FINAL

SAMPLING AND ANALYSIS PLAN ADDENDUM

FOR THE

PHASE II REMEDIAL INVESTIGATION OF THE WINKLEPECK BURNING GROUNDS AND DETERMINATION OF FACILITY-WIDE BACKGROUND at the RAVENNA ARMY AMMUNITION PLANT RAVENNA, OHIO

PREPARED FOR



U.S. ARMY CORPS OF ENGINEERS LOUISVILLE DISTRICT

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Prepared for

United States Army Corps of Engineers Louisville District CELRL-ED-GE Louisville, Kentucky 40201

Prepared by

SCIENCE APPLICATIONS INTERNATIONAL CORPORATION 800 Oak Ridge Turnpike Oak Ridge, Tennessee 37830 **FINAL**

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SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

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

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ACRONYMS

AOC	Area of Concern
BRA	baseline risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	chemical of concern
COPC	chemical of potential concern
CSF	cancer slope factor
DFA	Deactivation Furnace Area
DQO	Data Quality Objective
ecoRGO	ecological remedial goal option
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
FID	flame ionization detector
HCl	hydrochloric acid
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
I.D.	inside diameter
IDW	investigation-derived waste
ILCR	incremental lifetime cancer risk
Κ	hydraulic conductivity
LOAEL	Lowest Observed Adverse Effect Level
MRD	Missouri River Division
NCP	National Contingency Plan
NOAEL	No Observed Adverse Effect Level
OBG	Open Burning Ground
Ohio EPA	Ohio Environmental Protection Agency
ONG	Ohio National Guard
OVA	organic vapor analyzer
PCB	polychlorinated biphenyl
PID	photo-ionization detector
PRG	Preliminary Remediation Goal
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
QCP	Quality Control Plan
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RDX	cyclonite
RfD	reference dose
RGO	remedial goal option
RI	Remedial Investigation
RME	reasonable maximum exposure
RVAAP	Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation
SAP	Sampling and Analysis Plan

semivolatile organic compound
threatened and endangered
Target Analyte List
to be determined
U.S. Army Corps of Engineers
Upper Tolerance Limit
volatile organic compound
Winklepeck Burning Grounds

INTRODUCTION

This Phase II Remedial Investigation (RI) Sampling and Analysis Plan (SAP) Addendum for Winklepeck Burning Grounds (WBG) at Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio, has been prepared for RVAAP by Science Applications International Corporation (SAIC) under contract DACA62-94-D-0029, Delivery Order No. 60, with the United States Army Corps of Engineers (USACE), Louisville District. This SAP Addendum has been developed to tier under and supplement the Facility-Wide Sampling and Analysis Plan for the Ravenna Army Ammunition Plant, Ravenna, Ohio (USACE 1996) for the purpose of performing a Phase II RI, as defined in the Facility-wide SAP, at the WBG. The work to be performed includes collection of additional sitewide background characterization data. The Facility-wide SAP provides the base documentation (i.e., technical procedures and investigative protocols) for conducting investigations under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) at RVAAP, whereas the SAP Addenda include all of the investigation-specific sampling and analysis objectives, rationale, and activities, and criteria necessary to perform specific phases of the work [e.g., the Phase I RI of High-Priority Areas of Concern (AOCs) at RVAAP, and the Phase II RI of the WBG]. Consequently, the Phase II RI at WBG cannot be implemented without the guidance provided in both documents. The Facility-wide SAP and the Phase II RI SAP Addendum have been developed following the USACE guidance document, "Requirements for the Preparation of Sampling and Analysis Plans," EM 200-1-3, September 1994 (USACE 1994a), to collectively meet the requirements established by the Ohio Environmental Protection Agency (Ohio EPA), Northeast District, and the U.S. Environmental Protection Agency (EPA), Region V, for conducting CERCLA investigations.

As stated, this SAP Addendum contains only the project-specific details necessary to perform a Phase II RI at WBG. Where appropriate, the Phase II SAP Addendum contains references to the Facility-Wide SAP for base procedures and protocols, and to the Phase I SAP Addendum for specific modifications or additions to established procedures.

1. PROJECT DESCRIPTION

This Phase II Remedial Investigation (RI) of Winklepeck Burning Grounds (WBG) at the Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio, will define the extent of residual contamination identified in soils and groundwater during the Phase I RI (Figure 1-1). Concurrent with the Phase II RI at WBG, additional facility-wide background data will be collected to adequately determine a range of background concentrations for all significant media (surface soils, subsurface soils, sediment, surface water, and groundwater) at RVAAP.

1.1 WBG HISTORY AND CONTAMINANTS

A detailed history of process operations and waste processes for each area of concern (AOC) at RVAAP is presented in the *Preliminary Assessment for the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1996). The following is a summary of the history and related contaminants for WBG.

The WB Grounds (Figure 1-2) has been in operation since 1941 and consists of approximately 80.9 ha (200 acres). Recent activities were limited to a RCRA area at Burning Pad #37, an area of approximately 0.4 ha (1 acre). Prior to 1980, the burning was carried out in four pits, pads, and sometimes on the roads. The pits consisted of areas bermed on three sides, approximately $15.2 \times 22.9 \text{ m}$ ($50 \times 75 \text{ ft}$) in size. Of the four pits, Pit #1 was used most frequently. The pads consisted of $6 \times 12.2 \text{ m}$ ($20 \times 40 \text{ ft}$) areas without berms. Burning was conducted on bare ground and the ash was abandoned on site. Scrap metal was reclaimed and taken to the Landfill North of Winklepeck (RVAAP-19). It is not known how many pads were contained within this 80.9-ha (200-acre) unit. Currently 70 burning pads have been identified from historical drawings and aerial photographs.

According to reports from several former employees at RVAAP, some heavy artillery projectiles were melted out by being placed point side down on 7.6-cm (3-in.) channel irons. The channel irons were placed in a train configuration in a ditch along Road E. Fires were built around the channel irons using scrap wood, straw, and No. 2 fuel oil. A train of projectiles up to 609.6 m (2000 ft) long would sometimes be used in a ditch parallel to a road. The fire would cause the explosives to melt, flow out of the projectile, and burn. Some of the projectiles would explode and be ejected into the surrounding area as far as 152.4 to 182.9 m (500 to 600 ft), usually to the north side of the ditch. Many of the further flung projectiles are still in the field where they landed. In some instances, high-energy material such as black powder and explosives were also laid out in a string along a road and burned (U.S. Army Toxic and Hazardous Materials Agency 1978). Burning is also known to have occurred along Road D.

Prior to 1980, wastes disposed by burning included cyclonite (RDX), antimony sulfide, Composition B, lead oxide, lead thiocyanate, lead thiocyanate, TNT, propellant, black powder, sludge and sawdust from load lines, and domestic wastes. Also, small amounts of laboratory chemicals were routinely disposed of during production periods. Shrapnel and other metallic munitions fragments were allowed to remain on the site after detonation, as were possible residual explosives. Waste oil (hydraulic oils from machines and lubrication oils from vehicles) was disposed



Fig. 1-1. Ravenna Army Ammunition Plant Facility Map



Fig 1-2 Map of Winklepeck Burning Grounds

in the northeast corner of the burning ground until 1973. Ash from these areas was not collected (Jacobs Engineering 1989).

Since 1980, burns have been conducted in metal refractory-lined trays (with subsequent ash collection), set on top of a bed of slag, solely at Burning Pad #37. The trays initially consisted of 1/4-inch boiler plate, 1.2-m \times 18.3-m \times 25.4-cm (4-ft \times 60-ft \times 10-in), and refractory lining. The trays are set on a pad of crushed slag in an area approximately 30.5×30.5 m (100×100 ft) in size. Ash residues were drummed and stored in Building 1601 on the west side of the Burning Grounds. In 1994, four monitoring wells were installed at the active portion of the site (Jacobs Engineering 1989).

Currently three RCRA-regulated units reside within WBG (Figure 1-1) and are in the process of closure. These are the Deactivation Furnace Area, Building 1601, and the Open Burning Ground at Pad #37. Closure plans have been submitted to Ohio EPA for all three of these sites. Additional sampling of surface and subsurface soils at the Deactivation Furnace and Building 1601 in support of closure activities was conducted in the fall of 1997. Following agency approval of the closure plans, closure activities are scheduled to begin in April 1998. These consist of the decontamination and removal of the burning trays at Pad #37, sampling through the floor and outside the doors of Building 1601 and the building's subsequent decontamination, and the removal of the structures and contaminated soils at the Deactivation Furnace. Final closure of the Deactivation Furnace area is dependent on closure sampling to be conducted in 1998, and on the recalculation of site-wide background criteria for metals based on the Phase II RI background sampling results.

1.2 SUMMARY OF EXISTING DATA

Table 1-1 presents a summary of the results of previous investigations for WBG. Three previous investigations have been conducted at WBG: (1) Hazardous Waste Management Study No. 37-26-0442-84 Phase II of AMC Open-Burning/Open-Detonation Grounds Evaluation, Ravenna Army Ammunition Plant (U.S. Army AEHA 1983); (2) Phase I Remedial Investigation of High-Priority Areas of Concern at the Ravenna Army Ammunition Plant (USACE 1997a); and (3) Soil Sample Analysis, Winklepeck Burning Grounds (USACE 1997b). Figures 1-3a, -3b, and -3c present a comprehensive overview of the locations previously sampled. The results of the previous investigations are presented in Appendix A. Existing analytical data are discussed in greater detail in Section 4 of this Sampling and Analysis Plan (SAP) Addendum where the sampling rationale is presented for each medium to be investigated.

1.3 SPECIFIC SAMPLING AND ANALYSIS PROBLEMS

No specific sampling and analysis problems are anticipated.

	USAE	HA 1983 ^c		SAI	SAIC 1996 (Phase 1 RI) ^d			Jenkins 1997 ^{b,e}		
Burning Pad #	# Samples w/detections/ Total Samples	Explosives results (Max. mg/g)	Metals Results (Max. mg/L) ^a	# Samples/ w/detections/ Total Samples	Explosives Results (Max. mg/g)	Metals Results (Max. mg/kg)	# Samples w/detections/ Total Samples	Explosives Results (Max. mg/kg)	Metals Results (Max. mg/g)	
Road D Ditch	7/10	TNT (49.1) HMX (4.4)	ND	3/5	TNT (970)	As (15.1) Ba (226) Cr (16.9) Pb (27.3) Mn (897)				
37	6/7	TNT (22630.0) HMX (2.8) RDX (10.5)	ND	0/4	ND	Ba (173) Cd (1.8) Pb (108J) Mn (1840)	21/24	TNT (2.6) HMX (36) RDX (40.4)	NA	
38	4/5	TNT (165.7) HMX (19.4) DNT (10.6)	Cd (1.3) Pb (0.5)	0/2	ND	As (10.5J) Ba (596J) Cd (877J) Cr (27.2J) Pb (504) Mn (2170)				
39	0/6	ND	ND	0/1	ND	As (12.3J) Ba (41.9 J) Cd (0.24J) Pb (18.1J) Mn (275)				
40	0/5	ND	ND	0/1	ND	As (16.1J) Ba (67.3J) Cd (0.42J) Pb (189) Mn (861)				

Table 1-1. Summary of Previous Results from Soil and Sediment Sampling at Winklepeck Burning Grounds

Table 1-1 (continued)

	USAEI	HA 1983 ^c		SAI	SAIC 1996 (Phase 1 RI) ^{<i>d</i>}			Jenkins 1997 ^{b,e}		
Burning Pad #	# Samples w/detections/ Total Samples	Explosives results (Max. mg/g)	Metals Results (Max. mg/L) ^a	# Samples/ w/detections/ Total Samples	Explosives Results (Max. mg/g)	Metals Results (Max. mg/kg)	# Samples w/detections/ Total Samples	Explosives Results (Max. mg/kg)	Metals Results (Max. mg/g)	
52	1⁄2	RDX (2.0)	ND	0/1	ND	As (13.5) Ba (62.9) Cd (0.2J) Pb (14.4J) Mn (269)				
58	0/4	ND	ND	0/1	ND	As (19) Ba (174) Cd (4.6) Pb (202) Mn (575)				
59	5/7	TNT (27.2) RDX (5.0) HMX (2.7)	Cd (1.2) Pb (5.1)	1/2	TNT (33,000J)	As (12.1) Ba (96.1) Cd (1.3) Cr (118) Pb (916) Mn (405)				
60	4/7	TNT (36.0) HMX (3.1)	Cd (3.6) Pb (3.1)	1/2	TNT (300J)	As (11.6) Ba (207) Cd (15.1) Cr (27.8J) Pb (721J) Mn (428)				

Table 1-1 (continued)

	USAEHA 1983 ^c		SAI	SAIC 1996 (Phase 1 RI) ^{<i>d</i>}			Jenkins 1997 ^{b,e}		
Burning Pad #	# Samples w/detections/ Total Samples	Explosives results (Max. mg/g)	Metals Results (Max. mg/L) ^a	# Samples/ w/detections/ Total Samples	Explosives Results (Max. mg/g)	Metals Results (Max. mg/kg)	# Samples w/detections/ Total Samples	Explosives Results (Max. mg/kg)	Metals Results (Max. mg/g)
65	0/4	ND	ND	1/1	TNT (530)	As (17.2) Ba (170) Cd (0.12J) Cr (23) Pb (49.2) Mn (390)			
66	7/7	TNT (98.5) RDX (137.8) HMX (25.2) DNT (2.7)	Ba (197.0)	2/2	TNB (76,000) TNT (4x10 ⁶)	As (15.6) Ba (7780) Cd (4.8) Cr (16.5) Pb (289) Mn (784)			
67	4/4	TNT (2263.0) RDX (2976.0) HMX (686.1)		3/3	TNB (490,000) TNT (3x10 ⁶) HMX (2x10 ⁶) RDX (1x10 ⁷)	As (15.8) Ba (377) Cd (2.3J) Cr (12.5) Pb (54.7) Mn (568)	26/28	TNT (12100) HMX (292) RDX (1650)	Cd (7.97) Be 1.61) As (38.1) Pb (460)

^aResults shown are EP toxicity (liquid) extractions from soils for arsenic, barium, cadmium, chromium, lead, mercury, silver, and selenium.

^bResults shown are SW-846 Method 8330 for explosives and 3050A for metals, not colorimetric field laboratory results.

^{*c*}Sample depth 0 - 6 inches.

^{*d*}Sample depth 0 - 2 feet.

^eSample depth 0 - 6 inches, 6 - 12 inches, & 12 - 18 inches

NA = not analyzed

ND = not detected



Fig 1-3a Location of 1983 USAEHA WBG Investigation Sampling Stations



Fig 1-3b Location of Phase I RI WBG Sample Stations





Fig 1-3c Location of USACE 1997b Investigation Sample Stations

2. PROJECT ORGANIZATION AND RESPONSIBILITIES

The Phase II RI project organization and responsibilities are presented in Figure 2-1. The functional responsibilities of key personnel are described in Section 2 of the Facility-Wide SAP and, therefore, are not presented here. Figure 2-1 shows the Project Organization Chart for the Phase II RI of WBG. Figure 2-2 presents the planned project schedule.



Figure 2-1. Project Organization Chart for the Phase II RI for WBG at RVAAP

98-002MS/012198

ACTIVITY	ORIG	EARLY	EARLY	1997 1998 1999
DESCRIPTION	DUR	START	FINISH	MJJASONDJEMAMJJASONDJEMA
				Task 1 Scoping Meeting
Scoping Meeting - Task 1	204	6MAY97A	16FEB98	
Scoping Meeting	5	6MAY97A	9MAY97A	
Final Phase I RI Report	25	13JAN98A	16FEB98	
				Task 2 Project Plans
Notice to Proceed	0	10NOV97A	· · · · · · · · · · · · · · · · · · ·	
Project Plans - Task 2	71	1DEC97A	10MAR98	
Evaluate Existing Data	10	1DEC97A	12DEC97A	
Draft Work Plan Addenda	25	15DEC97A	19JAN98	
Submit Draft Work Plan Addenda	0		19JAN98	
Review of Draft WP Addenda	15	20JAN98	9FEB98	
Draft Work Plan Addenda Meeting	5	11FEB98	17FEB98	
Final Work Plan Addenda	10	18FEB98	3MAR98	
Approval of Final WP Addenda	5	4MAR98	10MAR98	
				Task 3 Community Relations
Community Relations - Task 3	_331	12NOV97A	19FEB99	
RAB Meetings	331	12NOV97A	19FEB99	
Monthly Reports	279	15JAN98	10FEB99	
				Task 4 Field Investigations
Field Investigation - Task 4	20	13APR98	8MAY98	
Mobilization	5	13APR98	17APR98	
Readiness Review	2	16APR98	17APR98	
Soil Sampling	12	20APR98	5MAY98	
Well Installation	8	20APR98	29APR98	
Groundwater Sampling/Test	5	4MAY98	8MAY98	
	••••••			Task 5 Background Investigation
Background Investigation - Task 5	23	4MAY98	3JUN98	
Well Installation	17	4MAY98	26MAY98	
Groundwater Sampling/Test	9	22MAY98	3JUN98	
Sediment/Surface Water Sampling	2	13MAY98	14MAY98	
	·			Task 6 Survey/Mapping
Survey/Map - Task 6	120	15DEC97A	1JUN98	
Phase I Mapping	10	15DEC97A	29DEC97A	
				Sheet 1 of 2
Data Date 15JAN98 Critical Activity Project Carte 1 HIN 7		Project S	Schedule	Date Port-t-
Project Finish 6APR99		RVAAP Pha	se II RI	Checked Approved
(C) Primavera Systems, Inc.	Wi	nklepeck Bu	rning Grounds	3

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Figure 2-2. Project Schedule for the Phase II RI for WBG at RVAAP

2-3

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ACTIVITY	ORIG	EARLY	EARLY	1997		97		1998				1999	
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Final IDW Report	20	17AUG98	11SEP98]		
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3. SCOPE AND OBJECTIVES

3.1 PHASE II RI SCOPE AND OBJECTIVES

The scope of this investigation is to determine the extent of contamination in affected media (soils, sediments, surface water, and groundwater) identified during the Phase I RI at WBG. The primary objectives of the Phase II RI are as follows:

- Characterize the physical environment of WBG and its surroundings to the extent necessary to define potential transport pathways and receptor populations and provide sufficient engineering data for preliminary screening of remedial action alternatives. This includes collection of additional facility-wide background soils, sediments, surface water, and groundwater data to augment the Phase I RI background characterization.
- Characterize the sources of contamination at WBG sufficient to evaluate remedial actions. Information on source locations, types and amounts, potential releases, physical and chemical properties of wastes present, and engineering characteristics will be evaluated.
- Characterize nature and extent of contamination at WBG such that a baseline risk assessment can be conducted to evaluate the potential threats to human health and the environment and to develop human health-based Preliminary Remediation Goals (PRGs) for use in determining areas that may require remediation and evaluating remedial alternatives during a Feasibility Study.
- Additionally, characterize facility-wide background soils, sediments, surface water, and groundwater data to augment the Phase I RI background investigation and to adequately determine a range of background chemical data for other significant media (e.g., groundwater, surface water and sediment).

Investigation-specific objectives have been developed using the Data Quality Objective (DQO) approach presented in the Facility-Wide SAP. Project-specific sampling objectives are presented for each environmental medium in Section 4 of the Facility-Wide SAP.

3.2 PHASE II RI DATA QUALITY OBJECTIVES

The project DQO is to provide sufficient high-quality data to address the primary project objectives identified in Section 3.1.

3.2.1 Conceptual Site Model

The conceptual site model presented in the Facility-Wide SAP is applicable to WBG for this Phase II RI, based on current knowledge. Information collected during the Phase I RI of High Priority Areas of Concern (USACE 1997) has also been used to refine the current model as follows:

Soils:

- Seventy-nine surface soil samples were collected from 0 to 0.15 m (0 to 0.5 ft) at former burning pads and roadside ditches and analyzed for explosives and metals during the Phase I RI. Explosives are present in several concentrated areas within the AOC, primarily on burning pads located along the south side of Pallet Road E East and E West; on the south side of Pallet Road C East [near the burning trays known as the Open Burning Ground (OBG)], and on the south side of Pallet Road A West. TNT was the most commonly detected explosive compound occurring in 19 samples with concentrations ranging from 0.230 to 3,800 mg/kg. The highest concentrations occur along Pallet Road E East on burning pads Nos. 66 and 67.
- Inorganics are present at concentrations above the Phase I RI site-wide background criteria for soils in 61 of the 79 sample locations. The distributions of metals are similar to the distribution of explosives: primarily on burning pads located along the south side of Pallet Road E East and E West; on the south side of Pallet Road C East (near the burning trays); and, to a lesser extent, on the south sides of Pallet Road C West and Pallet Road A West. Of the metals analyzed, cadmium, lead, barium, zinc, manganese chromium, silver, mercury, and aluminum were present above background concentrations in many locations. The other metals do not have background criteria to compare against.
- Organic compounds were present in four of the seven samples in which these compounds were evaluated. Three volatile organic compounds (VOCs) (toluene, chloroform, and methylene chloride) were detected at low concentrations. Seven semivolatile organic compounds (SVOCs), including four PAHs and two naphthalenes, were also detected. The distributions of these compounds are similar to those for inorganics and explosives described above and in Table 1-1.

Sediment:

- Thirteen drainage ditch samples were collected from 0 to 0.15 m (0 to 0.5 ft) and analyzed for explosives. Eleven of these were also analyzed for process-related metals, and two samples additionally received analysis for cyanide, VOCs, SVOCs, and polychlorinated biphenyls (PCBs)/pesticides.
- TNT was detected in three sediment samples from drainages samples during the Phase I RI at points from roadside ditches where burning was reported to have occurred. No other explosives compounds were identified in sediments, and explosives were not detected in soils in this general area. No explosives or metals above background were detected in sediments from drainages at points where they exit the WBG. However, two drainages located north of Pallet Road E, West were not sampled where they exit the burning grounds; however these drainages were sampled downstream of WBG during the Phase I RI. No explosives were detected.
- Aluminum, barium, chromium, lead, manganese, and zinc were all detected at concentrations exceeding the background criteria, in all but 2 of the 13 samples.
- Chloroform and toluene were detected in the two sediment samples analyzed for organic chemicals.

Groundwater was not investigated as part of the Phase I RI at WBG; however, groundwater monitoring results are available from 15 sampling events from the 4 monitoring wells at the OBG in the WBG regulated under the Resource Conservation and Recovery Act (RCRA). Two sampling events were conducted in 1992, and quarterly sampling events have been conducted thereafter. The analytical results, presented in Appendix D of the Revised Closure Plan for the OBG Hazardous Waste Treatment Unit (USACE 1997c), indicate a potential impact to groundwater quality from activities at the OBG. However, careful review of the analytical results reveals inconsistencies and possible sampling or laboratory errors. For example:

- 1,2-Dichloroethane was detected in three wells during the October 5, 1995, sampling event, and has not since been detected.
- RDX was detected in two wells during the November 11, 1993, sampling event, and has not since been detected.
- Selenium was detected only once, in well OBG-4 (43.0 mg/L), during the October 5, 1995, sampling event; detected at concentrations of 1.0 and 2.0 mg/L in the September 23, 1994, sampling event in OBG-2 and OBG-3, respectively; and also detected at concentrations of 2, 4, and 3 mg/L in the March 21, 1996, sampling event in OBG-1, OBG-2, and OBG-3, respectively.

In summary, the evaluation of groundwater at OBG in particular, and at WBG as a whole, has produced inconclusive results. Although statistical analysis of water quality indicator parameters has shown some local impact on the groundwater, the evidence of these is sporadic and shows no definite trend.

There is currently no evidence of off-site migration of contaminants in soils or sediment at WBG, although the drainage south of WBG and Mack's Pond have yet to be sampled. Although there is some isolated evidence of groundwater contamination in the four existing wells, there is not sufficient information to determine the impacts of surface soil and subsurface soil contamination on the groundwater system within or outside the site boundaries.

3.2.2 Problem Definition

Open burning of explosive wastes and munitions on earthen burning pads has potentially contaminated surface and subsurface soils. There is a potential for contaminant migration to groundwater via subsurface soils. The potential for surface water runoff to drainage ditches and surface water bodies is lessened given the results of the Phase I RI and geographic distance from surface water bodies, although two drainages are still to be sampled. A 1983 USAEHA investigation of 11 active burning pads found significant concentrations of explosives and metals in surface soils and in one drainage ditch. The Phase I RI demonstrated that contamination is present in surface soils, with the highest concentrations occurring on burning pads located in the northeastern portion of the burning grounds. RCRA quarterly monitoring of groundwater has shown that indicator parameters intermittently exceed statistical triggers.

The overall Phase I RI findings for the WBG identify 13 burning pads that require additional characterization data in order to determine the extent (horizontal and vertical) of surface and near-surface soil contamination. For the purposes of selecting areas where the extent of contamination in soils needs to be delineated, the guidelines outlined below are used. Extent of soil contamination

investigations addressed in this SAP are aimed at sampling locations or areas investigated in Phase I RI where the measured levels of residual soil contamination were as follows:

- greater than 1 mg/kg of explosives, or
- greater than 100 mg/kg of lead, or
- greater than 10 mg/kg of PCBs.

These levels are known to be protective of human health (e.g., 1 ppm TNT is 1/10 of EPA Region IX value for protection of human health). Using these criteria and the results from the Phase I RI, 13 burning pads require additional sampling to characterize extent of contamination.

Criterion	Burning Pads Exceeding Criterion	No. of Pads Exceeding Criterion					
Explosives > 1 mg/kg	5,6, 37, 38, 58, 59, 62, 66, 67	9					
Lead > 100 mg/kg	37, 38, 40, 58, 59, 60, 61, 62, 66, 67, 68	11					
PCBs > 10 mg/kg	None	NA					

NA = not applicable

3.2.3 Remedial Action Objectives

See Section 3.2.3 of the Facility-Wide SAP.

3.2.4 Identify Decisions

The key decisions for all investigations at RVAAP have been identified in Table 3-1 of the Facility-Wide SAP. Phase II data are necessary to address these decisions further.

3.2.5 Define the Study Boundaries

The investigation area boundary for WBG is that presented in Figure 1-2. This boundary was established to encompass all known or reported historical burning operations and potential surface water exit pathways.

3.2.6 Identify Decision Rules

Decision rules used to guide remediation decisions are provided in Section 3 of the Facility-Wide SAP. As stated therein, Phase I data were not sufficient to define nature and extent of contamination and, therefore, risk due to exposure to these contaminants.

3.2.7 Identify Inputs to the Decisions

Input to the decisions are analytical results that can be used to estimate risk.

3.2.8 Specify Limits on Decision Error

Limits on decision errors are addressed in Section 3.2.8 of the Facility-Wide FSP.

3.2.9 Optimize Sample Design

The sample design for the Phase II RI of WBG will be described in detail in Section 4 of this SAP Addendum.

3.3 DATA EVALUATION METHODS

The methods for identifying site-related chemicals are described in the following sections. The general process for identifying site-related chemicals involves four steps: initial data reduction, background characterization, background comparison, and weight of evidence screening. Analytical results are reported by the laboratory in electronic form and loaded into a database. Site data are extracted from the database so that only one result was used for each station and depth sampled. Quality control data such as sample splits and duplicates and laboratory reanalyses and dilutions will not be included in the definition of nature an extent or in the risk assessment. Samples rejected in the validation process also will be excluded. If it is found that a significant number of samples is rejected, the aggregate data set will be evaluated to determine if a representative data set exists without the rejected data. The percentage of rejected data will be presented in the Data Quality Assessment in the RI Report. Results from the site-specific background data collection will be used to determine if detected metals and potential anthropogenic compounds [such as polyaromatic hydrocarbons (PAHs)] are site related or naturally-occurring.

3.3.1 Determination of Site Chemical Background

Background results for all media will be used to develop site-specific background criteria. The site-specific background criteria will be determined using the following procedure:

- (1) Group analytes into one of three frequencies of detection categories:
- Frequency of detection \geq 50%.
- Frequency of detection between 0% and 50%.
- Frequency of detection = 0% (all non-detects).
- (2) When frequency of detection $\ge 50\%$, determine the best fit distribution for each analyte using the Shapiro-Wilk test. Use normal data and log-transformed data to test the hypothesis that data are normally distributed; if one fit is statistically significant (p >0.05), assign the distribution. If both fits have associated confidence of p >0.05, select the fit based on the largest p-value. Calculate the 95% Upper Tolerance Limit (UTL) using either the data or log-transformed data:

$$UTL = x + k(STD_x),$$

where:

- x = arithmetic mean of the background data,
- k = appropriate tolerance factor for one-sided tolerance interval,
- STD_x = standard deviation of the background concentrations.

If the UTL is greater than the maximum detected background concentration, use the maximum detected background concentration for the background criteria.

If the distribution is neither normal or log-normal (where p > 0.05), calculate the nonparametric UTL as described by Walpole and Myers (1978).

- (3) If the frequency of detection is between 0% and 50%, there is very little confidence that the background distribution can be adequately characterized. In this situation, use the 99th percentile of the background data as the background criteria.
- (4) If the frequency of detection is 0% (no detects), use the largest reported quantitation limit for the background screen.
- (5) If fewer than three samples are available for a given chemical, use the maximum detected background concentration for the screen.

Based on this procedure, the background criteria was set to the maximum detected result for all analytes.

3.3.2 Definition of Aggregates

Data collected from the WBG will be evaluated in two ways. First, data will be evaluated on a unitwide scale. Summary statistics, including an upper confidence limit on the mean, will be developed for the entire WBG data set. Second, "hot spot" areas will be identified spatially. Focused discussions will take place for these areas in both the "nature and extent" and the risk assessment.

3.3.3 Data Screening

For each soil aggregate the concentration of each metal for each sample will be compared to the background criteria. A metal will be considered site related if it is detected above the background criteria in more than 5% of the samples analyzed. If necessary, additional evidence may be used, including U.S. Geological Survey data for metal concentrations in surface soils in Ohio (USGS 1981).

Some metals that are essential elements will not be evaluated as contaminants in the human health risk assessment. Naturally occurring essential elements include calcium, iron, magnesium, potassium, and sodium. These chemicals are an integral part of the country's food supply, and are often added to foods as supplements, and thus are not generally addressed as contaminants. Data on these inorganics will be used to evaluate the subsurface geochemistry.

3.4 HUMAN HEALTH RISK ASSESSMENT

Using the results of the Phase II RI sampling at the WBG, a baseline human health risk assessment (HHRA) will be performed. The purpose of the risk assessment is to define the potential health risks associated with various current and future uses of the land at the WBG. The risk assessment will be performed in accordance with methods presented in the *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, (Part A)* (RAGS) (EPA 1989). Additional methodology has been taken from:

Dermal Exposure Assessment: Principles and Applications (EPA 1992b) Human Health Evaluation Manual, Supplemental Guidance "Standard Default Exposure Factors" (EPA 1991) Exposure Factors Handbook (EPA 1989) U.S. EPA Integrated Risk Information System Health Effects Summary Tables

The process used to accomplish the objectives of this risk assessment are:

- identify all chemicals of potential concern (COPCs) at the site,
- conduct an exposure assessment for site-related chemicals of concern,
- assess the toxicity of site-related chemicals of concern,
- quantify risks to human health, and
- identify health-based remediation cleanup goals.

3.4.1 Selection of Chemicals of Concern

The first step in the risk process involves identifying the COPCs. This step involves:

- screening data against available background data,
- screening data against risk-based screening levels, and
- evaluating remaining chemicals using various additional screens, as defined below.

Only validated data will be used for the assessment. Data flagged with an "R" qualifier during the analytical validation process will be evaluated for their usability. "Unusable" data will be excluded from the data set. The major data quality issue during Phase 1 stemmed from the need to dilute samples for explosives analysis because of the high concentrations of TNT in the samples. As the samples were diluted (generally 10 or 100 times) in order to be able to quantify results, the detection limit increased, generally on the same order as the dilution. The dilutions resulted in unacceptable detection limits for several analytes, primarily DNT. Several of the elevated detection limits exceed the risk-based screening criteria. In this situation, it is impossible to determine whether the analyte is present in the sample at levels above or below the risk-based screening values, and thus the results can not be used to determine if action is necessary to address that analyte. Since this occurred only with samples from the Load Line AOCs, it is not expected to be a problem for the WBG.

The first screening step is to screen results against naturally occurring, or "background" concentrations. Chemicals detected at levels below background concentrations will not be considered COPCs. The background screening process is described in detail in Section 3.3.

The second step of the process is to screen data against the risk-based screening value. These values are very conservative (based on 10^{-7} risk levels and a hazard quotient of 0.1). Chemicals detected below these concentrations are screened from further consideration. Risk-based screening levels used in the assessment are discussed in Section 5.0 of the Phase 1 Report and provided in Appendix A.

Additional data screens used to define COPCs are:

• Excluded essential human nutrients, including iron, magnesium, calcium, potassium, and sodium.
- For sample aggregations with >20 samples, analytes detected in <5% of the total samples in that aggregate will be screened out.
- Screen individual chemical results with unusually high detection limits because they could lead to risk estimates that would be unreasonably conservative.

Once all screens have been performed, a list of COPCs will be developed for each data aggregate. The COPCs will be further evaluated in the remaining steps of the baseline risk assessment (BRA).

3.4.2 Exposure Assessment

This section describes the exposure setting, develops information on exposure pathways, estimates the contaminant concentrations at points of human exposure, and determines receptor intakes.

3.4.2.1 Site Setting

The RVAAP installation is located in two counties of northeastern Ohio, Portgage County and Trumbell County, with a majority of the facility lying in Portgage County. According to the 1990 Census, the total population of Portgage and Trumbell counties was 142,585 and 227,813, respectively. The largest population centers in the area are the town of Ravenna (population 12,069), located approximately 2 miles to the west, and Newton Falls (population 4866), located approximately 1 mile to the southeast.

Land use within the facility is restricted access industrial. At the present time the RVAAP is an inactive facility maintained by a contracted caretaker, Mason and Hanger-Silas Co., Inc. Site workers infrequently visit the AOCs for maintenance purposes, e.g. mowing. The Ohio National Guard (ONG) also occupies parts of RVAAP and conducts training exercises. Personnel from the ONG may occasionally travel through AOCs at RVAAP but generally restrict training to areas outside of AOCs. No training exercises are known to be conducted within the WBG. The land use immediately surrounding the facility is primarily rural. Approximately 55 percent of Portage County is either woodland or farmland (Portgage County Soil and Water Conservation District Resources Inventory 1985; Census Bureau 1992). To the south of the facility is the Michael J. Kirwan Reservoir, which serves as a potable water source and is used for recreational purposes. The Reservoir is south of the site, across State Route 5. The Reservoir is fed by the West Branch of the Mahoning River, which flows south along the western edge of the installation. Hinkley Creek flows south across the western portion of the facility and eventually flows into the West Branch of the Mahoning River. The major surface drainages at RVAAP, Sand Creek and the South Fork of Eagle Creek, exit the facility property and eventually flow east to the Mahoning River.

Residential groundwater use occurs outside of the facility, with most of the residential wells tapping into the either Sharon Conglomerate or the surficial unconsolidated aquifer. Groundwater from onsite production wells was used during operations at the facility (SAIC 1996); however, all but two production wells have been abandoned at the facility. These wells, located in the central portion of the facility, provide sanitary water to the facility. The Sharon Conglomerate is the major producing aquifer at the facility. The chemicals detected in the soil at WBG during Phase 1 are generally relatively immobile explosives and metals and, therefore, are unlikely to migrate to groundwater. RCRA groundwater sampling from four monitoring wells located at WBG indicates very limited impact, if any, to groundwater has occurred (Section 3.2.1). In addition, groundwater sampling of

selected residential wells adjacent to RVAAP conducted by the Ohio EPA during 1997 found no indications of explosives in groundwater at the locations sampled.

Currently surface water is primarily used by wildlife. Based on conversations with site personnel, it is likely that some recreational trespasser use of surface water does occur on a limited basis, primarily associated with fishing. It is unlikely that any fishing occurs near the WBG since the drainages at the site are small and intermittent.

Future uses of the site are currently being determined; potential future uses include:

- continued storage of bulk explosives short term (<5 years);
- continued use of certain areas for training purposes by the ONG;
- expanded training and occupancy by the ONG to encompass the entire facility (long term) >5 years; and
- recreational use, e.g., hunting, fishing, hiking.

3.4.2.2 Selected Exposure Pathways

A complete exposure pathway consists of the following four elements: (1) a source and mechanism of contaminant release to the environment; (2) an environmental transport mechanism (fate and transport) for the released contaminants; (3) a point of human contact with the contaminated media (exposure point); and (4) a route of entry of the contaminant into the human receptor (exposure route) at the exposure point. An integration of sources and releases, fate and transport mechanisms, exposure points, and exposure routes is evaluated for complete exposure pathways.

Based on ongoing activities at RVAAP, current human receptors include:

- maintenance workers;
- military personnel, specifically ONG Training personnel; and
- recreational users (e.g., hunters).

Future potential receptors include all of the above plus

- construction workers and
- resident farmers.

Table 3-1 indicates potential pathways associated with each of the receptors. A complete summary of exposure parameters and models proposed for use in the risk assessment are presented in Appendix C.

3.4.2.3 Exposure Point Concentration

The exposure point concentration is regarded as a reasonable maximum average concentration in an environmental medium that a receptor will encounter over the exposure period. The WBG risk assessment will evaluate the reasonable maximum exposure (RME). The RME is an estimate of the highest exposure reasonably expected to occur at a site. Because of the uncertainty associated with

any estimate of exposure concentration, the UCL₉₅ for either a normal or lognormal distribution is the recommended statistic (EPA 1992a). A UCL₉₅ for the combined surface and subsurface soil data was used to represent the exposure point concentration for the receptors at WBG. In cases where the UCL₉₅ exceeded the maximum detected concentration, the maximum concentration was used as an estimate of the RME. Table 3-1 summarizes the exposure point concentrations used to estimate exposure at the sites.

Media/Pathway	Maintenance Worker	Military Personnel	Recreational/ Trespasser	Construction Worker	Industrial Worker	Resident Farmer
Soil						
Incidental Ingestion	•	•	•			
Dermal Contact	•	•	•			
Inhalation of Dust	•	•	•			
Subsurface Soil						
Incidental Ingestion	•					
Dermal Contact	•					
Inhalation of Dust	•					
Sediment						
Incidental Ingestion	•					
Dermal Contact	•					
Inhalation of Dust	•					
Surface Water				•		
Ingestion						
Dermal Contact						
Dermal Contact while Swimming						
Groundwater			-	-		
Ingestion						
Dermal Contact						
Ingestion of Foodstuffs (vegetable, meat, f	fish)	-	-		
Ingestion			▲ (fish and deer)			

 Table 3-1. Conceptual Exposure Model for WBG at RVAAP

Current pathway.

Potential pathway.

Potential complete pathway.

3.4.2.4 Quantification of Exposure

For estimating exposures at WBG, typical exposure models and parameter values from RAGS and from other regulatory guidance documents will be used. Parameter values include exposure frequencies, exposure times, and exposure durations, as well as chemical-specific values to describe chemical partitioning and uptake. Some site-specific parameters will be identified, primarily

associated with ONG training personnel and for recreational users. Parameter values for use in the risk assessment will be submitted to the OEPA prior to performing the baseline risk calculations.

The most likely pathways that will be quantified for exposures to contaminants at WBG are soil ingestion, dermal contact with soil, and inhalation of soil particles. For the future resident farmer, ingestion of foodstuff will also be addressed. For the industrial worker, only partial ingestion exposure to groundwater will be included. Additional pathways may be quantified as needed (e.g., inhalation of volatiles) but are not discussed below. The methodology used to estimate intakes is provided in Appendix C. Summaries of these equations are provided below. Intakes from ingestion are:

Chemical Intake
$$(mg/kg-d) = \frac{C \times IR \times CF \times EF \times ED}{BW \times AT}$$

where:

С	=	chemical concentration in environmental medial (mg/kg; mg/L),
IR	=	ingestion rate (mg/d; L/d),
CF	=	conversion factor (10 ⁻⁶ kg/mg - soils only),
EF	=	exposure frequency (days/year),
ED	=	exposure duration (years),
BW	=	body weight (kg),
AT	=	averaging time (carcinogens: 25,550 days; noncarcinogens: ED × 365 days).

The absorbed dose from **dermal contact with soil** is calculated using the method presented in the EPA Dermal guidance (1992) as follows:

Chemical DAD
$$(mg/kg-d) = \frac{C_s \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$
,

where:

DAD	=	dermally absorbed dose,
C _s	=	chemical concentration in soil (mg/kg),
CF	=	conversion factor (10^{-6} kg/mg) ,
SA	=	skin surface area exposed to soil (cm ² /day),
AF	=	soil to skin adherence factor (mg/cm ²),
ABS	=	absorption factor (chemical-specific),
EF	=	exposure frequency (days/year),
ED	=	exposure duration (years),
BW	=	body weight (kg),
AT	=	averaging time (carcinogens: $25,550$ days; noncarcinogens: ED \times 365 days).

The concentration of a **contaminant concentration in particulated dust** is calculated using a dust loading factor based on typical site activity by the following equation (DOE 1989):

$$C_d = C_s * K ,$$

where:

C _d	=	concentration in dust (mg/m^3) ,
Cs	=	concentration in soil (mg/kg),
Κ	=	dust loading factor (kg of soil/m ³ of air).

The intake for inhalation of soil particulates was calculated as follows:

Chemical Intake
$$(mg/kg-d) = \frac{C_d \times IR \times ET \times EF \times ED}{BW \times AT}$$
,

where:

C _d	=	contaminant concentration in air (mg/m ³),				
IR	=	inhalation rate (m ³ /hr),				
ET	=	exposure time (hr/day),				
EF	=	exposure frequency (days/year),				
ED	=	exposure duration (years),				
BW	=	body weight (kg),				
AT	=	averaging time (25,550 days for carcinogens, ED \times 365 days for				
		noncarcinogens).				

Evaluation of ingestion of foodstuff will be based on modified equations presented in Baes et al. (1984).

3.4.3 Toxicity Assessment

The toxicity assessment will be performed using standard EPA-derived toxicity. Toxicity factors have not been developed for several explosives derivatives. In these cases, EPA, and Army toxicologists will be consulted. The two primary toxicity factors used in the risk assessment include the cancer slope factor (CSF) and the reference dose (RfD). The CSF is defined as a plausible upperbound estimate of the probability of a response (e.g., cancer) per unit intake of a chemical over a lifetime (EPA 1989). Slope factors are specific for each contaminant and route of exposure. The potential for noncarcinogenic health effects resulting from exposure to chemicals is assessed by comparing an intake or dose to a RfD. The chronic RfD is defined as an estimate of daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime (EPA 1989). An RfD is also specific to a chemical and route of exposure.

Oral and inhalation CSF and RfDs are currently available. The inhalation values take into consideration a fractional amount of chemical absorbed by the mucus membranes into the blood. The oral values take into consideration a fractional amount of contaminant absorbed across the

gastrointestinal (gi) tract into the bloodstream when estimating toxic doses. Dermal CSFs and RfDs will be estimated from the oral toxicity values using chemical-specific gut absorption factors to calculate the total administered dose by the following equations (EPA 1992b):

$$CSF_{dermal} = CSF_{oral} / ABS_{gi}$$
,
 $RfD_{dermal} = RfD_{oral} \times ABS_{gi}$,

where:

CSF	=	chemical-specific cancer slope factors (mg/kg-day) ⁻¹
RfD	=	chemical-specific reference doses (mg/kg-day),
ABS_{gi}	=	chemical-specific gut absorption factor (unitless).

Gut absorption factors provided in the EPA Dermal Guidance document (EPA 1992b) will be used to estimate dermal toxicity values.

3.4.4 Risk Characterization

Risk characterization integrates the findings of the exposure assessment to estimate the likelihood that receptors experience adverse effects as a result of exposure to COPCs (EPA 1991). Risks will be calculated from toxicity information and the results of the exposure assessment. For carcinogens, incremental lifetime cancer risks (ILCRs), or the increased lifetime probability of cancer, will be calculated. These ILCRs represent the increase chance above the background of contracting cancer. In the United States, the background chance is approximately 3 chances in 10, or 3×10^{-1} (American Cancer Society 1990). The resulting ILCRs are compared to the range specified in the National Contingency Plan (NCP) (EPA 1990) of 10^{-6} to 10^{-4} , or 1 in 1 million to 1 in 10,000 persons developing cancer. ILCRs below 10^{-6} are considered acceptable risks. ILCRs above 10^{-4} , are considered unacceptable risks. For risks between 10^{-6} and 10^{-4} and any decisions to address them further either through further study or engineered control measures should carefully weight the risk benefit and cost impact of the action. The risk of developing cancer will be determined as follows (EPA 1989):

$$ILCR = I \times CSF$$

where:

ILCR	=	Incremental Lifetime Cancer Risk (unitless probability),
Ι	=	chronic daily intake or dermally absorbed dose from exposure assessment
CSF	=	(mg/kg-day or pCi), Cancer Slope Factor (mg/kg-day) ⁻¹ .
CSF	=	Cancer Slope Factor (mg/kg-day) ² .

For a given pathway, with simultaneous exposure of a receptor to several carcinogens, the total risk to a receptor is the sum of the ILCRs for each carcinogen encountered in all sources and each pathway. The equation that will be used to calculate the total ILCR is :

$$ILCR_{total} = \sum ILCR_i$$

where:

In addition to developing cancer from exposure to contaminants, an individual may experience toxic effects from exposures to hazardous substances. The term "toxic effects" describes a wide variety of systemic effects, ranging from minor irritations such as eye irritation and headaches to more substantial effects such as kidney or liver disease and neurological damage. The risks associated with toxic chemicals are evaluated by comparing an exposure level or intake to a reference dose. The reference dose is the threshold level below which no toxic effects are expected to occur in a normal population, including sensitive subpopulations. The ratio of intake over the reference dose is termed the hazard quotient (HQ) (EPA 1989) and is defined as:

$$HQ = \frac{I}{RfD}$$

where:

HQ	=	Hazard Quotient (unitless ratio),
I	=	daily intake of a contaminant (mg/kg-day),
RfD	=	Reference Dose (mg/kg-day).

The HQs for each contaminant are summed to obtain a hazard index (HI). An HI >1 has been defined as the level of concern for potential adverse noncarcinogenic health effects (EPA 1989). This approach is different from the probabilistic approach used to evaluate carcinogens. An HQ of 0.01 does not imply a 1 in 100 chance of an adverse effect, but indicates only that the estimated intake is 100 times less than the threshold level at which adverse health effects may occur. In the case where simultaneous exposure of a receptor to several chemicals occurs, a total HI is calculated as the sum of the individual HQs for all noncarcinogens encountered in all sources for each pathway as follows:

$$HI = \sum HQ_i$$

where:

HI	=	Total Hazard Index for toxic effects,
HQ	=	Hazard Quotient for the i th contaminant.

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A total ILCR and a total HQ associated with each media for each receptor will be estimated by summing the pathway-specific values. HQs will be summed where multiple chemicals affect the same organ or affect similar processes, or have similar methods of toxicity.

Chemicals of concern (COCs) will be identified as those COPCs that exceed acceptable risk criteria for each receptor and pathway. The COCs will be specific to media and receptor. These chemicals represent the main contributors to human health risks at the site that will need to be addressed during remedial action.

3.4.5 Uncertainty Analysis

There is uncertainty associated with every risk assessment. Assumptions built into a risk assessment tend in general to overestimate rather than underestimate potential risks, but occasionally can result in underestimating risk. For example, it is assumed that the toxic and carcinogenic effects of the COCs are additive with respect to pathway and media. This assumption can result in an underestimation of risks due to synergistic toxic effects, or an overestimation of risks due to antagonistic toxic effects. In addition, the risk parameters typically used reflect an upper bound for the population. These upperbound assumptions compounded for each parameter may result in an overestimation of risks to the typical population.

As part of the risk evaluation for the WBG, uncertainties will be identified and addressed where ever possible in order to better use the risk results.

3.4.6 Preliminary Remedial Goals

The Baseline HHRA will develop PRGs for chemicals where an unacceptable risk is identified that may potentially require remediation. PRGs will only be used if a remedial action is warranted. If necessary, PRGs will be developed using RAGS Part B equations and parameters developed in conjunction with the risk manager prior to completing the Draft Phase II RI Report. These values are risk-based criteria that are used in the Feasibility Study to define the extent of contamination in an area that must be remediated to help cost various alternatives. The results of the ERA as well as land use decisions are also a factor in evaluating remedial alternatives. Stakeholders will work together to determine the best land use/pathway combinations from the risk assessment for developing the PRGs should they be necessary.

3.5 ECOLOGICAL RISK ASSESSMENT

The planned ecological risk assessment (ERA) at RVAAP will follow the general framework recommended by U.S. EPA (1992a, 1997) and by the U.S. Army (Wentsel et al. 1996). Briefly, this framework consists of four interrelated activities: problem formulation, exposure assessment, effects assessment, and risk characterization. Additional guidance, as provided in the Scope of Work (USACE 1997) and the Ohio EPA during finalization of this Work Plan Addendum, will be followed as well.

There are a number of site- or RVAAP-specific matters whose resolution is part of the problem formulation activity. This plan presents how these site-specific matters will be addressed. Current consensus is based on a meeting in May 1997 at RVAAP with ecologists and risk assessors from Ohio EPA, USACE, RVAAP, and SAIC. Subsequent conversations with Ohio EPA and USACE

have occurred in December 1997 and January 1998. Also, a meeting in March 1998 at RVAAP served to clarify additional matters. The following shows the results of this process.

3.5.1 Conceptual Site Model Diagram

The conceptual site model for WBG describes how receptors present or likely to be present at the site are potentially exposed to contaminants present in one or more source media. The transport and exposure pathways linking contaminated source media and potential ecological receptors are diagramed in Figure 3-1. Potential routes of exposure to contaminants in potential exposure media (e.g., air, soil, surface water/sediment, and food) are indicated and evaluated for terrestrial and aquatic receptor classes. For example, there are likely a year-round pond and possibly streams inside the boundary of WBG and, although so-called sediments in Phase I were dry material, they came from a shallow water conveyance; therefore, exposure is possible to fish and sediment-dwelling organisms inside WBG. It is possible that surface water may be able to leave WBG and carry contaminated soil particles to a stream outside WBG and, if so, this type of exposure would be evaluated in another scope of work. Many terrestrial plants and animals will be exposed to soil as well as food. For example, mammals and birds directly ingest soil, and the soil fraction of diet will be used in the exposure equations. Such fractions as 5 and 10% are typical. The principal source of these data will be the Wildlife Exposures Handbook (EPA 1993). However, this source as well as knowledge of terrestrial top predators (hawk and fox) diet show soil fractions of diet at 0%. Top predators are exposed indirectly from soil via their prey organisms. For each type of receptor, potential exposure routes or pathways are classified as complete or incomplete depending on how likely is exposure by that route. Complete pathways are further classified as being evaluated quantitatively or qualitatively. Quantitatively means the use of numbers for exposure and effects. Qualitatively means the use of words, logical methods, and technical common sense.

3.5.2 Selection Criteria for Ecological Receptors

Receptors for the ERA for WBG were selected based on three criteria specified in *Proposed Guidelines for Ecological Risk Assessment* (USEPA 1997) and previous documents. Receptors were selected according to their ecological relevance, susceptibility to known or potential stressors, and representativeness of management goals (Table 3-2). Ecological relevance means that the receptor has or represents a role in energy flow (e.g., plants); nutrient cycling (e.g., earthworms); or population regulation (e.g., hawk, owl, and fox). Susceptibility means that the receptor is known to be sensitive to chemicals (e.g., rabbits) and/or exposure because food preference is high (e.g., shrews). Management goals mean the sustaining of ecosystems and ecological processes while maintaining the central mission of RVAAP which is to store bulk explosives and inert materials. The large tracts of natural land, needed as safety buffers, provide the natural resource base to be managed. Such management goals as the following support the mission and natural resource management plan: erosion control through vegetation, population management through hunting of such animals as deer, and protection of rare, threatened and endangered species such as the barn owl.

The selected receptors are ecologically relevant because they represent important elements of the ecosystems at RVAAP, contributing to the structure, function, and biodiversity. These receptors interact as resources and consumers, forming food webs through which both nutrients and contaminants move through the ecosystem. Due to their range of habitats, body sizes, diets, life spans, reproductive rates, home ranges and taxonomic relationships, these receptors represent a range of potential susceptibilities to contaminants at WBG. All of these receptors are potentially exposed to contaminants at WBG because they are present or likely occur there, and they ingest or



- Complete pathway evaluated qualitatively
- Complete pathway evaluated quantitatively

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- Incomplete pathway, not evaluated

Figure 3-1. Exposure Pathways for Terrestrial and Aquatic Receptors

	Selectio	n Criteria (USEPA	1996)
	Criterion 1	Criterion 2	Criterion 3
Receptor	Ecological Relevance	Susceptibility	Represents Management Goalsª
Plants (various species)	+++	+	+++
Earthworms (various species)	++	+	+
Short-tailed shrew (Blarina brevicauda)	+	++	+
American robin (Turdus migratorius)	+	++	+
White-tailed deer (Odocoileus virginianus)	+	+	+++
Eastern cottontail (Sylvilagus floridanus)	+	++	+
Red-tailed hawk (Buteo jamaicensis)	++	+	++
Barn owl (Tyto alba) endangered species	+	+	+++
Red fox (Vulpes vulpes)	++	+	+
Aquatic organisms	++	++	++
Sediment-dwelling organisms	++	++	+

Table 3-2. Reasons for Selecting Receptors for Ecological Risk Assessment at WBG

^{*a*} Includes protection of T&E or other special status species.

+++ = receptor very strongly meets criterion; ++ = receptor strongly meets criterion; and + = receptor meets criteria.

live in direct contact with contaminated media. The selected receptors are judged to be consistent with general management goals of protecting the environment, including threatened and endangered (T&E) or other species with special status. Regarding T&E species, other species of federal and status interest have been identified (ODNR 1993). For example, the Indiana bat (*Myotis sodalis*) was captured on the RVAAP installation. These T&E species will be handled qualitatively, and the barn owl will be handled quantitatively in the ecological risk assessment.

3.5.3 Terrestrial Food Web for Ecological Receptors

Figure 3-2 provides ingestion pathways for a variety of receptors in the terrestrial food web. Note that there are fewer receptors than really exist at RVAAP. The planned ERA is a screening level type. As such, it is satisfactory to deal with representatives of groups of organisms (e.g., shrew and robin for all insectivorous and worm-eating organisms). Initial discussions on appropriate receptors and food web started at RVAAP with RVAAP, Ohio EPA, USACE, and SAIC ecologists. Assessment and measurement endpoints to this point in the planning or problem formulation activity were developed cooperatively with Ohio EPA and the U.S. Army in December 1997 and January 1998.

3.5.4 Assessment Endpoints, Measurements, and Decision Rules

Table 3-3 emphasizes the relationships among policy goals, assessment endpoints, measurement endpoints, and the decisions relative to HQs. Each type of receptor has separate assessment endpoints, measurement endpoints, and decision criteria. An assessment endpoint is defined by EPA (EPA 1992a) as "an explicit expression of the environmental value that is to be protected." A measurement endpoint is defined by EPA (EPA 1992a) as "a measurement endpoint is defined by EPA (EPA 1992a) as "a measurement endpoint is defined by EPA (EPA 1992a) as "a measurement endpoint is defined by EPA (EPA 1992a) as "a measurement endpoint is defined by EPA (EPA 1992a) as "a measurement endpoint is defined by EPA (EPA 1992a) as "a measurable ecological characteristic



AE = assessment to some in terms with no AE in box means they are intermediate in terms of transfers.

Figure 3-2. Food Web at RVAAP for Ecological Risk Assessment

Table 3-3. Policy Goals, Ecological Assessment Endpoints, Measurement Endpoints, and Decision Rules for WBG

Policy Goals	Assessment Endpoint	Measurement Endpoint	Decision Rule
Policy Goal 1: The preservation and conservation of T&E species and their critical habitats.	Assessment Endpoint 1: Preservation of any state- or federally-designated threatened or endangered species. Endpoint Species: Barn owl	Measurement Endpoint 1: Modeled contaminant concentrations in prey (shrews, robins, and rabbits) based on measured soil concentrations.	Decision Rule for Assessment Endpoint 1: If T&E species are not present, or RME concentrations in the media do not contribute to chronic NOAEL exceedance (i.e., HQs <1), then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects and, therefore, the T&E species should be preserved. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.
Policy Goal 2: The maintenance and protection of terrestrial populations and ecosystems.	Assessment Endpoint 2: Maintenance of plant community for erosion control and energy production. Endpoint Species: plants of various species	Measurement Endpoint 2: Measured soil contaminant concentrations.	Decision Rule for Assessment Endpoint 2: If the HQ is <1, then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects and, therefore, maintain the plant populations and communities. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.
	Assessment Endpoint 3: Maintenance of soil-dwelling invertebrate community for nutrient and energy processing. Endpoint Species: earthworms	Measurement Endpoint 3: Measured soil contaminant concentrations	Decision Rule for Assessment Endpoint 3: If the HQ is <1, then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects and, therefore, maintain the soil invertebrate community. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.

Table 3-3 (continued)

Policy Goals	Assessment Endpoint	Measurement Endpoint	Decision Rule
	Assessment Endpoint 4: Maintenance of populations of herbivorous animals. Endpoint Species: cottontail rabbits and deer	Measurement Endpoint 4: Modeled contaminant concentrations in food chain based on measured soil contaminant concentrations.	Decision Rule for Assessment Endpoint 4: If the HQ is <1, then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects and, therefore, populations of the herbivores, e.g., cottontail rabbits, and deer, are maintained. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.
	Assessment Endpoint 5: Maintenance of worm-eating and/or insectivorous animals. Endpoint Species: mammal - shrew; bird - robin	Measurement Endpoint 5: Modeled contaminant concentrations in earthworms and other prey based on measured soil contaminant concentrations.	Decision Rule for Assessment Endpoint 5: If the HQ is <1, then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects and, therefore, populations of worm-eating and/or insectivorous animals are maintained. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.
	Assessment Endpoint 6: Maintenance of terrestrial predators. Endpoint Species: mammal - red fox; bird - red-tailed hawk	Measurement Endpoint 6: Modeled contaminant concentrations in prey (shrews, robins, and rabbits) based on measured soil contaminant concentrations.	Decision Rule for Assessment Endpoint 6: If the HQ is <1, then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects and, therefore, populations of terrestrial predators are maintained. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.

Table 3-3 (continued)

Policy Goals	Assessment Endpoint	Measurement Endpoint	Decision Rule						
Policy Goal 3: The maintenance and protection of aquatic populations and ecosystems.	Assessment Endpoint 7: Maintenance of aquatic organisms. Endpoint Species: aquatic organisms	Measurement Endpoint 7: Measured surface water contaminant concentrations.	Decision Rule for Assessment Endpoint 7: If the HQ is <1, then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects and, therefore, populations of aquatic organisms are maintained. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.						
	Assessment Endpoint 8: Maintenance of sediment-dwelling organisms. Endpoint Species: sediment-dwelling organisms	Measurement Endpoint 8: Measured sediment contaminant concentrations.	Decision Rule for Assessment Endpoint 8: If the HQ is <1, then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects and, therefore, populations of sediment-dwelling organisms are maintained. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.						

RME = Reasonable maximum exposure. T&E = Threatened and endangered.

NOAEL = No observed adverse effects level. HQ = Hazard (risk) quotient.

that is related to the valued characteristic chosen as the assessment endpoint." Further explanations about these terms are found in Wentsel (1996) and USEPA (1997).

Each endpoint species or receptor in the food web and Table 3-3 will have a table that provides information on home range, feeding habits, and other characteristics. Tables 3-4 and 3-5 show examples of such tables for the shrew and the red-tailed hawk that will be organized for each receptor modeled or used in the ecological risk assessment.

3.5.5 Procedural Assumptions for Exposure, Effects, and Risk Characterization

This section provides in bulleted form the important technical assumptions to be used in the screening ecological risk assessment.

- Reasonable maximum exposure (RME)concentrations will be used during the screening risk assessment. The RME is the smaller of the maximum detected concentration and the 95th upper confidence limit on the mean (UCL₉₅). RMEs will be used for soil, sediment, and surface water. When the UCL₉₅ percent confidence interval cannot be calculated, the measured maximum concentration will be used. Modeled tissue concentrations based on the RMEs based on measured abiotic media concentrations will be used in food chains.
- The sources of screening thresholds varies as a function of medium. In every case, Ohio EPA and EPA Region V (EcoUpdates) screening values will take precedence. For surface water, chronic ambient water quality criteria from EPA will be used first. In the absence of AWQC, Tier II chronic values from EPA will be used. After that, toxicity reference values for daphnids and fish from EPA will be used. For sediment, the order of preference (with first listed first and so forth) is Ecotox thresholds from US EPA (EPA 540-F-95-038), Ontario Ministry of Environment Lows (Persaud et al. 1993), and State of New York, Technical Guidance for Screening Contaminated Sediments. Finally, NOAA (1991) values are the fourth priority. For soil, there are no reliable sources as was discussed on March 18, 1998 at RVAAP among the U.S. Army, Ohio EPA, and SAIC ecological risk assessors. Therefore, it is recommended that this initial step (yes/no answer for one receptor) be omitted and that the next step (gradient answer for many receptors) be implemented.
- The area use factor will be 1.0 regardless of the size of home range area relative to exposure unit area.
- Exposure factors will be used extensively. For example, soil to plant uptake factors as well as plant to animal bioaccumulation factors will be used as published in the technical literature. This will provide estimated contaminant concentrations in prey based on measured soil, sediment, and water concentrations at Winklepeck. The primary sources are Baes et al. (1984), Travis and Arms (1988), and ATSDR (various years). A good secondary source is HAZWRAP (1994). When there is no value, the default value will be 1.0 for inorganic chemicals and 1.0 for organic chemicals. This is true for both terrestrial and aquatic food transfers.
- Bioavailability is assumed to be the same as that in the controlled laboratory/field exposure studies. There will be no adjustments.

		Receptor:	Short-tailed shrew
			(Blarina brevicauda)
Parameter	Definition	Value	Reference / Notes
BW	Body weight (kg)	0.017	Arithmetic mean of means, both sexes, fall and summer,
			western Pennsylvania (EPA 1993)
HR	Home range (ha)	0.36	Maximum, adult female, summer, Michigan (EPA 1993)
TUF	Temporal use factor	1	Will be 1 unless a specific value exists for a receptor
AUF	Area use factor	1	Will be 1 to maximize exposure
IR _F	Food ingestion rate $(g/g-d = kg/kgBW/d)^a$	0.56	Arithmetic mean of adults, both sexes, 25°C, Wisconsin
			(EPA 1993)
PF	Plant fraction of diet	0.13	June through October, New York (EPA 1993); assuming
			vegetative parts and fungi
AF	Animal fraction of diet	0.87	June through October, New York (EPA 1993); assuming
			100% earthworms
SF	Soil fraction of diet	0.13	Talmage and Walton (1993)
IR _w	Water ingestion rate $(g/g-d = L/kgBW/d)$	0.223	Adult, both sexes, Illinois, lab (EPA 1993)

Table 3-4. Receptor Parameters for Short-tailed Shrew

a Food ingestion rate (g/g-d) re-expressed as kg/kgBW/d is assumed not to include ingested soil; therefore, PF+AF = 1.0.

