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218-E-12B Burial Ground Sampling and Analysis Plan

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TERMS

AEA	alpha energy analysis
AG	amber glass
bgs	below ground surface
CE	container code for self-contained equipment
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CF	container code for fiberboard/plastic boxes, cartons, cases
CLARC	cleanup levels and risk calculations
CM	container code for metal boxes, cartons, cases
COC	contaminant of concern
CPT	cone penetrometer
CVAA	cold vapor atomic absorption
DM	container code for metal drums, barrels, kegs
dpm	disintegrations per minute
DQA	data quality assessment
DQO	data quality objective
DR	decision rule
EPA	U.S. Environmental Protection Agency
G	glass
GC/MS	gas chromatography/mass spectrometery
GEA	gamma energy analysis
GPC	gas proportional counting
GW	groundwater
HASQARD	DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Documents*
HEIS	*Hanford Environmental Information System*
HEPA	high-efficiency particulate air (filter)
ICP	inductively coupled plasma
LSC	liquid scintillation counting
MS	mass spectrometry
N/A	not applicable
OVM	organic vapor monitor
P	plastic
ppbv	parts per billion by volume
ppmv	parts per million by volume
QAPjP	quality assurance project plan
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1976*
RSW	retrievably stored waste
SAP	sampling and analysis plan
SC	container code for HEPA filters
SVOC	semivolatile organic compound
SWITS	*Solid Waste Information and Tracking System*
TBC	to be considered

TBD	to be determined
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TRU	waste materials contaminated with more than 100 nCi/g of transuranic materials having half-lives longer than 20 years
VOC	volatile organic compound
WIDS	*Waste Information Data System*

METRIC CONVERSION CHART

Into Metric Units			Out of Metric Units		
If You Know	*Multiply By*	*To Get*	*If You Know*	*Multiply By*	*To Get*
Length			**Length**		
inches	25.4	millimeters	millimeters	0.039	inches
inches	2.54	centimeters	centimeters	0.394	inches
feet	0.305	Meters	meters	3.281	feet
yards	0.914	Meters	meters	1.094	yards
miles	1.609	Kilometers	kilometers	0.621	miles
Area			**Area**		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.093	sq. meters	sq. meters	10.76	sq. feet
sq. yards	0.836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.6	sq. kilometers	sq. kilometers	0.4	sq. miles
acres	0.405	Hectares	hectares	2.47	acres
Mass (weight)			**Mass (weight)**		
ounces	28.35	Grams	grams	0.035	ounces
pounds	0.454	Kilograms	kilograms	2.205	pounds
ton	0.907	metric ton	metric ton	1.102	ton
Volume			**Volume**		
teaspoons	5	Milliliters	milliliters	0.033	fluid ounces
tablespoons	15	Milliliters	liters	2.1	pints
fluid ounces	30	Milliliters	liters	1.057	quarts
cups	0.24	Liters	liters	0.264	gallons
pints	0.47	Liters	cubic meters	35.315	cubic feet
quarts	0.95	Liters	cubic meters	1.308	cubic yards
gallons	3.8	Liters			
cubic feet	0.028	cubic meters			
cubic yards	0.765	cubic meters			
Temperature			**Temperature**		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius	Celsius	multiply by 9/5, then add 32	Fahrenheit
Radioactivity			**Radioactivity**		
picocuries	37	millibecquerel	millibecquerels	0.027	picocuries

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1.0 INTRODUCTION

This sampling and analysis plan (SAP) was developed to determine whether contaminants have been released to the vadose zone from retrievably stored waste (RSW)[1] in the 218-E-12B Burial Ground in the 200 East Area of the Hanford Site. This investigation addresses the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) Interim Milestone M-91-40, Requirement 2 (Ecology et al. 1989a).

This SAP is based on the sampling design developed during a data quality objective (DQO) process that was conducted specifically to plan the 218-E-12B Burial Ground sampling in response to the Tri-Party Agreement Interim Milestone M-91-40, Requirement 2 (WMP-20379, *DQO Summary Report for the 218-E-12B Burial Ground Contaminant Release Investigation*). The results of the DQO process are summarized in Section 1.3.

The DQO process was based in part on the DQO process that was performed for the 218-W-4C Burial Ground (CP-16886, *Data Quality Objectives Summary Report for the 218-W-4C Burial Ground Contaminant Release Investigation*). Differences from the sampling design described in the 218-W-4C Burial Ground DQO report (CP-16886) are required for the 218-E-12B Burial Ground sampling design because of differences in the burial ground trench designs. In addition, unlike the 218-W-4C Burial Ground, no characterization data were available for the 218-E-12B Burial Ground before the sampling design was developed.

Figure 1-1 shows the location of the 218-E-12B Burial Ground in the 200 East Area on the Hanford Site. Figure 1-2 shows the portions of the 218-E-12B Burial Ground trenches where RSW is stored and where this investigation is applicable.

1.1 BACKGROUND

The 218-E-12B Burial Ground is located approximately 300 m (1,000 ft) north of the 241-C Tank Farm and south of 12th Street. The original burial ground was designed to contain 29 trenches. The expansion to the north and west enlarged the burial ground to create the potential for 138 trenches orientated in a north-south direction. Sixty-one of the proposed trenches were designed to be 370 m (1,212 ft) long, 31 of the trenches were designed to be 293 m (960 ft) long, and the remaining trenches would vary in length from 94 m (307 ft) to 580 m (1,901 ft). The first six trenches were 1.2 m (4 ft) deep. The rest of the trenches were designed to be 4.8 m (16 ft) deep. The burial ground is marked and radiologically posted.

The 218-E-12B Burial Ground is located in the low-level burial grounds *Resource Conservation and Recovery Act of 1976* (RCRA) treatment, storage, and disposal unit. The 218-E-12B Burial Ground also is included in the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) 200-SW-2 Radioactive Landfills and Dumps Group Operable Unit (DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program*).

---

[1]Retrievably stored for purposes of the *Atomic Energy Act of 1954*.

Figure 1-1. Locations of the 200 East Area on the Hanford Site and the 218-E-12B Burial Ground in the 200 East Area.

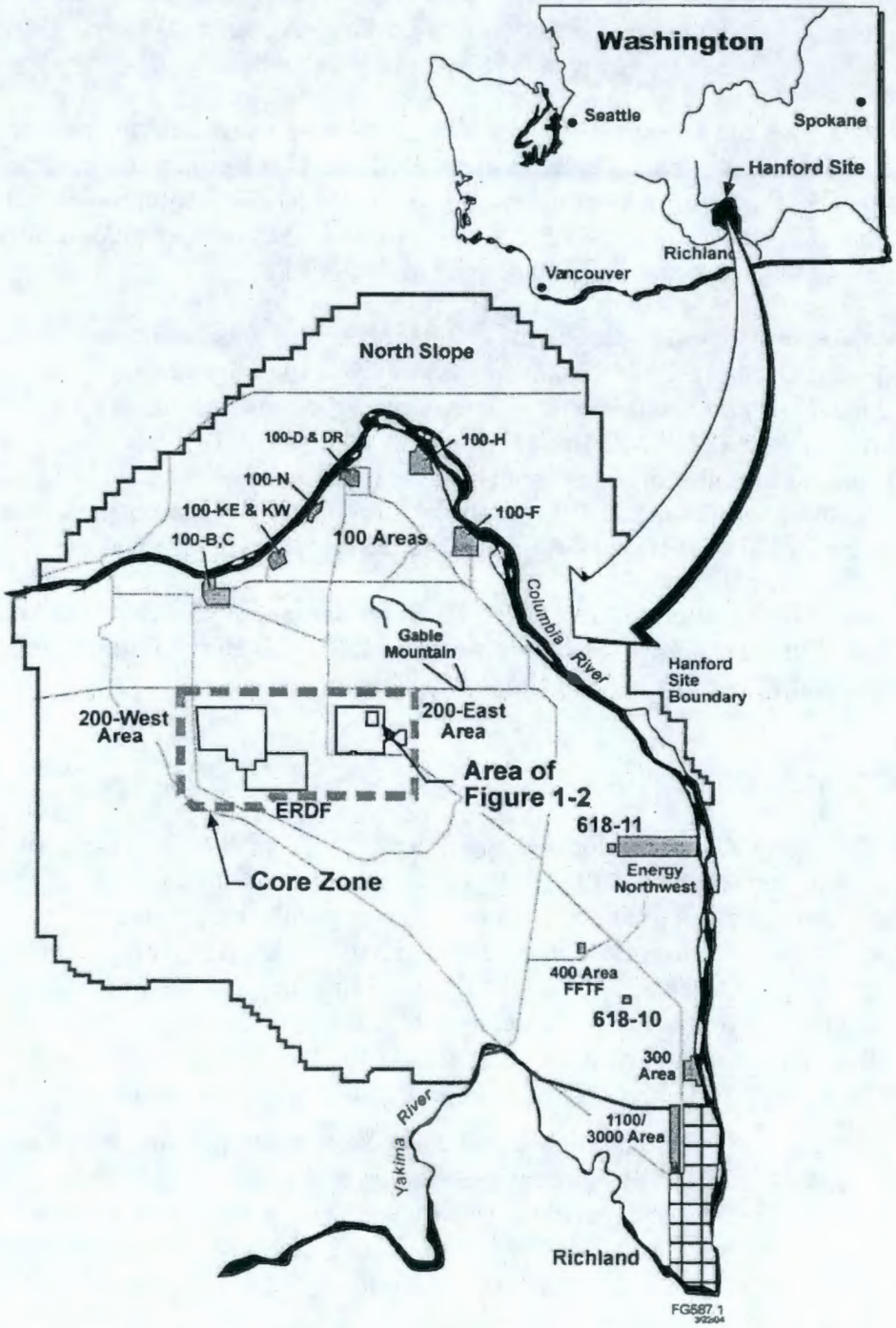
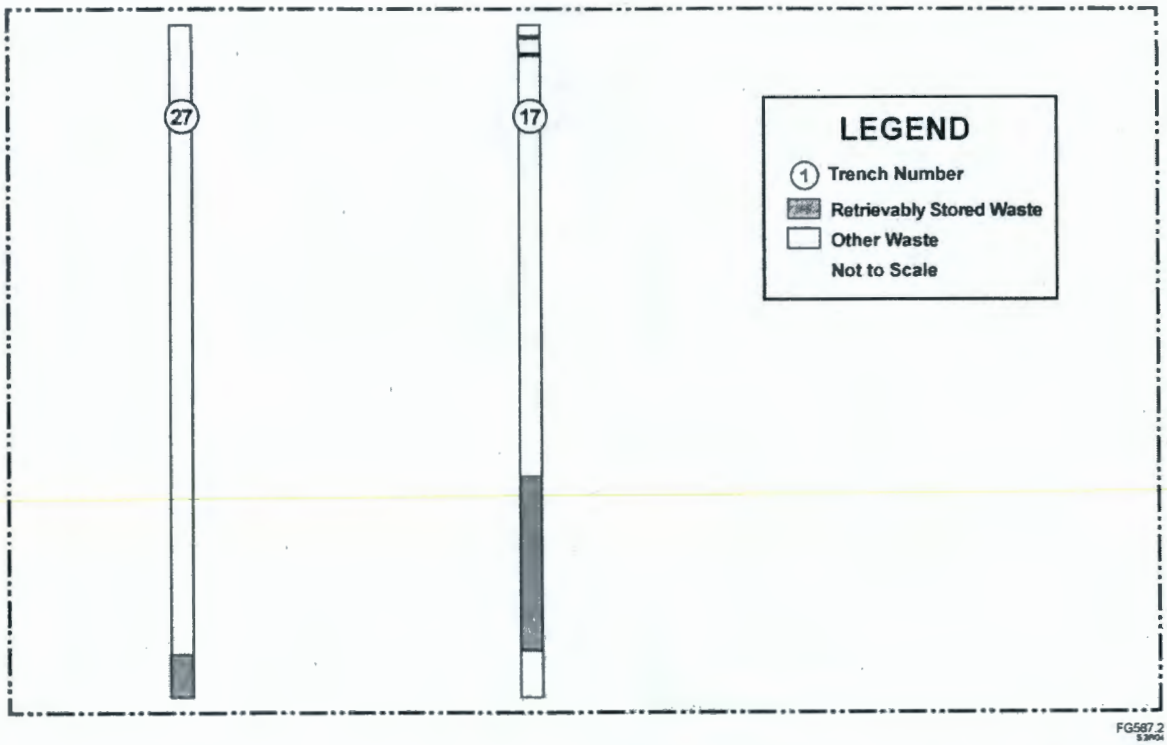


Figure 1-2. Location of Retrievably Stored Waste in the 218-E-12B Burial Ground Trenches T-17 and T-27.



The 218-E-12B Burial Ground began operating in 1967. As of 1995, the 218-E-12B Burial Ground had received 78,740 m^3 (102,988 yd^3) of solid, low-level waste generated mostly from facilities in the 200 East Area. Thirty-six trenches were filled completely and two were filled partially. Trench 94 contains U.S. Navy vessel defueled reactor compartments that were placed in this trench for disposal. A large portion of the property designated as the 218-E-12B Burial Ground has never been used.

Suspect TRU[2] waste originating from the Plutonium-Uranium Extraction Facility was placed in the southern portions of 218-E-12B Burial Ground Trenches T-17 and T-27 between May 1970 and October 1972 (Figure 1-2). Sixteen containers of suspect TRU waste also were placed in the northern portion of Trench T-17. The *Solid Waste Information and Tracking System* (SWITS) identifies 2,943 containers in the 218-E-12B Burial Ground as suspect TRU waste. The containers consist of 2,882 drums, with the remainder being boxes or other containers. The 2,882 drums include 2,873 208 L (55-gal) drums, five 114 L (30-gal) drums, and 4 containers listed in SWITS as "3x3x4"-size drums with a volume of 1022 L (270 gal). The 3x3x4 odd-size containers likely are misidentified as drums. WHC-EP-0225, *Contact-Handled Waste Characterization Based on Existing Records,* identifies 2,944 containers as suspect TRU

[2]Transuranic (waste materials contaminated with more than 100 nCi/g of transuranic materials having half-lives longer than 20 years).

waste in the 218-E-12B Burial Ground. It is unclear why WHC-EP-0225 and SWITS differ by one container in their respective inventories.

Drums were stacked horizontally in earthen trenches from 1970 to 1972. The waste drums were "direct buried" in the ground (i.e., not on asphalt pads as they are in the 218-W-4C Burial Ground) without tarps or plywood to separate the soil overlying the waste. Direct contact with the soil may increase the probability that containers have corroded and might be breached (WHC-EP-0225). Figure 1-3 shows the drum placement configuration used in the 218-E-12B Burial Grounds from 1970 to 1972.

The southeastern portion of the burial ground, which includes Trench T-17, was interim stabilized in 1981 with 46 to 61 cm (18 to 24 in.) of uncontaminated soil. The portion containing Trench T-27 was not interim stabilized. As a result, the thickness of the soil overlying Trench T-27 is expected to be less than the thickness of the soil overlying Trench T-17 (*Waste Information Data System Report for 218-E-12B*) (WIDS).

Surveillance and maintenance of the stabilized portion of the burial ground is performed periodically. In January 2000, two contaminated tumbleweeds were removed from the site (WIDS). The tumbleweeds read from 29,000 to 59,000 disintegrations per minute (dpm)/100 cm^2 beta/gamma and less than 20 dpm alpha. In addition, 13 tumbleweed fragments read from 2,500 to 399,000 dpm/100 cm^2 beta/gamma. The maximum dose rate was less than 0.5 mrem/h with the instrument window closed, implying that this total dose reading was primarily from gamma radiation, and 9.6 mrem/h when the instrument window was open, implying that this total dose reading was from both beta and gamma radiation.

A surface radiological survey of the stabilized portion was conducted from December 2003 through February 2004 (WIDS). Many growing, contaminated tumbleweeds were removed from the burial ground trenches.

