REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ORGANIZATION.

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
09/10/2009	Final	October 2009

4. TITLE AND SUBTITLE

Data Quality Objectives Report for the RVAAP-03 Open Demolition Area #1

5a. CONTRACT NUMBER
W912QR-08-D-0013

5b. GRANT NUMBER
N/A

5c. PROGRAM ELEMENT NUMBER
N/A

6. AUTHOR(S)

Dave Cobb, David Crispo, P.E., Andrea Steele

5d. PROJECT NUMBER
133616

5e. TASK NUMBER
03000001

5f. WORK UNIT NUMBER
N/A

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Shaw Environmental & Infrastructure, Inc.
100 Technology Center Drive
Stoughton, MA 02072

8. PERFORMING ORGANIZATION REPORT NUMBER
N/A

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

U.S. Army Corps of Engineers - Louisville District
600 Martin Luther King, Jr. Place
Louisville, KY 40202

10. SPONSOR/MONITOR'S ACRONYM(S)
CELRL-ED-EE

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
N/A

12. DISTRIBUTION/AVAILABILITY STATEMENT
Available for regulator review (see Distribution sheet).

13. SUPPLEMENTARY NOTES
The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision, unless designated by other documentation.

14. ABSTRACT

The purpose of this DQO Report is to determine if there are any data gaps from the past removal action at RVAAP-03 where the extent of contamination was not adequately characterized or if there are any other efforts required for environmental closure of the AOC. The evaluation processes presented in this document and performed under this delivery order were conducted in accordance with the Facility-Wide Data Quality Objectives described in the Facility-Wide Sampling and Analysis Plan and the revised Performance Work Statement. Data results from the Phase I RI Report (SAIC 2001) and the Interim Removal Action Report (MKM 2004) have been compared to the current RVAAP background values and the current most restrictive risk based Draft RGOs for contaminants detected at the site. Based on the available information, additional sampling of surface and subsurface soil is necessary to support an environmental remedy selection for the AOC as currently delineated. The extent of MEC scrap and debris at ODA 1 has not been adequately defined based on visual observations at the site. A geophysical investigation will be performed over the current AOC and areas just beyond the perimeter to identify any "push out areas".

15. SUBJECT TERMS
RVAAP-03, Open Demolition Area 1, Data Quality Objectives Report

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Dave Cobb
Unclassified	Unclassified	Unclassified	UL	158	19b. TELEPHONE NUMBER *(Include area code)* 617.589.5561

Reset

INSTRUCTIONS FOR COMPLETING SF 298

1. REPORT DATE. Full publication date, including day, month, if available. Must cite at least the year and be Year 2000 compliant, e.g. 30-06-1998; xx-06-1998; xx-xx-1998.

2. REPORT TYPE. State the type of report, such as final, technical, interim, memorandum, master's thesis, progress, quarterly, research, special, group study, etc.

3. DATES COVERED. Indicate the time during which the work was performed and the report was written, e.g., Jun 1997 - Jun 1998; 1-10 Jun 1996; May - Nov 1998; Nov 1998.

4. TITLE. Enter title and subtitle with volume number and part number, if applicable. On classified documents, enter the title classification in parentheses.

5a. CONTRACT NUMBER. Enter all contract numbers as they appear in the report, e.g. F33615-86-C-5169.

5b. GRANT NUMBER. Enter all grant numbers as they appear in the report, e.g. AFOSR-82-1234.

5c. PROGRAM ELEMENT NUMBER. Enter all program element numbers as they appear in the report, e.g. 61101A.

5d. PROJECT NUMBER. Enter all project numbers as they appear in the report, e.g. 1F665702D1257; ILIR.

5e. TASK NUMBER. Enter all task numbers as they appear in the report, e.g. 05; RF0330201; T4112.

5f. WORK UNIT NUMBER. Enter all work unit numbers as they appear in the report, e.g. 001; AFAPL30480105.

6. AUTHOR(S). Enter name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. The form of entry is the last name, first name, middle initial, and additional qualifiers separated by commas, e.g. Smith, Richard, J, Jr.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES). Self-explanatory.

8. PERFORMING ORGANIZATION REPORT NUMBER. Enter all unique alphanumeric report numbers assigned by the performing organization, e.g. BRL-1234; AFWL-TR-85-4017-Vol-21-PT-2.

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES). Enter the name and address of the organization(s) financially responsible for and monitoring the work.

10. SPONSOR/MONITOR'S ACRONYM(S). Enter, if available, e.g. BRL, ARDEC, NADC.

11. SPONSOR/MONITOR'S REPORT NUMBER(S). Enter report number as assigned by the sponsoring/ monitoring agency, if available, e.g. BRL-TR-829; -215.

12. DISTRIBUTION/AVAILABILITY STATEMENT. Use agency-mandated availability statements to indicate the public availability or distribution limitations of the report. If additional limitations/ restrictions or special markings are indicated, follow agency authorization procedures, e.g. RD/FRD, PROPIN, ITAR, etc. Include copyright information.

13. SUPPLEMENTARY NOTES. Enter information not included elsewhere such as: prepared in cooperation with; translation of; report supersedes; old edition number, etc.

14. ABSTRACT. A brief (approximately 200 words) factual summary of the most significant information.

15. SUBJECT TERMS. Key words or phrases identifying major concepts in the report.

16. SECURITY CLASSIFICATION. Enter security classification in accordance with security classification regulations, e.g. U, C, S, etc. If this form contains classified information, stamp classification level on the top and bottom of this page.

17. LIMITATION OF ABSTRACT. This block must be completed to assign a distribution limitation to the abstract. Enter UU (Unclassified Unlimited) or SAR (Same as Report). An entry in this block is necessary if the abstract is to be limited.

Final Data Quality Objectives for the RVAAP-03 Open Demolition Area #1
Version 1.0

Ravenna Army Ammunition Plant
8451 St. Route 5
Ravenna, Ohio 44266-9297

Contract No. W912QR-08-D-0013
Delivery Order 0002

Prepared for:

US Army Corps
of Engineers ®
Louisville District

600 Martin Luther King, Jr. Place
Louisville, Kentucky 40202

Prepared by:

Shaw® Shaw Environmental & Infrastructure, Inc.

100 Technology Center Drive
Stoughton, MA 02072

October 9, 2009

DOCUMENT DISTRIBUTION

Name/Organization	Number of Printed Copies	Number of Electronic Copies
Ohio EPA Facility Manager	2	2
Ohio EPA Federal Facilities Manager	1	1
OHARNG-Camp Ravenna Environmental Manager	1	1
RVAAP Facility Manager	2	4
USAEC Program Manager	0	1
USACE – Huntsville District	1	1
USACE – Louisville District	3	3
Shaw Project Manager	3	3

Ohio EPA – Ohio Environmental Protection Agency
OHARNG – Ohio Army National Guard
RVAAP – Ravenna Army Ammunition Plant
USAEC – U.S. Army Environmental Command
USACE – U.S. Army Corps of Engineers – Louisville District

CONTRACTOR STATEMENT OF INDEPENDENT TECHNICAL REVIEW

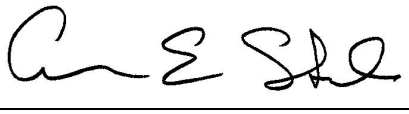
Shaw Environmental & Infrastructure, Inc. has completed the *Final Data Quality Objectives Report for RVAAP-03 Open Demolition Area #1* for the Ravenna Army Ammunition Plant, Ravenna, Ohio. Notice is hereby given that an independent technical review has been conducted that is appropriate to the level of risk and complexity inherent in the project. During the independent technical review, compliance with established policy, principles and procedures, utilizing justified and valid assumptions, was verified. This included review of data quality objectives; technical assumptions; methods, procedures and materials to be used; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets customer's needs consistent with law and existing Corps policy.