		Receptor:	Red-tailed hawk
			(Buteo jamaicensis)
Parameter	Definition	Value	Reference / Notes
BW	Body weight (kg)	1.13	Arithmetic mean, female and male, Michigan (EPA
			1993)
HR	Home range (ha)	697	Mean, adults, both sexes, winter, Michigan (EPA 1993)
TUF	Temporal use factor	1	Will be 1 unless a specific value exists for a receptor
AUF	Area use factor	1	Will be 1 to maximize exposure
IR _F	Food ingestion rate $(g/g-d = kg/kgBW/d)^a$	0.11	Adult female, winter, Michigan, captive outdoors (EPA 1993)
PF	Plant fraction of diet	0	Not stated in EPA (1993); assumed to be negligible
AF	Animal fraction of diet	1	Prey brought to nests (EPA 1993)
SF	Soil fraction of diet	0	Not stated in EPA (1993) and Beyer et al. (1994);
			assumed to be negligible.
IR _w	Water ingestion rate $(g/g-d = L/kgBW/d)$	0.057	Arithmetic mean, both sexes, estimated (EPA 1993)

Table 3-5. Receptor Parameters for Red-tailed Hawk

^{*a*} Food ingestion rate (g/g/-d) re-expressed as kg/kgBW/d is assumed not to include ingested soil; therefore, PF+AF = 1.0.

- No Observed Adverse Effect Level (NOAEL), especially chronic NOAELs, from controlled laboratory/field exposure studies will be the appropriate toxicological data for toxicity thresholds in the food web modeling of the screening ecological risk assessment. When chronic NOAELs are not available and subchronic NOAELs are available, a conversion factor of 10 will be used to convert sub-chronic to chronic NOAEL. When no NOAEL is available and a Lowest Observed Adverse Effect Level (LOAEL) is available, a conversion factor of 10 will be used to convert a LOAEL to a NOAEL.
- Body weight conversions from the test organism (usually a laboratory organism) to the receptors at RVAAP (usually wildlife) have a technical basis (metabolic) and will be used to adjust toxicity thresholds. Allometric or body-scaling will be done only after all conversions of toxicity values, e.g., LOAEL to NOAELs.
- An HQ >1.0 suggests unacceptable risk or the need for further work.

3.5.6 Next Step

Dialogue among USACE, Army, Ohio EPA, the public, risk assessors, and risk managers will determine what the findings of the screening ecological risk assessment mean. Such professional judgments and discussions need to clarify what to protect and what additional, if any, more definitive ecological risk characterization is warranted.

The development of professional judgment criteria can take different approaches. The most likely approach is a weight-of-evidence one that consists of such principles as:

- temporal association,
- spatial association,
- strength of dose response association, or
- biological plausibility.

These are based on three types of evidence:

- biological and habitat surveys at Ravenna,
- contaminant body burden measurements (if available) at Ravenna, and
- chemical specific toxicity information from the literature.

Note that many of these considerations will be part of a future installation-wide plan and implementation.

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4. FIELD ACTIVITIES

4.1 GROUNDWATER

4.1.1 Rationales

4.1.1.1 Monitoring Well Locations and Installation

WBG. Five monitoring wells will be installed as a part of the Phase II RI in the shallow water table at WBG (Figure 4-1). These monitoring wells (WBG MW-005, -006, -007, -008, and -009) will be located in the suspected upgradient and downgradient directions from the most concentrated areas of soil contamination, in the northeastern portion of the burning grounds. Based on water levels in the four existing RCRA monitoring wells located at Pad #37, the groundwater flow direction at WBG is anticipated to be east-southeast. Placement of the wells as shown on Figure 4-1 will allow the evaluation of potential contaminant migration via groundwater across and possibly beyond the WBG. One monitoring well will be located within the WBG near the burning pads identified as having the highest concentrations of explosives and metals contamination in soils. The rationale for the placement of this well is to evaluate groundwater quality adjacent to a potential major source of contaminant release within the WBG.

In addition, the four existing monitoring wells located at Pad #37 will be sampled as a part of the Phase II RI to further characterize groundwater adjacent to source areas within WBG.

Background Investigation. Four monitoring wells will be installed throughout the eastern half of RVAAP, in areas known to be unaffected by facility operations. Seven wells will be installed in the shallow unconsolidated water table aquifer. These wells will be paired with seven additional wells that will be installed, if possible, in the deeper bedrock aquifer. The locations shown in Figure 4-2 offer the best possibilities for shallow (<50 ft) penetration of the Sharon Conglomerate, the bedrock aquifer that underlies the eastern portion of RVAAP. This proposed placement of background wells will allow the evaluation of regional flow in the shallow and deep aquifers as well as provide chemical data on groundwater free of site-related contaminants. One monitoring well is included as a contingency to guard against the unsuccessful completion of one of the other wells as this problem was encountered during the Phase I RI. The location of the contingency monitoring well will be determined during the field investigation.

All monitoring wells will be installed using conventional drilling techniques (hollow-stem auger and air rotary) as described in Section 4.1.2.1, and will be installed to screen across the top of the water table or 3 m (~ 10 ft) into bedrock. The bedrock interval in each monitoring well borehole will be cored using NQ size conventional coring to additionally characterize the bedrock lithology. It is anticipated that the depth to the water table will vary between 1.5 m (5 ft) and 5.5 m (18 ft) below the ground surface, based on existing monitoring well information from Phase I RI and other previous studies. The maximum depth of each shallow monitoring well is expected to be ~ 9.1 m (30 ft) BGS or less. It is anticipated that the depth to bedrock will range between 8 m (26.5 ft) and 15.1 m (50 ft).



Fig 4-1 Location of Existing RCRA Monitoring Wells and Planned Phase II RI Monitoring Wells and Sediment Samples



4.1.1.2 Sample Collection for Field and Laboratory Analysis

All monitoring wells will be field screened for VOCs using a hand-held photo-ionization detector (PID) or flame ionization detector (FID) organic vapor analyzer (OVA) during groundwater sample collection. Screening will be accomplished by monitoring the headspace vapors at the top of the riser pipe. Field measurement of pH, temperature, specific conductance, and dissolved oxygen will be recorded for each groundwater sample. No samples will be collected for additional headspace analysis. Water level measurements will be collected immediately prior to groundwater sampling.

WBG. One unfiltered groundwater sample will be collected from each monitoring well (4 RCRA wells and 5 Phase II RI wells) and submitted for laboratory analysis of explosives, Target Analyte List (TAL) metals, cyanide, SVOCs, and VOCs. One filtered sample will be collected from each monitoring well at WBG and analyzed for TAL metals and cyanide. Table 4-1 summarizes the number of samples and the types of analyses to be performed during the Phase II RI.

Background Investigation. One unfiltered groundwater sample will be collected from each monitoring well and submitted for laboratory analysis for TAL metals (total) and cyanide. One filtered sample will be collected from each background monitoring well and analyzed for TAL metals (dissolved) and cyanide. Two monitoring wells will be additionally analyzed for VOCs, SVOCs, and pesticides/PCBs to ensure the integrity of the background sampling locations.

Table 4-2 summarizes the analytical parameters and methods that will be used during the background investigation for the Phase II RI. Analytical laboratory methods, analytes, and procedures are further discussed in the Phase II RI Quality Assurance Project Plan (QAPP) Addendum.

4.1.1.3 Quality Assurance (QA)/Quality Control (QC), and Blank Samples and Frequency

QA/QC duplicate split groundwater samples, equipment rinsate samples, and trip blanks will be collected during the Phase II RI. Duplicates and rinsates will be selected on a random statistical basis and analyzed for the same parameters as the environmental samples. Duplicate samples will be collected at a frequency of 10% of environmental samples. Split groundwater samples and equipment rinsate samples will be collected at a frequency of 5% of environmental samples. Trip blanks will accompany shipment of all VOC groundwater samples and will be analyzed for VOCs only.

One source blank will be collected from the potable water source located at Post #1, which will be used for all potable wash and rinse water for equipment decontamination during the Phase II RI. One source blank will also be collected from the deionized/distilled (ASTM Type I) water source used. The source blanks will be analyzed for the same constituents as the environmental samples. Section 8 of this Phase II RI SAP Addendum summarizes QA/QC sampling.

4.1.2 Monitoring Well Installation

4.1.2.1 Drilling Methods and Equipment

4.1.2.1.1 Equipment Condition and Cleaning

Requirements for the condition and cleaning of equipment used for well installation are described in Section 4.3.2.1.1 of the Facility-wide SAP. These requirements, as applicable, will be employed for equipment used to install monitoring wells in the Phase II RI.

Table 4-1. Summary of Phase II RI at WBG

Sampling Media	Sample Stations	Sampling Method	Depth (ft)	Samples/Station	Total No. of Samples	Explosives (Colorimetry)	Explosives (8330)	TAL Metals	Cyanide (9013)	VOCs (8260A)	SVOCs (8270B)	Grain Size (ASTM D422)	Moisture Content (ASTM D2216)	Atterberg Limits (ASTM D4318)	Unified Soil Classification	Bulk Density (ASTM D4531)	Porosity (EM1110-2-1906)	Total Organic Carbon	Hydraulic Conductivity (ASTM D5084)	Specific Gravity (ASTM D854)	pH (SW-946 9045)
Planned Samples																					
Surface Soils	53	Composite	0-1	1	53	53	53 ^{<i>a</i>}	53	53		4	6	6	6	6						
Subsurface Soils	13	Discrete	2-4	1	13	13	13	13	13		2	4	4	4	4						
Subsurface Soils	13	Discrete	4-6	1	13	13	13^{b}	13	13		2	4	4	4	4						
Sediment	4	Discrete	0-0.5	1	4	4	4	4	4	1	1	4						4			
Groundwater	9	Grab	-	1	9	-	9	18	18	9	9	5 ^c	5 ^c	5 ^c	5 ^c	5 ^c	5 ^c	5 ^c	5 ^c	5 ^c	5 ^c
Surface Water	1	Grab	-	1	1	-	1	2	2	1	1										
Slag	2	Discrete	0	1	2			2	2						2						
Total Planned	95				95	83	93	105	105	11	19	23	19	19	21	5	5	4			
Contingency Samples																					
Surface Soils	16	Composite	0-1	1	16	16	16 ^{<i>a</i>}	16	16												
Subsurface Soils	12	Discrete	2-4	1	12	12	12^{b}	12	12												
Subsurface Soils	2	Discrete	4-6	1	2	2	2	2	2												
Total Contingency	30				30	30	30	30	30												

^a Only samples >1 ppm TNT based on field colorimetry. Unused laboratory analyses will be applied to contingency sampling, if necessary.

^b Unused subsurface samples will be applied as necessary to contingency sampling.

^c Shelby tube soil samples from monitoring well boreholes.

SVOCs = Semivolatile organic compounds, TAL = target analyte list, VOCs = volatile organic compounds.

Sampling Media	Sample Stations	Sampling Method	Depth (ft)	Samples/Station	Total No. of Samples	Explosives (Colorimetry)	Explosives (8330)	TAL Metals	Cyanide (9013)	VOCs (8260A)	SVOCs (8270B)	Pesticides/PCBs (8081)	Grain Size (ASTM D422)	Moisture Content (ASTM D2216)	Atterberg Limits (ASTM D4318)	Unified Soil Classification	Bulk Density (ASTM D4531)	Porosity (EM1110-2-1906)	Total Organic Carbon	Hydraulic Conductivity (ASTM D5084)	Specific Gravity (ASTM D854)	pH (SW-846 9045)
Surface Soils	15	Composite	0-1	1	15	15		15	15	2	15	2	6	6	6	6			15			
Subsurface Soils	15	Discrete	1-3	1	15	15		15	15	2	15	2	6	6	6	6						
Subsurface Soils	15	Discrete	3-12	1	15	15	-	15					8	8	8	8						
Sediment	7	Grab	0-0.5	1	7	7		7	15	3	7	3	3	3	3	3						
Groundwater	15	Grab		1	15	15		30^{b}	30^b	2	2	2	16^a	16 ^{<i>a</i>}	16 ^{<i>a</i>}	16 ^{<i>a</i>}	8 ^{<i>a</i>}	8 ^a		8	8	8
Surface Water	7	Grab		1	7			7	7													┝─┦
Totals	74				74	67		89	82	9	39	9	39	39	39	39	8	8	15			

Table 4-2. Summary of Phase II RI Background Investigation

^a Eight Shelby tube soil samples and 8 grab/remolded samples from MW boreholes.

^b Both filtered and unfiltered analysis.

PCBs = Polychlorinated biphenyls, SVOCs = semivolatile organic compounds, TAL = target analyte list, VOCs = volatile organic compounds.

4.1.2.1.2 Drilling Methods

Conventional drilling techniques (hollow-stem auger and air rotary) will be used to install monitoring wells, as described in Section 4.3.2.1.2 of the Facility-wide SAP. It is anticipated that the third drilling scenario, described under Section 4.3.2.1.3, will be applicable for the installation of the 5 monitoring wells at WBG and the 14 background monitoring wells to be drilled as part of the Phase II RI. Monitoring well boreholes will be drilled to sufficient depth to install the bottom of a 3-m (10-ft) well screen , ~2.1 m (7 ft) below the current water table elevation. It is anticipated that the depth to the water table will range from 1.5 m (5 ft) to 5.5 m (18 ft) below the ground surface, based on existing information. The maximum depth of each monitoring well is expected to be ~9.1 m (30 ft) BGS or less. It is anticipated that the depth to bedrock will range between 8 m (26.5 ft) and 15.1 m (50 ft).

In all groundwater monitoring well boreholes, NQ-size coring shall be performed in the bedrock interval prior to 4-in (10.2-cm) diameter air-rotary drilling to install wells. The purpose of coring is to determine lithologies and the degree and nature of weathering and fracturing in bedrock. All rock cores will be stored in wooden boxes in such a manner as to preserve their relative positions by depth. Intervals of lost core shall be noted in the core sequence with wooden or styrofoam blocks. Boxes will be marked on the outside to provide the boring number, cored interval, and box number, if there are multiple boxes. All cores collected during Phase II of the RI will be documented (including photographing the core after it has been properly placed and labeled in the core boxes), and temporarily stored at RVAAP in accordance with Ohio EPA Technical Guidance for Hydrogeologic Investigations and Groundwater Monitoring (1995) and EM-1110-1-4000, Monitoring Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites (USACE 1994b). The core may eventually be transferred to the Ohio EPA-NE District office for storage.

4.1.2.2 Materials

4.1.2.2.1 Casing/Screen

The casing and screen materials for monitoring wells will be as presented in Section 4.3.2.2.1 of the Facility-wide SAP.

4.1.2.2.2 Filter Pack, Bentonite, and Grout

The filter pack, bentonite, and grout materials for monitoring wells will be as presented in Section 4.3.2.2.2 of the Facility-wide SAP.

4.1.2.2.3 Surface Completion

All wells will be constructed as above-ground installations, as described in Section 4.3.2.2.3 of the Facility-wide SAP.

4.1.2.2.4 Water Source

Potable water from Post #1 will be used during this investigation for monitoring well and decontamination purposes. The collection and evaluation of the water source sample will follow Section 4.3.2.2.4 of the Facility-wide SAP.

4.1.2.2.5 Delivery, Storage, and Handling of Materials

All monitoring well construction materials will be delivered, stored, and handled following Section 4.3.2.2.5 of the Facility-wide SAP.

4.1.2.3 Installation

All monitoring well installation will be in accordance with the procedures for above-ground installations as presented in Section 4.3.2.3 of the Facility-wide SAP. Unconsolidated surficial material in each location will be drilled using a 16.5-cm (6.5-in) inside diameter (I.D.) hollow-stem auger. Soil samples will be collected continuously from the surface to bedrock refusal or borehole termination, using a split-barrel sampler, for lithologic logging. If bedrock is encountered before borehole termination, the bedrock interval in a borehole will be drilled using air rotary with an NQ-size coring device as described in Section 4.1.2.1.2 above. Following coring, rock drilling will continue with a tricone roller bit.

4.1.2.4 Documentation

4.1.2.4.1 Logs and Well Installation Diagrams

4.1.2.4.1.1 Boring Logs

Boring logs will be completed for all monitoring well boreholes following Section 4.3.2.5.1.1 of the Facility-wide SAP. Visually determined USCS of each soil sample taken will be recorded on each boring log.

4.1.2.4.1.2 Well Construction Diagrams

All monitoring well activities will be documented according to the procedures presented in Section 4.3.2.4 of the Facility-wide SAP.

4.1.2.5 Well Abandonment

Any monitoring wells or borehole abandoned during the Phase II RI will be abandoned according to the procedures presented in Section 4.3.2.5 of the Facility-wide SAP.

4.1.2.6 Water Level Measurement

Water level measurements will follow the procedure presented in Section 4.3.3.6 of the Facility-wide SAP.

4.1.2.7 Well Development

Development of monitoring wells will be accomplished with a pump. Pumps may be replaced with bottom-filling bailers where well size or slow recharge rates restrict pump usage. Development will proceed until the following criteria are met:

- the water is clear to the unaided eye,
- the sediment thickness remaining in the well is less than 1% of the screen length or <30 mm (0.1 ft),
- a minimum of five times the standing water volume in the well (to include the well screen and casing plus saturated annulus, assuming 30% porosity), and
- indicator parameters (pH, temperature, and specific conductance) have stabilized to $\pm 10\%$ over three successive well volumes.

For each monitoring well developed during the Phase II RI, a record will be prepared to include the following information, per the Facility-wide SAP:

- project name and location;
- well designation and location;
- date(s) and time(s) of monitoring well installation;
- date(s) and time(s) of monitoring well development;
- static water level from top of well casing, before and 24 hours after completion of well development with dates and times of measurements;
- quantity of water lost during drilling, removed before well insertion, and/or added during granular filter placement;
- quantity of standing water contained in the well, and contained in the saturated annulus (assuming 30 percent porosity) before well development;
- field readings of pH, conductivity, and temperature, measured before, twice during, and after completion of well development, using an appropriate instrument and method in accordance with EPA Procedure 600/4-79-020 (refer to Section 4.3.3 of the Facility-wide SAP for a description of the instrument and procedure to be used for field measurements);
- depth from top of casing to bottom of well;
- length of the well screen;
- depth from top of the well casing to the top of sediment inside the well, both before and after development, as measured directly at the time of development;
- physical character of the removed water, including changes during development in clarity, color, particulates, and any noted odor;
- type and size/capacity of pump or bailer used for development;
- description of the surge technique used in well development;

- height of well casing above ground surface as measured directly at the time of development;
- estimated recharge rate into the well at the time of development;
- quantity of water removed from the well during development and the time for removal, presented as both incremental and total values.

4.1.3 Field Measurement Procedures and Criteria

All field measurement procedures and criteria will follow Section 4.3.3 of the Facility-wide SAP.

4.1.4 Sampling Methods for Groundwater (Collection of Filtered and Unfiltered Samples)

Groundwater sampling from monitoring wells will follow the procedures presented in Section 4.3.4 of the Facility-wide SAP.

4.1.4.1 Well Purging Methods

In order to minimize the quantity of liquid investigation-derived (IDW) generated as a result of well purging, wells will be micro-purged where conditions permit, in accordance with Ohio EPA technical guidance (OEPA 1995), as follows:

- a dedicated bladder or submersible pump is used for purging;
- the purge rate should not exceed 100 mL/min unless it can be shown that higher rates will not disturb the stagnant water column above the well screen (i.e., will not result in water level drawdown);
- the volume purged is either two pump and tubing volumes or a volume established through inline monitoring and stabilization of water quality indicators such as dissolved oxygen and specific conductance;
- sample collection should occur immediately after purging.

Where micro-purging cannot be accomplished for any reason, then purging of all monitoring wells installed during the Phase II RI will be conducted in accordance with procedures discussed in Section 4.3.4 of the Facility-wide SAP.

4.1.4.2 Filtration

Groundwater samples collected for dissolved metals will be filtered by negative pressure using a hand-operated pump, collection flask, polytetrafluoroethylene tubing, and a pre-sterilized, disposable 0.45-cm pore size filter assembly. Before collecting the water sample, the pump and filter apparatus will be assembled. A bailer will then be lowered into the monitoring well, filled with groundwater, and raised to the surface. The groundwater will be transferred from the bailer to a decontaminated collection flask and poured into the filter funnel portion of the filter assembly. Care will be taken to avoid transferring solids that may have settled to the bottom of the collection flask. The hand-operated pump will be used to create a vacuum in the assembly to start filtration. Sample bottles will

be filled with the filtered water. Filters will be replaced as they become restricted by solids buildup as well as between sample collection sites.

4.1.5 Sample Containers and Preservation Techniques

Requirements for sample containers and preservation techniques for groundwater samples are presented in Section 4.3.6 of the Facility-wide SAP.

4.1.6 Field Quality Control Sampling Procedures

Quality control samples for monitoring well groundwater sampling activities will include duplicates and split groundwater samples, equipment rinsates, and trip blanks as described in Section 4.1.1.3 above. Split samples will be sent to the USACE Missouri River Division (MRD) Laboratory for independent analyses.

4.1.7 Decontamination Procedures

Decontamination of equipment associated with groundwater sampling will be in accordance with the procedure presented in Section 4.3.8 of the Facility-wide SAP, except that a 2% hydrochloric acid (HCl) rinse will be used instead of a 10% solution.

4.1.8 In Situ Permeability Testing

A slug test will be performed in each of the monitoring wells installed as part of the Phase II RI, to determine the hydraulic conductivity of the geologic material surrounding each well. The slug test method involves lowering or raising the static water level in a well bore by the removal or insertion of a cylinder (slug) of known volume. The return of the water level to a pre-test static level is then measured over time. The change in water level over time is plotted on a logarithmic scale to determine hydraulic conductivity (K). K is a function of the formation permeability and the fluid in the formation. K is influenced by well construction.

The slug removal (rising head) test will be used for this investigation. If possible, the slug test will be performed in such a manner to prevent the water level in the well from dropping below the top of the screened interval when the slug is removed. All tests will be performed after the groundwater has been sampled as described in Section 4.1.4, and will be contingent upon a monitoring well containing sufficient water to allow testing.

Slug tests will only be initiated after the well has recovered from groundwater sampling, or a minimum of 12 hours has elapsed since sampling. The pressure transducer and decontaminated slug will be inserted into the well and the water level allowed to equilibrate to static conditions, or until at least six hours have elapsed. A slug that displaces 0.3 m (1 ft) of water should be sufficient to provide an adequate response for the analysis.

Prior to the start of the test, plastic sheeting will be placed around the well in a manner to minimize water contact with the ground surface. The static water level will be measured with an electronic water level indicator and recorded to the nearest 0.003 m (0.01 ft) below top of casing. The total depth of the well will be measured with an electronic water level indicator and recorded to the nearest 0.003 m (0.01 ft) below top of casing. These measurements will be used to calculate the

water column height in the well. Use of the electronic water level meter will follow procedures outlined in Section 4.3.3.1 of the Facility-wide SAP.

To begin the test, the slug will be withdrawn quickly from the well without surging, The time of the test will begin as soon as the slug leaves the water column. Water level measurements will be recorded continuously during the test with a pressure transducer and data logger programmed to make measurements to within 0.003 m (0.01 ft) and record them on a logarithmic scale. Water level change will be recorded for a period of six hours or until the well re-equilibrates to 90% of the pretest water level, whichever occurs first.

The test data will be evaluated by the Bouwer and Rice method (1976, 1989) or the Cooper, et al. method (1967). If the test geometry is not conducive to analysis to either of these two methods, an alternate method will be used.

4.2 SUBSURFACE SOILS

4.2.1 Rationales

Subsurface soil samples will be collected during the Phase II RI in both WBG and the background sampling locations to investigate potential subsurface contamination occurring as a result of disposal of explosives and transport pathways for such contaminants, and to determine naturally occurring concentrations of inorganic constituents. Table 4-1 summarizes the planned WBG subsurface sampling activities and Table 4-2 summarizes the planned background sampling for the Phase II RI.

4.2.1.1 Soil Boring Locations

WBG. Subsurface soil samples are planned at each of the 13 former burning pads in the area where surface soil samples collected during Phases I and II of the RI exhibited the highest levels of explosives contamination (based on Phase I laboratory analytical results and Phase II field colorimetry). One sample will be collected initially at 0.6 to 1.2 m (2 to 4 ft) at each pad to evaluate the vertical extent of contamination. A total of 13 samples will be collected in the 0.6 to 1.2 m (2 to 4 ft) interval and submitted for laboratory analysis of explosives and metals. These samples will be additionally analyzed in the field via colorimetry for TNT and RDX. If colorimetric analysis shows the 0.6 to 1.2 m (2 to 4 ft) interval to be contaminated with explosives (>1 ppm), the 1.2 to 1.8 m (4 to 6 ft) interval will be sampled from the same location and submitted for laboratory analysis of explosives and metals. It is anticipated that up to 13 samples will be collected in the 1.2 to 1.8 m (4 to 6 ft) interval from various former burn pads. Geotechnical and lithologic information will also be acquired from the subsurface intervals. The planned soil boring locations are shown in Figures 4-3 through 4-14.

Additional subsurface samples [12-.6 to 1.2 m (2 to 4 ft) and 2-1.2 to 1.8 m (4 to 6 ft)] are planned as contingency samples to be collected from areas adjacent to the burning pads that exhibit evidence of surface soil contamination based on field colorimetric analysis. Subsurface soil samples collected from areas adjacent to burning pads will be similarly submitted for field colorimetric explosives analysis and laboratory explosives, metals, and cyanide analysis.



Fig 4-3 WBG - Pad 5



Fig 4-4 WBG - Pad 6



Fig 4-5 WBG - Pad 37



Fig 4-62 WBG - Pad 38


Fig 4-7 WBG - Pad 40



Fig 4-8 WBG - Pad 58



Fig 4-9 WBG - Pad 59



Fig 4-10 WBG - Pad 60



Fig 4-11 WBG - Pad 61



Fig 4-12 WBG - Pad 62





Fig 4-14 WBG - PAD 68

Background Investigation. Continuous subsurface soil samples will be collected at each of the monitoring well borings, from 0.3 to 0.9 m (1 to 3 ft) and from 0.9 to 3.6 m (3 to 12 ft). Discrete, representative samples from both 0.3 to 0.9 m and 0.9 to 3.6 m (1 to 3 ft and 3 to 12 ft) intervals are to be analyzed for TAL metals, SVOCs, and cyanide in addition to being screened in the field for explosives (TNT and RDX). Two discrete, representative 0.3 to 0.9 m (1 to 3 ft) and two 0.9 to 3.6 m (3 to 12 ft) soil samples will be additionally analyzed for VOCs and SVOCs to ensure the integrity of the background sample stations. The purpose of the field explosives analysis is to determine in real time whether the chosen soil boring location is in an area that is free of explosives contamination and is representative of background conditions. The analyses of samples will be used to augment the existing Phase I RI background data set and support risk assessments for WBG and other sites. The locations of the background soil borings are shown in Figure 4-2.

4.2.1.2 Discrete/Composite Soil Sampling Requirements

WBG. One discrete soil sample will be collected from each of two depth intervals 0.6 to 1.2 m and 1.2 to 1.8 m (2 to 4 and 4 to 6 ft) at each soil boring location and submitted for field colorimetric analysis of explosives. Off-site laboratory analysis for explosive compounds, TAL metals, and cyanide will also be performed on each 0.6 to 1.2 m (2 to 4 ft) sample collected. Two subsurface soil samples from 0.6 to 1.2 m (2 to 4 ft) and two subsurface soils from 1.2 to 1.8 m (4 to 6 ft) will be additionally analyzed for SVOCs. At WBG, the purpose of this analysis is to define the extent of contamination. Therefore, the following strategy will be used:

- All subsurface soil samples will be sent to the off-site lab for analysis of explosives and metals regardless of field analytical results.
- If the concentration of TNT is <1 ppm, based on field colorimetric analysis, the field colorimetric analysis for RDX will be performed.

All subsurface soil samples collected during the Phase II RI will be discrete samples from the appropriate depth intervals. The samples will be collected using a bucket hand auger and composited over the depth interval, except for VOC samples, which will be collected from the middle of the interval without compositing.

Background Investigation. One discrete sample from the 0.3 to 0.9 m (1 to 3 ft) interval and one discrete sample from the 0.9 to 3.6 m (3 to 12 ft) interval will be selected from each soil boring for analysis. Efforts will be made to provide background concentrations for the various types of soils encountered over the specific depth ranges sampled with 7 or 8 impervious soil types (CL, CH, ML, MH, SC, GC, OH, or OL) and 7 or 8 permeable (SD, SM, GP, GM, SW, or GW) soil types.

4.2.1.3 Sample Collection for Field and Laboratory Analysis

Colorimetric analysis of soils for TNT and RDX will be performed following the field method presented in Appendix B of this Phase II SAP Addendum.

Background Investigation. One discrete soil sample will be collected from 0 to .3 m (0 to 1 ft) at each soil boring location and submitted for field colorimetric analysis for explosives. For the background investigation, the purpose of the colorimetric analysis is to confirm that the prospective sampling site is outside the area of influence of the process operations that introduced explosive contaminants to facility soils. For this reason, if the field method indicates the presence of either

TNT or RDX, the field team will not send the sample to the off-site lab, but rather will relocate the background sampling station.

Off-site laboratory analysis for TAL metals, cyanide, and SVOCs will also be performed for each 0.3 to 0.9 m (1 to 3 ft) sample collected. Two subsurface background samples (a frequency of 10%) will additionally be analyzed for VOCs and pesticides/PCBs, as shown in Table 4-1. Subsurface soil samples collected from 0.9 to 3.6 m (3 to 12 ft) will also be submitted for off-site laboratory analysis for TAL metals and cyanide.

Tables 4-1 and 4-2 summarize the analytical parameters and methods that will be used during the Phase II RI. Analytical laboratory methods, analytes, and procedures are further discussed in the Phase II RI QCP Addendum.

4.2.1.3.2 Organic Vapor Screening

All soil borings will be field screened for VOCs using a hand-held PID or FID OVA during sample collection. No samples will be collected for additional headspace analysis of VOCs.

4.2.1.4 Background, QA/QC, and Blank Samples and Frequency

Background samples will be collected as shown in Table 4-2 of this Phase II SAP Addendum. These background samples are intended to augment the Phase I background data collected in 1996, to allow recalculation of background criteria for inorganics previously investigated, and to establish background for some inorganic analytes that were not previously evaluated.

Subsurface soil QA/QC samples will be collected during the Phase II RI. Duplicate soil samples will be collected at a frequency of 10% (1 per 10 environmental samples). Split samples will be submitted to the USACE MRD laboratory for independent analysis. Split samples will be collected at a frequency of 5% (1 per 20 environmental samples). Duplicate and split samples will be selected based on a random statistical basis and submitted for the same analyses as the environmental samples. No field or rinsate blanks will be collected for subsurface soils. Section 8 of this Phase II QAPP Addendum summarizes QA/QC sampling.

4.2.2 Procedures

4.2.2.1 Drilling Methods

4.2.2.1.1 Equipment Condition and Cleaning

Requirements for the condition and cleaning of equipment used for well installation are described in Section 4.3.2.1.1 of the Facility-wide SAP. These requirements, as applicable, will be employed for equipment used to install monitoring wells in Phase II RI.

4.2.2.3 Field Measurement Procedures and Criteria

All field measurement procedures and criteria will follow Section 4.4.2.3 of the Facility-wide SAP, with the following exception. Headspace gases will not be screened in the field for organic vapors. Because there were no notable detections of VOCs during Phase I soil sampling, organic vapor monitoring of headspace gases is not necessary in Phase II RI.

4.2.2.4 Sampling for Geotechnical Analysis

WBG. Subsurface soil samples collected using the hand auger method are classified as disturbed samples; therefore, geotechnical analysis of samples collected using these methods will be limited to grain size, Atterberg limits, moisture content, and unified soil classification. Each soil sample collected will be visually classified according to the USCS in the field. Procedures for sampling for geotechnical analysis using the bucket hand auger method are presented in Section 4.4.2.4.2 of the Facility-wide SAP.

Complete geotechnical analysis, including grain size, Atterberg limits, moisture content, and laboratory-determined unified soil classification will be conducted on four representative grab/remolded soil samples each from both the 0.6 to 1.2 m (2 to 4 ft) and 1.2 to 1.8 m (4 to 6 ft) intervals. One Shelby tube soil sample will be collected from each of the five WBG monitoring wells. Efforts will be made to provide geotechnical data from the various types of soil encountered over the depth ranges sampled, e.g., impervious soil (CL, CH, ML, MH, SC, GG, OH, or OL) and pervious soil (SP, SM, GP, GM, SW, or GW). All samples will receive analyses for grain size, moisture content, Atterburg limits, unified soil classification, bulk density, porosity, total organic carbon, hydraulic conductivity, specific gravity, and pH.

Background Investigation. Subsurface sampling of soils will be accomplished using a thin-walled (Shelby) tube sampler. Samples will be collected using this device as part of hollow-stem auger drilling of boreholes for monitoring well installation. Shelby tube sampling will proceed as discussed in Section 4.4.2.4.1 of the Facility-wide SAP.

Shelby tube samples will be collected from the 0.3 to 0.9 m (1 to 3 ft) interval in 6 of the 14 monitoring well borings. At eight borings, Shelby tube samples will be collected from the 0.9 to 3.6 m (3 to 12 ft) interval. Efforts will be made to provide background geotechnical data for the various types of soils encountered over the specific depth ranges sampled, e.g., with 7 or 8 impervious (CL, CH, ML, MH, SC, GC, OH, or OL) soil samples and 7 or 8 permeate (SP, SM, GP, GM, SW, or GW) soil types. All samples will receive analyses for moisture content, grain size, Atterberg limits, unified soil classification, bulk density, porosity, total organic carbon, hydraulic conductivity, specific gravity, and pH.

4.2.2.5 Sampling for Chemical Analysis

WBG. Procedures for sampling of subsurface soils for chemical analysis using the Bucket Hand Auger Method are presented in Section 4.4.2.5.2 of the Facility-wide SAP.

Background Investigation. Procedures for sampling of subsurface soils for chemical analysis using the Hollow-Stem Auger Method are presented in Section 4.4.2.5.1 of the Facility-wide SAP.

4.2.2.6 Sample Containers and Preservation

Requirements for sample containers and preservation techniques for subsurface soil samples are presented in Section 4.4.2.6 of the Facility-wide SAP and the Phase II RI QAPP Addendum.

4.2.2.7 Field Quality Control Sampling Procedures

Subsurface soil QA/QC samples will be collected during the Phase II RI. Duplicate soil samples will be collected at a frequency of 10% (1 per 10 environmental samples). Split samples will be submitted to the USACE MRD laboratory for independent analysis. Split samples will be collected at a frequency of 5% (1 per 20 environmental samples). Duplicate and split samples will be selected based on a random statistical basis and submitted for the same analyses as the environmental samples. No field or rinsate blanks will be collected for subsurface soils. The Phase II RI QAPP Addendum summarizes QA/QC sampling.

4.2.2.8 Decontamination Procedures

The decontamination procedure for subsurface soil sampling activities is presented in Section 4.4.2.8 of the Facility-wide SAP, except that a 2% HCl acid rinse will be used instead of a 10% solution.

4.3 SURFACE SOIL AND SEDIMENT

4.3.1 Rationales

4.3.1.1 Surface Soil Sampling Locations

WBG. The rationale for biased surface soil sampling locations at WBG is to augment the Phase I and other previous data sets to establish the nature of contamination in soils at each of 13 former burn pads. Phase II RI surface soil sampling is planned at 13 individual former burning pads identified in the Phase I RI as having either explosives in excess of 1 ppm or lead in excess of 100 ppm in the surface soils (see Figures 4-3 through 4-15). The results from the USACE Cold Regions Research and Engineering Laboratory (USACE 1997a) investigations at burning pads #37 and #67 (Figures 4-5 and 4-14) will be used in the Phase II RI to characterize surface soils at those locations. Each pad is to be initially sampled at up to five locations exclusive of the Phase I RI sampling points. The results of the Phase I RI sampling at each pad will be used in the Phase II RI for characterization purposes. The purpose of the initial sampling is to evaluate the lateral extent of surface soil contamination on the burning pad and adjacent areas.

Nine surface soil samples will also be collected around the perimeter of the Deactivation Furnace Area (DFA) within the WBG, which is currently in the process of closure under RCRA (see Figure 4-15). Sampling will take place in and/or adjacent to areas of suspected releases or potential source areas to further characterize the extent of contamination based on the results of the recent investigation of the DFA (USACE 1998). Nine sampling stations have been located in the DFA to investigate the extent of potential contamination. Two contingency surface soil sampling stations are planned at the DFA based on the results of the Phase II field colorimetry results.

Fifty-three surface sampling locations are proposed initially (Table 4-3) to cover the eleven pads and the Deactivation Furnace Area (Figures 4-3 through 4-14). Sixteen surface soil samples are included for this Phase II RI as contingency samples for which locations are yet to be determined (TBD). Contingency surface soil samples will be used to determine the horizontal extent of contaminated areas as determined by the results of field colorimetry testing for explosives on surface soils from the 13 burning pads and DFA. The rationale for locating contingency surface soil samples will be



Figure 4.15. Deactivation Furnace Area (Pad #45).

Site Location	No. Sample Stations	Sample Station IDs	Location Description	Sample Station Rationale
Pad #5	3	WBGss-099	NW quadrant of pad	Extent of pad contamination
		WBGss-100	NE quadrant of pad	
		WBGss-101	S half of pad	
Pad # 6	3	WBGss-102	NW quadrant of pad	Extent of pad contamination
		WBGss-103	NE quadrant of pad	
		WBGss-104	S half of pad	
Pad # 37	2	WBGss-105	15 ft NW of pad	Extent of contamination off pad
		WBGss-106	15 ft SE of pad	
Pad #38	3	WBGss-107	N half of pad	Extent of pad contamination
		WBGss-108	S half of pad	
		WBGss-109	5 ft E of pad	Extent of contamination off pad
Pad #40	3	WBGss-110	NW quadrant of pad	Extent of pad contamination
		WBGss-111	NE quadrant of pad	
		WBGss-112	S half of pad	
Pad #58	3	WBGss-113	NW quadrant of pad	Extent of pad contamination
		WBGss-114	NE quadrant of pad	
		WBGss-115	5 ft S of pad	
Pad #59	3	WBGss-116	NW quadrant of pad	Extent of pad contamination
		WBGss-117	SW quadrant of pad	
		WBGss-118	5 ft W of pad	Extent of contamination off pad
Pad #60	4	WBGss-119	5 ft S of pad	Extent of contamination off pad
		WBGss-120	5 ft E of pad	
		WBGss-121	5 ft W of pad	
		WBGss-122	5 ft N of pad	
Pad #61	4	WBGss-123	5 ft S of pad	Extent of contamination off pad
		WBGss-124	5 ft E of pad	
		WBGss-125	5 ft W of pad	
		WBGss-126	5 ft N of pad	
Pad #62	3	WBGss-127	5 ft S of pad	Extent of contamination off pad
		WBGss-128	5 ft E of pad	
		WBGss-129	5 ft N of pad	

 Table 4-3. Phase II RI Surface Soil and Sediment Sampling Locations and Rationale

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Table 4-3 (continued)

Site Location	No. Sample Stations	Sample Station IDs	Location Description	Sample Station Rationale
Pad #66	5	WBGss-130	15 ft NW of USAEHA #37/38	Extent of contamination off pad
		WBGss-131	15 ft SW of USAEHA #39	
		WBGss-132	10 ft S of pad	
		WBGss-133	10 ft E of pad	
		WBGss-134	10 ft N of pad	
Pad #67	5	WBGss-135	15 ft NW of WBGss-070	Extent of contamination off pad
		WBGss-136	15 ft SW of WBGss-070	
		WBGss-137	25 ft E of USAEHA #40	
		WBGss-138	15 ft E of SE quadrant	
		WBGss-139	15 ft S of SE quadrant	
Pad #68	3	WBGss-140	10 ft S of pad	Extent of contamination off pad
		WBGss-141	10 ft E of pad	
		WBGss-142	10 ft N of pad	
Deac. Furn.	9	WBGss-143	20 ft NE of RCRA boundary	Extent of contamination beyond RCRA unit
		WBGss-144	20 ft SE of RCRA boundary	
		WBGss-145	20 ft NW of RCRA boundary	
		WBGss-146	20 ft SW of RCRA boundary	
		WBGss-147	50 ft E of RCRA boundary	
		WBGss-148	50 ft W of RCRA boundary	
		WBGss-149	50 ft N of RCRA boundary	
		WBGss-150	TBD based on field colorimetry	
		WBGss-151	TBD based on field colorimetry	
Slag	2	WBGss-152	Road E east adjacent to Pad #65	
		WBGss-153	Road E east adjacent to Pad #70	
Sediment	4	WBGsd-154	SE drainage – 300 ft from WBGsd-090	
		WBGsd-155	E drainage – colocate with WBGsd-088	
		WBGsd-156	Mack's Pond	
		WBGsd-157	Downstream of Mack's before Sand Creek	
Total	59			

to move concentrically from the contaminated area(s) and locate contingency surface soil sampling points ~1.5 m (5 ft) from the outer extent of the burning pad. If field colorimetric testing indicates no explosives are present outside of the burning pad area, no further sampling will be performed in that area. However, if colorimetry shows explosives > 1 ppm (TNT or RDX), then additional subsurface soil sampling (Section 4.2.1.1) will be performed using contingency samples to determine vertical extent at one location. Additional surface soil contingency samples will be located ~4.5 m (15 ft) in an outward direction from the identified contamination. The intent is to use contingency soil samples to bound the extent (vertical and horizontal) of contamination identified at each area investigated. Contingency samples for pads #37 and #67 have been located on Figures 4-5 and 4-14 to illustrate this rationale. Contingency sampling will be utilized based on field colorimetry results to define extent in each area; however, the contract capacity for sampling, as defined in Table 4-1, cannot be exceeded. In the event that an area(s) cannot be fully delineated using contingency sampling, a supplemental investigation will be necessary.

Surface soil samples will be collected from 0 to 0.3 m (0 to 1 ft), and homogenized from three subsamples collected from a 0.9×0.9 m (3×3 ft) area. All surface soil samples will be analyzed using field colorimetry for explosives and, based on these results, samples will be additionally submitted for laboratory analysis of explosives, TAL metals, and cyanide. Geotechnical and lithologic information will also be acquired from these intervals. The planned soil sampling locations are shown in Figures 4-1 through 4-15.

Background Investigation. The rationale for background surface soil sampling is to develop a background data set that characterizes natural site-wide variability in the 23 TAL metals. Surface soil samples will be collected from each of the 14 background monitoring well locations. Surface soils will be collected from 0 to 0.3 m (0 to 1 ft), homogenized, and analyzed in the field via colorimetry for explosives, in order to determine if the prospective location is in an area outside the influence of site operations. Background surface soil samples will be submitted for laboratory analysis of TAL metals, cyanide, SVOCs, and TOC. Two surface soil background samples will be additionally analyzed for VOCs and pesticides/PCBs. The background sampling locations, shown in Figure 4-2, are coincident with the sites for the background monitoring wells.

In addition, four samples of slag, used throughout RVAAP as road mettle, will be collected: one sample from each of the two northernmost roads (Pallet Road E East and Pallet Road D East) on the east side of the WBG. The purpose of this sampling is to determine whether slag is a potential source of heavy metals observed in WBG and other RVAAP soils during the Phase I RI.

4.3.1.2 Sediment Sampling Locations from Drainage Channels

WBG. Sediment sampling will be performed during the Phase II RI at the WBG. Sediments will be collected from one location in Mack's Pond near the southern AOC boundary in a tributary to Sand Creek, and in two small drainages that exit the AOC on its eastern boundary (See Figure 4-1). These four locations were selected to evaluate whether the drainages at WBG allow contaminants to migrate beyond the AOC boundary.

Background Investigation. Seven locations for the sampling of sediment and surface water representative of background conditions have been selected along Hinkley, Sand, and Eagle Creeks (see Figure 4-2). The background sampling locations were selected at biased locations in areas believed to represent native sediment conditions at RVAAP. These locations are upgradient of surface water runoff and process effluent discharge associated with past process operations, as well

as upwind of the major load lines. Two samples will be taken from each creek, with one additional location TBD. The samples in the creek will be collected at the furthest upstream points (e.g., where the creek enters the facility boundary), and at the furthest downstream points that are still upstream from the load lines and other process areas.

All sediment samples will be collected from 0 to 0.15 m (0 to 0.5 ft) from areas of the stream channels where surface water is pooled or ponded. Sediment samples will not be collected from areas demonstrating turbid or rapid flow. Surface water and sediment samples will be collected in the same locations. Surface water will be collected first, beginning with the furthest downstream point and moving upstream, to minimize the effects of turbidity.

4.3.1.3 Discrete/Composite Soil and Sediment Sampling Requirements

All surface soil 0 to 0.3 m (0 to 1 ft) and sediment samples 0 to 0.15 m (0 to 0.5 ft) will be homogenized from three subsamples collected about 0.9 m (3 ft) from one another in a roughly equilateral triangle pattern. Sampling will be accomplished using a stainless steel spoon or scoop. Equal portions of soil from the subsamples will be homogenized in a stainless steel bowl. Once the subsamples are homogenized, a portion will be analyzed with the colorimetry method described in Appendix B, and another portion will be sent for laboratory analysis as described in Section 4.3.1.4.

4.3.1.4 Sample Collection for Field and Laboratory Analysis

All surface soil and sediment samples will be field screened for VOCs using a hand-held PID or FID OVA during collection. No samples will be collected for additional headpsace analysis of VOCs.

WBG. All surface soil and sediment samples will be subject to field colorimetric analysis for TNT and RDX. At WBG, the purpose of this analysis is to define the extent of contamination. Therefore, the following strategy will be used:

- If the field method indicates TNT is present at ≥ 1 ppm, the sample will be sent to the off-site lab for analysis of explosives.
- If the concentration of TNT is <1 ppm, the analysis for RDX will be performed.
- If RDX is present at concentrations >1 ppm, the sample will be sent to the off-site laboratory for analysis of explosives.
- In addition, 15% of the samples showing non-detects of TNT or RDX will be sent to the off-site laboratory for analysis of explosives. Historical performance by the USACE using these methods has indicated that 15% is more than sufficient to guard against false negative results.
- All samples collected, regardless of field colorimetry results, will be submitted for TAL metals and cyanide analysis. However, the contract capacity for analysis, as defined in Tables 4-1 and 4-2, will not be exceeded.
- Four surface soil samples, randomly selected, will be submitted for additional SVOC analysis.

Surface soil and sediment samples will be submitted for analysis as shown in Table 4-1.

Background Investigation. For the background investigation, the purpose of the colorimetric analysis is to confirm that the prospective sampling site is outside the area of influence of the process operations that introduced explosive contaminants to facility soils. For this reason, if the field method indicates the presence of either TNT or RDX, the field team will not send the sample to the off-site lab, but rather will relocate the background sampling site. All background surface soil and sediment samples will be submitted for off-site laboratory analysis. Table 4-2 summarizes the analytical parameters and methods that will be employed for the Phase II RI at WBG. Surface soil and sediments will be analyzed for TAL metals and cyanide. Five background surface soil samples will also be analyzed for VOCs and pesticides/PCBs.

4.3.1.5 QA/QC, and Blank Samples and Frequency

Background samples will be collected as shown in Table 4-2 of this Phase II SAP Addendum. These background samples are intended to augment the Phase I RI background data collected in 1996, to allow recalculation of background criteria for inorganics previously investigated, and to establish background for some inorganic analytes that were not previously evaluated.

Surface soil/sediment QA/QC samples will be collected during the Phase II RI. Duplicate soil samples will be collected at a frequency of 10% (1 per 10 environmental samples). Split samples will be submitted to the USACE MRD laboratory for independent analysis. Split samples will be collected at a frequency of 5% (1 per 20 environmental samples). Duplicate and split samples will be selected based on a random statistical basis and submitted for the same analyses as the environmental samples. No field or rinsate blanks will be collected for surface soils/sediments. Section 8 of this Phase II QAPP Addendum summarizes QA/QC sampling.

4.3.2 Procedures

4.3.2.1 Sampling Methods for Soil/Dry Sediments

4.3.2.1.1 Bucket Hand Auger Method

Surface soil and dry sediment samples will be collected with a bucket hand auger in accordance with Section 4.5.2.5 of the Facility-wide SAP. In this investigation, auger buckets 15.24 cm (6.0 in) in length and 7.62 cm (3.0 in) in diameter will be used. At each location, an auger will be advanced in two 15.24-cm (6.0-in) intervals to a total depth of 30.48 cm (1.0 ft) BGS. Material collected from each 15.24-cm (6.0-in) interval will be placed in a common steel bowl and composited.

A composite soil sample will be created from three subsamples collected in the manner described above. The three subsamples will be collected in a roughly equilateral triangle pattern with the subsamples positioned about 0.9 m (3 ft) apart from each other. As each subsample is added to the compositing bowl, the soil will be mixed thoroughly.

At the locations where VOC sample fractions are to be collected, the portion of the sample designated for VOC analyses will be placed into laboratory containers first, i.e., no sample for VOC analysis will be collected from composited or homogenized sample volumes.

4.3.2.1.2 Trowel/Scoop Method

Surface soils and dry sediment may also be collected using the trowel method as presented in Section 4.5.2.1.2 of the Facility-wide SAP. The trowel will be used to manually obtain sediment to a depth of 15.24 cm (6.0 in) BGS. At sample locations where VOC fractions are to be collected, the VOC containers will be filled with the first materials obtained. Sample containers for the remaining analytes will be filled with material that has been mixed and composited from three separate subsamples as described in Section 4.3.2.1.1 of this Phase II SAP Addendum.

4.3.2.2 Sampling Methods for Underwater Sediments from Streams

4.3.2.2.1 Trowel Method

Sediment samples, in locations where water depth does not exceed 15.24 cm (6.0 in.), will be collected with a stainless steel trowel. The trowel will be used to manually obtain sediment to a depth of 15.2 cm (6 in.) below the sediment surface. At sample locations where VOC fractions are to be collected, the VOC containers are filled with the first sediment obtained. Sample containers for remaining analytes will be filled with sediment that has been mixed and composited from the entire interval as described in Section 4.4.2.5.1 of the Facility-wide FSP.

4.3.2.2.2 Hand Core Sampler Method

A sludge sampler will be used to collect sediment at locations where the depth of the surface water exceeds 15.24 cm (6 in.). Samples will be collected following the guidelines presented in Section 4.5.2.5 of the Facility-wide FSP.

The sludge sampler consists of a stainless steel, 8.26 cm (3.25 in.) OD, 30.48 cm (12 in.) long capped tube which can be fitted with either an auger- or core-type sampler end. Each sampler end is equipped with a butterfly valve to prevent loss of sample upon retrieval. In this investigation, the core-type end will be preferentially used. The auger-type sampler end will be used only in the event that the sediment becomes too gravelly or consolidated for the efficient use of the core type-end. The sludge sampler will be extended to the sampling depth by connecting 60.96, 91.44, 121.92, or 152.40 cm (2, 3, 4, or 5 ft) stainless steel extension rods to the sampler. The extension rods will be attached to a cross handle and will be pushed or augered by hand.

4.3.2.3 Field Measurement Procedures and Criteria

4.3.2.3.1 Field Colorimetric Analysis for TNT and RDX

Colorimetric analysis of surface soils for TNT and RDX will be performed following the field method presented in Appendix B of this SAP Addendum.

WBG. One composite soil sample will be collected from 0 to 0.3 m (0 to 1 ft) at each of the soil boring locations and submitted for field colorimetric analysis of explosives.

Background Investigation. One homogenized soil sample will be collected from 0 to 0.3 m (0 to 1 ft) at each soil boring location and submitted for field colorimetric analysis of explosives.

Tables 4-1 and 4-2 summarize the analytical parameters and methods that will be used during the Phase II RI. Analytical laboratory methods, analytes, and procedures are further discussed in the Phase II RI QAPP Addendum.

4.3.2.3.2 Organic Vapor Screening

All field measurement procedures and criteria will follow Section 4.4.2.3 of the Facility-wide SAP, with the following exception. Headspace gases will not be screened in the field for organic vapors. Because there were no notable detections of VOCs during Phase I RI soil sampling, organic vapor monitoring of headspace gases is not necessary in Phase II.

4.3.2.4 Sampling for Geotechnical Analysis

WBG. Surface soil and sediment samples collected using the hand auger method are classified as disturbed samples. Therefore, geotechnical analysis of samples collected using these methods will be limited to grain size, Atterberg limits, moisture content, and unified soil classification. Procedures for sampling for geotechnical analysis using the bucket hand auger method are presented in Section 4.4.2.4.2 of the Facility-wide SAP. Six representative surface soil/sediment samples shall be submitted for geotechnical analysis.

Background Investigation. Surface sampling of soils and sediments will be accomplished using a bucket hand auger. Samples will be collected using this device prior to hollow-stem auger drilling of boreholes for monitoring well installation. Procedures for collecting geotechnical samples using the bucket hand auger method are discussed in Section 4.4.2.4.2 of the Facility-wide SAP.

Six representative surface soil samples will be submitted for geotechnical analysis as described above.

4.3.2.5 Sampling for Chemical Analysis

WBG. Procedures for sampling of surface soils and sediment for chemical analysis using the Bucket Hand Auger Method are presented in Section 4.4.2.5.2 of the Facility-wide SAP.

Background Investigation. Procedures for sampling of surface soils for chemical analysis using the Hollow-Stem Auger Method are presented in Section 4.4.2.5.1 of the Facility-wide SAP.

4.3.2.6 Sample Containers and Preservation

Requirements for sample containers and preservation techniques for surface soil and sediment samples are presented in Section 4.4.2.6 of the Facility-wide SAP and the Phase II QAPP Addendum.

4.3.2.7 Field Quality Control Sampling Procedures

Surface soil and sediment QA/QC samples will be collected during the Phase II RI. Duplicate soil samples will be collected at a frequency of 10% (1 per 10 environmental samples). Split samples will be submitted to the USACE MRD laboratory for independent analysis. Split samples will be collected at a frequency of 5% (1 per 20 environmental samples). Duplicate and split samples will be selected based on a random statistical basis and submitted for the same analyses as the

environmental samples. No field or rinsate blanks will be collected for surface soils. Section 8 of this Phase II SAP Addendum summarizes QA/QC sampling.

4.3.2.8 Decontamination Procedures

The decontamination procedure for surface soil and sediment sampling activities is presented in Section 4.4.2.8 of the Facility-wide SAP, except that a 2% HCl rinse will be used instead of at 10% solution.

4.4 SURFACE WATER

Evaluation of surface water will be performed only for one location in WBG and for the background investigation of this Phase II RI.

4.4.1 Rationales

WBG. The rationale for surface water sampling at WBG is to determine surface water quality at Mac's Pond, where surface water runoff from the western half of the AOC accumulates before exiting the AOC. One sample will be collected from the outlet of the pond, coincident with the location of the pond sediment sample.

Background Investigation. Surface water sampling locations will be colocated with the sampling locations for sediment samples, [i.e., at the seven locations along Hinkley, Sand, and Eagle Creeks (Figure 4-2)]. These sampling locations are in areas believed to represent native stream conditions at RVAAP, and are upgradient of surface water runoff and process effluent discharge points associated with past process operations. Where possible, surface water samples are coincident with former water quality monitoring stations where sampling has been historically performed by RVAAP to monitor water quality. Two samples will be taken from each creek, with one additional location TBD. The samples in the creek will be collected at the furthest upstream points (e.g., at or near the point where the creek enters the facility), and at the furthest downstream points that are still upstream from the load lines and other process areas.

Filtered and unfiltered surface water samples will be submitted to the analytical laboratory for analysis of TAL metals and cyanide. The sample from Mack's Pond will additionally be analyzed for explosives, VOCs, and SVOCs.

4.4.2 Procedures—General

All surface water sampling will be conducted as described in Section 4.6.2.1.1 of the Facility-wide SAP. The hand-held bottle method will be used to sample water in the creeks. The sample container will be submerged, with the cap in place, into the surface water flow. Then container will then be slowly and continuously filled using the cap to regulate the rate of sample entry into the container. The sample container will be removed from the flow with minimal disturbance to the sample. Immediately after collection of the sample and proper labeling, the container will be placed into a sealable plastic bag and placed into an ice-filled cooler to ensure preservation

All surface water sample collection will begin at the sampling point furthest downstream in the channel and proceed upstream, to minimize the effects of sediment turbidity on surface water quality.

4.4.2.1 Sampling Methods for Surface Water—Filtration

Surface water collected during the Phase II RI will not be filtered prior to analysis.

4.4.2.2 Field Measurement Procedures and Criteria

Surface water field measurements to be performed during the Phase II RI will include determination of pH, conductivity, dissolved oxygen content (D.O.) and temperature. These measurements will be performed in the same manner as described in Section 4.3.3 of the Facility-wide SAP.

4.4.2.3 Sample Containers and Preservation Techniques

Information regarding sample containers and preservation techniques for surface water samples collected for chemical analysis during the Phase II RI is presented in Section 4 of the QAPP portion of the Facility-wide SAP. All sample containers will be provided by the contracted laboratory, including pre-preserved containers for VOC samples.

4.4.2.4 Field Quality Control Sampling Procedures

Surface water QA/QC samples will be collected during the Phase II RI. Duplicate samples will be collected at a frequency of 10% (1 per 10 environmental samples). Split samples will be submitted to the USACE MRD laboratory for independent analysis. Split samples will be collected at a frequency of 5% (1 per 20 environmental samples). Duplicate and split samples will be selected based on a random statistical basis and submitted for the same analyses as the environmental samples. No field or rinsate blanks will be collected for surface water. The Phase II QAPP Addendum summarizes QA/QC sampling.

4.4.2.5 Decontamination Procedures

Decontamination of any equipment used for collection of surface water samples during the Phase II RI will be conducted in the same manner as described for 38 nondedicated sampling equipment in Section 4.3.8 of the Facility-wide SAP, except that a 2% HCl rinse will be used instead of a 10% solution.

In addition to the surface water sampling equipment, field measurement instruments will also be decontaminated between sampling locations. Only those portions of each instrument that come into contact with potentially contaminated surface water will be decontaminated.

5. SAMPLE CHAIN OF CUSTODY/DOCUMENTATION

5.1 FIELD LOGBOOK

All field logbook information will follow structures identified in Section 5.1 of the Facility-Wide SAP.

5.2 PHOTOGRAPHS

Information regarding the documentation of photographs for WBG is presented in Section 4.3.2.4.3 of the Facility-Wide SAP.

5.3 SAMPLE NUMBERING SYSTEM

The sample numbering system that will be used to identify samples collected during the Phase II RI of WBG is explained in Section 5.3 of the Facility-Wide SAP. The specific identifying information that will be used to implement this system during the Phase II RI is presented in Figure 5-1 of this SAP Addendum. Because samples have already been collected at WBG and entered into the electronic data base, sample numbering for the Phase II RI will continue the sequence established in Phase I, as shown in Table 4-3.

5.4 SAMPLE DOCUMENTATION

All sample label, logbook, field record, and field form information will follow structures identified in Section 5.4 of the Facility-Wide SAP.

5.5 DOCUMENTATION PROCEDURES

Documentation and tracking of samples and field information will follow the series of steps identified in Section 5.5 of the Facility-Wide SAP.

5.6 CORRECTIONS TO DOCUMENTATION

Any corrections to documentation will follow guidance established in Section 5.6 of the Facility-Wide SAP.

5.7 MONTHLY REPORTS

Monthly reports will be submitted during implementation of the field investigation and through the data analysis phase of the project. Monthly report information will follow structures identified in Section 5.7 of the Facility-Wide SAP.

Sample Station Location Identification: XXXmm-NNN(n)

XXX = Area Designator

Load Line 1 = LL1 Load Line 2 = LL2 Load Line 3 = LL3 Load Line 4 = LL4 Load Line 12 = L12 Building 1200 = B12 Landfill North of Winklepeck Burning Ground = LNW Winklepeck Burning Ground = WBG Demolition Area No. 2 = DA2 Load Line 12 Waste Water Treatment Plant = L12^{*} Upper and Lower Cobbs Pond = CPC * Combined with LL12 because proximity of AOCs

<u>mm = Sample Location Type</u>

- ss = Surface Soil Location
- so = Soil Boring Location
- sd = Sediment Sampling Location
- tr = Trench Location
- wp = Well Point Location

NNN = Sequential Sample Number Location

Unique sequence for each area designator

(n) =Special Identifier

- d = Drainage Channel Sample
- p = Pond Sample
- b = Background Sample

Sample Identification: XXXmm-NNN(n)-####-tt

<u>#### = Sequential Sample Number</u> Unique to each Phase 1 RI Sample

<u>tt = Sample Type</u>

- GW = Unfiltered Groundwater Sample
- SO = Soil Sample
- SD = Sediment Sample

TB = Trip Blank

FB = Field Blank

ER = Equipment Rinsate

6. SAMPLE PACKAGING AND SHIPPING REQUIREMENTS

Sample packaging and shipping shall generally follow Section 6 of the Facility-Wide SAP. Because the analytical laboratory is located less than 50 miles from the site, the contract laboratory will provide same-day pickup of coolers containing samples. This will reduce the need for some of the packaging measures described in the Facility-Wide SAP, which are intended for air-shipped coolers. Specifically:

- COC forms can be hand-carried by the courier to the laboratory.
- No airbills will be attached to couriered coolers.
- "THIS END UP" and "FRAGILE" stickers will not be required for couriered containers.

Sample coolers shipped to the USACE's QA laboratory will be prepared and shipped in accordance with the Facility-Wide SAP.

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7. INVESTIGATION-DERIVED WASTE

All IDW will be managed in accordance with Section 7 of the Facility-Wide SAP. At the conclusion of field activities in the Phase II RI of WBG, a letter report will be submitted documenting characterization and classification of the wastes, and all solid and liquid IDW, including solvent wastes from the field colorimetry laboratory, will be removed from the site and disposed of by a licensed waste disposal contractor. All IDW from background locations will be disposed on site.

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QUALITY ASSURANCE PROJECT PLAN ADDENDUM FOR THE PHASE II REMEDIAL INVESTIGATION OF THE WINKLEPECK BURNING GROUNDS AND DETERMINATION OF FACILITY-WIDE BACKGROUND AT THE RAVENNA ARMY AMMUNITION PLANT RAVENNA, OHIO

Prepared for

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FINAL

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ACRONYMS

FSP	Field Sampling Plan
RI	Remedial Investigation
QA	quality assurance
QAMP	Quality Assurance Management Plan
QAPP	Quality Assurance Project Plan
QC	quality control
RVAAP	Ravenna Army Ammunition Plant
SAP	Sampling and Analysis Plan
USACE	U.S. Army Corps of Engineers
WBG	Winklepeck Burning Grounds

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INTRODUCTION

This Quality Assurance Project Plan (QAPP) addendum addresses supplemental project specific information pertaining to the Phase II Remedial Investigation for the Winklepeck Burning Grounds (WBG) and Determination of Facility-wide Background in relation to the Facility-wide QAPP (USACE 1996) for the Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio. Each QAPP section is presented documenting adherence to the Facility-wide QAPP or stipulating project specific added requirements.
98-003P(WPD)(QAPP-ADD)/033198

1. PROJECT DESCRIPTION

1.1 SITE HISTORY/BACKGROUND INFORMATION

This information is contained in Section 1.1 of the Phase II Remedial Investigation (RI), Sampling and Analysis Plan (SAP) Addendum for the Winklepeck Burning Grounds (WBG).

1.2 PAST DATA COLLECTION ACTIVITY/CURRENT STATUS

This information is contained in Section 1.2 of the Phase II RI, SAP Addendum for the WBG.