The number of containers and the estimated dose rates for remote-handled and contact-handled waste in Trenches T-17 and T-27 in the 218-E-12B Burial Ground are summarized in Table 1-1. According to SWITS, 96 containers are classified as remote handled. Three containers are boxes and the remaining 93 are drums. Remote-handled waste, when exhumed, will require special handling that may include time, distance, and shielding to protect workers from radiation dose. Tri-Party Agreement Interim Milestone M-91-41 (Ecology et al. 1989a) requires that full-scale retrieval of remote-handled RSW be initiated by 2011.

Figure 1-3. Drum Configuration of Retrievably Stored Waste in the 218-E-12B Burial Ground Trenches from 1970 to 1972 (from WHC-EP-0912, *The History of the 200 Area Burial Ground Facilities*).

Table 1-1. Estimated Number of Containers by Dose Rate (from 218-E-12B Trenches T-17 and T-27).

Contact Handled/Remote Handled	Dose Rate (mrem/h)	Number of Containers	% of Containers	Cumulative (%)
Contact handled	≤ 200	2,847	96.7	96.7
Remote handled	> 200 to 1,000	48	1.6	98.4
Remote handled	> 1,000 to 2,000	20	0.7	99.0
Remote handled	> 2,000 to 5,000	22	0.7	99.8
Remote handled	> 5,000 to 10,000	1	< 0.1	99.8
Remote handled	> 10,000 to 20,000	2	0.1	99.9
Remote handled	> 20,000 to 30,000	3	0.1	100.0
Remote handled	> 30,000	0	0	100.0
	Totals	2,943	100.0	--

Table 1-2 summarizes the contents of the 218-E-12B Burial Grounds by trench and container type. The container types include drums, self-contained equipment, cardboard boxes, metal boxes, and high-efficiency particulate air (HEPA) filters. Eight HEPA filters are identified as a container type. The SWITS does not make clear if these HEPA filters are disposed of as is or if they are inside a container.

Table 1-2. Summary of the 218-E-12B Burial Ground Containers by Trench and Container Type.

Container	Type	Trench T-17		Trench T-27	
		Containers	Vol (m^3)	Containers	Vol (m^3)
30-gal drum	DM	5	0.58	--	--
55-gal drum	DM	2634	553.14	239	50.19
270-gal drum	DM	--	--	4	4.08
Self-contained equipment	CE	1	0.210	--	--
Fiberboard/plastic boxes, cartons, cases	CF	24	2.98	--	--
Metal boxes, cartons, cases	CM	28	21.10	--	--
HEPA filters	SC	8	4.94	--	--
Totals		2700	582.95	243	54.99

CE = self-contained equipment.
CF = fiberboard/plastic boxes, cartons, cases.
CM = metal boxes, cartons, cases.
DM = metal drums, barrels, kegs.
HEPA = high-efficiency particulate air.
SC = HEPA filters.

1.2 CONTAMINANTS OF CONCERN

Contaminants of concern (COC) for sampling and analysis at the 218-E-12B Burial Ground in response to the Tri-Party Agreement Interim Milestone M-91-40, Requirement 2, were determined during the DQO process conducted to support development of this SAP (WMP-20379).

Because no vent risers are present at the 218-E-12B Burial Ground, an alternative to the requirements specified in Tri-Party Agreement Interim Milestone M-91-40, Requirement 2 (Ecology et al. 1989a) to sample the vent risers was addressed by the DQO process. The resolution was to perform passive soil-vapor sampling in the overlying soil covering the applicable portions of Trenches T-17 and T-27 from which RSW will be retrieved.

For passive soil-vapor sampling in the overlying soils and active soil-vapor sampling in the vadose zone, the COCs will include only volatile organic constituents. Soil-vapor monitoring and radiation screening on the surface of the trench floor will be performed using hand-held instruments for total organic vapor concentrations and gross beta/gamma and gross alpha activities. Substrate soil samples from the first 15.2 cm (6 in.) of native soils will be analyzed for suites of RCRA constituents that include metals, volatile organic compounds (VOC), and semivolatile organic compounds (SVOC) and for a suite of CERCLA radiological constituents that are not subject to Tri-Party Agreement Interim Milestone M-91-40, Requirement 2. Source, special nuclear, and byproduct materials, as defined by the *Atomic Energy Act of 1954*, as amended, are excluded from the RCRA definition of solid waste. Such materials at the Hanford Site are subject to management under the sole authority of the U.S. Department of Energy, even when commingled with a hazardous component that is subject to regulation under RCW 70.105, "Public Health and Safety," "Hazardous Waste Management," (the Washington State Hazardous Waste Management Act of 1976). Accordingly, any procedures, methods, data, or information provided to regulatory agencies, that are contained in this document and that relate solely to radionuclides or to the radioactive component of mixed waste, are for information purposes only and are outside the scope of the regulatory agencies' authority. Radionuclides, when they are COCs, may be regulated pursuant to CERCLA cleanup actions. The radionuclides discussed in this SAP are regulated pursuant to the *Atomic Energy Act of 1954* and CERCLA, in accordance with responsible agency protocols.

The passive soil-vapor samples will be analyzed for VOCs by the vendor of this technology at the vendor's laboratory. The list of specific VOCs that will be analyzed is the list provided by the vendor. The VOCs that will be analyzed in active soil-vapor samples using field-screening methods will depend on the availability and configuration of the specific field-screening instrument used. The VOCs that will be analyzed in active soil-vapor samples using laboratory analytical methods will include the full suite of VOCs identified in the laboratory test method. Soil-vapor samples collected using active soil-vapor sampling techniques for laboratory analysis will be analyzed for VOCs using U.S. Environmental Protection Agency (EPA) methods that can identify individual VOCs in vapor mixtures:

- Method TO-14 (EPA/600/4-89/017, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*)

- Method TO-15 (EPA/625/R-96/010b, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition*)
- Method 8260B (SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update III-A*).

These methods are similar to the analytical methods used to analyze the soil-vapor samples collected using active sampling techniques at vent risers in the 218-W-4C Burial Ground in 1996 (HNF-SD-WM-RPT-309, *Report on Sampling and Analysis of Air at Trenches 218-W-4C and 218-W-5 #31 of the Low Level Burial Grounds*) and in 2003.

To identify and quantify the metals, VOCs, and SVOCs in soil samples, full-suite analytical methods will be used. Soil samples will be analyzed for VOCs using SW-846 Method 8260B, for SVOCs using SW-846 Method 8270C, and for metals using EPA Method 200.8 (EPA/600/R-94/111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*) or SW-846 Method 6010B. (If Method 6010B is used, mercury will be analyzed by SW-846 Method 7471A.) Tentatively identified compounds (i.e., organic constituents that are not contained in the calibration standards used for these analyses) also will be qualitatively identified by the full-suite analyses for VOCs and SVOCs and will be reported for evaluation. Soil samples will be analyzed for radionuclides by the appropriate laboratory methods used for individual isotopes and classes of radionuclides of concern.

The COCs for soil-vapor samples, trench floor surveys, and soil samples are listed in Tables 1-3 through 1-5, respectively.

Table 1-3. Contaminants of Concern (Volatile Organic Compounds) for Soil-Vapor Sampling. (2 Pages)

Passive Soil-Vapor Samples
Laboratory analysis for 1,1-dichloroethane, 1,2-dichloroethane, 1,4-dichlorobenzene, benzene, carbon tetrachloride, chlorobenzene, chloroform, cis-1,2-dichloroethene, ethylbenzene, toluene, tetrachloroethene, trans-1,2-dichloroethene, trichloroethene, xylene using SW-846 Methods 5041A and 8260B. This list of VOCs is provided by the vendor of the passive soil-vapor technology.
Active Soil-Vapor Samples
Field screening for carbon tetrachloride and chloroform using the Innova[a] multi-gas analyzer and/or for carbon tetrachloride, chloroform, 1,1-dichloroethane, tetrachloroethene, 1,1,1-trichloroethane, methylene chloride, trichloroethene, and 1,1,2-trichloroethane using the field-based gas chromatograph and/or for acetone, ammonia, benzene, n-butyl alcohol, carbon dioxide, carbon disulfide, carbon tetrachloride, chlorobenzene, chloroform, p-dichlorobenzene, 1,1-dichloroethane, 1,2-dichloroethene, ethyl benzene, ethyl chloride (chloroethane), ethylene dichloride (1,2-dichloroethane), methane, methyl chloride (chloromethane), methyl chloroform (1,1,1-trichloroethane), methyl ethyl ketone (2-butanone), methyl isobutyl ketone (4-methyl-2-pentanone), methylene chloride, tetrachloroethene, styrene, toluene, 1,1,2-trichloroethane, 1,1,2,2-tetrachloroethane, trichloroethene, vinyl chloride, vinylidene chloride (1,1-dichloroethene), and xylene using the MIRAN SapphIRe Ambient Air Analyzer[b] (MIRAN analyzer). The VOCs listed for each field-screening instrument are those for which that instrument is calibrated. The MIRAN analyzer can be used to scan for all these compounds and identify up to five compounds with the highest concentrations. The MIRAN analyzer also can be used to analyze for any compounds detected during the passive soil-vapor survey for which it is calibrated.

Table 1-3. Contaminants of Concern (Volatile Organic Compounds) for Soil-Vapor Sampling. (2 Pages)

Active Soil-Vapor Samples (cont)
Laboratory analysis for full suite of VOCs using GC/MS Method 8260B (SW-846), EPA Method TO-14 (EPA/600/4-89/017), or EPA Method TO-15 (EPA/625/R-96/010b).

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

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

EPA/600/4-89/017, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air.*

EPA/625/R-96/010b, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition.*

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

EPA = U.S. Environmental Protection Agency.
GC/MS = gas chromatography/mass spectrometry.
VOC = volatile organic compound.

Table 1-4. Contaminants of Concern for Trench Floor Organic Vapor Monitoring/Radionuclide Surveys.

Volatile Organic Compounds
Surveys using hand-held monitoring devices (e.g., organic vapor monitoring) that detect total organic vapor concentrations.
Radionuclides
Surveys using hand-held monitoring devices that detect gross gamma/beta and gross alpha activities.

Table 1-5. Contaminants of Concern for Substrate Soil Sampling.

Metals
Laboratory analysis for full suite of metals using inductively coupled plasma (SW-846 Method 6010B or EPA Method 200.8) and for mercury (SW-846 Method 7471A or EPA Method 200.8).
Volatile Organic Compounds
Laboratory analysis for full suite of VOCs using GC/MS (SW-846 Method 8260B).
Semivolatile Organic Compounds
Laboratory analysis for full suite of SVOCs using GC/MS (SW-846 Method 8270C).
Radionuclides
Laboratory analyses for a target list of radionuclides consisting of isotopic americium (AEA), isotopic plutonium (AEA), isotopic uranium (AEA), total radioactive strontium (GPC), Tc-99 (LSC),Cs-137 (GEA), Co-60 (GEA), Eu-152 (GEA), Eu-154 (GEA), Eu-155 (GEA), and Ni-63 (LSC) using AEA, GPC, LSC, or GEA as indicated.

EPA 200.8 is found in EPA/600/R-94/111, *Methods for the Determination of Metals in Environmental Samples, Supplement I.*

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

AEA = alpha energy analysis.
EPA = U.S. Environmental Protection Agency.
GC/MS = gas chromatography/mass spectrometry.
GEA = gamma energy analysis.
GPC = gas proportional counting.
LSC = liquid scintillation counting.
SVOC = semivolatile organic compound.
VOC = volatile organic compound.

1.3 DATA QUALITY OBJECTIVES

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

This section summarizes the key outputs resulting from the implementation of the seven-step DQO process. Additional details are included in the DQO summary report (WMP-20379).

1.3.1 Statement of the Problem

To assess whether contaminant releases to the environment have occurred from the RSW that will be retrieved from the 218-E-12B Burial Ground, data regarding concentrations of burial ground contaminants of concern in the substrate soils are needed, in accordance with the Tri-Party Agreement Interim Milestone M-91-40, Requirement 2 (Ecology et al. 1989a).

1.3.2 Decision Rules

Decision rules are developed from consideration of the principal study questions, decision statements, remedial-action alternatives, data needs, COC action levels, analytical requirements, and scale of the decisions. Decision rules are structured as "IF…THEN" statements that indicate that the action that will be taken when a prescribed condition is met. Decision rules incorporate the following:

- Population parameter of interest (e.g., the population mean concentration)
- The statistic that will be used to estimate the population parameter of interest (e.g., the sample mean as estimated by the 95 percent upper confidence limit of the sample distribution)
- The scale of the decision (e.g., location)
- The preliminary action level(s) (e.g., COC concentration above which a specific action will be taken)
- The resulting actions.

The decision rules developed during the DQO process for sampling at the 218-E-12B Burial Ground in response to the Tri-Party Agreement Interim Milestone M-91-40, Requirement 2, support decision making for the 218-E-12B Burial Ground (WMP-20379). The decision rules are summarized in Table 1-6.

Table 1-6. Decision Rules.

DR #	Decision Rule
1	If the VOC vapor concentrations measured in samples collected from the soil overlying RSW trenches in the 218-E-12B Burial Ground are greater than the compound-specific detection limits* for the analytical equipment, then add the detected VOCs to the COC list for sampled trenches and use the detected or maximum detected concentrations to identify the locations for subsequent trench floor surveys; otherwise do not add to the COC list or identify survey locations.
2	If the trench floor beneath the buried waste has visual indications of staining from contact with organic solvents, and/or the detected VOC vapor concentrations on the trench floor surface are greater than the compound-specific detection limits* for the analytical equipment, and/or the detected radiological activity on the trench floor is greater than the background radiation detected by the field detector, then use the hot-spot locations to guide substrate soil characterization beneath the surface of the trench floor; otherwise, hot-spot locations are not available to guide substrate soil characterization.
3	If the VOC soil-vapor concentrations in the vadose zone soil underlying the trench floor are greater than the compound-specific detection limits* for the analytical equipment, and/or the detected radiological activity on sampling equipment removed from the subsurface during this vadose zone soil-vapor sampling is greater than the background radiation detected by the field detector, then use those locations to guide substrate soil characterization; otherwise, hot-spot locations are not available to guide substrate soil characterization.
4	If the detected chemical or radiological constituent concentrations in the substrate soils beneath the trench floor are greater than the action levels defined in Table 2-2, then decision makers will evaluate the need for additional characterization deeper in the vadose zone through the cleanup processes set forth in RCRA and/or CERCLA and will add the identified COCs to the conceptual distribution model; otherwise, decision makers will evaluate the data and decide against additional characterization deeper in the vadose zone and adding COCs to the conceptual distribution model.

*Compound-specific detection limits per Tables 2-1 and 2-2 in this sampling and analysis plan.

CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
COC = contaminant of concern.
DR = decision rule.
RCRA = *Resource Conservation and Recovery Act of 1976.*
RSW = retrievably stored waste.
VOC = volatile organic compound.

1.3.3 Error Tolerance and Decision Consequences

Because analytical data only can estimate the true condition of the site under investigation, decisions that are made based on measurement data potentially could be in error (i.e., decision error). For sampling designs that are statistically based, statistical methods normally used to quantify uncertainty can be used to probabilistically determine decision errors.

For sampling designs that are nonstatistically based (i.e., judgmental), uncertainty is evaluated qualitatively to estimate decision error.

The charter for the characterization in this study is Tri-Party Agreement Interim Milestone M-91-40, Requirement 2 (Ecology et al. 1989a). The directive in the milestone includes initial sampling through vent risers in the burial grounds before waste retrieval. Because the 218-E-12B Burial Ground has no vent risers, no vent riser sampling can be performed. Instead, a statistical sampling design aimed at identifying soil-vapor hot spots will be performed (Appendix A).