Reviewed / Approved by:  Date: October 9, 2009

David Cobb
Project/Program Manager

Reviewed by:  Date: October 9, 2009

David Crispo, P.E.
Technical/Regulatory Lead

Prepared by:  Date: October 9, 2009

Andrea E. Steele
Environmental Scientist

Table of Contents

Table of Contents *(continued)*

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AOC	Area of Concern
bgs	below ground surface
BEHP	bis(2-ethylhexyl)phthalate
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
COC	chemical of concern
COPC	contaminant of potential concern
CSM	conceptual site model
CUG	Cleanup Goal
DNT	dinitrotoluene
DoD	Department of Defense
DQO	Data Quality Objective
EPC	Exposure Point Concentration
FSAP	Facility-Wide Sampling and Analysis Plan
GPO	geophysical prove out
GPS	global positioning system
HHRA	human health risk assessment
HMX	octhydro-1,3,5,5-tetranitro-1,3,5,7-tetrazocine
HQ	Hazard Quotient
IRA	Interim Removal Action
IRP	Installation Restoration Program
MD	munitions debris
MEC	munitions and explosives of concern
mg/kg	milligrams per kilogram
MI	multi-increment
MKM	MKM Engineers, Inc.
NTA	National Advisory Committee for Aeronautics Test Area (RVAAP-38)
OB/OD	open burning and open detonation
ODA1	Open Demolition Area #1
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
PCB	polychlorinated biphenyl
PRG	Preliminary Remediation Goal
RI	Remedial Investigation
RTK	Real-Time Kinematic
RTS	Robotic Total Station
RVAAP	Ravenna Army Ammunition Plant
RDX	1,3,5-trinitro-1,3,5-triazacyclohexane
RRSE	Relative Risk Site Evaluation
SAIC	Science Applications International Corporation
Shaw	Shaw Environmental & Infrastructure, Inc.
SOW	scope of work

Acronyms and Abbreviations (continued)

SVOC	semivolatile organic compound
TAL	Target Analyte List
TNT	trinitrotoluene
UCL	Upper Confidence Limit
USACHPPM	United States Army Center for Health Promotion and Preventive Medicine
USACE	United States Army Corps of Engineers
USATHAMA	United States Army Toxic and Hazardous Materials Agency
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound

This page intentionally left blank.

1.0 Introduction

1.1 Purpose and Scope

This *Data Quality Objectives (DQO) Report* provides a systematic approach for evaluating data requirements to support the decision making process associated with possible future actions for Ravenna Army Ammunition Plant (RVAAP)-03 - Open Demolition Area #1 (ODA1) located at RVAAP in Ravenna, Ohio (Figure 1-1). This *DQO Report* is being prepared by Shaw Environmental & Infrastructure, Inc. (Shaw) under Delivery Order (DO) 0002 for Architectural/Engineering Environmental Services at RVAAP under the Indefinite Delivery/Indefinite Quantity Contract No. W912QR-08-D-0013. The task order was issued by the United States Army Corps of Engineers, Louisville District (USACE) on September 22, 2008.

The purpose of this *DQO Report* is to determine if there are any data gaps from past investigation and remedial activities at RVAAP-03 where the extent of contamination was not adequately characterized or delineated or if there are any other efforts required to assess environmental closure of the Area of Concern (AOC). The evaluation processes presented in this document and performed under this DO were conducted in accordance with the Facility-Wide DQOs described in the *Facility-Wide Sampling and Analysis Plan* (*FSAP*) (Science Applications International Corporation [SAIC], 2001a) and the revised Scope of Work (SOW), dated August 26, 2008, included as an attachment to the DO contract. Since the proposed activities in this DQO report are occurring after the final Phase I Remedial Investigation (RI) Report, data collected during activities identified in the DQO report will be incorporated into the Feasibility Study and used as part of the remedy selection process. This approach has been discussed with the Ohio Environmental Protection Agency (Ohio EPA) and they have concurred on the approach. At present, a geophysical survey of areas within ODA1 is being proposed. Additional environmental media sampling may be required based on the results of the geophysical survey.

1.2 RVAAP Description and Background

The RVAAP is located in northeastern Ohio within Portage and Trumbull Counties, approximately 1.6 km (1 mile) northwest of the city of Newton Falls and 4.8 km (3 miles) east-northeast of the city of Ravenna (Figure 1-1). The facility is a parcel of property approximately 17.7 kilometers (11 miles) long and 5.6 kilometers (3.5 miles) wide bounded by State Route 5, the Michael J. Kirwan Reservoir, and the CSX System Railroad on the south; Garret, McCormick, and Berry roads on the west; the Norfolk Southern Railroad on the north; and State Route 534 on the east (Figure 1-2).

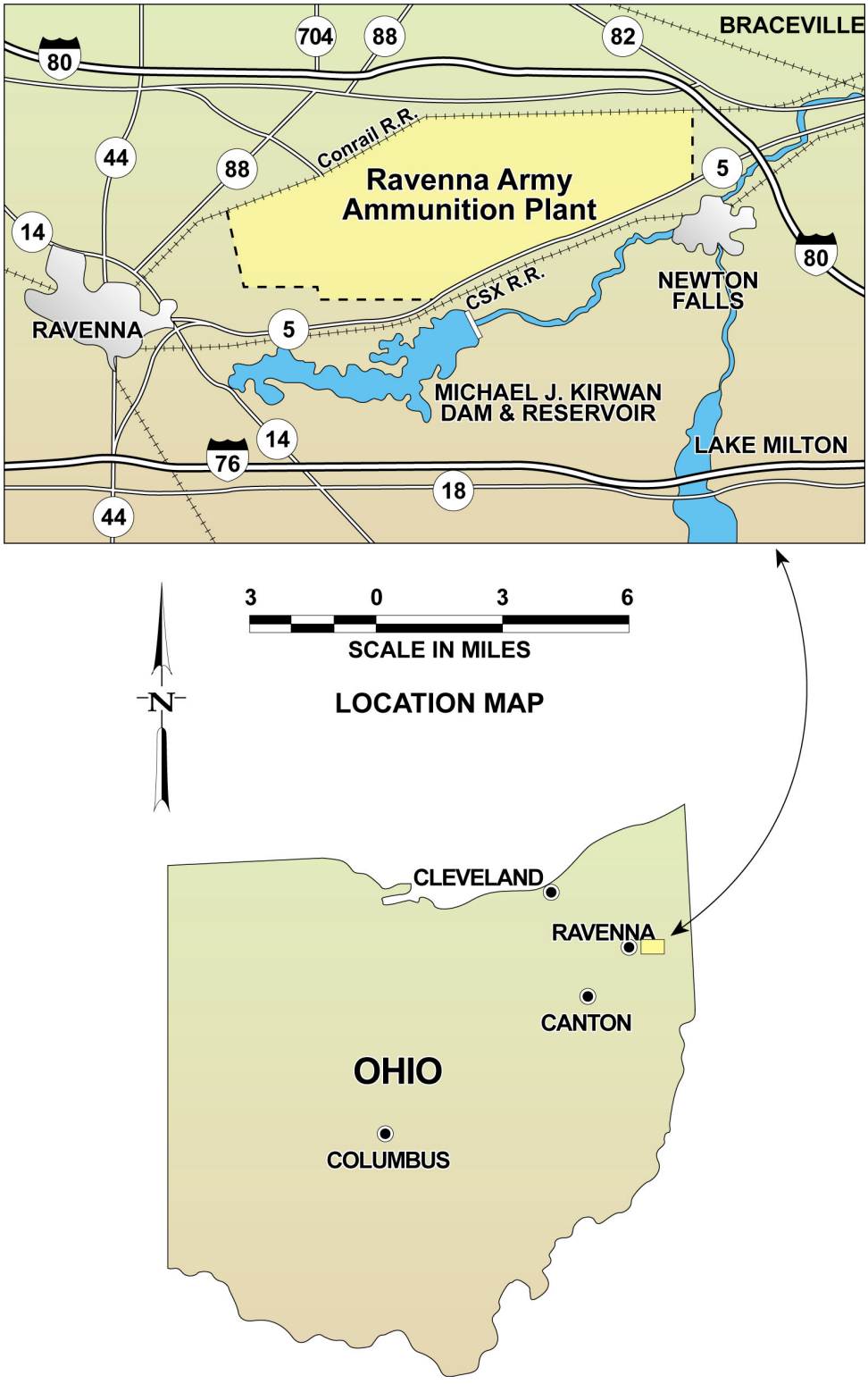
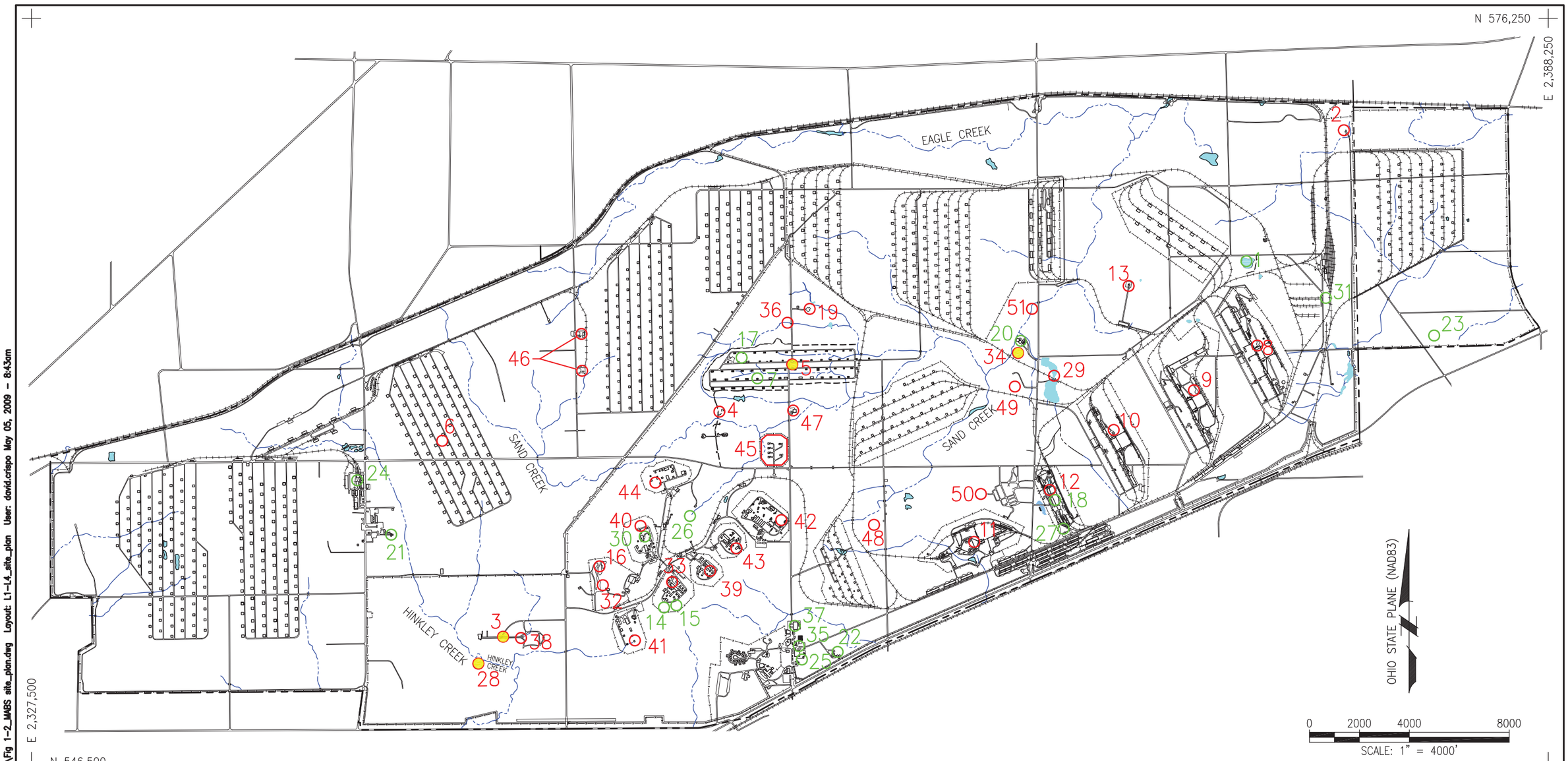