1.3 PROJECT OBJECTIVES AND SCOPE

This information is contained in Section 3 of the Phase II RI, SAP Addendum for the WBG.

1.4 SAMPLE NETWORK DESIGN AND RATIONALE

This information is contained in Section 4 of the Phase II RI, SAP Addendum for the WBG.

1.5 PARAMETERS TO BE TESTED AND FREQUENCY

Sample matrix types, analytical parameters, and analytical methods are discussed in Section 4 of the Phase II RI, SAP Addendum for the WBG. These are summarized in Tables 1-1 and 1-2 of this Quality Assurance Project Plan (QAPP) Addendum, in conjunction with anticipated sample numbers, quality assurance (QA) sample frequencies, and field quality control (QC) sample frequencies.

1.6 PROJECT SCHEDULE

The Phase II RI schedule is discussed in Section 2 of the Phase II RI, SAP Addendum for the WBG.

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(JP(WPD)	Parameter	Methods	Field Samples	Field Duplicate Samples	Site Source Water"	Sampler Rinsates	Trip Blanks	Total A-E Samples	USACE QA Split Samples	Ohio EPA QA Split Samples
ÔÅ	Soils/Sediments									
P-ADD)/040198	VOCs, TCL	SW-846, 8260A	7	1	-	-	-	8	1	-
	SVOCs, TCL	SW-846, 8270B	37	4	-	-	-	41	3	-
	Pesticides/PCBs, TCL	SW-846, 8081	7	1	-	-	-	8	1	-
	Metals, TAL	SW-846, 6010A/7471	52	6	-	-	-	58	3	-
	Cyanide	SW-846, 9013	52	6	-	-	-	58	3	-
-	Explosives	SW-846, 8330	0	0	-	-	-	0	0	-
	Total organic carbon		15	2	-	-	-	17	1	-
	Grain size, moisture content, Atterburg limits	ASTM D422, D2216, D4310	42	-	-	-	-	42	-	-
2	Bulk density, porosity	ASTM D453, EM1110-2-1906	8	-	-	-	-	8	-	-
	Groundwater/Surface Water									
	VOCs, TCL	SW-846, 8260A	2	1	2	-	1	6	1	-
	SVOCs, TCL	SW-846, 8270B	2	1	2	-	-	5	1	-
	Pesticides/PCBs, TCL	SW-846, 8081	2	1	2	-	-	5	1	•
	Metals (total), TAL	SW-846, 6010A/7470	22	2	2	1	-	27	1	-
	Metals (dissolved), TAL	SW-846, 6010A/7470	22	2	2	1	-	27	1	-
	Cyanide	SW-846, 9013	37	3	4	1	-	45	2	-
	Explosives	SW-846, 8330	0	0	0	0	-	0	0	-

Table 1-1. Phase II RI Site Background, RVAAP-Sampling and Analytical Requirements

" Site source waters = one potable water source and one ASTM water supply lot for the project.

EPA = U.S. Environmental Protection Agency

RVAAP = Ravenna Army Ammunition Plant Semivolatile organic compounds SVOCs =

PCB = Polychlorinated biphenyl = Quality control QA

TAL = Target analyte list

= Remedial investigation RI

= Target compound list TCL

USACE = U.S. Army Corps of Engineers VOCs = Volatile organic compounds

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Parameter	Methods	Field Samples	Field Duplicate Samples	Site Source Water	Sampler Rinsates	Trip Blanks	Total A-E Samples	USACE Split Samples	Ohio EPA Split Samples
Soils/Sediments									
SVOCs, TCL	SW-846, 8270B	9	1	-			10	1	-
Metals, TAL	SW-846, 6010A/7471	115	12	-	-	-	127	7	-
Cyanide	SW-846, 9013	115	12	-		-	127	7	-
Explosives	SW-846, 8330	113	12		-	<u> </u>	125	6	_
Total organic carbon	<u> </u>	4			-	<u> </u>	4	0	-
Groundwater/Surface Water									
VOCs, TCL	SW-846, 8260A	10	1			3	14_	0	-
SVOCs, TCL	SW-846, 8270B	10	1		-	-	11	0	-
Metals (total), TAL	SW-846, 6010A/7470	10	1	-	-	-	11	0	-
Metals (dissolved), TAL	SW-846, 6010A/7470	10	1	-	-	-	11	0	-
Cyanide (total)	SW-846, 9013	10	1	-	_	-	11	0	_
Cyanide (dissolved) SW-846, 90		10	1	-	-	-	11	0	-
Explosives SW-846, 8330		10	1		-	_	11	0	-
EPA = U.S. Environmental Prot RI = Remedial investigation	tection Agency SVOC TAL	cs = Semi = Targe	volatile organic t analyte list	compounds	S USA VO	ACE = U Cs = V	.S. Army Cor olatile organi	ps of Enginee	rs

Table 1-2. Phase II RI Winklepeck Burning Ground, RVAAP-Sampling and Analytical Requirements

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RVAAP = Ravenna Army Ammunition Plant

= Target compound list

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TCL

98-003P(WPD)(QAPP-ADD)/040198

2. PROJECT ORGANIZATION AND RESPONSIBILITY

The functional project organization and responsibilities are described in Section 2 of the Facility-wide Field Sampling Plan (FSP) and the Phase II RI, SAP Addendum for the WBG.

Analytical support for Phase II RI at WBG has been assigned to Quanterra Environmental Services, Inc. The majority of analysis will be completed by Quanterra's North Canton, Ohio, facility, with explosive determinations being performed by the Knoxville, Tennessee, facility. These laboratories have been validated by the U.S. Army Corp of Engineers (USACE) Missouri River District Hazardous, Toxic, and Radioactive Waste, Mandatory Center of Expertise, Omaha, Nebraska. Quanterra Environmental Services' Quality Assurance Management Plan (QAMP) Revision 2, June 30, 1997, is available for review upon request. The laboratory's organizational structure, roles, and responsibilities are identified in Section 1 of their QAMP and facility specific appendices.

Analytical Facilities

Quanterra Environmental Services, Inc. North Canton, OH 4101 Shuffel Drive, N.W. North Canton, OH 44720

> Tel: (330) 497-9396 Fax: (330) 497-0772

Quanterra Environmental Services, Inc. Knoxville, TN 5815 Middlebrook Pike Knoxville, TN 37921

> Tel: (423) 588-6401 Fax: (423) 584-4315

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3. QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT

3.1 DATA QUALITY OBJECTIVES

Data quality objectives summaries for this investigation will follow Tables 3-1 and 3-2, as presented in the Facility-wide QAPP. All QC parameters stated in the specific SW-846 methods will be adhered to for each chemical listed. Laboratories are required to comply with all methods as written: recommendations are considered requirements.

3.2 LEVEL OF QUALITY CONTROL EFFORT

QC efforts will follow Section 3.2 of the Facility-wide QAPP. Field QC measurements will include field source water blanks, trip blanks, field duplicates, and equipment rinsate blanks. Laboratory QC measurements will include method blanks, laboratory control samples, laboratory duplicates, and matrix spike/matrix spike duplicate samples.

3.3 ACCURACY, PRECISION, AND SENSITIVITY OF ANALYSIS

Accuracy, precision, and sensitivity goals identified in the Facility-wide QAPP Section 3.3 and Tables 3-1 through 3-3 will be imposed for these investigations.

3.4 COMPLETENESS, REPRESENTATIVENESS, AND COMPARABILITY

Completeness, representativeness, and comparability goals identified in the Facility-wide QAPP Section 3.4 and Tables 3-1 and 3-2 will be imposed for these investigations.

4. SAMPLING PROCEDURES

Sampling procedures are discussed in the Facility-wide FSP and the SAP Addendum for the WBG for Phase II.

Tables 4-1 and 4-2 summarize sample container, preservation, and holding time requirements for soil, sediment, and water matrices for these investigations. The number of containers required are estimated in these tables.

Analyte Group	Approx. No. of Bottles	Container	Minimum Sample Size	Preservative	Holding Time
VOCs	9	1— 4 oz glass jar with Teflon®-lined cap (no headspace)	20 g	Cool, 4°C	14 days
SVOCs	56	1—8 oz glass jar with Teflon®-lined cap	100 g	Cool, 4°C	14 days (extraction) 40 days (analysis)
Pesticide/PCB Compounds	9	Use same container as SVOC	100 g	Cool, 4°C	14 days (extraction) 40 days (analysis)
Explosive Compounds	131	Use type same container as SVOC	20 g	Cool, 4°C	14 days (extraction) 40 days (analysis)
Metals (other than Hg)	190	1—8 oz wide mouth polybottle	50 g	Cool, 4°C	180 days
Mercury	190	Use same container as other metals	10 g	Cool, 4°C	28 days
Total Organic Carbon (TOC)	22	1—8 oz glass jar with Teflon®-lined cap	10 g	Cool, 4°C	28 days
Cyanide	190	Use same container as metals	25 g	Cool, 4° C	14 days

Table 4-1. Container Requirements for Soil and Sediment Samples at RVAAP

Polychlorinated biphenyl Semivolatile organic compounds Volatile organic compounds PCB = SVOCs = VOCs =

Samples incl. Analyte Group Field QC		Container	Minimum Sample Size	Preservative	Holding Time	
VOCs	50	2—40 mL glass vials with Teflon®-lined septum (no headspace)	80 mL	HCl to pH <2 Cool, 4°C	14 days	
SVOCs	17	1—L amber glass bottle with Teflon®-lined lid	1000 mL	Cool, 4°C	7 days (extraction) 40 days (analysis)	
Pesticide/PCB Compounds	6	1—L amber glass bottle with Teflon®-lined lid	1000 mL	Cool, 4°C	7 days (extraction) 40 days (analysis)	
Explosive Compounds	11	1—40 mL amber glass vial with Teflon®-lined lid	40 mL	Cool, 4°C	7 days (extraction) 40 days (analysis)	
Metals (other than Hg)	78	1—L polybottle	500 mL	HNO3 to pH <2 Cool, 4°C	180 days	
Mercury	78	Use same container as other metals	200 mL	HNO, to pH <2 Cool, 4°C	28 days	
Cyanide	67	500 mL polybottle	500 mL	NaOH to pH > 12 Cool, 4° C	14 days	

Table 4-2. Container Requirements for Water Samples at RVAAP⁴

" One sample will be tripled in volume for the laboratory to perform appropriate laboratory quality control analysis.

PCB Polychlorinated biphenyl =

SVOCs = Semivolatile organic compounds VOCs = Volatile organic compounds

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5. SAMPLE CUSTODY

5.1 FIELD CHAIN-OF-CUSTODY PROCEDURES

Sample handling, packaging, and shipment procedures will follow those identified in Section 5.1 of the Facility-wide QAPP.

5.2 LABORATORY CHAIN-OF-CUSTODY PROCEDURES

Laboratory chain-of-custody will follow handling and custody procedures identified in Section 8.5.3 of the Quanterra QAMP.

5.3 FINAL EVIDENCE FILES CUSTODY PROCEDURES

Custody of evidence files will follow those criteria defined in Section 5.3 of the Facility-wide QAPP.

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6. CALIBRATION PROCEDURES AND FREQUENCY

6.1 FIELD INSTRUMENTS/EQUIPMENT

Field instruments and equipment calibrations will follow those identified in Section 6.1 of the Facility-wide QAPP. Field laboratory equipment will be calibrated in accordance with Appendix B of the Phase II RI SAP.

6.2 LABORATORY INSTRUMENTS

Calibration of laboratory equipment will follow procedures identified in Section 8.5.4 of the Quanterra QAMP, corporate and facility specific operating procedures.

7. ANALYTICAL PROCEDURES

7.1 LABORATORY ANALYSIS

Analytical methods, parameters and quantitation or detection limits are those listed in Table 3-3 of the Facility-wide QAPP.

Quanterra's QAMP Section 8.0 and the facility specific addenda for the North Canton and Knoxville facilities will be followed during the analysis of these samples and the following laboratory standard operating procedures will implement the defined U.S. Environmental Protection Agency (EPA) Methods.

- GC/MS Volatile Organics Analysis, Based on Methods 8240B and 8260A, SW846, CORP-MT-0002NC, rev 1.1, 04/18/97.
- GC/MS Semivolatile Analysis, Based on Methods 270B, SW846, CORP-MS-0001NC, rev. 1.3, 05/09/97.
- Gas Chromatographic Analysis, Based on Methods 8000A, 8010B, 8020A, 8021A, 8080A, 8081, 8150B, and 8051, SW846, CORP-GC-0001, rev. 2, 01/31/96.
- Extraction and Cleanup of Organic Compounds from Waters and Soils, Based on SW846 3500 Series, 3600 Series, 8150, 8151, and 600 Series Methods, CORP-OP-0001NC, rev. 2.2, 04/18/97.
- Total Organic Carbon and Total Inorganic Carbon, NC-WC-0017, rev. 1, 11/20/97.
- Inductively Coupled Plasma-Atomic Emission Spectroscopy, Spectrometric Method for Trace Element Analysis, Methods 6010A and 200.7, CORP-MT-0001NC, rev. 1.2, 04/17/97.
- Graphite Furnace Atomic Absorption Spectroscopy, SW846 Methods 7000A and MCAWW 200 series methods, CORP-MT-0003, rev. 1, 08/22/95.
- Mercury in Aqueous Samples by Cold Vapor Atomic Absorption, SW846 7470A and MCAWW 245.1, CORP-MT-0005NC, rev. 1.1, 04/19/97.
- Mercury in Solid Samples by Cold Vapor Atomic Absorption, SW846 7471A and MCAWW 245.5, CORP-MT-0007NC, rev. 1.1, 04/17/97.

Quanterra facilities will at all times maintain a safe and contaminant free environment for the analysis of samples. The laboratories will demonstrate thorough instrument blanks, holding blanks, and analytical method blanks, such that the laboratory environment and procedures will not and do not impact analytical results.

Quanterra facilities will also implement all reasonable procedures to maintain project reporting levels for all sample analysis. Where contaminant and sample matrix analytical interferences impact the laboratory's ability to obtain project reporting levels, the laboratory will institute sample cleanup processes, minimize dilutions, adjust instrument operational parameters, or propose alternative analytical methods or procedures. Elevated reporting levels will be kept to a minimum throughout the execution of this work.

7.2 FIELD SCREENING ANALYTICAL PROTOCOLS

Procedures for field analysis are identified in the Facility-wide FSP Section 6 and in the Phase II, SAP Addendum, Section 4.

8. INTERNAL QUALITY CONTROL CHECKS

8.1 FIELD SAMPLE COLLECTION

Field QC sample types, numbers, and frequencies are identified in Section 4 of the Phase II RI, SAP Addendum for the WBG. In general, field duplicates will be collected at a frequency of 10%, field equipment rinsates and blanks will be collected at a frequency of 5% for samples collected with nondedicated equipment, and volatile organic trip blanks will accompany all shipments containing volatile organic samples.

8.2 FIELD MEASUREMENT

Refer to Section 4 of the Phase II RI, SAP Addendum for details regarding these measurements.

8.3 LABORATORY ANALYSIS

Analytical QC procedures will follow those identified in the referenced EPA methodologies. These will include method blanks, laboratory control samples, matrix spike/matrix spike duplicate samples, laboratory duplicate analysis, calibration standards, internal standards, surrogate standards, and calibration check standards.

Quanterra facilities will conform to their QAMP, facility-specific appendices, and implement their established standard operating procedures to perform the various analytical methods required by the project. QC frequencies will follow those identified in Section 8.3 of the Facility-wide QAPP.

9. DATA REDUCTION, VALIDATION, AND REPORTING

9.1 DATA REDUCTION

Sample collection and field measurements will follow the established protocols defined in the Facility-wide QAPP, Facility-wide FSP, and Phase II RI, SAP Addendum. Laboratory data reduction will follow Quanterra's QAMP Section 8.6 guidance and conform to general direction provided by the Facility-wide QAPP.

9.2 DATA VALIDATION

Data validation will follow the direction provided in the Facility-wide QAPP.

9.3 DATA REPORTING

Analytical data reports will follow the direction provided in the Facility-wide QAPP.

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10. PERFORMANCE AND SYSTEM AUDITS

10.1 FIELD AUDITS

A minimum of one field surveillance for each media being sampled during the investigation will be performed by the SAIC QA Officer and/or the SAIC Field Team Leader. These audits will encompass the sampling of surface soils, subsurface soils, well installation, and well sampling.

Surveillances will follow SAIC QAPP No. 18.3.

USACE, EPA Region V, or Ohio EPA audits may be conducted at the discretion of the respective agency.

10.2 LABORATORY AUDITS

Routine Missouri River District, Hazardous, Toxic, and Radioactive Waste, Mandatory Center of Expertise on-site laboratory audits will be conducted by the USACE. EPA Region V or Ohio EPA audits may be conducted at the discretion of the respective agency.

Internal performance and systems audits will be conducted by Quanterra's QA staff as defined in the laboratory QAMP, Section 9.2.

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11. PREVENTIVE MAINTENANCE PROCEDURES

11.1 FIELD INSTRUMENTS AND EQUIPMENT

Maintenance of all field analytical and sampling equipment will follow direction provided in Section 11.1 of the Facility-wide QAPP.

11.2 LABORATORY INSTRUMENTS

Routine and preventive maintenance for all laboratory instruments and equipment will follow the direction of Section 8.11 of Quanterra's QAMP.

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12. SPECIFIC ROUTINE PROCEDURES TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

12.1 FIELD MEASUREMENTS DATA

Field data will be assessed as outlined in Section 12.1 of the Facility-wide QAPP.

12.2 LABORATORY DATA

Laboratory data will be assessed as outlined in Section 12.2 of the Facility-wide QAPP.

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13. CORRECTIVE ACTIONS

13.1 SAMPLE COLLECTION/FIELD MEASUREMENTS

Field activity corrective action protocol will follow directions provided in Section 13.1 of the Facility-wide QAPP.

13.2 LABORATORY ANALYSES

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Laboratory activity corrective action protocol will follow directions provided in Section 13.2 of the Facility-wide QAPP and Section 9.1 of Quanterra's QAMP.

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14. QUALITY ASSURANCE REPORTS TO MANAGEMENT

Procedures and reports will follow the protocol identified in Section 14 of the Facility-wide QAPP and those directed by Section 9.4 of Quanterra's QAMP.

15. REFERENCES

Additional references to the Facility-wide QAPP are:

Quanterra Environmental Services, Inc. Quality Assurance Management Plan, Revision 2, June 30, 1997.

GC/MS Volatile Organics Analysis Based on Methods 8240B and 8260A, SW846, CORP-MT-0002NC, rev 1.1, 04/18/97.

GC/MS Semivolatile Analysis Based on Methods 8270B, SW846, CORP-MS-0001NC, rev. 1.3, 05/09/97.

Gas Chromatographic Analysis Based on Methods 8000A, 8010B, 8020A, 8021A, 8080A, 8081, 8150B, and 8051, SW846, CORP-GC-0001, rev. 2, 01/31/96.

Extraction and Cleanup of Organic Compounds from Waters and Soils, Based on SW846 3500 Series, 3600 Series, 8150, 8151, and 600 Series Methods, CORP-OP-0001NC, rev. 2.2, 04/18/97.

Total Organic Carbon and Total Inorganic Carbon, NC-WC-0017, rev. 1, 11/20/97.

Inductively Coupled Plasma-Atomic Emission Spectroscopy, Spectrometric Method for Trace Element Analysis, Methods 6010A and 200.7, CORP-MT-0001NC, rev. 1.2, 04/17/97.

Graphite Furnace Atomic Absorption Spectroscopy, SW846 Methods 7000A and MCAWW 200 series methods, CORP-MT-0003, rev. 1, 08/22/95.

Mercury in Aqueous Samples by Cold Vapor Atomic Absorption, SW846 7470A and MCAWW 245.1, CORP-MT-0005NC, rev. 1.1, 04/19/97.

Mercury in Solid Samples by Cold Vapor Atomic Absorption, SW846 7471A and MCAWW 245.5, CORP-MT-0007NC, rev. 1.1, 04/17/97.

15-2

APPENDIX A

RESULTS OF PREVIOUS INVESTIGATIONS OF WINKLEPECK BURNING GROUNDS

98-003P(WPD)(FSP)/033098
UNITED STATES ARMY ENVIRONMENTAL HYGIENE AGENCY

TEATINE

ABERDEEN PROVING GROUND, MD 21010-5422

HAZARDOUS WASTE MANAGEMENT STUDY NO. 37-26-0442-84 PHASE 2 OF AMC OPEN-BURNING/OPEN-DETONATION GROUNDS EVALUATION RAVENNA ARMY AMMUNITION PLANT RAVENNA, OHIO 31 OCTOBER - 3 NOVEMBER 1983

Distribution limited to US Government agencies only; protection of privileged information evaluating another command; Aug 84. Requests for this document must be referred to Commander, Ravenna Army Ammunition Plant, Ravenna, OH 44266.



Mr. Hoddinott/or1/AUTOVON DEPARTMENT OF THE ARMY U.S. ARMY ENVIRONMENTAL HYGIENE AGENCY ABERDEEN PROVING GROUND, MARYLAND 21010

REPLY TO Attention of

7 SEP 1984

HSHB-ES-E/WP

SUBJECT: Hazardous Waste Management Study No. 37-26-0442-84, Phase 2 of AMC Open-Burning/Open-Detonation Grounds Evaluation, Ravenna Army Ammunition Plant, Ravenna, Ohio, 31 October - 3 November 1983

Commander US Army Materiel Command ATTN: AMCSG 5001 Eisenhower Avenue Alexandria, VA 22333-0001

1. Copies of subject coport are inclosed.

2. The information contained in this report is based on a limited number of samples taken for the specific purposes of this study and may not be representative of the total situation at the installation. Pending promulgation of final environmental standards and complete interpretation of all data, this report should be used for informational purposes only.

FOR THE COMMANDER:

l Incl as (10 cy)

Kant Stanlel

KARL J. DAUBEL, P.E. Colonel, MSC Director, Environmental Quality

CONTRACT NO

CF:	
HQDA	(DASG-PSP) wo incl
Cdr,	AMC (AMCIS-A)
Cdr,	AMCCOM [DRSMC-ISE(R)/DRSMC-SG(R)]
Cdr,	HSC (HSCL-P)
Cdr,	TEAD (SDSTE-AE)
Cdr,	USATHAMA (DRXTH-TE/DRXTH-ES)
Cdr,	Ravenna AAP (2 cy)
Cdr,	WRAMC (PVNTMED Svc)
Cdr,	MEDDAC, Ft Knox (PVNTMED Svc) (2 cy)
C, US	SAEHA-Rgn Div North

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CF AMSIO-EQ COE, NASHUILLE } 4 3 96

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DEPARTMENT OF THE ARMY U.S. ARMY ENVIRONMENTAL HYGIENE AGENCY ABERDEEN PROVING GROUND, MARYLAND 21010

REPLY TO Attention of

HSHB_ES_E/WP

HAZARDOUS WASTE MANAGEMENT STUDY NO. 37-26-0442-84 PHASE 2 OF AMC OPEN-BURNING/OPEN-DETONATION GROUNDS EVALUATION RAVENNA ARMY AMMUNITION PLANT RAVENNA, OHIO 3 31 OCTOBER - 3 NOVEMBER 1980

1. AUTHORITY. Letter, DRCIS-A/DRCSG, HQ DARCOM, 13 March 1981, subject: Request for Services, Open-Burning/Open-Detonation Grounds, with initial indorsement, HSPA-P, HQ HSC, 20 March 1981.

2. REFERENCES. For a list of references, see Appendix A.

3. PURPOSE AND OBJECTIVES.

a. The overall purposes of the DARCOM Open-Burning/Open-Detonation Grounds Evaluation are:

(1) To evaluate the status of OB/OD grounds relative to existing Federal hazardous waste regulations (references 1 through 5, Appendix A).

(2) To evaluate the potential for contaminant migration from OB/OD grounds to the ground and surface waters (reference 6, Appendix A).

(3) To determine, based on these evaluations, which OB/OD grounds are the best sites for future OB/OD operations.

b. The specific objectives of the RAAP site investigation are:

(1) To determine the total explosive content of soil and residue samples from active OB/OD grounds at RAAP.

(2) To determine if the soil and residues at active OB/OD grounds at RAAP are hazardous wastes by the characteristic of EP Toxicity for heavy metals content.

(3) To determine the need for additional sampling and analyses of OB/OD areas at RAAP.

4. GENERAL.

a. <u>Abbreviations and Definitions</u>. Definitions of terms and abbreviations used in this report are included in Appendix B.

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b. <u>Personnel Contacted</u>. Installation personnel contacted during this investigation were:

(1) Mr. J. Lawless, Facility Manager, Firestone Corporation.

(2) Mr. H. Cooper, Environmental Coordinator, Firestone Corporation.

(3) Mr. R. Casper, COR, RAAP.

c. <u>Background</u>. A general background description of OB/OD operations and a discussion of environmental issues related to OB/OD are included in Appendix C.

d. <u>Installation</u>. A general description of RAAP, its location, and its operations can be found in reference 7, Appendix A.

e. <u>OB/OD Operations</u>. Active OB/OD operations were conducted in two adjacent areas located in the central portion of the installation.

f. <u>Sampling</u>. A study team from this Agency visited RAAP in late October/early November 1983. The team took a total of 80 samples from the two active OB/OD areas. A summary of sampling procedures is provided in paragraph 3a, Appendix C.

5. FINDINGS AND DISCUSSION.

a. <u>Analytical Data</u>. A summary of the analytical data is shown in the following Table with a description of the findings for each active area. Complete data are provided in Appendix D.

TABLE. SUMMARY OF ANALYTICAL RESULTS

Sampled	Explosives Analysis	EP Toxicity Metals Analysis	Remarks
OB Pads	Explosive compounds were detected in 34 of the 70 samples. Explosive content ranged from 1.4 µg/g to 2976.0 µg/g.	Twelve of the samples contained detectable amounts of heavy metals.	Five of the soil samples could be considered hazard- ous with respect to EP Toxicity.
OD Area	All 10 samples con- tained some amount of an explosive compound.	Four of the samples contained detectable amounts of heavy metals.	Only one sample could be considered hazardous with respect to EP Toxicity.

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b. OB Pads.

(1) Active burning at RAAP took place at an 80-acre site known as the Winklepeck Burning Grounds. These grounds consisted of 70 burn pads connected by a series of roads. However, by the criteria of this study, only 12 of these pads and the shoulder of lane D were considered active. These criteria designated an area as active if it either had been used for burning in the last 5 years or could possibly be used for burning in the next 5 years. Each pad measured approximately 20 by 40 feet and was constructed over the natural ground surface using fill material. The configuration of these pads is shown in Figure 1.

(2) Burning operations at these grounds consisted of thermal treatment of fuses, boosters, aluminum caps, bulk explosives, sump waste, and rocket motors. Actual burn pads used were assigned by random selection from among the available pads.

(3) A total of 70 samples was taken from locations on the active burn areas which appeared to be near the point of actual burning. In the case of the pads containing burn cages, the soil was sampled approximately 6 inches away from the cage. The following is a description of the pads sampled, organized by lane number. Complete data are provided in Appendix D.

(a) Lane C. The active pads of this lane were pads 37 through 40. At the time of this study these pads were barren, having been recently scraped to remove all topsoil and burn residue. The scrapings were piled on three sides of each pad. Sampling locations are shown in Figure 2.

(b) Lane D. Open burning in this area occurred on one pad (pad 52) and along the shoulders of the lane. Pad 52 was overgrown with grasses and was being used to store dunnage. The shoulder of lane D had been used to burn out rocket motors (see Figure 3).

(c) Lane E. The active pads of this lane were pads 58 through 61 and 65 through 67. Pads 58 through 61 were mainly used for flashing materials and soil barriers used in production. Pads 65 through 67 were used for dunnage storage and the demilitarization of fuses and boosters (see Figure 4).

(4) Analysis for the soil's explosive content detected measurable quantities of some explosive compounds in 34 of the 70 samples. Explosive levels ranged from 1.4 μ g/g to 686.1 μ g/g HMX, 20 μ g/g to 2976.0 μ g/g RDX, and 2.1 μ g/g to 2263.0 μ g/g TNT. The following is a list of the findings by pad.

(a) Pad 37. All samples contained detectable amounts of some combination of HMX, RDX, and TNT. Although most samples resulted in amounts which were less than 15 μ g/g, three samples contained substantial quantities of TNT. These measurements were 2263.0 μ g/g in one 0-6 inch sample, and 120 μ g/g and 608.5 μ g/g in two of the 6-18 inch samples. These results were possibly due to the burial of old surface residue by clean fill.







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(b) Pad 38. Three soil samples and one residue sample resulted in detectable amounts of TNT. The residue sample also contained detectable levels of HMX and 2,4-DNT. Two of the samples exceeded 20 μ g/g of TNT; one, the residue sample, contained 165.7 μ g/g, while the other, a 0-6 inch soil sample, contained 152.3 μ g/g of TNT.

(c) Pads 39 and 40 - No explosive compounds were detected.

(d) Lane D and Pad 52. Six soil samples contained measurable quantities of TNT. In addition, one sample contained a measurable quantity of RDX, while two others contained detectable HMX. However, no individual explosive compound exceeded 50 μ g/g.

(e) Pad 58. No explosive compounds were detected.

(f) Pad 59. Measurable quantities of HMX, RDX, and TNT were found in a pile of waste soil taken from one of the production lines. Also, one of the O-6 inch soil samples taken from the pad contained 19.5 μ g/g of TNT.

(g) Pad 60. Two 0-6 inch soil samples detected 36.0 μ g/g and 11.6 μ g/g TNT. While 3.1 μ g/g HMX was detected in the site residue.

(h) Pads 61 and 65. No explosive compounds were detected.

(i) Pads 66 and 67. All samples taken from this site yielded some combination of HMX, RDX, and TNT. While most of these results were less than 100 μ g/g, the maximum detected values were 686.1 μ g/g HMX, 2976.0 μ g/g RDX, and 1516.0 μ g/g TNT. These two sites were reported together since no clear distinction could be made to separate the burn marks between the pads.

(5) Analysis of heavy metals, as measured by the EP Toxicity analysis, revealed detectable quantities in 12 of the 70 samples taken from this area. Five of these twelve failed to meet the regulatory limits set under RCRA for either barium, cadmium, or lead (reference 2, Appendix A). The following is a list of findings of EP Toxicity analysis by pad.

(a) Pad 37. One 0-6 inch soil sample contained 0.2 mg/L cadmium.

(b) Pad 38. Two samples contained measurable quantities of heavy metals. One O-6 inch soil sample contained O.1 mg/L cadmium, while a sample from the pad's scrapings contained 1.3 mg/L cadmium and O.5 mg/L lead. This last sample exceeds the RCRA criteria for cadmium, thus some of the soil from this site may be a hazardous waste.

(c) Pads 39, 40, 52, 58 and Lane D. No EP Toxic metals were detected.

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(d) Pad 59. Cadmium and lead were detected in three of the samples from this pad. The analysis revealed 0.1 mg/L cadmium and 2.0 mg/L lead in a soil sample taken from a depth of 6-18 inches; 0.3 mg/L cadmium and 5.1 mg/L lead, and 1.2 mg/L cadmium and 3.4 mg/L lead, respectively in two samples collected from a depth of 18-24 inches in two separate holes. These last two samples contained some residue and failed the RCRA hazard criteria. The first deep sample (021) exceeded the limit of 5.0 mg/L lead, while the other (020) exceeded the limit of 1.0 mg/L cadmium. These results and the nature of the soil color indicate that another burn pad may have been buried under the present pad. While the residual metal results could have been by translocation and leaching, the insolubility of lead under acidic soil conditions makes the possibility of the buried burn pad more likely. Based on these results, the soil of this buried pad could be considered a hazardous waste under RCRA. Additional sampling should be conducted at this site to confirm these findings.

(e) Pad 60. Two samples taken at this site contained measurable quantities of heavy metals. One soil sample collected from a depth of 6-18 inches contained 0.1 mg/L cadmium. A sample taken from the pad's scrapings contained 0.1 mg/L cadmium, and 3.1 mg/L lead.

(f) Pad 61. Both soil samples taken at this pad contained measurable quantities of heavy metals. The O-6 inch sample contained O.1 mg/L cadmium, while the 6-18 inch sample contained 3.6 mg/L cadmium and O.5 mg/L lead. This last sample exceeds the RCRA limit of 1.0 mg/L for cadmium, thus the soil at this pad could be considered a hazardous waste. This pad should be resampled to confirm these results.

(g) Pads 65 and 67. No EP Toxic metals were detected.

(h) Pad 66. Two samples taken from near the fuse and booster cage contained measurable quantities of barium. The 0-6 inch sample contained 32.6 mg/L of barium while the 6-18 inch sample of the same hole contained 197 mg/L barium. This last sample exceeds the RCRA limit of 100 mg/L for barium, thus the soil of this pad could be considered a hazardous waste. This pad should be resampled to confirm these results.

(6) The consistent results of deeper soil samples containing higher levels of metals indicate a movement of contamination within the site, possibly driven by acidic precipitation or erosional disturbance. This, combined with the general level of contamination over the site, indicates an operation which is not environmentally clean. A more detailed evaluation of this site should be performed to designate the vertical and horizontal extents of migration for the purpose of cleanup and closure of the unnecessary portion(s) of these grounds.

(7) The OB area at RAAP encompassed more land than was needed for an efficient thermal treatment of the quantities of waste which would be generated under the installation's full operation. The installation should evaluate its present and projected needs for thermal treatment and reduce the area used at the Winklepeck-Burning Grounds.

c. <u>Detonation</u> Area.

(1) The detonation area at RAAP consisted of one bermed trench measuring approximately 25 feet wide by 75 feet long, with 10- to 12-foot berms on three sides. The open side was 25 feet wide and served to drain the trench of precipitation (see Figure 1).

(2) A total of 6 soil samples was taken at this trench in a grid pattern. Four additional samples were taken of the blast residue and the drainageway out of the trench.

(3) This site had a dual purpose; waste ordnance detonation and testing of ordnance and explosives developed by the Firestone Research and Development Laboratory.

(4) Although all samples contained measurable quantities of some combination of HMX, RDX, and TNT, only two samples resulted in amounts greater than 100 μ g/g. One of these was a residue sample which resulted in 19,598.0 μ g/g HMX, 535.0 μ g/g RDX, 238.4 μ g/g TNT, 2.4 μ g/g 2,6 DNT, and 1.4 μ g/g 2,4 DNT. The other sample was located in the middle of the trench and resulted in measured concentrations 225.2 μ g/g HMX, 456.9 μ g/g RDX, and 14.4 μ g/g INT.

(5) Analysis of the samples, by the EP Toxicity analysis, revealed that 4 of the 10 samples contained measurable quantities of barium or lead. The residue from the trench contained 25.3 mg/L barium, while one of the soil samples from the trench contained 535.0 mg/L lead. This sample exceeds the RCRA limit of 5.0 mg/L for lead, thus the soil of this trench could be considered a hazardous waste. The two other locations which contained heavy metals were along the drainageway. Analysis of these samples yielded 1.8 mg/L and 4.3 mg/L lead, 'respectively.

(6) While measurable quantities were detected in the soil of the drainageway of this trench, the severe disruption of this site by explosions and regrading operations makes a definite determination of pollutant movement impossible.

6. CONCLUSIONS.

a. The soil samples from pads 59, 61, 66, and 38 and the active blast trench (trench 7) were hazardous by the characteristic of EP Toxicity for heavy metals.

b. The soil samples from most pads and the OD area were contaminated with explosive compounds.

c. The OB area was much larger than needed for existing or future thermal treatment at RAAP.

d. A more detailed evaluation of the extent of contamination is needed at the Winklepeck Burning Grounds.

e. The information contained in this report is based on a limited number of samples taken for the specific purposes of this study and may not be representative of the total situation at the installation. Therefore, pending promulgation of final environmental standards and complete interpretation of all data, this report should be used for informational purposes only and should not be released to other agencies without DARCOM approval.

7. RECOMMENDATIONS.

a. Sample the entire burning grounds to determine the extent of contamination and to confirm the results of this study [paragraph 5b(6), this report]. (This recommendation is based on good engineering practice.)

b. Recommendations pertaining to the overall DARCOM OB/OD Grounds Evaluation will be addressed in reference 9, Appendix A.

8. TECHNICAL ASSISTANCE. For additional information or assistance regarding this report, contact the Chief, Waste Disposal Engineering Division, this Agency, AUTOVON 584-2024.

Keith Hoddinott

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APPROVED:

FRÉDERICK W. BØECHER MAJ(P), MSC Chief, Waste Disposal Engineering Division

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APPENDIX A

REFERENCES

1. Public Law (PL) 94-580, Resource Conservation and Recovery Act of 1976, 21 October 1976.

2. Title 40, Code of Federal Regulations (CFR), 1983 rev, Part 261, Identification and Listing of Hazardous Waste.

3. Title 40, CFR, 1983 rev, Part 262, Standards Applicable to Generators of Hazardous Waste.

4. Title 40, CFR, 1983 rev, Part 264, Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities.

5. Title 40, CFR, 1983 rev, Part 265, Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities.

6. Letter, HSE-ES/WP, this Agency, 2 March 1982, subject: Phase I, Hazardous Waste Special Study No. 39-26-0147-82, DARCOM Open Burning/Open Detonation Ground Evaluation, March-November 1981.

7. Installation Assessment of Ravenna Army Ammunition Plant Records Evaluation Report No. 132R, April 1981, USATHAMA, Aberdeen Proving Ground, MD.

8. Letter, HSHB-ES/WP, this Agency, 17 May 1983, subject: Draft Interim Environmental Criteria for Open Burning and Open Detonation (OB/OD) Grounds (USAEHA Control No. 39-267-0197-83).

9. Letter, HSHB-ES-H/WP, this Agency, subject: Phase 3, Hazardous Waste Study No. 37-26-0147-84, Summary of DARCOM Open-Burning/Open-Detonation Ground Evaluations, November 1981 - September 1983 (in preparation).

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- ignitability A characteristic of solid waste whereby the waste is capable, under standard temperature and pressure, of causing fire through friction, adsorption of moisture, or spontaneous chemical changes and, when ignited, burns so vigorously and persistently that it presents a hazard.
- leachate Any liquid, including suspended components in the liquid, that has percolated through or drained from hazardous waste.
- OB open burning
- OB area That area or portion of the facility where open-burning operations are conducted (syn OB-grounds).
- OB grounds That area or portion of the facility where open-burning operations are conducted (syn -OB area).
- OD open detonation
- OD area That area or portion of the facility where open-detonation operations are conducted (syn-OD grounds, demolition range).
- OD grounds That area or portion of the facility where open-detonation operations are conducted (syn-OD area, demolition range).
- open burning Combustion of any material without the following characteristics:
 - (1) Control of combustion air.
 - (2) Containment of combustion reaction in an enclosed device.
 - (3) Control of gaseous combustion product emissions. This definition includes open detonation.
- PEP pyrotechnics, explosives, and propellants
- RAAP Ravenna Army Ammunition Plant
- RCRA Resource Conservation and Recovery Act of 1976
- reactivity A characteristic of a solid waste whereby the waste is:
 - (1) Capable of detonation or explosion if subjected to a strong initiating source or if heated under confinement.
 - (2) Readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure.

APPENDIX B

ABBREVIATIONS AND DEFINITIONS

- BG burning ground
- COR Contracting Officer's Representative
- CWP Contaminated Waste Processor

demolition range same as OD grounds, sometimes including OB grounds

- detonation A violent chemical reaction within a chemical compound or a mechanical mixture evolving heat and pressure and which proceeds through the reacted material toward the unreacted material at a supersonic velocity, exerting extremely high pressure on the surrounding medium, forming a propagating shock wave which is originally of supersonic velocity.
- disposal The discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid waste or hazardous waste into or on any land or water so that such solid waste or hazardous waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including ground waters.

EPA US Environmental Protection Agency

EP Toxicity An extraction test to evaluate the leachability of eight different metals from a hazardous waste. The metals are arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), lead (Pb), mercury (Hg), silver (Ag), and selenium (Se).

EWI Explosive Waste Incinerator

facility All contiguous land and structures, other appurtenances, and improvements on the land used for treating, storing, or disposing of hazardous waste. For permitting purposes a facility may consist of an entire installation or any part or combination of parts of that installation where treatment, storage, or disposal operations are located (see OB grounds, OD grounds, OB area, OD area, and demolition range).

ground water Water below the surface in a zone of saturation.

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treatment Any method, technique, or process designed to change the chemical, physical, or biological character or composition of any hazardous waste so as to recover energy or material resource from the waste, or to render such waste nonhazardous, or less hazardous, or safer to transport.

USATHAMA US Army Toxic and Hazardous Materials Agency

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APPENDIX C

OB/OD BACKGROUND

1 GENERAL.

a. As part of routine operations, the Department of Defense produces, stores, and uses large quantities of munition items commonly referred to as PEP. Each year large quantities of PEP and PEP-related materials must be disposed of as waste. These wastes include manufacturing wastes and residues; items in storage or manufacture which have failed quality assurance tests; out-of-date and obsolete explosives, propellants, and munitions items; and any unsafe munitions items, components, explosives, excess propellant and munitions items from military training operations, plus those unusual laboratory chemicals and items turned in to Explosive Ordnance Disposal units for disposal. Other related wastes include materials which may have become contaminated by contact with PEP during production, storage, and handling.

b. At present, OB/OD of PEP and PEP-contaminated wastes are the safest and most effective means of destroying many items, decontaminating large metal objects, and reducing combustible materials to a smaller volume. The Army has developed an EWI and a CWP for the incineration of PEP and PEPcontaminated wastes. These units are expensive to construct and difficult to operate. Also, due to the size and infrequent use, small quantities of some of the wastes requiring open-flame treatment, an EWI or CWP is often impractical or economically unjustifiable. The OB/OD are presently the most economical methods available for disposal of many PEP and PEP-contaminated wastes.

2. REGULATIONS.

a. The RCRA and the regulations promulgated through it (references 1 through 5, Appendix A) set forth standards and guidance for the "cradle to grave" management of hazardous wastes. Under these regulations (reference 2, Appendix A), one of the criteria for designating a waste as hazardous is reactivity, which is defined to include wastes which may detonate from strong initiation or when heated under confinement, and specifically includes "forbidden," "Class A," and "Class B" explosives as specified by the Department of Transportation in 49 CFR. This definition includes most PEP wastes and certain PEP-contaminated wastes.

b. The OB/OD meet the definition of hazardous waste treatment (reference 2, Appendix A). The regulations prohibit the open burning of hazardous waste. However, an exemption is granted for OB/OD of waste explosives and propellants which cannot be safety disposed of by other means (40 CFR 265.832). This exemption is only from the prohibition on OB and does not in any way exempt the facility or its operations from compliance with all other applicable regulations for treaters, storers, and disposers of hazardous waste. The OB/OD is also subject to regulations under the Clean Air Act and may require waivers or permits under existing state air pollution abatement plans.

c. The OB/OD are regulated as a Thermal Treatment process under 40 CFR 265. Under the general facility requirements of these regulations, OB/OD facilities must have waste analysis plans, training plans, inspection plans, contingency plans, closure plans, and comply with recordkeeping requirements. Facilities must also comply with specific quantity distance requirements which parallel those already in use by the Department of Defense.

d. There are presently no 40 CFR 264, Phase II regulations for OB/OD facilities. It is expected, however, that the EPA will eventually issue some type of standards for such facilities. A separate, ongoing project at this Agency is the development of interim standards for DARCOM, consistent with existing regulations which will be applicable to OB/OD facilities.

e. According to the hazardous waste definition (reference 2, Appendix A), residues from hazardous waste treatments are, themselves, considered to be hazardous until proven otherwise. Since the original PEP wastes treated are hazardous by characteristic of reactivity, the residues must also be considered reactive until proven otherwise. It is the explosive content of the PEP wastes which make them reactive, and, though there are currently no established environmental regulatory standards for concentrations of explosive compounds, such materials may present an environmental problem due to their chemical properties. Hence, the amount of explosive in the waste residue should be measured. Also, since many PEP wastes contain toxic heavy metals, there is the potential for some of these metals to be released from the waste to the environment. The waste residues should, therefore, be analyzed for the characteristic of EP Toxicity to determine if they are a hazardous waste based on heavy metals content. The incomplete combustion or detonation of a PEP waste could lead to the formation of byproducts. These byproducts will be chemically different from the pure compounds and may not be reactive enough to detonate but, because of their composition, may still present a significant ignitability hazard. Additional testing should, therefore, be performed to determine if the waste residues are, in fact, ignitable.

f. Currently, most OB facilities bury the ash and residues onsite, while the very nature of OD operations causes any residues to be incorporated into the soil. Either of these processes constitutes disposal as defined in 40 CFR 261, and, should the residues be hazardous, the OB or OD area could be construed as a hazardous waste disposal site and subject to regulation as such. Should the residues be nonhazardous, OB/OD areas could still be considered solid waste disposal sites and subject to existing applicable regulations.

g. The main thrust of the Federal hazardous waste regulations is the protection of ground water. Hazardous waste disposal sites are required, under new regulations (reference 5, Appendix A), to install ground-water

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monitoring systems which will measure the impact of the disposal facility on the uppermost aquifer. As previously mentioned, there are explosive and heavy metals constituents in PEP wastes which could migrate from the OB/OD facility to the ground water and/or surface water. Analysis of soil and residue samples for EP Toxicity (heavy metals leachability) and explosive content, coupled with a knowledge of site geology, will allow for assessment of the potential of any given site to contaminate the ground water due to OB/OD operations.

3. OB/OD STUDY.

a. <u>Sampling</u>.

(1) In active OD areas surface soil samples were taken in the demolition craters. Since the OD process violently disturbs the soil at the site, it was felt that surface samples of resettled soil would provide a reasonably homogeneous sample of OD residues.

(2) The actual number and location of samples taken at each OB/OD area was determined onsite by the study team leader, based on the size and configuration of the area, its level of activity, and the variety of materials being open burned and/or open detonated. The individual samples taken are not necessarily representative of the overall situation at any given location. The analyses do, however, represent the range of potential contaminants and concentrations that may be expected at OB/OD areas. The issue of what constitutes a representative sample for determining whether the residues are hazardous wastes and the OB/OD areas are hazardous waste disposal facilities is presently being investigated and must be evaluated before the final status of OB/OD areas can be resolved.

b. Analysis and Data Evaluation.

(1) The measurement of EP toxicity will determine if the soils and residues are hazardous by that characteristic. However, a conclusion to this evaluation is frustrated by the lack of environmental regulatory standards for concentrations of explosives in soil or water. Therefore, the explosives content data cannot be used directly to determine if the soils or residues are hazardous. There are also insufficient data available on the migration potential of these compounds from the soil to the ground water and/or surface water. A complete evaluation of the total environmental impact of OB/OD operations and their potential effect on ground water will require research and development on the mobility/leachability of explosive compounds leading to the setting of standards for acceptable environmental soil and water concentrations of these compounds.

(2) Evaluation of the soil and residues for reactivity and ignitability is also not possible at this time because there are no available EPA-approved tests for explosive reactivity or solid ignitability. The EPA and USATHAMA are currently working on the development of methods to evaluate explosives reactivity. The EPA is also investigating methods to test solids ignitability. Development of these tests will be essential to the total evaluation of OB/OD residues, and efforts should be made to standardize such tests as soon as possible. A representative group of samples with high concentrations of explosives from each installation is being retained by this Agency and is available for testing, pending standardization.

(3) The compilation of the data discussed above, plus satisfaction of the identified data gaps, will allow for a complete assessment of the status of OB/OD facilities relative to existing (and expected) Federal hazardous waste regulations. Such a data base will permit assessment of which sites show the best potential for future continued OB/OD operations.

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APPENDIX D

ANALYTICAL RESULTS

Sample No and				E1	P Tox1	city*					Residua	l Explos	ive+	
Description	As	Ba	Cd	Cr	Hg	Pb	Se	Ag	HMX	RDX	Tetryl	TNT	2.6-DNT	2,4-DNT
0442-01 Detonation Residue	BDL	25.3	BDL	BDL	BDL	BDL	BDL	BDL	19598.0	535.0	BDL	238.4	2.4	1.4
0442-02 Detonation Crater	BDL	BDL	BOL	BDL	BDL	535.0	BDL	BDL	80.4	BDL	BOL	8DL	BOL	BDL
0442-03 Detonation Crater	8DL	BOL	BOL	8DL	8DL	BOL	80L	BOL	75.4	94.6	BOL	1.2	BDL	BDL
0442-04 Detonation Crater	BDL	BDL	BDL	BDL	BDL	BDL	BOL	BDL	21.9	BDL	BOL	BDL	BDL	BOL
0442-05 Detonation Crater	BDL	BDL	BDL	BDL	BDL	BDL	BOL	BDL	225.2	456.9	BDL	14.4	BDL	BDL
0442-06 Detonation Crater	BDL	BDL	BDL	BOL	BOL	BDL	BDL	BDL	5.0	BDL	BDL	BDL	BDL	BDL
0442-07 Detonation Crater	BOL	BDL	BDL	BDL	BOL	BDL	BDL	BDL	1.6	BDL	BDL	BDL	BDL	BDL
0442-08 Crater Drainway	BDL	BOL	BDL	BDL	BDL	1.8	80L	BDL	25.7	2.2	BDL	1.6	BDL	BDL
0442-09 Crater Drainway	BOL	BDL	BDL	BOL	BOL	4.3	8DL	BDL	69.1	12.7	BDL	BDL	BDL	BOL
0442-10 Crater Drainway	BDL	BOL	BDL	BDL	BDL	BDL	BDL	BDL	9.9	BDL	BDL	BDL	BDL	BDL

* All units in mg/L † All units in µg/g BDL – Below Detection Limit

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PETER FIANU Chief, Metals Analysis Branch Radiological and Inorganic Chemistry Division

Richard a Casedy RICHARD A. CASSIDY

RICHARD A. CASSIDY 1LT, MSC Chief, Chromatographic Analysis Branch Organic Environmental Chemistry Division

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TABLE D-2. OB AREA ANALYTICAL RESULTS

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Sample No and				EP	Toxic	ity*					Residua!	Explos	ve+	
Description	As	Ba	Cd.	Cr	Hg	Pb	Se	Aq	HMX	RDX	Tetryl	TNT	2.6-DNT	2,4-0NT
0442-11 Lane E Pad 58 0-6*	BOL	BDL	BDL	BDL	80L	BOL	BDL	BOL.	BDL	BDL	BOL	BOL	BOL	BOL
0442-12 Lane E Pad 58 6-18"	BDL	BDL	BDL	BDL	BOL	BDL	80L	BOL	BDL	BDL	BOL	BDL	BDL	60L
0442-13 Lane E Pad 58 0-6*	BOL	BOL	BDL	BDL	BOL	BOL	80L	BDL	BDL	BDI,	BOL	BDL	BDL	80L
0442-14 Lane E Pad 58 6-18"	BOL	BDL	801	80L	80L	BOL	80L	BOL	89L	BDL	80L	BOL	BDL	BOL
0442-15 Lane E Pad 59 0-6"	BOL	BOL	BDL	BDL	80L	801	BOL,	BDL	80L	BDL	80L	BOL	60L	80L
0442-16 Lane E Pad 59 6-18*	80L	BDL	BDL	BOL	BDL	BOL	BOL	BDL	80L	80L	80L	BOL	BOL	BOL
0442-17 Lane E Pad 59 0-6"	80L	BOL	BDL	80L	BDL	BÓL	BDL	BDL	BOL	80L	60L	19.5	BDL	BOL
0442-18 Lane E Pad 59 6-18"	BDL	BOL	0.1	80L	80L	2.0	80L	BOL	BOL	BOL	801	BOL	80L	BDL
0442-19 Lane E Pad 59 Dirt													•	
Scraping	60L	BDL	BOL	BDL	80L	BOL	BDL	BDL	2.7	5.0	BDL	27.2	801.	80L
0442-20 Lane E Pad 59 18-24	80L	BOL	0.3	BOL	BDL	5.1	BDL	BOL	80L	BOL	BOL	80L	BOL	60L
0442-21 Lane E Pad 59 18-24*	BDL	BDL	1.2	80L	BOL	3.4	BOL	BDL	BOL	80L	BOL	BDL	BDL	80L
0442-22 Lane E Pad 60 0-6"	BDL	8DL	BBL	80L	896	BOL	BOL	80L	BOL	89L	80L	36.0	BDL	BOL
0442-23 Lane E Pad 60 6-18"	BOL	60L	BDL	BDL	BOL	80L	80L	80L	80L	BDL	BOL	11.6	BDL	BOL
0442-24 Lane E Pad 60 0-6"	80L	BOL	BDL	BDL	BDL	80L	BDL	801	BOL	BDL	BOL	80L	BOL	60L
0442-25 Lane E Pad 60 6-18"	BDL	60L	0.1	80L	BDL	BOL	BDL	BOL	BOL	80L	60L	801	60L	BOL
0442-26 Lane E Pad 60 Dirt														
Scarping	BOL	BOL	0.1	80L	60L	3,1	BOL	BDL	3.1	80L	BDL	801	BDL	BOL
0442-27 Lane E Pad 60 0-6	BOL	BDL	0.1	BDL	80L	80L	801.	BOL	BOL	BOL	BDL	BOL	BDL	801
0442-28 Lane E Pad 60 6-18"	BDL	80L	3.6	BOL	BDL	0.5	8DL	BDL	BOL	BDL	BDL	80L	801	BOL
0442-29 tane E Pad 65 0-6"	BOL	BOL	BOL	BDL	BDL	BDL	BDL	BDL	80L	80L	60L	80L	80L	BDL
0442-30 Lane E Pad 65 6-18"	BOL	BDL	89L	80L	80L	BDL	80L	BDL	BDL	BDL	80L	BDL	80L	BOL
0442-31 Lane E Pad 65 0-6"	BDL	BDL	BDL	BDL	80L	BOL	BOL	BÓL	60L	BDL	BOL	BOL	BOL	801
0442-32 Lane E Pad 65 6-18"	BOL	8DL	BDL	BDL	80L	60L	80L	BOL	BOL	BOL	BOL	BOL	BOL	80L
0442-33 Lane E Pad 66 0-6*	BOL	BOL	BDL	BDL	801	BOL	891	BOL	7.0	16.6	BÓL	7.4	BOL	801
0442-34 Lane E Pad 66 6-18"	801	BOL	BOL	BOL	BDL	801	80L	89L	1.7	5.1	BDL	80L	BOL	BDL
0442-35 Lane E Pad 66 0-6*	801	801	BOL	BOL	BDL	BDL	BDL	BDL	25.2	137.8	BOL	90.5	BOL	BDL
0442-36 Lane E Pad 66 6-18"	BOL	BDL	BOL	80L	6DL	BDL	BOL	BDL	2.2	9.5	80L	6.6	BOL	BÔL
0442-37 Lane E Pad 56 0-6"	BDL	32.6	BOL	BOL	BOL	BOL	BOL	BDL	12.4	16.4	800	61.7	BDL	60L
0442-38 Lane E Pad 66 6-18*	BOL	197.0	BDL	BDL	BOL	BOL	BOL	BDL	2.2	4.7	BDL	5.4	BOL	BOL
0442-39 Lane E Pad 66 Residue	801	BOL	BDL	BDL	89L	BOL	BÔL	80L	1.4	6.2	BOL	1.9	BÓL	2.7
0442-40 Lane E Pad 67 0-6*	BOL	BOL	BOL	BDL	BOL	BOL	801	80L	686.1	2976.0	BOL	1516.0	00L	BDL
0442-41 Lane E Pad 67 6-18"	80L	BDL	BOL	BDL	BDL	801.	801	80L	21.6	124.0	BOL	31.2	BOL	80L
0442 42 Lane E Pad 67 0-6"	BOL	BDL	800	BOL	6DL	BDL	BDL	BDL	2.2	2.5	601	6.2	801	B0I.
0442-43 Lane E Pad 67 6-18"	BDL	BOL	891	80L	80L	BDL	80L	80L	3.3	2.3	BOL	BDL	BOL	BOL
0442-44 Lane D Shoulder	BDL	BOL	BDL	BDL	801	80L	BOL	BOL	4.4	BDL	BDL	BOL	BDL	BDL
0442-45 Lane D Shoulder	BOL	BOL	BOL	BDL	BOL	801	BOL	801	60L	60L	BOL	BOL	BOL	80L
0442-46 Lane D Pad 52 0-6*	BOL	BDL	801	80L	BOL	BDL	BDL	BOL	BDL	80L	80L	BDL	80L	BOL
0442.47 Lane D Pad 52 5-18"	BDL	BDL	BDL	BOL	BOL	BOL	BDL	BOL	80L	2.0	80L	BDL	BOL	BDL
0442.48 Lane C Pad 37 0-6*	BOL	801	BOL	BDL	BDL	BDL	BOL	BOL	2.8	BDL	BDL	2263.0	BOL	BDL
0442.49 Lane C Pad 37 6-18"	BDL	BDL	800	BDL	BDL	BDL	BDL	BDL	801	60L	80L	120.1	90L	BOL
0442.50 Lane C Pad 37 0-6"	BDL	BDL	0.2	801	60L	BOL	BDL	BOL	1.9	10.5	BOL	7.2	801	BOL
0442 51 Lane C Pad 37 5-18"	BOI	BDI	BOI	BDI	801	ROL	801	801	891	BOL	801	608.5	BOL	BDL
0442 52 Lane C Pad 37 0-6"	801	RDI	BÛL	BDI	801	801	BDL	801	1.9	4.6	BDL	BDL	BDL	BDL
0442.53 Lane C Pad 37 6-18"	BDI	BDI	801	601	BOL	BOL	BDL	BDL	BOL	4.8	801	8DL	BOL	BDI.
0442-54 Lane C Pad 38 0-6*	BDI	BDI	BDI	801	BDL	BOL	601	BOL	BDL	801	80L	BDL	801.	BDL
0442-55 Lane C Pad 37 91rt	QUL.													
Scraning	801	801	801	BOL	BDL	801	BOL	801	80L	BOL	BDL	2.4	BOL	BDL.
0442 56 Lane C Pad 39 0.6*	RNI	BDI	0.1	BDI	BDL	BOL	BOL	BOL	801	BOL	806	BDL	801.	BOL.
0442-50 Lane C Pad 38 6-18"	BOL	BDI	BDI	801	BDL	BOL	BOL	BOL	BOL	BOL	801	BDL	BOL	801.
0442-51 Cane C Fad 38 0.6*	801	BGI	BDL	BOL	801	801	801	601	BOL	BOL	BD1,	152.3	BOL	8D1,
	BDI	801	BOI	BDL	ADI	801	BDL	801	801	801	801	1.9	801	BDI.
Viic Ji Lane C Fau Jo O-10	301	300	201	901										
0442-60 Lane C Pad 38 Dirt	P A /					0.0		801	10 4	901	801	166 1	801	10.6
Scraping	BOL	BDL	1.3	BUL	BOL	0.5	SAF	BUL	19.4	50L	0UL 851	100./ µAt	90L 90L	RIN1
0442 61 Lane C Pad 39 0-6*	· 80L	300	BOL	BUL	BUL	60L	BUL	001.	60L	000	501.	001	801	801
0442 67 Lane C Pad 39 6-18	801	BDL	BOL	BOL	BUL	BUL	800	601	BUL	DUL DUL	001	000	500	201
0442 63 Lane C Pad 39 0 6"	60L	BDL	BDL	BDL	BDL	BOL	801	BUL	BUL	DUL	BUI.	001.	001	19171
0442 64 Lane C Pad 39 6 18"	80L	60L	BOL	BDL	BDL	801	801	800	BOL	50L	60L	001	001	001
0442-65 Lane C Pad 39 0-6	BDL	BDL	60L	80L	BDL	BDL	BDL	BDL	BUL	BDC	801.	BUL	501	1) (21
0442-66 Lane C Pad 39 6-18"	BDL	8D1.	8DL	80L	60L	BDL	BOI.	BDL	BDL	801	BDL	801.	BUL	001.
0442-67 Lane C Pad 40 0-6"	80L	BDL	BDL	801.	80L	801	601	BOL	801.	BOL.	BDL	BOL	801.	1101.
Q442-68 Lane C Pad 40 6-18"	80L	80L	BQL	BDL	801	801	80L	801	601	BOL	BOL	BUL	BUI.	nul.
0442 69 Lane C Pad 40 0-6"	BDL	BDL	80L	BOL	BOL	BOL	BOL	801	8DL	BOL	BOL	KDI	BUL	DD1.
0442 70 Lane C Pad 40 6-18"	801	BDL	BDL	8DL	BOL	BOL	BOL	BDL	801.	BDL	BUL	1996	801.	INUL.
0442 /1 Lane C Pad 40 Dirt										_				
Scraping	60L	BOL	BOL	BOL	BD1.	806	80L	80L	8 9i	80L	801	801	RDI.	804
0442-72 Lane D Shoulder	801	BOL	BOL	BDI.	BUL	801	BÐL	801	801.	80L	BDI.	2.3	BDI.	HDI
0442 73 Lane D Shoulder	801	801	80L	BOL	BOL	BDL	BOL	BDL	NDL.	BÐL	801	2.1	801.	B0L
0442-74 Lane D Shoulder	601	801	801	801	BOL	BDL	801	801	BDI.	BDL	BOL	49.1	BDI.	BDL
0442-75 Lane D Shoulder	BDL	BDL	BDL	BDL	BDL	801	801	801	804.	BOL	BOL	4.8	BDL	801.
0442 76 Lane D Shoulder	801	800	BOL	80L	BDL	801.	BDL	801	BDL	80L	801	BDL	80.	801
0442-17 Lane D Shoulder	BDI	801	801	801	BOL	BOL	801	BDL	80L	BÓL	601.	2.2	BDI.	BOI
0442.78 Lane D Shoulder	BDI	BDI	BDI	801	601	801	601	BDL	BOL	BOL	BDI.	BDL	BOL	894
0442 79 Lane D Shoulder	BDI	BDI	BDL	BDL	BDL	801	80L	801	1.9	0 BDL	80L	8.1	BDL	BDI.
A442 8D Lane C Pad 39 Dirt														
Scraping	801	800	801	801	BDL	BOL	80L	BOL	BDL	BDL	8DL	60L	BOL	BDI.
							=							a a ser e

★ All units in mg/L + All units in µg/g BDL - Below Detection Limit

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ALL Salue PETER FIANU Chief, Metals Analysis Branch Radiological and Inorganic Chemistry Division

Richard G. Courdy RICHARD A. CASSIDY 111, MSC Chief. Chromatographic Analysis Branch Organic Environmental Chemistry Division

TABLE D-3. DETECTION LIMITS

Sample No and	EP Toxicity*									Residual Explosive+				
Description	As	Ba	Cđ	Çr	Hg	Pb	Se	Ag	HMX	RDX	Tetryl	TNT	2.6-DNT	2.4-DNT
Detection Limit RCRA Criteria Limit	0.5 5.0	10 100	0.1 1.0	0.5 5.0	0.02 0.2	0.5 5.0	0 <i>.</i> 1 1.0	0.5 5.0	1.0	1.0	1.0	1.0	1.0	1.0

* All units in mg/L + All units in µg/g

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ANALYTICAL RESULTS BY SAMPLE FOR WINKLEPECK BURNING GROUNDS

Notes on Data Tables

Analyses that were not performed for a given sample have no "Result, Qual" heading and no entry in the table.

All analyses were validated and are reported with one of the following qualifiers:

=Indicates that the value has been validated and that the compound has been positively identified and the associated concentration value is accurate.