A focused sampling approach will be used to guide selection of locations for vadose zone soil-vapor sampling and soil sampling in the substrate soils following waste retrieval. Sampling locations will be based on the following:

- Location of any soil-vapor hot spots identified in the overlying soils before waste retrieval
- Visual observations of the trench floor
- Organic monitoring and radiological surveys conducted on the trench floor and during sample collection activities
- Results of previous soil-vapor sampling.

The uncertainty associated with the decisions to be made based on determining whether the substrate soils are contaminated is considered to be relatively low. The uncertainty associated with missing a hot spot is quantified in the statistically based hot-spot sampling design (Appendix A). That, coupled with collecting additional samples at biased locations based on visual observations, conducting surveys of the soil-vapor on the trench floor and in substrate soils, and conducting radiological surveys during sample collection further reduces the likelihood of missing a hot spot if one is present.

The statistically based hot-spot sampling design is a form of random sampling. The shape of the elliptical target of interest and the chance of missing an existing hot spot are specified. Once these specifications are made, an estimate can be made of the grid spacing required to detect a hot spot within the desired specification. The location of the first grid node is chosen randomly, and the grid is laid out from there. The decision makers must specify the length of the semimajor axis of the smallest hot spot important to detect, the expected shape of the elliptical target, and an acceptable probability of not finding the hot spot. The probability of not finding a hot spot is equivalent to the false positive decision error (i.e., determining that no COCs are present in the soil vapor because no hot spot was found, when a hot spot actually exists). For the purpose of this investigation, the proposed length of the semimajor axis for soil-vapor sampling in the overlying soils is 3 m (10 ft), the proposed shape of the elliptical target is an ellipse with a major-axis-to-semimajor-axis ratio of 1:0.8, and the proposed acceptable probability of not finding a hot spot is 10 percent. If a statistically based sampling design is implemented for substrate and/or vadose zone characterization, the proposed length of the semimajor axis is 5 m (16 ft), the proposed shape of the elliptical target is an ellipse with a major-axis-to-semimajor-axis ratio of 1:0.8, and the proposed acceptable probability of not finding a hot spot is 10 percent.

1.3.4 Sample Design Summary

This summary provides the basis for the sampling design. The details of the sampling design are presented in Chapter 3.0.

The sampling design presented in this SAP was developed during the DQO process (WMP-20379) in response to the Tri-Party Agreement Interim Milestone M-91-40, Requirement 2 (Ecology et al. 1989a). The primary elements of the sampling design, as specified in the Tri-Party Agreement Interim Milestone M-91-40, Requirement 2, are vapor sampling through vent risers in the trenches before waste retrieval and characterization of the substrate soils beneath the trenches following waste retrieval. Because the 218-E-12B Burial Ground has no vent risers, a sampling design has been developed to characterize soil vapor that may be present in the soils overlying the trenches before waste retrieval. This investigation applies only to the retrievably stored suspect TRU waste in the trenches in the 218-E-12B Burial Ground (the portions of the trenches indicated in Figure 1-2).

Resources in the sampling design are focused in areas with the highest potential for detecting the burial ground COCs and moving to additional sampling in a focused manner. This calls for a three-step sampling design. In Step I, this approach targets the soil overlying the 218-E-12B Burial Ground trenches before beginning waste retrieval operations, an activity expected to have the lowest degree of uncertainty and the lowest cost. Passive soil-vapor sampling will be conducted in the overlying soils. In Step II, the sampling design shifts to the trench floor and vadose zone soils. Visual observations, organic vapor monitoring, and radiological surveys will be conducted on the trench floor. These data, and the data collected during the soil-vapor surveys conducted in Step I, will be evaluated to determine if additional characterization in the vadose zone soils will be performed for VOCs in soil vapor and radionuclides adhering to sampling equipment as it is retrieved from the subsurface. Step III involves assessing the data collected in Step I and Step II, potentially leading to characterization of the substrate soils beneath the retrieved RSW.

The Step I soil-vapor sampling will be conducted before waste retrieval. The Step II and Step III sampling to characterize the surface of the trench floor, vadose zone soils, and substrate soils will be conducted when the entire RSW portion of the trench has become accessible and sampling activities will not interfere with waste retrieval operations.

Changes to the work scope detailed in the SAP may be required because of unexpected field conditions, new information, health and safety concerns, waste left in place, or other unforeseen conditions. Minor changes that have no adverse effect on the technical adequacy of the job (i.e., on the DQOs) or schedule can be made in the field with approval by the project manager or assigned task lead and can be documented in the daily field logbook and/or field summary reports. Changes that affect DQOs will require concurrence by the U.S. Department of Energy, Richland Operations Office, and the lead regulatory agency and can be documented through unit managers' meetings. Alternatively, if substantial changes are required, the SAP can be revised with U.S. Department of Energy, Richland Operations Office, and regulator approval.

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2.0 QUALITY ASSURANCE PROJECT PLAN

The quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection, including sampling, field measurements, and laboratory analysis. The QAPjP complies with the requirements of the following:

- *Hanford Federal Facility Agreement and Consent Order Action Plan*, Sections 6.5, "Quality Assurance," and 7.8, "Quality Assurance" (Ecology et al. 1989b), as applicable
- EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans* (EPA QA/R-5), March 2001 as revised
- EPA/240/R-02/009, *Guidance for Quality Assurance Project Plans* (EPA QA/G-5), December 2002 as revised
- SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update III-A*, as amended
- DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Documents*.

To meet the site-specific needs for the 218-E-12B Burial Ground sampling and analysis investigation in response to the Tri-Party Agreement Interim Milestone M-91-40, Requirement 2 (Ecology et al. 1989a), this QAPjP includes the following elements, which were developed during the DQO process. The additional QAPjP elements required by EPA QA/R-5 are addressed in the companion DQO summary report WMP-20379 or in other sections of this SAP. A matrix that shows how the EPA QA/R-5 required elements are addressed is provided as Appendix B to this SAP.

- **Analytical Performance**. Requirements for detection limits, precision, and accuracy are presented in Section 2.1.
- **Field Quality Control**. The frequency and type of quality control (QC) samples to be collected are addressed in Section 2.2.
- **Sample Preservation, Containers, and Holding Time**. The requirements for the specific test and laboratory methods are addressed in Section 2.3.
- **Onsite Measurements Quality Control**. The specific types of QC samples for onsite measurements and the frequency of collection are addressed in Section 2.4.
- **Data Management**. The processes use to manage the data generated as a result of the activities described in this SAP are described in Section 2.5.
- **Data Validation and Usability**. Specific validation requirements, including the frequency and level of validation, are addressed in Sections 2.6 and 2.7.

- **System and Performance Assessments, Frequency, and Corrective Actions**. The processes for conducting system and performance assessments and corrective actions are found in Section 2.8.

- **Technical Specifications**. The technical specifications relevant to sample collection (e.g., sample containers, field documentation, etc.) are found in Section 2.9.

2.1 ANALYTICAL PERFORMANCE REQUIREMENTS

The applicable analytical methods and the associated requirements for detection limits, precision, and accuracy are presented in Tables 2-1 and 2-2. The requirements for laboratory instrument calibration and frequency are specified in the analytical methods referenced in the tables or in statements of work provided to the laboratories before sample shipment.

2.2 FIELD QUALITY CONTROL

Field QC samples are collected to evaluate homogeneity, the potential for cross contamination, and laboratory performance. Field QC for sampling at the 218-E-12B Burial Ground trenches will differ depending on the type of sampling being conducted. Field QC includes collecting duplicate, field-split, equipment-blank, and trip-blank samples.

For passive soil-vapor samples and vadose zone active soil-vapor samples collected in Tedlar[3] bags or SUMMA[4] canisters for analysis, field QC will require the collection of duplicate samples and equipment-blank samples. For vadose zone active soil-vapor samples drawn directly into the field-screening instrument for analysis, field QC will require analysis of duplicate samples.

For soil samples, field QC will require the collection of duplicate samples, field-split samples, and equipment-blank and trip-blank samples.

2.2.1 Duplicates

For passive soil-vapor samples collected on sorbent media, duplicates are defined as two individual samplers placed in the same sample collection location and exposed to soil vapor over the same time interval. These samples will be collected to evaluate variability of the sample collection and analytical methodology by comparing two analyses of sample collection media exposed to equivalent conditions.

For vadose zone soil-vapor samples collected in Tedlar bags, duplicates are defined as samples collected with enough volume to permit two separate analyses, performed sequentially using the same analytical equipment. These samples will be collected to evaluate performance of the analytical methodology by comparing two analyses of the vapor concentration in one Tedlar bag.

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[3]Tedlar is a registered trademark of E. I. du Pont de Nemours and Company, Wilmington, Delaware.

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

Table 2-1. Analytical Performance Requirements for Soil-Vapor Samples. (3 Pages)

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

Table 2-1. Analytical Performance Requirements for Soil-Vapor Samples. (3 Pages)

Contaminant of Concern	Chemical Abstracts Service #	Preliminary Action Level[a]		Name/Analytical Technology	Target Required Quantitation Limits	Precision Vapor[f] (%)	Accuracy Vapor (%)
		TBD Industrial (mg/kg)	GW Protection (mg/kg)		Vapor		
Ethyl chloride (Chloroethane)	75-00-3	N/A	N/A	MIRAN SapphiIRe Ambient Air Analyzer	1 ppmv	+/- 25	75 - 125
Ethylene dichloride (1,2-dichloroethane)	107-06-2	N/A	N/A	MIRAN SapphiIRe Ambient Air Analyzer	0.7 ppmv	+/- 25	75 - 125
Methane	74-82-8	N/A	N/A	MIRAN SapphiIRe Ambient Air Analyzer	1.5 ppmv	+/- 25	75 - 125
Methyl chloride (Chloromethane)	74-87-3	N/A	N/A	MIRAN SapphiIRe Ambient Air Analyzer	1.7 ppmv	+/- 25	75 - 125
Methyl chloroform (1,1,1-Trichloroethane)	71-55-6	N/A	N/A	MIRAN SapphiIRe Ambient Air Analyzer	0.15 ppmv	+/- 25	75 - 125
Methyl ethyl ketone (2-butanone)	78-93-3	N/A	N/A	MIRAN SapphiIRe Ambient Air Analyzer	1.6 ppmv	+/- 25	75 - 125
Methyl isobutyl ketone (4-methyl-2-pentanone)	108-10-1	N/A	N/A	MIRAN SapphiIRe Ambient Air Analyzer	0.35 ppmv	+/- 25	75 - 125
Styrene	100-42-5	N/A	N/A	MIRAN SapphiIRe Ambient Air Analyzer	0.6 ppmv	+/- 25	75 - 125
Toluene	108-88-3	N/A	N/A	MIRAN SapphiIRe Ambient Air Analyzer	1 ppmv	+/- 25	75 - 125
1,1,2,2-tetrachloroethane	79-34-5	N/A	N/A	MIRAN SapphiIRe Ambient Air Analyzer	0.25 ppmv	+/- 25	75 - 125
Vinyl chloride	75-01-4	N/A	N/A	MIRAN SapphiIRe Ambient Air Analyzer	0.6 ppmv	+/- 25	75 - 125
Vinylidene chloride (1,1-dichloroethene)	75-35-4	N/A	N/A	MIRAN SapphiIRe Ambient Air Analyzer	0.2 ppmv	+/- 25	75 - 125
Xylene	1330-20-7	N/A	N/A	MIRAN SapphiIRe Ambient Air Analyzer	1.3 ppmv	+/- 25	75 - 125

Table 2-1. Analytical Performance Requirements for Soil-Vapor Samples. (3 Pages)

Contaminant of Concern	Chemical Abstracts Service #	Preliminary Action Level[a]		Name/Analytical Technology	Target Required Quantitation Limits	Precision Vapor[f] (%)	Accuracy Vapor (%)
		TBD Industrial (mg/kg)	GW Protection (mg/kg)		Vapor		
Laboratory Measurements							
1,1-dichloroethane	75-34-3	N/A	N/A	Passive soil-vapor analysis using SW-846 Methods 5041A and 8260B	2 to 5 ng/volume of absorbent	+/- 25	70 – 130
1,2-dichloroethane	107-06-2						
1,4-dichlorobenzene	106-46-7						
Benzene	71-43-2						
Carbon tetrachloride	56-23-5						
Chlorobenzene	108-90-7						
Chloroform	67-66-3						
cis-1,2-dichloroethene	156-59-2						
Ethylbenzene	100-41-4						
Toluene	108-88-3						
Tetrachloroethene	127-18-4						
trans-1,2-dichloroethene	156-60-5						
Trichloroethene	79-01-6						
Xylene	1330-20-7						
Full suite of VOCs	Compound-specific	N/A	N/A	Active soil-vapor analysis using Method TO-14 (EPA 600/4-89/017), TO-15 (EPA 625/R-96-010b), or SW-846 Method 8260B.	2 to 5 ppbv	+/- 25	70 – 130

[a]The preliminary action levels are N/A for this study (as noted in WMP-20379).

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

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

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

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

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

EPA 600/4-89/017, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air.*

EPA 625/R-96-010b, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition.*

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

WMP-20379, *Data Quality Objectives Summary Report for the 218-E-12B Burial Ground Contaminant Release Investigation.*

GW = groundwater.
N/A = not applicable.
ppbv = parts per billion by volume.
ppmv = parts per million by volume.
TBD = to be determined.
VOC = volatile organic compound.

Table 2-2. Analytical Performance Requirements for Soil Samples. (4 Pages)

Contaminant of Concern	Chemical Abstracts Service #	Preliminary Action Level[a]		Name/Analytical Technology	Target Required Quantitation Limits		Precision Water (%)	Accuracy Water (%)	Precision Soil (%)	Accuracy Soil (%)
		TBC Industrial (pCi/g or mg/kg)	GW Protection (pCi/g or mg/kg)		Water[b] Conc. (pCi/L or mg/L)	Soil-Other Conc. (pCi/g or mg/kg)				
Field-Screening Measurements – Radionuclides[c]										
Am-241	N/A	N/A	N/A	PG-2 NaI detector	N/A	5 pCi/g	N/A	N/A	±20	80-120
Gamma-emitting Radionuclides	N/A	N/A	N/A	Portable NaI detector	N/A	6.2 pCi/g	N/A	N/A	±20	80-120
Gross alpha	N/A	N/A	N/A	SHP380-AB Probe DP6DB Probe	N/A	90 dpm/100 cm^2 (fixed) 20 dpm/100 cm^2 (removable)	N/A	N/A	±20	80-120
Laboratory Measurements – Radionuclides[c]										
Americium-241	14596-10-2	22,400	TBD	Americium isotopic – Am AEA	1	1	±20	80-120	±35	65-135
Cesium-137	10045-97-3	156	TBD	GEA	15	0.1	±20	80-120	±35	65-135
Cobalt-60	10198-40-0	32.8	TBD	GEA	25	0.05	±20	80-120	±35	65-135
Europium-152	14683-23-9	78	TBD	GEA	50	0.1	±20	80-120	±35	65-135
Europium-154	15585-10-1	6.8	TBD	GEA	50	0.1	±20	80-120	±35	65-135
Europium-155	14391-16-3	2,840	TBD	GEA	50	0.1	±20	80-120	±35	65-135
Nickel-63	13981-37-8	4,026	TBD	Nickel-63 – liquid scintillation	15	30	±20	80-120	±35	65-135
Plutonium-238	13981-16-3	3,140	TBD	Plutonium isotopic – Pu AEA	1	1	±20	80-120	±35	65-135
Plutonium-239/240	Pu-239/240	2,840	TBD	Plutonium isotopic – Pu AEA	1	1	±20	80-120	±35	65-135
Strontium-90	Rad-Sr	16,060	TBD	Total radioactive strontium – GPC	2	1	±20	80-120	±35	65-135
Technetium-99	14133-76-7	2,740,000	TBD	Technetium-99 – liquid scintillation	15	15	±20	80-120	±35	65-135