Figure 1-1
Location Map

Figure 1-2
RVAAP Facility Map



This page intentionally left blank

As of February 2006, a total of 20,403 acres of the former 21,683-acre RVAAP have been transferred to the United States Property and Fiscal Officer for Ohio and subsequently licensed to the Ohio Army National Guard (OHARNG) for use as a training site. Currently, RVAAP consists of 1,280 acres in several distinct parcels scattered throughout the confines of the Camp Ravenna Joint Military Training Center (Camp Ravenna). RVAAP's remaining parcels of land are located completely within Camp Ravenna. Camp Ravenna did not exist when RVAAP was operational, and the entire 21,683-acre parcel was a government-owned, contractor-operated industrial facility.

The RVAAP Installation Restoration Program (IRP) encompasses investigation and cleanup of past activities over the entire 21,683 acres of the former RVAAP, and therefore references to the RVAAP in this document are considered to be inclusive of the historical extent of the RVAAP, which is inclusive of the combined acreages of the current Camp Ravenna and RVAAP, unless otherwise specifically stated. The Ohio EPA is the lead regulatory agency for the investigation and remediation conducted by USACE under the United States Department of Defense (DoD) IRP.

1.3 Open Demolition Area #1

The ODA1 AOC is approximately 6 acres and was formerly used primarily for the open burning and open detonation (OB/OD) of munitions, explosives and associated materials (Figures 1-3 and 1-4). ODA1 is located within the National Advisory Committee for Aeronautics (NACA) Test Area (NTA) (RVAAP-38). It is believed that ODA1 was used primarily during the 1940's. The OB/OD area within ODA1 was surrounded by an oval shaped earthen berm and is located adjacent to areas where aircraft used at the NTA were staged. Burning areas at ODA1 may have been cleared by pushing debris and scrap to the periphery of ODA1 using heavy equipment. Historical information and visual inspections conducted in 2008 indicate that the boundaries of ODA1 may not have been fully defined. Munitions and explosives of concern (MEC)/munitions debris (MD) has been observed in areas outside of the previously remediated areas and north of the former NACA crash strip. ODA1 is currently covered with grass and the berms around the OB/OD area essentially removed. ODA1 has been unused since the cessation of OB/OD activities although dismounted troop training by the OHARNG has been ongoing at the surrounding NTA site since 1969. Seibert stakes have been installed to define the current boundary of the ODA1 site.

Topography across the ODA1 AOC is relatively flat with little change in elevation. The AOC is slightly elevated as compared to its immediate surroundings and surface drainage is to the east, west, and south. Drainage from within the bermed OB/OD area is south via a culvert towards a shallow ditch which ultimately discharges at ground surface within the Hinkley Creek drainage