JIndicates that the compound was positively identified; the associated numerical value is the approximate concentration of the compound in the sample.

RIndicates that the sample results for the compound are rejected or unusable due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the compound cannot be verified.

UIndicates that the compound was analyzed for, but was not detected above the reported sample quantitation limit.

UJIndicates that the compound was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the compound in the sample.

	1 Station	WBGSS-032	WBGSS-033	WBGss-001	WBGss-002	WBGss-003	WBGss-004	WBGss-005	WBGss-006	WBGss-007	WBGss-008
	Date Collected	8/7/96	8/6/96	7/31/96	7/31/96	7/31/96	7/30/96	7/30/96	7/30/96	7/30/96	7/30/96
	Depth	0.0 - 0.5 FT	0.0 - 2.0 FT	0.0 - 0.7 FT	0.0 - 2.0 FT						
Media: Soil											
Metals	Units	Result Qual									
Aluminum	MG/KG	30400 =	10700 ≈	10100 =	10600 =	9000 =	1410 =	7570 =	10400 =	8070 -	8420 =
Antimony	MG/KG										0.31 U
Arsenic	MG/KG	2.5 J	14.7 J	11 =	14.2 =	16.4 =	21.3 J	20.4 J	16.5 J	14.3 J	16.7 =
Barium	MG/KG	466 =	93.3 J	48.5 ≈	53.4 =	30 =	11.7 =	24 =	59.6 =	32.2 =	45.2 =
Beryllium	MG/KG										0.65 =
Cadmium	MG/KG	26.8 =	6.7 J	0.04 U	0.05 U	0.04 U	0.15 J	0.06 J	0.43 J	0.07 J	0.13 J
Calcium	MG/KG										2330 =
Chromium	MG/KG	37.6 =	16.9 J	13.2 =	14.4 =	10.4 =	5.4 =	8.8 =	12.4 =	9.5 =	9.8 =
Cobalt	MG/KG										8.9 =
Соррег	MG/KG										14.4 =
Iron	MG/KG										22600 =
Lead	MG/KG	23.8 J	436 =	11 =	14.7 =	12.8 =	21.1 =	12.4 =	18.4 =	14 =	15.7 =
Magnesium	MG/KG										1480 =
Manganese	MG/KG	2580 =	637 =	299 =	275 =	342 =	65.4 =	269 =	334 =	307 =	639 =
Mercury	MG/KG	0.04 U	0.03 U	0.03 U	0.04 U	0.04 U	0.04 U	0.04 U	0.25 =	0 04 11	0.03.11
Nickel	MG/KG									0.070	13 =
Potassium	MG/KG										493 1
Selenium	MG/KG	2.4 =	0.91 J	0.82 =	1 =	0.79 =	1 =	1.6 =	1.5 =	1.4 =	21 =
Silver	MG/KG	1.5 =	0.2 U	0.19 U	0.22 U	0.21 U	0.2 U	0.21 U	0.22 1/	02117	021
Sodium	MG/KG									0.21 0	168 1
Thallium	MG/KG										31=
Vanadium	MG/KG										16 =
Zinc	MG/KG	315 =	248 J	46.6 =	57.5 =	56.7 =	28.6 =	51.4 =	56.8 =	48.7 =	41.8 =
Volatile Organics	Units										Result Qual
1.1.1-Trichloroethane	UG/KG										₹ 11
1.1.2.2-Tetrachloroethane	UG/KG										5 U K 11
1.1.2-Trichloroethane	UG/KG										2 U # 11
1.1-Dichloroethane	UG/KG										50
1.1.Dichloroethene	UG/KG										5 U
1.2.Dichloroethene	UG/KG										50
-)DIVINOIOCIIIANC	00/00										5 U

Table 4.17. Analytical Results by Sample for Surface Soil and Sediment at Winklepeck Burning Grounds

Table 4.17.	Winklepeck	Burning	Grounds	(continued)
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	Station	WBG55- 009	WBGss-010	WBGas-011	WBGss-012	WBGss-013	WBGss-014	WBGss-015	WBGss-016	WBGss-017	WBGss-018
	Date Collected	8/5/96	8/5/96	8/5/96	8/5/96	8/5/96	8/8/96	8/5/96	8/6/96	8/6/96	8/6/96
	Depth	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 1.5 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 1.5 FT
Media: Soil											
Metals	Units	Resu Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual
Aluminum	MG/KO	9880 =	9030 =	11400 =	14000 =	10400 =	8090 =	11800 =	10300 =	11500 =	8250 =
Antimony	MG/KG										0200
Arsenic	MG/KG	12.6 =	15.3 =	14 =	11.1 =	15 =	12 =	14 =	11 J	13.7 J	12.3 J
Barium	MG/KG	52.6 =	53 =	46.9 =	59.1 =	81 -	34.8 =	57.9 =	74 J	54.8 J	476 J
Beryllium	MG/KG								,	21101	47.0 5
Cadmium	MG/KG	0.47 U	0.05 U	0.05 U	0.05 U	0.1 U	0.04 U	0.19 U	0.34 J	0 22 1	0341
Calcium	MG/KG									V.82 J	0.04 0
Chromium	MG/KG	13.9 =	11.4 =	13.3 =	16.1 =	12.9 =	8.5 =	14.8 =	10.8 J	14.1 J	10.2 1
Cobalt	MG/KG										10.20
Copper	MG/KG										
Iron	MG/KG										
Lead	MG/KG	13.4 =	17.7 =	17.1 =	15.9 =	15.6 =	12.7 =	18.9 =	13.7 =	11.4 =	151 =
Magnesium	MG/KG										
Manganese	MG/KG	396 =	1120 =	278	201 =	613 =	453 =	411 ==	464 =	206 =	301 =
Mercury	MG/KG	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.03 U	0.04 11
Nickel	MG/KG										0.010
Potassium	MG/KG										
Selenium	MG/KG	1.7 =	1.1 =	1.1 =	0.4 J	0.96 =	0.33 U	1.4 =	0.44 J	0.69 J	0.55 1
Silver	MG/KG	0.21 U	0.22 U	0.22 U	0.22 U	0.22 U	0.21 U	0.22 U	0.21 U	0.19 U	0.21 U
Sodium	MG/KG										0.21 0
Thallium	MG/KG										
Vanadium	MG/KG										
Zinc	MG/KG	54.4 =	37.8 =	51 =	54.3 =	49 =	39 =	50.5 -	51.5 J	45.2 J	36 =
Volatile Organics	Units										
1,1,1-Trichloroethane	UG/KG										
1,1,2,2-Tetrachloroethane	UG/KG										
1,1,2-Trichloroethane	UG/KG										
1,1-Dichloroethane	UG/KG										
1,1-Dichloroethene	UG/KG										
1.2-Dichloroethane	UG/KG										

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	Table 4.17. Winklepeck Burning Grounds (continued)												
	Station	WBGss-019	WBGss-020	WBG53-021	WBGss-022	WBGss-023	WBGss-024	WBGss-025	WBGss-026	WBGss-027	WBGss-028		
	Date Collected	8/6/96	8/5/96	8/5/96	8/5/96	8/5/96	8/5/96	8/5/96	8/6/96	8/6/96	8/7/96		
	Depth	0.0 - 1.5 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 0.5 FT	0.0 - 1.3 FT	0.0 - 0.5 FT	0.0 - 2.0 FT		
Media: Soil													
Metals	Units	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Quai	Result Qual		
Aluminum	MG/KG	9490 ≈	11400 =	12500 =	17400 =	8500 =	12300 =	10600 =	14900 =	13100 =	12800 -		
Antimony	MG/KG			0.3 UJ									
Arsenic	MG/KG	12.5 J	12.9 =	15 .1 ≠	7.9 =	19.8 =	16.1 =	7.6 =	16.9 J	14.2 J	12.2 J		
Barium	MG/KG	31.2 J	75.7 =	42.7 =	100 =	39.2 =	55.6 =	132 =	64.2 J	112 J	56.4 =		
Beryllium	MG/KG			0.58 ≔									
Cadmium	MG/KG	0.2 J	0.57 J	0.07 U	0.07 U	0.05 U	0.12 U	8.2 =	0.37 J	0.42 J	0.16 J		
Calcium	MG/KG			805 =							ľ		
Chromium	MG/KG	10.3 J	13.7 =	15.2 J	18.4 ≕	12.4 =	14.7 =	9.1 =	18 J	17.9 J	15.2 =		
Cobalt	MG/KG			7.2 =									
Copper	MG/KG			18.8 =									
Iron	MG/KG			27300 =							1		
Lead	MG/KG	12.5 =	12.9 =	13.7 =	15.8 =	13.2 =	17.9 =	56.2 =	15.5 =	18.5 =	17 J		
Magnesium	MG/KG			2640 =									
Manganese	MG/KG	223 =	723 =	116 =	147 =	320 =	257 =	1820 =	304 =	782 =	419 =		
Mercury	MG/KG	0.04 U	0.04 U	0.03 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U		
Nickel	MG/KG			18.5 J									
Potassium	MG/KG			824 =									
Selenium	MG/KG	0.88 J	2.1 =	1.8 =	0.79 =	0.69 ==	1.4 =	1 =	1.1 J	0.85 J	0.69 ≔		
Silver	MG/KG	0.21 U	0.21 U	0.19 U	0.23 U	0.21 U	0.24 U	0.2 U	0.2 U	0.21 U	0.22 U		
Sodium	MG/KG			162 J									
Thailium	MG/KG			1.8 =									
Vanadium	MG/KG			19.6 ≈									
Zinc	MG/KG	45.4 J	47.4 =	49.6 =	57.7 =	65.4 =	54 =	329 =	69 J	68.6 J	48.5 =		
Volatile Organics	Units			Result Qual									
1,1,1-Trichloroethane	UG/KG			5 U									
1,1,2,2-Tetrachloroethane	UG/KG			5 U									
1,1,2-Trichloroethane	UG/KG			5 U									
1,1-Dichloroethane	UG/KG			5 U									
1,1-Dichloroethene	UG/KG			5 U									
1,2-Dichloroethane	UG/KG			5 U									

Table 4.17. Winklepeck Burning Grounds (continued)

RVAAP Phase I Remedial Investigation

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			Table 4.17.	Winklepeck	K Burning G	rounds (con	tinued)				
	Station	WBGss-029	WBGss-030	WBG55-031	WBGss-034	WBGss-035	WBGss-036	WBGss-037	WBGss-038	WBGss-039	WBGss-040
	Date Collected Depth	8/7/96 0.0 - 2.0 FT	8/7/96 0.0 - 1.5 FT	8/7/96 0.0 - 2.0 FT	8/6/96 0.0 - 2.0 FT	7/31/96 0.0 - 2.0 FT	7/31/96 0.0 - 2.0 FT				
Media: Soji											
Metals	Units	Result Qual	Result Qual								
Aluminum	MG/KG	12300 =	12300 =	16900 =	15300 =	22200 =	10200 =	8730 =	8980 =	13500 =	12400 =
Antimony	MG/KG			0.3 U							
Arsenic	MG/KG	11.4 J	17.7 J	8.9 =	10.5 J	7.1 J	12.3 J	16.1 J	21.6 J	14.1 =	12.4 =
Barium	MG/KG	54.5 =	65.8 =	173 =	596 J	255 J	41.9 J	67.3 J	55.8 J	63.7 =	41.8 =
Beryllium	MG/KG			2.6 =							
Cadmium	MG/KG	0.16 J	0.58 =	1.8 =	877 J	63.4 J	0.24 J	0.42 J	0.36 J	0.04 UJ	0.04 J
Calcium	MG/KG			88900 =							
Chromium	MG/KG	14.2 =	17.8 =	11.1 =	26.6 J	27.2 J	11.6 J	10.5 J	9.2 J	16.6 =	15.4 =
Cobalt	MG/KG			4.6 =							
Copper	MG/KG			13 =							
Iron	MG/KG			12800 =							
Lead	MG/KG	18.6 J	108 J	21.5 =	504 =	236 =	18.1 =	189 =	18.1 =	13.4 =	13.7 =
Magnesium	MG/KG			13100 =							
Manganese	MG/KG	327 =	351 =	1840 =	1480 =	2170 =	275 =	861 ==	359 =	241 J	133 J
Mercury	MG/KG	0.04 U	0.04 U	0.03 J	0.03 U	0.03 U	0.04 U	0.04 U	0.04 U	0.03 U	0.03 U
Nickel	MG/KG			7.4 =							
Potassium	MG/KG			1600 =							
Selenium	MG/KG	0.64 =	0.62 =	0.58 =	5 J	1.4 J	0.64 J	0.89 J	1.7 J	0.56 J	0.72 J
Silver	MO/KO	0.22 U	0.21 U	0.19 U	0.2 U	0.19 =	0.21 U	0.2 U	0.2 U	0.2 U	0.19 U
Sodium	MG/KG			962 =							
Thallium	MG/KG			2.7 =							
Vanadium	MG/KG			12.7 =							
Zinc	MG/KG	54.6 =	133 =	41.8 =	342 J	316 J	82.2 J	317 J	45 J	69.4 =	55.6 =
Volatile Organics	Units			Result Qual							
1.1.1-Trichloroethane	UG/KG			5 UJ							
1,1,2,2-Tetrachloroethane	UG/KG			5 UJ							

5 UJ

5 UJ

5 UJ

5 UJ

UG/KG

UG/KG

UG/KG

UG/KG

1,1,2-Trichloroethane

1,1-Dichloroethane

1,1-Dichloroethene

1,2-Dichloroethane

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	Station	WBGss-041	WBGss-042	WBGss-043	WBGss-044	WBGss-045	WBGss-046	WBGss-047	WBGss-048	WBGss-049	WBGss-050
	Date Collected	7/31/96	8/7/96	8/7/96	8/7/96	8/7/96	8/7/96	8/7/96	8/7/96	8/7/96	8/7/96
	Depth	0.0 - 0.5 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 1.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 1.0 FT
Media: Soil											
Metals	Units	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual
Aluminum	MG/KG	9910 =	8320 =	10000 =	10100 =	12600 =	12400 =	12800 -	11200 -	14600	11600 -
Antimony	MG/KG				10100	12000	12100	12000	11500	14000	11000 -
Arsenic	MG/KG	12 } =	1651	14 1	13.1.1	1761	16.4 📼	156 -	12 5 -	146 -	16.2 -
Barinm	MG/KG	90 9 =	365 =	43.5 =	319 -	39.9	657 -	13.0 - \$2	13.5 -	14.0 =-	15.2 =
Bendlium	MG/KG	22.2	30.5	43.9 -	51.6 -	30.0 -	05.7 -	55 -	02.9 =	37.3 =	63.3 =
Cedmin	MG/KG	19-	0 27 1	\$7_	0.14.1	A 90 _	0.00 1	0.40.1			
Cathian		1.0 -	0.373	5.7 -	0.14 J	0.88 =	0.28 J	0.43 J	0.2 3	10 ≠	0.41 J
Chromium	MG/KO	69 -	114 -	12.1 -	110_	154-	166-	160 -	12.4		
Cabolt	MORG	0.8 -	11.4 ~	12.1 -	11.0 -	IJ.4 <i>≈</i>	10.0 =	15.9 =	13.4 =	13.9 =	14 =
Conner	MO/KO										
Copper	MO/KO										
Lond	MG/KG	314 =	1241	1271	14.4.1	1771	14 4 1	140.1			
Momorium	MG/KG	514 -	14.4 J	13.7 3	14.4 J	17.7 3	14.4 J	14.9 J	14.4 J	21.5 J	32.5 1
Magnesium	NOKO	708 -	<u> </u>	313	104	160					
Manganese	MO/KO	796 -	230 -	213 =	194 =	160 =	321 =	2/3 =	269 =	194 ≃	401 =
Mercury Number	MO/KO	0.04 0	0.04 0	0.04 0	0.04 0	0.04 U	0.04 U	0.04 J	0.04 U	0.04 J	0.04 =
Nickei	MO/KO										
Polassium	MG/KG	0.00 -	0.7								
Selenium	MOKG	0.82 =	0.7 ≈	0.51 3	0.75 ≈	0.97 =	0.77 =	0.92 =	0.34 U	0.72 =	0.96 =
Silver	MO/KG	0.21 U	0.21 U	0.21 U	0.22 U	0.21 U	0.22 U	0.23 U	0.21 U	0.24 U	0.22 U
Sodium	MG/KG										
Thallium	MG/KG										
Vanadium	MG/KG	_									
Zine	MG/KG	349 =	54.2 =	79.2 =	50.5 =	60.4 =	65 =	57 =	58.2 =	67.7 =	67.2 =
Volatile Organics	Units										
1,1,1-Trichloroethane	UG/KG										
1,1,2,2-Tetrachloroethane	UG/KG										
1,1,2-Trichloroethane	UG/KG										
1,1-Dichloroethane	UG/KG										
1,1-Dichloroethene	UG/KG										
1,2-Dichloroethane	UG/KG										

Table 4.17. Winklepeck Burning Grounds (continued)

			Table 4.17.	winklepeck	Burning Gi	rounds (cont	inued)				
	Station	WBGss-051	WBGss-052 WF	WBGss-053	WBGss-054	WBGss-055	WBGss-056	WBGss-057	WBGss-058	WBGss-059	WBGss-06
	Date Collected Depth	8/8/96 0.0 - 2.0 FT	8/7/96 0.0 - 2.0 FT	8/13/96 0.0 - 2.0 FT	8/8/96 0.0 - 0.5 FT	8/8/96 0.0 - 2.0 FT	8/8/96 0.0 - 2.0 FT	8/7/96 0.0 - 2.0 FT	8/7/96 0.0 - 1.4 FT	8/8/96 0.0 - 1.0 FT	8/8/96 0.0 - 2.0 Fi
Media: Soll											
Metals	Units	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qu
Aluminum	MG/KG	8270 =	9320 =	15200 =	12500 =	11600 =	7070 =	9130 =	11300 =	12100 =	10300 =
Antimony	MG/KG	0.43 U									
Arsenic	MG/KG	9.7 J	12 =	12.5 =	19 =	12.1 =	7.4 =	10.1 =	11.6 =	14.3 =	11.5 =
Barium	MG/KG	41.5 =	66.6 =	59.2 =	174 =	96.1 =	43.1 =	207 =	138 =	138 =	58 =
Beryllium	MG/KG	0.43 U									
Cadmium	MG/KG	0.18 U	0.31 J	0.31 J	4.6 =	1.3 =	0.36 J	15.1 =	11.4 =	52.6 =	11=
Calcium	MG/KG	2100 =									•••
Chromium	MG/KG	10.1 =	15.5 J	17.2 =	29.3 =	118 =	11.5 =	27.8 J	27.4 J	18.5 =	13.1 =
Cobait	MG/KG	5.5 J								10.0	
Copper	MG/KG	13.1 =									
Iron	MG/KG	17600 =									
Lead	MG/KG	10.2 ≃	45.2 J	11.4 =	202 =	916 =	39 =	721 J	522 J	124 =	279 =
Magnesium	MG/KG	1930 =									20.5
Manganese	MG/KG	208 J	276 =	169 =	575 =	405 =	177 =	428 =	261 =	435 =	525 =
Mercury	MG/KG	0.04 =	0.04 J	0.04 U	0.21 =	0.04 U	0.04 U	0.05 =	0.09 =	0.04 =	0.04 =
Nickel	MG/KO	12.2 =							0107	0.04	0.04
Potassium	MG/KG	543 =									
Selenium	MG/KG	0.79 =	1.2 =	0.35 U	1.3 =	1.1 =	0.34 U	1.7 =	1.3 =	37=	0.85 =
Silver	MG/KG	0.2 U	0.21 U	0.22 U	6.4 =	0.54 J	0.22 J	5 =	47 ==	0.48 1	0.02 1
Sodium	MG/KG	163 J						-		0.40 0	V.64 J
Thallium	MG/KG	1.4 =									
Vanadium	MG/KG	13.8 =									
Zinc	MG/KG	39.9 =	58.1 =	58.3 =	604 =	1040 =	91.1 =	1050 =	469 =	195 =	108 =
Volatile Organics	Units	Result Qual									
1,1,1-Trichloroethane	UG/KG	5 U									
1,1,2,2-Tetrachloroethane	UG/KG	5 U									
1.1.2-Trichloroethane	UG/KG	5 U									
1,1-Dichloroethane	UG/KG	5 U									
1,1-Dichloroethene	UG/KG	5 U									

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UG/KG

5 U

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1,2-Dichloroethane

	Station	WBGss-061	WBGss-062	WBGss-063	WBGss-064	WBGss-065	WBGss-066	WBGss-067	WBGss-068	WBGss-069	WBGss-070
	Date Collected	8/8/96	8/8/96	8/7/96	8/7/96	8/9/96	8/9/96	8/9/96	8/9/96	8/9/96	8/9/96
	Depth	0.0 - 2.0 F T	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 F T	0.0 - 2.0 FT			
Media: Soll											
Metals	Units	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual
Aluminum	MG/KG	12700 =	10200 =	14300 ≈	13500 =	11300 =	9890 =	17500 =	12900 =	14800 =	10500 =
Antimony	MG/KG						0.31 U				
Arsenic	MG/KG	12.1 =	10.4 =	14.9 ≃	14.3 =	14.8 =	12.6 =	17.2 =	11.7 =	15.6 =	10.7 =
Barium	MG/KG	130 =	140 =	79.7 =	69.2 =	180 =	83.1 =	170 =	176 =	7780 =	377 =
Beryllium	MG/KG						0.55 =				
Cadmium	MG/KG	5.5 ≠	2.2 =	0.35 J	0.5 J	0.23 J	0.04 U	0.12 J	0.05 U	4.8 =	0.23 J
Calcium	MG/KG						1310 J				
Chromium	MG/KG	16.8 =	15.4 =	20 J	18.6 J	13.3 =	10.6 =	23 =	14.9 =	16.5 =	12.5 =
Cobalt	MG/KG						8.7 =				
Соррег	MG/KG						9.9 =				
Iron	MG/KG						18500 =				
Lead	MG/KG	49.9 =	87.2 =	40.1 J	57.7 J	31.9 =	16 =	49.2 =	17.5 =	289 =	54.7 =
Magnesium	MG/KG						1660 =				
Manganese	MG/KG	596 =	863 =	566 =	581 =	603 =	712 =	390 =	358 =	784 =	568 ⇒
Mercury	MG/KG	0.05 =	0.09 =	0.05 =	0.04 J	0.04 U	0.03 U	0.04 U	0.04 U	0.28 =	0.04 J
Nickel	MG/KG						11 =				
Potassium	MG/KG						622 =				
Selenium	MG/KG	1 =	0.92 =	1.3 =	1.8 =	0.5 J	0.31 U	0.35 U	0.36 U	0.37 U	0.42 J
Silver	MG/KG	0.22 J	0.23 J	0.23 U	0.23 U	0.23 U	0.2 U	0.27 J	0.23 U	0.33 J	0.23 U
Sodium	MG/KG						169 J				
Thallium	MG/KG						1.9 =				
Vanadium	MG/KG						19.1 =				
Zine	MG/KG	229 =	269 =	79 =	288 =	68.5 =	43.5 =	170 =	79 =	1050 =	83.3 =
Volatile Organics	Units						Result Qual				
1,1,1-Trichloroethane	UG/KG						5 U				
1,1,2,2-Tetrachloroethane	UG/KG						5 U				
1,1,2-Trichloroethane	UG/KG						5 U				
I, I-Dichloroethane	UG/KG						5 U				
l, l-Dichloroethene	UG/KG						5 U				

5 U

Table 4.17. Winklepeck Burning Grounds (continued)

1,2-Dichloroethane

UG/KG

		ſ	Table 4.17.	Winklepeck	Burning G	rounds (cont	tinued)				
	Station	WBGss-071	WBGss-072	WBGss-073	WBGss-074	WBGss-075	WBGss-076	WBGss-077	WBG55-097	WBGss-098	WBGss-004
	Date Collected	8/9/96	8/9/96	8/9/96	8/9/96	8/9/96	8/9/96	8/13/96	8/13/96	8/14/96	8/13/96
	Depth	0.0 - 1.0 FT	0.0 - 2. 0 FT	0.0 - 2.0 FT	0.0 - 0.5 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 0.8 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 0.6 FT
Media: Soil											
Metals	Units	Result Quel	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	
Aluminum	MG/KG	6330 =	7420 =	7700 =	7420 =	6000	9980 =	20500 =	8740 <i>=</i>	11000 =	
Antimony	MG/KG		2.6 =				0.3 U				
Arsenic	MG/KG	15.8 =	9.3 =	7.8 =	11.7 =	10.8 =	7.8 =	9.7 J	13.3 J	10.3 J	
Barium	MG/KG	69.8 =	920 =	581 =	38.1 =	35.6 =	49.9 =	263 =	41.4 =	190 =	
Beryllium	MG/KG		0.47 =				0.47 =				
Cadmium	MG/KG	0.07 J	1 =	0.96 =	0.16 J	0.16 J	0.1 J	3 =	0.19 J	0.14 J	
Calcium	MG/KG		3600 J				1200 J				
Chromium	MG/KG	7 =	14 =	23 =	9.3 =	10.2 =	10 =	11.2 =	10.3 =	11.1 =	
Cobalt	MG/KG		5.8 =				7.2 =				
Copper	MG/KG		29.3 =				9.3 =				
Iron	MG/KG		15100 =				14400 =				
Lead	MG/KG	16.1 =	201 =	589 =	19.7 =	11.7 =	11 =	28.1 J	17.9 J	14.5 J	
Magnesium	MG/KG		1690				1710 =				
Manganese	MG/KG	165 =	443 =	246 =	309 =	438 =	464 =	3910 J	221 J	389 J	
Mercury	MG/KG	0.13 =	0.16 =	0.07 =	0.04 J	0.04 U	0.03 U	0.04 =	0.06 =	0.04 =	
Nickel	MG/KG		10.2 =				11.1 =				
Potassium	MG/KG		400 J				559 =				
Selenium	MG/KG	0.34 U	0.37 J	0.36 U	0.33 U	0.34 J	0.6 =	0.85 =	0.56 J	0.36 J	
Silver	MG/KG	0.22 U	0.2 U	0.23 U	0.21 U	0.21 U	0.19 U	0.21 U	0.22 U	0.22 U	
Sodium	MG/KG		86.5 J				77.8 1			0.22 0	
Thallium	MG/KG		1.9 =				1.9 =				
Vanadium	MG/KG		13.1 =				16.4 =				
Zine	MG/KG	36.2 =	149 =	221 =	59.3 =	54 =	47.9 =	81.7 =	46.7 ≠	56.8 ≈	
Volatile Organics	Units		Result Qual				Result Qual				Result Qual
1,1,1-Trichloroethane	UG/KG		5 UJ				5 U				6 UJ
1,1,2,2-Tetrachloroethane	UG/KG		5 UJ				5 U				6 UJ
1,1,2-Trichloroethane	UG/KG		5 UJ				5 U				6 UJ
1,1-Dichloroethane	UG/KG		5 UJ				5 U				6 UJ
1,1-Dichloroethene	UG/KG		5 UJ				5 U				6 UJ
1,2-Dichloroethane	UG/KG		5 UJ				5 U	`			6 UJ

	Station	WBGss-030	WBGss-057
	Date Collected Depth	8/13/96 0.0 - 1.5 FT	8/13/96 1.5 - 2.0 FT
Media: Soil			
Metals	Units		
Aluminum	MG/KG		
Antimony	MG/KG		
Arsenic	MG/KG		
Barium	MG/KG		
Beryllium	MG/KG		
Cadmium	MG/KG		
Calcium	MG/KG		
Chromium	MG/KG		
Cobalt	MG/KG		
Copper	MG/KG		
Iron	MG/KG		
Lead	MG/KG		
Magnesium	MG/KG		
Manganese	MG/KG		
Mercury	MG/KG		
Nickel	MG/KG		
Potassium	MG/KG		
Selenium	MG/KG		
Silver	MG/KG		
Sodium	MG/KG		
Thallium	MG/KG		
Vanadium	MG/KG		
Zinc	MG/KG		
Volatile Organics	Units	Result Qual	Result Qual
1,1,1-Trichloroethane	UG/KG	6 UJ	31 UJ
1,1,2,2-Tetrachloroethane	UG/KG	6 UJ	31 UJ
1,1,2-Trichloroethane	UG/KG	6 UJ	31 UJ
1,1-Dichloroethane	UG/KG	6 UJ	31 UJ
1,1.Dichloroethene	UG/KG	6 UJ	31 UJ
1,2-Dichloroethane	UG/KG	6 UJ	31 UJ

Table 4.17. Winklepeck Burning Grounds (continued)

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Table 4.17. Winklepeck Burning Grounds (continued)											
	Station	WBGSS-032	WBGSS-033	WBGss-001	WBGss-002	WBGss-003	WBGss-004	WBGss-005	WBGss-006	WBGss-007	WBGss-008
	Date Collected Depth	8/7/96 0.0 - 0.5 FT	8/6/96 0.0 - 2.0 FT	7/31/96 0.0 - 2.0 FT	7/31/96 0.0 - 2.0 FT	7/31/96 0.0 - 2.0 FT	7/30/96 0.0 - 0.7 FT	7/30/96 0.0 - 2.0 FT			
Media: Soil											
Volatile Organics	Units										Result Qual
1,2-Dichloropropane	UG/KG										5 U
1,2-cis-Dichloroethene	UG/KG										5 U
1,2-trans-Dichloroethene	UG/KG										5 U
1,3-cis-Dichloropropene	UG/KG										5 U
1,3-trans-Dichloropropene	UG/KG										5 U
2-Butanone	UG/KG										5 UJ
2-Hexanone	UG/KG										5 UJ
4-Methyl-2-pentanone	UG/KG										5 U
Acetone	UG/KG										5 R
Benzene	UG/KG										5 U
Bromodichloromethane	UG/KG										5 U
Bromoform	UG/KG										5 U
Bromomethane	UG/KG										5 U
Carbon Disulfide	UG/KG										5 U
Carbon Tetrachloride	UG/KG										5 U
Chlorobenzene	UG/KG										5 U
Chloroethane	UG/KG										5 UJ
Chloroform	UG/KG										511
Chloromethane	UG/KG										511
Dibromochloromethane	UG/KG										50
Ethylbenzene	UG/KG										50
Methylene Chloride	UG/KG										5 U
Styrene	UG/KO										511
Tetrachloroethene	UG/KG										511
Toluene	UG/KG										5 U
Trichloroethene	UG/KG										50
Vinyl Chloride	UG/KG										5 U
Xylenes, Total	UG/KG										511
o-Xylene	UG/KG										5 U

	Station	WBGss- 009	WBGas-010	WBGss-011	WBGss-012	WBGss-013	WBG ss-014	WBGss-015	WBGss-016	WBGss-017	WBGss-018
	Date Collected	8/5/96	8/5/96	8/5/96	8/5/96	8/5/96	8/8/96	8/5/96	8/6/96	8/6/96	8/6/96
	Depth ().0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 1.5 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 1.5 FT
Media: Soil											
Volatile Organics	Units										
1,2-Dichloropropane	UG/KG										
1,2-cis-Dichloroethene	UG/KG										
1,2-trans-Dichloroethene	UG/KG										
1,3-cis-Dichloropropene	UG/KG										
1,3-trans-Dichloropropene	UG/KG										
2-Butanone	UG/KG										
2-Hexanone	UG/KG										
4-Methyl-2-pentanone	UG/KG										
Acetone	UG/KG										
Benzene	UG/KG										
Bromodichloromethane	UG/KG										
Bromoform	UG/KG										
Bromomethane	UG/KG										
Carbon Disulfide	UG/KG										
Carbon Tetrachloride	UG/KG										
Chlorobenzene	UG/KG										
Chloroethane	UG/KG										
Chloroform	UG/KG										
Chloromethane	UG/KG										
Dibromochloromethane	UG/KG										
Ethylbenzene	UG/KG										
Methylene Chloride	UG/KG										
Styrene	UG/KG										
Tetrachloroethene	UG/KG										
Toluene	UG/KG										
Trichloroethene	UG/KG										
Vinyl Chloride	UG/KG										
Xylenes, Total	UG/KG										
0-Xylene	UG/KG										

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			Table 4.17.	Winklepeck	Burning G	rounds (cont	inued)					12
	Station	WBGss-019	WBG ss-02 0	WBGss-021	WBGss-022	WBGss-023	WBGss-024	WBGss-025	WBGss-026	WBGss-027	WBGss-028	AAF
	Date Collected Depth	8/6/96 0.0 - 1.5 FT	8/5/96 0.0 - 2.0 FT	8/5/96 0.0 - 0.5 FT	8/6/96 0.0 - 1.3 FT	8/6/96 0.0 - 0.5 FT	8/7/96 0.0 - 2.0 FT	Phase				
Media: Soil												
Volatile Organics	Units			Result Qual								eme
1,2-Dichloropropane	UG/KG			5 U								dia
1,2-cis-Dichloroethene	UG/KG			5 U								1
1,2-trans-Dichloroethene	UG/KG			5 U								IVe
1,3-cis-Dichloropropene	UG/KG			5 U								Si.
1,3-trans-Dichloropropene	UG/KG			5 U								Ĩ
2-Butanone	UG/KG			5 U								Įδ.
2-Hexanone	UG/KG			5 U								~
4-Methyl-2-pentanone	UG/KG			5 U								
Acetone	UG/KG			5 U								
Benzene	UG/KG			5 U								ſ
Bromodichloromethane	UG/KG			5 U								
Bromoform	UG/KG			5 U								
Bromomethane	UG/KG			5 UJ								i i
Carbon Disulfide	UG/KG			5 U								
Carbon Tetrachloride	UG/KG			5 U								
Chlorobenzene	UG/KG			5 U								
Chloroethane	UG/KG			5 13								1
Chloroform	UG/KG			5 U								
Chloromethane	UG/KG			5 U								
Dibromochloromethane	UG/KG			5 U								
Ethylbenzene	UG/KG			5 U								
Methylene Chloride	UG/KG			5 U								ł
Styrene	UG/KG			5 U								
Tetrachloroethene	UG/KG			5 U								
Toluene	UG/KG			40 =								1
Trichloroethere	UG/KG			511								
Vinyl Chloride	UG/KG			۶0 ۲П								1
Yulones Total				5 U 5 U								1
Ayrenes, rotar Ayrenes, rotar	UG/KG			50								
0-WALLE	Cond			50								

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			Table 4.17.	Winklepeck	Burning G	rounds (cont	inued)					ł
	Station	WBGss-029	WBGss-030	WBGss-031	WBGss-034	WBGss-035	WBGss-036	WBGss-037	WBGss-038	WBGss-039	WBGss-040	
	Date Collected Depth	8/7/96 0.0 - 2.0 FT	8/7/96 0.0 - 1.5 FT	8/7/96 0.0 - 2.0 FT	8/6/96 0.0 - 2.0 FT	7/31/96 0.0 - 2.0 FT	7/31/96 0.0 - 2.0 FT					
Media: Soli												
Volatile Organics	Units			Result Qual								
1,2-Dichloropropane	UG/KG			5 UJ								Į
1,2-cis-Dichloroethene	UG/KG			5 UJ								ł
1,2-trans-Dichloroethene	UG/KG			5 UJ								ł
1,3-cis-Dichloropropene	UG/KG			5 UJ								I
1,3-trans-Dichloropropene	UG/KG			5 UJ								I
2-Butanone	UG/KG			5 UJ								I
2-Hexanone	UG/KG			5 UJ								Ì
4-Methyl-2-pentanone	UG/KG			5 UJ								
Acetone	UG/KG			5 UJ								I
Benzene	UG/KG			5 UJ								I
Bromodichloromethane	UG/KG			5 UJ								ł
Bromoform	UG/KG			5 UJ								Į
Bromomethane	UG/KG			5 UJ								I
Carbon Disulfide	UG/KG			5 UJ								ł
Carbon Tetrachloride	UG/KG			5 UJ								I
Chlorobenzene	UG/KG			5 UJ								ļ
Chloroethane	UG/KG			5 UJ								
Chloroform	UG/KG			5 បរ								ì
Chloromethane	UG/KG			5 UJ								I
Dibromochloromethane	UG/KG			5 UJ								I
Ethylbenzene	UG/KG			5 UJ								
Methylene Chloride	UG/KG			5 UJ								I
Styrene	UG/KG			5 UJ								Į
Tetrachloroethene	UG/KG			5 UJ								I
Toluene	UG/KG			17 J								
Trichloroethene	UG/KG			5 UJ								l
Vinyl Chloride	UG/KG			5 UJ								ł
Xylenes, Total	UG/KG			5 UJ								I
o-Xylene	UG/KG			5 UJ								١

			Table 4.17.	Winklepeck	Burning G	rounds (cont	inued)				
	Station	WBGss-041	WBGss-042	WBGss-043	WBGss-044	WBGss-045	WBGss-046	WBGss-047	WBGss-048	WBGss-049	WBGss-050
	Date Collected Depth	7/31/96 0.0 - 0.5 FT	8/7/96 0.0 - 2.0 FT	8/7/96 0.0 - 2.0 FT	8/7/96 0.0 - 2.0 FT	8/7/96 0.0 - 1.0 FT	8/7/96 0.0 - 2.0 FT	8/7/96 0.0 - 1.0 FT			
Media: Soil											
Volatile Organics	Units										
1,2-Dichloropropane	UG/KG										
1,2-cis-Dichloroethene	UG/KG										
1,2-trans-Dichloroethene	UG/KG										
1,3-cis-Dichloropropene	UG/KG										
1,3-trans-Dichloropropene	UG/KG										
2-Butanone	UG/KG										
2-Hexanone	UG/KG										
4-Methyl-2-pentanone	UG/KG										
Acetone	UG/KG										
Benzene	UG/KG										
Bromodichloromethane	UG/KG										
Bromoform	UG/KG										
Bromomethane	UG/KG										
Carbon Disulfide	UG/KG										
Carbon Tetrachloride	UG/KG										
Chlorobenzene	UG/KG										
Chloroethane	UG/KG										
Chloroform	UG/KG										
Chloromethane	UG/KG										
Dibromochloromethane	UG/KG										
Ethylbenzene	UG/KG										
Methylene Chloride	UG/KG										
Styrene	UG/KG										
Tetrachloroethene	UG/KG										
Toluene	UG/KG										
Trichloroethene	UG/KG										
Vinyl Chloride	UG/KG										
Xylenes, Total	UG/KG										
o-Yulana	UG/KG										

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Table 4.17. Winklepeck Burning Grounds (continued)												Ì
	Station	WBGss-051	WBGss-052	WBGss-053	WBGss-054	WBGss-055	WBG35-056	WBGss-057	WBGss-058	WBGss-059	WBGss-060	ľ
	Date Collected Depth	8/8/96 0.0 - 2.0 FT	8/7/96 0.0 - 2.0 FT	8/13/96 0.0 - 2.0 FT	8/8/96 0.0 - 0.5 FT	8/8/96 0.0 - 2.0 FT	8/8/96 0.0 - 2.0 FT	8/7/96 0.0 - 2.0 FT	8/7/96 0.0 - 1.4 FT	8/8/96 0.0 - 1.0 FT	8/8/96 0.0 - 2.0 FT	
Media: Soil Volatile Organics	Units	Result Qual										
1,2-Dichloropropane	UG/KG	5 U										I
1,2-cis-Dichloroethene	UG/KG	5 U										I
1,2-trans-Dichloroethene	UG/KG	5 U										
1,3-cis-Dichloropropene	UG/KG	5 U										l
1,3-trans-Dichloropropene	UG/KG	5 U										
2-Butanone	UG/KG	5 U										Ì
2-Hexanone	UG/KG	5 U										I
4-Methyl-2-pentanone	UG/KG	5 U										l
Acetone	UG/KG	5 U										ĺ
Benzene	UG/KG	5 U										l
Bromodichloromethane	UG/KG	5 U										ĺ
Bromoform	UG/KG	5 U										l
Bromomethane	UG/KG	5 UJ										l
Carbon Disulfide	UG/KG	5 U										
Carbon Tetrachloride	UG/KG	5 U										l
Chlorobenzene	UG/KG	5 U										l
Chloroethane	UG/KG	5 UJ										l
Chloroform	UG/KG	5 U										l
Chloromethane	UG/KG	5 U										l
Dibromochloromethane	UG/KG	5 U										l
Ethylbenzene	UG/KG	5 U										l
Methylene Chloride	UG/KG	12 =										
Styrene	UG/KG	5 U										l
Tetrachloroethene	UG/KG	5 U										
Toluene	UG/KG	5 U										l
Trichloroethene	UG/KG	5 U										ł
Vinyl Chloride	UG/KO	5 U										l
Xylenes, Total	UG/KG	5 U										l
o-Xylene	UG/ KG	5 U										

Station WBGs-00				Table 4.17.	Winklepeck	Burning Gr	ounds (cont	inued)					۱
Date Callected 88996 89796 87796 87996 89796 87995		Station	WBGss-061	WBGss-062	WBGss-063	WBGss-064	WBGss-065	WBG55-066	WBGss-067	WBGss-068	WBGss-069	WBGss-070	l
Netla: Soli Result Qual 1,2-Jichloropopane VOKG 1,2-Jichloropopane VOKG 2,4-iso-Dichloropopane VOKG 1,2-trans-Dichloropopane VOKG 1,2-trans-Dichloropopane VOKG 1,2-trans-Dichloropopane VOKG 1,2-trans-Dichloropopane VOKG 1,2-trans-Dichloropopane VOKG 1,2-trans-Dichloropopane VOKG 2-Batanone VOKG Bornodichloromethane VOKG Bornodichloromethane VOKG Bornodichloromethane VOKG Carbon Disulfa' VOKG Choromethane VOKG Choromethane VOKG VOKG S U Choromethane VOKG Dibronochloroomethane VOKG		Date Collected Depth	8/8/96 0.0 - 2.0 FT	8/8/96 0.0 - 2.0 FT	8/7/96 0.0 - 2.0 FT	8/7/96 0.0 - 2.0 FT	8/9/96 0.0 - 2.0 FT						
J.2-DichloropropenUO/KOS U1,2-DichloropropenUG/KOS U1,2-tian-DichlorophropenUG/KOS U1,3-tian-DichlorophropenUG/KOS U1,3-tian-DichlorophropenUG/KOS U1,3-tian-DichlorophropenUG/KOS U1,3-tian-DichlorophropenUG/KOS U2-BatanoeUG/KOS UU2-BatanoeUG/KOS UU2-BatanoeUG/KOS U2-BatanoeUG/KOS U2-BatanoeUG/KOS UBoronofichloronethaneUG/KOS UBoronofichloronethaneUG/KOS UBromofichloronethaneUG/KOS UCarbon DisalifacUG/KOS UChoronethaneUG/KOS UChoronethaneUG/KOS UChoronethaneUG/KOS UChoronethaneUG/KOS UChoronethaneUG/KOS UChoronethaneUG/KOS UChoronethaneUG/KOS UChoronethaneUG/KOS UChoronethaneUG/KOS UDibronochloronethaneUG/KOS UDibronochloronethaneUG/KOS UDibronochloronethaneUG/KOS UDibronochloronethaneUG/KOS UStyreneUG/KOS UValoreetheneUG/KOS UValoreetheneUG/KOS UValoreetheneUG/KOS UValoreetheneUG/KOS UValoreethe	Media: Soil Volatile Organics	Linite						Result Ousi					
1,2-bichloropetane UG/KG 5 U 1,2-cis-Dichlorophene UG/KG 5 U 1,3-trans-Dichlorophene UG/KG 5 U 1,3-trans-Dichlorophene UG/KG 5 U 2-Butanoe UG/KG 5 UJ 2-Butanoe UG/KG 5 UJ 2-Hexanoie UG/KG 5 UJ 2-Hexanoie UG/KG 5 UJ 2-Hexanoie UG/KG 5 U 2-Hexanoie UG/KG 5 U 2-Reazone UG/KG 5 U Benzone UG/KG 5 U BronodichloromHane UG/KG 5 U BronodichloromHane UG/KG 5 U Carbon Disulfide UG/KG 5 U Carbon Disulfide UG/KG 5 U Chloroform UG/KG 5 U Chloroform UG/KG 5 U Chloroform UG/KG 5 U Chloroform UG/KG 5 U Dhromonethane UG/KG 5 U Dhromonethane UG/KG </td <td>Column Col Builder</td> <td>01000</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>MUMIC QUI</td> <td></td> <td></td> <td></td> <td></td> <td></td>	Column Col Builder	01000						MUMIC QUI					
1,2-icn-Dichloredthene UG/KG 5 U 1,2-irna-Dichloredthene UG/KG 5 U 1,3-icn-Dichloregtropene UG/KG 5 U 1,3-icn-Dichloregtropene UG/KG 5 U 2-Buanose UG/KG 5 UJ 2-Buanose UG/KG 5 UJ 2-Hexanone UG/KG 5 UJ 4-Atelyh-2-pentanone UG/KG 5 U Acetone UG/KG 5 U Benzene UG/KG 5 U Benzene UG/KG 5 U Bromodichberomethane UG/KG 5 U Bromodichberomethane UG/KG 5 U Carbon Tetrasloride UG/KG 5 U Carbon Tetrasloride UG/KG 5 U Chlorodenzene UG/KG 5 UJ Chlorodenzene UG/KG 5 U Chlorodentane UG/KG 5 U Dibromochloronethane UG/KG 5 U Dibromochloronethane UG/KG 5 U Dibromochloronethane UG/KG 5 U	1,2-Dichloropropane	UG/KG						5 U					I
1,3-rans-Dichlorotenten UGKG 5 U 1,3-cis-Dichlorotopopene UGKG 5 U 1,3-trans-Dichlorotopopene UG/KG 5 U 2-butanone UG/KG 5 UJ 2-butanone UG/KG 5 U 2-butanone UG/KG 5 U 4-Methyl-2-perilanone UG/KG 5 U Acetone UG/KG 5 U Beazene UG/KG 5 U Bromodichloronethane UG/KG 5 U Bromodichloronethane UG/KG 5 U Bromodichloronethane UG/KG 5 U Carbon Disulfide UG/KG 5 U Chorobenzone UG/KG 5 U Chlorobenzone UG/KG 5 U Chlorobenzone UG/KG 5 U Chlorobenzone UG/KG 5 U Dibromodishorotethane UG/KG 5 U Chlorotenzone UG/KG 5 U Dibromodishorotethane UG/KG 5 U Dibromodishorotethane UG/KG 5 U	1,2-cis-Dichloroethene	UG/KG						5 U					
1,3-is-Dichloropropene UG/KG 5 U 1,3-trans-Dichloropropene UG/KG 5 U 2-Butanone UG/KG 5 U 2-Atexanone UG/KG 5 U 4-Methyl-2-pentanone UG/KG 5 U Acetone UG/KG 5 U Acetone UG/KG 5 U Benzone UG/KG 5 U Benzone UG/KG 5 U Benzone UG/KG 5 U Bromodichloromethane UG/KG 5 U Bromodichloromethane UG/KG 5 U Carbon Disulfide UG/KG 5 U Chorobenzene UG/KG 5 U Chloroform UG/KG 5 U Ehylbenzene UG/KG 5 U Ehylbenzene UG/KG 5 U Ehylbenc Chloride UG/KG 5	1,2-trans-Dichloroethene	UG/KG						5 U					1
1,3-trans-Dichloropropene UG/KG 5 U 2-Butanone UG/KG 5 UJ 2-Hexanone UG/KG 5 U 4-Methyl-2-pentanone UG/KG 5 U Acetone UG/KG 5 U Benzene UG/KG 5 U Benzene UG/KG 5 U Bromodichloromethane UG/KG 5 U Bromodichloromethane UG/KG 5 U Bromonoforn UG/KG 5 U Bromonoforn UG/KG 5 U Carbon Disulfide UG/KG 5 U Chorobernene UG/KG 5 U Chorobernene UG/KG 5 U Chloroforn UG/KG 5 U Dibromochloromethane UG/KG 5 U Retylbenzene UG/KG 5 U Totuene <td>1,3-cis-Dichloropropene</td> <td>UG/KG</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>5 U</td> <td></td> <td></td> <td></td> <td></td> <td></td>	1,3-cis-Dichloropropene	UG/KG						5 U					
2-Buanone UG/KG 5 UJ 2-Hexanone UG/KG 5 UJ 4-Methyl-2-pentanone UG/KG 5 U Acetone UG/KG 5 R Benzone UG/KG 5 U Bromodichsboronethane UG/KG 5 U Bromodichsboronethane UG/KG 5 U Bromodichsboronethane UG/KG 5 U Bromodichsboronethane UG/KG 5 U Carbon Disulfide UG/KG 5 U Choronethane UG/KG 5 U Ethylbenzene UG/KG 5 U Ethylbenzene UG/KG 5 U Ethylbenzene UG/KG 5 U Totuene UG/KG 5 U Totuene UG/KG	1,3-trans-Dichloropropene	UG/KG						5 U					ł
2-Hexanone UG/KG 5 UJ 4-Methyl-2-pentanone UG/KG 5 U Acetone UG/KG 5 R Benzene UG/KG 5 U Bromofichloromethane UG/KG 5 U Bromofichloromethane UG/KG 5 U Bromofichloromethane UG/KG 5 U Carbon Disulfide UG/KG 5 U Carbon Disulfide UG/KG 5 U Choroberzene UG/KG 5 U Dibromochloromethane UG/KG 5 U Dibromochloromethane UG/KG 5 U Dibromochloromethane UG/KG 5 U Styrene UG/KG 5 U Styrene UG/KG 5 U Tetrachloroethene UG/KG 5 U Tolouene UG/KG 5 U Yujotloride UG/KG 5 U	2-Butanone	UG/KG						5 UJ					I
4-Methyl-2-pentanone 5 U Acetone UG/KG 5 R Berozene UG/KG 5 U Bromodichloronethane UG/KG 5 U Bromodichloronethane UG/KG 5 U Bromodichloronethane UG/KG 5 U Carbon Disulfide UG/KG 5 U Carbon Disulfide UG/KG 5 U Carbon Tetrachloride UG/KG 5 U Chloroform UG/KG 5 U Dibromochloronethane UG/KG 5 U Chloroform UG/KG 5 U Dibromochloronethane UG/KG 5 U Dibromochloronethane UG/KG 5 U Dibromochloronethane UG/KG 5 U Styrene UG/KG 5 U Tetrachloroethene UG/KG 5 U Trichloroethene U	2-Hexanone	UG/KG						5 UJ					I
Actone UG/KG 5 R Benzoe UG/KG 5 U Bromofichforomethane UG/KG 5 U Bromofichare UG/KG 5 U Bromofichare UG/KG 5 U Carbon Disulfide UG/KG 5 U Carbon Disulfide UG/KG 5 U Carbon Disulfide UG/KG 5 U Chlorobenzene UG/KG 5 U Chlorobenzene UG/KG 5 U Chlorobenzene UG/KG 5 U Chloromthane UG/KG 5 U Chloromthane UG/KG 5 U Chloromthane UG/KG 5 U Dibromochloromethane UG/KG 5 U Dibromochloromethane UG/KG 5 U Styrene UG/KG 5 U Styrene UG/KG 5 U Totuene UG/KG 5 U Vinyl Chloride UG/KG 5 U Vinyl Chloride UG/KG 5 U Vinyl Chloride UG/KG <td< td=""><td>4-Methyl-2-pentanone</td><td>UG/KG</td><td></td><td></td><td></td><td></td><td></td><td>5 U</td><td></td><td></td><td></td><td></td><td>I</td></td<>	4-Methyl-2-pentanone	UG/KG						5 U					I
Benzene UG/KG 5 U Bromodichløromethane UG/KG 5 U Bromoform UG/KG 5 U Bromomethane UG/KG 5 U Carbon Disulfide UG/KG 5 U Carbon Disulfide UG/KG 5 U Carbon Tetrachloride UG/KG 5 U Chlorobenzene UG/KG 5 U Chloroform UG/KG 5 U Chloroform UG/KG 5 U Chloroform UG/KG 5 U Chloroform UG/KG 5 U Dibromochloromethane UG/KG 5 U Dibromochloromethane UG/KG 5 U Methylene Chloride UG/KG 5 U Styrene UG/KG 5 U Tetrachloroethene UG/KG 5 U Toluene UG/KG 5 U Vinjt Chloride UG/KG<	Acetone	UG/KG						5 R					ł
Bromodichloromethane UG/KG S U Bromodiom UG/KG S U Bromomethane UG/KG S U Carbon Disulfide UG/KG S U Carbon Disulfide UG/KG S U Carbon Tetrachloride UG/KG S U Chlorobenzene UG/KG S U Chlorothane UG/KG S U Chlorothane UG/KG S U Chloromethane UG/KG S U Chlorothane UG/KG S U Chlorothane UG/KG S U Dibromochloromethane UG/KG S U Ethylbenzene UG/KG S U Styrene UG/KG S U Styrene UG/KG S U Tetrachlorothene UG/KG S U Toluene UG/KG S U Vinyl Chloride UG/KG	Benzene	UG/KG						5 U					ſ
Bromoform UG/KG 5 U Bromomethane UG/KG 5 U Carbon Disulfide UG/KG 5 U Carbon Tetrachloride UG/KG 5 U Chlorobenzene UG/KG 5 U Dibromochloromethane UG/KG 5 U Dibromochloromethane UG/KG 9 U Styrene UG/KG 9 U Styrene UG/KG 5 U Toluene UG/KG 5 U Toiloroethene UG/KG 5 U Vinyl Chloride UG/KG	Bromodichloromethane	UG/KG						5 U					I
Bromonethane UG/KG S U Carbon Disulifide UG/KG S U Carbon Tetrackloride UG/KG S U Chlorobenzene UG/KG S U Chlorotethane UG/KG S U Chlorotoftm UG/KG S U Chlorotoftm UG/KG S U Chlorotoftm UG/KG S U Dibromochlorontethane UG/KG S U Dibromochlorontethane UG/KG S U Dibromochlorontethane UG/KG S U Styrene UG/KG S U Tetrachloroethene UG/KG S U Toluene UG/KG S U Vinyl Chloride UG/KG S U	Bromoform	UG/KG						5 U					I
Carbon Disulfide UG/KG 5 U Carbon Tetrachloride UG/KG 5 U Chlorobenzene UG/KG 5 U Chlorotehane UG/KG 5 U Chloroform UG/KG 5 U Chloromethane UG/KG 5 U Dibromachloromethane UG/KG 5 U Ethylbenzene UG/KG 5 U Methylene Chloride UG/KG 9 U Styrene UG/KG 9 U Styrene UG/KG 9 U Tetrachloroethene UG/KG 9 U Vinyl Chloride UG/KG 5 U Toluene UG/KG 5 U Vinyl Chloride UG/KG 5 U Ox/gene UG/KG 5 U	Bromomethane	UG/KG						5 U					
Carbon Tetrachloride UG/KG S U Chlorobenzene UG/KG S U Chlorocthane UG/KG S U Chloroform UG/KG S U Chloromethane UG/KG S U Chloromethane UG/KG S U Dibromochloromethane UG/KG S U Ethrybenzene UG/KG S U Methrylene Chloride UG/KG 9 U Styrene UG/KG 9 U Tetrachloroethene UG/KG 9 U Toluene UG/KG 9 U Yinyl Chloride UG/KG 5 U Vinyl Chloride UG/KG 5 U Ox/kene 5 U 5 U	Carbon Disulfide	UG/KG						5 U					
ChlorobenzeneUG/KGS UChlorothaneUG/KGS UChloroformUG/KGS UChloromethaneUG/KGS UDibromochloromethaneUG/KGS UEthylbenzeneUG/KGS UMethylene ChlorideUG/KG9 UStyreneUG/KGS UTolueneUG/KGS UTolueneUG/KG19 =TrichloroetheneUG/KGS UVinyl ChlorideUG/KGS UVinyl ChlorideUG/KGS UStylenes, TotalUG/KGS Uo-XyleneUG/KGS U	Carbon Tetrachloride	UG/KG						5 U					ł
ChlorothaneUG/KG5 UJChloroformUG/KG5 UChloromethaneUG/KG5 UDibromochloromethaneUG/KG5 UEthylbenzeneUG/KG5 UMethylene ChlorideUG/KG9 UStyreneUG/KG5 UTetrachloroetheneUG/KG5 UTolueneUG/KG5 UTolueneUG/KG5 UVinyl ChlorideUG/KG5 Uo-XyleneUG/KG5 U	Chlorobenzene	UG/KG						5 U					I
Chloroform UG/KG 5 U Chloromethane UG/KG 5 U Dibromochloromethane UG/KG 5 U Ethylbenzene UG/KG 5 U Methylene Chloride UG/KG 9 U Styrene UG/KG 5 U Tetrachloroethene UG/KG 5 U Toluene UG/KG 5 U Vinyl Chloride UG/KG 5 U Vinyl Chloride UG/KG 5 U Xylenes, Total UG/KG 5 U o-Xylene UG/KG 5 U	Chloroethane	UG/KG						5 UJ					I
ChloromethaneUG/KG5 UDibromochloromethaneUG/KG5 UEthylbenzeneUG/KG5 UMethylene ChlorideUG/KG9 UStyreneUG/KG5 UTetrachloroetheneUG/KG5 UTolueneUG/KG19 =TrichloroetheneUG/KG5 UVinyl ChlorideUG/KG5 UXylenes, TotalUG/KG5 Uo-XyleneUG/KG5 U	Chloroform	UG/KG						5 U					I
DibromochloromethaneUG/KGS UEthylbenzeneUG/KGS UMethylene ChlorideUG/KG9 UStyreneUG/KGS UTetrachloroetheneUG/KGS UTolueneUG/KG19 =TrichloroetheneUG/KGS UVinyl ChlorideUG/KGS UXylenes, TotalUG/KGS Uo-XyleneUG/KGS UUG/KGS U	Chloromethane	UG/KG						5 U					L
EthylbenzeneUG/KG5 UMethylene ChlorideUG/KG9 UStyreneUG/KG5 UTetrachloroetheneUG/KG5 UTolueneUG/KG19 =TrichloroetheneUG/KG5 UVinyl ChlorideUG/KG5 UXylenes, TotalUG/KG5 Uo-XyleneUG/KG5 UUG/KG5 U	Dibromochloromethane	UG/KO						5 U					ł
Methylene ChlorideUG/KG9 UStyreneUG/KG5 UTetrachloroetheneUG/KG5 UTolueneUG/KG19 =TrichloroetheneUG/KG5 UVinyl ChlorideUG/KG5 UXylenes, TotalUG/KG5 Uo-XyleneUG/KG5 U	Ethylbenzene	UG/KG						5 U					I
StyreneUG/KG5 UTetrachloroetheneUG/KG5 UTolueneUG/KG19 =TrichloroetheneUG/KG5 UVinyl ChlorideUG/KG5 UXylenes, TotalUG/KG5 Uo-XyleneUG/KG5 U	Methylene Chloride	UG/KG						9 U					I
TetrachloroetheneUG/KG5 UTolueneUG/KG19 =TrichloroetheneUG/KG5 UVinyl ChlorideUG/KG5 UXylenes, TotalUG/KG5 Uo-XyleneUG/KG5 U	Styrene	UG/KG						5 U					ł
TolueneUG/KG19 =TrichloroetheneUG/KG5 UVinyl ChlorideUG/KG5 UXylenes, TotalUG/KG5 Uo-XyleneUG/KG5 U	Tetrachloroethene	UG/KG						5 U					I
TrichloroetheneUG/KG5 UVinyl ChlorideUG/KG5 UXylenes, TotalUG/KG5 Uo-XyleneUG/KG5 U	Toluene	UG/KG						19 =					ł
Vinyl ChlorideUG/KG5 UXylenes, TotalUG/KG5 Uo-XyleneUG/KG5 U	Trichloroethene	UG/KG						5 U					
Xylenes, TotalUG/KG5 Uo-XyleneUG/KG5 U	Vinyl Chloride	UG/KG						5 U					
o-Xylene UG/KG 5 U	Xylenes, Total	UG/KG						5 U					1
	0-Xylene	UG/KG						5 U					

		(Table 4.17.	Winklepeck	Burning G	rounds (cont	inued)				
	Station	WBGss-071	WBGss-072	WBGss-073	WBGss-074	WBGss-075	WBGss-076	WBGss-077	WBGss-097	WBGss-098	WBGss-004
	Date Collected Depth	8/9/96 0.0 - 1.0 FT	8/9/96 0.0 - 2.0 FT	8/9/96 0.0 - 2.0 FT	8/9/96 0.0 - 0.5 FT	8/9/96 0.0 - 2.0 FT	8/9/96 0.0 - 2.0 FT	8/13/96 0.0 - 0.8 FT	8/13/96 0.0 - 2.0 FT	8/14/96 0.0 - 2.0 FT	8/13/96 0.0 - 0.6 FT
Media: Soil											
Volatile Organics	Units		Result Qual				Result Qual				Result Qual
1,2-Dichloropropane	UG/KG		5 UJ				5 U				6 UJ
1,2-cis-Dichloroethene	UG/KG		វ បរ				5 U				6 UJ
1,2-trans-Dichloroethene	UG/KG		5 UJ				5 U				6 UJ
1,3-cis-Dichloropropene	UG/KG		5 UJ				5 U				6 UJ
1,3-trans-Dichloropropene	UG/KG		5 UJ				5 U				6 UJ
2-Butanone	UG/KG		5 UJ				5 UJ				6 UJ
2-Hexanone	UG/KG		5 UJ				5 UJ				6 UJ
4-Methyl-2-pentanone	UG/KG		5 UJ				5 U				6 UJ
Acetone	UG/KG		5 R	•			5 R				6 UJ
Benzene	UG/KG		5 UJ				5 U				6 UJ
Bromodichloromethane	UG/KG		5 UJ				5 U				6 UJ
Bromoform	UG/KG		5 UJ				5 U				6 UJ
Bromomethane	UG/KG		5 UJ				5 U				6 UJ
Carbon Disulfide	UG/KG		5 UJ				5 U				6 UJ
Carbon Tetrachloride	UG/KG		5 UJ				5 U				6 បរ
Chlorobenzene	UG/KG		5 UJ				5 U				6 UJ
Chloroethane	UG/KG		5 UJ				5 UJ				6 UJ
Chloroform	UG/KG		5 UJ				2 J				3 J
Chloromethane	UG/KG		5 UJ				5 U				6 UJ
Dibromochloromethane	UG/KG		5 UJ				5 U				6 UJ
Ethylbenzene	UG/KG		5 UJ				5 U				6 UJ
Methylene Chloride	UG/KG		20 UJ				12 U				12 UJ
Styrene	UG/KG		5 UJ				5 U				6 UJ
Tetrachloroethene	UG/KG		5 UJ				5 U				6 UJ
Toluene	UG/KG		81 J				170 =				6 UJ
Trichloroethene	UG/KG		5 UJ				5 U				6 UJ
Vinyl Chloride	UG/KG		5 UJ				5 U				6 UJ
Xylenes, Total	UG/KG		5 UJ				5 U				6 UJ
o-Xylene	UG/KG		5 UJ				5 U				6 UJ

.