Table 2-2. Analytical Performance Requirements for Soil Samples. (4 Pages)

Contaminant of Concern	Chemical Abstracts Service #	Preliminary Action Level[a]		Name/Analytical Technology	Target Required Quantitation Limits		Precision Water (%)	Accuracy Water (%)	Precision Soil (%)	Accuracy Soil (%)
		TBC Industrial (pCi/g or mg/kg)	GW Protection (pCi/g or mg/kg)		Water[b] Conc. (pCi/L or mg/L)	Soil-Other Conc. (pCi/g or mg/kg)				
Uranium-234	13966-29-5	17,760	TBD	Uranium isotopic – U AEA	1	1	±20	80-120	±35	65-135
Uranium-235	15117-96-1	674	TBD	Uranium isotopic – U AEA	1	1	±20	80-120	±35	65-135
Uranium-238	U-238	3,360	TBD	Uranium isotopic – U AEA	1	1	±20	80-120	±35	65-135
Laboratory Measurements – Metals										
Antimony	7440-36-0	1,400	5.42	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP/MS)	0.06	6	+/- 30	70 - 130	+/- 30	70 - 130
Arsenic	7440-38-2	87.5	20[d]	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP/MS)	0.1	10	+/- 30	70 - 130	+/- 30	70 - 130
Barium	7440-39-3	245,000	923	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP)	0.2	20	+/- 30	70 - 130	+/- 30	70 - 130
Beryllium	7440-41-7	7,000	63.2	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP/MS)	0.005	0.5	+/- 30	70 - 130	+/- 30	70 - 130
Cadmium	7440-43-9	3,500	0.81[d]	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP/MS)	0.005	0.5	+/- 30	70 - 130	+/- 30	70 - 130
Chromium	7440-47-3	Unlimited	2,000	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP/MS)	0.01	1	+/- 30	70 - 130	+/- 30	70 - 130
Copper	7440-50-8	130,000	22[d]	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP/MS)	0.01	1	+/- 30	70 - 130	+/- 30	70 - 130
Lead	7439-92-1	Unlimited	840	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP/MS)	0.1	10	+/- 30	70 - 130	+/- 30	70 - 130
Manganese	7439-96-5	490,000	50.2	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP/MS)	0.05	5	+/- 30	70 - 130	+/- 30	70 - 130
Nickel	7440-02-0	70,000[f]	130.4	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP/MS)	0.04	4	+/- 30	70 - 130	+/- 30	70 - 130

Table 2-2. Analytical Performance Requirements for Soil Samples. (4 Pages)

Contaminant of Concern	Chemical Abstracts Service #	Preliminary Action Level[a]		Name/Analytical Technology	Target Required Quantitation Limits		Precision Water (%)	Accuracy Water (%)	Precision Soil (%)	Accuracy Soil (%)
		TBC Industrial (pCi/g or mg/kg)	GW Protection (pCi/g or mg/kg)		Water[b] Conc. (pCi/L or mg/L)	Soil-Other Conc. (pCi/g or mg/kg)				
Selenium	7782-49-2	17,500	1[g]	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP/MS)	0.1	10	+/- 30	70 - 130	+/- 30	70 - 130
Silver	7440-22-4	17,500	0.884	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP/MS)	0.02	2	+/- 30	70 - 130	+/- 30	70 - 130
Vanadium	7440-62-2	24,500	2,240	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP/MS)	0.025	2.5	+/- 30	70 - 130	+/- 30	70 - 130
Zinc	7440-66-6	Unlimited	226	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP/MS)	0.01	1	+/- 30	70 - 130	+/- 30	70 - 130
Mercury	7439-97-6	1,050	0.33[g]	SW-846 Method 7471A (CVAA) or EPA Method 200.8 (ICP/MS)	N/A	0.20	N/A	N/A	+/- 30	70 - 130
Mercury	7439-97-6	1,050	0.33[g]	SW-846 Method 7470A (CVAA) or EPA Method 200.8 (ICP/MS)	0.0005	N/A	+/- 30	70 - 130	N/A	N/A

Table 2-2. Analytical Performance Requirements for Soil Samples. (4 Pages)

Contaminant of Concern	Chemical Abstracts Service #	Preliminary Action Level[a]		Name/Analytical Technology	Target Required Quantitation Limits		Precision Water (%)	Accuracy Water (%)	Precision Soil (%)	Accuracy Soil (%)
		TBC Industrial (pCi/g or mg/kg)	GW Protection (pCi/g or mg/kg)		Water[b] Conc. (pCi/L or mg/L)	Soil-Other Conc. (pCi/g or mg/kg)				
Laboratory Measurements – Semivolatile Organics										
Full suite of SVOCs	Compound-specific	Compound-specific[e]	Compound-specific[e]	SW-846 Method 8270C	0.02	0.33 to 0.85[h]	+/- 30[f]	70 – 130[f]	+/- 30[f]	70 – 130[f]
Laboratory Measurements – Volatile Organics										
Full suite of VOCs	Compound-specific	Compound-specific[e]	Compound-specific[e]	SW-846 Method 8260B[i]	0.005	0.005 to 0.05[h]	+/- 30[f]	70 – 130[f]	+/- 30[f]	70 – 130[f]

[a]The preliminary action levels for nonradionuclides are consistent with guidance contained in CLARC tables (Ecology 94-145) or risk based values used to determine the appropriate analytical requirements (target required quantitation limits). The preliminary action levels for radionuclides are based on 100 mrem/yr above background and are used to determine appropriate analytical requirements.

[b]Water values for sampling quality control (e.g., equipment blanks/rinses) or drainable liquid (if recovered).

[c]Radiological contaminants of concern pertain to CERCLA activities only.

[d]Table 740-1 of WAC 173-340-900, "Tables."

[e]No action levels are specified for general groupings of compounds; action levels are compound-specific.

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

[g]Background value.

[h]Values shown are "nominal" compound-specific minimums and maximums. Most constituents will be within the given range. A limited number would have higher detection limits Individual compounds will be evaluated against established laboratory contractual agreements (based on U.S. Environmental Protection Agency guidance documents).

[i]SW-846 Method 5035A will be used as appropriate for VOC sampling and preservation.

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

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

EPA/600/R-94/111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1.*

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

AEA = alpha energy analysis.
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
CLARC = cleanup levels and risk calculations.
CVAA = cold vapor atomic absorption.
dpm = disintegrations per minute.
EPA = U.S. Environmental Protection Agency.
GEA = gamma energy analysis.
GPC = gas proportional counting.
GW = groundwater.
ICP = inductively coupled plasma.
ICP/MS = inductively coupled plasma/mass spectrometry.
N/A = not applicable.
SVOC = semivolatile organic compound.
TBC = to be considered.
TBD = to be determined.
VOC = volatile organic compound.

For vadose zone soil-vapor samples drawn directly into the field-screening instrument for analysis, duplicates are defined as two separate analyses, performed sequentially, using the same analytical equipment.

At least 5 percent of the total collected soil-vapor samples will be duplicated (i.e., 1 field duplicate will be analyzed for every 20 samples or, at a minimum, 1 duplicate per day). The duplicate samples will be designated during the field analyses. Where feasible, duplicates will be selected after the initial sample is analyzed and shown to contain detectable concentrations of VOCs, so that valid comparisons between the analyses can be made (i.e., concentrations will be above the detection limit).

The following strategy will be used for analyzing duplicate Tedlar bag samples and duplicate samples drawn directly into the field-screening instrument. One sample in every 20 samples will be analyzed sequentially as a sample and then as a duplicate sample. The first sample in the 20-sample group with detectable VOCs will provide the duplicate sample for that 20-sample group. If a second sample in the 20-sample group has a significantly higher VOC concentration, it also may be analyzed as a duplicate sample. If the first 19 samples in the 20-sample group have no detectable VOCs, the 20th sample will be used as the duplicate.

For vadose zone soil-vapor samples collected in SUMMA canisters, duplicates are defined as independent samples collected as close as possible to the same point in space and time, taken from the same source, stored in separate containers, and analyzed independently (i.e., not homogenized). One duplicate sample will be collected for every 20 samples collected or, at a minimum, 1 duplicate per day of the SUMMA-canister sample collection.

For soil samples, duplicates are defined in the same way as for vapor samples collected in SUMMA canisters. Duplicate samples are useful in evaluating the degree of inhomogeneity in the soil. One duplicate sample will be collected during soil sampling. Generally, the duplicates should be collected from areas that are expected to have some contamination so that valid comparisons can be made between the samples (i.e., at least some of the COCs will be above the detection limit).

2.2.2 Field Splits

Field split samples are used to provide an estimate of the overall variability in the measurement system (i.e., from sample collection through analysis). Field split samples will be collected for soil samples only. One field split sample will be collected for every 20 samples. All split samples will be retrieved from the same sample interval using the same equipment (e.g., collected from one split spoon). Samples shall be homogenized, split into two separate aliquots in the field, and sent to two independent laboratories. Field splits should be collected from a zone that is contaminated. Zones of potential contamination will be determined by evaluating data collected during Step I and Step II characterization (WMP-20379), maximizing the potential for meaningful duplicate analysis results.

2.2.3 Equipment Blanks

Equipment blanks will be collected at the same frequency that the duplicate samples were collected, where applicable, and will be used to verify the adequacy of sampling equipment decontamination procedures.

For passive soil-vapor samples collected on sorbent media, no equipment blanks will be collected. The sampling kits containing the collection media are provided in containers that protect the media from the environment until they are opened and the media are immediately placed in the sampling location. Thus, there is no decontamination procedure requiring evaluation, and the sample collection media contact no sampling equipment requiring the type of evaluation available through the use of equipment blanks.

A Tedlar bag might be re-used if the additional sample(s) is to be collected from the same location and depth as the previous sample(s), and/or if no contaminants were detected in the previous sample(s), and if the bag is in good condition. If the Tedlar bag is to be re-used, it will be cleaned by filling and emptying it with atmospheric air a minimum of three times. The cleaned Tedlar bags will be filled with certified clean air and analyzed to ensure that the Tedlar bag material is not responsible for VOC cross contamination. Equipment blanks shall be analyzed for COCs identified for soil vapor (Table 1-3) collected in Tedlar bags.

For vadose zone soil-vapor samples drawn directly into the field-screening instrument for analysis, no equipment blanks will be collected.

SUMMA canisters are cleaned by the analytical laboratory. At the laboratory, cleaned SUMMA canisters will be filled with certified clean air and analyzed for cleanliness. These cleaning batch certification analyses will serve as equipment blanks and will be analyzed for VOCs. At least 10 percent of the cleaned, evacuated SUMMA canisters will be checked for cleanliness.

For soil samples, the equipment blanks shall consist of pure deionized water washed through decontaminated sampling equipment and placed in containers identical to those used for actual field samples. Equipment blanks shall be analyzed for COCs identified for soils (Table 1-3).

2.2.4 Trip Blanks

Trip blanks are prepared as a check for possible contamination originating from container preparation methods, shipment, handling, storage, or site conditions. A trip blank will be prepared for each batch (cooler) of soil sample containers shipped. The trip blank shall consist of pure deionized water added to clean sample containers. These containers will be transported to the field with the bottle sets and will be returned unopened to the laboratory. The trip blanks will be analyzed for VOCs only.

For passive soil-gas samples collected on sorbent media, one unused sampler will be opened and immediately placed in the container provided for post-sample collection transport to the laboratory. The unused media will be sent to the laboratory for analysis to check for contamination that may occur during sample transport.

Trip blanks are not required to accompany the SUMMA canister or Tedlar bag samples. The SUMMA canisters will be cleaned, evacuated, and sealed using a valve before sampling, and resealed using a valve following sampling. The Tedlar bags will be analyzed in the field, negating the value of a trip blank. If Tedlar bags are sent to a laboratory for analysis (because field analysis instrumentation is unavailable), the equipment blanks collected will serve the purpose of the trip blank.

2.3 SAMPLE PRESERVATION, CONTAINERS, AND HOLDING TIMES

Sample preservation, containers, and holding times are presented in Tables 2-3 and 2-4 for vapor and soil-vapor samples and in Table 2-5 for soil samples. Final sample collection requirements will be identified on the Sampling Authorization Form.

Table 2-3. Vapor Sample Preservation, Container, and Holding Time Guidelines for Field Screening.

Analytes	Analytical Priority	Matrix	Tedlar Bag[a]		Preservation	Packing Requirements	Holding Time
			Number	Volume[b]			
Volatile Organic Compounds							
VOCs	1	Vapor	TBD	1 L	N/A	N/A	6 hours

[a]Tedlar is a registered trademark of E. I. du Pont de Nemours and Company, Wilmington, Delaware.
[b]These are optimal volumes, which may be adjusted downward to accommodate the possibility of small sample recoveries. Minimum sample size will be defined on the Sampling Authorization Form.
N/A = not applicable.
TBD = to be determined.
VOC = volatile organic compound.

Table 2-4. Vapor Sample Preservation, Container, and Holding Time Guidelines for Laboratory Analyses.

Analytes	Analytical Priority	Matrix	SUMMA Canister[a]		Preservation	Packing Requirements	Holding Time
			Number	Volume[b]			
Volatile Organic Compounds							
VOCs	1	Vapor	TBD	6 L	Ambient temperature, at or near atmospheric pressure	N/A	14-28 days
NOTE: Passive soil-vapor samples will be collected using the EMFLUX[c] or GORE-SORBER[d] technology. The sampling will be conducted according to the vendor's instructions. In both cases, the vendor supplies the samplers. Soil vapor is collected on solid adsorbent material while the samplers are placed in the soil. The samplers are then sent back to the vendor for analysis.							

[a]SUMMA is a registered trademark of Moletrics, Inc., Cleveland, Ohio.
[b]This is the typical volume applicable to SUMMA canister sample collection (if used). A vacuum is applied to the SUMMA canisters in a laboratory, and they are shipped to the field with this negative pressure. Active soil-gas samples are drawn into the canister by opening a valve and allowing gas to replace the vacuum. Thus, a volume of gas is contained in the SUMMA canister after collection. Minimum sample size will be defined on the Sampling Authorization Form.
[c]EMFLUX is a registered trademark of Beacon Environmental Services, Inc., Bel Air, Maryland.
[d]GORE-SORBER is a registered trademark of W. L. Gore and Associates, San Francisco, California.
N/A = not applicable.
TBD = to be determined.
VOC = volatile organic compound.

Table 2-5. Soil Sample Preservation, Container, and Holding Time Guidelines for Laboratory Analysis.

Analytes	Analytical Priority	Matrix	Bottle		Amount[a,b]	Preservation	Packing Requirements	Holding Time
			Number	Type				
Chemicals								
Metals (6010B or 200.8)	3	Soil	1	G/P	10-500 g	None	None	6 months
Mercury (7471A or 200.8)	4	Soil	1	G	5-125 g	None	Cool 4°C	28 days
VOC (8260B)	1	Soil	3	40 mL AG	200 g	None	Cool 4°C	14 days
SVOC (8270C)	2	Soil	1	AG	125-1000 g	None	Cool 4°C	14/40 days
Radionuclides								
Americium isotopic (AEA)	5	Soil	1	G/P	5 g	None	None	6 months
Uranium isotopic (AEA)	5	Soil	1	G/P	5 g	None	None	6 months
Plutonium isotopic (AEA)	5	Soil	1	G/P	5 g	None	None	6 months
Cesium-137 (GEA)	5	Soil	1	G/P	500 g	None	None	6 months
Cobalt-60 (GEA)	5	Soil	1	G/P	500 g	None	None	6 months
Europium-152 (GEA)	5	Soil	1	G/P	500 g	None	None	6 months
Europium-154 (GEA)	5	Soil	1	G/P	500 g	None	None	6 months
Europium-155 (GEA)	5	Soil	1	G/P	500 g	None	None	6 months
Nickel-63 (LSC)	5	Soil	1	G/P	10 g	None	None	6 months
Total radioactive strontium (GPC)	5	Soil	1	G/P	25 g	None	None	6 months
Technetium-99 (LSC)	5	Soil	1	G/P	10 g	None	None	6 months

[a]These are optimal volumes, which may be adjusted downward to accommodate the possibility of retrieving a small amount of sample.