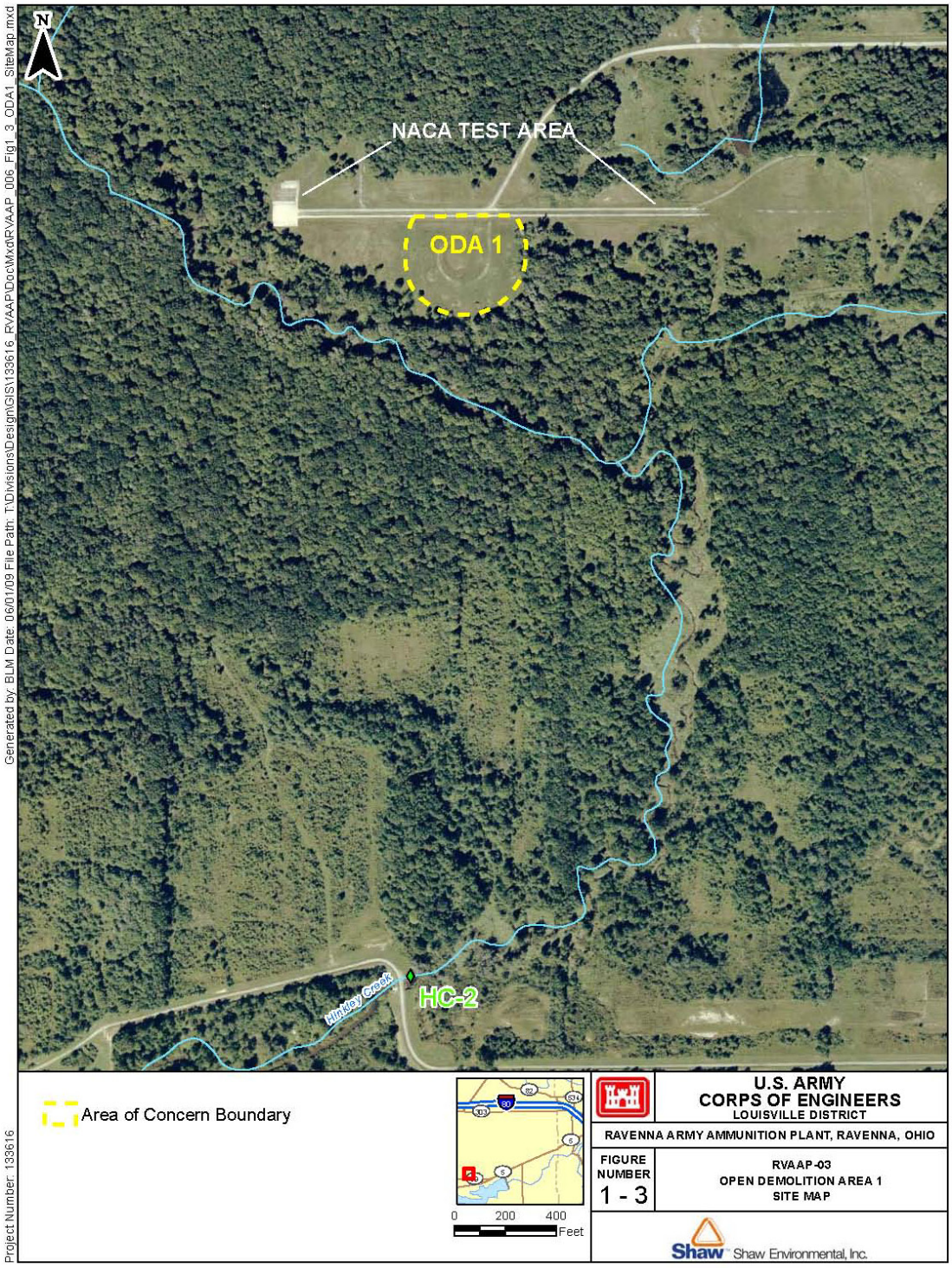


Figure 1-3
Open Demolition Area #1 Site Map

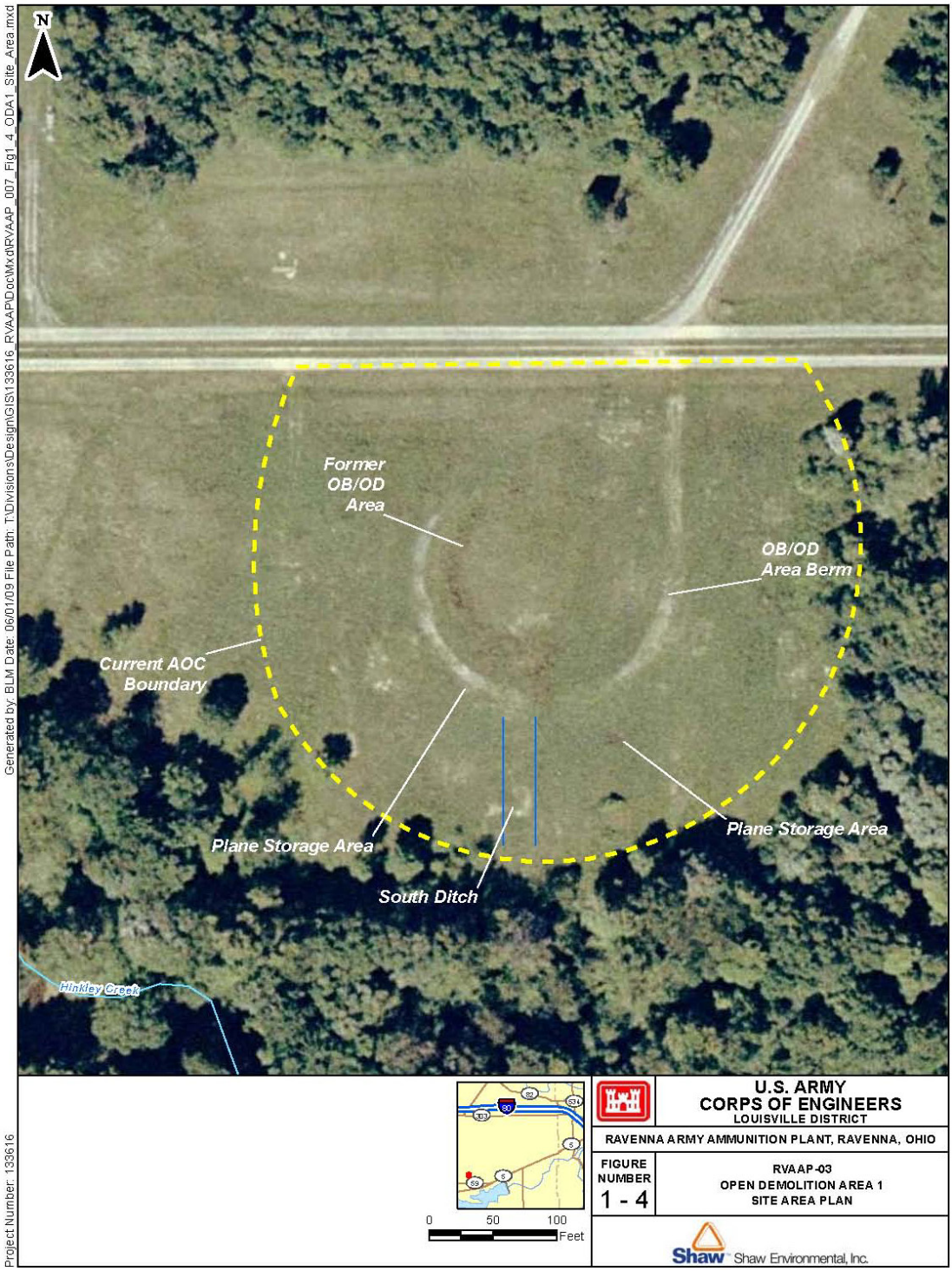


Figure 1-4
Open Demolition Area #1 Site Area Plan

area. Depth to groundwater at the site and the adjacent NTA site has been observed to be 15 to 16 feet below ground surface (bgs).

A Phase I RI focusing on the OB/OD area was conducted in 1999 (SAIC, 2001b) to further evaluate the occurrence and distribution of contamination in five media within the AOC: surface soils (from 0 to 1 foot bgs), subsurface soils (1 to 3 feet bgs, 3 to 5 feet bgs, and 6 to 8 feet bgs), sediment, surface water, and groundwater. The one groundwater sample collected under the Phase I RI was obtained using direct-push boring techniques. Groundwater obtained from well points at RVAAP is solely used for screening purposes. Specifically, any detects are considered minimal values and non-detects do not definitively indicate lack of contamination. Groundwater data that is used at RVAAP for the purpose of evaluation, risk assessment, etc., must be obtained from properly installed, developed, and sampled monitoring wells. The RI results indicated the primary media of concern were the surface and subsurface soil. Contaminants detected in the surface soil greater than background included metals, low levels of explosives and propellants (i.e., 8 of 17 detections are estimated values less than the reporting limits), and isolated low level detections of volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs) (i.e., detections are estimated values less than the reporting limits). Subsurface soils were primarily found to contain metals greater than background criteria with isolated, low level detections of VOCs and SVOCs (i.e., 8 of 9 VOCs detections and each of the SVOCs detections are estimated values less than the reporting limits). The detected contaminants are consistent with the historical activities performed at the site.

An interim removal action (IRA) (Section 1.2.3) was performed in 2000-2001 (MKM Engineers, Inc. [MKM], 2004) to address impacted soils identified in the Phase I RI and remove residual MEC debris. The removal activities consisted of the collection and disposal of residual MEC related scrap in the surface and subsurface soils and the assessment, excavation, and off-site disposal of soils from areas within ODA1 that had previously indicated explosives contamination. Soil excavation and screening activities were based on data from the Phase I RI. Confirmatory sampling was also performed as part of the IRA to assess contaminant concentrations in soils left in place at the base of the grid excavations. As a result, a large portion of the surface and subsurface characterization data presented in the Phase I RI may not be applicable since the soil has been subsequently removed and the areas resampled.

1.3.1 Summary of Investigation Activities at Open Demolition Area #1

Previous investigation activities at ODA1 consisted of the following:

1.3.1.1 1996 USACHPPM Evaluation

Three surface soil samples were collected and analyzed as part of a Relative Risk Site Evaluation (RRSE) in 1996 by United States Army Center for Health Promotion and Preventive Medicine (USACHPPM, 1996). Although the data indicated the presence of seven metals and one explosive (2,4,6-trinitrotoluene [TNT]) in the soil samples collected, the limited amount of data

and associated quality assurance documents did not allow for a comprehensive assessment of the extent of contaminant impact to soil media from ODA1 (SAIC, 2001b).

1.3.1.2 Water Quality Surveillance Program

Surface water samples were collected and analyzed at HC-2 (see Figure 1-3) as part of the installation Water Quality Surveillance Program by United States Army Toxic and Hazardous Materials Agency (USATHAMA, 1980-1992). Low concentrations (i.e., detections are estimated values less than the reporting limits) of copper, zinc, and 1,3,5-trinitro-1,3,5-triazacyclohexane (RDX) were observed on one occasion at HC-2 (Figure 1-3). However, the limited amount of data, associated quality assurance documents, and the distance and location of HC-2 from ODA1 did not allow for a comprehensive assessment of the extent of contaminant impact to surface water media from ODA1 (SAIC, 2001b).