Station	WBGss-030	WBGss-057
Date Collected	8/13/96	8/13/96
Depth	0.0 - 1.5 FT	1.5 - 2.0 FT

Media: Soil

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Volatile Organics	Units	Result Qual	Result Qua
1,2-Dichloropropane	UG/KG	6 UJ	31 UJ
1,2-cis-Dichloroethene	UG/KG	6 UJ	31 UJ
1,2-trans-Dichloroethene	UG/KG	6 UJ	31 UJ
1,3-cis-Dichloropropene	UG/KG	6 UJ	31 UJ
1,3-trans-Dichloropropene	UG/KG	6 UJ	31 UJ
2-Butanone	UG/KG	6 UJ	31 UJ
2-Hexanone	UG/KG	6 UJ	31 UJ
4-Methyl-2-pentanone	UG/KG	6 UJ	31 UJ
Acetone	UG/KG	6 UJ	31 UJ
Benzene	UG/KG	6 UJ	32 J
Bromodichloromethane	UG/KG	6 UJ	31 UJ
Bromoform	UG/KG	6 UJ	31 UJ
Bromomethane	UG/KG	6 UJ	31 UJ
Carbon Disulfide	UG/KG	6 UJ	31 UJ
Carbon Tetrachloride	UG/KG	6 UJ	31 UJ
Chlorobenzene	UG/KG	6 UJ	31 UJ
Chloroethane	UG/KG	6 UJ	31 UJ
Chloroform	UG/KG	3 J	23 J
Chloromethane	UG/KG	6 UJ	31 UJ
Dibromochloromethane	UG/KG	6 UJ	31 UJ
Ethylbenzene	UG/KG	6 UJ	160 J
Methylene Chloride	UG/KG	15 UJ	68 UJ
Styrene	UG/KG	6 UJ	36 J
Tetrachloroethene	UG/KG	6 UJ	31 UJ
Toluene	UG/KG	6 UJ	190 J
Trichloroethene	UG/KG	6 UJ	31 UJ
Vinyl Chloride	UG/KG	6 UJ	31 UJ
Xylenes, Total	UG/KG	6 UJ	20 J
0-Xylene	UG/KG	6 UJ	20 J

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	Station	WBGSS-032	WBGSS-033	WBGss-001	WBGss-002	WBGss-003	WBGss-004	WBGss-005	WBGss-006	WBGss-007	WBGss-008
	Date Collected	8/7/96	8/6/96	7/31/96	7/31/96	7/31/96	7/30/96	7/30/96	7/30/96	7/30/04	7/30/04
	Depth	0.0 - 0.5 FT	0.0 - 2.0 FT	0.0 - 0.7 FT	0.0 - 2.0 FT						
Media: Soil											
Semi-Volatile Organics	Units										Result Qual
1,2,4-Trichlorobenzene	UG/KG										690 U
1,2-Dichlorobenzene	UG/KG										690 U
1,3-Dichlorobenzene	UG/KG										690 U
1,4-Dichlorobenzene	UG/KG										690 U
2,2'-oxybis (1-chloropropane)	UG/KG										690 11
2,4,5-Trichlorophenol	UG/KG										1700 11
2,4,6-Trichlorophenol	UG/KG										600 11
2,4-Dichtorophenol	UG/KG										600 11
2,4-Dimethylphenol	UG/KG										690 U
2,4-Dinitrophenol	UG/KG										1700 U
2-Chloronaphthalene	UG/KG										1700 U
2-Chlorophenol	UG/KG										690 0
2-Methylnaphthalene	UG/KG										0900
2-Methylphenol	UG/KG										80 J
2-Nitroaniline	UG/KG										1700 []
2-Nitrophenol	UG/KG										600 11
3,3'-Dichlorobenzidine	UG/KG										1700 11
3-Nitroaniline	UG/KG					•					1700 U
4,6-Dinitro-o-Cresol	UG/KG										1700 U
4-Bromophenyl-phenyl Ether	UG/KG										690 0
4-Chloroaniline	UG/KG										690 0
4-Chlorophenyl-phenylether	UG/KG										690 U
4-Methylphenol	UG/KG										690 0
4-Nitroaniline	UG/KG										690 U
4-Nitrophenol	UG/KG										1700 U
4-chloro-3-methylphenol	UG/KG										1700 U
Acenaphthene	UG/KG										690 U
Acenaphthylene	UG/KG										690 U
Anthracene	UG/KG										690 U
Benzo(a)anthracene	UG/KG										690 U
Benzo(a)pyrene	UG/KG										690 U
· // /·											690 U

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Table 4.17. Winklepeck Burning Grounds (continued)											
	Station	WBG ss - 009	WBGss-010	WBGss-011	WBGss-012	WBGss-013	WBGss-014	WBGss-015	WBGss-016	WBGss-017	WBGss-018
	Date Collected	8/5/96	8/5/96	8/5/96	8/5/96	8/5/96	8/8/96	8/5/96	8/6/96	8/6/96	8/6/06
	Depth	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 1.5 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 1.5 FT
Madia: Sail											
Semi-Valatile Organice	Linita										
Send- Volaçãe Organits	UIUIS										
1,2,4-Trichlorobenzene	UG/KG										
1,2-Dichlorobenzene	UG/KG										
1,3-Dichlorobenzene	UG/KG										
1,4-Dichlorobenzene	UG/KG										
2,2'-oxybis (1-chloropropane)	UG/KG										
2,4,5-Trichlorophenol	UG/KG										
2,4,6-Trichlorophenol	UG/KG										
2,4-Dichlorophenol	UG/KO										
2,4-Dimethylphenol	UG/KG					•					
2,4.Dinitrophenol	UG/KG										
2-Chloronaphthalene	UG/KG										
2-Chlorophenol	UG/KG										
2-Methylnaphthalene	UG/KG										
2-Methylphenol	UG/KG										
2-Nitroaniline	UG/KG										
2-Nitrophenol	UG/KG										
3,3'-Dichlorobenzidine	UG/KG										
3-Nitroaniline	UG/KG										
4,6-Dinitro-o-Cresol	UG/KG										
4-Bromophenyl-phenyl Ether	UG/KG										
4-Chloroaniline	UG/KG										
4-Chlorophenyl-phenylether	UG/KG										
4-Methylphenol	UG/KG										
4-Nitroaniline	UG/KG										
4-Nitrophenol	UO/KG										
4-chloro-3-methylphenol	UG/KG										
Acenaphthene	UG/KG										
Acenaphthylene	UG/KG										
Anthracene	UG/KG										
Benzo(a)anthracene	UG/KG										
Benzo(a)nvrene	UG/KG										

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			Table 4.17.	Winklepeck	Burning G	rounds (cont	inued)				
	Station	WBGss-019	WBGss-020	WBGss-021	WBGss-022	WBGss-023	WBGss-024	WBGss-025	WBGss-026	WBGss-027	WBGss-028
	Date Collected	8/6/96	8/5/96	8/5/96	8/5/96	8/5/96	8/5/96	8/5/96	8/6/96	8/6/96	8/7/96
	Depth	0.0 - 1.5 FT	0.0 - 2.0 FT	0.0 - 2.0 ET	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 0.5 FT	0.0 - 1.3 FT	0.0 - 0.5 FT	0.0 - 2.0 FT
Media: Sail											
Semi-Volatile Organics	Units			Result Qual							
1.2.4-Trichlorobenzene	UG/KG			330 U							
1,2-Dichlorobenzene	UG/KG			330 U							
1,3-Dichlorobenzene	UG/KG			330 U							
1,4-Dichlorobenzene	UG/KG			330 U							
2,2'-oxybis (1-chloropropane)	UG/KG			330 U							
2,4,5-Trichlorophenol	UG/KG			810 U							
2,4,6-Trichlorophenol	UG/KG			330 U							
2,4-Dichlorophenot	UG/KG			330 U							
2,4-Dimethylphenol	UG/KG			330 U							
2.4-Dinitrophenol	UG/KG			810 U							
2-Chloronaphthalene	UG/KG			330 U							
2-Chlorophenol	UG/KG			330 U							
2-Methyinaphthalene	UG/KG			330 U							
2-Methylphenol	UG/KG			330 U							
2-Nitroaniline	UG/KG			810 U							
2-Nitrophenol	UG/KG			330 U							
3,3'-Dichlorobenzidine	UG/KG			810 U							
3-Nitroaniline	UG/KG			810 U							
4,6-Dinitro-o-Cresol	UG/KG			330 U							
4-Bromophenvi-phenvi Ether	UG/KG			330 U							
4-Chloroaniline	UG/KG			330 U							
4-Chlorophenyl-phenylether	UG/KG			330 U							
4-Methylphenol	UG/KG			330 U							
4-Nitroaniline	UG/KG			810 U							
4-Nitrophenol	UG/KG			810 U							
4-chloro-3-methyinhenol	UG/KG			330 U							
Acenanhthene	UG/KG			330 U							
Acenaphthylene	UG/KG			330 U							
Authracene	UG/KG			330 U							i
Benzo(a)anthracene	UG/KG			330 U							
Benzo(a)nyrene	UG/KG			330 U							

			Table 4.17.	Winklepeck	: Burning Gr	counds (cont	inued)				1
	Station	WBG33-029	WBGss-030	WBGss-031	WBGss-034	WBGss-035	WBGss-036	WBGss-037	WBGss-038	WBGss-039	WBGss-040
	Date Collected Depth	8/7/96 0.0 - 2.0 FT	8/7/96 0.0 - 1.5 FT	8/7/96 0.0 - 2.0 FT	8/6/96 0.0 - 2.0 FT	7/31/96 0.0 - 2.0 FT	7/31/96 0.0 - 2.0 FT				
Media: Soll											
Semi-Volatile Organics	Units			Result Qual							
1,2,4-Trichlorobenzene	UG/KG			330 U							
1,2-Dichlorobenzene	UG/KG			330 U							
1,3-Dichlorobenzene	UG/KG			330 U							ł
1,4-Dichlorobenzene	UG/KG			330 U							
2,2'-oxybis (1-chloropropane)	UG/KG			330 U							
2,4,5-Trichlorophenol	UG/KG			800 U							
2,4,6-Trichlorophenot	UG/KG			330 U							
2,4-Dichlorophenol	UG/KG			330 U							
2,4-Dimethylphenol	UG/KG			330 U							
2.4-Dinitrophenol	UG/KG			800 U							
2-Chloronaphthalene	UG/KG			330 U							
2-Chlorophenol	UG/KG			330 U							
2-Methylnaphthalene	UG/KG			330 U							
2-Methylphenol	UG/KG			330 U							
2-Nitroaniline	UG/KG			800 U							
2-Nitrophenol	UG/KG			330 U							Į
3,3'-Dichlorobenzidine	UG/KG			800 U							
3-Nitroaniline	UG/KG			800 U							
4,6-Dinitro-o-Cresol	UG/KG			330 U							
4-Bromophenyl-phenyl Ether	UG/KG			330 U							
4-Chloroaniline	UG/KG			330 U							
4-Chlorophenyl-phenylether	UG/KG			330 U							
4-Methylphenol	UG/KG			330 U							
4-Nitroaniline	UG/KG			800 U							
4-Nitrophenol	UG/KG			800 U							
4-chloro-3-methylphenol	UG/KG			330 U							
Acenaphthene	UG/KG			330 U							
Acenaphthylene	UG/KG			330 U							
Anthracene	UG/KG			330 U							
Benzo(a)anthracene	UG/KG			330 U							
Benzo(a)pyrene	UG/KG			330 U							

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	Station	WBGss-041	WBGss-042	WBGss-043	WBGss-044	WBGss-045	WBGss-046	WBGss-047	WBGss-048	WBGss-049	WBGss-050
	Date Collected	7/31/96	8/7/96	8/7/96	8/7/96	8/7/96	8/7/96	8/7/96	8/7/96	8/7/96	9/7/04
	Depth	0.0 - 0.5 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 1.0 FT	0.0 - 2.0 FT	0.0 - 1.0 FT			
Media: Soil											
Semi-Volatile Organics	Units										
1,2,4-Trichlorobenzene	UG/KG										
1,2-Dichlorobenzene	UG/KG										
1,3-Dichlorobenzene	UG/KG										
1,4-Dichlorobenzene	UG/KG										
2,2'-oxybis (1-chloropropane)	UG/KG										
2,4,5-Trichlorophenol	UG/KG										
2,4,6-Trichlorophenol	UG/KG										
2,4-Dichlorophenol	UG/KG										
2,4-Dimethylphenol	UG/KG										
2,4-Dinitrophenol	UG/KG										
2-Chloronaphthalene	UG/KG										
2-Chlorophenol	UG/KG										
2-Methylnaphthalene	UG/KG										
2-Methylphenol	UG/KG										
2-Nitroaniline	UG/KG										
2-Nitrophenol	UG/KG										
3,3'-Dichlorobenzidine	UG/KG										
3-Nitroaniline	UG/KG										
4,6-Dinitro-o-Cresol	UG/KG										
4-Bromophenyl-phenyl Ether	UG/KG										
4-Chloroaniline	UG/KG										
4-Chlorophenyl-phenylether	UG/KG										
4-Methylphenol	UG/KG										
4-Nitroaniline	UG/KG										
4-Nitrophenol	UG/KG										
4-chloro-3-methylphenol	UG/KG										
Acenaphthene	UG/KG										
Acenaphthylene	UG/KG										
Anthracene	UG/KG										
Benzo(a)anthracene	UG/KG										
Benzo(a)pyrene	UG/KG										

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			Laule 4.1/.	winkiepeck	a burning G	rounas (con	tinuea)				
	Station	WBGss-051	WBGss-052	WBGss-053	WBGss-054	WBGss-055	WBGss-056	WBGss-057	WBGss-058	WBGss-059	WBGss-060
	Date Collected	8/8/96	8/7/96	8/13/96	8/8/96	8/8/96	8/8/96	8/7/96	8/7/96	8/8/96	8/8/96
	Depth	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 0.5 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 1.4 FT	0.0 - 1.0 FT	0.0 - 2.0 FT
Media: Soil											
Semi-Volatile Organics	Units	Result Qual									
1,2,4-Trichlorobenzene	UG/KG	340 U									
1,2-Dichlorobenzene	UG/KG	340 U									
1,3-Dichlorobenzene	UG/KG	340 U									
1,4-Dichlorobenzene	UG/KG	340 U									
2,2'-oxybis (1-chloropropane)	UG/KG	340 U									
2,4,5-Trichlorophenol	UG/KG	830 U									
2,4,6-Trichlorophenol	UG/KG	340 U									
2,4-Dichlorophenol	UG/KG	340 U									
2,4-Dimethylphenol	UG/KG	340 U									
2,4-Dinitrophenol	UG/KG	830 U									
2-Chloronaphthalene	UG/KG	340 U									
2-Chlorophenol	UG/KG	340 U									
2-Methylnaphthalene	UG/KG	340 U									
2-Methylphenol	UG/KG	340 U									
2-Nitroaniline	UG/KG	830 U									
2-Nitrophenol	UG/KG	340 U									
3,3'-Dichlorobenzidine	UG/KG	830 U									
3-Nitroaniline	UG/KG	830 U									
4,6-Dinitro-o-Cresol	UG/KG	340 U									
4-Bromophenyl-phenyl Ether	UG/KG	340 U									
4-Chloroaniline	UG/KG	340 U									
4-Chlorophenyl-phenylether	UG/KG	340 U									
4-Methylphenol	UG/KG	340 U									
4-Nitroaniline	UG/KG	830 U									
4-Nitrophenol	UG/KG	830 U									
4-chloro-3-methylphenol	UG/KG	340 U									
Acenaphthene	UG/KG	340 U									
Acenaphthylene	UG/KG	340 U									
Anthracene	UG/KG	340 U									
Benzo(a)anthracene	UG/KG	340 U						-			

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	Station	WBGss-061	WBGss-062	WBGss-063	WBGss-064	WBGss-065	WBGss-066	WBGss-067	WBGss-068	WBGss-069	WBGss-070
	Date Collected	8/8/96	8/8/96	8/7/96	8/7/96	8/9/96	8/9/96	8/9/96	8/9/96	8/9/96	8/9/96
	Debty	v.v - 2.v f l	u.u - 4.u f i	U.U - 4.U I <u>'</u> I	0.0 - 2.V F I	0.0 ~ 2.0 f f	U.U - 2.U F 1	U.U - Z.U F L	U.U - 2.0 F I	0.0 - 2.0 FT	0.0 - 2.0 FT
Media: Soil											
Semi-Volatile Organics	Units						Result Qual				
1,2,4-Trichlorobenzene	U G/KG						340 U				
1,2-Dichlorobenzene	UG/KG						340 U				
1,3-Dichlorobenzene	UG/KG						340 U				
1,4-Dichlorobenzene	UG/KG						340 U				
2,2'-oxybis (1-chloropropane)	UG/KG						340 U				
2,4,5-Trichlorophenol	UG/KG						830 U				
2,4,6-Trichlorophenol	UG/KG						340 U				
2,4-Dichlorophenol	UG/KG						340 U				
2,4-Dimethylphenol	UG/KG						340 U				
2,4-Dinitrophenol	UG/KG						830 UJ				
2-Chloronaphthalene	UG/KG						340 U				
2-Chlorophenol	UG/KG						340 U	•			
2-Methylnaphthalene	UG/KG						340 U				
2-Methylphenol	UG/KG						340 U				
2-Nitroaniline	UG/KG						830 U				
2-Nitrophenol	UG/KG						340 U				
3.3'-Dichlorobenzidine	UG/KG						830 U				
3-Nitroaniline	UG/KG						830 U				
4.6-Dinitro-o-Cresol	UG/KG						340 U				
4-Bromophenyl-phenyl Ether	UG/KG						340 U				
4-Chloroaniline	UG/KG						340 U				
4-Chlorophenyl-phenylether	UG/KG						340 U				
4-Methylphenol	UG/KG						340 U				
4-Nitroaniline	UG/KG						830 U				
4-Nitrophenol	UG/KG						830 U				
4-chloro-3-methylphenol	UG/KG						340 U				
Acenaphthene	UG/KG						340 U				
Acenaphthylene	UG/KG						340 U				
Anthracene	UG/KG						340 U				
Benzo(a)anthracene	UG/KG						340 U				
Benzo(a)nyrene	UG/KG						340 U				
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RVAAP Phase I Remedial Investigation

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			Table 4.17.	Winklepeck	Burning Gr	ounds (cont	inued)				
	Station	WBGss-071	WBGss-072	WBGss-073	WBGss-074	WBGss-075	WBGss-076	WBGss-077	WBGss-097	WBGss-098	WBGss-00
	Date Collected Depth	8/9/96 0.0 - 1.0 FT	8/9/96 0.0 - 2.0 FT	8/9/96 0.0 - 2.0 FT	8/9/96 0.0 - 0.5 FT	8/9/96 0.0 - 2.0 FT	8/9/96 0.0 - 2.0 FT	8/13/96 0.0 - 0.8 FT	8/13/96 0.0 - 2.0 FT	8/14/96 0.0 - 2.0 FT	8/13/96 0.0 - 0.6 FT
Media: Soil											
Semi-Volatile Organics	Units		Result Qual				Result Qual				
1,2,4-Trichlorobenzene	UG/KG		340 U				330 U				
1,2-Dichlorobenzene	UG/KG		340 U				330 U				
1,3-Dichlorobenzene	UG/KG		340 U				330 U				
1,4-Dichlorobenzene	UG/KG		340 U				330 U				
2,2'-oxybis (1-chloropropane)	UG/KG		340 U				330 U				
2,4,5-Trichlorophenol	UG/KG		820 U				800 U				
2,4,6-Trichlorophenol	UG/KG		340 U				330 U				
2,4-Dichlorophenol	UG/KG		340 U				330 U				
2,4-Dimethylphenol	UG/KG		340 U				330 U				
2,4-Dinitrophenol	UG/KG		820 UJ				800 111				
2-Chloronaphthalene	UG/KG		340 U				330 11				
2-Chlorophenol	UG/KG		340 U				330 U				
2-Methylnaphthalene	UG/KG		340 U				330 11				
2-Methylphenol	UG/KG		340 U				330 11				
2-Nitroaniline	UG/KG		820 U				800 11				
2-Nitrophenol	UG/KG		340 U				330 U				
3,3'-Dichlorobenzidine	UG/KG		820 U				800 U				
3-Nitroaniline	UG/KG		820 U				800 U				
4,6-Dinitro-o-Cresol	UG/KG		340 U				330 U				
4-Bromophenyl-phenyl Ether	UG/KG		340 U				330 U				
4-Chloroaniline	UG/KG		340 U				330 U				
4-Chlorophenyl-phenylether	UG/KG		340 U				330 U				
4-Methylphenol	UG/KG		340 U				330 U				
4-Nitroaniline	UG/KG		820 U				800 U				
4-Nitrophenol	UG/KG		820 U				800 11				
4-chloro-3-methylphenol	UG/KG		340 U				330 11				
Acenaphthene	UG/KG		340 U				330 U	· · ·			
Acenaphthylene	UG/KG		340 U				330 11				
Anthracene	UG/KG		340 U				330 11				
Benzo(a)anthracene	UG/KG		340 U				330 0				
Benzo(a)nyrene	UG/KG		340 U				220 U				

RVAAP Phase I Remedial Investigation

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Station	WBGss-030	WBGss-057
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Date Collected	8/13/96	8/13/96
Depth	0.0 - 1.5 FT	1.5 - 2.0 FT

Media: Soil

Semi-Volatile Organics	Units
1,2,4-Trichlorobenzene	UG/KG
1,2-Dichlorobenzene	UG/KG
1,3-Dichlorobenzene	UG/KG
1,4-Dichlorobenzene	UG/KG
2,2'-oxybis (1-chloropropane)	UG/KG
2,4,5-Trichlorophenol	UG/KG
2,4,6-Trichlorophenol	UG/KG
2,4-Dichlorophenol	UG/KG
2,4-Dimethylphenol	UG/KG
2,4-Dinitrophenol	UG/KG
2-Chloronaphthalene	UG/KG
2-Chlorophenol	UG/KG
2-Methylnaphthalene	UG/KG
2-Methylphenol	UG/KG
2-Nitroaniline	UG/KG
2-Nitrophenol	UG/KG
3,3'-Dichlorobenzidine	UG/KG
3-Nitroaniline	UG/KG
4,6-Dinitro-o-Cresol	UG/KG
4-Bromophenyl-phenyl Ether	UG/KG
4-Chloroaniline	UG/KG
4-Chlorophenyl-phenylether	UG/KG
4-Methylphenol	UG/KG
4-Nitroaniline	UG/KG
4-Nitrophenol	UG/KG
4-chloro-3-methylphenol	UG/KG
Acenaphthene	UG/KG
Acenaphthylene	UG/KG
Anthracene	UG/KG
Benzo(a)anthracene	UG/KG
Benzo(a)pyrene	UG/KG

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	Station	WBGSS-032	WBGSS-033	WBG55-001	WBG88-002	WBGss-003	WBGss-004	WBGss-005	WBGss-006	WBGss-007	WBGss-008
	Date Collected	8/7/96	8/6/96	7/31/96	7/31/96	7/31/96	7/30/96	7/30/96	7/30/96	7/30/96	7/30/96
	Depth	0.0 - 0.5 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 0.7 FT	0.0 - 2.0 FT			
Media: Soil											
Semi-Volatile Organics	Units										Result Qual
Benzo(b)fluoranthene	UG/KG										690 U
Benzo(g,h,i)perylene	UG/KG										690 U
Benzo(k)fluoranthene	UG/KG										690 U
Bis(2-chloroethoxy)methane	UG/KG										690 U
Bis(2-chloroethyl)ether	UG/KG										690 U
Bis(2-ethylhexyl)phthalate	UG/KG										690 U
Butyl Benzyl Phthalate	UG/KG										690 U
Carbazole	UG/KG										690 U
Chrysene	UG/KG										690 U
Di-n-butyl Phthalate	UG/KG										690 U
Di-n-octyl Phthalate	UG/KG										690 U
Dibenzo(a,h)anthracene	UO/KG										690 U
Dibenzofuran	UG/KG										690 11
Diethyl Phthalate	UG/KG										690 U
Dimethyl Phthalate	UG/KG										690 11
Fluoranthene	UG/KG										11 069
Fluorene	UG/KG										690 U
Hexachlorobenzene	UG/KG										690 11
Hexachlorobutadiene	UG/KG										690 U
Hexachlorocyclopentadiene	UG/KG										690 11
Hexachloroethane	UG/KG										690 11
Indeno(1,2,3-cd)pyrene	UG/KG										690 11
Isophorone	UG/KG										690 U
N-Nitroso-di-n-propylamine	UG/KG										690 U
N-Nitrosodiphenylamine	UG/KG								·		690 11
Naphthalene	UG/KG										76 1
Pentachlorophenol	UG/KG										1700 11
Phenanthrene	UG/KG										70.1
Phenol	UG/KG										70 J 400 U
Pyrene	UG/KG										690 11
											090 0

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	Station	WBG ss - 009	WBGss-010	WBGss-011	WBG35-012	WBGss-013	WBGss-014	WBGss-015	WBGss-016	WBGss-017	WBGss-018
	Date Collected	8/5/96	8/5/96	8/5/96	8/5/96	8/5/96	8/8/96	8/5/96	8/6/96	8/6/96	8/6/96
	Depth	0.0 - 2.0 FT	0.0 - 2 .0 FT	0.0 - 2.0 FT .	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 1.5 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 1.5 FT
Media: Sail											
Semi-Volatile Organics	Units										
Benzo(b)fluoranthene	UG/KG										
Benzo(g,h,i)pervlene	UG/KG										
Benzo(k)fluoranthene	UG/KG										
Bis(2-chloroethoxy)methane	UG/KG										
Bis(2-chloroethyl)ether	UG/KG										
Bis(2-ethylhexyl)phthalate	UG/KG										
Butyl Benzyl Phthalate	UG/KG										
Carbazole	UG/KG										
Chrysene	UG/KG										
Di-n-butyl Phthalate	UG/KG										
Di-n-octyl Phthalate	UG/KG										
Dibenzo(a,h)anthracene	UG/KG										
Dibenzofuran	UG/KG										
Diethyl Phthalate	UG/KG										
Dimethyl Phthalate	UG/KG										
Fluoranthene	UG/KG										
Fluorene	UG/KG										
Hexachlorobenzene	UG/KG										
Hexachlorobutadiene	UG/KG										
Hexachlorocyclopentadiene	UG/KG										
Hexachloroethane	UG/KG										
Indeno(1,2,3-cd)pyrene	UG/KG										
Isophorone	UG/KG										
N-Nitroso-di-n-propylamine	UG/KG										
N-Nitrosodiphenylamine	UG/KG										
Naphthalene	UG/KG										
Pentachlorophenol	UG/KG										
Phenanthrene	UG/KG										
Phenol	UG/KG										
Pyrene	UG/KG										

			Table 4.17.	Winklepeck	Burning G	rounds (cont	inued)				
	Station	WBGss-019	WBGss-020	WBGss-021	WBGss-022	WBG85-023	WBGss-024	WBGss-025	WBGss-026	WBGss-027	WBGss-028
	Date Collected Depth	8/6/96 0.0 - 1.5 FT	8/5/96 0.0 - 2.0 FT	8/5/96 0.0 - 0.5 FT	8/6/96 0.0 - 1.3 FT	8/6/96 0.0 - 0.5 FT	8/7/96 0.0 - 2.0 FT				
Media: Soil	T F 4.										
Semi-Volatile Organics	Units			Result Qual							
Benzo(b)fluoranthene	UG/KG			330 U							
Benzo(g,h,i)perylene	UG/KG			330 U							
Benzo(k)fluoranthene	UG/KG			330 U							
Bis(2-chloroethoxy)methane	UG/KG			330 U							
Bis(2-chloroethyl)ether	UG/KG			330 U							
Bis(2-ethylhexyl)phthalate	UG/KG			330 U							
Butyl Benzyl Phthalate	UG/KG			330 U							
Carbazole	UG/KG			330 U							
Chrysene	UG/KG			330 U							
Di-n-butyl Phthalate	UG/KG			330 U							
Di-n-octyl Phthalate	UG/KG			330 U							
Dibenzo(a,h)anthracene	UG/KG			330 U							
Dibenzofuran	UG/KG			330 U							
Diethyl Phthalate	UG/KG			330 U							
Dimethyl Phthalate	UG/KG			330 U							
Fluoranthene	UG/KG			330 U							
Fluorene	UG/KG			330 U							
Hexachlorobenzene	UG/KG			330 U							
Hexachlorobutadiene	UG/KG			330 U							
Hexachlorocyclopentadiene	UG/KG			330 U							
Hexachloroethane	UG/KG			330 U							
Indeno(1,2,3-cd)pyrene	UG/KG			330 U							
Isophorone	UG/KG			330 U							
N-Nitroso-di-n-propylamine	UG/KG			330 U							
N-Nitrosodiphenylamine	UG/KG			330 U							
Naphthalene	UG/KG			330 U							
Pentachlorophenol	UG/KG			810 U							
Phenanthrene	UG/KG			330 U							
Phenol	UG/KG			330 U							
Pyrene	UG/KG			330 U							

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			Table 4.17.	Winklepeck	Burning G	ounds (cont	inued)				
	Station	WBGss-029	WBGss-030	WBGss-031	WBGss-034	WBGss-035	WBGss-036	WBGss-037	WBGss-038	WBGss-039	WBGss-040
	Date Collected Depth	8/7/96 0.0 - 2.0 FT	8/7/96 0.0 - 1.5 FT	8/7/96 0.0 - 2.0 FT	8/6/96 0.0 - 2.0 FT	7/31/96 0.0 - 2.0 FT	7/31/96 0.0 - 2.0 FT				
Media: Soil											
Semi-Volatile Organics	Units			Result Qual							
Benzo(b)fluoranthene	UG/KG			330 U							
Benzo(g,h,i)perylene	UG/KG			330 U							
Benzo(k)fluoranthene	UG/KG			330 U							
Bis(2-chloroethoxy)methane	UG/KG			330 U							
Bis(2-chloroethyl)ether	UG/KG			330 U							
Bis(2-ethylhexyl)phthalate	UG/KG			34 J							
Butyl Benzyl Phthalate	UG/KG			330 U							
Carbazole	UG/KG			330 U							
Chrysene	UG/KG			330 U							
Di-n-butyl Phthalate	UG/KG			53 J							
Di-n-octyl Phthalate	UG/KG			330 U							
Dibenzo(a,h)anthracene	UG/KG			330 U							
Dibenzofuran	UG/KG			330 U							
Diethyl Phthalate	UG/KG			330 U							
Dimethyl Phthalate	UG/KG			330 U							
Fluoranthene	UG/KG			330 U							
Fluorene	UG/KG			330 U							
Hexachtorobenzene	UG/KG			330 U							
Hexachlorobutadiene	UG/KG			330 U							
Hexachlorocyclopentadiene	UG/KG			330 UJ							
Hexachloroethane	UG/KG			330 U							
Indeno(1,2,3-cd)pyrene	UG/KG			330 U							
Isophorone	UG/KG			330 U							
N-Nitroso-di-n-propylamine	UG/KG			330 U							
N-Nitrosodiphenylamine	UG/KG			330 U							
Naphthalene	UG/KG			330 U							
Pentachiorophenoi	UG/KG			800 U							
Phenanthrene	UG/KG			330 U							
Phenol	UG/KG			330 U							
Pyrene	UG/KG			330 U							
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			Table 4.17.	Winklepeck	Burning G	rounds (cont	tinued)				
	Station	WBGss-041	WBGss-042	WBGss-043	WBGss-044	WBGss-045	WBGss-046	WBGss-047	WBGss-048	WBGss-049	WBGss-050
	Date Collected Depth	7/31/96 0.0 - 0.5 FT	8/7/96 0.0 - 2.0 FT	8/7/96 0.0 - 2.0 FT	8/7/96 0.0 - 2.0 FT	8/7/96 0.0 - 1.0 FT	8/7/96 0.0 - 2.0 FT	8/7/96 0.0 - 1.0 FT			
Media: Soil											
Semi-Volatile Organics	Units										
Benzo(b)fluoranthene	UG/KG										
Benzo(g,h,i)perylene	UG/KG										
Benzo(k)fluoranthene	UG/KG										
Bis(2-chloroethoxy)methane	UG/KG										
Bis(2-chloroethyl)ether	UG/KG										
Bis(2-ethylhexyl)phthalate	UG/KG										
Butyl Benzyl Phthalate	UG/KG										
Carbazole	UG/KG										
Chrysene	UG/KG										
Di-n-butyl Phthalate	UO/KG										
Di-n-octyl Phthalate	UG/KG										
Dibenzo(a,h)anthracene	UG/KG										
Dibenzofuran	UG/KG										
Dicthyl Phthalate	UG/KG										
Dimethyl Phthalate	UG/KG										
Fluoranthene	UG/KG										
Fluorene	UG/KG										
Hexachlorobenzene	UG/KG										
Hexachlorobutadiene	UG/KG										
Hexachlorocyclopentadiene	UG/KG										
Hexachloroethane	UG/KG										
Indeno(1,2,3-cd)pyrene	UG/KG										
Isophorone	UG/KG										
N-Nitroso-di-n-propylamine	UG/KG										
N-Nitrosodiphenylamine	UG/KG										
Naphthalene	UG/KG										
Pentachiorophenol	UG/KG										
Phenanthrene	UG/KG										
Phenol	UG/KG										
Pyrene	UG/KG										
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	Station	WBGss-051	WBGss-052	WBGss-053	WBGss-054	WBGss-055	WBGss-056	WBGss-057	WBGss-058	WBGss-059	WBGss-060
	Date Collected	8/8/96	8/7/96	8/13/96	8/8/96	8/8/96	8/8/96	8/7/96	8/7/96	8/8/96	8/8/96
	Depth	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 0.5 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 1.4 FT	0.0 - 1.0 FT	0.0 - 2.0 FT
Media: Soil											
Semi-Volatile Organics	Units	Result Qual									
Benzo(b)fluoranthene	UG/KG	340 U									
Benzo(g,h,i)perylene	UG/KG	340 U									
Benzo(k)fluoranthene	UG/KG	340 U									
Bis(2-chloroethoxy)methane	UG/KG	340 U									
Bis(2-chloroethyl)ether	UG/KG	340 U									
Bis(2-ethylhexyl)phthalate	UG/KG	340 U									
Butyl Benzyl Phthalate	UG/KG	340 U									
Carbazole	UG/KG	340 U									
Chrysene	UG/KG	340 U									
Di-n-butyl Phthalate	UG/KG	340 U									
Di-n-octyl Phthalate	UG/KO	340 U									
Dibenzo(a,h)anthracene	UG/KG	340 U									
Dibenzofuran	UG/KG	340 U									
Diethyl Phthalate	UG/KG	340 U									
Dimethyl Phthalate	UG/KG	340 U									
Fluoranthene	UG/KG	340 U									
Fluorene	UG/KG	340 U									
Hexachlorobenzene	UG/KG	340 U									
Hexachlorobutadiene	UG/KG	340 U									
Hexachlorocyclopentadiene	UG/KG	340 U									
Hexachloroethane	UG/KG	340 U									
Indeno(1,2,3-cd)pyrene	UG/KG	340 U									
Isophorone	UG/KG	340 U									
N-Nitroso-di-n-propylamine	UG/KG	340 U									
N-Nitrosodiphenylamine	UG/KG	340 U							-		
Naphthalene	UG/KG	340 U									
Pentachlorophenol	UG/KG	830 U									
Phenanthrene	UG/KG	340 U									
Phenol	UG/KG	340 U									
Pyrene	UG/KG	340 U									

			Table 4.17.	Winklepeck	Burning Gi	ounds (cont	inued)					
	Station	WBGss-061	WBGss-062	WBGss-063	WBGss-064	WBGss-065	WBGss-066	WBGss-067	WBGss-068	WBGss-069	WBGss-070	
	Date Collected Depth	8/8/96 0.0 - 2.0 FT	8/8/96 0.0 - 2.0 FT	8/7/96 0.0 - 2.0 FT	8/7/96 0.0 - 2.0 FT	8/9/96 0.0 - 2.0 FT						
Media: Soil Semi-Volatile Organics	Units						Result Qual					
Benzo(b)fluoranthene	UG/KG						340 U					
Benzo(g,h,i)perylene	UG/KG						340 U					
Benzo(k)fluoranthene	UG/KG						340 U					
Bis(2-chloroethoxy)methane	UG/KG						340 U					
Bis(2-chloroethyl)ether	UG/KG						340 U					
Bis(2-ethylhexyl)phthalate	UG/KG						340 U					
Butyl Benzyi Phthalate	UG/KG						340 U					
Carbazole	UG/KG						340 U					
Chrysene	UG/KG						340 U					
Di-n-butyl Phthalate	UG/KG						340 U					1
Di-n-octyl Phthalate	UG/KG						340 U					
Dibenzo(a,h)anthracene	UG/KG						340 U					
Dibenzofuran	UG/KG						340 U					
Diethyl Phthalate	UG/KG						340 U					
Dimethyl Phthalate	UG/KG						340 U					ŀ
Fluoranthene	UG/KG						40 J					ľ
Fluorene	UG/KG						340 U					
Hexachlorobenzene	UG/KG						340 U					
Hexachlorobutadiene	UG/KG						340 U					
Hexachlorocyclopentadiene	UG/KG						340 UJ					
Hexachloroethane	UG/KG						340 U					
Indeno(1,2,3-cd)pyrene	UG/KG						340 U					
Isophorone	UG/KG						340 U					
N-Nitroso-di-n-propylamine	UG/KG						340 U					
N-Nitrosodiphenylamine	UG/KG						340 U					
Naphthalene	UG/KG						340 U					
Pentachlorophenol	UG/KG						830 U					1
Phenanthrene	UG/KG						340 U					
Phenol	UG/KG						340 U					1
Pyrene	UG/KG						36 J					

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	Station	WBGss-071	WBGss-072	WBGss-073	WBGss-074	WBGss-075	WBGss-076	WBGss-077	WBGss-097	WBGss-098	WBGss-004
	Date Collected	8/9/96	8/9/96	8/9/96	8/9/96	8/9/96	8/9/96	8/13/96	8/13/96	8/14/96	8/13/96
	Depth	0.0 - 1.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 0.5 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 0.8 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 0.6 FT
Medla: Soil											
Semi-Volatile Organics	Units		Result Qual				Result Quai				
Benzo(b)fluoranthene	UG/KG		340 U				330 U				1
Benzo(g,h,i)perylene	UG/KG		340 U				330 U				
Benzo(k)fluoranthene	UG/KG		340 U				330 U				:
Bis(2-chloroethoxy)methane	UG/KG		340 U				330 U				
Bis(2-chloroethyl)ether	UG/KG		340 U				330 U				
Bis(2-ethylhexyl)phthalate	UG/KG		340 U				330 U				
Butyl Benzyl Phthalate	UG/KG		340 U				330 U				
Carbazole	UG/KG		340 U				330 U				
Chrysene	UG/KG		340 U				330 U				
Di-n-butyl Phthalate	UG/KG		340 U				330 U				
Di-n-octyl Phthalate	UG/KG		340 U				330 U				
Dibenzo(a,h)anthracene	UG/KG		340 U				330 U				
Dibenzofuran	UG/KG		340 U				330 U				
Diethyl Phthalate	UG/KG		340 U				330 U				
Dimethyl Phthalate	UG/KG		340 U				330 U				
Fluoranthene	UG/KG		340 U				330 U				
Fluorene	UG/KG		340 U				330 U				
Hexachlorobenzene	UG/KG		340 U				330 U				
Hexachlorobutadiene	UG/KG		340 U				330 U				
Hexachlorocyclopentadiene	UG/KG		340 UJ				330 UJ				
Hexachloroethane	UG/KO		340 U				330 U				
Indeno(1,2,3-cd)pyrene	UG/KG		340 U				330 U				
Isophorone	UG/KG		340 U				330 U				
N-Nitroso-di-n-propylamine	UG/KG		340 U				330 U				
N-Nitrosodiphenylamine	UG/KG		340 U				330 U				
Naphthalene	UG/KG		340 U				330 U				
Pentachlorophenol	UG/KG		820 U				800 U				
Phenanthrene	UG/KG		340 U				330 U				
Phenol	UG/KG		340 U				330 U				
Pyrene	UG/KG		340 U				330 U				

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	Station	WBGss-030	WBGss-057
	Date Collected Depth	8/13/96 0.0 - 1.5 FT	8/13/96 1.5 - 2.0 FT
Media: Soil			
Semi-Volatile Organics	Units		
Benzo(b)fluoranthene	UG/KG		
Benzo(g,h,i)perylene	UG/KG		
Benzo(k)fluoranthene	UG/KG		
Bis(2-chloroethoxy)methane	UG/KG		
Bis(2-chloroethyl)ether	UG/KG		
Bis(2-ethylhexyl)phthalate	UG/KG		
Butyl Benzyl Phthalate	UG/KG		
Carbazole	UG/KG		
Chrysene	UG/KG		
Di-n-butyl Phthalate	UG/KG		
Di-n-octyl Phthalate	UG/KG		
Dibenzo(a,h)anthracene	UG/KG		
Dibenzofuran	UG/KG		
Diethyl Phthalate	UG/KG		
Dimethyl Phthalate	UG/KG		
Fluoranthene	UG/KG		
Fluorene	UG/KG		
Hexachlorobenzene	UG/KG		
Hexachlorobutadiene	UG/KG		
Hexachlorocyclopentadiene	UG/KG		
Hexachloroethane	UG/KG		
Indeno(1,2,3-cd)pyrene	UG/KG		
Isophorone	UG/KG		
N-Nitroso-di-n-propylamine	UG/KG		
N-Nitrosodiphenylamine	UG/KG		
Naphthalene	UG/KG		
Pentachlorophenol	UG/KG		
Phenanthrene	UG/KG		
Phenol	UG/KG		
Pyrene	UG/KG		

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	Station	WBGSS-032	WBGSS-033	WBGss-001	WBGss-002	WBGss-003	WBGss-004	WBGss-005	WBGss-006	WBGss-007	WBGss-008
	Date Collected	8/7/96	8/6/96	7/31/96	7/31/96	7/31/96	7/30/96	7/30/96	7/30/96	7/30/96	7/30/96
	Depth	0.0 - 0.5 FT	0.0 - 2.0 FT	0.0 - 0.7 FT	0.0 - 2.0 FT						
Media: Soil											
Pesticides and/or PCBs	Units										Result Qual
4,4'-DDD	UG/KG										2.6 UJ
4,4'-DDE	UG/KG										2.6 U
4,4'-DDT	UG/KG										2.6 UJ
Aldrin	UG/KG										1.4 U
Alpha Chlordane	UG/KG										1.4 U
Alpha-BHC	UG/KG										1.4 U
Aroctor-1016	UG/KG										34 U
Aroclor-1221	UG/KG										34 11
Aroclor-1232	UG/KG										34 []
Aroclor-1242	UG/KG										34 []
Aroclor-1248	UG/KG										34 11
Arocior-1254	UG/KG										70 U
Aroclor-1260	UG/KG										70 11
Beta-BHC	UG/KG										1411
Delta-BHC	UG/KG										1411
Dieldrin	UG/KG										260
Endosulfan I	UG/KG										1411
Endosulfan II	UG/KG										2611
Endosulfan Sulfate	UG/KG										2.6 U
Endrin	UG/KG										2611
Endrin Aldehyde	UG/KG										2.6 0
Endrin Ketone	UG/KG										2.6 0
Gamma Chlordane	UG/KG										1411
Gamma-BHC (Lindane)	UG/KG										141
Heptachlor	UG/KG										1411
Heptachlor Epoxide	UG/KG										141
Methoxychlor	UG/KG										14 111
Toxaphene	UG/KG										86 U

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			Table 4.17	7. Winklepe	eck Burning	Grounds (c	ontinued)				
	Station	WBGss- 009	WBGss-010	WBGss-011	WBGss-012	WBGss-013	WBGss-014	WBGss-015	WBGss-016	WBGss-017	WBGss-018
	Date Collected	8/5/96	8/5/96	8/5/96	8/5/96	8/5/96	8/8/96	8/5/96	8/6/96	8/6/96	8/6/96
	Depth 0.0) - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 1.5 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 1.5 FT
Media: Soli	T714-										
resticides and/or PUBS	Units										
4,4'-DDD	UG/KG										
4,4'-DDE	UG/KG										
4,4'-DDT	UG/KG										
Aldrin	UG/KG										
Alpha Chlordane	UG/KG										
Alpha-BHC	UG/KG										
Aroclor-1016	UG/KG										
Aroclor-1221	UG/KG										
Aroclor-1232	UG/KG										
Aroctor-1242	UG/KG										
Aroclor-1248	UG/KG										
Aroclor-1254	UG/KG										
Aroclor-1260	UG/KG										
Beta-BHC	UG/KG										
Delta-BHC	UG/KG										
Dieldrin	UG/KG										
Endosulfan I	UG/KG										
Endosulfan II	UG/KG										
Endosulfan Sulfate	UG/KG										
Endrin	UG/KO										
Endrin Aldehyde	UG/KG										
Endrin Ketone	UG/KG										
Gamma Chlordane	UG/KG										
Gamma-BHC (Lindane)	UG/KG										
Heptachlor	UG/KG										
Heptachlor Epoxide	UG/KG										
Methoxychlor	UG/KG										
Toxaphene	UG/KG										

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			.71.4 əldaT	Winklepeck	19 guinnud	uoo) spuno.	(pənuj				
	noitat2	47BCss-019	WBC33-020	WBG23-021	/ABC222-033	WBC32-023	WBC33-024	VBC55-025	/ABC228-056	20-5598A	870-ss:Daw
	Date Collected Depth	96/9/8 TH 2.1 - 0.0	96/ 3/8 1.1 0.2 - 0.0	0.0 - 2.0 FT TJ 0.2 - 0.0	LH 0'7 - 9'0 LH 0'7 - 9'0	0.0 - 2.96 8/5/96	LH 0'7 - 0'0 1 - 3'96	96/S/8 T3 2.0 - 0.0	96/9/8 E.1 - 0.0	96/9/8 T¥ 2.0 - 0.0	0.0 - 2.0 FT 8/7/96
Media: Soil Pesticides and/or PCBs	Units			Result Qual							
4'4-DDD	∩G\KG			101 S 72							
4'4-DDE	NG/KG			0 S.S							
4,4'-DDT	NG/KG			10 2.5 UJ							
ninblA	NG/KG			U £.1							
Alpha Chlordane	DG/KG			U £.1							
Alpha-BHC	O C \KG			U £.1							
Aroclor-1016	Ω Θ\ ΚΘ			U 88							
Aroclor-1221	D3/DA			U EE							
Aroclor-1232	DØ/KG			U 88							
Aroclor-1242	DO/KG			U 88							
Aroclor-1248	DG/KG			33 N							
Aroclor-1254	£00,KG			П 8 9							
Aroclot-1260	DB/KG			Ω 89							
Beta-BHC	ne/kg			U E.I							
Delta-BHC	DG/KG			U E.I							
Dieldrin	DB/KG			0 S.S							
Endosulfan I	∩ G\K G			U E.I							
ll nsilusobn 3	DG/KG			2°2 N							
Endosulfan Sulfate	DO/KG			3 ,5 U							
Endrin	DG/KG			U 2.5							
Endrin Aldehyde	∩0\KC			0 S.S							
Endrin Ketone	ΟΘ/ΚΟ			0 S Z							
Gamma Chlordane	DQ/KG			U 8.1							
Gamma-BHC (Lindane)	DQ/KG			Ω £'1							
Heptachlor	00,KG			U E.I							
Heptachlor Epoxide	00/80			U E.I							
Viethoxychlor	00/KG			13 01							
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	Station	WBGss-029	WBGss-030	WBGss-031	WBGss-034	WBGss-035	WBGss-036	WBGss-037	WBGss-038	WBGss-039	WBGss-040
	Date Collected Depth	8/7/96 0.0 - 2.0 FT	8/7/96 0.0 - 1.5 FT	8/7/96 0.0 - 2.0 FT	8/6/96 0.0 - 2.0 FT	8/6/96 0.0 - 2.0 FT	8/6/96 0.0 - 2.0 FT	8/6/96 0.0 - 2.0 FT	8/6/96 0.0 - 2.0 FT	7/31/96 0.0 - 2.0 FT	7/31/96 0.0 - 2.0 FT
Media: Soil											
Pesticides and/or PCBs	Units			Result Qual							
4,4'-DDD	UG/KG			2.5 U							
4,4'-DDE	UG/KG			2.5 U							
4,4'-DDT	UG/KG			2.5 UJ							
Aldrin	UG/KG			1.3 U							
Alpha Chlordane	UG/KG			1.3 U							
Alpha-BHC	UG/KG			1.3 U							
Aroctor-1016	UG/KG			33 U							
Aroclor-1221	UG/KG			33 U							
Aroclor-1232	UG/KG			33 U							
Aroclor-1242	UG/KG			33 U							
Aroclor-1248	UG/KG			33 U							
Aroclor-1254	UG/KG			67 U							
Aroclor-1260	UG/KG			67 U							
Beta-BHC	UG/KG			1.3 U							
Delta-BHC	UG/KG			1.3 U							
Dieldrin	UG/KG			2.5 U							
Endosulfan I	UG/KG			1.3 U							
Endosulfan II	UG/KG			2.5 UJ							
Endosulfan Sulfate	UG/KG			2.5 UJ							
Endrin	UG/KG			2.5 UJ							
Endrin Aldehyde	UG/KG			2.5 UJ							
Endrin Ketone	UG/KG			2.5 U							
Gamma Chlordane	UG/KG			1.3 U							
Gamma-BHC (Lindane)	UG/KG			1.3 U							
Heptachlor	UG/KG			1.3 U							
Heptachlor Epoxide	UG/KG			1.3 U							
Methoxychlor	UG/KG			13 UJ							
Toxaphene	UG/KG			83 U							

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	Station	WBGss-041	WBGss-042	WBG ss- 043	WBGss-044	WBGss-045	WBGss-046	WBGss-047	WBGss-048	WBGss-049	WBGss-050
	Date Collected	7/31/96	8/7/96	8/7/96	8/7/96	8/7/96	8/7/96	8/7/96	8/7/96	8/7/96	8/7/96
	Depth	0.0 - 0.5 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 1.0 FT	0.0 - 2.0 FT	0.0 - 1.0 FT			
Media: Soil											
Pesticides and/or PCBs	Units										
4,4'-DDD	UG/KG										I
4,4'-DDE	UG/KG										I
4,4'-DDT	UG/KG										I
Aldrin	UG/KG										1
Alpha Chlordane	UG/KG										I
Alpha-BHC	UG/KG										I
Aroclor-1016	UG/KG										,
Aroclor-1221	UG/KG										
Aroclor-1232	UG/KG										
Aroclor-1242	UG/KG										
Aroclor-1248	UG/KG										
Aroclor-1254	UG/KG										
Aroclor-1260	UG/KG										
Beta-BHC	UG/KG										
Delta-BHC	UG/KG										
Dieldrin	UG/KG										
Endosulfan I	UG/KG										
Endosulfan II	UG/KG										
Endosulfan Sulfate	UG/KG										I
Endrin	UG/KG										I
Endrin Aldehyde	UG/KG										
Endrin Ketone	UG/KG										
Gamma Chlordane	UG/KG										
Gamma-BHC (Lindane)	UG/KG										
Heptachlor	UG/KG										
Heptachlor Epoxide	UG/KG										
Methoxychlor	UG/KG										
Toxanhene	UG/KG										ł
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	Station	WBGss-051	WBGss-052	WBGss-053	WBGss-054	WBGss-055	WBGss-056	WBGss-057	WBGss-058	WBGss-059	WBGss-060
	Date Collected Depth	8/8/96 0.0 - 2.0 FT	8/7/96 0.0 - 2.0 FT	8/13/96 0.0 - 2.0 FT	8/8/96 0.0 - 0.5 FT	8/8/96 0.0 - 2.0 FT	8/8/96 0.0 - 2.0 FT	8/7/96 0.0 - 2.0 FT	8/7/96 0.0 - 1.4 FT	8/8/96 0.0 - 1.0 FT	8/8/96 0.0 - 2.0 FT
Media: Soll											
Pesticides and/or PCBs	Units	Result Qual									
4,4'-DDD	UG/KG	2.6 U									
4,4'-DDE	UG/KG	2.6 U									
4,4'-DDT	UG/KG	2.6 U									
Aldrin	UG/KG	1.4 U									
Alpha Chlordane	UG/KG	1.4 U									
Alpha-BHC	UG/KG	1.4 U									
Aroclor-1016	UG/KG	34 U									
Aroclor-1221	UG/KG	34 U									
Aroclor-1232	UG/KG	34 U									
Aroclor-1242	UG/KG	34 U									
Aroclor-1248	UG/KG	34 U									
Aroclor-1254	UG/KG	70 U									
Aroclor-1260	UG/KG	70 U									
Beta-BHC	. UG/KO	1.4 U									
Delta-BHC	UG/KG	1.4 U									
Dieldrin	UG/KG	2.6 U									
Endosulfan I	UG/KG	1.4 U									
Endosulfan II	UG/KG	2.6 U									
Endosulfan Sulfate	UG/KG	2.6 U									
Endrin	UG/KG	2.6 U									
Endrin Aldehyde	UG/KG	2.6 U									
Endrin Ketone	UG/KG	2.6 U									
Gamma Chlordane	UO/KO	1.4 U									
Gamma-BHC (Lindane)	UG/KG	1.4 U									
Heptachlor	UG/KG	1.4 U				•					
Heptachlor Epoxide	UG/KG	1.4 U									
Methoxychlor	UG/KG	14 U									
Toxaphene	UG/KG	86 U									

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RVAAP Phase I Remedial Investigation

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	Station	WBGss-061	WBGss-062	WBGss-063	WBGss-064	WBGss-065	WBG55-066	WBGss-067	WBGss-068	WBGss-069	WBGss-070
	Date Collected	8/8/96	8/8/96	8/7/96	8/7/96	8/9/96	8/9/96	8/9/96	8/9/96	8/9/96	8/9/96
	Depth	0.0 - 2.0 FT	0.0 - 2. 0 FT								
Medla: Soll											
Pesticides and/or PCBs	Units						Result Qual				
4,4'-DDD	UG/KG						2.6 U				
4,4'-DDE	UG/KG						2.6 U				
4,4'-DDT	UG/KG						2.6 U				
Aldrin	UG/KG						1.4 U				
Alpha Chlordane	UG/KG						1.4 U				
Alpha-BHC	UG/KG						1.4 U				
Arocler-1016	UG/KG						34 U				
Aroclor-1221	UG/KG						34 U				
Aroclor-1232	UG/KG						34 U				
Aroclor-1242	UG/KG						34 U				
Aroclor-1248	UG/KG						34 U				
Aroclor-1254	UG/KG						70 U				
Aroclor-1260	UG/KG						70 U				
Beta-BHC	UG/KG						1.4 U				
Delta-BHC	UG/KG						1.4 U				
Dieldrin	UG/KG						2.6 U				
Endosulfan I	UG/KG						1,4 U				
Endosulfan II	UG/KG						2.6 U				
Endosulfan Sulfate	UG/KG						2.6 U				
Endrin	UG/KG						2.6 U				
Endrin Aldehyde	UG/KG						2.6 U				
Endrin Ketone	UG/KG						2,6 U				
Gamma Chlordane	UG/KG						1.4 U				
Gamma-BHC (Lindane)	UG/KG						1.4 U	•			
Heptachlor	UG/KG						1.4 U				
Heptachlor Epoxide	UG/KG						1.4 U				
Methoxychlor	UG/KG						14 U				
Toxaphene	UG/KG						86 U				

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	Station	WBGss-071	WBGss-072	WBGss-073	WBGss-074	WBGss-075	WBG33-076	WBGss-077	WBGss-097	WBGss-098	WBGss-004
	Date Collected Depth	8/9/96 0.0 - 1.0 FT	8/9/96 0.0 - 2.0 FT	8/9/96 0.0 - 2.0 FT	8/9/96 0.0 - 0.5 FT	8/9/96 0.0 - 2.0 FT	8/9/96 0.0 - 2.0 FT	8/13/96 0.0 - 0.8 FT	8/13/96 0.0 - 2.0 FT	8/14/96 0.0 - 2.0 FT	8/13/96 0.0 - 0.6 FT
Media: Soli											
Pesticides and/or PCBs	Units		Result Qual				Result Qual				
4,4'-DDD	UG/KG		2.6 U				2.5 U				
4,4'-DDE	UG/KG		2.6 U				2.5 U				
4,4'-DDT	UG/KG		2.6 U				2.5 U				
Aldrin	UG/KG		1.3 U				1.3 U				
Alpha Chlordane	UG/KG		1.3 U				1.3 U				
Alpha-BHC	UG/KG		1.3 U				1.3 U				
Aroclor-1016	UG/KG		34 U				33 U				
Aroclor-1221	UG/KG		34 U				33 U				
Aroclor-1232	UG/KG		34 U				33 U				
Aroclor-1242	UG/KG		34 U				33 U				
Aroclor-1248	UG/KG		34 U				33 U				
Aroclor-1254	UG/KG		69 U				67 U				
Aroclor-1260	UG/KG		69 U				67 U				
Beta-BHC	UG/KG		1.3 U				1.3 U				
Delta-BHC	UG/KG		1.3 U				1.3 U				
Dieldrin	UG/KG		2.6 U				2.5 U				
Endosulfan I	UG/KG		1.3 U				1.3 U				
Endosulfan II	UG/KG		2.6 U				2.5 U				
Endosulfan Sulfate	UG/KG		2.6 U				2.5 U				
Endrin	UG/KG		2.6 U				2.5 U				
Endrin Aldehyde	UG/KG		2.6 U				2.5 U				
Endrin Ketone	UG/KG		2.6 U				2.5 U				
Gamma Chlordane	UG/KG		1.3 U				1.3 U				
Gamma-BHC (Lindane)	UG/KG		1,3 U				1.3 U			-	
Heptachlor	UG/KG		1.3 U				1.3 U				
Heptachlor Epoxide	UG/KG		1.3 U				1.3 U				
Methoxychlor	UG/KG		13 U				13 U				
Toxaphene	UG/KG		86 U				83 U				

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	Station	WBGss-030	WBGss-057		
	Date Collected	8/13/96	8/13/96		
	Depth	0.0 - 1.5 FT	1.5 - 2.0 FT		
Media: Soil					
Pesticides and/or PCBs	Units				
4,4'-DDD	UG/KG				
4,4'-DDE	UG/KG				
4,4'-DDT	UG/KG				
Aldrin	UG/KG				
Alpha Chlordane	UG/KG				
Alpha-BHC	UG/KG				
Aroclor-1016	UG/KG				
Aroclor-1221	UG/KG				
Aroclor-1232	UG/KG				
Aroclor-1242	UG/KG				
Aroclor-1248	UG/KG				
Aroclor-1254	UG/KG				
Aroclor-1260	UG/KG				
Beta-BHC	UG/KG				
Delta-BHC	UG/KG				
Dieldrin	UG/KG				
Endosulfan I	UG/KG				
Endosulfan II	UG/KG				
Endosulfan Sulfate	UG/KG				
Endrin	UG/KG				
Endrin Aldehyde	UG/KG				
Endrin Ketone	UG/KG				
Gamma Chlordane	UG/KG				
Gamma-BHC (Lindane)	UG/KG				
Heptachlor	UG/KG				
Heptachlor Epoxide	UG/KG				
Methoxychlor	UG/KG				
Toxaphene	UG/KG				

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	Station	WBGss- 009	WBG3s-010	WBGss-011	WBGss-012	WBGss-013	WBGss-014	WBGss-015	WBGss-016	WBGss-017	WBGss-018
	Date Collected	8/5/96	8/5/96	8/5/96	8/5/96	8/5/96	8/8/96	8/5/96	8/6/96	8/6/96	8/6/96
	Depth	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 1.5 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 1.5 FT
Media: Soll Miscellaneous	Units										
Cvanide	MG/KG										
_,											
Explosives	Units	Resu Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual
1,3,5-Trinitrobenzene	UG/KG	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U
1,3-Dinitrobenzene	UG/KG	250 U	250 U	250 U	250 U	250 U	250 UJ	250 U	250 U	250 U	250 U
2,4,6-Trinitrotoluene	UG/KG	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U
2.4-Dinitrotoluene	UG/KG	250 UJ	250 UJ	250 UJ	250 UJ	250 UJ	250 UJ	250 UJ	250 UJ	250 UJ	250 UJ
2,6-Dinitrotoluene	UG/KG	260 U	260 U	260 U	260 U	260 U	260 U	260 U	260 U	260 U	260 U
2-Nitrotoluene	UG/KG	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U
3-Nitrotoluene	UG/KG	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U
4-Nitrotoluene	UG/KG	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U
нмх	UG/KG	2000 U	2000 U	2000 U	2000 U	2000 U	2000 U	2000 U	2000 U	2000 U	2000 U
Nitrobenzene	UG/KG	260 U	260 U	260 U	260 U	260 U	260 U	260 U	260 U	260 U	260 U
RDX	UG/KG	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U
Tetryl	UG/KG	650 U	650 U	650 U	650 U	650 U	650 U	650 U	650 U	650 U	650 U

			Table 4.17.	Winklepeck	Burning G	rounds (con	tinued)				
	Station	WBGss-019	WBGss-020	WBGss-021	WBGss-022	WBGss-023	WBGss-024	WBGss-025	WBGss-026	WBGss-027	WBGss-028
	Date Collected Depth	8/6/96 0.0 - 1.5 FT	8/5/96 0.0 - 2.0 FT	8/5/96 0.0 - 0.5 FT	8/6/96 0.0 - 1.3 FT	8/6/96 0.0 - 0.5 FT	8/7/96 0.0 - 2.0 FT				
Media: Soil Miscellaneous	Units			Result Qual							
Cyanide	MG/KG			0.1 U							
Explosives	Units	Result Qual									
1,3,5-Trinitrobenzene	UG/KG	250 U									
1,3-Dinitrobenzene	UG/KG	250 U									
2,4,6-Trinitrotoluene	UG/KG	250 U									
2,4-Dinitrotoluene	UG/KG	250 UJ									
2,6-Dinitrotoluene	UG/KG	260 U									
2-Nitrotoluene	UG/KG	250 U									
3-Nitrotoluene	UG/KG	250 U									
4-Nitrotoluene	UG/KG	250 U									
НМХ	UG/KG	2000 U									
Nitrobenzene	UG/KG	260 U									
RDX	UG/KG	1000 U									
Tetryl	UG/KG	650 U									

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	Station	WBG55-029	WBGss-030	WBGss-031	WBGss-034	WBGss-035	WBGss-036	WBGss-037	WBG\$\$-038	WBGss-039	WBGss-040
	Date Collected Depth	8/7/96 0.0 - 2.0 FT	8/7/96 0.0 - 1.5 FT	8/7/96 0.0 - 2.0 FT	8/6/96 0.0 - 2.0 FT	7/31/96 0.0 - 2.0 FT	7/31/96 0.0 - 2.0 FT				
Media: Soil Miscellaneous	Units			Result Qual							
Cyanide	MG/KG			0.23 J							
Explosives	Units	Result Qual	Result Qual								
1,3,5-Trinitrobenzene	UG/KG	250 U	250 U	250 U	250 U	250 UJ	250 U	250 U	250 U	250 U	250 U
1,3-Dinitrobenzene	UG/KG	250 U	250 U	250 U	250 U	250 UJ	250 U	250 U	250 U	250 U	250 U
2,4,6-Trinitrotoluene	UG/KG	250 U	250 U	250 U	250 U	2800 J	250 U	250 U	250 U	250 U	250 U
2,4-Dinitrotoluene	UG/KG	250 UJ	250 UJ	250 UJ	310 J	250 UJ	250 UJ	250 UJ	250 UJ	250 U	250 U
2,6-Dinitrotoluene	UG/KG	260 U	260 U	260 U	260 U	260 UJ	260 U	260 U	260 U	260 U	260 U
2-Nitrotoluene	UG/KG	250 U	250 U	250 U	250 U	250 UJ	250 U	250 U	250 U	250 U	250 U
3-Nitrotoluene	UG/KG	250 U	250 U	250 U	250 U	250 UJ	250 U	250 U	250 U	250 U	250 U
4-Nitrotoluene	UG/KG	250 U	250 U	250 U	250 U	250 UJ	250 U	250 U	250 U	250 U	250 U
нмх	UG/KG	2000 U	2000 U	2000 U	2000 U	2000 UJ	2000 U	2000 U	2000 U	2000 U	2000 U
Nitrobenzene	UG/KG	260 U	260 U	260 U	260 U	260 UJ	260 U	260 U	260 U	260 U	260 U
RDX	UG/KG	1000 U	1000 U	1000 U	1000 U	1000 UJ	1000 U	1000 U	1000 U	1000 U	1000 U
Tetryl	UG/KO	650 U	650 U	650 U	650 U	650 UJ	650 U	650 U	650 U	650 UJ	650 UJ