[b]Soil samples that are submitted to the analytical laboratory for analyses for specific analytes require a minimum of a 10 g soil sample for all 6010B analyses, a 5 g sample (which may be included in the same bottle as those for 6010B analysis) for 7471A analyses, a 30 g sample for 8260B analyses, and a 125 g soil sample for 8270C analyses.

EPA Method 200.8 is found in EPA/600/R-94/111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*.

Four-digit EPA methods are found in SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update III-A*.

AEA = alpha energy analysis.
AG = amber glass.
EPA = U.S. Environmental Protection Agency.
G = glass.
GEA = gamma energy analysis.
GPC = gas proportional counting.
LSC = liquid scintillation counting.
P = plastic.
SVOC = semivolatile organic compound.
VOC = volatile organic compound.

2.4 ONSITE MEASUREMENTS QUALITY CONTROL

The collection of QC samples applies to the soil-vapor samples and soil samples described in this plan. Field-screening instrumentation will be calibrated, maintained, and controlled according to approved procedures.

2.5 DATA MANAGEMENT

Data resulting from the implementation of this QAPjP will be managed and stored by the Fluor Hanford, Inc., organization responsible for sampling and characterization, in accordance with applicable data management procedures. At the direction of the task lead, all analytical data packages will be subject to final technical review by qualified personnel before being submitted to regulatory agencies or included in reports. Electronic data access, when appropriate, will be via a database (e.g., *Hanford Environmental Information System* [HEIS] or a project-specific database). Where electronic data are not available, hard copies will be provided in accordance with Section 9.6 of the Tri-Party Agreement (Ecology et al. 1989a).

2.6 VALIDATION AND VERIFICATION REQUIREMENT

Data verification and validation are performed on analytical data sets primarily to confirm that sampling and chain-of-custody documentation are complete, sample numbers can be associated with the specific sampling locations, samples were analyzed within the required holding times, and analyses met the data quality requirements specified in the DQO summary report (WMP-20379). For soil samples, data verification and validation will be conducted to level C as defined in HNF-20433, *Data Validation Procedure for Chemical Analyses*, and HNF-20434, *Data Validation Procedure for Radiochemical Analyses*. Validation will be performed on a minimum of one completed data package or 10 percent of the data by a qualified data validator. A copy of the validated data package will be provided to the Washington State Department of Ecology following completion of the data validation process. Formal data validation will not be performed on field-screening analytical results. For field-screening data, the data will be reviewed to ensure that they are usable.

2.7 DATA QUALITY ASSESSMENT

The data quality assessment (DQA) process is used to determine whether or not the data meet the project DQOs. Additional steps of the DQA process involve data plotting, testing for outlying data points, and statistical hypothesis testing relative to the null and alternative hypotheses stated in the DQOs. When statistical sampling designs are used, the outcome of the DQA process is a statement that the statistical hypothesis testing suggests that the null hypothesis is accurate, that the null hypothesis has been rejected, or that not enough data exist to make a determinative conclusion based on the hypothesis test used. In the latter case, either additional data must be collected to support the statistical hypothesis testing or the data user must make a decision with higher uncertainty than the desired levels expressed in the DQOs.

The DQA chemists and statisticians recognize that data that are flagged during the data validation process are not necessarily invalid. Flagged data are reviewed during the DQA process to determine whether the validation flags affect the intended use of the data. During the DQA activity for the data generated during characterization of the 218-E-12B Burial Ground, the determination of whether or not any flagged data are recommended for use will be documented in the DQA report.

2.8 SYSTEM AND PERFORMANCE ASSESSMENTS, FREQUENCY, AND CORRECTIVE ACTIONS

All sampling, field analytical, and laboratory analytical services required by this SAP will be performed in accordance with DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD). The HASQARD specifies the quality principles, practices, and procedures for Fluor Hanford, Inc., and the subcontracted entities that provide sampling and analytical services. The Fluor Hanford, Inc., Waste Disposal/Groundwater Remediation Project will ensure that field analytical and sampling services are assessed and evaluated in accordance with the HASQARD and Groundwater Remediation Project quality assurance requirements. Laboratory analytical services will be assessed in accordance with HASQARD as part of the scheduled HASQARD Integrated Contractor Audit Team assessment or HASQARD-equivalent U.S. Department of Energy audits for laboratories providing services under this SAP.

2.8.1 System and Performance Assessments

A system assessment is an evaluation of an entire system to ensure that it will meet the project requirements. An example of a system assessment is an onsite laboratory audit that ensures that the sample receiving, sample storage, sample analysis, data reduction, and documentation procedures used at the laboratory will meet the requirements of the project. A performance assessment is the evaluation of the performance of one aspect of a system. An example of a performance assessment is the insertion of performance evaluation samples to test the laboratory system. Performance evaluation samples are samples containing analytes of interest at known concentrations. Neither a system assessment nor a performance assessment will be performed as part of this project except as noted previously. However, both the project and the analytical laboratory will comply with systems in place for these types of assessments.

2.8.2 Corrective Action

Corrective-action procedures are implemented whenever sampling, field monitoring, or laboratory analysis results do not meet the required quality assurance/QC standards. The types of corrective action that apply to environmental analysis are laboratory corrective actions and field corrective actions.

2.8.2.1 Laboratory Corrective Action

Laboratories providing analytical services in support of this SAP will be responsible for establishing a corrective action program that is consistent with the requirements of HASQARD. Corrective action processes that shall be addressed by the laboratory include the following:

- Evaluation of impacts of laboratory QC failures on data quality
- Root cause analysis of QC failures
- Evaluation of recurring conditions that are adverse to quality
- Trend analysis of quality-affecting problems
- Implementation of a quality improvement process
- Control of nonconforming materials that may affect data quality.

Implementation of these corrective action processes will be evaluated as part of the yearly HASQARD Integrated Contractor Audit Team assessment or HASQARD-equivalent U.S. Department of Energy audits of laboratories providing services under this SAP.

2.8.2.2 Field Corrective Action

The field team leader and project manager are responsible for ensuring that all field procedures are followed completely and that field personnel are trained adequately. The field team leader and the project manager must document situations that may impair the usability of the samples and/or data in the field logbook or nonconformance report forms in accordance with internal corrective action procedures, as appropriate. The field team leader will note any deviations from the standard procedures for sample collection, COCs, sample transport, or monitoring that occurs. The field team leader also will be responsible for coordinating all activities relating to the use of field monitoring equipment, such as dosimeters and industrial hygiene equipment. Field personnel will document in the logbook all noncompliant measurements taken during field sampling. Ultimately, the project manager, or the field team leader at the discretion of the project manager, will be responsible for communicating field corrective action procedures, for documenting all deviations from procedure, and for ensuring that immediate corrective actions are applied to field activities. Problems with sample collection, custody, or data acquisition that adversely impact the quality of data or that impair the ability to acquire data, or failure to follow procedure, shall be documented in accordance with internal corrective action procedures as appropriate.

2.8.3 Reports to Management

Reports to management on data quality issues will be made if and when these issues are identified. These issues will be reported by laboratory personnel to the project manager. Subsequently, standard reporting protocols (e.g., project status reports) will be used to communicate these issues to management. Because no performance or system assessments are planned as part of this activity, the project manager will not be providing audit or assessment reports to management for this activity unless an unanticipated request is made to conduct such an assessment. At the end of the project, a DQA will be prepared to evaluate whether the type, quality, and quantity of data that were collected meet the intent of the DQO and SAP.

2.9 TECHNICAL SPECIFICATIONS

Sampling and field measurements will be conducted in accordance with the following technical specifications.

2.9.1 Sample Location

Sample locations for soil-vapor sampling will be staked and labeled before the activity is started. Sampling locations will be staked by the technical lead or field team leader assigned to the sampling activities described in this SAP. After the locations have been staked, minor adjustments to the location may be made to mitigate unsafe conditions, avoid structural

interferences, and bypass utilities. Locations will be identified during or after sampling following approved procedures. Changes in sample locations that do not affect the DQOs will require approval of the Fluor Hanford, Inc., project manager for this SAP. However, changes to sample locations that result in impacts to the DQOs will require decision-maker concurrence.

2.9.2 Sample Identification

The Fluor Hanford, Inc., Sample and Data Tracking database will be used to track the samples through the collection and laboratory analysis process. The HEIS database is the repository for the laboratory analytical results. The HEIS sample numbers will be issued to the sampling organization for this project in accordance with approved procedures. Samples tracked through HEIS will be identified and labeled with a unique HEIS sample number. The sample location, depth, and corresponding HEIS numbers are documented in the sampler's field logbook.

Sample containers are labeled with the following information using a waterproof marker on firmly affixed, water-resistant labels:

- Sampling Authorization Form number
- HEIS number
- Sample collection date and time
- Name or initials of person collecting the sample
- Analysis required.

2.9.3 Field Sampling Log

The sampling team will be responsible for recording all information pertinent to field sampling and analysis in bound logbooks in accordance with approved procedures. Logbook entries will be dated and signed by the individual making the entry.

2.9.4 Sample Custody

Chain-of-custody procedures will be followed throughout sample collection, transfer, analysis, and disposal in accordance with approved procedures to ensure that sample integrity is maintained. Each time responsibility for custody of the sample changes, the new and previous custodians will sign a record and note the date and time.

2.9.5 Sample Containers

Tedlar bags (1 L capacity), and SUMMA canisters will be used for collecting the soil-vapor samples identified in this SAP, as noted in Tables 2-3 and 2-4. Passive soil-vapor samples will be collected on adsorbent media. After sample collection, all gas prefilters used will be surveyed. In addition, Tedlar bags and SUMMA canisters that are filled inside of surface contamination areas will be surveyed externally for contamination. Container requirements for potential soil samples are specified in Table 2-5. Based on the amount of sample that can be

obtained using proposed sampling techniques, bottle size requirements could vary. Final types and volumes to be used for vapor and soil will be listed on the Sampling Authorization Form.

2.9.6 Inspection/Acceptance Requirements for Supplies and Consumables

Sample containers will be obtained from vendors who certify that the cleaning protocol used is appropriate for the analyses to be performed on the sample. Inspection and acceptance of these items will be documented in field logbooks or, when the manufacturer provides certifications, maintained in project files to ensure the availability of these records.

3.0 FIELD SAMPLING PLAN

3.1 SAMPLING OBJECTIVES

The objective of these sampling and analysis activities is to determine whether a release of contaminants to the substrate soil has occurred in the 218-E-12B Burial Ground. The field sampling plan is based on the sampling design developed during the DQO process (WMP-20379) and describes the pertinent elements of the sampling program. This section identifies, to the extent possible, sample methods, locations, frequencies, analytes of interest, and container requirements.

The primary use of the data acquired through the sampling design developed in this report is defined in the Tri-Party Agreement Interim Milestone M-91-40, Requirement 2 (Ecology et al. 1989a). Other potential uses for the data include developing the 200-SW-2 Operable Unit preliminary conceptual contaminant-distribution models and evaluating the risk assessment remedial action alternatives and remedial action decisions.

This sampling design applies only to those portions of the trenches in which RSW was placed.

A three-step sampling design has been developed for this project. The three steps in this sampling design are as follows.

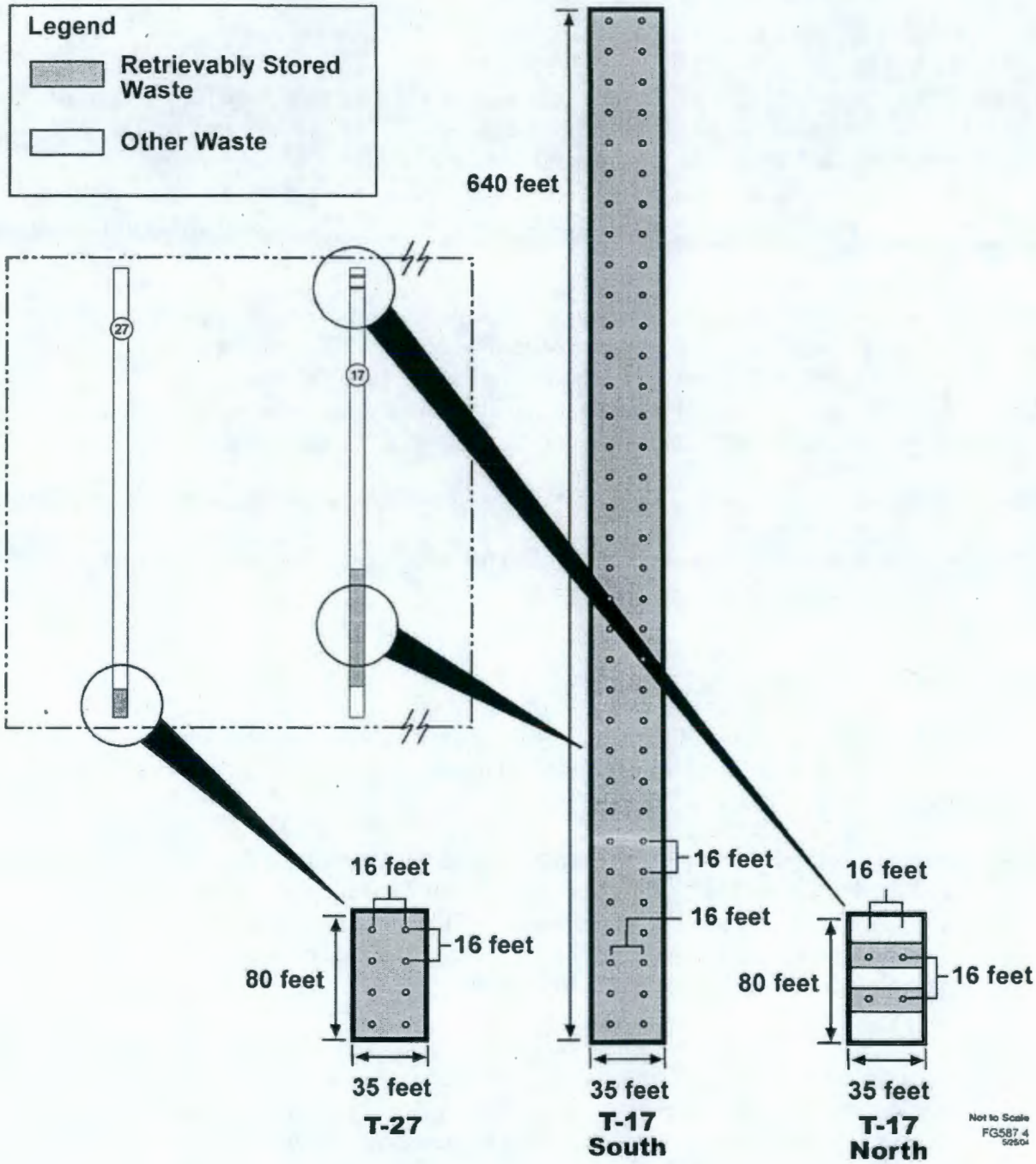
3.1.1 Step I

The main component of Step I of the sampling design is soil-vapor sampling of the overlying soils covering the RSW in the 218-E-12B Burial Ground. The following activities make up Step I sampling.

- A passive soil-gas survey will be conducted for VOC-contaminated vapor. Sampling will be limited to the overlying soils of those portions of Trenches T-17 and T-27 that currently contain retrievably stored waste. While the sampling design assumes full accessibility to these surface soils, only the areas that are accessible without posing health and safety risks (e.g., the potential for subsidence) to workers will be sampled.