1.3.1.3 Phase I Remedial Investigation

A Phase I RI was performed in 1999 (SAIC, 2001b) to assess the occurrence, distribution, and potential risks from contamination in soil to a depth of 2.4 meters (8 feet) bgs, sediment, groundwater, and surface water. The RI activities were focused on the OB/OD area of ODA1 and surrounding areas to also identify whether releases of contamination beyond the AOC boundary had occurred. The one groundwater sample collected under the Phase I RI was obtained using direct-push boring techniques. Groundwater obtained from well points at RVAAP is solely used for screening purposes. Specifically, any detects are considered minimal values and non-detects do not definitively indicate lack of contamination. Groundwater data that is used at RVAAP for the purpose of evaluation, risk assessment, etc., must be obtained from properly installed, developed, and sampled monitoring wells. Surface water and sediment were assessed by collecting samples from existing upgradient and downgradient surface water and sediment drainage channels. The results of the Phase I RI at ODA1 indicated the presence of site-related contamination in soil. Sediment and surface water in Hinkley Creek do not appear to have received significant contamination related to AOC operations. Contaminant migration off of the AOC also appears to be negligible based on the Phase I RI data. Screening of chemical data against risk-based criteria (Section 5.4 of the Phase I RI [SAIC, 2001]) showed the presence of human health and ecological contaminants of potential concern (COPCs) in each environmental medium. The Phase I RI identified human health as the primary factor for facilitating further remedial activities at ODA1 based on the present and continued use of the site for OHARNG training. A baseline human health risk assessment (HHRA) and a Screening Ecological Risk Assessment were also recommended by the Phase I RI. The data collected during the Phase I investigation included: 42 surface soil samples, 77 subsurface soil samples, 4 sediment samples, 3 surface water samples, and 1 groundwater sample. Soil sample locations are presented on Figure 1-5. Surface water, sediment and groundwater sample locations are shown on Figure 1-6. The findings of the Phase I RI indicated the following for each media:

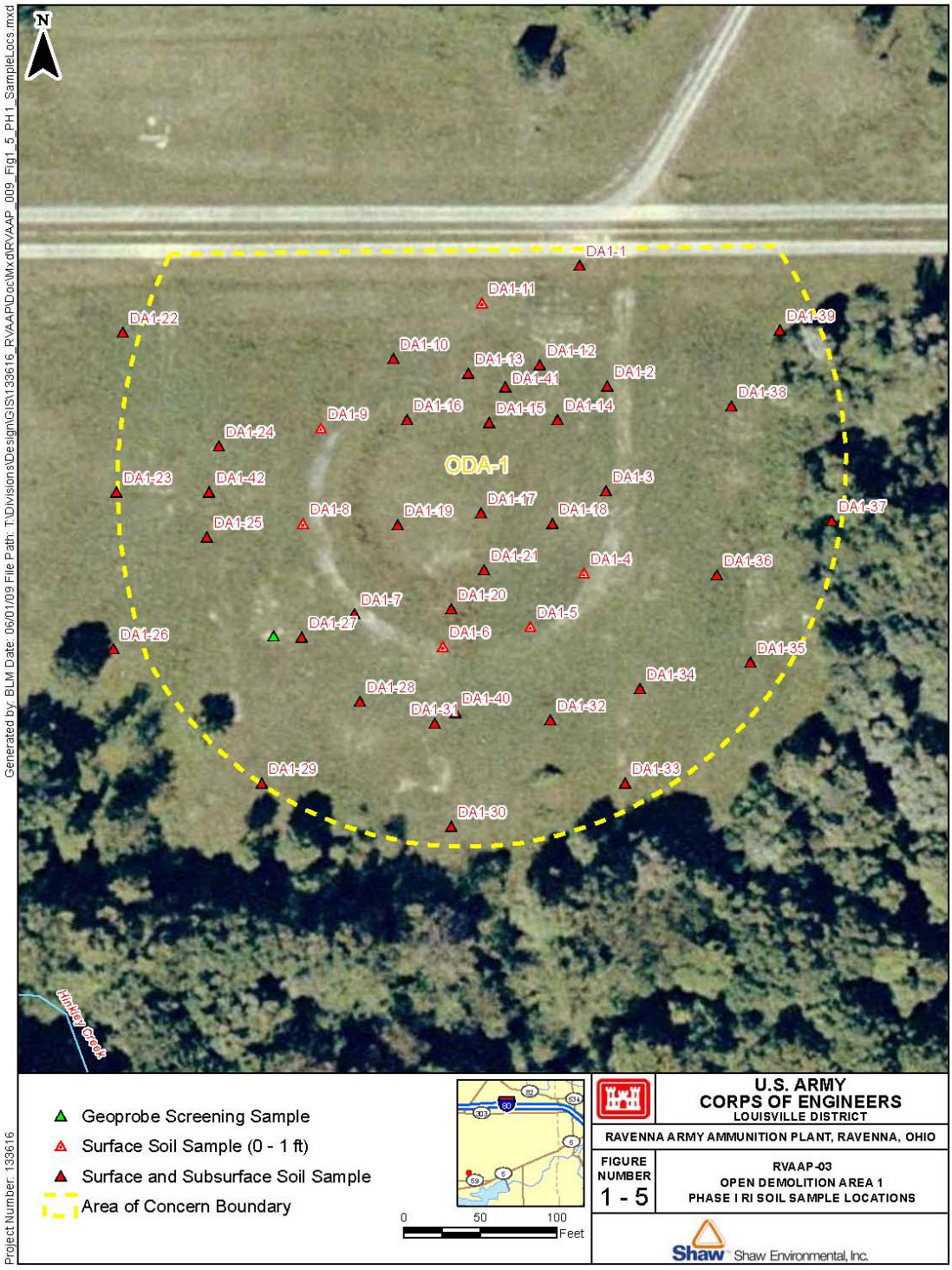


Figure 1-5
Open Demolition Area #1 Phase I RI Soil Sample Locations

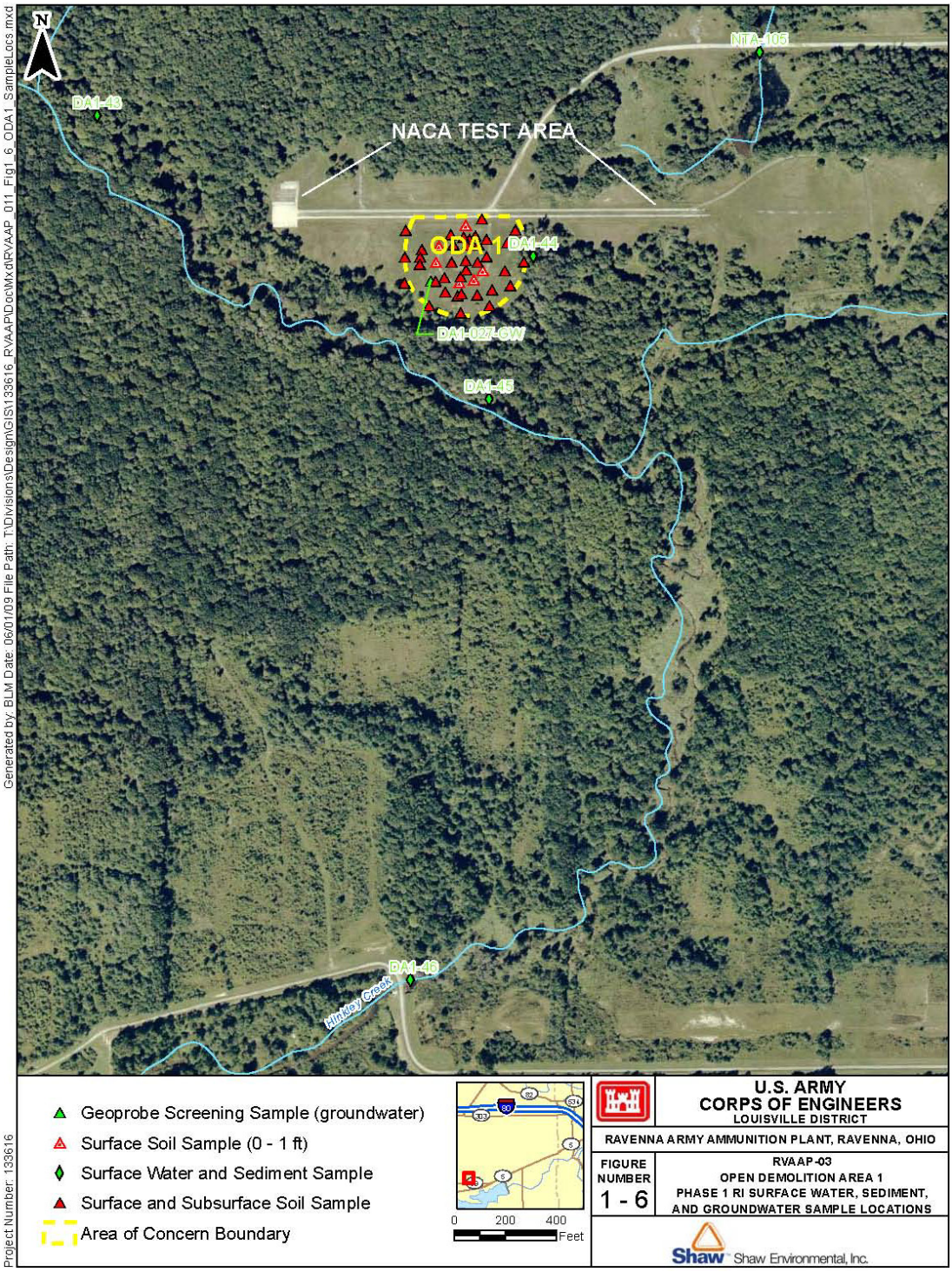


Figure 1-6
Open Demolition Area #1 Phase I RI Surface Water, Sediment, and Groundwater Sample Locations