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Table 4.17. Winklepeck Burning Grounds (continued)											
	Station	WBGss-041	WBG ss-042	WBG38-043	WBGss-044	WBGss-045	WBG\$\$-046	WBGss-047	WBGss-048	WBGss-049	WBGss-050
	Date Collected	7/31/96	8/7/96	8/7/96	8/7/96	8/7/96	8/7/96	8/7/96	8/7/96	8/7/96	8/7/96
	Depth	0.0 - 0.5 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 1.0 FT	0.0 - 2.0 FT	0.0 - 1.0 FT			
Media: Soil											
Miscellaneous	Units										
Cyanide	MG/KG										
Explosives	Units	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual
1,3,5-Trinitrobenzene	UG/KG	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U
1,3-Dinitrobenzene	UG/KG	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U
2,4,6-Trinitrotoluene	UG/KG	250 U	250 U	250 U	250 U	250 U	250 UJ				
2,4-Dinitrotoluene	UG/KG	250 U	250 UJ	250 UJ	250 UJ	250 UJ	250 U				
2,6-Dinitrotoluene	UG/KG	260 U	260 U	260 U	260 U	260 U	260 U	260 U	260 U	260 U	260 U
2-Nitrotoluene	UG/KG	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U
3-Nitrotoluene	UG/KG	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U
4-Nitrotoluene	UG/KG	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U
HMX	UG/KG	2000 U	2000 U	2000 U	2000 U	2000 U	2000 U	2000 U	2000 U	2000 U	2000 U
Nitrobenzen e	UG/KG	260 U	260 U	260 U	260 U	260 U	260 U	260 U	260 U	260 U	260 U
RDX	UG/KG	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U
Tetryl	UG/KG	650 U	650 U	650 U	650 U	650 U	650 UJ				

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	Station	WBGss-051	WBGss-052	WBGss-053	WBGss-054	WBG58-055	WBGss-056	WBGss-057	WBGss-058	WBGss-059	WBGss-060
	Date Collected Depth	8/8/96 0.0 - 2.0 FT	8/7/96 0.0 - 2.0 FT	8/13/96 0.0 - 2.0 FT	8/8/96 0.0 - 0.5 FT	8/8/96 0.0 - 2.0 FT	8/8/96 0.0 - 2.0 FT	8/7/96 0.0 - 2.0 FT	8/7/96 0.0 - 1.4 FT	8/8/96 0.0 - 1.0 FT	8/8/96 0.0 - 2.0 FT
Media: Soil Miscellaneous	Units	Result Qual									
Cyanide	MG/KG	0.1 U									
Explosives	Units	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual
1,3,5-Trinitrobenzene	UG/KG	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U
1,3-Dinitrobenzene	UG/KG	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U
2,4,6-Trinitrotoluene	UG/KG	250 U	250 UJ	450 J	250 U	33000 J	250 U	300 J	250 UJ	380 J	250 U
2,4-Dinitrotoluene	UG/KG	250 U	250 U	250 UJ	250 U						
2,6-Dinitrotoluene	UG/KG	260 U	260 U	260 U	260 U	260 U	260 U	260 U	260 U	260 U	260 U
2-Nitrotoluene	UG/KG	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U
3-Nitrotoluene	UG/KG	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U
4-Nitrotoluene	UG/KG	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U
нмх	UG/KG	2000 U	2000 U	2000 U	2000 U	2000 U	2000 U	2000 U	2000 U	2000 U	2000 U
Nitrobenzene	UG/KG	260 U	260 U	260 U	260 U	260 U	260 U	260 U	260 U	260 U	260 U
RDX	UG/KG	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U
Tetryl	UG/KG	650 U	650 UJ	650 U	650 U	650 U	650 U	650 U	650 UJ	650 U	650 U

Table 4.17. Winklepeck Burning Grounds (continued)												
	Station	WBGss-061	WBGss-062	WBG55-063	WBG ss-064	WBGss-065	WBGss-066	WBGss-067	WBG55-068	WBGss-069	WBGss-070	
	Date Collected	8/8/96	8/8/96	8/7/96	8/7/96	8/9/96	8/9/96	8/9/96	8/9/96	8/9/96	8/9/96	
	Depth	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 2.0 FT				
Media: Soil												
Miscellaneous	Units						Result Qual					
Cyanide	MG/KG						0.1 UJ					
Explosives	Units	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	
1,3,5-Trinitrobenzene	UG/KG	250 U	490 J	250 U	250 U	250 U	250 U	250 U	250 U	76000 =	490000 =	
1,3-Dinitrobenzene	UG/KG	250 U	250 U	250 U	250 U	250 UJ	250 UJ	250 UJ	250 UJ	12500 UJ	250 UJ	
2,4,6-Trinitrotoluene	UG/KG	250 U	36000 J	250 UJ	250 UJ	420 J	250 U	530 =	470 =	4E+06 =	3E+06 =	
2,4-Dinitrotoluene	UG/KG	250 U	250 U	250 U	250 U	250 UJ	250 UJ	250 UJ	250 UJ	12500 UJ	250 UJ	
2,6-Dinitrotoluene	UG/KG	260 U	260 U	260 U	260 U	260 U	260 U	260 U	260 U	13000 U	260 U	
2-Nitrotoluene	UG/KG	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	12500 U	250 U	
3-Nitrotoluene	UG/KG	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	12500 U	250 U	
4-Nitrotoluene	UG/KG	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	12500 U	250 U	
НМХ	UG/KG	2000 U	38000 =	2000 U	2000 U	2000 U	2000 U	2000 U	2000 U	100000 U	2E+06 =	
Nitrobenzene	UG/KG	260 U	260 U	260 U	260 U	260 U	260 U	260 U	260 U	13000 U	260 U	
RDX	UG/KG	1000 U	270000 J	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	50000 U	1E+07 =	
Tetryl	UG/KG	650 U	650 U	650 UJ	650 UJ	650 U	650 U	650 U	650 U	32500 U	650 U	

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	Station	WBGss-071	WBGss-072	WBGss-073	WBGss-074	WBGss-075	WBG ss-076	WBGss-077	WBGss-097	WBGss-098	WBGss-004
	Date Collected Depth	8/9/96 0.0 - 1.0 FT	8/9/96 0.0 - 2.0 FT	8/9/96 0.0 - 2.0 FT	8/9/96 0.0 - 0.5 FT	8/9/96 0.0 - 2.0 FT	8/9/96 0.0 - 2.0 FT	8/13/96 0.0 - 0.8 FT	8/13/96 0.0 - 2.0 FT	8/14/96 0.0 - 2.0 FT	8/13/96 0.0 - 0.6 FT
Media: Soii Miscellaneous	Units		Result Qual				Result Qual				
Cyanide	MG/KG		0.76 U				0.13 U				
Explosives	Units	Result Qual	Result Qual	Result Qual		Result Qual	Result Qual	Result Qual	Result Qual	Result Qual	
1,3,5-Trinitrobenzene	UG/KG	250 U	250 U	250 U		250 U	250 U	250 U	250 U	250 U	
1,3-Dinitrobenzene	UG/KG	250 UJ	250 UJ	250 UJ		250 UJ	250 UJ	250 U	250 U	250 U	
2,4,6-Trinitrotoluene	UG/KG	2300 =	250 U	480 J		480 J	250 U	250 U	250 U	280 =	
2,4-Dinitrotoluene	UG/KG	250 UJ	250 UJ	250 UJ		250 UJ	250 UJ	250 UJ	250 UJ	250 UJ	
2,6-Dinitrotoluene	UG/KG	260 U	260 U	260 U		260 U	260 U	260 U	260 U	260 U	
2-Nitrotoluene	UG/KG	250 U	250 U	250 U		250 U	250 U	250 U	250 U	250 U	
3-Nitrotoluene	UG/KG	250 U	250 U	250 U		250 U	250 U	250 U	250 U	250 U	
4-Nitrotoluene	UG/KG	250 U	250 U	250 U		250 U	250 U	250 U	250 U	250 U	
HMX	UG/KG	2000 U	2000 U	2000 U		1900 J	2000 U	2000 U	2000 U	2000 U	
Nitrobenzene	UG/KG	260 U	260 U	260 U		260 U	260 U	260 U	260 U	260 U	
RDX	UG/KG	1000 U	1000 U	1000 U		1000 U	1000 U	1000 U	1000 U	1000 U	
Tetryl	UG/KG	650 U	650 U	650 U		650 U	650 U	650 U	650 U	650 U	

			Table 4.17.	Winklepeck Burning Grounds (continued)
	Station	WBGss-030	WBG ss-057	
	Date Collected	8/13/96	8/13/96	
	Depth	0.0 - 1.5 FT	1.5 - 2.0 FT	
Media: Soil				
Miscellaneous	Units			
Cyanide	MG/KG			
Fyplosius	l'aite			
Explosives	Cinta			
1,3,5-Trinitrobenzene	UG/KG			
1,3-Dinitrobenzene	UG/KG			
2,4,6-Trinitrotoluene	UG/KG			
2,4-Dinitrotoluene	UG/KG			
2,6-Dinitrotoluene	UG/KG			
2-Nitrotoluene	UG/KG			
3-Nitrotoluene	UG/KG			
4-Nitrotoluene	UG/KG			
HMX	UG/KG			
Nitrobenzene	UG/KG			
RDX	UG/KG			
Tetryl	UG/KG			

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	Station Date Collected Depth	WBGsd-078 8/11/96 0.0 - 1.5 FT	WBGsd-079 8/11/96 0.0 - 2.0 FT	WBGsd-080 8/11/96 0.0 - 2.0 FT	WBGsd-081 8/11/96 0.0 - 1.5 FT	WBGsd-082 8/11/96 0.0 - 2.0 FT	WBGsd-083 8/11/96 0.0 - 2.0 FT	WBGsd-084 8/11/96 0.0 - 1.8 FT	WBGsd-085 8/11/96 0.0 - 2.0 FT
Media: Sediment						-	-		
Metals	Units	Result Qual							
Aluminum	MG/KG	16100 =	7930 =	9900 =	12500 =	10600 =	7460 =	9960 =	14100 =
Antimony	MG/KG			0.3 U			0.32 J		
Arsenic	MG/KO	11.7 =	18.1 =	15.5 =	15.1 =	13.1 =	12.1 =	14 =	15.6 =
Barium	MG/KG	173 =	78.3 =	66.9 =	118 =	528 =	85.2 =	39.5 =	78.9 =
Beryllium	MG/KG			0.6 =			0.45 <i>=</i>		
Cadmium	MG/KG	0.05 U	0.05 U	0.04 U	0.18 J	0.16 J	0.04 U	0.05 U	0.05 U
Calcium	MG/KG			1720 =			1080 =		
Chromium	MG/KG	14 =	10.6 =	13.3 =	16.9 =	14.2 =	9.9 =	12.1 =	16.1 =
Cobalt	MG/KG			10.4 =			8.6 =		
Copper	MG/KG			18.8 =			18.6 =		
Iron	MG/KG			24000 =			18200 =		
Lead	MG/KG	16.9 =	25.4 =	11.1 =	27.3 =	11.3 =	10.2 =	13.3 =	12.6 =
Magnesium	MG/KØ			3280 =			2050 =		
Manganese	MG/KG	1050 =	328 =	362 =	897 =	728 =	318 =	242 =	225 =
Mercury	MG/KG	0.04 U	0.04 U	0.03 U	0.04 U	0.04 U	0.03 U	0.04 U	0.04 U
Nickel	MG/KG			28.3 =			15.9 =		
Potassium	MG/KG			1030 =			665 =		
Selenium	MG/KG	0.37 U	0.36 U	0.3 U	0.59 U	0.49 J	0.37 J	0.38 J	0.34 U
Silver	MG/KG	0.23 U	0.23 U	0.19 U	0.23 U	0.22 U	0.19 U	0.22 U	0.21 U
Sodium	MG/KG			74 J			52.3 J		
Thallium	MG/KG			1.8 =			1.5 =		
Vanadium	MG/KG			15.9 ≖			13 =		
Zinc	MG/KG	64.8 	79.7 =	57 =	64.8 =	51.9 =	51.9 =	38.3 =	58.7 =
Volatile Organics	Units			Result Qual			Result Qual		
1,1,1-Trichloroethane	UG/KG			5 U			5 U		
1,1,2,2.Tetrachloroethane	UG/KG			5 UJ			5 U		
1,1,2-Trichloroethane	UG/KG			5 U			5 U		
1,1-Dichloroethane	UG/KG			5 U			5 U		
1,1-Dichloroethene	UG/KG			5 U			5 U		
1,2-Dichloroethane	UG/KG			5 U			5 U		

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	Station	WBGsd-086	WBGsd-087	WBGsd-088	WBGsd-089	WBGsd-090
	Date Collected	8/11/96	8/11/96	8/11/96	8/11/96	8/11/96
	Depth	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 1.0 FT	0.0 - 1.0 FT	0.0 - 1.0 FT
Media: Sediment						
Metals	Units	Result Qual				
Aluminum	MG/KG	12100 =	10600 =	15100 =	14800 =	4740 =
Antimony	MG/KG					
Arsenic	MG/KG	13.2 =	12.6 =	8.1 =	13.6 =	10.4 =
Barium	MG/KG	236 =	54.5 =	226 =	81.1 =	36.8 =
Beryllium	MG/KG					
Cadmium	MG/KG	0.17 J	0.05 U	0.56 J	0.06 J	0.18 J
Calcium	MO/KG					
Chromium	MG/KG	14.5 =	14.2 =	12.6 =	16.9 =	7.2 =
Cobalt	MG/KG					
Copper	MG/KG					
Iron	MG/KG					
Lead	MG/KG	21.8 =	15.2 =	25 =	13.6 =	14.6 =
Magnesium	MG/KG					
Manganese	MG/KG	183 =	338 =	350 =	548 =	303 =
Mercury	MG/KG	0.04 =	0.05 U	0.07 U	0.05 =	0.05 U
Nickel	MG/KG					
Potassium	MG/KG					
Selenium	MG/KG	1.7 =	0.44 J	0.59 U	0.59 J	0.41 U
Silver	MG/KG	0.22 U	0.26 U	0.37 U	0.25 U	0.26 U
Sodium	MG/KG					
Thallium	MG/KG					
Vanadium	MG/KG					
Zinc	MG/KG	46.9 =	52.3 =	155 =	90.1 =	148 =
Volatile Organics	Units					
1,1,1-Trichloroethane	UG/KG					
1,1,2,2-Tetrachloroethane	UG/KG					
1,1,2-Trichloroethane	UG/KG					

1,1-Dichloroethene

UG/KG UG/KG

UG/KG

1,1-Dichloroethane

1,2-Dichloroethane

	Station Date Collected Depth	WBGsd-078 8/11/96 0.0 - 1.5 FT	WBGsd-079 8/11/96 0.0 - 2.0 FT	WBGsd-080 8/11/96 0.0 - 2.0 FT	WBGsd-081 8/11/96 0.0 - 1.5 FT	WBGsd-082 8/11/96 0.0 - 2.0 FT	WBGsd-083 8/11/96 0.0 - 2.0 FT	WBGsd-084 8/11/96 0.0 - 1.8 FT	WBGsd-085 8/11/96 0.0 - 2.0 FT
Media: Sediment									
Volatile Organics	Units			Result Qual			Result Qual		
1,2-Dichloropropane	UG/KG			5 U			5 U		
1,2-cis-Dichloroethene	UG/KG			5 U			5 U		
1,2-trans-Dichloroethene	UG/KG			5 U			5 U		
1,3-cis-Dichloropropene	UG/KG			5 U			5 U		
1,3-trans-Dichloropropene	UG/KG			5 U			5 U		
2-Butanone	UG/KG			5 UJ			5 U		
2-Hexanone	UG/KG			5 UJ			5 U		
4-Methyl-2-pentanone	UG/KG			5 UJ			5 U		
Acetone	UG/KG			5 R			5 UJ		
Benzene	UG/KG		•	5 U			5 U		
Bromodichloromethane	UG/KG			5 U			5 U		
Bromoform	UG/KG			5 U			5 U		
Bromomethane	UG/KG			5 U			5 U		
Carbon Disulfide	UG/KG			5 U			5 U		
Carbon Tetrachloride	UG/KG			5 U			5 U		
Chlorobenzene	UG/KG			5 UJ			5 U		
Chloroethane	UG/KG			5 UJ			5 UJ		
Chloroform	UG/KG			5 U			2 J		
Chloromethane	UG/KG			5 U			5 U		
Dibromochloromethane	UG/KG			5 U			5 U		
Ethylbenzene	UG/KG			5 UJ			5 U		
Methylene Chloride	UG/KG			6 U			5 U		
Styrene	UG/KG			5 UJ			5 U		
Tetrachloroethene	UG/KG			5 UJ			5 U		
Toluene	UG/KG			25 J			5 U		
Trichloroethene	UG/KG			5 U			5 U		
Vinyl Chloride	UG/KG			5 U			5 U		
Xylenes, Total	UG/KG			5 UJ			5 U		
o-Xylene	UG/KG			5 UJ			5 U		

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	Station	WBGsd-086	WBGsd-087	WBGsd-088	WBGsd-089	WBGsd-090
	Date Collected	8/11/96	8/11/96	8/11/96	8/11/96	8/11/96
	Depth	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 1.0 FT	0.0 - 1.0 FT	0.0 - 1.0 FT
Media: Sediment				-		
Volatile Organics	Units					
1,2-Dichloropropane	UG/KG					
1,2-cis-Dichloroethene	UG/KG					
1,2-trans-Dichloroethene	UG/KG				,	
1,3-cis-Dichloropropene	UO/KG				,	
1,3-trans-Dichloropropene	UG/KG					
2-Butanone	UG/KG					
2-Hexanone	UG/KG					
4-Methyl-2-pentanone	UG/KG					
Acetone	UG/KG					
Benzene	UG/KG					
Bromodichloromethane	UG/KG					
Bromoform	UG/KG					
Bromomethane	UG/KG					
Carbon Disulfide	UG/KG					
Carbon Tetrachloride	UG/KG					
Chlorobenzene	UG/KG					
Chloroethane	UG/KG					
Chloroform	UG/KG					
Chloromethane	UG/KG					
Dibromochloromethane	UG/KG					
Ethylbenzene	UG/KG					
Methylene Chloride	UG/KG					
Styrene	UG/KG					
Tetrachloroethene	UG/KG					
Toluene	UG/KG					
Trichloroethene	UG/KG					
Vinyl Chloride	UG/KG					
Xylenes, Total	UG/KG					
o-Xylene	UG/KG					

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		Table	4.17. Winklep	eck Burning G	rounds (contin	iued)			
	Station	WBGsd-078	WBGsd-079	WBGsd-080	WBGsd-081	WBGsd-082	WBGsd-083	WBGsd-084	WBGsd-085
	Date Collected	8/11/96	8/11/96	8/11/96	8/11/96	8/11/96	8/11/96	8/11/96	8/11/96
	Depth	0.0 - 1.5 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 1.5 FT	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 1.8 FT	0.0 - 2.0 FT
Media: Sediment									
Semi-Volatile Organics	Units			Result Qual			Result Qual		
1,2,4-Trichlorobenzene	UG/KG			330 U			330 U		
1,2-Dichlorobenzene	UG/KG			330 U			330 U		
1,3-Dichlorobenzene	UG/KG			330 U			330 U		
1,4-Dichlorobenzene	UG/KG			330 U			330 U		
2,2'-oxybis (1-chloropropane)	UG/KG			330 U			330 U		
2,4,5-Trichlorophenol	UG/KO			800 U			810 U		
2,4,6-Trichlorophenol	UG/KG			330 U			330 U		
2,4-Dichlorophenol	UG/KG			330 U			330 U		
2,4-Dimethylphenol	UG/KG			330 U			330 U		
2,4-Dinitrophenol	UG/KG			800 UJ			810 UJ		
2-Chloronaphthalene	UG/KG			330 U			330 U		
2-Chlorophenol	UG/KG			330 U			330 U		
2-Methyinaphthalene	UG/KG			330 U			330 U		
2-Methylphenol	UG/KG			330 U			330 U		
2-Nitroaniline	UO/KG			800 U			810 U		
2-Nitrophenol	UG/KG			330 U			330 U		
3,3'-Dichlorobenzidine	UG/KG			800 U			810 U		
3-Nitroaniline	UG/KG			800 U			810 U		
4,6-Dinitro-o-Cresol	UG/KG			330 U			330 U		
4-Bromophenyl-phenyl Ether	UG/KG			330 U			330 U		
4-Chloroanilíne	UG/KG			330 U			330 U		
4-Chlorophenyl-phenylether	UG/KG			330 U			330 U		
4-Methylphenol	UG/KG			330 U			330 U		
4-Nitroaniline	UG/KG			800 U			810 U		
4-Nitrophenol	UG/KG			800 U			810 U		
4-chloro-3-methylphenol	UG/KG			330 U			330 U		
Acenaphthene	UG/KG			330 U			330 U		
Acenaphthylene	UG/KG			330 U			330 U		
Anthracene	UG/KG			330 U			330 U		
Benzo(a)anthracene	UG/KG			330 U			330 U		
Benzo(a)pyrene	UG/KG			330 U			330 U		
Benzo(b)fluoranthene	UG/KG			330 U			330 U		
Benzo(g,h,i)perylene	UG/KG			330 U			330 U		
Benzo(k)fluoranthene	UG/KG			330 U			330 U		
Bis(2-chloroethoxy)methane	UG/KG			330 U			330 U		

	Station	110630-000	\YBG90-087 *	WBGsa-086	WBG\$11-U89	W BGsd-UYU
	Date Collected	8/11/96	8/11/96	8/11/96	8/11/96	8/11/96
	Depth	0.0 - 2.0 FT	0.0 - 2.0 F T	0.9 - 1.0 FT	0.0 - 1.0 FT	0.0 - 1.0 FT
Media: Sediment						
Semi-Volatile Organics	Units					
1,2,4-Trichlorobenzene	UG/KG					
1,2-Dichlorobenzene	UG/KG					
1,3-Dichlorobenzene	UG/KG					
1,4-Dichlorobenzene	UG/KG					
2,2'-oxybis (1-chloropropane)	UG/KG					
2,4,5-Trichlorophenol	UG/KG					
2,4,6-Trichlorophenol	UG/KG					
2,4-Dichlorophenol	UG/KG					
2,4-Dimethylphenol	UG/KG					
2,4-Dinitrophenol	UG/KG					
2-Chloronaphthalene	UG/KG					
2-Chlorophenol	UG/KG					
2-Methylnaphthalene	UG/KG					
2-Methylphenol	UG/KG					
2-Nitroaniline	UG/KG					
2-Nitrophenol	UG/KG					
3,3'-Dichlorobenzidine	UG/KG					
3-Nitroaniline	UG/KG					
4,6-Dinitro-o-Cresol	UG/KG					
4-Bromophenyl-phenyl Ether	UG/KG					
4-Chloroaniline	UG/KG					
4-Chlorophenyl-phenylether	UG/KG					
4-Methylphenol	UG/KG					
4-Nitroaniline	UG/KG					
4-Nitrophenol	UG/KG					
4-chloro-3-methylphenol	UG/KG					
Acenaphthene	UG/KG					
Acenaphthylene	UG/KG					
Anthracene	UG/KG					
Benzo(a)anthracene	UG/KG					
Benzo(a)pyrene	UG/KG					
Benzo(b)fluoranthene	UG/KG					
Benzo(g,h,i)perylene	UG/KG					
Benzo(k)fluoranthene	UG/KG					
Bis(2-chloroethoxy)methane	UG/KG					

	Station Date Collected	WBGsd-078 8/11/96	WBGsd-079 8/11/96	WBGsd-080 8/11/96	WBGsd-081 8/11/96	WBGsd-082 8/11/96	WBGsd-083 8/11/96	WBGsd-084 8/11/96	WBGsd-085 8/11/96
	Debtu	0.0 - 1.3 F I	0.0 - 2.0 F I	0.0 - 2.0 F I	U.U - 1.5 F1	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 1.8 FT	0.0 - 2.0 FT
Media: Sediment									
Semi-Volatile Organics	Units			Result Qual			Result Qual		
Bis(2-chloroethyl)ether	UG/KG			330 U			330 11		
Bis(2-ethylhexyl)phthalate	UG/KG			330 U			330 U		
Butyl Benzyl Phthalate	UG/KG			330 U			330 U		
Carbazole	UG/KG			330 U			330 U		
Chrysene	UG/KG			330 U			330 U		
Di-n-butyl Phthalate	UG/KG			330 U			330 U		
Di-n-octyl Phthalate	UG/KG			330 U			330 U		
Dibenzo(a,h)anthracene	UG/KG			330 U			330 U		
Dibenzofuran	UG/KG			330 U			330 U		
Diethyl Phthalate	UG/KG			330 U			330 U		
Dimethyl Phthalate	UG/KG			330 U			330 U		
Fluoranthene	UG/KG			330 U			330 U		
Fluorene	UG/KG			330 U			330 U		
Hexachlorobenzene	UG/KG			330 U			330 U		
Hexachlorobutadiene	UG/KG			330 U			330 U		
Hexachlorocyclopentadiene	UG/KG			330 UJ			330 UJ		
Hexachloroethane	UG/KG			330 U			330 U		
Indeno(1,2,3-cd)pyrene	UG/KG			330 U			330 U		
Isophorone	UG/KG			330 U			330 U		
N-Nitroso-di-n-propylamine	UG/KG			330 U			330 U		
N-Nitrosodiphenylamine	UG/KG			330 U			330 U		
Naphthalene	UG/KG			330 U			330 U		
Pentachlorophenol	UG/KG			800 U			810 U		
Phenanthrene	UG/KG			330 U			330 U		
Phenol	UG/KG			330 U			330 U		
Pyrene	UG/KG			330 U			330 U		

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	Station	WBGsd-086	WBGsd-087	WBGsd-088	WBGsd-089	WBGsd-090
	Date Collected	8/11/96	8/11/96	8/11/96	8/11/96	8/11/96
	Depth	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 1.0 FT	0.0 - 1.0 FT	0.0 - 1.0 FT
Media: Sediment						
Semi-Volatile Organics	Units					
Bis(2-chloroethyl)ether	UG/KG					
Bis(2-ethylhexyl)phthalate	UG/KG					
Butyl Benzyl Phthalate	UG/KG					
Carbazole	UG/KG					
Chrysene	UG/KG					
Di-n-butyl Phthalate	UG/KG					
Di-n-octyl Phthalate	UG/KG					
Dibenzo(a,h)anthracene	UG/KG					
Dibenzofuran	UG/KG					
Diethyl Phthalate	UG/KG					
Dimethyl Phthalate	UG/KG					
Fluoranthene	UG/KG					
Fluorene	UG/KG					
Hexachlorobenzene	UG/KG					
Hexachlorobutadiene	UG/KG					
Hexachlorocyclopentadiene	UG/KG					
Hexachloroethane	UG/KG					
Indeno(1,2,3-cd)pyrene	UG/KG					
Isophorone	UG/KG					
N-Nitroso-di-n-propylamine	UG/KG					
N-Nitrosodiphenylamine	UG/KG					
Naphthalene	UG/KG					
Pentachlorophenol	UG/KG					
Phenanthrene	UG/KG					
Phenol	UG/KG					
Pyrene	UG/KG					

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	Station Date Collected Depth	WBGsd-078 8/11/96 0.0 - 1.5 FT	WBGsd-079 8/11/96 0.0 - 2.0 FT	WBGsd-080 8/11/96 0.0 - 2.0 FT	WBGsd-081 8/11/96 0.0 - 1.5 FT	WBGsd-082 8/11/96 0.0 - 2.0 FT	WBGsd-083 8/11/96 0.0 - 2.0 FT	WBGsd-084 8/11/96 0.0 - 1.8 FT	WBGsd-085 8/11/96 0.0 - 2.0 FT
Media: Sediment									
Pesticides and/or PCBs	Units			Result Qual			Result Qual		
4,4'-DDD	UG/KG			2.5 U			2.5 U		
4,4'-DDE	UG/KG			2.5 U			2.5 U		
4,4'-DDT	UG/KG			2.5 UJ			2.5 UJ		
Aldrin	UG/KG			1.3 U			1.3 U		
Alpha Chlordane	UG/KG			1.3 UJ			1.3 UJ		
Alpha-BHC	UG/KG			1.3 U			1.3 U		
Aroclor-1016	UG/KG			33 U			33 U		
Aroclor-1221	UG/KG			33 U			33 U		
Aroclor-1232	UG/KG			33 U			33 U		
Aroclor-1242	UG/KG			33 U			33 U		
Aroclor-1248	UG/KG			33 U			33 U		
Aroclor-1254	UG/KG			67 U			68 U		
Aroclor-1260	UG/KG			67 U			68 U		
Beta-BHC	UG/KG			1.3 U			1.3 U		
Delta-BHC	UG/KG			1.3 U			1.3 U		
Dieldrin	UG/KG			2.5 U			2.5 U		
Endosulfan I	UG/KG			1.3 UJ			1.3 UJ		
Endosulfan II	UG/KG			2.5 UJ			2.5 UJ		
Endosulfan Sulfate	UG/KG			2.5 U			2.5 U		
Endrin	UG/KG			2.5 UJ			2.5 UJ		
Endrin Aldehyde	UG/KG			2.5 UJ			2.5 UJ		
Endrin Ketone	UG/KG			2.5 UJ			2.5 UJ		
Gamma Chlordane	UG/KG			1.3 UJ			1.3 UJ		
Gamma-BHC (Lindane)	UG/KG			1.3 U			1.3 U		
Heptachlor	UG/KG			1.3 UJ			1.3 UJ		
Heptachlor Epoxide	UG/KG			1.3 U			1.3 U		
Methoxychlor	UG/KG			13 UJ			13 UJ		
Toxaphene	UG/KG			83 U			84 U		

	Station	WBGsd-086	WBGsd-087	WBGsd-088	WBGsd-089	WBGsd-090
	Date Collected	8/11/96	8/11/96	8/11/96	8/11/96	8/11/96
	Depth	0.0 - 2.0 FT	0.0 - 2.0 FT	0.0 - 1.0 FT	0.0 - 1.0 FT	0.0 - 1.0 FT
Media: Sediment						·
Pesticides and/or PCBs	Units					
4,4'-DDD	UG/KG					
4,4'-DDE	UG/KG					
4,4'-DDT	UG/KG					
Aldrin	UG/KG					
Alpha Chlordane	UG/KG					
Alpha-BHC	UG/KG					
Aroclor-1016	UG/KG					
Aroclor-1221	UG/KG					
Aroclor-1232	UG/KG					
Aroclor-1242	UG/KG					
Aroclor-1248	UG/KG					
Aroclor-1254	UG/KG					
Aroclor-1260	UG/KG					
Beta-BHC	UG/KG					
Delta-BHC	UG/KG					
Dieldrin	UG/KG					
Endosulfan I	UG/KG					
Endosulfan II	UG/KG					
Endosulfan Sulfate	UG/KG					
Endrin	UG/KG					
Endrin Aldehyde	UG/KG					
Endrin Ketone	UG/KG					
Gamma Chlordane	UG/KG					
Gamma-BHC (Lindane)	UG/KG					
Heptachlor	UG/KG					
Heptachlor Epoxide	UG/KG					
Methoxychlor	UG/KG					
Toxaphene	UG/KG					

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	Station Date Collected Depth	WBGsd-078 8/11/96 0.0 - 1.5 FT	WBGsd-079 8/11/96 0.0 - 2.0 FT	WBGsd-080 8/11/96 0.0 - 2.0 FT	WBGsd-081 8/11/96 0.0 - 1.5 FT	WBGsd-082 8/11/96 0.0 - 2.0 FT	WBGsd-083 8/11/96 0.0 - 2.0 FT	WBGsd-084 8/11/96 0.0 - 1.8 FT	WBGsd-085 8/11/96 0.0 - 2.0 FT
Media: Sediment Miscellaneous Cyanide Organic Carbon	Units MG/KG MG/KG	Result Qual 12300 =	Result Quai 15700 =	Result Qual 0.1 U	Result Qual 8160 =	Result Qual 2420 =	Result Qual 0.11 J 2270 =	Result Qual 5950 =	Result Qual 16200 =
Explosives	Units	Result Qual							
1,3,5-Trinitrobenzene	UG/KG	250 U							
1,3-Dinitrobenzene	UG/KG	250 U							
2,4,6-Trinitrotoluene	UG/KG	360 J	970 =	250 U	420 J	250 U	250 U	250 U	250 U
2,4-Dinitrotoluene	UG/KG	250 U							
2,6-Dinitrotoluene	UG/KG	260 U							
2-Nitrotoluene	UG/KG	250 U							
3-Nitrotoluene	UG/KG	250 U							
4-Nitrotoluene	UG/KG	250 U							
HMX	UG/KG	2000 U							
Nitrobenzene	UG/KG	260 U							
RDX	UG/KG	1000 U							
Tetryl	UG/KG	650 U							

	Station Date Collected Depth	WBGsd-086 8/11/96 0,0 - 2.0 FT	WBGsd-087 8/11/96 0.0 - 2.0 FT	WBGsd-088 8/11/96 0.0 - 1.0 FT	WBGad-089 8/11/96 0.0 - 1.0 FT	WBGsd-090 8/11/96 0.0 - 1.0 FT
Media: Sediment Miscellancous	Units	Result Qual	Result Qual	Result Qual	Result Oual	Result Oual
Cvanide	MG/KG		-		-	•
Organic Carbon	MG/KG	7380 =	2240 =	25800 =	5960 =	13000 =
Evolosives	Linite	Recult Anal	Result Qual	Result Aug	Perult Anal	Rocult Anal
1 3 5-Trinitrohenzene	UG/KG	250 U	250 11	250 17	250 11	250 []
1 3-Dinitrobenzene	UG/KG	250 U				
2,4,6-Trinitrotoluene	UG/KG	250 U				
2,4-Dinitrotoluene	UG/KG	250 U				
2,6-Dinitrotoluene	UG/KG	260 U				
2-Nitrotoluene	UG/KG	250 U				
3-Nitrotoluene	UG/KG	250 U				
4-Nitrotoluene	UG/KG	250 U				
HMX	UG/KG	2000 U				
Nitrobenzene	UG/KG	260 U				
RDX	UG/KG	1000 U				
Tetryl	UG/KG	650 U				

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COLD REGIONS RESEARCH AND ENGINEERING LABORATORY, CORPS OF ENGINEERS HANOVER, NEW HAMPSHIRE 03755-1290

CECRL-GL

20 October 1997

MEMORANDUM THRU District Engineer, U.S. Army Corps of Engineers, Louisville District, ATTN: CELRL-ED-GE/ Environmental Engr. Section, John Jent, Post Office Box 59 Louisville, KY 40201

SUBJECT: Soil Sample Analysis

1. Attached are the analytical results for soil samples collected at Ravenna AAP in July 1997. These samples were analyzed using two on-site methods for TNT and RDX as well as SW846 method 8330. Sample numbers in the Tables of Data for Winklepeck Burning Ground Pads 67 and 37, and Load Lines 1 and 12 are keyed to the Maps enclosed. Also included in the Tables of Data are the results of metals analysis for Pb, Cd, As and Be.

2. We are in the process of thoroughly analyzing this data. Our analysis to date indicates that the numerical results from the on-site TNT test correlate very well with TNT results from SW846 Method 8330. This is good news, demonstrating that you can use this test with confidence in upcoming site characterization activities to be conducted by SAIC. The situation is quite different for the on-site RDX results where the correlation between the numerical results from the on-site method and Method 8330 is only fair. We are attempting to determine the cause of the poorer results for the RDX test at Ravenna; this situation has not occurred elsewhere. Even though the numerical agreement was not as good as we would like, the RDX field test did pinpoint areas of high RDX concentration. In only one case was a false negative result found, and that was where Method 8330 indicated the RDX concentration to be about 30 mg/kg.

3. I have also enclosed a copy of CRREL Special Report 96-9 with this letter. This report documents some statistical analysis we did for Corps HTRW Center of Expertise at the Omaha District. In particular, there is a discussion of the on pages 15-17 of the degree of agreement of explosives data from split soil samples analyzed in different laboratories using SW846 Method 8330. I feel that it is useful to compare the agreement we found for the on-site and Method 8330 results for TNT at Ravenna with that found for split samples analyzed using the same method at two different laboratories.

CECRL-GL SUBJECT: Soil Sample Analysis

4. Once our analysis of these results is complete, I will prepare a letter report to you discussing our conclusions relative to the usability of the on-site methods for site characterization at Ravenna. In addition, I will provide an analysis of the utility of compositing, for the preparation of representative samples. Clearly the lack of good representative samples has been the rule rather than the exception for explosives site characterization activities in the past. If you wish, I will present these results to the work group at Ravenna so that any questions regarding these results can be answered.

5. I have enjoyed my association with you and the work group, particularly Eileen Mohr at the Ohio EPA. I hope this information proves useful to you as you plan and conduct characterization at the Ravenna AAP site.

Copies Furnished:

Eileen Mohr, Ohio EPA Bob Whelove, IOC Martin Stutz, AEC

THOMAS F. JENKINS Reasearch Chemist Geological Sciences Division

			AD 67	_					
	RNING GR	UUNU - P	METHOD 8	330 RES	ULTS	<u> </u>		0_00	RIMETRIC
-			(n	ng/kg)	T		_	ONSIDE	NALYSIS
					-			mg	/kg)
Sample #	HMX	RDX	TNB	DNT	2-Am-DNT	4-Am-DNT	TNT	TNT	RDX
67.1 (0-6)	0.9	2.5	19.6	<d< td=""><td>4.9</td><td>6.1</td><td>5.4</td><td>6,0</td><td><1</td></d<>	4.9	6.1	5.4	6,0	<1
67-2 (0-6)	0.8	0.5	<d< td=""><td><d< td=""><td><d< td=""><td><d< td=""><td>2.2</td><td><1</td><td><1</td></d<></td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td><d< td=""><td>2.2</td><td><1</td><td><1</td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td>2.2</td><td><1</td><td><1</td></d<></td></d<>	<d< td=""><td>2.2</td><td><1</td><td><1</td></d<>	2.2	<1	<1
67-3 (0-6)	6.5	13.4	32.7	<d< td=""><td>3.5</td><td>5.5</td><td>5.8</td><td>3.3</td><td>1.5</td></d<>	3.5	5.5	5.8	3.3	1.5
67-A (0-6)	7.5	9.6	60.3	<d< td=""><td>9.3</td><td>11.9</td><td>35.9</td><td>34.7</td><td>5.4</td></d<>	9.3	11.9	35.9	34.7	5.4
87-comp 1-4	3.4	5.3	25.7	<d< td=""><td>4</td><td>5.3</td><td>10.9</td><td>5.2</td><td>1.7</td></d<>	4	5.3	10.9	5.2	1.7
87.5 (0.6)	0.1	0.4	<d< td=""><td><d< td=""><td><d< td=""><td>3.7</td><td>5.3</td><td><1</td><td><1</td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td>3.7</td><td>5.3</td><td><1</td><td><1</td></d<></td></d<>	<d< td=""><td>3.7</td><td>5.3</td><td><1</td><td><1</td></d<>	3.7	5.3	<1	<1
67 6 (0-6)	<d< td=""><td><d< td=""><td><d< td=""><td><d< td=""><td>0.2</td><td>1.1.</td><td>0.4</td><td><1</td><td><1</td></d<></td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td><d< td=""><td>0.2</td><td>1.1.</td><td>0.4</td><td><1</td><td><1</td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td>0.2</td><td>1.1.</td><td>0.4</td><td><1</td><td><1</td></d<></td></d<>	<d< td=""><td>0.2</td><td>1.1.</td><td>0.4</td><td><1</td><td><1</td></d<>	0.2	1.1.	0.4	<1	<1
67.7 (0.6)		<d< td=""><td><d< td=""><td><q< td=""><td><d< td=""><td>1.1</td><td>0.6</td><td><1</td><td><1</td></d<></td></q<></td></d<></td></d<>	<d< td=""><td><q< td=""><td><d< td=""><td>1.1</td><td>0.6</td><td><1</td><td><1</td></d<></td></q<></td></d<>	<q< td=""><td><d< td=""><td>1.1</td><td>0.6</td><td><1</td><td><1</td></d<></td></q<>	<d< td=""><td>1.1</td><td>0.6</td><td><1</td><td><1</td></d<>	1.1	0.6	<1	<1
67 R (0.6)	<d< td=""><td><d< td=""><td><d< td=""><td><d< td=""><td>0.2</td><td>0.5</td><td>1.1</td><td><1</td><td><1</td></d<></td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td><d< td=""><td>0.2</td><td>0.5</td><td>1.1</td><td><1</td><td><1</td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td>0.2</td><td>0.5</td><td>1.1</td><td><1</td><td><1</td></d<></td></d<>	<d< td=""><td>0.2</td><td>0.5</td><td>1.1</td><td><1</td><td><1</td></d<>	0.2	0.5	1.1	<1	<1
67 pomp 5-8	<0	0.2	<d< td=""><td><d< td=""><td>0.1</td><td>1.2</td><td>0.6</td><td><1</td><td>14.5</td></d<></td></d<>	<d< td=""><td>0.1</td><td>1.2</td><td>0.6</td><td><1</td><td>14.5</td></d<>	0.1	1.2	0.6	<1	14.5
67-comp 5-0	<d< td=""><td>0.3</td><td>d</td><td><d< td=""><td><d< td=""><td><d< td=""><td>0.2</td><td><1</td><td><1</td></d<></td></d<></td></d<></td></d<>	0.3	d	<d< td=""><td><d< td=""><td><d< td=""><td>0.2</td><td><1</td><td><1</td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td>0.2</td><td><1</td><td><1</td></d<></td></d<>	<d< td=""><td>0.2</td><td><1</td><td><1</td></d<>	0.2	<1	<1
67-9 (0-0)	-d	<d< td=""><td><d< td=""><td><d< td=""><td><d< td=""><td><d< td=""><td>0.1</td><td><1</td><td><1</td></d<></td></d<></td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td><d< td=""><td><d< td=""><td>0.1</td><td><1</td><td><1</td></d<></td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td><d< td=""><td>0.1</td><td><1</td><td><1</td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td>0.1</td><td><1</td><td><1</td></d<></td></d<>	<d< td=""><td>0.1</td><td><1</td><td><1</td></d<>	0.1	<1	<1
67.11 (0-6)	0.4	0.2	<d< td=""><td><d< td=""><td>0.2</td><td>1.6</td><td>1.7</td><td><1</td><td><1</td></d<></td></d<>	<d< td=""><td>0.2</td><td>1.6</td><td>1.7</td><td><1</td><td><1</td></d<>	0.2	1.6	1.7	<1	<1
67 12 (0-6)	0.3	0.1	<d< td=""><td><d< td=""><td>0.1</td><td>1.3</td><td>0.4</td><td><1</td><td><1</td></d<></td></d<>	<d< td=""><td>0.1</td><td>1.3</td><td>0.4</td><td><1</td><td><1</td></d<>	0.1	1.3	0.4	<1	<1
67 comp 9-12	0.2	0.1	0.2	<d< td=""><td>0.1</td><td>0.5</td><td>0.5</td><td><1</td><td><1</td></d<>	0.1	0.5	0.5	<1	<1
67 13 (0.6)	<d< td=""><td><d< td=""><td><d< td=""><td><d< td=""><td><d< td=""><td><d< td=""><td>0.3</td><td><u><1</u></td><td>1.0</td></d<></td></d<></td></d<></td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td><d< td=""><td><d< td=""><td><d< td=""><td>0.3</td><td><u><1</u></td><td>1.0</td></d<></td></d<></td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td><d< td=""><td><d< td=""><td>0.3</td><td><u><1</u></td><td>1.0</td></d<></td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td><d< td=""><td>0.3</td><td><u><1</u></td><td>1.0</td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td>0.3</td><td><u><1</u></td><td>1.0</td></d<></td></d<>	<d< td=""><td>0.3</td><td><u><1</u></td><td>1.0</td></d<>	0.3	<u><1</u>	1.0
67 14 (0.6)	03	0.1	<d< td=""><td><d< td=""><td>, 0.1</td><td>0.8</td><td>0.5</td><td><1</td><td>3.2</td></d<></td></d<>	<d< td=""><td>, 0.1</td><td>0.8</td><td>0.5</td><td><1</td><td>3.2</td></d<>	, 0.1	0.8	0.5	<1	3.2
07 15 (0.6)	0.3	0.2	<d< td=""><td><d< td=""><td>0.2</td><td>0.9</td><td><d< td=""><td><1</td><td><1</td></d<></td></d<></td></d<>	<d< td=""><td>0.2</td><td>0.9</td><td><d< td=""><td><1</td><td><1</td></d<></td></d<>	0.2	0.9	<d< td=""><td><1</td><td><1</td></d<>	<1	<1
07-15 (0-0)	<d< td=""><td><d< td=""><td><d< td=""><td><d< td=""><td>0.3</td><td>1.6</td><td><d< td=""><td>2.</td><td><1</td></d<></td></d<></td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td><d< td=""><td>0.3</td><td>1.6</td><td><d< td=""><td>2.</td><td><1</td></d<></td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td>0.3</td><td>1.6</td><td><d< td=""><td>2.</td><td><1</td></d<></td></d<></td></d<>	<d< td=""><td>0.3</td><td>1.6</td><td><d< td=""><td>2.</td><td><1</td></d<></td></d<>	0.3	1.6	<d< td=""><td>2.</td><td><1</td></d<>	2.	<1
07-10 (U-0)	<			<d< td=""><td>0.1</td><td>1.0</td><td>0.5</td><td><</td><td><1</td></d<>	0.1	1.0	0.5	<	<1
107-1 comp 13-10	241	571	158	<d< td=""><td>7.4</td><td>32.5</td><td>12100</td><td>28200</td><td>101</td></d<>	7.4	32.5	12100	28200	101
01-51 (0-0)	94	28	45.9	<d< td=""><td><d< td=""><td><d< td=""><td>2680</td><td>24.0</td><td>5.7</td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td>2680</td><td>24.0</td><td>5.7</td></d<></td></d<>	<d< td=""><td>2680</td><td>24.0</td><td>5.7</td></d<>	2680	24.0	5.7
107-51 (0-12)	84	28.9	43.6	<d< td=""><td>4.4</td><td>2.8</td><td>3000</td><td>2390</td><td>7.0</td></d<>	4.4	2.8	3000	2390	7.0
107-51 (0-12) OUP	<u><u> </u></u>	82	2.2	<d< td=""><td>0.4</td><td><d< td=""><td>158</td><td>222</td><td>2.1</td></d<></td></d<>	0.4	<d< td=""><td>158</td><td>222</td><td>2.1</td></d<>	158	222	2.1
107-51 (12-10)	108	386	161	<d< td=""><td>20.5</td><td>47.3</td><td>65</td><td>186</td><td>256</td></d<>	20.5	47.3	65	186	256

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NINKLEPECK BU	RNING GRO	JUND - P	AD 67 (CON					000	RINEIRIC
			METHOD 8	330 RESU					ANALISIS
	[(n	ng/kg)		- ·· ·		014-311: /	ANAL SIC
				••••• -			-	UIS TNT	CIT
Sample #	HMX	RDX_	TNB	DNT	2-Am-DNT	4-Am-DNI			PLA
67-52 (6-12)	292	1650	80.8	<d< td=""><td>9.8</td><td>15.9</td><td>12.8</td><td>14.9</td><td></td></d<>	9.8	15.9	12.8	14.9	
67-52 (12-18)	3.4	9.4	7.1	<d< td=""><td>0.6</td><td>1.2</td><td>1.4</td><td>4.0</td><td>1 Juli 1</td></d<>	0.6	1.2	1.4	4.0	1 Juli 1
87-7MS	0.3	0.2	0.3	<d< td=""><td><u> </u></td><td></td><td>0.8</td><td></td><td></td></d<>	<u> </u>		0.8		
SAMPLING WHE	EL TO ASSE	ISS SHOP	T-RANGE	HETEROG	ENEITY IN	WINKLEPE	CK BURNI	NG GRU	DUNEDIC
	[METHOD	8330 RESI	JLTS		-		ANTILICIC
	-		(r	ng/kg)				ON-SIE	ANALISIS
							·	ng ng	y/kg
Samale #	HMX	RDX	TNB	DNT	2-Am-DNT	4-Am-DNT	TNT		KIX
Minoel Presition W	ithin Pad 67		1	ł					·
VVIGEEL P USAGOT TY	4.0	7.1	1.4	0.3	4.6	7.6	136	16.5	1
18	3.9	5.0	1.4	1.8	4.6	11.2	177	19.5	13
	8.5	19.3	109	218	19.2	22.4	3930	396	1)2
28	61	16.3	83.2	3.9	16.0	19.2	4060	680)	116
20	7.5	9.6	6.0	0.9	9.4	12.0	46.2	82.	
38	7.5	9.6	60.3	<d< td=""><td><d< td=""><td><d< td=""><td>35.9</td><td>94.'</td><td>12</td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td>35.9</td><td>94.'</td><td>12</td></d<></td></d<>	<d< td=""><td>35.9</td><td>94.'</td><td>12</td></d<>	35.9	94.'	12
30	12.3	8.9	12.7	0.9	12.4	15.4	89.9	140	1 27
48	10.7	82	9.7	0.6	10.0	12.4	129	13!	\$5
40	10.7	84	5.5	1.1	10.0	35.0	69.0	77.	
58	10.5	81	5.3	1.1	9.5	18.6	51.5	96!	36
50	10.5	79	7.0	1.1	17.0	18.2	190	475)	10
6a	12.2	10.2	7.5	19.4	22.8	23.2	207	26!	28
6D	65	13 3	33	0.2	3.6	5.4	7.5	<',	7.5
7a	0.5	13.4	32.7	<d< td=""><td><d< td=""><td><d< td=""><td>5.8</td><td>9.)</td><td>36</td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td>5.8</td><td>9.)</td><td>36</td></d<></td></d<>	<d< td=""><td>5.8</td><td>9.)</td><td>36</td></d<>	5.8	9.)	36
76	- 70	87	23.1	1.5	10.2	23.0	403	149	4.7
comp a (1-7)	1.3	9.7	15.0	0.9	10.8	32.4	298	84)	£.3
comp b (1-7)	8.1		16.0	13	12.0	20.6	1028	10:0	4.3
comp c (1–7)	8.4	1 11.4	10.3	1.0					

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ANALYTICAL RESULTS FOR SOILS SAMPLED AT FAVENNA AAP - JULY 1997

WINKLEPECK BU	IRNING GF	ROUND - PA	ND 67			.]]		} .
	HMX	RDX	TNB	DNT	2-im-DN	- 4-Am-DNT	TNT)
SAIC DATA	2000	10000	490	<d< th=""><th><d< th=""><th><q< th=""><th>3000</th><th></th></q<></th></d<></th></d<>	<d< th=""><th><q< th=""><th>3000</th><th></th></q<></th></d<>	<q< th=""><th>3000</th><th></th></q<>	3000	
AEHA -1 (0-6)	686	2976	<(<d< td=""><td><d< td=""><td><d< td=""><td>1516</td><td> · · · · · · · · · ·</td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td>1516</td><td> · · · · · · · · · ·</td></d<></td></d<>	<d< td=""><td>1516</td><td> · · · · · · · · · ·</td></d<>	1516	 · · · · · · · · · ·
AEHA -1 (6-18)	21.6	, 124	<	<d< td=""><td><d< td=""><td><d< td=""><td>31.2</td><td></td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td>31.2</td><td></td></d<></td></d<>	<d< td=""><td>31.2</td><td></td></d<>	31.2	
AEHA -2 (0-6)	2.2	2.4	<	<d< td=""><td><d< td=""><td><d< td=""><td>6.2</td><td>ļ </td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td>6.2</td><td>ļ </td></d<></td></d<>	<d< td=""><td>6.2</td><td>ļ </td></d<>	6.2	ļ
AEHA -2 (6-18)	3.3	2.3	ব	<q< td=""><td><d< td=""><td><d< td=""><td><d< td=""><td></td></d<></td></d<></td></d<></td></q<>	<d< td=""><td><d< td=""><td><d< td=""><td></td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td></td></d<></td></d<>	<d< td=""><td></td></d<>	
]		Ì		1	1		

WINKLEPECK BU	RNING GR	OUND - P.	AD 37	1				<u> </u>	!
			METHOD	8330 RES	ULTS			COLC	RIMETRIC
	,			mg/kg)				ON-SITE	ANALYSIS
			Į					(m <u>(</u>	j/kg)
Sample #	НИХ	RDX	TNB	DNT	2-Am-DNT	4-Am-DNT			RDX
		 				- max			
37-1 (0-6)	‹ ۲	2.8	0.1	0.2	0.6	<d< td=""><td>2.6</td><td><1</td><td>5.3</td></d<>	2.6	<1	5.3
37-2 (0-6)	C.)	0.3	<d< td=""><td>0.4</td><td><d< td=""><td><d< td=""><td>0.1</td><td><1</td><td>14.0</td></d<></td></d<></td></d<>	0.4	<d< td=""><td><d< td=""><td>0.1</td><td><1</td><td>14.0</td></d<></td></d<>	<d< td=""><td>0.1</td><td><1</td><td>14.0</td></d<>	0.1	<1	14.0
37-3 (0-6)	<d< td=""><td>0.2</td><td><d< td=""><td>0.5</td><td><d< td=""><td><d< td=""><td>0.3</td><td>2.6</td><td>5.7</td></d<></td></d<></td></d<></td></d<>	0.2	<d< td=""><td>0.5</td><td><d< td=""><td><d< td=""><td>0.3</td><td>2.6</td><td>5.7</td></d<></td></d<></td></d<>	0.5	<d< td=""><td><d< td=""><td>0.3</td><td>2.6</td><td>5.7</td></d<></td></d<>	<d< td=""><td>0.3</td><td>2.6</td><td>5.7</td></d<>	0.3	2.6	5.7
37-4 (0-6)	4	0.2	<d< td=""><td>0.5</td><td></td><td><d< td=""><td>0.1</td><td>2.3</td><td>1.8</td></d<></td></d<>	0.5		<d< td=""><td>0.1</td><td>2.3</td><td>1.8</td></d<>	0.1	2.3	1.8
37-comp 1-4	<d< td=""><td>1.0</td><td><d< td=""><td>0.4</td><td>0.2</td><td><d< td=""><td>1.0</td><td>2,4</td><td>9.3</td></d<></td></d<></td></d<>	1.0	<d< td=""><td>0.4</td><td>0.2</td><td><d< td=""><td>1.0</td><td>2,4</td><td>9.3</td></d<></td></d<>	0.4	0.2	<d< td=""><td>1.0</td><td>2,4</td><td>9.3</td></d<>	1.0	2,4	9.3
37-5 (0-6)	1.7	1.5	<d< td=""><td>0.7</td><td><d< td=""><td><d< td=""><td>1.2</td><td>1.4</td><td>4.9</td></d<></td></d<></td></d<>	0.7	<d< td=""><td><d< td=""><td>1.2</td><td>1.4</td><td>4.9</td></d<></td></d<>	<d< td=""><td>1.2</td><td>1.4</td><td>4.9</td></d<>	1.2	1.4	4.9
37-5 (0-6) dup	<d< td=""><td><d _<="" td=""><td><d td="" <=""><td><d< td=""><td><d< td=""><td><d .<="" td=""><td><d< td=""><td>1.5</td><td>3.2</td></d<></td></d></td></d<></td></d<></td></d></td></d></td></d<>	<d _<="" td=""><td><d td="" <=""><td><d< td=""><td><d< td=""><td><d .<="" td=""><td><d< td=""><td>1.5</td><td>3.2</td></d<></td></d></td></d<></td></d<></td></d></td></d>	<d td="" <=""><td><d< td=""><td><d< td=""><td><d .<="" td=""><td><d< td=""><td>1.5</td><td>3.2</td></d<></td></d></td></d<></td></d<></td></d>	<d< td=""><td><d< td=""><td><d .<="" td=""><td><d< td=""><td>1.5</td><td>3.2</td></d<></td></d></td></d<></td></d<>	<d< td=""><td><d .<="" td=""><td><d< td=""><td>1.5</td><td>3.2</td></d<></td></d></td></d<>	<d .<="" td=""><td><d< td=""><td>1.5</td><td>3.2</td></d<></td></d>	<d< td=""><td>1.5</td><td>3.2</td></d<>	1.5	3.2
37-6 (0-6)	<1	0.8	<d td="" <=""><td>0.9</td><td>0.2</td><td>0.5</td><td>0.1</td><td><1</td><td>4.6</td></d>	0.9	0.2	0.5	0.1	<1	4.6
37-7 (0-6)	- <1	<d< td=""><td> <d td="" <=""><td>0.1</td><td><d< td=""><td><d< td=""><td>0.3</td><td><1</td><td>1.4</td></d<></td></d<></td></d></td></d<>	<d td="" <=""><td>0.1</td><td><d< td=""><td><d< td=""><td>0.3</td><td><1</td><td>1.4</td></d<></td></d<></td></d>	0.1	<d< td=""><td><d< td=""><td>0.3</td><td><1</td><td>1.4</td></d<></td></d<>	<d< td=""><td>0.3</td><td><1</td><td>1.4</td></d<>	0.3	<1	1.4
37-8 (0-6)		0,1	<d< td=""><td><d< td=""><td><d< td=""><td><d< td=""><td>0.5</td><td><1</td><td>11.1</td></d<></td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td><d< td=""><td>0.5</td><td><1</td><td>11.1</td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td>0.5</td><td><1</td><td>11.1</td></d<></td></d<>	<d< td=""><td>0.5</td><td><1</td><td>11.1</td></d<>	0.5	<1	11.1
37-comp 5-8		0.7	d>	0.7	<q< td=""><td></td><td>0.3</td><td><1</td><td>1.1</td></q<>		0.3	<1	1.1
37-9 (0-6)	~	<d< td=""><td><d< td=""><td>0.1</td><td>0.5</td><td><d< td=""><td>0.2</td><td><1</td><td>2.6</td></d<></td></d<></td></d<>	<d< td=""><td>0.1</td><td>0.5</td><td><d< td=""><td>0.2</td><td><1</td><td>2.6</td></d<></td></d<>	0.1	0.5	<d< td=""><td>0.2</td><td><1</td><td>2.6</td></d<>	0.2	<1	2.6
37-10 (0-6)	≺ €	0.1	<d< td=""><td><d< td=""><td><d< td=""><td><u><q< u=""></q<></u></td><td>0.3</td><td>2.0</td><td><1</td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td><u><q< u=""></q<></u></td><td>0.3</td><td>2.0</td><td><1</td></d<></td></d<>	<d< td=""><td><u><q< u=""></q<></u></td><td>0.3</td><td>2.0</td><td><1</td></d<>	<u><q< u=""></q<></u>	0.3	2.0	<1
37-11 (0-6)	< <u>(</u>	0.3) <d< td=""><td>0.5</td><td>0.4</td><td>0.5</td><td>0.2</td><td>2.0</td><td><1</td></d<>	0.5	0.4	0.5	0.2	2.0	<1
37-12 (0-6)	·	<d< td=""><td><d< td=""><td><d< td=""><td></td><td><u><d< u=""></d<></u></td><td><d< td=""><td><1</td><td><1</td></d<></td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td></td><td><u><d< u=""></d<></u></td><td><d< td=""><td><1</td><td><1</td></d<></td></d<></td></d<>	<d< td=""><td></td><td><u><d< u=""></d<></u></td><td><d< td=""><td><1</td><td><1</td></d<></td></d<>		<u><d< u=""></d<></u>	<d< td=""><td><1</td><td><1</td></d<>	<1	<1
37-12 (D-6) dup	<d< td=""><td><d< td=""><td><d< td=""><td><d< td=""><td><d< td=""><td><d< td=""><td><7</td><td><1</td><td><1</td></d<></td></d<></td></d<></td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td><d< td=""><td><d< td=""><td><d< td=""><td><7</td><td><1</td><td><1</td></d<></td></d<></td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td><d< td=""><td><d< td=""><td><7</td><td><1</td><td><1</td></d<></td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td><d< td=""><td><7</td><td><1</td><td><1</td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td><7</td><td><1</td><td><1</td></d<></td></d<>	<d< td=""><td><7</td><td><1</td><td><1</td></d<>	<7	<1	<1
37-comp 9-12	a l	0.1	<d< td=""><td>0.1</td><td>0.4</td><td>0.2</td><td>0.1</td><td><1</td><td><1</td></d<>	0.1	0.4	0.2	0.1	<1	<1
37-13 (0-6)	- d - "	<d< td=""><td><d< td=""><td><q< td=""><td><d< td=""><td><d< td=""><td>D.1</td><td><1</td><td> <1</td></d<></td></d<></td></q<></td></d<></td></d<>	<d< td=""><td><q< td=""><td><d< td=""><td><d< td=""><td>D.1</td><td><1</td><td> <1</td></d<></td></d<></td></q<></td></d<>	<q< td=""><td><d< td=""><td><d< td=""><td>D.1</td><td><1</td><td> <1</td></d<></td></d<></td></q<>	<d< td=""><td><d< td=""><td>D.1</td><td><1</td><td> <1</td></d<></td></d<>	<d< td=""><td>D.1</td><td><1</td><td> <1</td></d<>	D.1	<1	<1
37-14 (0-6)	<1	0.1		0.1	<d< td=""><td><d< td=""><td>0.9</td><td><1</td><td><1</td></d<></td></d<>	<d< td=""><td>0.9</td><td><1</td><td><1</td></d<>	0.9	<1	<1
37-15 (0-6)	র	3.0	<d< td=""><td>0.3</td><td><d< td=""><td>< d</td><td>1.4</td><td><1</td><td>79</td></d<></td></d<>	0.3	<d< td=""><td>< d</td><td>1.4</td><td><1</td><td>79</td></d<>	< d	1.4	<1	79
37-16 (0-6)	4	40.4	<d< td=""><td>0.7</td><td><d< td=""><td><d< td=""><td>1.1</td><td>2.3</td><td>9.0</td></d<></td></d<></td></d<>	0.7	<d< td=""><td><d< td=""><td>1.1</td><td>2.3</td><td>9.0</td></d<></td></d<>	<d< td=""><td>1.1</td><td>2.3</td><td>9.0</td></d<>	1.1	2.3	9.0
37-1 comp 13-16	36	6.1	<d< td=""><td>0.2</td><td>0.4</td><td><d< td=""><td>0.5</td><td>1.1</td><td>21.4</td></d<></td></d<>	0.2	0.4	<d< td=""><td>0.5</td><td>1.1</td><td>21.4</td></d<>	0.5	1.1	21.4
37-1 comp near	23	1.6	<d< td=""><td>0.4</td><td><d< td=""><td><d< td=""><td>0,9</td><td>1.0</td><td>4.0</td></d<></td></d<></td></d<>	0.4	<d< td=""><td><d< td=""><td>0,9</td><td>1.0</td><td>4.0</td></d<></td></d<>	<d< td=""><td>0,9</td><td>1.0</td><td>4.0</td></d<>	0,9	1.0	4.0
37.1 comp fat	32	0.1	<d< td=""><td>0.3</td><td><d< td=""><td> <d< td=""><td>0.2</td><td>1.0</td><td>1.8</td></d<></td></d<></td></d<>	0.3	<d< td=""><td> <d< td=""><td>0.2</td><td>1.0</td><td>1.8</td></d<></td></d<>	<d< td=""><td>0.2</td><td>1.0</td><td>1.8</td></d<>	0.2	1.0	1.8