- Passive soil-vapor samples will be collected on absorbent materials contained in tubes that are placed in the overlying soils. Depending on the technique chosen, the passive samplers will remain in place between 3 and 14 days. Sampling locations will be spaced at 4.9 m (16-ft) intervals. A random number generator will be used to determine the location of the first sampling location from the corner (Figure 3-1). Once collected, the samples will be shipped to the soil-vapor sampler vendor's laboratory for analysis using gas chromatography/mass spectrometry instrumentation capable of analyzing for a large target list of VOCs and capable of conducting tentatively identified compound searches for nontarget analytes.

Figure 3-1. Sampling Grid for Passive Soil-Vapor Sampling.



- Step I sampling results will be used to guide locations for sample collection during Step II sampling (i.e., locations not associated with the statistically based hot-spot random sampling design).

3.1.2 Step II

Step II includes surveying the exposed trench floor using appropriate field-screening instruments after waste retrieval. Following these surveys, decisions for additional characterization will be made. Several options for additional characterization techniques are available during Phase II. The decisions on which of the techniques to implement will be based on the data obtained during previous surveys and/or characterization activities. The complete list of Step II activities is as follows.

- Pertinent inspection records and/or occurrence reports regarding subsidence and/or flooding in the 218-E-12B Burial Ground trenches will be reviewed for indications of biased sampling locations. Observations made during waste retrieval also will be reviewed to indicate possible judgmental survey and sampling locations.

- Surveys using radiological and organic vapor monitor (OVM) field detectors and visual observations will be performed over the exposed area of the trench floor following waste retrieval. The surveys will be made when the trench floor underlying the RSW has become accessible and sampling will not interfere with waste retrieval operations. The results of these surveys and visual observations will be documented and evaluated for obvious indications of locations for substrate soil characterization.

- During the surveys, the soil at the trench floor will be examined for indications of discoloration, staining, or bleaching that could be caused by leakage of organic solvents or other liquid waste from drums. This evaluation of the trench floor soil provides a basis for Step III sampling.

- At locations where characterization data obtained in Step I or Step II activities indicate a potential hot spot, soil-vapor sampling using a direct-push technology (e.g., a core penetrometer [CPT]) or hand auger will be performed.

- If no potential hot spots were indicated by previous characterization activities, decision makers will evaluate whether substrate soil-vapor characterization using a direct-push technology (e.g., CPT) or hand auger should be performed in a grid pattern aimed at locating hot spots (Appendix A). The presence of hot spots indicates locations where contained waste may have drained into the substrate soils. The sampling locations for the grid survey (if needed) will be as described in Appendix A and will be augmented by the results of activities conducted in Step I and Step II. As needed, sampling locations will be spaced at 7.6 m (25-ft) intervals. A random number generator will be used to determine the location of the first sampling location from the corner (Figure 3-2). At each sampling location, soil-vapor samples will be collected at 1.8 m (6-ft) and 3.7 m (12-ft) depth intervals below ground surface and collected in Tedlar bags (or drawn directly into the analytical instrument) for field-screening analysis or in SUMMA

canisters for laboratory analysis. Also at each location, the CPT rods or hand-augering equipment will be surveyed by hand-held radioactivity detectors on their removal from each location. If the trench floor is not accessible by vehicle, depths greater than those achievable with a hand auger will not be sampled. Additional sampling locations may be established between the 7.6 m (25-ft-) spaced locations to reduce the grid size and better define potential hot spots based on results of Step I and Step II characterization and/or visual observations.

- Deeper soil-vapor sampling will be conducted using a direct-push technology (e.g., CPT). Samples will be taken adjacent to the initial locations with elevated vapor concentrations that appear to define a VOC plume. Samples will be collected at 1.8 m (6-ft) intervals below ground surface until refusal or until a maximum depth of approximately 9.8 m (32 ft) below the depth of the substrate soils is reached. The samples will be analyzed using a field-screening instrument.

3.1.3 Step III

Step III activities involve sampling substrate soils. To determine if this intrusive characterization is required, the results of the Step I and Step II characterization activities will be evaluated by decision makers. During the review, decision makers will weigh detected contaminant concentrations, uncertainties, and costs. If the Step I and Step II data evaluations indicate a need for Step III characterization, the following methods will be considered as needed.

- Soil samples will be collected to represent the first 15.2 cm (6 in.) of exposed soil in the trench floors. If an engineered fill that resembles gravel or cobble is present, the sampling depth will be 0.6 m (2 ft) below the onset of native soils.

- These samples will be analyzed in the laboratory for the full suite of VOCs, SVOCs, metals, and radionuclides. If contaminants are detected in soil samples, the decision about how to move forward will be made through the cleanup processes set forth in RCRA and/or CERCLA.

The Step I, Step II, and Step III sampling design features are summarized in Table 3-1.

3.2 FIELD MEASUREMENTS

The field measurements described in this section are designed to address the sampling objectives for Steps I through III. The section includes the sampling design, sampling requirements, and potential sample design limitations.

Figure 3-2. Sampling Grid for Soil-Vapor Sampling in Deeper Vadose Zone and/or Substrate Soils.

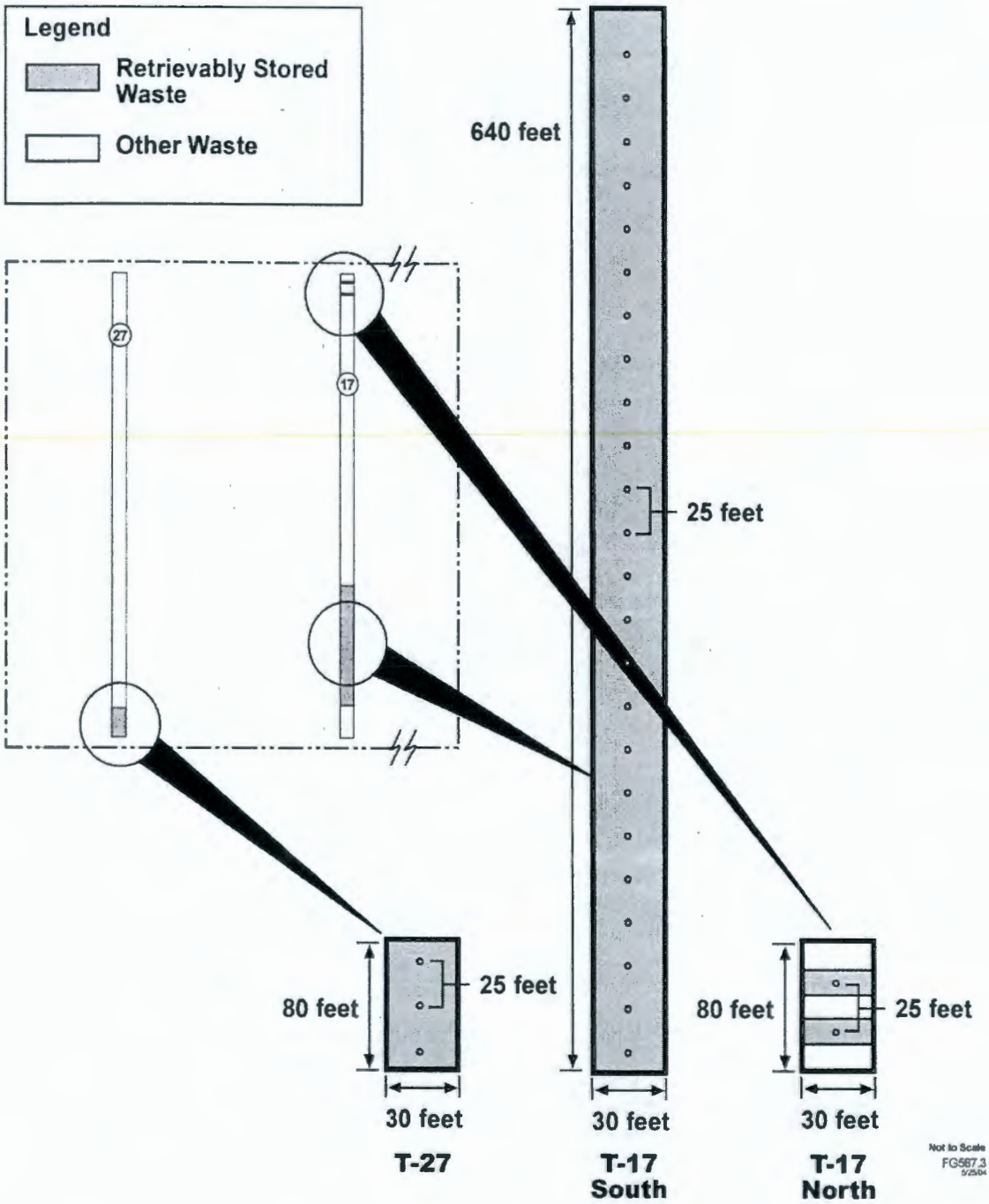


Table 3-1. 218-E-12B Burial Ground Sampling Design. (3 Pages)

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
Step I Sampling		
Vapor sampling from soils overlying RSW in 218-E-12B Burial Ground trenches.	Conduct passive soil-vapor sampling using a systematic grid with a random start location (Figure 3-1). The sampling locations will be at 5 m (16-ft) intervals. Place the samplers to a depth of 20 to 30 cm (8 to 12 in.). Follow the passive soil vapor vendor's instructions for sampler placement and subsequent collection. Return the passive samplers to the vendor for laboratory analysis. The vendor will use a GC/MS and analytical method capable of identifying individual VOCs. To the extent possible, place all of the passive soil-gas samplers on the same day. Following the passive collection interval recommended by the vendor, collect all of the passive soil-gas samplers on the same day.	Inexpensive means of soil-vapor sampling above the RSW in burial ground trenches. Results can be used to focus Step II sampling.
Step II Sampling		
Surveys on the trench floor using an organic vapor monitor and radiological field detectors.	Using appropriate field-screening instruments, including an OVM, perform a systematic grid survey over the exposed surfaces of the trench floor. Include locations where Step I overlying soil-vapor sampling and observations made during waste retrieval indicate the potential for elevated VOC concentrations.	Locations on the trench floor with elevated concentrations of organic vapors or radiological activity provide a basis for identifying potential contamination areas in the soil beneath the trench floor.
Visual observations of the trench floor.	During the surveys, examine the trench floor, looking for indications of discoloration caused by organic solvents leaking from drums.	Stains on the trench floor may indicate organic solvent pathways through the trench floor to the substrate soils. This is a basis for Step III sampling.
Review of inspection records and/or occurrence reports.	Review the pertinent 218-E-12B Burial Ground trench inspection records and/or occurrence reports regarding subsidence and/or flooding for indications of biased sampling locations.	Review may indicate locations for biased sampling.
Evaluate data from Step I and Step II characterization performed to this point.	Decision makers review existing characterization data to determine the need for additional characterization.	Detected contaminant concentrations, uncertainties, and costs are weighed to determine the need for additional characterization.
As needed, soil-vapor sampling in the vadose zone beneath the trench floor using a direct - push technology (e.g., CPT) or auger.	Based on the results obtained in Step I and Step II, determine whether to use a direct-push technology to access the vadose zone for soil-vapor sampling at locations of elevated VOC concentrations. At each sampling location, collect soil-vapor samples in Tedlar[a] bags (or draw the samples directly into the analytical instrument) at depths of 1.8 m (6 ft) and 3.7 m (12 ft) bgs. Analyze the samples for VOCs using field-screening instruments.	Soil-vapor sampling may locate areas where organic solvents have penetrated the substrate soils. These are potential organic contaminant pathways into the vadose zone.

Table 3-1. 218-E-12B Burial Ground Sampling Design. (3 Pages)

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
As needed, soil-vapor sampling in the vadose zone beneath the trench floor using a direct-push technology (e.g., CPT) or auger. (cont.)	Decision makers evaluate the use of a direct-push technology for subsurface access at 7.6 m (25-ft) intervals using a systematic grid sampling design with a random start location. If implemented, collect soil-vapor samples in Tedlar bags (or draw the samples directly into the analytical instrument) at depths of 1.8 m (6 ft) and 3.7 m (12 ft) bgs at each sampling location. Analyze the samples for VOCs using field-screening instruments.	Laying out a systematic grid is a hot-spot search technique that could investigate substrate soils in areas where data from surveys or visual observations are not available to indicate the potential for elevated VOCs.
	As needed, use a direct-push technology to collect additional soil-vapor samples at locations between the initial locations with elevated VOC concentrations. At each sampling location, collect soil-vapor samples in Tedlar bags (or draw the samples directly into the analytical instrument) at depths of 1.8 m (6 ft) and 3.7 m (12 ft) bgs. Analyze the samples for VOCs using field-screening instruments.	Soil-vapor samples that are collected at locations between the initial locations are used to reduce the grid spacing and better define any VOC hot spots.
	If soil-vapor concentrations detected at 6 or 12 ft bgs indicate the presence of COCs, decision makers will evaluate whether to use direct-push technology to conduct deeper soil-vapor sampling adjacent to the initial locations with elevated VOC concentrations that appear to define a VOC plume in the vadose zone. At the location in an apparent plume with the highest VOC concentrations based on field screening, collect soil-vapor samples in SUMMA[b] canisters for laboratory analysis. At these locations, sample at 1.8 m (6-ft) intervals bgs until refusal or until reaching a maximum depth of approximately 9.8 m (32 ft) below the depth of the trench floor. If no VOC plumes are apparent at a given trench, laboratory samples will not be collected.	The initial results will be used to guide vertical profiling for VOCs.
	If organic contaminants are detected in soil-vapor samples, the decision of how to move forward will be determined by the cleanup processes set forth in RCRA and/or CERCLA.	Sampling beyond this SAP will be conducted at the discretion of the decision makers.
Step III Sampling		
Evaluate data from Step I and Step II characterization.	Decision makers review existing characterization data to determine the need for additional characterization.	Detected contaminant concentrations, uncertainties, and costs are weighed to determine the need for additional characterization.

Table 3-1. 218-E-12B Burial Ground Sampling Design. (3 Pages)

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
As needed, sample the soils beneath the trench floor.	Collect soil samples at a depth of 0 to 15.2 cm (0 to 6 in.) at locations determined by Step II characterization and Step III soil-vapor sampling results. Collect samples using hand tools. Alternatively, use a direct-push technology (e.g., drive casing) for access to the desired depth and collect samples using a device such as a split-spoon sampler. Analyze for the constituents that were detected on the trench floor surface or in vadose zone soils (e.g., if chemical constituents were detected, analyze for chemical constituents. If radiological constituents were detected, analyze for radiological constituents).	Soil samples can provide data on all COCs at specified depths below the surface of the trench floor.
	If contaminants are detected in soil samples, the decision as to how to move forward will be determined through the cleanup processes set forth in RCRA and/or CERCLA.	Sampling beyond this SAP will be conducted at the discretion of the decision makers.

[a]Tedlar is a registered trademark of E. I. du Pont de Nemours and Company, Wilmington, Delaware.
[b]SUMMA is a trademark of Moletrics, Inc. Cleveland, Ohio.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980.
Resource Conservation and Recovery Act of 1976.

bgs = below ground surface.
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
COC = contaminant of concern.
CPT = cone penetrometer.
GC/MS = gas chromatography/mass spectrometery.
OVM = organic vapor monitor.
RCRA = *Resource Conservation and Recovery Act of 1976.*
RSW = retrievably stored waste.
SAP = sampling and analysis plan.
VOC = volatile organic compound.

3.2.1 Step I and Step II Sampling Design Features

This section presents the primary features of the Step I and Step II sampling design, which are as follows.

- Accessible areas of soils overlying RSW will be sampled for VOC vapors. If some areas are not accessible because of safety concerns, vapor samples will be collected around the trench in a systematic fashion at spacing consistent with the sampling design, as explained in Appendix A. Vapor samples will be collected on passive soil-gas collection media for laboratory analysis using gas chromatography/mass spectrometry instrumentation capable of analyzing for VOCs, including compounds regulated by RCRA for the characteristic of toxicity. The passive soil-gas technique offers a simple inexpensive means of sampling the vapor within the overlying soils of the burial ground trenches, providing data for a large number of organic constituents. Sampling is being done to meet the intent of the vent riser sampling designated in the Tri-Party Agreement Interim Milestone M-91-40, Requirement 2 (Ecology et al. 1989a). The results will be used to focus Step II and Step III sampling. The grid pattern that will be used to collect passive soil-vapor samples is shown in Figure 3-1.