Surface Soil

- The south ditch and "hot spots" in the western and southern portions of the plane storage area (see Figure 1-4) represent the principal locations having contamination greater than background levels. The highest concentrations of explosives and propellants are clustered along the south drainage ditch, indicating potential contaminant migration via surface water runoff across the AOC and deposition along the ditch.

- Surface soils contained explosives (2,4,6-TNT and 2,4-dinitrotoluene [DNT]) and nitrocellulose with 2,4,6-TNT exceeding the residential risk-based screening criterion used at the time of the sampling at four locations (DA1-001, DA1-010, DA1-030, and DA1-040) and 2,4-DNT exceeding the residential criterion at three locations (DA1-010, DA1-014, and DA1-022).

- Ten (10) metals were identified as COPCs. Of these metals, aluminum, arsenic, cadmium, chromium, lead, and manganese exceeded both background values and risk-based screening criteria used in the Phase 1. The greatest exceedances of human health risk-based screening criteria were observed in the western and southern portions of the plane storage area.

- 4-Methylnapthlene was the only SVOC identified as a COPC due to lack of a risk-based screening criterion for comparison.

- VOCs are not COPCs in surface soil.

- Screening of data against migration to groundwater criteria shows that 2,4-DNT, antimony, arsenic, barium, cadmium, chromium, and zinc exceeded their respective criteria.

Subsurface Soil

- Explosives, SVOCs, and VOCs were not identified as COPCs in subsurface soil.

- Aluminum, arsenic, cadmium, chromium, copper, lead, and zinc were identified as COPCs in subsurface soil. All but copper and zinc exceeded both risk-based screening criteria and background concentrations available at the time of the RI investigation. Almost all exceedances of background and risk-based screening levels occured in the western half of the AOC. In general, the concentrations of metals are lower in subsurface soil samples than in surface soil samples.

- Screening of data against migration to groundwater criteria shows that arsenic, cadmium, and chromium exceeded their respective criteria (Section 5.4 of the Phase I RI [SAIC, 2001b]).

Sediment and Surface Water

Aluminum and chromium were the only constituents identified as human health COPCs in sediment. The maximum detected value of 14,400 milligrams per kilogram (mg/kg) in dry sediment at station DA1-044 only slightly exceeds the background criteria (13,900 mg/kg) for

aluminum. The only chromium result greater than background (18.1 mg/kg) occurred at station DA1-046 at HC-2 (18.8 mg/kg). Sediment ecological COPCs include polychlorinated biphenyl (PCB)-1260, lead, nickel, aluminum, and magnesium.

Zinc concentrations greater than background concentrations were observed in surface water samples collected at station DA1-045 in Hinkley Creek. DA1-45 is the closest point in Hinkley Creek to ODA1 and is located to the south of the AOC. RDX was also detected once at the facility exit point (DA1-046, HC-2) at an estimated concentration (0.24 µg/L) less than the detection limit. Two additional compounds bis(2-ethylhexyl)phthalate (BEHP) and chloroform, were also detected in surface water samples collected from DA1-043 that exceeded their risk-based screening criteria at the time of the RI. However, DA1-043 is located upgradient of ODA1 indicating the contaminants are not related to ODA1. Surface water ecological COPCs include BEHP, RDX, zinc, and calcium.

The data collected during the Phase I RI indicated that sediment and surface water in Hinkley Creek has not been significantly contaminated as a result of former operations at ODA1.

1.3.1.4 Confirmatory Sampling for IRA

Following the excavation and removal of soil as part of the IRA performed in 2000-2001 at ODA1, confirmatory samples, consisting of soils from four locations from the base of each grid excavated, were collected to assess residual contaminant impact to soil. A total of 29 soil samples were collected from depths ranging between 2 and 4 feet depending upon the type of excavation being performed. Given the depth of the sample locations, these samples equate to a subsurface soil sample by RVAAP definition. All soil samples were submitted for Target Analyte List (TAL) metals and explosives analysis. Ten (10) percent of the samples (3 total) were also analyzed for the RVAAP full suite of parameters (pesticides, PCBs, propellants, VOCs, SVOCs, and cyanide). Field duplicates of samples designated for the full suite of analysis were also analyzed for the full suite (3 additional samples). In addition, excavated soils were also screened in the field for explosives to determine if soils could be reused as backfill. Representative soil samples were screened using the Jenkins analysis for RDX and TNT. A further description of the removal activities is presented below in Section 1.3.2.

1.3.2 Summary of Removal Actions at Open Demolition Area #1

MEC Debris Removal & Interim Removal Action

The MEC debris removal and IRA at ODA1 were initiated based on the findings of the Phase I RI conducted in 1999 at ODA1. The objective of the removal action at ODA1 was to remove the MEC debris, and the hazards associated with it, to a depth of 4 feet bgs and to eliminate the human health exposure to environmental chemicals of concern (COCs) that may have originated from activities at ODA1. Sixteen (16) 50 by 50-foot grids (Grids #1 through 16) were

established for excavation based on residual chemical contamination observed in the RI. Grid locations were based on Phase I samples indicating metals concentrations greater than RVAAP background values (as developed in the Winklepeck Burning Grounds Phase II RI [USACE, 2001]) and/or detections of explosive compounds in soil. Based upon the Phase I sample results, the 0 to 1 foot lift from all 16 grids exceeded these criteria. Grid #7 exceeded these criteria to a depth of 3 feet bgs. In addition, four other areas (Grids # 17- 20) were identified as having a high concentration of MEC related debris on the surface outside of the designated environmental grids. These four grids were excavated and MEC debris removed through sifting at the site. The soil from these four grids did not exceed the established chemical criteria at the time based upon the Phase I sampling results and the soils could be used immediately for backfill.

Figure 1-7 shows the approximate grid locations overlain on the ODA1 site. Eleven (11) grids exhibited explosives contamination with MEC contamination in soil (Grids # 1, 2, 3, 4, 5, 6, 11, 13, 14, 15, 16); 1 grid exhibited high lead contamination with MEC contamination in soil (Grid # 7); 4 grids exhibited explosive and metals contamination with MEC contamination in soil (Grids # 8, 9, 10, 12); and 4 grids exhibited the presence of high surficial MEC contamination with no environmental concerns (Grids # 17, 18, 19, 20). The grids were excavated to between 2 and 8 feet bgs with the majority to 4 feet bgs. Grid 5 includes a 10-feet x 5-feet area excavated to between 6 and 8 feet bgs. Grid 11A was excavated to 5 feet bgs. Grids 17, 18, 19, and 20 were excavated to 2 feet bgs. Grid 21 was excavated to between 2 and 4 feet bgs. The road base bisecting Grids 3, 4, 8, and 14 was not removed.

The 16 grids with environmental contamination were excavated to a total depth of 4 feet bgs. The top lift (0 to 1 foot for all grids except for Grid #7 which was 0 to 3 feet) was excavated, sifted and staged for waste characterization. The remaining soil was excavated and staged in 100 cubic yard stockpiles after sifting and screened for explosives using the Jenkins Field Test Kit. Soils with no detections for explosives and less than background concentrations for metals were used as backfill. The four grids with MEC only concerns were excavated to approximately 2 feet bgs, sifted and returned to the AOC for backfill. A total of 81,800 pounds of MEC scrap was removed from the site. Segregated soils for the grid excavations were sampled for waste characterization. After review and approval of the data, Ohio EPA determined the soils did not pose a risk to human health and gave the approval to reuse the material as backfill (Grids # 1, 2 and 20) and regrading material in ODA1. A total of approximately 1,455 cubic yards of soil was segregated from the IRA at ODA1 before being reused at the site. Also, at the time of MKM's report, approximately 8 cubic yards of VOC impacted soils remained at the site pending removal from the site. The 8 cubic yards was transported offsite for disposal by URS in 2008.