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NALISES OF SU			METHOD 8330 RESULTS				·	ON-SITE ANALYS	
• • •			(mg/kg)					(mg	(ka)
	LINAX	RDX	TNB	DNT	2-Am-DNT	4-Am-DNT	TNT	TNT	RDX
	1 110121							4500	212
	20.2	260	70.6	<d< td=""><td>5.4</td><td>4.0</td><td>5780</td><td>1000</td><td><u> </u></td></d<>	5.4	4.0	5780	1000	<u> </u>
2-1 (U-6)	29.2	18.2	24.1	<d< td=""><td>1.6</td><td>1.6</td><td>192</td><td>120</td><td>12</td></d<>	1.6	1.6	192	120	12
2-1 (6-12)	21	8.2	7.9	<d< td=""><td>0.4</td><td><d< td=""><td>635</td><td>200</td><td>20</td></d<></td></d<>	0.4	<d< td=""><td>635</td><td>200</td><td>20</td></d<>	635	200	20
2-1 (12-18)	35	21.8	2.4	<d< td=""><td><d< td=""><td><d< td=""><td>267</td><td>$\frac{524}{056}$</td><td>2.0</td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td>267</td><td>$\frac{524}{056}$</td><td>2.0</td></d<></td></d<>	<d< td=""><td>267</td><td>$\frac{524}{056}$</td><td>2.0</td></d<>	267	$\frac{524}{056}$	2.0
2-1 (18-24)	0.0	5.8	<d< td=""><td><d< td=""><td>4.4</td><td>1.4</td><td>68.6</td><td>95.0</td><td>16.7</td></d<></td></d<>	<d< td=""><td>4.4</td><td>1.4</td><td>68.6</td><td>95.0</td><td>16.7</td></d<>	4.4	1.4	68.6	95.0	16.7
2-1 (24-30)	27 4	199	22.2	<d< td=""><td>0.4</td><td>0.2</td><td>2080</td><td></td><td>22</td></d<>	0.4	0.2	2080		22
2-1 (30-37)	07	11.2	<d< td=""><td><d< td=""><td>11.2</td><td>10.0</td><td>89.8</td><td>92.2</td><td>24 0</td></d<></td></d<>	<d< td=""><td>11.2</td><td>10.0</td><td>89.8</td><td>92.2</td><td>24 0</td></d<>	11.2	10.0	89.8	92.2	24 0
2-1 (3/-45)	215	189	17.5	<d< td=""><td>7.4</td><td>3.0</td><td>1994</td><td>1/10</td><td>24.3</td></d<>	7.4	3.0	1994	1/10	24.3
2-2 (0-6)	15	86	<d< td=""><td><d< td=""><td><d< td=""><td><d td="" <=""><td>0.5</td><td>4070</td><td>4280</td></d></td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td><d td="" <=""><td>0.5</td><td>4070</td><td>4280</td></d></td></d<></td></d<>	<d< td=""><td><d td="" <=""><td>0.5</td><td>4070</td><td>4280</td></d></td></d<>	<d td="" <=""><td>0.5</td><td>4070</td><td>4280</td></d>	0.5	4070	4280
2-3 (0-6)	355	3970	95.2	<d< td=""><td>1.0</td><td>1.6</td><td>3150</td><td>18/0</td><td>1200</td></d<>	1.0	1.6	3150	18/0	1200
2-4 (0-6)	- 33	04	<d< td=""><td><d< td=""><td>3.8</td><td>2.4</td><td>27.1</td><td>40.4</td><td></td></d<></td></d<>	<d< td=""><td>3.8</td><td>2.4</td><td>27.1</td><td>40.4</td><td></td></d<>	3.8	2.4	27.1	40.4	
2-5 (0-6)	<u></u>	22	3.3	<d< td=""><td>8.2</td><td>8.0</td><td>1.6</td><td><pre><1</pre></td><td></td></d<>	8.2	8.0	1.6	<pre><1</pre>	
2-5 (6-12)	1.0	37	6.4	<d< td=""><td>1.4</td><td>1.0</td><td>2.1</td><td></td><td>20</td></d<>	1.4	1.0	2.1		20
2-5 (12-18)	n 5	0.8	5.3	<d< td=""><td><d< td=""><td><0</td><td>1.4</td><td>1.8</td><td><u> </u></td></d<></td></d<>	<d< td=""><td><0</td><td>1.4</td><td>1.8</td><td><u> </u></td></d<>	<0	1.4	1.8	<u> </u>
2-5 (18-27)	0.0	03	0.1	<d< td=""><td><d< td=""><td><d< td=""><td>0.5</td><td></td><td>5.0</td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td>0.5</td><td></td><td>5.0</td></d<></td></d<>	<d< td=""><td>0.5</td><td></td><td>5.0</td></d<>	0.5		5.0
12-5 (27-35)	0.2	0.2	<d< td=""><td><d< td=""><td><d< td=""><td><u><d< u=""></d<></u></td><td>0.6</td><td></td><td></td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td><u><d< u=""></d<></u></td><td>0.6</td><td></td><td></td></d<></td></d<>	<d< td=""><td><u><d< u=""></d<></u></td><td>0.6</td><td></td><td></td></d<>	<u><d< u=""></d<></u>	0.6		
12-5 (35-45)	0.0	0.2	<d< td=""><td><d< td=""><td><d< td=""><td>0.1</td><td>0.1</td><td></td><td>61.6</td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td>0.1</td><td>0.1</td><td></td><td>61.6</td></d<></td></d<>	<d< td=""><td>0.1</td><td>0.1</td><td></td><td>61.6</td></d<>	0.1	0.1		61.6
12-6 (0-6)	123	1359	224	<d< td=""><td>20.8</td><td>15.8</td><td>5780</td><td>0300</td><td></td></d<>	20.8	15.8	5780	0300	
12-7 (0-6)	0.6	0.9	<d< td=""><td><d< td=""><td><d< td=""><td>3.1</td><td>- 1.4</td><td></td><td>21</td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td>3.1</td><td>- 1.4</td><td></td><td>21</td></d<></td></d<>	<d< td=""><td>3.1</td><td>- 1.4</td><td></td><td>21</td></d<>	3.1	- 1.4		21
12-B (U-0)		30.5	<d< td=""><td><d< td=""><td><d< td=""><td>8.0</td><td>2.0</td><td></td><td></td></d<></td></d<></td></d<>	<d< td=""><td><d< td=""><td>8.0</td><td>2.0</td><td></td><td></td></d<></td></d<>	<d< td=""><td>8.0</td><td>2.0</td><td></td><td></td></d<>	8.0	2.0		
12-9 (U-6)	h>	<d< td=""><td><d< td=""><td>d></td><td></td><td><d< td=""><td>0.4</td><td><u> </u></td><td>244</td></d<></td></d<></td></d<>	<d< td=""><td>d></td><td></td><td><d< td=""><td>0.4</td><td><u> </u></td><td>244</td></d<></td></d<>	d>		<d< td=""><td>0.4</td><td><u> </u></td><td>244</td></d<>	0.4	<u> </u>	244
12-10 (0-6)	447	1600	184	<pre><d< pre=""></d<></pre>	10.2	5.4	5780	8030	<u> </u>

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ANALYSES OF SC	DIL SAMPI	LES FRON	LOAD LIN	IĘ 1					· ·
						· · · · · · · · · · · · · ·		i · ·	
		<u> </u>	METHOD) 8331 RES	ULTS				RIMETRIC
				(1.1.2.2.2.				(mg	/kgi
	них	BUX	TNB	DNT	2-Am-DNT	4-Am-DNT	TNT	TNT	RDX
	0.1	0.1		0.5	1.4	<d td="" <=""><td>0.6</td><td>1 1</td><td>1 1</td></d>	0.6	1 1	1 1
		h>	h>	<d< td=""><td>0.1</td><td><d< td=""><td>D 1</td><td><1</td><td>(1</td></d<></td></d<>	0.1	<d< td=""><td>D 1</td><td><1</td><td>(1</td></d<>	D 1	<1	(1
LL1-2 (0-6)		sd	b>	<d< td=""><td><d< td=""><td><d td="" <=""><td>02</td><td><1</td><td><1</td></d></td></d<></td></d<>	<d< td=""><td><d td="" <=""><td>02</td><td><1</td><td><1</td></d></td></d<>	<d td="" <=""><td>02</td><td><1</td><td><1</td></d>	02	<1	<1
LL1-2 (6-12)			01	<d< td=""><td><d <<="" td=""><td>0.1</td><td>0.3</td><td><1</td><td><1</td></d></td></d<>	<d <<="" td=""><td>0.1</td><td>0.3</td><td><1</td><td><1</td></d>	0.1	0.3	<1	<1
LL1-2 (12-18)			< <u></u>	- D.3	0.7	0.2.	0.5	<1	<1
LL1-3 (0-6)	< <u>a</u>					<d td="" <=""><td><d< td=""><td><1</td><td><1</td></d<></td></d>	<d< td=""><td><1</td><td><1</td></d<>	<1	<1

CELRL-ED-G

		-							
- I			METHOD	3330 RES mg/kg)	JLTS			COLC ON-SITE	RIMETRI ANALYSI /kg)
Sample #	НМХ	RDX	TNB	DNT	2-Am-DNT	4-Am-DNT	TNT	ТИТ	RDX
LL2 SS14 (0-6)	40278	8649	1174	65.8	79.4	d	1451	1490 1700	181C0 323C0
LL2 SS 14 (surface under building)	43	1936	518	3.5	6.0	<d <d< td=""><td>56.0</td><td>127</td><td>1135</td></d<></d 	56.0	127	1135

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	Metals Analy	sís - Ator	nic Absor	ption (Meth	nod 3050A)	
Sample #		Depth	Pb	Co	As	Be
		Inches	mg/kg	mg/kg	mg/kg	mg/kg
ocation						0 705
57-1].	0-6	235	0.652	10.6	0.795
37-2		0-6	52.3	0.455	11.9	0.972
37-3	1	0-6	261	1.45	B.20	0.443
37-4		0-6	172	1.91	10.0	0.547
37-5		0-6	48.0	1.83	10.1	0.804
57-6		D-6	77.1	3.81	10.6	0.740
87.7		0-6	23.5	0.404	13.5	0.829
67-8		0.6	92.2	2,56	15.2	0.658
B7-9		0-6	41.7	1.57	17.7	0.668
67-10		0-6	26.5	7.97	13.1	0.623
67-11	· · ·	0-6	195	3.05	14.4	0.504
67-12		0-6	65.(0.865	8.82	1.200
67-13		0.6	83.1	0.308	13.0	0.581
87.14	1	0-6	176	D.341	38.1	0.619
87-15		0-6	713	3.67	10.6	1.610
67-16		0-6	184	2,19	9.96	1.500
Comp67 1-4		0-6	19)	1.22	12.9	0.833
Comp67 5-A		0-6	637	2.05	12.4	0.714
Comp87 0-1	2	0-6	86.4	1.30	14.2	0.603
Comp67 13-	<u></u> 16	0.6	1 33	0.772	12.2	1.000
67.S1	- T	0-6	151	1.03	9.80	0.788
47 61		6.12	3E 2	0.574	15.0	0.541
67 64		12-18	130	0.024	9.70	0.436
67.00		0.6	177	0.820	8.56	0.669
01-52		8.12	512	1 22	10.4	0.660
01-52	·· . [10 10	Ato	0.041	10.7	0.512

Point of Conlact: Thomas F. Jenkins, CRREL, 603-646-4385

SAMPLING WHEEL TO ASSESS SHORT-RANGE HETEROGENEITY										
WINKLEPECK BURI	VING GROUND	PAU 67	- At							
Metals	metals Analysis - Atomic Absolption (metalod 3030A)									
			_ · ·	· · ·	• •					
Sample #	Depth	Pb	Cd	As	Be					
Wheel Position Within	Pad 57	mg/kg	mg/kg	mg/kg	mg/kg					
	Inches									
	0.6	154	2 23	10.7	0.538					
18	0-6	144	2 47	11.2	0 502					
10	0.6	375	2 35	10.1	0 537					
28	0-6	124	2.55	114	0.550					
20	0-0	172	1.91	9.53	0.547					
38	0-6	161	2.04	8 76	0.623					
	0-6	151	1.56	9.53	0.524					
48	0-6	138	1.52	873	0.548					
	0-6	165	1.90	7.29	0.471					
58	0.6	178	2.08	11.7	0.490					
	0-6	169	2.18	12.1	0.565					
	0-6	113	2.01	8.39	0.593					
70	0-6	261	1.46	8.20	0.443					
76	0-6	298	1.56	9.37	0.650					
comp a (1-7)	0-6	188	2.04	10.3	0.533					
comp b $(1-7)$	0-6	155	2.07	12.2	0.548					
comp c (1-7)	0-6	353	2.17	11.8	0,603					
comp d (1-7)	0-6	173	1.97	12.0	0.488					
comp e (1-7)	0-6	181	2.29	9.60	0.537					
comp + (1-7)	- 0-6 i	217	2.25	12.7	0.647					
1 = 1 = 1 = 1 = 1 = 1 = 1 = 1 = 1 = 1 =	0.6	172	2.14	10.6	0.501					
3	6-12	460	4.94	14.1	0.517					
i i	12-18	54.6	1.20	15.0	0,731					

Point of Contact: Thomas F. Jenkins, CRREL, 603-646-4385

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CELRL-ED-G



Locations for soil samples at Ravenna AAP, Winklepeck Burning Grounds Pad 67.



Locations for soil samples at Ravenna AAP, Winklepsck Burning Gounds Pad 37.

TJ-58





USACHREL - Maria	nne E. Walsh	2 603-646-4785	D <u>11/7/97</u>	©2:37 PM	<u>G</u> 1/3
X	DATE:	Friday, November 7, 1997	ME	EM	0
	TO:	John Jent, Louisville District	Here is a draft le	iter, Tom would	like to
4	FAX:	502 582-5168	send this letter b to Bob Whalove Cicero. If you w within contact T	y mail to you wi , Eileen Mohr, a ant any changes ant any changes	th copies and John : in the Mecianum
	FROM:	USACRREL - Marianne E. Waleh			
	PAGES	: 3		**	

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USACRAEL-Marianne E. Walsh

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Draft Memorandum for: John Jent

Subject: Use of Colorimetric RDX Field Test at RAAP

1. In July 1997, soils from RAAP were analyzed by field colorimetric and laboratory methods to determine the presence of explosives-residues. The results of these analyses showed that the field estimates of TNT consultations were in good agreement with estimates obtained by laboratory analyses. However, the field estimates of RDX showed poor constantion with laboratory results. We have reanalyzed some of these soils and the results of these analyses are attached.

2. We have identified the following limitations to the use of the Colorimetric RDX Field Test at RAAP:

A. Some soil extracts from RAAP yielded a canary yellow color following the RDX colorimetric test. The source of this color is unknown. This background color can mask the pink color that forms from RDX when RDX concentrations are low.

B. The presence of nitrate in soil will yield a positive interference for RDX.

C. High concentrations of TNT relative to RDX will result in low concentration estimates of RDX by the field method

D. One soil (Sample 37-16 (0-6)) tested by the RDX test yielded a very low estimate of RDX compared to the HPLC analysis. A matrix spike of this soil showed poor recovery.

3. Based on these limitations, we recommended the following approach for RAAP if the objective is to screen for explosives-residues in soil:

A. Perform TNT Field Colorimetric Test first.

a. If the test is positive for TNT, the soil is contaminated so the RDX test is not necessary.

b. If the test is negative for TNT, perform the RDX test. To avoid positive interference from nitrate and nitrite, use the anion exchange cartridges as described in the method to remove these anions from the acetone extract. 2 e

B. The RDX test should be considered positive if a pinkish color forms. If no color forms, the test is negative. If a bright yellow color forms, the results are ambiguous and should be confirmed by laboratory analyses.

C. Quality control should include matrix spike recovery tests to identify the presence of negative interferences. We recommend using composite soil samples for these tests.

4. Another option may be to consider the use of the DTech RDX test at RAAP. Quantitative results with this test are often only marginal, but if the test is only being conducted to choose samples for lab analysis, it may be adequate. We had five DTech kits available at CRREL and ran the five samples indicated in the attached data table. The DTech test appeared to give acceptable results for these five soils. If you would like us to pursue this option, we can discuss how to accomplish a more extensive comparison.



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RAAP ROX Test Ann	eats		Concentration (mo/kg)						
		Colorimetric	Acetone HPLC			Method 8330		DTech	
	Anioh	Color				BUX	нму	BUX	
	EXCHANGE		- DUA -	1926		1650	2921		
2 **>2 (b-12)		Pillik in auk or	1.386					gana <mark>a</mark> an saya	
7.52 (12-14)	00	pink	11	79	2.6	9.4	3.4		
36 (12-19)	VêS.	pink	7.6	• • •	{			<u> </u>	
7-comp 5-6	no	coloriess	0.68	0.10	<d< td=""><td>0.2</td><td><d< td=""><td></td></d<></td></d<>	0.2	<d< td=""><td></td></d<>		
	Ves	coloriese	0.68						
V11 1 Subsamp 1	no	pink fiesh	2.5	13	1.6				
	YES	pink flesh	1.3						
					· · · · · · · · · · · · · · · · · · ·				
V11-1 Subsamp 2	no	pink Tesh	1.9	1,3	7. 0)	2.0	J, 9		
	<u> </u>		1.41						
N11-5	50	vellow	5.6	2.4	6.9	8.1	10,4	2.5 to 4.5	
	Yes	vellow	4.7	/					
A 11/A	no.	yellow	4.8	2.8	40	7,9	10.5	1.5 to 2.5	
	yes	yeilow	6 .1				· · ·	L	
1			0.541		0.60			-0.5	
7-comp 1-4	no.	Coloness	0.92	0,50	v.	,	*G	40.0	
	усь	COIDFIESS	9.76						
7.5 (0.5)	00	paie pink	1.63	1,80	78	1.5	0.7		
10-010-01	Ves	coloriess	0.72						
May 1 and 1 and						<u>کان بر اکتر او</u>			
7-16 (0-6)	no	pink	3.60	46.9	6.7	40.4	<d< td=""><td>75 10 125</td></d<>	75 10 125	
	_yes	bale hink	1.39						
								i	
7-15 (0-6) Spiked	-	nink	4.74		1			(
1	,	Recovery -	24%			-			
and a second second						<u> </u>			
37 comp 13-16	no	yellow	5.4	10.5	2.8	6.1	3.6	}	
	yes.	pale pink	2,1					L	
		the second second second	15.641	410		2970	100	5500	
M12-4	no		1541	-10	0.3	3979	439	}	
A STATE -		AND A LOCAL DATE OF A LOCAL DA	[[]]]				· · · · · · · · · · · · · · · · · · ·	1	
N12-7	ิกษ	yellew in 2011 all	127	182	0.4	1389	(23		
(and the set of the s		met prink in augult de	48712	35500		1939	43	I	
							6		
AEC Soil Spiked at			10.0		1				
50 ft 87 g) yes	Deseuters	1004		í			(

NOTE: Eviorimetrie, Acetone HPI C and Direch analyses used the same acetone extract. Method 8330 used a separate P-p coil subsample and aceton tile extraction.

T20 0 Manane & Walsh, USACRREL, 603-646-4666

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John Jent CELRL-ED-GE PO Box 59 Louisville, KY 40201

Re: Analysis of Pb, Cd, As, and Be in soil samples collected on burn pad #67.

Enclosed are results obtained for the various soil samples obtained by Dr. Tom Jenkins et al., at RVAAP-05, during their recent site visit. These analyses were performed on approximately 2 grams of air dried soil, taken directly from the bags and bottles that have been proceed by the CRRFI sampling team. As with those samples prepared for munitions analysis, a conscious effort was made to only removed the fines (< 1 mm) for extraction. For the metal determinations, all of the Ravenna samples and NIST reference materials were extracted on a hot plate using a combination of HNO₉ and hydrogen peroxide as described in Method 3050A, of the SW-846.

All analyses were performed by Graphite Furnace Atomic Absorption, using Zeeman background correction. Unfortunately, we did not have a reference material that included a certified or even a qualified value for Be, thus, the determination of this metal was performed without any form of quality assurance/quality control. As a check of the efficiency of the extraction process samples representative of each quadrant were re-extracted after the initial hot plate procedure (Method 3050), by using Method 3051, a microwave assisted extraction procedure. This second extraction of the residual soil matrix did not show any significant (<5%) additional release of any of these four metals.

If for some reason, you would like conformation of any of the values reported, please let us know. We still have a generous amount of the original soil samples and I expect we will keep the acid extracts for at least 6 months.

I've enclosed some papers covering some of my work with extraction procedures and with XRF analysis. A visual inspection of the data did not find any correlation between the metals.

Sincerely, Ale A. Henrift

Alan D Hewitt

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Ravenna Army Ammur	nition Plant	<u> </u>			
Winklepeck Burning G	rounds (RVAAP-C	5) Burn pad	#67		
Method 3050A - 2 g o	f air dried sample	9			
Sampling	Danth	un Dh / m	Cale		un Rolat
Location				10.6	
67-1		230	0.002	11.0	0.795
67-2	0-0	061	1 465	11.5	0.972
67-3	<u> </u>	201	1.40	10	0.443
67-4	0.6	A 9	1.91	10.1	0.547
67-5	0-6	77 4	1.00	10.1	0.804
67-0	0.6	22 3	0 404	13.5	0.829
67-7	0.0	23.3	404.U 33 C	15.0	0.629
67-8	0.0	<u> </u>	1 87	177	0.058
67-9	0.6	41.7	7.07	12.1	0.000
67-10	U-0	20.5	<u> </u>	13.1	0.623
67.11	<u>U-6</u>	195	3.05	14.4	0.504
67-12	D+6	CO 7	0.000	<u> </u>	0.601
67-13	0-6	83./	0.308	13	0.561
67-14	U-0	71 3	0.341	1.06	0.019
67-15	U-D	1.0	3.D/ 3.10	10.0	1.01
67-16	0-6	104	<u>4.19</u>	9.30	0 822
Comp67 1-4	0-0	199	1.44		0.033
Comp67 5-8	0-6	03./	2,03		0.714
Comp67 9-12	0-6	86.4	1.3	14.4	0.603
Comp67_13-16		133	0.772	12.2	0 700
6 <u>7-S1</u>	0-6	151	1.03	<u> </u>	0.788
<u>67-S1</u>	6-12		0.5/4		0.541
67-S1	12-18	13	0.024	<u> </u>	0.436
67-S2	0+6	1//	0.82	8.36	9.669
67-52	6-12	53.2	1.22	10.4	0.60
67-S2	12-18	48.8	0.041	10.7	0.512
W11-1A	0-6	154	2.23	10.7	0.538
W11-1B	0-6	144	2,47	11,2	0.502
W11-2A	0-6	375	2.35	10.1	0.537
W11-2B	0-6	124	2.55	11,4	0.55
W11-3A	0-6	172	1.91	9.53	0.547
W11-3B	0-6	161	2.04	8.76	0.623
W11-3	6-12	460	4.94	14,1	0.517
W11-3	12-18	54.6	1.2	18	0.73
W11-4A	0.6	151	1.56	9.5	0.524
W11-4B	0-6	138	1.52	8.73	0.548
W11-5A	0-6	165	1.5	7.2	0,47
W11-5B	0.6	178	2.08	11.	0.49
W11-6A	0-6	169	2.18	12.	0.56
W11-6B	0-6	113	2.01	<u> </u>	0.593

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Sheet1

W11-7A	0-6	261	1.40	8.2	0.443
W11-7B	0-6	298	1.56	9.37	0.65
W11Comp A	:0-6	188	2.04	10.3	0.533
W11Comp B	0-6	155	2.07	کھ، چر ا	V.340
W11Comp C	0-6	353	2.17	11.8	0.603
W11Comp D	U-6	173	1.97	12	0 486
W11Comp E	0-0	<u>187</u>	2 29	9.6	
W11Comp +	0-0	217	2.25	12.7	0.647
W11Comp G	0-6	172	2,14	10.6	0.501
AUCT 27114		1260	40.8	118	•
NIST-2111A	·	1100	38.3	115	
NIST-27110		1130	3.6	112	
Mean Recovery	+ + + + + + + + + + + + + + + + +	1163	39.03	115	
Certified Values		1152-(31)		105-(8)	
			41.70-(0.25)		
Aver. % Recovery		10096	03.60%	109 60%	
* No supporting OA dat	8		<u> </u>		

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APPENDIX B

FIELD COLORIMETRIC ANALYTICAL PROCEDURE

98-003P(WPD)/012198

DRAFT

FIELD METHOD FOR THE DETERMINATION

OF 2,4,6-TNT AND RDX IN SOIL

1.0 Purpose

This method is applicable for the field or laboratory determination of 2,4,6-TNT and RDX in soil or sediment samples, employing battery operated equipment.

2.0 Method Summary

A 20-gram sample of undried sample is placed in an appropriate size glass bottle and extracted with 100 mL of acetone. After particulate removal, the absorbance of the acetone extract is measured at 540 nm to determine inherent background absorbance readings. Sodium sulfite (Na_2SO_3) and potassium hydroxide (KOH) are added to an aliquot of the extract to form a colored TNT complex. After reaction, the colored extract is filtered and the absorbance is measured at 540 nm for TNT. The initial background absorbance reading is doubled and subtracted from the final complexed sample reading to obtain a value which is proportional to the concentration of 2,4,6-TNT in the original sample.

For RDX, a 10-mL aliquot of extract is passed through an Alumina-A strong anion exchange cartridge at approximately 5 mL/min to remove any nitrate ion present in the extract. A 5-mL aliquot of this treated extract is acidified with 0.5 mL of glacial acetic acid and reeacted with 0.3 g of zinc dust in the barrel of a plastic disposable syringe fitted with a disposable filter unit. Contact between the extract and zincc should be approximately 15 seconds and not longer than 30 seconds. The contents of a Hach NitriVer3 (or equivalent) powder pillow are added and the vial shaken briefly, then allowed to stand for 15 minutes. Once the reaction is complete, a pink to red color indicates the presence of RDX; absorbance is measured at 507 nm.

The method has been employed over a 2,4,6-TNT concentration range of 1 to 22 ug/g, and for RDX over a range of Concentrations of analyte greater than this can be determined through volumetric dilution of the extract prior to addition of reagents for color development.

3.0 References

- **3.1** Jenkins, T.F. (1990), "Development of a simplified Field Method for the Determination of TNT in Soil", U.S. Cold Regions Research and Engineering Laboratory, Special Report 90-30.
- **3.2** Science Applications International Corporation Quality Assurance Program Plan (SAIC QAPP).
- **3.3** Science Applications International Corporation Quality Assurance Administrative Procedures (SAIC QAAPs).
- 3.4 Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual, U.S. EPA, Region IV Environmental Services Division, February,

1991.

- **3.5** Science Applications International Corporation Field Technical Procedure (SAIC TFP) May 5, 1995.
- **3.6** Jenkins, T. F., and Walsh, M. E. (199?). "Determination of TNT/RDX in Soils Using Colorimetry," U.S. Cold Regions Research and Engineering Laboratory.

4.0 Responsibilities

4.1 Group Manager

The SAIC Group Manager is responsible for approving this procedure.

4.2 Quality Assurance/Quality Control (QA/QC) Officer

The QA/QC Officer is responsible for approving this procedure and verifying that this procedure is being implemented.

4.3 Health and Safety (H&S) Officer

The H&S Officer is responsible for ensuring that appropriate SAIC and contractual H&S polices and procedures are in effect and verify enforcement of same by line management.

4.4 Program or Project Manager

The Program or Project Manager is responsible for:

- designating a qualified person to train personnel who will be using this procedure;
- ensuring that this and all appropriate procedures are followed;
- the interpretation of these operating instructions; and
- verifying that the appropriate training records are submitted to the Central Records Facility.

4.5 Field Sampling Team Leader

The Field Sampling Team Leader is responsible for:

- assigning field sampling team members to teams;
- coordinating and preparing for field sampling and field analytical activities by ensuring compliance with the SAP and field procedures (including operating instruction);
- ensuring that the field sampling team members and the field analysts are appropriately trained and the training is properly documented; and

overall management of field activities.

4.6 Field Sampling Team Members

The field sampling team members are responsible for:

- assisting the field sampling team leader by selecting locations and intervals for sampling as identified in the SAP and
- collecting the required field samples, appropriately documenting sample collection activities, properly labeling samples, and delivering the sample to the field analysts.

4.7 Field Analysts

The field analysts are responsible for:

- implementation of and adherence to this field analytical procedure;
- performing appropriate calibrations;
- analyzing samples;
- performing QC analysis;
- maintaining analytical equipment; and
- documenting information according to the steps define in this procedure.

5.0 General Information

- 5.1 Any deviation from this procedure's requirements will be justified to and authorized by the Project Manager or Program Manager.
- **5.2** Deviations from this procedure's requirements must be sufficiently documented to allow re-creation of the modified process.
- **5.3** Refer to and implement the site- or project-specific H&S Plan for relevant H&S requirements.
- **5.4** Refer to and implement the project-specific SAP for relevant sampling and analysis requirements.
- 5.5 It is SAIC policy to maintain an effective program to control employee exposure to chemical, radiological, and physical stress which is consistent with U.S. Occupational Safety and Health Administration (OSHA) established standards and requirements.
- 5.6 Refer to and implement the site- or project-specific Waste Management Plan for relevant waste and waste disposal requirements.

- **5.7** SAIC subcontractor personnel who implement this procedure must provide documented evidence of having been trained in the procedure to the Program Manager of Project Manager in accordance with subsection 4.5.
- **5.8** Data Quality Objectives (DQOs) for field analyses should be identified in projectspecific documents (WP, SAP, QAPjP). As presented, this procedure provides appropriate guidance to produce quantitative screening data. QC includes multi-level calibration, method blank information, and control sample analysis. Duplicate analytical information is optional.
- **5.9** Sample analytical reports and QC information will be provided to the Sampling Team Leader daily. In addition, sample results may be requested as determine by the Sampling Team Leader.
- **5.10** Upon completion of a project, final data packages will be assembled including but not limited to; analytical results, QC data, calibration information, and a written summary of each day's activities.
- **5.11** For additional information regarding instrument calibration, adjustment, maintenance, or replacement components, consult the manufacturer's instruction and operational manuals.
- **5.12** Sampling equipment needed for the collection of soils and sediments will vary depending on project requirements and will be identified in the project-specific SAP.

6.0 Interferences

- 6.1 Several other nitroaromatic compounds have been investigated which develop a visible color when processed through the procedure at 540 nm; Tetryl (orange), TNB (red), DNB (purple) and 2,6-DNT (pink). These compounds, if present, may contribute to the sample absorbance and be calculated as TNT. In addition the compounds 1,3-DNB (purple), TNT (red), TNB (red), Tetryl (orange) and 2,6-DNB (pinkish-purple) could contribute to the sample absorbance at 570 nm and be calculated as DNT.
- **6.2** Similar color development was not observed for other nitroaromatics, e.g., RDX, HMX, nitrobenzene, o-nitrotoluene, m-nitrotoluene, p-nitrotoluene, nitroglycerine, 4-amino-2,6-dinitrotoluene or 2-amino-4,6-dinitrotoluene, with the TNT method. These compounds, if present, would not contribute to the color intensity at 540 nm and at 570 nm.
- 6.3 Humic organic matter in soil is extracted to some degree with the TNT method and yields a yellow color that becomes darker upon addition of the procedure's reagents. The contribution of this interference is estimated and accounted for with the background correction step outlined in this procedure.
- **6.4** Percentage of H₂O (ice and water) in soil samples can alter the color development time. In addition, results should be noted as wet weight.

6.5 The Griess Reaction that produces the red azo dye in the RDX determination will also produce similarly-colored products if HMX, nitroglycerine, nitrocellulose, PETN, or nitroguanidine are present in the soil.

6.6 Humic substances that produce a background yellow color in the acetone extract are removed when the extract is acidified with acetic acid and filtered prior to RDX determination. Therefore, there is no requirement to obtain and subtract an initial absorbance from the final absorbance after color development.

7.0 Safety Information

- 7.1 Normal safety precautions associated with laboratory use of a flammable organic solvent should be employed.
- 7.2 Acetone and acetone solutions spilled on skin should be rapidly rinsed off with water.
- **7.3** Organic solvents and solvent wastes must be stored separately from strong oxidizers (e.g., nitric acid) and never mixed with them.
- 7.4 Flammable materials must be stored in approved containers and locations.
- 7.5 Eye protection must be worn at all times and by all individuals entering the field laboratory area.

8.0 Instrumentation and Supplies

8.1 Instrumentation

- **8.1.1** A field portable, battery operated colorimeter. When a controlled electrical source is available, a standard colorimeter can be employed (e.g., HACH DR2010 spectrophotometer or equivalent, bandpass 20 nm).
- 8.1.2 An electronic balance, to determine sample weights. The balance should be capable of weighing to the nearest 0.1g or better. When a controlled electrical source is not available, a battery operated balance or a mechanical balance can be employed.

8.2 Chemicals and Reagents

- 8.2.1 2,4,6-TNT standard (SARM quality).
- 8.2.2 RDX standard (SARM quality).
- 8.2.3 Acetone, commercial grade.
- 8.2.4 Glacial acetic acid, reagent grade.
- 8.2.5 Potassium hydroxide, reagent grade pellets.
- 8.2.6 Sodium sulfite, reagent grade.
- 8.2.7 Zinc dust, reagent grade.
- 8.2.8 Clean sand, e.g., an aliquot of sand used in well construction.

- 8.2.9 Deionized water.
- 8.2.10 Hach NitriVer3 powder pillows.
- 8.3 Supplies
 - 8.3.1 125 mL and 30 mL polypropylene vials.
 - **8.3.2** Volumetric pipettes (0.5 mL, 2.0 mL, 5.0 mL, 10.0 mL, 25.0 mL). Graduated pipettes. Sizes are recommended, analysts will need to determine what sizes are most appropriate to address their site application.
 - 8.3.3 50 mL and 100 mL graduated cylinders.
 - **8.3.4** Glass or polypropylene (pp) volumetric flasks (100mL, 250 mL, 500 mL). Sizes are recommended, analysts will need to determine what sizes are most appropriate to address their site application.
 - 8.3.5 Disposable vacuum filter units (130mL).
 - **8.3.6** Syringes (Plastipak or equivalent) (20 mL, 50 mL). Sizes are recommended, analysts will need to determine what sizes are most appropriate to address their site application.
 - 8.3.7 Gas-tight liquid syringes, 10YL, 100 YL.
 - 8.3.8 Cuvette bottles with caps (25 mL or 10 mL capacity), 25 mm path length.
 - 8.3.9 Spatula and Forceps.
 - 8.3.10 Alumina-A ion exchange cartridges (or equivalent).
 - **8.3.11** Other equipment as deemed necessary or desirable by the analysts (e.g., filter pump and tubing).

9.0 Method Calibration

9.1 Standards Preparation

<u>Primary Stock Standard:</u> Solid TNT (SARM grade) and RDX (SARM grade) are dried to a constant weight and stored in a vacuum desiccator in the dark. Separate solutions should be prepared for each compound. Approximately 0.1 g is weighed to the nearest 0.001 g, transferred to a 250 mL volumetric flask and diluted to volume with acetone. This stock standard is prepared in the laboratory before proceeding to the field. The TNT andRDX primary stock standards are approximately 400 mg/L. A liquid standard of 1000 ug/mL or higher could be substituted for dry standards. Dilution to 400 mg/L would be similar.

<u>Working Stock Standard:</u> These standards are prepared by diluting 25 mL of the primary stock standards to 250 mL in glass volumetric with acetone reagent. These stock standards are prepared in the laboratory before proceeding to the field. The TNT andRDX working stock standards are approximately 40 mg/L.

<u>Calibration Solutions:</u> Calibration solutions are prepared as described in Table 1. Glass volumetric pipettes are used to dispense the working stock standard and the distilled water, and a 100 mL graduated cylinder is used to add the acetone. Each solution is prepared in a 4 oz glass bottle (30 mL vial), capped and shaken.

9.2 Initial Calibration

Establish the zero absorbance setting on the spectrophotometer utilizing pure acetone reagent and implementing the instrument zeroing procedure as directed by the manufacturer's instructions.

Approximately 0.5 g of sodium sulfite (added in excess) and two pellets of potassium hydroxide are added to a 50 mL aliquot of each calibration solution. To determine the TNT curve each calibration solution is shaken for 3 minutes and then allowed to stand for 2 minutes. A portion of each solution is then filtered into the spectrophotometer cuvette and the absorbance is measured at 540 nm, immediately. The remaining prefilter solution is allowed to set for 30 min. The remainder of each solution is then filtered into the spectrophotometer cuvette and the spectrophotometer cuvette and the absorbance is measured at 540 nm, immediately. The remaining prefilter solution is allowed to set for 30 min. The remainder of each solution is then filtered into the spectrophotometer cuvette and the absorbance is measured at 507 nm, immediately. NOTE: Depending on ambient air temperatures, sample color development may be as short as 2 minutes or as long as 30 minutes (i.e., in cold weather). The analyst should determine the best waiting period for the greatest response (i.e., color development) prior to field sample determinations.

<u>Linear Regression:</u> The calibration data can be evaluated by means of a linear regression calibration. The correlation coefficient (r value) of the standard solution data should be at least 0.992. If the correlation coefficient is less than 0.992, evaluate the individual data points to determine which standard (s) are in question. Prepare a new standard, reanalyze and calculate a new correlation coefficient.

<u>Response Factors:</u> Calculate a Response Factor (RF for each of the individual standard solutions as follows:

- RF = <u>standard concentration</u> standard absorbance
- where: RF = the Response Factor for a given standard with units of mg/L per unit of Absorbance.

standard concentration = the concentration of TNT/DNT for a given standard solution with units of mg/L.

standard absorbance = the instrument absorbance response reading for the given standard solution in units of Absorbance.

Determine the average response factor and the standard deviation for the set of standard solution response factors. Calculate the Relative Standard Deviation (%RSD) of the response factors as follows:

%RSD = <u>response factor standard deviation</u> X 100 average response factor

The %RSD of the standard solution calibration data should be \pm 25% or less. If the

%RSD is greater than \pm 25%, examine the individual data points to determine which standard (s) may be in question. Prepare a new standard, reanalyze and calculate a new %RSD.

9.3 Daily Calibration Check

A daily calibration check standard must be analyzed before any samples are analyzed. This calibration check is not required if the multi-point calibration is performed. The daily calibration check standard is prepared at a mid-point concentration (2.0 mg/L, Table 1) and analyzed (section 9.2).

Analysis of another mid-point standard at the conclusion of a day's analytical activities must also be performed.

These checks will document the stability of the spectrophotometer and the analytical method implementation throughout the day.

<u>Daily Calibration Check Response Factor:</u> Calculate a response factor for each calibration check standard and determine its % Deviation from the average response factor evaluated during initial calibration.

The daily calibration check response factor will be employed to calculate sample concentrations for that day's analysis.

RF (daily)	.=	<u>daily check standard concentration</u> daily check standard absorbance
% Deviation	=	RF (daily) - RF (average) X 100

RF (average)

Where:

RF (daily) = the response factor for the daily calibration check standard.

RF (average) = the average response factor determine during initial calibration.

The % deviation of the RF (check) should be within \pm 25% of the RF (average). If the deviation exceeds the \pm 25% limit, perform maintenance on the instrument or prepare and analyze a new check standard. If re-analysis still exceeds the \pm 25% limit, a new initial calibration must be performed before samples are analyzed.

10. Sample Preparation and Analysis

- 10.1 Samples are collected by sampling personnel and delivered to the field analytical area. Sample extraction containers should be 4 oz amber glass bottles (or 125 mL pp vials) with caps.
- **10.2** Mix the sample thoroughly to ensure a representative sub-sample will be extracted for analysis. Sediment samples containing substantially (greater than 7 times) more

than approximately 3% interstitial water should be air dried prior to analysis. Complete dryness is not recommended, however, a period of 8-16 hours air drying time should be sufficient.

- **10.3** Normal Determinations (soil concentrations 0 20 ug/g):
- **10.3.1** Obtain a 20 g sub-sample of soil and weigh to the nearest 0.1 g in a glass extraction bottle.
- 10.3.2 Add 100 mL of acetone utilizing a graduated cylinder, cap the bottle, and shake for 3 minutes.
- **10.3.3** Allow the soil extract to settle for several minutes.
- **10.3.4** Decant a portion of the extract (approximately 30 mL), and filter through a 0.45 micron filter into a spectrophotometer cuvette.

To determine TNT

- 10.3.5 Measure and record the background reading for the sample at 540 nm.
- **10.3.6** Transfer the contents of the cuvette into a clean 30 mL plastic vial and add about 0.5 g of Na_2SO_3 and two pellets of KOH. Cap the bottle and immediately shake for 3 minutes.
- **10.3.7** Allow the solution to stand for 2 minutes.
- **10.3.8** Remove a portion of the complexed acetone extract and filter through a 0.45 micron filter into a spectrophotometer cuvette.
- 10.3.9 Immediately measure and record the total sample absorbance at 540nm.
- **10.3.10** If the absorbance reading exceeds the absorbance for the high concentration standard (4 mg/L or 20 ug/g), a dilution of the original extract must be analyzed.
- **10.3.11** Dilute an aliquot of the original sample extract (step 10.3.3) to 100 mL with acetone. Employing this diluted extract solution repeat steps 10.3.4 through 10.3.11.

To Determine RDX from 10.3.4:

- 10.3.12 Draw approximately 10 mL of filtered acetone sample extract into a 10-mL disposable syringe, and attach a disposable membrane filter unit to the tip of the syringe. Attach the filter unit to an ion exchange cartridge and slowly force the extract through the cartridge at a flow rate no greater than 5 mL/minute. Use the first two mL to rinse the cartridge and then collect 5.0 mL in a 10-mL graduated cylinder. Add 5.0 mL of glacial acetic acid to the graduated cylinder, using a dropper.
- **10.3.13** Remove the tip and plunger from a 10-mL disposable syringe and attach a disposable filter unit. Place about 0.3 g of zinc dust in the barrel of the

syringe. Pour the contents of the graduated cylinder into the syringe, insert the plunger and mix briefly. As rapidly as possible, filter the extract into a vial containing 20 mL of deionized water. Contact between the zincccc and the solution should be about 15 seconds but not exceed 30 seconds. An attempt should be made to keep the reaction time for the standard and samples as consistent as possible.

- **10.3.14** Open a NitriVer3 powder pillow and pour the contents into the vial. Shake the vial briefly and allow to stand for 15 minutes.
- **10.3.15** Place approximately 25 mL of acetone into a spectrophotometer cuvette and zero the instrument with the wavelength set at 507 nm.
- 10.3.16 If, after standing for 15 minutes, the solution develops a visible pink to red color, RDX is present. Pour the contents of the vial into a cuvette and insert the cuvette into the spectrophotometer. Obtain the RDX absorbance at 507 nm.
- **10.3.17** Calculate the RDX concentration (C_{RDX}) by dividing the RDX absorbance (A_{RDX}) by the RDX response factor (RF_{RDX}) and multiplying by 5, the factor that converts concentration in solution (mg/L) to concentration in soil (mg/kg) (based on a 20-g soil sample and a 100-mL volume of acetone used for extraction), and finally multiplying by the dilution factor (DF) used to get the final absorbance in the linear range:

 C_{RDX} (mg/kg) = (A_{RDX} / RF_{RDX}) * 5 *DF

- **10.3.18** If the absorbance reading exceeds the absorbance for the high concentration standard (4 mg/L or 20 ug/g), a dilution of the original extract must be analyzed.
- **10.3.19** Dilute an aliquot of the original sample extract (step 10.3.3) to 100 mL with acetone. Employing this diluted extract solution repeat steps 10.3.12 through 10.3.17.

10.4 High-Level Determinations (soil concentrations 100 ug/g - 2,000 ug/g)

- **10.4.1** Generate initial sample acetone extract as in steps 10.3.1 through 10.3.3.
- **10.4.2** Remove 1 mL of the initial extract and dilute to 100 mL with acetone.
- **10.4.3** Utilizing this diluted extract, proceed with steps 10.3.4 through 10.3.17.
- 11. Calculations
 - 11.1 An adjustment for humic organic matter background levels is made before determining the concentration of 2,4,6-TNT in the sample. Twice the background absorbance (measured in step 10.3.5) is subtracted from the total sample absorbance (measured in step 10.3.9).

Corrected Abs. = Total Abs. - (2 X Background Abs.)

11.2 The concentration of 2,4,6-TNT and RDX in the extract is determined by multiplying the background corrected sample absorbance by the daily calibration check standard response factor.

Conc. in Extract = Corrected Abs. X RF (daily)

where:

Conc. in Extract = the concentration of 2,4,6-TNT and 2,4-DNT in the extract solution measured.

Corrected Abs. = the Absorbance of the analyzed extract corrected for background, as determined in section 11.1.

RF (daily) = the Response Factor determined for the daily check standard, section 9.3.

11.3 The concentration of 2,4,6-TNT in the original soil or sediment sample is calculated as follows:

2,4,6-TNT (ug/g) = Conc. in Extract (mg/L) X DF X <u>1000ug</u> X 0.10L X <u>1</u> 1 mg Wt samp (g)

Where:

2,4,6-TNT (ug/g) = the concentration of 2,4,6-TNT in the soil sample.

DF = the Dilution Factor for the extract, expressed as the ratio of the final volume of the diluted extract divided by the volume of the original extract, which was diluted.

1000 ug = is employed for conversion of "mg" to "ug" units. 1 mg

0.1 L = is the final volume of the original extract before any dilutions.

Wt samp (g) = is the initial weight of sample extracted, in grams.

12. Quality Control

- 12.1 Prepare an analytical Method Blank on a daily basis or for each batch of 20 field samples. "Clean" sand can be used as the matrix material for this method blank. A 20 g portion of the sand is prepared and analyzed as described in section 10, however, the sand is extracted with 100 mL of acetone plus 3 mL of water, rather than 100 mL of acetone only. The 3 mL of water compensates for natural levels of moisture present in field samples and maintains solubility factors for the KOH and Na₂S0₃.
- **12.2** Prepare an analytical control sample on a daily basis or for every batch of 20 field samples. The sample can be a known control obtained from a reliable source (NIST, DOD, etc.), or it may be prepared as a blank spike of the "clean" sand employed as

method blank material. This is prepared utilizing 20 grams of the "clean" sand and spiking or fortifying it with 200ug of TNT standard. This can be accomplished by taking 20 grams "clean" sand, 5 mL of 40 mg/L working stock standard, 95 mL of acetone, and 3 mL of water. This control sample is put through the analytical process as described in section 10,3.2 through 10.3.9. Repeat for RDX.

Calculate the concentration of 2,4,6-TNT and RDX as described in section 11 and calculate the spike recovery according to the following equation:

% Recovery (TNT) = <u>TNT/RDX Measured in spiked sample (ug/g)</u> X 100 Theoretical TNT/RDX spiked (ug/g)

Recoveries should be in the range of 50-150%. When recoveries fall outside this range, check calculations and re-analyze the spiked sample, if necessary. If recoveries remain outside this range, evaluate the factors which present potential sources of error and correct the problem before proceeding with additional analyses. Same for RDX.

Utilize five to ten control sample measurements to establish acceptance criteria within a 3 sigma range. Maintain a control chart of the analytical control sample data to monitor method performance throughout the duration of the analytical effort.

12.3 Calculate the Relative Percent Difference (RPD) for blank spike control samples using the following equation:

RPD = <u>TNT/RDX (ug/g) Spike # 1 - TNT/RDX (ug/g) Spike # 2</u> X 100% Average of TNT/RDX Spike # 1 and TNT/RDX Spike # 2

The RPD values should fall within the range of 0-50%. When the values fall outside of this range the potential error sources should be investigated and problems corrected. Same for RDX.

12.4 Duplicate samples should be prepared and analyzed for every set of 20 field samples. Selection of samples with known or suspected explosives content will provide useful information regarding the homogeneity of the material sampled. Compare analytical values for the duplicates as identified in section 12.3.

If the RPD values exceed the 50% level and the blank spike data show acceptable recovery and RPD the samples may be exhibiting non-homogeneity.

12.5 Calculate a reporting level for samples based on the low-level calibration standard (0.2 mg/L), the dilution factor for the individual sample analysis, and the actual weight of the individual sample extracted. For example:

Reporting Level TNT (ug/g)	=	0.2 (mg/L) X DF X <u>1000ug</u> X 0.11	_X_1
		1 mg	Wt samp (g)

Sample results determined at levels less than the reporting level will be reported as Reporting Level. Same for RDX.

13. Analytical Wastes

The major waste generated during the implementation of this procedure will be extract solutions and colored complex solutions. These solutions are flammable solvent wastes, and should be handled as such. These waste must be properly containerized and labeled. Coordination must be established with the site waste manager and disposal must be in accordance with the site Waste Management Plan.

Other general waste generated during the analysis should not represent a chemical or biological hazard, however, proper site handling and disposal procedures should be implemented.

Approximate* Calibration Associated** Solution Conc. (mg/L)	Volume of Working Std. (mL)	Volume of Acetone (mL)	Volume of Distilled Water (mL)	Sol. Conc. (ug/g)
0.0	0	100	3.0	0.0
0.2	0.5	99.5	3.0	1.0
0.4	1.0	99	3.0	2.0
0.8	2.0	98	3.0	4.0
2.0	5.0	95	3.0	10.0
4.0	10.0	90	3.0	20.0

Table 1. Preparation of Calibration Solutions

- * Does not include the volume of water in the determination of standard concentration. All field samples are assumed to contain water of an unknown quantity and all calculation will ignore this small water volume contribution.
- ** This concentration is the comparable soil 2,4,6-TNT and RDX concentration if 20 g of soil is used and 100 mL of acetone used for extraction. The concentration is based on wet weight of soil.

APPENDIX C

HUMAN HEALTH RISK ASSESSMENT ALGORITHMS

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Appendix C Human Health Risk Assessment Algorithms

Appendix C contains the equations used to estimate risk to human receptor populations. Risk estimation is conducted in several steps including: estimation of exposure concentration, calculation of intake and dose, toxicity assessment, and risk characterization. The methods and equations used in each step are described in the sections below.

C.1 ESTIMATION OF EXPOSURE CONCENTRATION

Exposure concentrations are medium-specific contaminant concentrations a potential receptor is expected to encounter. Exposure concentrations from direct contact with environmental media (soils, sediment, groundwater, surface water) are based on the sampling results of the media. Exposure concentrations for contaminants that have migrated into secondary media (air, fish, venison, beef, vegetables) are modeled from the equations presented in the following sections.

Chemical Concentrations in Air. Chemicals present in soils may migrate into air as a result of volatilization or the generation of fugitive dust during specific activities such as construction work and groundskeeping.

Air Concentration from Fugitive Dust. The following equation is used to estimate concentrations of contaminants in air as the result of fugitive dust generated by construction activity:

$$C_a = (D)(C_s)(CF_l) \, ,$$

where:

 $C_a =$ contaminant concentration in air (mg/m³, calculated), D = dust loading factor (g or soil/m³ of air), C = contaminant concentration in soil (mg/kg), $CF_1 =$ conversion factor (10⁻³ kg/g).

It is assumed that for excavation activities the value for D is 0.0006 g/m³. General construction activity would result in D = 0.0001 g/m³. The latter value will also be used to estimate contaminant concentration in air for a groundskeeper.

Other receptors are likely to be exposed to fugitive dust that is generated as a result of wind erosion. The rate of erosion is expressed as a particulate emission rate. This site-specific rate is calculated by the following:

$$PEF = \frac{LS \times V \times DH \times 3600 s/hr}{A} \times \frac{1000 g/kg}{0.036 \times (1-G) \times (U_m/U_l)^3 \times F_{(x)}},$$

where:

PEF = particulate emission factor (m^3/kg) , LS = width of contaminated area (m),

V	=	wind speed in mixing zone (m/s),
DH	=	diffusion height (m),
Α	=	area of contamination (m ²),
0.036	=	respirable fraction (g/m ² -hr),
G	=	fraction of surface covered with vegetation (unitless),
Um	=	mean annual wind speed (m/sec),
U,	=	equivalent threshold value of wind speed at 10 m (m/sec),
F(x)	=	function dependent on U_m/U_t (unitless).

The chemical concentration in air as the result of wind erosion is calculated as follows:

$$C_a = \frac{C_s}{PEF},$$

where:

C,	=	chemical concentration in air (mg/m ³),
C _s	=	chemical concentration in soil (mg/kg),
PEF	=	particulate emission factor (m ³ /kg).

Air Concentration Due to Volatilization from Soil. Receptors may be exposed to chemicals volatilizing from soils. The chemical concentration of volatilizing compounds can be calculated using the following equation:

$$C_a = \frac{C_s}{VF}$$

.

where:

 $C_a =$ chemical concentration in air (mg/m³), $C_a =$ chemical concentration in soil (mg/kg),

 C_s = chemical concentration in soil (mg/kg), VF = chemical-from-soil volatilization factor (m³/kg, chemical-specific).

The chemical-from-soil volatilization factor is calculated as follows:

$$VF = \frac{(LS \times V \times DH)}{A} \times \frac{(3.14 \times \alpha T)^{1/2}}{(2 \times D_{ei} \times E \times K_{as} \times 10^{-3} kg/g)} ,$$

where:

VF = chemical-from-soil volatilization factor (m³/kg, chemical-specific),

- LS = width of contaminated area (m),
- V = wind speed in mixing zone (m/s),
- DH = diffusion height (m),
- A = area of contamination (m²),
- D_{ei} = effective diffusivity (cm²/s), calculated from $D_i \times E^{0.33}$
- $D_i = molecular diffusivity (cm²/s)$
- E = true soil porosity (unitless),
- K_{as} = soil/air partitioning coefficient (g soil/cm³ air), calculated from H/K_d

H = Henry's law constant (atm-m³/mol),

 K_d = soil/water patitioning coefficient (cm³/g)

T = exposure interval (seconds),

 α = is defined by the equation:

$$\alpha = \frac{(D_{ei} \times E)}{E + (P_s)(1-E)/K_{as}}$$

,

 ρ_s = true soil density or particulate density (g/cm³).

Chemical Concentration in Venison. Concentrations in venison are estimated by calculating the concentration in venison food sources due to soil contamination. The contaminant levels in forage are estimated by the following:

$$C_p = (CF)(C_s)(B_p) ,$$

where:

- C_p = concentration of contaminant in forage (mg/kg dry weight),
- CF = conversion factor to adjust for soil containing 20 percent moisture (1.25 unitless),
- $C_s = concentration of contaminant in soil (mg/kg),$
- B_p = soil-to-forage biotransfer factor (mg chemical per kg of dry plant/mg of chemical per kg or dry soil)(chemical specific).

The B_p for metals are taken from the available literature. The B_p for semivolatile organics are calculated using the following formulas:

$$logB_{p} = 1.588 - 0.578 logK_{ow}$$

where:

log B_p = soil-to-forage biotransfer factor (mg chemical per kg of dry plant/mg of chemical per kg or dry soil)(chemicalspecific),

 K_{ow} = octanol-water partitioning coefficient (unitless, chemical-specific).

A B_p is not estimated for VOCs, because these chemicals are expected to volatilize rapidly from soils and plants and thus are insignificant in food chain pathways.

The concentration of contaminants in venison from ingestion of contaminated forage is estimated using the following equation:

$$C_{v} = (\mathcal{Q}_{p})(C_{p})(FI_{e})(B_{v}) :$$

where:

C _v	=	contaminant concentration in venison (mg/kg),
Q,	=	browse ingestion rate (0.87 kg dry weight/day),
Ċ	=	contaminant concentration in browse (mg/kg dry weight),

- FI_e = fraction browse ingested from the contaminated site (site area/home range),
- $B_v =$ biotransfer factor for venison (days/kg).

The B_v for beef is used for deer due to a lack of available literature values for deer. Both of these animals are ruminants; therefore, the uptake and bioaccumulation of contaminants is likely to be similar. The meat of deer contains less fat than commercial beef, 14.4 percent fat for beef as compared to 2.9 percent for venison. Organic chemicals have a greater affinity to fat and thus would not accumulate as much in venison. Therefore, the beef biotransfer factors for organics are adjusted by 2.9/14.4 (0.20) to reflect this lower accumulation rate.

The B_v values for metals are taken from the published literature. The B_v values for organics are calculated as follows:

$$B_v = R_f x \, 10^{-7.6 + \log K_{ow}}$$
,

where:

 $B_v = biotransfer factor for venison (days/kg),$ $R_f = ratio of the fat content in venison to the fat content of beef (0.20),$ $K_{ow} = octanol-water partitioning coefficient (unitless, chemical-specific).$

Chemical Concentrations in Fish. Fish may bioconcentrate contaminants from water and sediment.

The contaminant concentration in fish due to bioconcentrating contaminants from surface water is estimated using the following equation:

$$C_{fw} = (C_w)(BCF) ,$$

where:

C _{fw}	=	contaminant concentration in fish from surface water (mg/kg),
C _w	=	contaminant concentration in water (mg/L),
BCF	=	fish bioconcentration factor (L/kg).

Many BCF factors for fish are available from the literature. In the absence of a BCF literature value for an organic, the value was estimated using the following equation:

$$logBCF = 0.76 \ x \ K_{ov} - 0.23$$
 ,

where:

Ingestion of Homegrown Produce. The model comprises basically two equations: one for the concentration of contaminant on plant surfaces (C_p) at the time of consumption, the other for the concentration of contaminant in plant tissues (C_t) so that the total concentration of a contaminant in a plant (C_{TOT}) at the time of consumption is:

$$C_{TOT} = C_p + C_t$$

Equations for C_p and C_t are input-output, mass balance formulations of the fluxes to and from the plant. Both integrate the constant inputs from irrigation and atmospheric deposition and exponential losses from decay and degradation over appropriate time intervals to give an average concentration over that interval.

Concentration on Plant Surface (C_p). Uptake of a contaminant onto plant surfaces occurs over the growing season, t_e , as a result of deposition of irrigation with contaminated water (denoted by d_w) and deposition of contaminated airborne dust (denoted by d_d). A fraction of each contaminant flux (r_w and r_d) is retained on the plant surface, so that $(d_w)(r_w)$ and $(d_d)(r_d)$ represent the actual amount of material deposited on the plant. Note that the deposition rate for irrigation is the actual average hourly rates of deposition during the growing season, not the annualized average hourly rate.

During the growing season (t_e), contaminant is lost from the plant surface exponentially with rate constant λ_{tot} , where $\lambda_{tot} = \lambda_r + \lambda_w$, and λ_r represents a decay-degradation rate constant and λ_w represents the wash-off rate constant. During the ensuing post-harvest interval leading up to consumption (t_h), exponential decay-degradation continues to occur with rate λ_r . Thus, the concentration of the contaminant on the plant surface can be formulated as:

$$C_{p} = \left[\frac{(d_{w}r_{w}+d_{d}r_{d})}{Y}\right] \left[\frac{(1-e^{-\lambda_{TOT}})}{\lambda_{TOT}}\right] e^{-\lambda_{J_{h}}},$$

where:

 C_p = concentration of contaminant on plant surface (pCi/kg) (mg/kg),

$$d_d$$
 = contaminant deposition flux from resuspended dust (pCi/m²-hr) (mg/m²-hr),
where

 $d_d = (C_{air})(V_d)$, and

 C_{air} = estimated or measured concentration in air (mg/m³),

 V_d = dust deposition velocity (m/hr),

 $d_w = contaminant$ deposition flux from irrigation water (pCi/m²-hr) (mg/m²-hr), where

$$=$$
 (C_w)(I), and

 $C_w = \text{concentration in irrigation water (pCi/L)(mg/L)},$

I = irrigation deposition rate (L/m^2-hr) ,

 r_d = fraction of deposited dust retained on plant surface (unitless),

- $r_w =$ fraction of water borne material retained on plant surface (unitless),
- $r_w = fraction of water borne ma$ Y = agricultural yield (kg/m²),
- $t_e = growing season (hrs),$

d,

 $t_{\rm h}$ = duration of period between harvest and consumption (hrs),

 λ_{TOT} = effective depletion constant of contaminant in surface soils due to washoff and radioactive decay/chemical degradation (hr⁻¹), where

$$\lambda_{\text{TOT}} = \lambda_{\text{w}} + \lambda_{\text{p}}$$
 and

 λ_{w} = effective depletion constant of contaminant on the surface plants, also known as the weathering removal rate (hr⁻¹),

 λ_r = radioactive or chemical decay constant of contaminant (hr⁻¹).

In this equation, the first term represents the deposited material retained on the plant surface from water and dust, and the second term accounts for removal from the plant surface by weathering and radiological or biological degradation. The third term accounts for radiological decay during the time from harvest to ingestion.

Concentration in Plant Tissue—Uptake from Soil (C₀). Uptake from the soil by the plant occurs only during the growing season. The amount taken up from the soil during this interval is determined by the average soil concentration (C_s) and the dry soil to wet plant partitioning coefficient for the contaminant (B_v). During the growing season (t_e), the contaminant is lost from the plant tissue as a result of exponential decay-degradation with rate constant λ_r . During the ensuing post-harvest interval leading up to consumption (t_h), decay or degradation continues to occur exponentially with rate constant λ_r . Thus, the concentration of contaminant in plant tissue can be formulated as

$$C_{i} = (B_{v})(C_{s})(e^{-\lambda_{r}t_{s}})(e^{-\lambda_{r}t_{h}}) ,$$
$$C_{r} = (B_{v})(C_{s})(e^{-\lambda_{r}(t_{s}+T_{h})}) ,$$

where:

or,

 $C_t = concentration of contaminant in plant tissue from root uptake (pCi/kg) (mg/kg),$ B_v = dry soil to wet plant partitioning coefficient (unitless).