- A survey will be conducted over the exposed surfaces of the trench floor once the RSW has been removed, using an OVM and portable radiological detectors. Sampling will be

conducted when the trench floor has become accessible and sampling activities will not interfere with waste retrieval operations. If no potential hot spots are indicated by previous characterization activities, decision makers will evaluate whether substrate soil-vapor characterization using a direct-push technology (e.g., CPT) or hand auger should be performed. If the characterization is performed, sampling will be done in a grid pattern aimed at locating hot spots (Appendix A). If a grid survey is initiated for vadose zone soil-vapor characterization, the locations of sample collection will be those shown in Figure 3-2. Vadose zone soil-vapor sampling will be conducted at locations where Step I passive soil-gas sampling, OVM characterization or radiation surveys, and visual observations indicated a potential for elevated VOC or radionuclide concentrations. Locations on the trench floor that have detectable radioactivity greater than background provide a basis for identifying potential contamination areas in the soils.

- During the radiation surveys, the trench floor also will be visually examined for indications of discoloration, staining, and bleaching that could be caused by waste leaking from drums. This evaluation of the trench floor provides another basis for determining appropriate locations for Step III sampling (if required).

- Pertinent 218-E-12B Burial Ground trench inspection records and/or occurrence reports regarding subsidence and/or flooding will be reviewed for indications of biased sampling locations.

- The decision makers will review the characterization data from Step I and the trench floor surveys conducted in Step II to determine the need for soil-vapor sampling in the vadose zone soils. During the review, detected contaminant concentrations, uncertainties, and costs will be weighed to determine the need for additional Step II characterization. Additional Step II activities may include sampling soil vapor from the vadose zone below the trench floor and analyzing the samples for additional VOCs.

- Vadose zone soil-vapor sampling will be conducted in the soil at locations of visible staining and elevated VOC concentrations or radiation readings, based on results obtained during Step I characterization, and/or at the locations shown in Figure 3-2. The sampling will be conducted using a direct-push technology (e.g., CPT) for subsurface access. At each sampling location, soil-vapor samples will be collected at depths of 1.8 m (6 ft) and 3.7 m (12 ft) below ground surface in Tedlar bags (or drawn directly into the analytical instrument) and analyzed using field-screening instruments.

- As needed, additional sampling locations may be established between the initial locations with elevated VOC concentrations, to reduce the grid size and better define potential VOC hot spots. At each sampling location, soil-vapor samples would be collected at depths of 1.8 m (6 ft) and 3.7 m (12 ft) below ground surface.

- If the trench floor is accessible by vehicles, deeper soil-vapor sampling may be conducted at the initial locations of elevated VOC concentrations that appear to define a VOC plume in the vadose zone. In these locations, the sampling will be conducted using a direct-push technology (e.g., CPT) for subsurface access. At each sampling location, soil-vapor samples will be collected in SUMMA canisters at 1.8 m (6-ft) intervals below

ground surface until refusal or until reaching a maximum depth of approximately 9.8 m (32 ft) below the surface of the substrate soil. The samples will be sent for laboratory analysis. Refusal occurs when the direct-push technology is no longer able to advance deeper into the subsurface.

- If organic contaminants are detected in soil-vapor samples, the decision as to how to move forward will be made through the cleanup processes set forth in RCRA and/or CERCLA.

Soil-vapor sampling using a passive soil-gas technology will involve one-time installation of sample collection absorbent and vapor sampling, followed by removal of the sample collection media and their subsequent analysis at an offsite laboratory.

Soil-vapor sampling using direct-push technology generally will involve one-time installation of direct-push rods and vapor sampling, followed by removal of the rods. However, in locations with elevated vapor concentrations, the project may elect to leave the rods in place for longer term vapor sampling or may install temporary vapor sampling stations (using sintered metallic filters). Direct-push technology rods that are left in place will be completed at the upper 45.7 cm (18 in.) with concrete pads and brass survey markers (consistent with groundwater well installations).

An advanced drive-point technology, the wire-line CPT, is being considered for collecting soil-vapor samples. The wire-line CPT avoids a potential difficulty inherent in direct-push sampling—removing the rods and reinserting them in the same hole. Several advanced characterization tools can be used with the wire-line CPT to sample soil vapor in the vadose zone. The wire-line CPT vapor sampler can be used to draw soil-vapor samples to the surface for analysis, and the wire-line CPT grouting module can be used to grout the hole after sampling has been completed.

Use of these characterization tools will depend on their availability, cost-effectiveness, and capability of fulfilling the sampling objectives for this investigation. If trucks are not allowed in or near the 218-E-12B Burial Ground trenches, hand-augering equipment will be needed to penetrate into the substrate soils. Soil-vapor samples then can be collected in SUMMA canisters or Tedlar bags (or drawn directly into the analytical instrument) for analysis.

3.2.2 Step III Sampling Design Features

This section presents the primary features that could be applied in the Step III sampling design as needed. The following activities make up Step III sampling.

- Substrate soil samples will be collected as needed using hand tools or a direct-push technology at locations determined by the Step I and Step II characterization. Samples will be collected at a depth of 0 to 15.2 cm (0 to 6 in.). The soil samples will be analyzed in the laboratory. The analyses performed will depend on the constituents detected during the surveys on the trench floor. If chemical constituents (i.e., VOCs) are detected, the analyses will include metals, VOCs, and SVOCs. If only radionuclides are detected, the samples will be analyzed for only metals and radionuclides.

Soil samples can provide data on all COCs that may be present within the first 15.24 cm (6 in.) of the exposed waste-soil interface. If contaminants are detected in soil samples, the decision about how to move forward will be made in accordance with the cleanup processes set forth in RCRA and/or CERCLA.

Soil sampling using direct-push technology or hand-auger methods generally will involve one-time installation of direct-push rods, collection of soil samples, and removal of the rods. However, in locations with elevated concentrations, the project may elect to leave the rods in place temporarily for longer term sampling to confirm the initial results. The direct-push technology rods that are left in place will be completed at the upper 45.7 cm (18 in.) depth with concrete pads and brass survey markers (consistent with groundwater well installations).

Use of these characterization tools will depend on their availability, cost effectiveness, and capability in fulfilling the sampling objectives for this investigation.

3.2.3 Passive Soil-Vapor Sampling Requirements

Soil-vapor samples will be collected from overlying soils in 218-E-12B Burial Ground trenches. Passive soil-vapor samples will be collected on absorbent materials placed in tubes and then will be placed approximately 1 ft deep in the overlying soils. Depending on the technique chosen, the samplers will remain in place for between 3 and 14 days. The samples then will be shipped to the soil sampler vendor's laboratory for analysis using gas chromatography/mass spectrometry instrumentation capable of analyzing for a large target list of VOCs and for conducting tentatively identified compound searches for nontarget analytes.

Soil-vapor sampling using a passive soil-gas technology will involve one-time installation of sample collection absorbent and vapor sampling, followed by removal of the sample collection media and sample analysis at an offsite laboratory.

3.2.4 Vapor and Radionuclide Survey Requirements

Surveys using radiological and OVM field detectors and visual observations will be performed over the exposed area of substrate soils following waste retrieval. Areas that are inaccessible will not be surveyed. The results of these surveys and visual observations will be documented and evaluated for obvious indications of locations for substrate soil characterization.

During the surveys, the soil surface will be examined for indications of discoloration, staining, or bleaching that could be caused by organic solvents or other liquid waste leaking from drums. This evaluation of the substrate soil surface provides another basis for selecting sampling locations for additional Step II and/or Step III sampling.

3.2.5 General Soil-Vapor Sampling Requirements

Soil-vapor samples will be collected in Tedlar bags (or drawn directly into the analytical instrument) or evacuated SUMMA canisters through probes and/or tubing. The Tedlar bags (or analytical instrument) will be plumbed with a "tee" fitting that allows venting of one volume of

air from the sampling probe and tubing before collecting the sample. The venting time will be based on the length of the probes and tubing and the pumping rate. After venting, the valves will be aligned to fill the Tedlar bag (or analytical instrument). Sampling is complete when the bags are filled to approximately 75 percent of their capacity. The SUMMA canisters will be attached to the tubing for sample collection after venting and after confirmation that the canister has maintained sufficient vacuum. The sample will be drawn by opening a valve on the SUMMA canister long enough to allow an adequate volume of vapor to be collected. Care will be taken to ensure that the rate of gas flow into the SUMMA canister is not so fast as to result in outside air leaking in at the tubing connections and diluting the vapor sample.

The soil vapor in Tedlar bags may be analyzed using an Innova multi-gas analyzer or other field-screening instrument that can differentiate all of the VOCs specified in Table 2-1 at the target-required quantitation limits. The soil vapor in SUMMA canisters will be analyzed at the laboratory for the broad suite of VOCs specified in Table 1-1.

3.2.6 Soil Sampling Requirements

Potentially, soil samples for chemical and radionuclide analyses may be obtained with a hand tool or a split-spoon or appropriate sampling device developed for the specific investigative process (e.g., direct-push technology). To the extent possible, the selected sampling method must ensure that material collected represents nondisturbed media.

3.2.7 Potential Sample Design Limitations

The sampling design might not fill all vadose zone data gaps. As presented, the sampling design allows for reassessment of characterization, remediation, and financial priorities. This approach recognizes that decision makers will be in a better position to initiate expensive, deep vadose zone characterization after conceptual model data gaps have been filled.

Other potential limitations of the proposed sampling designs are as follows.

- Access to the burial ground overlying soil before waste retrieval, and to substrate soil following retrieval, could be limited because of worker protection requirements or other constraints.
- Some items still may be present in the trench that could limit access to certain substrate soil locations for this sampling activity.
- Backfill placed over waste that is adjacent to the RSW but that will not be retrieved may limit access to certain substrate soil locations for this sampling activity.

3.2.8 Visual Observations

Surveys and visual observations will be made of the trench surface during RSW removal operations. Observations describing containers removed, soil staining, odors, and container integrity will be made available by removal operations personnel.

3.2.9 Waste Management Sampling

An evaluation will be conducted to identify any additional sampling that might be required to support management of the waste generated from the field sampling activities. The evaluation will consist of reviewing the contaminants of potential concern identified for the 218-E-12B Burial Ground trench and analyzing any additional constituents that should be evaluated to complete the waste designation and profile. Additional sampling requirements specific to waste management issues may be identified for the field activities described in this SAP.

3.2.10 Supplemental Sampling for Other Projects

Supplemental sampling to support other projects such as the 200-SW-2 Operable Unit remedial investigation were not identified before this document was prepared. However, supplemental sampling may be requested as part of the decision-maker evaluation of the data during the sampling activities described in the SAP.

3.3 POSITIONAL SURVEYING

All sampling locations established during this sampling activity will be surveyed after the sampling and decommissioning activities are completed. Surveys will be performed according to approved procedures. Data will be recorded using NAVD88, *North American Vertical Datum of 1988*, and NAD83, *North American Datum of 1983*, for the Washington State Plane (South Zone), with the 1991 adjustment for horizontal coordinates. All survey data will be recorded in meters and feet.

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4.0 HEALTH AND SAFETY

All field operations will be performed in accordance with appropriate health and safety requirements and procedures. In addition, appropriate documentation will be prepared that will further control site operations. This documentation will consist of an activity hazard analysis, a site-specific health and safety plan, and applicable work permits. Work shall be performed in accordance with site-specific health and safety plans and applicable work permits. The sampling procedures and associated activities will take into consideration exposure reduction and contamination control techniques that will minimize the sampling team's exposure.

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5.0 MANAGEMENT OF CHARACTERIZATION-GENERATED WASTE

Waste generated by 218-E-12B Burial Ground characterization activities will be managed in accordance with appropriate procedures. The waste characterization and disposition will be coordinated with and managed by the 218-E-12B Retrieval Operations Project in accordance with applicable procedures implemented for waste designation of the RSW after it has been removed from the 218-E-12B Burial Ground trenches.

The COCs for waste disposition will be all contaminants needed to determine whether the waste generated during the sampling meets the waste acceptance criteria for the respective disposal facilities. The results from previous investigations and/or process knowledge will be used to develop a list of COCs for waste-designation purposes.

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APPENDIX A

SAMPLING DESIGN FOR THE IDENTIFICATION OF HOT SPOTS DURING SOIL-VAPOR SURVEYS AND SUBSTRATE SOIL SAMPLING

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APPENDIX A

SAMPLING DESIGN FOR THE IDENTIFICATION OF HOT SPOTS DURING SOIL-VAPOR SURVEYS AND SUBSTRATE SOIL SAMPLING

A1.0 SAMPLING DESIGN FOR THE DETERMINATION OF HOT SPOTS IN TRENCH SURFACE AND SUBSTRATE SOIL

This sampling design will be used to investigate the occurrence of organic soil-vapor hot spots in the surface soils over the portions of the 218-E-12B Burial Ground that contain retrievably stored TRU[1] waste before waste retrieval and that contain organic soil vapor and radionuclide hot spots in the substrate soils following waste retrieval. If organic chemicals are present in the 218-E-12B Burial Ground trenches, they also could be present in any soil vapor currently above the waste and in condensate that might have entered the substrate soils within the trenches. The *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) Interim Milestone M-91-40 (Ecology et al. 1989) requires the U.S. Department of Energy to "sample and analyze trench substrates with the purposes of determining whether or not releases of contaminants to the environment have occurred, and, if so, the nature and extent of contamination."

A1.1 ASSUMPTIONS

The following assumptions were used in developing the sampling design.

- The target (hot spot) is circular or elliptical. For subsurface targets this applies to the projection of the target to the surface.
- Samples or measurements are taken on a square, rectangular, or triangular grid.
- The distance between grid points is much larger than the area sampled, measured, or cored at grid points (i.e., a very small proportion of the area being studied actually can be measured).
- The definition of hot spot is clear and unambiguous. This definition implies that the types of measurement and the levels of contamination that constitute the hot spot are clearly defined. For the surface soil-vapor sampling and the substrate soil that will be exposed following waste retrieval in the 218-E-12B Burial Ground trenches, these definitions have been provided as outputs of steps in the DQO process (WMP-20379, *Data Quality Objectives Summary Report for the 218-E-12B Burial Ground Contaminant Release Investigation*).

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

- No measurement misclassification errors occur (i.e., no errors are made in deciding when a hot spot has been detected).

- The grid spacing calculations will be applied only to the surface locations in Trenches T-17 and T-27 where retrievably stored TRU waste will be exhumed and to accessible locations in the substrate soil following waste retrieval.

A1.2 GRID SPACING

The grid spacing required to find a hot spot of a prescribed size and shape with specified confidence may be determined from the following procedure.

1. Specify L, the length of the semimajor axis of the smallest hot spot important to detect. L is one-half the length of the long axis of the ellipse.

2. Specify the expected shape, S, of the elliptical target, where

$$S = \frac{\textit{length of short axis of the ellipse}}{\textit{length of long axis of the ellipse}} \qquad \text{Equation A-1}$$

   Note that $0 < S < 1$ and that $S = 1$ for a circle. If S is not known in advance, a conservative approach is to assume a rather skinny elliptical shape, perhaps $S = 0.5$, to give a smaller spacing between grid points than if a circular or "fatter" ellipse is assumed (i.e., sample on a finer grid to compensate for lack of knowledge about the target shape).