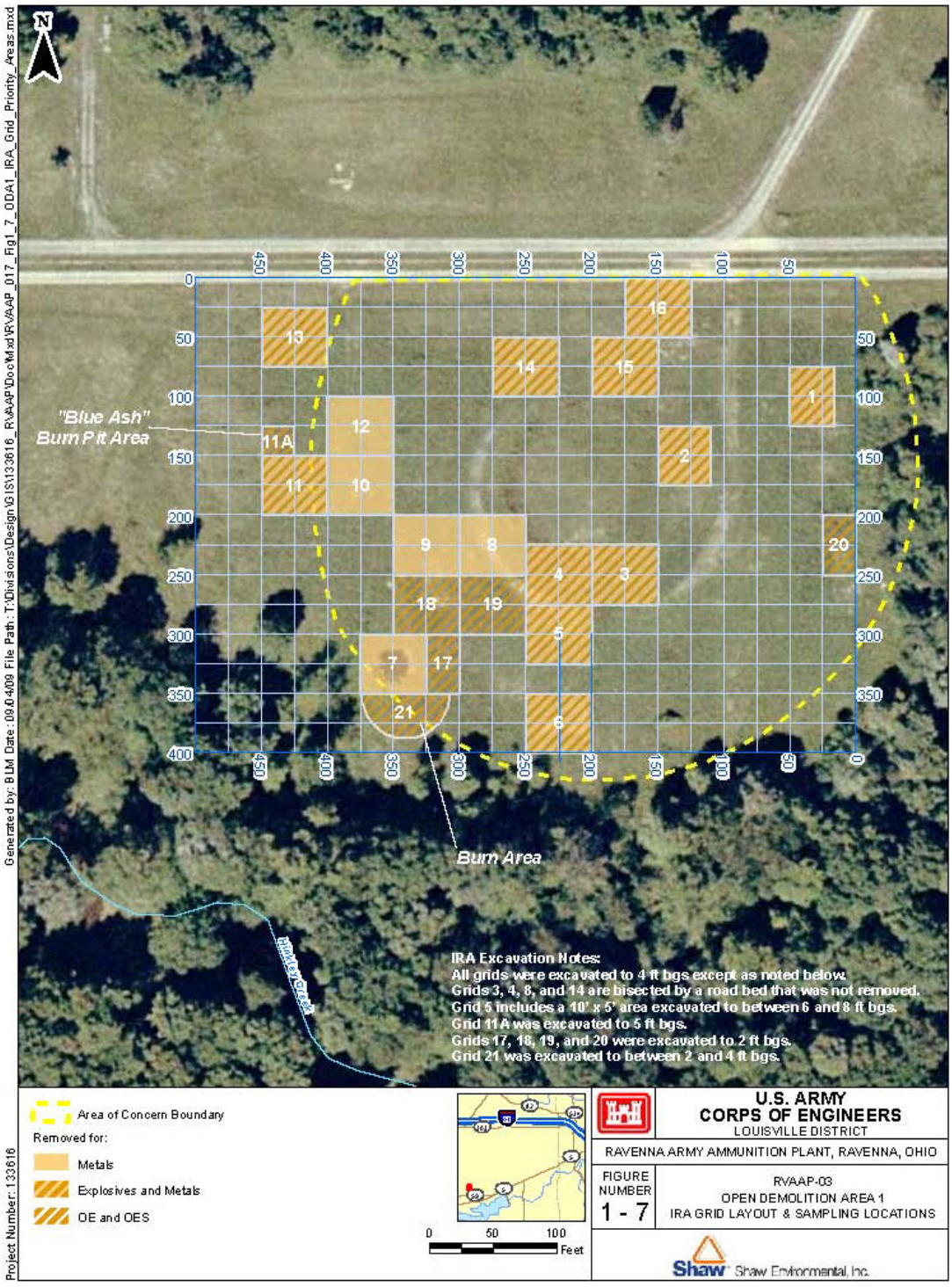


Figure 1-7
Open Demolition Area #1 IRA Grid Locations and Sampling Location Plan

This page intentionally left blank.

2.0 Data Quality Objectives

As part of the facility-wide approach to environmental investigation activities at RVAAP, facility-wide DQOs have been developed per the requirements outlined in the *FSAP* (SAIC, 2001a). As stated in the *FSAP*, the DQO process is a tool to guide investigations at Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) sites and will be incorporated to identify data gaps at ODA1. The DQOs serve two major purposes: (1) to present the facility-wide approach to sampling at the installation, and (2) to present the process that will be used to develop AOC-specific sampling and analysis plans. The DQO process culminates in the reduction of uncertainty associated with decisions related to remedial design and response actions. The following steps will be used by Shaw to implement the DQO process:

1. Develop the Conceptual Site Model (CSM)
2. State the problem
3. Identify decisions to be made
4. Define the study boundaries
5. Develop the decision rule (if/then)
6. Identify inputs to the decision (data uses and data needs)
7. Specify limits on uncertainty
8. Optimize the sample design

2.1 Conceptual Site Model

A conceptual site model (CSM) is the cornerstone for planning a field sampling effort. It reflects an understanding of the known or expected site conditions and serves as the basis for making decisions about sample locations, frequencies, and required analytes. A good CSM is inclusive of all available information, incorporating the hydrogeologic features and other characteristics of the site that combine to define the problem to be addressed (e.g., location of buried waste, primary contaminants and their properties, contaminant transport pathways, and potential human exposure scenarios).

The CSM presented in the *FSAP* is applicable for use at ODA1 for this DQO Report. Site information that adds to the CSM for ODA1 is discussed in Section 1.3 of this *DQO Report.* Operational information and analytical data collected during historical environmental investigations at the site are further discussed in Section 3.0 of this *DQO Report.* This information has been used to refine the CSM that was presented in the Phase I report. Refinements to the CSM are as follows:

Surface Soils: Previous surface soil samples collected at the site focused primarily on identified potential source areas within the AOC boundaries – the OB/OD area, plane storage areas, and

low lying drainage areas. Sample results indicated that surface soils had been impacted by primarily metals and low level explosives (i.e., detections are primarily estimated values less than the reporting limits) and the bulk of the contamination was concentrated around the south ditch and other isolated hot spot areas. Following the removal of soils from the grids established during the 2000 IRA, surface soils remain impacted by metals.

Subsurface Soils: Following the removal of soils from the grids established during the 2000 IRA, confirmatory composite samples from the base of these excavations indicated that subsurface soils had been impacted by metals (aluminum, arsenic, beryllium, chromium, copper, and lead).

Sediment: Sediment samples collected under the Phase I RI did not indicate impact from ODA1 activities. Discussions with stakeholders (30 December 2008 Data Gaps conference call) indicate that if additional sediment investigations were determined necessary, they would be performed under activities associated with the NTA site because ODA1 is not considered a possible source for impact to sediment.

Surface Water: Surface water samples collected under the Phase I RI did not indicate impact from ODA1 activities. Discussions with stakeholders (30 December 2008 Data Gaps conference call) indicate that if additional surface water investigations were determined necessary, they would be performed under activities associated with the NTA site because ODA1 is not considered a possible source for impact to surface water.

Groundwater: The one groundwater sample collected under the Phase I RI was obtained using direct-push boring techniques. Groundwater obtained from well points at RVAAP is solely used for screening purposes. Specifically, any detects are considered minimal values and non-detects do not definitively indicate lack of contamination. Groundwater data that is used at RVAAP for the purpose of evaluation, risk assessment, etc., must be obtained from properly installed, developed, and sampled monitoring wells. The groundwater sample did not indicate any impact from ODA1 activities. Future sampling of groundwater would be performed under a facility-wide program for groundwater.

2.2 State the Problem

The surface and subsurface soils are impacted primarily by metals even after the removal action. The extent of environmental impacts need to be determined through additional sampling. In addition, the actual boundary of ODA1 needs to be verified. Visual observations at the site and historical operational data indicate MEC debris may extend beyond the current boundaries. Consequently, additional environmental sampling for surface and subsurface soils will be required if the MEC debris is found to extend beyond the current boundaries. Additional surface

water, sediment, and groundwater sampling related to the ODA1 area will be conducted as part of the NTA and facility-wide sampling programs.