The average concentration of a contaminant in the soil over the growing season (C_s) is a function of the concentration at the beginning of the growing season (C_s(0)) and the increase in the average concentration due to the combined input of contaminant to the soil from irrigation water and atmospheric deposition during the growing season. A fraction of each flux of contaminant into the system during the growing season (d_w and d_d) is deposited directly onto the soil surface, i.e., (d_w)(1-r_w) and (d_d)(1-r_d), where r_w and r_d are, respectively, the fractions of the irrigation water and air deposited material initially intercepted by the plant. In addition, the matter lost from the plant surface as a result of wash-off during the growing season with rate constant λ_w is deposited onto the soil. During the growing season (t_e), contaminant is lost from the soil as a result of exponential decay-degradation and leaching; this occurs irrespective of the source of the material. Thus,

assuming that
$$\lambda_{u} >> 1$$
, the average concentration of a contaminant in soil can be formulated as:

$$C_s = C_s(0)e^{-\lambda_s t_e} + d_s \frac{\left(1 - e^{-\lambda_s t_e}\right)}{\rho \lambda_s} e^{-\lambda_s t_h}$$

and

$$C_s(0) = d_a \left[\frac{(1 - e^{\lambda_s t_{bd}})}{\rho \lambda_s} \right] ,$$

and

$$\bar{d}_{s} = d_{w}(1 - r_{w}) + d_{d}(1 - r_{d}) + \left[(d_{w}r_{w} + d_{d}r_{d}) \left(\frac{(1 - e^{-\lambda_{w}t_{e}})}{\lambda_{w}} \right) \frac{1}{t_{e}} \right]$$

where:

 $C_i = \text{concentration of contaminant in the soil available for plant uptake during the growing season (pCi/g) (mg/kg),}$

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- C_s(0)= concentration of contaminant in the soil at beginning of growing season (time zero) (pCi/g; mg/kg),
- λ_s = effective loss rate from the soil, where
 - $\lambda_{\rm s} = \lambda_{\rm r} + \lambda_{\rm l}$, and

 λ_1 = leaching loss term (-hr),

- $\lambda_r = \text{degradation rate (-hr)},$
- ρ = effective dry surface soil density (kg/m²).

The first term of this equation is the total input flux rate $(mg/m^2 \cdot hr)$ due to irrigation, $d_w(1-r_w)$; the second term is the rate for that portion of the flux due to atmospheric deposition, $d_d(1-r_d)$; and the third term is the rate for the fraction of what is intercepted by the plants that is subsequently washed off into the soil, i.e., $[(d_w r_w + d_d r_d)(\lambda_w - [1-e^{-\lambda wte}]/\lambda_w t_e)]$, which must be added back to the flux to the soil. The contaminant input to the soil by these fluxes undergoes decay-degradation and leaching during the growing season, which is represented by the final term.

The concentration of contaminant at the beginning of the growing season, $C_s(0)$, is a function of the aerial deposition rate (d_d) during the non-growing season (t_{bd}) and the effective loss rate over that interval, with rate constant λ_s , which assumes that no contamination deposited with irrigation water during the growing season remains in the soil at the start of the next growing season. This will be the case if the duration of the non-growing season (t_{bd}) is significantly greater than the growing season (t_c) and the soil loss rate, with constant l_s , is large relative to the irrigation rate (d_w) .

C.2 ESTIMATION OF INTAKE AND DOSE

The quantification of exposure to receptors from contact with chemicals in different media involves estimating the amount of contaminant that is taken into the body via various routes of exposures. This section describes the models used to quantify doses or intakes of contaminants by exposure pathways identified for a site. The intake of contaminants from environmental media (soils, groundwater, and surface water) and secondary sources (deer and fish) are discussed below.

Estimated Intakes and Doses from Soils and Sediment.

Potential exposure pathways for soils include incidental ingestion, inhalation of fugitive dust and VOCs, and dermal contact with soils. The equations used to estimate potential intakes and doses from these exposure pathways are discussed below.

Incidental Ingestion. The intake of chemicals from incidental ingestion of soils and sediments is estimated using the following equation:

$$I_s = \frac{(C_s)(IR)(FI_s)(EF_T)(ED)(CF)}{(BM)(AT)}$$

where:

I_s = ingested intake (mg/kg-day, calculated), C_s = concentration in soil or sediment (mg/kg), IR_s = ingestion rate of soil (mg/day), FI_s = fraction of exposure attributed to site soil (unitless),

- EF_{T} = exposure frequency (days/year),
- ED = exposure duration (years),
- CF = conversion factor (10⁻⁶ kg/mg),
- BW = body weight (kg),
- AT = averaging time (days).

Inhalation of VOCs and Dust. The following equation is used to estimate the inhalation intake of contaminants in air from airborne dust and VOCs:

$$I_a = \frac{(C_a)(IR_a)(FI_a)(EF_a)(EF_T)(ED)}{(BW)(AT)},$$

where:

- I_a = inhaled intake of COPC (mg/kg-day, calculated),
- $C_a = \text{concentration of COPC in air (mg/m³),}$
- $IR_a =$ inhalation rate (m³/hour),
- $FI_a = fraction of exposure attributed to the media (unitless),$
- $ET_{a} = exposure time (hours/day),$
- EF_{τ} = exposure frequency (days/year),
- ED = exposure duration (years),
- BW = body weight (kg),
- AT = averaging time (days).

Dermal Contact with COPCs in Soil. The dermal dose of a contaminant is estimated from the equation:

$$DAD = \frac{(DA)(SAS)(EF_T)(ED)}{(BW)(AT)}$$

,

where:

DAD	Ŧ	average dermally absorbed dose of the COPC (mg/kg-day, calculated),
DA	=	dose absorbed per unit body surface area per day (mg/cm ² -day),
SAS	=	surface area of the skin available for contact with contaminated medium (cm ²),
EF_{T}	=	exposure frequency (days/year),
ED		exposure duration (years),
BW	=	body weight (kg),
AT	=	averaging time (days).

Dermal uptake of constituents from soils and sediments assumes that absorption is a function of the fraction of a dermally applied dose that is absorbed. It is calculated from the equation:

$$DA = (C_s)(FI_s)(CF)(AF)(ABS)$$
,

where:

DA = dose absorbed per unit body surface area per day (mg/cm²-day, calculated),

 $C_s = \text{concentration of COPC in soil (mg/kg)},$

- $FI_s =$ fraction of exposure attributed to site soil or sediment (unitless),
- CF = conversion factor (10⁻⁶ kg/mg),
- AF = soil-to-skin adherence factor (mg/cm²-day),
- ABS= absorption fraction (unitless, chemical-specific).

ABS values have been empirically determined for very few chemicals. EPA (1992) discussed the available empirical data, as well as several predictive approaches for estimating ABS, but refrains from recommending any single approach. EPA (1995) recommends reasonable default values of 0.1% for inorganic chemicals and 1% for organic chemicals, to reflect the matrix effect (i.e., binding to organic matter in soil), which will be used when empirical data are not available.

Estimated Intakes and Doses from Groundwater and Surface Water

Potential exposure pathways for groundwater and surface water include ingestion, inhalation of VOCs, and dermal contact. The equations used to estimate potential intakes and doses from these exposure pathways are discussed below.

Ingestion Drinking Water. Ingestion of groundwater or surface water used as a potable water source is quantified with the following equation:

$$Iw = \frac{(C_w)(IR_w)(FI_w)(EF_T)(ED)}{(BW)(AT)},$$

where:

- I_w = ingested intake of COPC in drinking water (mg/kg-day),
- $C_w = concentration of COPC in drinking water (mg/L),$
- $IR_w = drinking water ingestion rate (L/day),$
- FI_w = fraction of exposure attributed to site medium (unitless),
- $EF_{T} = exposure frequency (days/year),$
- ED = exposure duration (years),
- BW = body weight (kg),
- AT = averaging time (days).

Incidental Ingestion while Swimming. Incidental ingestion of surface water while swimming is quantified with the following equation:

$$I_{swim} = \frac{(C_w)(IR_w)(ET_w)(EF_T)(ED)}{(BW)(AT)},$$

where:

- I_{swim} = incidental ingestion intake (mg/kg-day),
- C_w = concentration in surface water (mg/L),
- IR_{w} = incidental ingestion rate while swimming (L/day),
- $Et_w = exposure time (hours/day)$
- $EF_{T} = exposure frequency (days/year),$
- ED = exposure duration (years),
- BW = body weight (kg),
- AT = averaging time (days).

Inhalation of VOCs Released from Groundwater. Groundwater concentrations may be used to estimate saturated soil concentrations using a chemical-specific soil to water partitioning coefficient, K_d , by the following equation:

$$C_s = C_{gw} \times K_d,$$

where:

 $C_s = contaminant concentration in the saturated soil zone (mg/kg),$ $C_{gw} = contaminant concentration in the groundwater (chemical-specific; mg/l),$ $K_d = soil to water partitioning coefficient (chemical-specific; l/kg).$

 K_d values may be calculated by the relationship:

$$K_d = K_{oc} \ x \ f_{oc} \ ,$$

where:

 K_{oc} = organic carbon to water partitioning coefficient (chemical-specific; l/kg),

 f_{oc} = site-specific fraction of organic carbon in the soil (0.00158; unitless).

The calculated saturated soil concentrations may be used to estimate VOC emission rate using a model by Mackay and Matsugu (1973) presented in the GRI manual (1988). The contaminant-specific emission rates per unit area are then estimated by the following:

$$Q/A_c = \frac{k_a x (P - P_{\omega})}{R x T_p},$$

where:

$Q/A_c = mass flux per unit area of soil (moles/m2)$
--

- P = water vapor pressure at the soil surface (chemical-specific; atm),
- P_{-} = water vapor pressure in the bulk of the atmosphere (assumed 0 when VOC is dispersed into the atmosphere; atm),
- $R = gas constant 8.21 \times 10^{-5} (atm m^3/moles ^{\circ}K),$
- T_p = pool temperature of waste surface temperature (ave. summer temp 295°K),
- k. = air mass transfer coefficient (m/hr) calculated by:

$$k_a = 0.292 \ x \ (U^{0.78}) \ x \ (D_p^{-0.11}) \ x \ (S_c^{-0.67})$$
,

where:

U = site-specific wind speed (based on 5 mph; 8.1×10^3 m/hr),

- D_p = diameter of the waste boundary (alt. 4 15 m; alt. 5 2.6 m),
- S_c = Schmidt gas number (1.7 for molecular weights <100; 2.1 for molecular weights 100-200; unitless).

The mass flux per unit area of soil is then converted to a total flux leaving the site, Q. This contaminant-specific total flux or emission rate for the site is calculated by the following:

$$Q = Q/A_c \times MW \times A_c \times CF_1 \times CF_2 ,$$

where:

Q	=	emission rate or total flux leaving site (µg/sec),
Q/A _c	=	mass flux per unit area of soil (moles/m ² hour),
MW	=	chemical-specific molecular weight (chemical-specific; g/mole),
A _c	=	contaminated surface area of site (alt. 4 217 m ² ; alt. 5 6.97 m ²),
CF ₁	=	1/3600 (hour/sec),
CF ₂	=	$10^{6} (\mu g/g).$

An air concentration for each contaminant is estimated using a Near Field Box Model (Pasquill 1975; Horst 1979; Environ 1986), as presented in the GRI manual (1988), and the calculated total emission rates. The ambient air concentrations are calculated as follows:

$$C_a = \frac{Q}{H_b \times W_b \times U_m} ,$$

where:

C _a	=	contaminant concentration in ambient air on-site ($\mu g/m^3$),
Q	=	emission rate of contaminant (µg/sec),
H _b	=	downwind height of box (assuming a receptor height of 5 ft.; 1.5 m),
W _b	-	site-specific width of box (alt. 4 15 m; alt. 5 10 m),
U _m	=	average wind speed through the box calculated by:

$$U_m = 0.22 \ x \ U_{10} \ x \ \ln(2.5 \ x \ H_b)$$
,

where:

 U_{10} = site-specific annual mean wind speed at 10 meters (based on 5 mph; 2.24 m/s.

Inhalation of VOCs while Showering. The daily intake from the inhalation of VOCs while showering may be evaluated using the following model (Murphy 1987):

 $I_{s} = [(1000 \times N_{s} \times T_{s} \times IR \times C_{gw} \times F)/(A \times V)] \times [1 + (1/(A \times T_{s})) \times (e^{-A \times T_{s}} - 1)] \times [1 - e^{-1/(0.93 \times 1.48 \times 10^{-34/3})}],$

where:

I,	=	estimated inhalation exposure during showering (mg/day),
N _s	=	number of showers per day (1 shower/day),
T,	=	duration of shower (0.2 hours/shower),
IR	=	inhalation rate (0.83 m ³ /hour),
Cgw	=	concentration in groundwater (chemical-specific; mg/l),
•		

- F = shower water flow rate (m³/hour),
- A = air exchange rate between shower and rest of home (12 hour⁻¹),
- V = volume of shower or bathroom (12 m³),
- H = Henry's law constant (chemical-specific; atm-m³/mole).

Inhalation of VOCs from Household Water Use. The daily intake of contaminants from the inhalation of VOCs from non-showering household water use may be calculated as follows:

$$I_{ns} = \frac{[T_h \ x \ IR \ x \ C_{gw} \ x \ Q_w \ x \ M] \ x \ [1 - e^{1.26 + (2 \ x \ 10^{-3})/H}]}{Q_a}$$

where:

- I_{ns} = estimated intake due to other household water use (mg/day),
- $T_{h} = time spent in home (20 hours/day),$
- IR = inhalation rate (0.83 m^3 /hour),
- C_{gw} = concentration in groundwater (chemical-specific; mg/l),
- Q_{w} = quantity of household water used (980 l/day),
- M = mixing factor (0.5 unitless),

H = Henry's law constant (chemical-specific; atm-m³/day),

 $Q_s = volume air exchange rate for home (8700 m³/day).$

The total daily intake from household water use was the sum of the intake from showering and other household water use:

$$I = I_s + I_{ns} ,$$

where:

- I = total daily intake (mg/day),
- $I_s = daily intake from showering (mg/day),$
- I_{ns} = daily intake from nonshowering activities (mg/day).

Dermal Contact. The dermal dose is estimated as the dose that crosses the skin and is systematically absorbed. The dermal dose is estimated from the equation:

$$DAD = \frac{(DA)(SAS)(EF_T)(ED)}{(BW)(AT)},$$

where:

- DAD = average dermally absorbed dose of the COPC (mg/kg-day, calculated),
- DA = dose absorbed per unit body surface area per day (mg/cm²-day),
- SAS = surface area of the skin available for contact with contaminated medium (cm^2) ,
- EF_{T} = exposure frequency (days/year),
- ED = exposure duration (years),
- BW = body weight (kg),
- AT = averaging time (days).

Quantification of dermal uptake of constituents from water depends on the permeability coefficient (PC), which describes the rate of movement of a constituent from water across the dermal barrier to the systemic circulation. The equation for dermal uptake of chemicals from water is the same as the equation for dermal uptake of chemicals from soil. Separate calculation methods are applied to estimate DA for inorganic and organic chemicals in water. For inorganic chemicals, DA is calculated from the following equation:

$$DA = (C_w)(PC)(ET_w)(CF),$$

where:

The PC has been determined for very few inorganic compounds. For those inorganic compounds for which empirical data are not available, EPA (1992) recommends a default of 10⁻³ cm/hour.

The PC for organic chemicals varies by several orders of magnitude (EPA 1992). The PC for organic chemicals is highly dependent on lipophilicity, expressed as a function of the octanol/water partition coefficient (K_{ow}). Because the stratum corneum (the outer skin layer) is rich in lipid content, it may act as a sink, initially reducing the transport of chemical to the systemic circulation. With continued exposure and the attainment of steady state conditions, the rate of dermal uptake increases. Therefore, different equations are used to estimate DA_{event} depending on whether the exposure time is lesser or greater than the estimated time to reach steady state.

Dermal exposure from bathing (showers, baths, washing hands, etc.) is estimated to be a short period of time (0.25 to 1.0 hour). For these pathways, it also is assumed that steady state is not reached. Under these short term exposure conditions, DA_{event} my be calculated from the following equation:

$$DA_{event} = 2 \ x \ PC \ x \ C_w \ x \ CF \ \sqrt{\frac{6 \ x \ \tau \ x \ ET_w}{\pi}} ,$$

where:

- DA = dose absorbed per unit body surface area per day (mg/cm²-day,
- PC = permeability coefficient (cm/hour),
- C_w = concentration of constituent in water (mg/kg),
- $CF = conversion factor (0.001 L/cm^3),$
- τ = time for concentration of contaminant in stratum corneum to reach steady state (hours),
- $Et_w = exposure time (hours).$

When possible, values for PC are taken from EPA (1992). If PC values are not available, they may are calculated from the formula:
$$\log (PC) = -2.72 + 0.71 \log (K_{ow}) - 0.0061 MW$$
,

where:

РС	=	permeability coefficient (cm/hour, calculated),
K _{ow}	=	octanol/water partition coefficient (unitless),
MW	=	molecular weight.

If literature values for t are not available, they are calculated from the equation:

$$\tau = \frac{L_{sc}}{6 \times 10^{(-2.72 - 0.0061 \times MW)}}$$

,

where:

t	=	time for concentration of contaminant in stratum corneum to reach steady state
		(hours, calculated),
L _{sc}	=	effective thickness of the stratum corneum (10^{-3} cm) ,
MW	=	molecular weight.

Estimation of Intakes from Consumption of Game

The intake from ingestion of venison and fish by the sportsman is estimated from the equation:

$$I_{g} = [(C_{v})(IR_{v})(FI_{v}) + (C_{f})(IR_{f})(FI_{f})]\frac{(EF_{G})(ED)}{(BW)(AT)},$$

where:

- $I_g =$ ingested intake in game (venison and fish) (mg/kg-day, calculated),
- \ddot{C}_v = concentration in venison (mg/kg),
- $IR_v =$ ingestion rate of venison (kg/day),
- $FI_v =$ fraction of daily intake of venison from contaminated sources (unitless),
- C_f = concentration in fish (mg/kg, see below),
- $IR_f = ingestion rate of fish (kg/day),$
- FI_f = fraction of daily intake of fish from contaminated sources (unitless),
- $EF_{G} = exposure frequency (days/year),$
- ED = exposure duration (years),
- BW = body weight (kg),
- AT = averaging time (days).

C.3 TOXICITY ASSESSMENT

To understand the potential health risk associated with a potentially hazardous chemical, information on chemical-specific toxicity is required. Toxicity information is used in conjunction with the results of the exposure assessment to characterize potential health risks. The toxic mechanisms for chemicals are divided into two categories, carcinogenicity and systemic toxicity (noncancer effects).

Assessment of Chemical Carcinogens

Although few chemicals are known human carcinogens, many chemicals are suspected to be human carcinogens based on the results of animal studies. The evaluation of the potential carcinogenicity of a chemical includes both a qualitative and a quantitative aspect (EPA 1989). The qualitative aspect is a weight-of-evidence evaluation of likelihood that a chemical might induce cancer in humans. The EPA recognizes six weight-of-evidence group classifications for carcinogenicity:

Group A—Human Carcinogen. Data for humans are sufficient to identify the chemical as a human carcinogen.

Group B1—Probable Human Carcinogen. Human data indicate a causal association is credible, but alternative explanations cannot be dismissed.

Group B2—Probable Human Carcinogen. Human data are insufficient to support a causal association, but testing data support a causal association in animals.

Group C—Possible Human Carcinogen. Human data are inadequate or lacking, but animal data suggest a causal association, although the studies have deficiencies that limit interpretation.

Group D-Not Classifiable as to Human Carcinogenicity. Human and animal data are lacking or inadequate.

Group E-Evidence of Noncarcinogenicity to Humans. Data for humans show negative results or are lacking, and adequate animal data indicate no association with cancer.

The quantitative evaluation is an estimate of carcinogenic potency. Potency estimates are developed only for chemicals in Groups A, B1, B2, and C. The potency estimates are statistically derived from the dose-response curve from the best human or animal study or studies available for a given chemical. In the case of animal studies, pharmacokinetic data or principles are used to estimate an equivalent human dose. The potency estimates are referred to as the cancer slope factor (CSF), and are expressed as risk per unit dose (per mg/kg-day). In order to be appropriately conservative, the CSF is usually the 95 percent upper bound on the slope of the dose-response curve extrapolated from high (experimental) doses to the low-dose range expected in environmental exposure scenarios. It is assumed that there is no threshold for carcinogens (e.g., a dose below which exposure is safe), and, therefore, any exposure represents some quantifiable risk. The discussion of chemical carcinogenicity includes the EPA's classification of carcinogenicity and the CSF recommended by the EPA. The CSF presented is for discussion purposes only. The CSF used in evaluating the carcinogenic risks associated with exposure to the contaminant are obtained from the Integrated Risk Information Service (IRIS) computer database for the Health Effects Assessment Summary Tables (HEAST) (EPA 1997a, 1997b). Separate CSFs are available for oral and inhalation exposures.

The potential incremental lifetime cancer risks (ILCRs) for inhalation are estimated by multiplying the concentration by the inhalation unit risk factors [i.e., value per $(\mu g/m^3)$]. This value is converted to a CSF [i.e., value per (mg/kg-day)] by dividing the unit risk factor by the average respiration rate of an adult (20 m³/day) and multiplying it by the average weight (70 kg) and by 1,000 to convert micrograms to milligrams.

Noncancer Effects

Many chemicals pose a potential health effect other than cancer. The range of potential noncancer effects is great (e.g., ranging from liver damage to dental florirosis). The evaluation of noncancer effects (EPA 1989) involves:

- Identification of the critical effect (or threshold effect) for each duration of exposure [i.e., the adverse effect that occurs at the lowest dose (e.g., if liver damage occurs at 20 mg/kg-day, and mortality occurs at 100 mg/kg-day, liver damage is the critical effect].
- Quantification of the threshold dose for the critical effect for each duration of exposure (i.e., the dose at or above which the effect occurs, and below which the effect does not occur).
- Development of an uncertainty factor (i.e., quantification of the uncertainty associated with interspecies extrapolation, intraspecies variation in sensitivity, severity of the critical effect and slope of the dose-response curve, and deficiencies in the database) in regard to developing a reference dose (RfD) for human exposure.
- Identification of the target organ(s) for the critical effect for each route of exposure.

The information described above is used to derive RfDs, expressed as mg/kg-day, which is considered to be the dose to humans at which adverse effects are not expected to occur. Because it is assumed that there is a threshold (e.g., a safe dose for noncarcinogens), the RfD is a non-probabilistic expression of the likelihood that an adverse effect might occur. RfDs are derived separately for oral and inhalation exposure pathways because of possible differences in the rate of absorption, target organs, and mechanisms of toxicity.

The inhalation RfD is generally expressed as the reference concentration (i.e., that concentration of a chemical in air that is not likely to have an adverse effect upon human receptors). The reference concentration is converted to a reference dose by multiplying the reference concentration (μ g/m³) by the average respiration rate of an adult (20 m³/day) and dividing by the average weight (70 kg). The final RfD value was converted from micrograms to milligrams by dividing by 1,000.

Chronic exposure is generally defined as an exposure equal to or greater than 7 years. Some receptors (i.e., construction workers and on-site child residents) have a subchronic exposure. As a conservative measure, chronic RfDs, may be used to evaluate the potential adverse health effects associated with exposure to chemicals.

Evaluation of Lead. No suitable dose-response values exist for assessing the risks associated with exposure to lead. The EPA has developed the IEUBK (version 0.99D), which is used to estimate blood-levels in children 0-7 years old following exposure to lead in various environmental media. EPA has identified a blood level of $10 \mu g/dL$ as a concentration of concern that should be avoided (EPA 1991). Because children are the most sensitive receptors, blood-lead levels are calculated for children. If the blood-lead levels for children are less than $10 \mu g/dL$, it can be inferred that there is no substantial risk for older receptors. Therefore, blood-lead levels resulting from children being exposed to contaminated environmental media are estimated.

Dermal Evaluation of Chemicals

Methodologies for estimating inhaled or ingested intake of a chemical account for the amount of chemical presented to the barrier membrane of the pulmonary or gastrointestinal mucosa, respectively. However, the dermal dose is estimated as the dose that crosses the skin and is systematically absorbed. For this reason, dermal toxicity values are also based on absorbed dose.

Dermal RfD and SF values may be derived from the corresponding oral values. In the derivation of a dermal RfD, the oral RfD is multiplied by the gastrointestinal absorption factor (GAF), expressed as a unitless fraction. The resulting dermal RfD is an RfD based on absorbed dose, which is the appropriate value with which to compare dermal doses because dermal doses are expressed as absorbed rather than exposure doses. In a similar manner, and for the same reasons, a dermal SF is derived by dividing the oral cancer slope factor by the GAF.

Not all COPCs have specific GAF values. When quantitative data are insufficient, a default GAF is used. EPA (1995) recommends a GAF of 0.8 for VOCs, 0.5 for SVOCs, and 0.2 for inorganic chemicals.

A.5 Risk Characterization

Risk characterization is the final step during which exposure and toxicity information are integrated to qualitatively or quantitatively evaluate the potential health risks associated with exposure to contaminants. Quantitative estimates of both carcinogenic and noncarcinogenic risks are calculated for each contaminant and each potentially complete exposure pathway.

Methodology for Carcinogens

The risk attributed to exposure to chemical carcinogens is estimated as the probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. At low doses, the risk of developing cancer is determined as follows (EPA 1989):

$$Risk = (CDI)(SF)$$
,

where:

Risk	=	risk of cancer incidence, expressed as a unitless probability,
CDI	=	chronic daily intake averaged over 70 years (mg/kg-day),
SF	=	slope factor (mg/kg-day) ⁻¹ .

For a given pathway with simultaneous exposure of a receptor to several carcinogens, the following equation is used to sum cancer risks:

where:

Risk = total risk of cancer incidence, chem_i = individual carcinogenic chemical. Contaminants contributing significantly to the total risk associated with a site are identified as contaminants of concern (COC).

Methodology for Noncarcinogens

The risks associated with the effects of noncarcinogenic hazardous chemicals are evaluated by comparing an exposure level or intake to a reference dose. The ratio of intake over the reference dose is termed the Hazard Quotient (HQ) (EPA 1989) and is defined as:

$$HQ = I/RfD$$
,

where:

HQ = hazard quotient (unitless), I = intake of a chemical (mg/kg-day), RfD = reference dose (mg/kg-day).

When using this equation to estimate potential risk, both the intake and the RfD must refer to exposures of equivalent duration (i.e., sub-chronic, chronic, or less than two weeks). Chemical exposures are evaluated in all cases on a chronic basis, using chronic RfD values.

This approach is different from the probabilistic approach used to evaluate carcinogens. An HQ of 0.01 does not imply a 1 in 100 chance of an adverse effect, but indicates only that the estimated intake is 100 times less than the reference dose. An HQ of unity (1) indicates that the exposure intake is equal to the RfD. If the HQ is greater than 1 or "above unity," there may be concern for potential health effects.

In the case of simultaneous exposure of a receptor to several chemicals, a Hazard Index (HI) is calculated as the sum of the Hazard Quotients by:

$$HI = I_1/RfD_1 + I_2/RfD_2 + ... I/RfD_1$$
,

where:

 I_i = intake for the ith toxicant, where i = 1, 2, 3... RfD_i = reference dose for the ith toxicant, where i = 1, 2, 3...

Hazard indices are determined by assuming dose additivity for those chemicals acting by the same mechanism and inducing the same effects (EPA 1989). Initially all of the chemicals are assumed to have the same mechanism of toxicity. If the HI is below 1, then the target organ specific HIs will also be below 1.0. If the HI exceeds 1.0, then HIs are calculated for each target organ. This provides a more accurate estimation of the potential systemic toxicity associated with exposure to a chemical mixture.

Uncertainty

There are uncertainties associated with all phases of the Human Health Risk Assessment (HHRA), including collection and laboratory analysis of the samples, exposure assessment, toxicity assessment, and risk characterization. Site-specific uncertainties will be discussed as part of the risk

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assessment for each of the sites and the impact of the uncertainties will be quantitatively addressed when possible.

Uncertainty in Exposure Assessment

Three major types of uncertainties should be considered when reviewing the results of the exposure assessment: (1) uncertainties associated with predicting future land use, (2) uncertainties associated with estimating chemical concentrations at receptor locations, and (3) uncertainties associated with assumptions used in the exposure models.

Physiological values (e.g., body weight, inhalation rates) and behavioral values (e.g., average time spent in one place, amount of soil ingested) used to model the RME are a combination of average and upper-bound levels taken from reliable sources. The use of upper-bound estimates will tend to overestimate exposure for RME. Therefore, the range of potential risks is likely to be greater than the actual risks. This provides a conservative, health-protective approach for the risk assessment.

Uncertainty in Toxicity Assessment

The toxicological parameters used to quantify potential risk to a receptor include CSFs and RfDs. These values are often derived from laboratory animal studies. The following overriding uncertainties associated with the use of laboratory animal studies are:

- The extrapolation of toxic effects observed at the high dose necessary to conduct animal studies to effects that might occur at the much lower, environmentally relevant doses.
- The extrapolation from toxic effects in animals to toxic effects in man (i.e., the potential for animal responses to differ from responses of man).

The EPA has derived CSFs using a weight-of-evidence approach from studies in the scientific literature. The CSFs represent the upper 95% confidence limits on the slope of the dose response curve for carcinogenic responses. Because CSFs represent the near upper limits of the slope of the line, the use of the CSF is more likely to overestimate the actual risk than under estimate it.

Uncertainties also arise in the development of the RfDs used to characterize noncarcinogenic effects. These reference values are derived using studies in humans or animals by identifying the lowest-observed-adverse-effect level (LOAEL) or no-observed-adverse-effect level (NOAEL). Two basic types of uncertainty arise. The first is related to the extrapolation from toxic effects seen at high dose to predict effects at the low dose usually encountered in the environment. The second involves extrapolation from effects in animals to effects in man. Each of these is offset by an uncertainty factor that is actually a product of as many as five separate factors, each intended to account for one type of uncertainty (EPA 1989). The LOAEL and NOAEL is divided by this composite uncertainty factor. The uncertainty factors usually range from 10 to 10,000. The five types of uncertainty (each representing an uncertainty factor of 5 to 10) included in the assignment of the uncertainty factor are:

- sensitive subpopulations in the general population,
- extrapolation from animals to humans,
- extrapolation from a subchronic study to a chronic estimate,

- extrapolation from a LOAEL to a NOAEL, and
- additional uncertainties in the critical study used in setting the RfD or reference concentration.

In addition, the absence of established toxicity criteria for some COPCs may result in an underestimation of risks.

Uncertainty in Risk Characterization

The risk characterization evaluates the potential risks associated with exposure to numerous chemicals via multiple pathways. There is uncertainty associated with exposure to chemical mixtures because chemicals may have synergistic or antagonistic effects on other chemicals. It is assumed that all chemicals have additive toxicity and that the potential health effects would be equal to the sum of each of the individual chemical actions for chemicals that act upon the same target organ. This may result in the overestimation or underestimation of certain risks.

In general, sources of uncertainty may be categorized into site-specific factors (e.g., variability in analytical data, modeling results, and exposure parameter assumptions) and toxicity factors. The use of conservative assumptions in the risk assessment is believed to result in an overestimate of risk. Actual site risks are likely to be lower.

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FINAL

SITE SAFETY AND HEALTH PLAN ADDENDUM

FOR THE

PHASE II REMEDIAL INVESTIGATION OF THE WINKLEPECK BURNING GROUNDS AND DETERMINATION OF FACILITY-WIDE BACKGROUND at the RAVENNA ARMY AMMUNITION PLANT RAVENNA, OHIO

PREPARED FOR



U.S. ARMY CORPS OF ENGINEERS LOUISVILLE DISTRICT

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Prepared for

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April 1998

APPROVALS

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ACRONYMS

FSHP	Facility-wide Safety and Health Plan
PPE	personal protective equipment
SAIC	Science Applications International Corporation
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
UXOs	unexploded ordnances
WBG	Winklepeck Burning Grounds

INTRODUCTION

Science Applications International Corporation's (SAIC) formal policy, stated in the Environmental Compliance and Health and Safety Program manual, is to take every reasonable precaution to protect the health and safety of our employees, the public, and the environment. To this end, the Ravenna Army Ammunition Plant Facility-wide Safety and Health Plan (FSHP) and this Site Safety and Health Plan (SSHP) Addendum collectively set forth the specific procedures required to protect SAIC and SAIC subcontractor personnel involved in the field activities. All field personnel are required to comply with the requirements of these plans. In addition, subcontractors are responsible for providing their employees with a safe workplace and nothing in these plans relieves such subcontractors of this responsibility. If the requirements of these plans are not sufficient to protect the employees of a subcontractor, that subcontractor is required to supplement this information with work practices and procedures that will ensure the safety of its personnel.

The FSHP addresses program issues and hazards and hazard controls common to the entire installation. This SSHP Addendum to the FSHP serves as the lower tier document addressing the hazards and controls specific to this project. Copies of the FSHP and this SSHP Addendum will be present at the work site.

SAIC will perform field investigations at Winklepeck Burning Grounds (WBG) and at several background (uncontaminated) locations. The WBG has been used for the disposal of a variety of materials, including munitions and wastes from munitions loading and demilitarization. Contaminants of concern include unexploded ordnances (UXOs), explosives residues (RDX, TNT), and metals.

The following are tasks to be performed as part of this project.

- soil boring and sampling with power augers,
- groundwater sampling,
- installation of groundwater monitoring wells with auger drill rig,
- installation of groundwater monitoring wells with air rotary drill rig,
- subsurface soil/rock sampling using drill rigs,
- well development,
- field screening of soils for explosives contamination,
- surface water sampling,
- soil sampling with hand augers or scoops,
- sediment sampling in stream and a pond, and
- sampling equipment decontamination.

Potential hazards posed by the tasks planned at these locations include UXOs, moving equipment (power auger and drill rig), fuel or decontamination solvent fires, chemical exposure, temperature extremes, noise, stinging/biting insects, poisonous plants, and snakes.

The potential for chemical overexposure appears to be very low given the nature of planned tasks. All of the expected contaminants have low vapor pressures, making overexposure through vapor inhalation very unlikely. All of the planned tasks, with the exception of air rotary drilling, pose minimal potential for creating airborne particulate. Air rotary drill discharge will be routed through a particulate control system to minimize airborne particulate and the spread of contamination. There is some potential for adverse effects due to dermal contact with contaminated soil. The crew will use

protective gloves to handle potentially contaminated materials and, if necessary, the Site Safety and Health Officer (SSHO) will upgrade the required personal protective equipment (PPE) to prevent dermal contact with potentially contaminated materials. The SSHO will observe all site tasks during daily safety inspections and will use professional judgement, coupled with instrument readings, to determine if upgrading PPE is required. A detailed analysis of these hazards and specific appropriate controls is presented in Section 2, Table 2-2.

This investigation will be performed in Level D PPE, plus chemical-resistant gloves when handling potentially contaminated materials, unless one of several action levels is exceeded or the potential for increased risk becomes apparent during the investigation. Protective procedures, including protective clothing, will be upgraded as necessary by the SSHO based on established action levels or judgment.

1. SITE DESCRIPTION AND CONTAMINATION CHARACTERIZATION

1.1 SITE DESCRIPTION

Ravenna Army Ammunition Plant is located in northeastern Ohio within Portage and Trumbull Counties, approximately 4.8 km (3 miles) northeast of the Town of Ravenna. The installation consists of 8668 ha (21,419 acres) in a 17.7-km (11-mile) long, 5.6-km (3.5-mile) wide tract bordered by a sparsely inhabited private residential area. The site is an inactive government owned armament, munitions, and chemical command facility maintained by a contracted caretaker, Mason and Hanger-Silas Co., Inc.

The installation was active from 1941 to 1992. Activities included loading, assembling, storing, and packing military ammunition; demilitarization of munitions; production of ammonium nitrate fertilizer; and disposal of "off-spec" munitions. Munitions handled on the installation included artillery rounds of 90 mm or more and 2000-lb bombs.

Winklepeck Burning Grounds (WBG) is an 81-ha (200-acre) area that was used for open burning of RDX, antimony sulfide, composition B, lead azide, TNT, propellant, black powder, waste oils, sludge from the load lines, domestic wastes, and small amounts of laboratory chemicals. For additional site information see the Facility-wide Safety and Health Plan (FSHP) and the Sampling Analysis Plan.

1.2 CONTAMINANTS

Table 1-1 lists contaminants known to occur at WBG. Inclusion in this table indicates the potential presence of a contaminant but does not necessarily indicate that the contaminant is present in sufficient quantity to pose a health risk to workers. Several of the detected contaminants, such as pesticides and polychlorinated Biphenyl, occur at insufficient concentrations to pose a threat of overexposure during this project.

Contaminant	Maximum Reported Concentration	Quantities to be Encountered
Polychlorinated biphenyl compounds	310 Fg/kg	Small quantities contained in samples and adjacent surfaces.
Semivolatile organic compounds	1700 Fg/kg (2,4,5-Trichlorophenol)	
Volatile organic compounds	160 Fg/kg (Ethylbenzene)	
Unexploded ordnance (UXO)	Not available	No known UXO; however, nature of area of concern activities cause it to be of concern, especially in the northeastern part of the area of concern
Chromium	118 Fg/g	
DNT (Dinitrotoluene)	25,500 Fg/kg	

Table 1-1.	Contaminants	in	Soil at WBG
1 ant 1-1.	Contaminanto		

Contaminant	Maximum Reported Concentration	Quantities to be Encountered
HMX (Octogen)	2 H 10 ⁶ Fg/kg	
Lead	916 mg/kg	Small quantities contained in samples and adjacent surfaces.
RDX (Cyclonite)	9,500,000 Fg/kg	
TNT (Trinitrotoluene)	4 H 10 ⁶ Fg/kg	

2. HAZARD/RISK ANALYSIS

The purpose of the task hazard/risk analysis is to identify and assess potential hazards that may be encountered by personnel and to prescribe required controls. Table 2-1, a general checklist of hazards that may be posed by this project, indicates whether a particular major type of hazard is present. If additional tasks or significant hazards are identified during the work, this document will be modified by addendum or field change order to include the additional information.

Table 2-1. Hazards Inventory

Yes	No	Hazard		
	Х	Confined space entry		
	Х	Excavation entry (deeper than 1.2 m)		
Х		Heavy equipment (drill rigs and power augers)		
Х		Fire and explosion (fuels)		
Х		Electrical shock (utilities)		
Х		Exposure to chemicals		
Х		Temperature extremes		
Х		Biological hazards		
	Х	Radiation or radioactive contamination		
Х		Noise		
X		Drowning		

Specific tasks are as follows:

- Soil sampling with hand augers or scoops.
- Field laboratory analysis.
- Soil boring and sampling with power augers.
- Sediment sampling in streams and a pond.
- Well development.
- Monitoring well installation and subsurface soil sampling using hollow stem auger and air rotary drill rigs.
- Groundwater sampling.
- Surface water sampling.
- Equipment decontamination at the central equipment decontamination facility.

2.1 TASK-SPECIFIC HAZARD ANALYSIS

Table 2-2 presents task-specific hazards, task-specific hazard analyses (Risk Assessment Code), relevant hazard controls, and required monitoring, if appropriate, for all of the planned site tasks. The Risk Assessment Codes in Table 2-2 are derived through a qualitative risk assessment process using probability codes and severity codes. The severity codes are

- I = injuries/illnesses involving permanent total disability or death;
- II = injuries/illnesses with permanent partial disability or temporary total disability;
- III = injuries/illnesses resulting in temporary, reversible conditions with period of disability of less than 3 months; and
- IV = injuries/illnesses with reversible adverse effects requiring only minor treatment.

The probability codes are

- A = likely to occur immediately;
- B = probably will occur in time;
- C = possible to occur in time; and
- D = unlikely to occur.

2.2 POTENTIAL EXPOSURES

Environmental contamination is known to exist at WBG and controls will be used to minimize exposure. The background sampling locations have been selected specifically to avoid contamination, so no contaminant exposure is expected at these locations.

Information on the significant contaminants at WBG and chemical tools that will be used for the project is contained in Table 2-3. This table includes potential contaminants that pose a potential to cause adverse effects in site workers during or after the execution of this project. It excludes potential contaminants that are unlikely to pose a threat to site workers.

Table 2-2. Hazards Analysis

	Risk		
Safety and Health Hazards	Assess. Codes	Controls	Monitoring
Safety and Health Hazarus	Coues	Controis	Wollitoring
		Well Development and Groundwater Sampling	
Safety hazards associated with equipment	D, IV	Level D PPE including hardhat (see Section 5). Hazardous Waste Site Operations (HAZWOPER) training. Buddy system. Medical clearance.	Daily safety inspections of SAIC operations.
Contact with unexploded ordnance (UXO)	D, II	On-site training in ordnance recognition for all field personnel. Visual surveillance for the presence of UXO. Withdrawal of all SAIC and subcontractor personnel and field marking of the area if ordnance or suspected ordnance is discovered. Notification of USACE and facility EOD personnel if ordnance is discovered.	Visual surveys for ordnance.
Exposure to chemicals (see Table 2-3)	D, IV	Natural rubber or similar gloves for contact with potentially contaminated material. Heavy duty re-usable PVC or neoprene boots, doffed upon exit from exclusion zone. Gloves will be disposed after single use, boots will be dedicated to work in exclusion zone and will be deconned after each use or maintained in exclusion zone. Washing face and hands and any other exposed areas prior to taking anything by mouth. Minimal contact. 15- minute eyewash in the immediate work area.	Photoionization detector.
Gunfire (deer hunting with shotguns loaded with slugs is allowed in some areas on Friday and Saturday during season)	D, I	No field work at dawn or dusk in areas open to hunting. High visibility vests in these areas. When possible, schedule work in these areas for Sunday through Thursday.	None.
Animal hazards (bees, ticks, wasps, snakes)	C, III	PPE (boots, work clothes). Pants tucked into boots or wrapped with duct tape. Insect repellant, as necessary.	Visual survey.
Temperature extremes	C, II	Administrative controls (see Section 8).	Ambient temperature, heart rates as appropriate.
	Soil B	oring and Soil Sampling Using a Hand Operated Power Auger	
General safety hazards (rotating machinery, moving equipment, slips, falls)	C, II	Level D PPE (see Section 5) plus hardhat. Operate auger per manufacturers' directions. Positive action control (Deadman switch) or easily accessible kill switch on power auger. HAZWOPER training. Buddy system. Medical clearance.	Daily site safety inspections.

	Risk Assess		
Safety and Health Hazards	Codes	Controls	Monitoring
Contact with UXO	D, II	On-site training in ordnance recognition for all field personnel. Withdrawal of all SAIC and subcontractor personnel and field marking of suspect area if ordnance or suspected ordnance is discovered. Notification of USACE Project Manager and facility EOD personnel if ordnance is discovered.	Visual surveys for ordnance.
Exposure to chemicals (see Table 2-3)	D, II	Natural rubber or similar gloves for contact with potentially contaminated material. Heavy duty re-usable PVC or neoprene boots, doffed upon exit from exclusion zone. Gloves will be disposed after single use, boots will be dedicated to work in exclusion zone and will be deconned after each use or maintained in exclusion zone. Washing face and hands and any other exposed areas prior to taking anything by mouth. Minimal contact.	Photoionization detector, visual surveillance for dust generation, visual surveillance for significant contamination.
Gunfire (deer hunting with shotguns loaded with slugs is allowed in some areas on Friday and Saturday during season)	D, II	No field work at dawn or dusk in areas open to hunting. High visibility vests in these areas. When possible, schedule work in these areas for Sunday through Thursday.	None.
Noise	B, II	Hearing protection within 7.6 m (25 ft) of equipment.	Daily safety inspections.
Fire (fuels)	D, III	Fuel in safety cans. No ignition sources in fuel storage or refueling areas. Fire extinguisher (see Section 9).	Daily safety inspection.
Animal hazards (bees, ticks, wasps, snakes)	C, III	PPE (boots, work clothes). Pants tucked into boots or wrapped with duct tape. Insect repellant, as necessary.	Visual survey.
Electric shock	D, II	Identification and clearance of underground utilities.	Visual of all work areas.
Temperature extremes	C, II	Administrative controls (see Section 8)	Ambient temperature, heart rates as appropriate.
		Field Laboratory Analysis	
General safety hazards	D, IV	Level D PPE (see Section 5). HAZWOPER training. Medical clearance.	Daily site safety inspections.
Contact with UXO	D, II	On-site training in ordnance recognition for all field personnel. Visual surveillance for the presence of UXO. Withdrawal of all SAIC and subcontractor personnel and field marking of the area if	Visual surveys for ordnance.

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Table 2-2 (continued)

	Risk			
Safety and Health Hazards	Assess. Codes	Controls	Monitoring	
		ordnance or suspected ordnance is discovered. Notification of USACE Project Manager and facility EOD personnel if ordnance is discovered.		
Exposure to chemicals (see Table 2-3)	D, III	Natural rubber or similar gloves for contact with potentially contaminated material. Washing face and hands and any other exposed areas prior to taking anything by mouth. Minimal contact. Adequate ventilation of laboratory setting. Perform screening in well ventilated area. 15-minute eyewash within 100 ft.		
Fire (chemical reagents)	D, III	Control of flammable material. Fire extinguisher (see Section 9). Adequate ventilation of laboratory setting.	Daily safety inspection.	
Electric shock	D, II	Identifying and securing electrical shock hazards associated with laboratory equipment.	Visual inspection of all work areas.	
Soil Sampling with Hand Augers or Scoops				
General safety hazards (manual lifting, slips, falls)	D, IV	Level D PPE (see Section 5). HAZWOPER training. Buddy system. Medical clearance.	Daily site safety inspections.	
Contact with UXO	D, II	On-site training in ordnance recognition for all field personnel. Visual surveillance for UXO. Withdrawal of all SAIC and subcontractor personnel and field marking of the area if ordnance or suspected ordnance is discovered. Notification of USACE Project Manager and facility EOD personnel if ordnance is discovered.	Visual surveys for ordnance.	
Exposure to chemicals (see Table 2-3)	D, III	Natural rubber or similar gloves for contact with potentially contaminated material. Heavy duty re-usable PVC or neoprene boots, doffed upon exit from exclusion zone. Gloves will be disposed after single use, boots will be dedicated to work in exclusion zone and will be deconned after each use or kept in exclusion zone. Washing face and hands and any other exposed areas prior to taking anything by mouth. Minimal contact. 15- minute eyewash in the immediate work area.	Photoionization detector, visual surveillance for significant contamination.	
Gunfire (deer hunting with shotguns loaded with slugs allowed in some areas on Friday and Saturday during	D, I	No field work at dawn or dusk in areas open to hunting. High visibility vests in these areas. When possible, schedule work in these areas for Sunday through Thursday.	None.	

2-5

	Risk		
Safety and Health Hazards	Codes	Controls	Monitoring
season)			
Animal hazards (bees, ticks, wasps,	C, III	PPE (boots, work clothes). Pants tucked into boots or wrapped	Visual survey.
snakes)		with duct tape. Insect repellant, as necessary.	
Temperature extremes	C, II	Administrative controls (see Section 8).	Ambient temperature, heart rates as appropriate.
	Sed	iment and Surface Water Sampling in Streams and a Pond	
General safety hazards (moving	D, IV	Level D PPE (see Section 5). Good housekeeping. HAZWOPER	Daily site safety inspections.
equipment, slips, falls)	,	training. Buddy system. Medical clearance.	5 5 1
Drowning	C, II	Personal flotation devices must be worn if within 1.5 m (5 ft) of	Daily site safety inspections.
		water deeper than 1.2 m (4 ft).	
Exposure to chemicals (see Table 2-3) Gunfire (deer hunting with shotguns	D, III D. I	Natural rubber or similar gloves for contact with potentially contaminated material. Washing face and hands and any other exposed areas prior to taking anything by mouth. Heavy duty PVC or neoprene boots or waders, doffed upon exit from potentially contaminated area. Gloves will be disposed after a single use. Boots or waders will be dedicated to work in potentially contaminated areas and will be deconned following each use or bogged pending subsequent use. Minimal contact. 15-minute eye wash within immediate area. No field work at dawn or dusk in areas open to hunting. High	Daily site safety inspections.
loaded with slugs is allowed in some areas on Friday and Saturday during season)	2,1	visibility vests in these areas. When possible, schedule work in these areas for Sunday through Thursday.	TORC.
Contact with UXO	D, II	On-site training in ordnance recognition for all field personnel. Visual surveillance for UXO. Withdrawal of all SAIC and subcontractor personnel and field marking of the area if ordnance or suspected ordnance is discovered. Notification of USACE Project Manager and facility EOD personnel if ordnance is discovered.	Visual surveys for ordnance
Animal hazards (bees, ticks, wasps, snakes)	C, III	PPE (boots, work clothes). Pants tucked into boots or wrapped with duct tape. Insect repellant, as necessary. Snake chaps if moving through underbrush.	Visual survey.

	Risk		
Safety and Health Hazards	Codes	Controls	Monitoring
Temperature extremes	C, III	Administrative controls (see Section 8)	Ambient temperature, heart rates as appropriate.
Installation of Mo	onitoring V	Vells and Subsurface Soil Sampling Using Hollow Stem Auger and	Air Rotary Drills
General safety hazards (power	D, III	Level D PPE (see Section 5) plus hardhat. Personnel not involved	Daily site safety inspections.
machinery, moving equipment, slips,		with equipment will stand clear during operation. HAZWOPER	
falls)		training. Buddy system. Medical clearance.	
Contact with UXO	D, II	On-site training in ordnance recognition for all field personnel.	Visual surveys for ordnance.
		Visual surveillance for UXO. Withdrawal of all SAIC and	
		subcontractor personnel and field marking of the area if ordnance	
		or suspected ordnance is discovered. Notification of USACE	
		Project Manager and facility EOD personnel if ordnance is	
	D 111	discovered.	
Exposure to chemicals	D, III	Natural rubber or similar gloves for contact with potentially	Photoionization detector, visual
(see Table 2-3)		contaminated material. Heavy duty PVC or neoprene boots, doffed	surveillance for dust generation,
		upon exit from exclusion zone. Gloves will be disposed after single	visual surveillance for significant
		be decopped after each use or kept in the exclusion zone. Washing	contamination.
		face and hands and any other exposed areas prior to taking	
		anything by mouth Minimal contact. Air rotary drill rigs will be	
		equipped with dust suppression systems 15 minute evenash in the	
		immediate area.	
Gunfire (deer hunting with shotguns	D, I	No field work at dawn or dusk in areas open to hunting. High	None.
loaded with slugs is allowed in some		visibility vests in these areas. When possible, schedule work in	
areas on Friday and Saturday during		these areas for Sunday through Thursday.	
season)			
Noise	B, III	Hearing protection within 7.6 m (25 ft) of equipment during	Daily safety inspections.
		operation.	
Fire (fuels)	D, III	Fuel in safety cans. Ignition sources excluded from fuel storage	Daily safety inspection.
		and fuel pouring areas. Fire extinguisher (see Section 9).	
Animal hazards (bees, ticks, wasps,	C, III	PPE (boots, work clothes). Pants tucked into boots or wrapped	Visual survey.
snakes)		with duct tape. Insect repellant, as necessary.	
Electric shock	D, II	Identification and clearance of aboveground and underground	Visual of all work areas.

Safety and Health Hazards	Risk Assess. Codes	Controls	Monitoring
		utilities.	
Temperature extremes	C, II	Administrative controls (see Section 8). Ambient temperature, he appropriate.	
Disposal of Investigation-Derived Wastes (Soil Cuttings and Decontamination Rinsates)			
General safety hazards (power machinery, moving equipment, slips, falls)	D, III	Level D PPE (see Section 5) plus heavy duty work gloves. Hardhat if overhead hazards are present. Personnel not involved with equipment (trailer mounted liquid tank, manual drum truck, drum grappler, Tommy lift, etc.) will stand clear during operation. HAZWOPER training. Buddy system. Medical clearance. No personnel under lifted loads. Only adequately trained, experienced personnel will be allowed to operate equipment. Equipment used to lift or move drums will be used within its rated weight capacity.	Daily site safety inspections.
Contact with UXO	D, II	On-site training in ordnance recognition for all field personnel. Visual surveillance for UXO. Withdrawal of all SAIC and subcontractor personnel and field marking of the area if ordnance or suspected ordnance is discovered. Notification of USACE Project Manager and facility EOD personnel if ordnance is discovered.	Visual surveys for ordnance.
Exposure to chemicals (see Table 2-3)	D, III	Natural rubber or similar gloves for contact with potentially contaminated material. Washing face and hands and any other exposed areas prior to taking anything by mouth. Minimal contact	Daily site safety inspections.
Gunfire (deer hunting with shotguns loaded with slugs allowed in some areas on Friday and Saturday during season)	D, I	No field work at dawn or dusk in areas open to hunting. High visibility vests in these areas. When possible, schedule work in these areas for Sunday through Thursday.	None.
Fire (fuels)	D, III	Fuel in safety cans. Exclude ignition sources from fuel storage and refueling areas. Fire extinguisher (see Section 9).	Daily safety inspection.
Animal hazards (bees, ticks, wasps, snakes)	C, III	PPE (boots, work clothes). Pants tucked into boots or wrapped with duct tape. Insect repellant, as necessary.	Visual survey.
Temperature extremes	C, II	Administrative controls (see Section 8)	Ambient temperature, heart rates as appropriate.

Risk Assess.		
Codes	Controls	Monitoring
ent Deconta	amination (Hot Water Washing, Soap and Water Washing, Solver	nt Rinse)
C, III	Level D+ PPE (see Section 5) plus: Nitrile or PVC gloves, face	Daily safety inspections.
	shield and Saranax or rain suit (when operating steam washer).	
	HAZWOPER training. Medical clearance.	
B, II	Hearing protection when within 7.6 m (25 ft) of operating washer.	Daily safety inspections.
D, III	Exclusion of ignition sources during solvent use. Control of	Daily safety inspections.
	flammable materials (quantities in decontamination area limited to	
	single day use, proper storage). Fire extinguisher (see Section 9).	
D, III	Natural rubber or similar gloves for handling potentially	None.
	contaminated materials. Adequate ventilation during solvent use.	
	Washing face and hands and any other exposed areas prior to	
	taking anything by mouth. Minimal contact.	
C, II	Administrative controls (see Section 8).	Temperature measurements as
		appropriate, heart rate monitoring as
		appropriate.
	Risk Assess. Codes ent Deconta C, III B, II D, III D, III C, II	Risk Assess. CodesControlsent Decontamination (Hot Water Washing, Soap and Water Washing, Solver C, IIIC, IIILevel D+ PPE (see Section 5) plus: Nitrile or PVC gloves, face shield and Saranax or rain suit (when operating steam washer). HAZWOPER training. Medical clearance.B, IIHearing protection when within 7.6 m (25 ft) of operating washer.D, IIIExclusion of ignition sources during solvent use. Control of flammable materials (quantities in decontamination area limited to single day use, proper storage). Fire extinguisher (see Section 9).D, IIINatural rubber or similar gloves for handling potentially contaminated materials. Adequate ventilation during solvent use. Washing face and hands and any other exposed areas prior to taking anything by mouth. Minimal contact.C, IIAdministrative controls (see Section 8).

EOD=Explosives ordnance disposalHAZWOPER=Hazardous Waste Site OperationsPPE=Personal protective equipmentPUE=Number of the trace of the PVC = Polyvinyl chloride Science Applications International Corporation
U.S. Army Corps of Engineers
Unexploded ordnance SAIC USACE

UXO

Che
Chromium
DNT (dinit

Table 2-3. Potential Exposures

Chemical ^a	TLV/PEL/STEL/IDLH ^b	Health Effects/ Potential Hazards ^c	Chemical and Physical Properties ^c	Exposure Route(s) ^c	Location
Chromium	TLV/TWA: 0.5, A4 mg/m ³ IDLH: 25 mg/m ³	Eye irritation, sensitization	Solid; properties vary depending upon specific compound	Inhalation Ingestion Contact	WBG
DNT (dinitrotoluene)	TLV/TWA: 0.15, A2 mg/m ³ IDLH: Ca [50 mg/m ³]	Suspected human carcinogen, anorexia, cyanosis, reproductive effects	Orange-yellow solid, VP: 1 mm; FP: 404EF	Inhalation Absorption Ingestion Contact	WBG
Gasoline (used for fuel)	TLV/TWA: 300 ppm IDLH: Ca	Potential carcinogen per NIOSH, dizziness, eye irritation, dermatitis	Liquid with aromatic odor; FP: -45EF; VP: 38-300 mm	Inhalation Ingestion Absorption Contact	All
Hydrochloric acid (used for equipment decontamination)	TLV: 5 ppm ceiling IDLH: 50 ppm	Irritation of eyes, skin, respiratory system	Liquid; VP: fuming; IP: 12.74 eV; FP: none	Inhalation Ingestion Contact	Equipment decontamination area
Isopropyl alcohol (potentially used for equipment decontamination)	TLV/TWA: 400 ppm STEL: 500 ppm IDLH: 2000 ppm	Irritation of eyes, skin, respiratory system; drowsiness, headache	Colorless liquid with alcohol odor; VP: 33 mm; IP: 10.10 eV; FP: 53EF	Inhalation Ingestion Contact	Equipment decontamination area
Lead	TLV/TWA: 0.05, A3 mg/m ³ PEL/TWA: 0.05 mg/m ³ IDLH: 100 mg/m ³	Weakness, anorexia, abdominal pain, anemia	Solid metal; VP: 0 mm; FP: NA; IP: NA	Inhalation Ingestion Contact	WBG
Liquinox (used for decontamination)	TLV/TWA: None	Inhalation may cause local irritation to mucus membranes	Yellow odorless liquid (biodegradable cleaner); FP: NA	Inhalation Ingestion	Equipment decontamination area
Methanol (used for equipment decontamination)	TLV/TWA: 200 ppm Skin notation IDLH: 6000 ppm	Irritation of eyes, skin, respiratory system; headache; optic nerve damage	Liquid; VP: 96 mm; IP: 10.84 eV; FP: 52EF	Inhalation Absorption Ingestion Contact	Equipment decontamination area

Table 2-3 (continued	e 2-3 (continued)
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Chemical ^a	TLV/PEL/STEL/IDLH ^b	Health Effects/ Potential Hazards ^c	Chemical and Physical Properties ^c	Exposure Route(s) ^c	Location
HMX (octogen)	TLV/TWA: None	Explosive; assumed irritation of	Assumed similar to RDX- FP:	Assumed:	WBG
	established, toxicity	eyes and skin, dizziness,	explodes;	Inhalation	
	assumed to be similar to	weakness	VP: 0.0004 mm at 230EF	Absorption	
	RDX as compounds are			Ingestion	
	very similar			Contact	
RDX (cyclonite)	TLV/TWA: 1.5 mg/m ³	Explosive; irritation of eyes and	White powder; FP: explodes;	Inhalation	WBG
	Skin notation	skin, dizziness, weakness	VP: 0.0004 mm at 230EF	Absorption	
	IDLH: none established			Ingestion	
				Contact	
TNT	TLV/TWA: 0.5 mg/m ³	Cluster headache; irritation of	Pale solid; FP: explodes;	Inhalation	WBG
	Skin notation	skin and mucus membranes,	VP: 0.0002 mm	Absorption	
	IDLH: 500 mg/m ³	liver damage, kidney damage		Ingestion	
				Contact	

^aThe potential chemicals were obtained from the Ravenna Army Ammunition Plant Phase I Remedial Investigation Report (1997).

^bFrom 1997 Threshold Limit Values, NIOSH Pocket Guide to Chemical Hazards, 1994.

^cFrom 1994 NIOSH Pocket Guide to Chemical Hazards, the Condensed Chemical Dictionary, Tenth Edition.

= confirmed human carcinogen = suspected human carcinogen A1 A2 CNS = central nervous system = Not Classifiable as a human carcinogen IP = ionization potential TWA = time-weighted average A4 PEL = permissible exposure limit VP = vapor pressure FP = flash point = short-term exposure limit IDLH = immediately dangerous to life and health STEL NA = not available NIOSH = National Institute for Occupational Safety and Health TLV = threshold limit value

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3. STAFF ORGANIZATION, QUALIFICATIONS, AND RESPONSIBILITIES

This section presents the personnel (and their associated telephone numbers) responsible for site safety and health and emergency response. Table 3-1 identifies the Science Applications International Corporation (SAIC) and subcontractor individuals who will fill key roles. See the FSHP for information on the roles and responsibilities of key positions.

Position	Name	Phone
Program Manager (DACA62-94-D-0029)	Greg Grim	423-481-8786
Deputy Program Manager	Ike Diggs	423-481-8710
Health and Safety Manager	Steve Davis CIH, CSP	423-481-4755
Project Manager	Steve Selecman	423-481-8761
Field Operations Manager	Kathy Dominick	513-429-2699
Site Safety and Health Officer	Martha Clough	513-429-2699

Table 3-1. Staff Organization

4. TRAINING

See the FSHP. In addition to the FSHP's requirements at least two first aid/CPR trained personnel must be onsite during field activities.

5. PERSONAL PROTECTIVE EQUIPMENT

See the FSHP and hazard/risk analysis section.
6. MEDICAL SURVEILLANCE

7. EXPOSURE MONITORING/AIR SAMPLING PROGRAM

Assessment of airborne chemical concentrations will be performed, as appropriate, to ensure that exposures do not exceed acceptable levels. Action levels, with appropriate actions, have been established for this monitoring. In addition to the specified monitoring, the Site Safety and Health Officer (SSHO) may perform, or require, additional monitoring such as organic vapor monitoring in the equipment decontamination area, personnel exposure sampling for specific chemicals, etc. The deployment of monitoring equipment will depend on the activities being conducted and the potential exposures. All personal exposure monitoring records will be maintained in accordance with 29 *CFR* 1910.20. The minimum monitoring requirements and action levels are presented in Table 7-1.

Hazard or Measured Parameter	Area	Interval	Limit	Action	Tasks
Airborne organics with PID or equivalent	Breathing zone [0.9 m (3 ft) from source or 0.36 m (14 in.)] in front of employee's shoulder	At least once every 30 minutes during intrusive activities; continuously if readings exceed background	<5 ppm >5 ppm ???	Level D Withdraw and evaluate • identify contaminants • notify Project Manager and H&S Manager	All intrusive tasks
Detector tubes	Breathing zone	If organic vapor >5 ppm	PEL/TLV	Withdraw and evaluate, controls may include engineering, administrative, or personal protective measures	Any indicated by organic vapor instrument readings
Flammability and oxygen content with combustible gas indicator	Near borehole and any area where flammable gases are suspected	Only if PID readings exceed 100 ppm or other indicators of flammability observed	<10% LEL	Continue and evaluate source Withdraw and allow area to ventilate; notify Project Manager and H&S Manager	Intrusive tasks
Noise	None, SAIC has performed monitoring of drill rigs and generators on previous projects.	Only if there is some doubt about noise levels	85 dBA and any area perceived as noisy	Require the use of hearing protection	None; hearing protection will be worn within the exclusion zone around drill rigs, excavation equipment, power augers, and generators
Visible contamination	All	Continuously	Visible contamination of skin or personal clothing	Upgrade PPE to preclude contact; may include disposable coveralls, boot covers, etc.	All

Table 7-1. Monitoring Requirements and Action Limits

7-2

Hazard or					
Measured					
Parameter	Area	Interval	Limit	Action	Tasks
Visible airborne	All	Continuously	Visible dust	Stop work; use dust suppression	All
dust			generation	techniques such as wetting	
				surface	

Table 7-1 (continued)

H&S = Health and Safety LEL = Lower explosive limit PEL = Permissible exposure limit PID = Photoionization detector

PPE = Personal protective equipment SAIC = Science Applications International Corporation TLV = Threshold limit value

8. HEAT/COLD STRESS MONITORING

9. STANDARD OPERATING SAFETY PROCEDURES

10. SITE CONTROL MEASURES

11. PERSONNEL HYGIENE AND DECONTAMINATION

12. EQUIPMENT DECONTAMINATION

13. EMERGENCY PROCEDURES AND EQUIPMENT

Emergency contacts, telephone numbers, directions to the nearest medical facility, and general procedures can be found in the FSHP. The SAIC Field Operations Manager will remain in charge of all SAIC and subcontractor personnel during emergency activities. The SAIC field office will serve as the assembly point if it becomes necessary to evacuate one or more sampling locations. The SSHO will verify that the emergency information in the FSHP is correct during mobilization for the Phase I.

14. LOGS, REPORTS, AND RECORD KEEPING