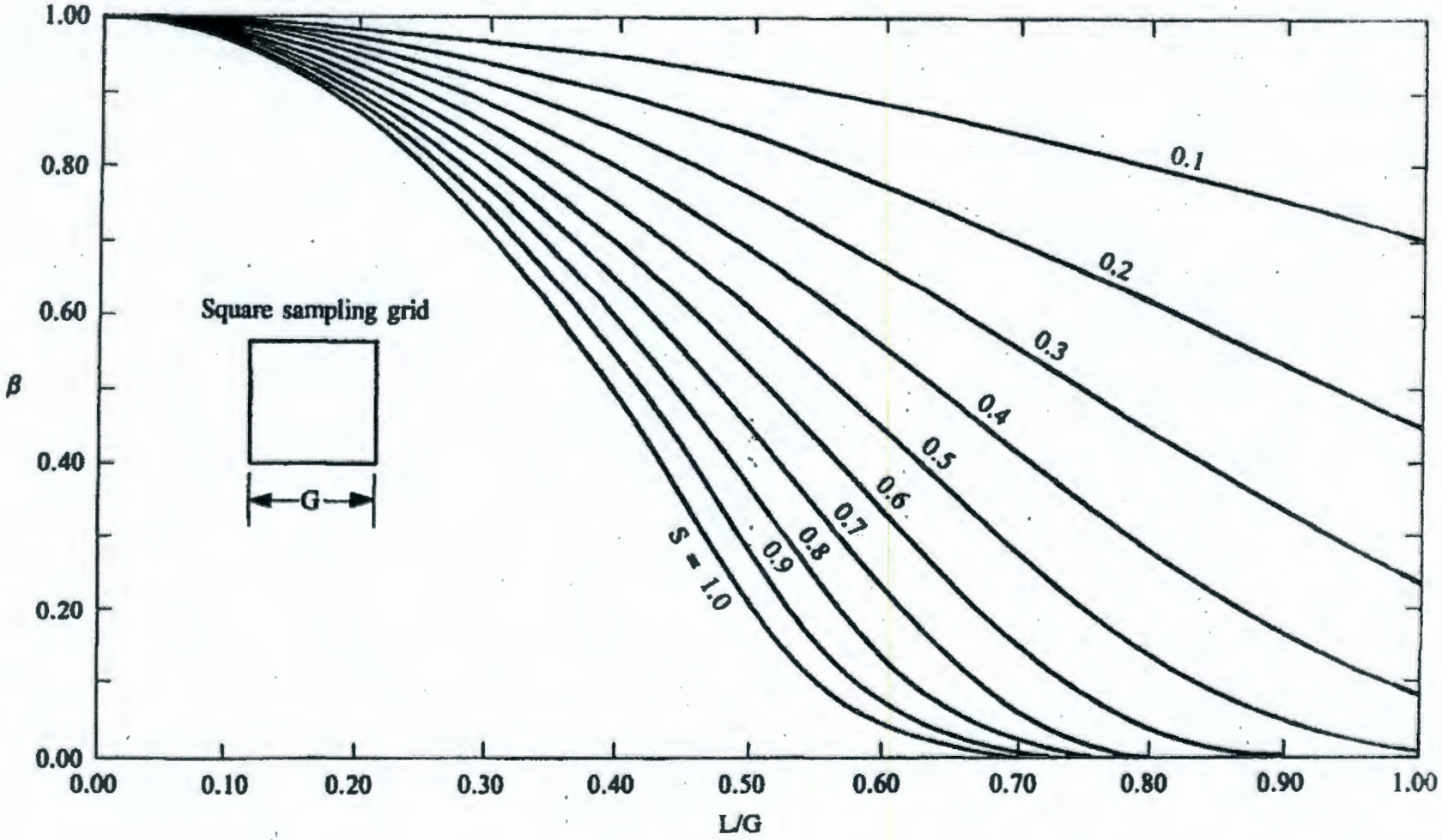
3. Specify an acceptable probability, β, of not finding the hot spot. The value β is known as the "consumer's risk." To illustrate, a probability of 20 percent ($\beta = 0.20$) (1 chance in 5) of not finding a hot spot may be acceptable for a small hot spot (e.g., one for which $L = 5$ cm). However, for a larger hot spot (e.g., one for which $L = 5$ m), a probability of 10 percent ($\beta = 0.10$) (1 chance in 10) of not finding a hot spot may be required.

4. Use Figure A-1 for a square grid. This nomograph gives the relationship between β and the ratio L/G, where G is the spacing between grid lines. Using the curve corresponding to the shape, S, of interest, find L/G on the horizontal axis that corresponds to the prespecified β. Then solve L/G for G, the required grid spacing.

5. The total number of grid points (sampling locations) then can be found because the dimensions of the land area to be sampled are known.

This procedure is used to establish a square grid pattern in which samples are collected at the four nodes where the grid lines intersect. The square grid pattern is relevant to a two-dimensional land surface. This procedure was applied for sampling the soil vapor on the trench surfaces and the soils in the exposed trench bottom following waste retrieval. To identify the location of sample points in the square grid pattern, the location of the first sampling point (i.e., grid node) is chosen randomly, and the rest of the grid is established with lines parallel to the boundaries of the trench.

Figure A-1. Curves Relating *L/G* to Consumer's Risk, β, for Different Target Shapes when Sampling is on a Square Grid Pattern (after Figure 3 in Zirschky and Gilbert [1984]).



A1.3 SOIL-VAPOR HOT SPOT SIZE

The length of the semimajor axis of the ellipse (i.e., the size of the hot spot) must be defined. Because the method used to detect the possible presence of a soil-vapor hot spot in the surface soil samples above the buried waste will be passive soil-gas sampling, and because analysis is for volatile organic constituents, which tend to readily diffuse in a porous medium such as soil, a rather large hot spot size could be selected. However, because these locations also will be used to impose additional sample locations on the grid used for substrate soil sampling, and the cost of the sampling and analysis for VOCs using this technique is relatively small, a finer grid than that used for the substrate sampling is appropriate. For the soil-vapor samples, the distance of the semimajor axis of the ellipse of interest, L, will be assumed to be 3 m (10 ft). If it is assumed that the shape of interest, $S = 0.8$, and the acceptable probability of not finding a hot spot, which correlates to false positive decision error, is 10 percent (this is a consumer's risk, β, of 0.1), the nomograph can be used to solve for the grid spacing, G.

Using the tolerances-specified results in a value for L/G of 0.627, G can be resolved as follows:

$$G = \frac{10\ feet}{0.627} = 15.949\ feet \qquad \text{Equation A-2}$$

Using this sampling design will require collecting samples every 4.86 m (15.949 ft). For practical purposes, a grid spacing distance of 4.9 m (16 ft) will be used, which would correspond to a slight increase of the semimajor axis size of interest to 3.05 m (10.02 ft). Therefore, sample collection will be conducted starting at a randomly chosen location within a 16-ft arc of the southwest corner of the 218-E-12B Burial Ground, then once at the nodes of the grid, spaced every 4.9 m (16 ft) apart. If organic vapors are detected at any of the measurement locations, additional samples may be collected on a finer grid interval from those locations, to further delineate and characterize the hot spots detected.

A1.4 SUBSTRATE SOIL HOT-SPOT SIZE

The length of the semimajor axis of the ellipse (i.e., the size of the hot spot) must be defined. The method used to detect the possible presence of a hot spot will be collection of soil vapors at depths of 1.83 m (6 ft) and 3.66 m (12 ft) and radiation surveys at the surface of the substrate soil. If hot spots are detected, subsequent soil samples will be collected to represent the first 6 in. of soil in contact with buried waste. Because the sampling grid used will be augmented by sampling points related to detection of soil vapors in the surface soils and those sampling points added as a result of visual observations of the substrate soil, a rather large hot spot size can be selected. For this activity, the distance of the semimajor axis of the ellipse of interest, L, will be assumed to be 5 m (16 ft). If it is assumed that the shape of interest, $S = 0.8$ (i.e., the contaminants of concern have moved only slightly further in one direction from the point at which the hot spot emanates than in any other direction), and the acceptable probability of not finding a hot spot, which correlates to a false positive decision error, is 10 percent (this is a consumer's risk, β, of 0.1), the nomograph can be used to solve for the grid spacing, G.

Using the tolerance-specified results in a value for L/G of 0.627, G can be resolved as follows:

$$G = \frac{16\ feet}{0.627} = 25.518\ feet \qquad \text{Equation A-3}$$

Using this sampling design will require collecting samples every 7.78 m (25.518 ft). For practical purposes, a grid spacing distance of 8 m (25 ft) will be used, which would correspond to a slight decrease of the semimajor axis size of interest to 4.78 m (15.67 ft). The shape of the trench bottom following waste retrieval is expected to consist of sloping sides and a relatively flat bottom. Because detection of residual contamination resulting from leaking waste containers is most likely in the lowest elevations of the trench bottom, the sampling grid will be applied only to the bottom of the trench and not to the sloped sides. Therefore, sample collection will be conducted starting at a randomly chosen location within a 25-ft arc from the southwest corner of the relatively flat bottom of the empty 218-E-12B Burial Ground trench, then once at the nodes of the grid, spaced every 8 m (25 ft) apart. If burial ground contaminants of concern are detected in soil vapor or beta-gamma radiation surveys at any of the sample collection locations, soil samples may be collected, or decisions about how to move forward will be determined, in accordance with the cleanup processes set forth in the *Resource Conservation and Recovery Act of 1976* and/or the *Comprehensive Environmental Response, Compensation, and Recovery Act of 1980*.

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APPENDIX B

CROSS-REFERENCE BETWEEN THE U.S. ENVIRONMENTAL PROTECTION AGENCY QUALITY ASSURANCE PROJECT PLAN AND FIELD SAMPLING PLAN REQUIREMENTS AND THE 218-E-12B BURIAL GROUND SAMPLING AND ANALYSIS PLAN

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APPENDIX B

CROSS-REFERENCE BETWEEN THE U.S. ENVIRONMENTAL PROTECTION AGENCY QUALITY ASSURANCE PROJECT PLAN AND FIELD SAMPLING PLAN REQUIREMENTS AND THE 218-E-12B BURIAL GROUND SAMPLING AND ANALYSIS PLAN

In 1989, the U.S. Environmental Protection Agency (EPA) published EPA/540/G-89/004, *Guidance for Conducting Remedial Investigations and Feasibility Studies CERCLA, Interim Final*. This document stated that a sampling and analysis plan consists of two separate documents: a field sampling plan and a quality assurance project plan (QAPP).[1] In 2001, the EPA published EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R-5, and in 2002 the EPA published EPA/240/R-02/009, *EPA Guidance for Quality Assurance Project Plans*, EPA QA/G-5. These recent documents expand on the guidance provided in the 1989 EPA guidance document (EPA/540/G-89/004). Most notably, the 2001 and 2002 documents take the elements defined in the 1989 guidance document, which required both a field sampling plan and a QAPP, and combine them into one document. Thus, the EPA's 2001 and 2002 direction implies that only a single document is required for each sampling and analysis activity. To alleviate confusion between the old and new nomenclature, this sampling and analysis plan, along with the accompanying data quality objectives (DQO) summary report for this activity, includes all the elements required in a QAPP and in a field sampling plan, regardless of which EPA guidance is followed. To demonstrate this compliance and to aid readers in locating specific information of interest, a cross-reference between the EPA 1989 guidance document (EPA/540/G-89/004), the EPA 2001 requirements document (EPA/240/B-01/003), the EPA 2002 guidance document (EPA/240/R-02/009), and the DQO summary report (WMP-20379, *Data Quality Objectives Summary Report for the 218-E-12B Burial Ground Contaminant Release Investigation*) and the sampling and analysis plan prepared for this activity is provided in Table B-1.

[1]In this sampling and analysis plan, the quality assurance project plan is referred to as the QAPjP. In the referenced EPA documents, however, the term quality assurance project plan is referred to as the QAPP. In this appendix, the acronym QAPP is retained when referring to the quality assurance project plan described in EPA documents.

Table B-1. Comparison of Quality Assurance Project Plan Elements in EPA/240/B-01/003 and EPA/240/R-02/009 to EPA/540/G-89/004 and to WMP-20379 and this Sampling and Analysis Plan. (2 Pages)

QAPP Elements from EPA/240/B-01/003 and EPA/240/R-02/009		QAPP Elements from EPA/540/G-89/004		Applicable Sections from WMP-20379 and/or this SAP	
A	**Project Management**				
A1	Title and Approval Sheet		Title Page	SAP	Title and Approval Sheet
A2	Table of Contents		Table of Contents	SAP	Table of Contents in Hanford Document Control Format
A3	Distribution List		N/A	SAP	Distribution
A4	Project/Task Organization	2.	Project Organization and Responsibilities	DQO 1.6	Data Quality Objective Team Members and Key Decision Makers
A5	Problem Definition/Background	1.	Project Description	DQO 1.0	Step 1 – State The Problem
A6	Project/Task Description	1.	Project Description	DQO 1.0 SAP 1.0	Step 1 – State The Problem Introduction
A7	Quality Objectives and Criteria	3.	Quality Assurance Objectives for Measurement	SAP 2.1	Analytical Performance Requirements
A8	Special Training Requirements/Certification		N/A		N/A
A9	Documents and Records		N/A	SAP 2.5	Data Management
B	**Measurement/Data Acquisition**				
B1	Sampling Process Designs (Experimental Designs)		N/A	SAP 3.1	Sampling Objectives
B2	Sampling Methods	4.	Sampling Procedures	SAP 3.1	Sampling Objectives
B3	Sample Handling and Custody	5.	Sample Custody	SAP 2.9.2 2.9.4 2.9.5	Sample Identification Sample Custody Sample Containers
B4	Analytical Methods	7.	Analytical Procedures	SAP 2.1	Analytical Performance Requirements
B5	Quality Control	9.	Internal Quality Control	SAP 2.2	Field Quality Control

Table B-1. Comparison of Quality Assurance Project Plan Elements in EPA/240/B-01/003 and EPA/240/R-02/009 to EPA/540/G-89/004 and to WMP-20379 and this Sampling and Analysis Plan. (2 Pages)

QAPP Elements from EPA/240/B-01/003 and EPA/240/R-02/009		QAPP Elements from EPA/540/G-89/004		Applicable Sections from WMP-20379 and/or this SAP	
B6	Instrument/Equipment Testing, Inspection, and Maintenance	6. 11.	Calibration Procedures Preventive Maintenance	SAP 2.1 SAP 2.4	Analytical Performance Requirements Onsite Measurements Quality Control
B7	Instrument/Equipment Calibration and Frequency	7. 9.	Analytical Procedures Internal Quality Control	SAP 2.1 SAP 2.4	Analytical Performance Requirements Onsite Measurements Quality Control
B8	Inspection/Acceptance of Supplies and Consumables	9.	Internal Quality Control	SAP 2.9.6	Inspection/Acceptance Requirements for Supplies and Consumables
B9	Non-Direct Measurements	12.	Data Assessment Procedures	DQO 3.3	Computational and Survey and Analytical Methods
B10	Data Management	8.	Data Reduction, Validation, and Reporting	SAP 2.5	Data Management
C	**Assessment/Oversight**				
C1	Assessments and Response Actions	10. 13.	Performance and System Audits Corrective Actions	SAP 2.8.1 SAP 2.8.2	System and Performance Assessments Corrective Actions
C2	Reports to Management	14.	Quality Assurance Reports	SAP 2.8.3	Reports to Management
D	**Data Validation and Usability**				
D1	Data Review, Verification, and Validation	8. 12.	Data Reduction, Validation, and Reporting Data Assessment Procedures	SAP 2.6	Validation and Verification Requirements
D2	Verification and Validation Methods	12.	Data Assessment Procedures	SAP 2.6	Validation and Verification Requirements
D3	Reconciliation with User Requirements	12.	Data Assessment Procedures	SAP 2.7	Data Quality Assessment

DQO = data quality objectives (document).
N/A = not applicable.
QAPP = quality assurance project plan.
SAP = sampling and analysis plan.

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