Drilling and Sampling Using Hollow-Stem Auger and Rotary Drilling and Rock Coring Techniques*
OPS-PRO.117	*Plugging and Abandonment of Boreholes*
OPS-PRO.121	*Soil Gas Sampling and Field Analysis*
OPS-PRO.124	*Push Subsurface Soil Sampling*
OPS-PRO-947	*Location/Surveying*
PRO-1058-ASD-005	*Environmental Data Management Procedure*
PRO-1130-ASD-006	*Spatial Data Map Control*
PRO-908-ASD-004	*On-Site Transfer and Off-Site Shipment of Samples*
RF/RMRS-98-200	*Evaluation of Data for Usability in Final Reports*