2.3 Identify Decisions to be Made

The key decisions for all investigations at RVAAP have been identified in Section 3.2.4 and in Table 3-1 of the *FSAP*. Additional investigation data (both environmental sampling and a geophysical survey) is necessary to finalize the decision process and determine whether additional response action is needed. Data collected during the additional investigation would satisfy the following data needs:

- The geophysical survey data would be of sufficient quality to determine if the boundaries of ODA1 (RVAAP-03) need to be expanded beyond its current designation.
- The data for additional environmental soil samples (both planned and those resulting from the geophysical survey) are of sufficient quality to support a determination as to the need for a remedial response;
- The data are to be of sufficient quality to determine if contaminants detected during any additional investigation are associated with ODA1 (RVAAP-03) or related to operations at the surrounding sites (RVAAP-38).
- The data are to be of sufficient quality to be legally defensible.
- The data are to be of sufficient quality and quantity to support screening assessments for human health and the environment.

If the geophysical survey results indicate the need for additional sampling is necessary, this report will be amended to account for any new proposed activities.

2.4 Define Study Boundaries

Previous site investigations and IRAs at ODA1 indicate that the nature and extent of contamination has not been adequately defined for the purposes of supporting the development of a path to closure for the site. In addition, the extent of the MEC debris area may not be fully defined based on historical information and visual observations made at the site. As a result, a geophysical survey will be performed to reevaluate the current boundaries of the site.

2.5 Identify Decision Rules

Decision rules used to guide remediation decisions are provided in Section 3.2.6 of the *FSAP*. Application of the decision rules will result in the determination of the extent of releases at ODA1. The decision rules also provide information necessary to allow Ohio EPA to make a determination on the regulatory status of the site. As stated in the *FSAP*, the purposes of the sampling assessment data are to determine the type of contamination, to compare these data to

the risk-based facility-wide Cleanup Goals (CUGs) for unrestricted land use or OHARNG use and to determine if further investigation is needed. The Phase I RI report characterized the nature of environmental impact at ODA1. A subsequent IRA addressed the more contaminated surface and subsurface soils based on the Phase I results, collected and removed MEC debris, and sampled subsurface soils to 4 feet. Consequently, ODA1, outside of any further delineation of the boundaries of the current ODA1, appears to be adequately characterized to support the selection of an approach to environmental closure in accordance with the decision rules presented in the *FSAP*. However, the comparison data used in the Phase I RI and IRA (i.e., 1999 United States Environmental Protection Agency [USEPA] Region 9 Preliminary Remediation Goals [PRGs] among other general risk-based criteria) have been updated since the time those activities were performed. The Phase I RI and IRA data are now to be compared to more current CUGs as identified in Section 3.0 to determine if the site has been adequately characterized.

During the Feasibility Study (FS) stage, Shaw will complete a screening level ecological risk assessment (SLERA) following procedures in the *Final Ravenna Army Ammunition Plant Facility Wide Ecological Risk Work Plan* (USACE, 2003) and USEPA's *Ecological Risk Assessment Guidance for Superfund Sites* (USEPA, 1997). Ecological screening values or benchmarks used in the SLERA must be pre-approved by USACE and Ohio EPA.

2.6 Identify Inputs to the Decision

Inputs to the decision process are the analytical and geophysical results and the revised CSM developed from these field observations.

2.7 Specify Limits on Decision Error

Limits on decision errors for geophysical investigations are specified in *Section G, Contractor Minimum Control Requirements,* of the SOW provided to Shaw.

2.8 Optimize the Sample Design

The sample design and rationale for additional investigation at ODA1 is described in detail in Section 4.0 of this *DQO Report*. The intent of additional sampling and analysis at the site is to focus on the criteria identified in Section 3.2.9.1 of the *FSAP*.

A geophysical investigation will be performed over the site prior to additional environmental investigation activities to identify potential source areas and materials that may require removal. Identified potential source areas of debris and contaminant accumulation points represent specific focus areas for additional surface and subsurface sampling. Additional environmental sampling may be required based on the results of the proposed geophysical survey. If additional environmental sampling is required, any changes to the proposed sampling design program for ODA1 will be documented in future CERCLA documents.

3.0 Data Evaluation

This section presents the data evaluation methods and screening criteria used to identify COPCs and COCs for soils sampled during the Phase I RI and IRA activities. In general, the evaluation and screening methodology will initially compare constituents present at ambient concentrations (i.e., RVAAP-wide background) from those present at concentrations that indicate potential impacts related to historical operations at ODA1. The identified constituents will then be compared to the facility-wide CUGs for unrestricted land use scenarios for the Residential Farmer (adult and child) and the desired use of the land by OHARNG. Summary analytical results are presented in this section that addresses each data aggregate collected during the Phase I RI and IRA activities. A table summary of the analytical results for detected constituents included in the *Phase I RI Report* (SAIC, 2001b) and the *OE/UXO Removal & Interim Removal Action Report for the Open Demolition Area #1* (MKM, 2004) for surface and subsurface soil samples are presented in Tables 3-1, 3-3, and 3-5 (at the end of this section).

Surface water and sediments were not included in the evaluation because ODA1 does not appear to be a source to either media based on information presented in the Phase I RI Report. Future sampling of sediment and surface water, if required, and the means to manage any detected contaminants will be addressed under the NTA site characterization effort. Groundwater is not considered since any wells in this area will ultimately be addressed on a facility-wide basis.

3.1 Data Reduction and Screening

The data reduction process employed to identify COPCs involved identifying frequency of detection summary statistics, comparison to RVAAP facility-wide background values (inorganics only) and evaluation of essential nutrients. This analysis was presented for the Phase I RI data in the *Phase I RI Report* (SAIC, 2001b). The IRA data has not previously undergone this process, thus, historical site data was used from the *OE/UXO Removal & Interim Removal Action Report for the Open Demolition Area #1* (MKM, 2004). Quality control (QC) samples and field duplicates were excluded from the screening data sets. All analytes having at least one detected value were included in the data reduction process. Following the data reduction processes outlined in the following sections, the data was then screened to identify COPCs and COCs.

3.1.1 Frequency of Detection

The frequency of detection screening methodology is appropriate for discrete sample data sets as is the case for the environmental samples collected during the Phase I RI activities. The IRA samples were composites and are not subject to frequency of detection screening. Chemicals that are detected infrequently in discrete samples, except explosives and propellants, may be

artifacts in the data due to sampling, analytical, or other problems, and therefore may not be related to the site activities. For sample aggregations, except for explosives and propellants, with at least 20 samples and frequency of detection of less than 5 percent, a weight of evidence approach is used to determine if the chemical is AOC related. The magnitudes and clustering of the detections and the potential source of the chemical will be evaluated. If detected results are not clustered, and the chemical is not found in other media at the study area, and the concentrations are not substantially elevated relative to the detection limit, and the chemical was not used in the area being investigated, then the chemical will be considered spurious and be eliminated from further consideration. Therefore, chemicals that are detected only at low concentrations in less than 5 percent of the samples from a given medium are dropped from further consideration, unless their presence is expected on historical information about the site, or it is unlikely to identify the existence of a 'hot spot' (USACE, 2005).

3.1.2 Facility-Wide Background Screen

For each inorganic constituent, concentrations were compared against established RVAAP facility-wide background values. For inorganic constituents, if the value was greater than its respective background criterion, it was considered to be a COPC. It should be noted that not all inorganic compounds, analyzed as part of the Phase I RI and IRA sampling events, have established screening levels or background values; therefore, in the event an inorganic constituent does not have an established background value, any detected result for that constituent was considered to be greater than background. This conservative process ensured that detected constituents were not eliminated as COPCs simply because they were not detected in the background data set. All detected organic compounds were considered to be greater than background because these classes of compounds do not occur naturally.

3.1.3 Essential Nutrient Screen

Chemicals that are considered to be essential nutrients (calcium, chloride, iodine, iron, magnesium, potassium, phosphorus, and sodium) are an integral part of the food supply and are often added to foods as supplements. The USEPA recommends that these chemicals not be evaluated as COPCs as long as they are 1) present at low concentrations (i.e., only slightly greater than naturally occurring levels) and 2) toxic at very high doses (i.e., much higher than those that could be associated with contact at the site) (USACE, 2005). For the Phase I RI and IRA sampling events, analyses were conducted for calcium, iron, magnesium, potassium and sodium. These five constituents were eliminated as COPCs in all environmental media based on comparison to background values.

3.1.4 Cleanup Goal Screening Criteria

Historical data collected at ODA1 and retained for further screening as COPCs as identified in the previous sections, was compared to the unrestricted land use criteria developed for the

Residential Farmer (adult and child) Land Use Scenario for RVAAP. At a minimum, each AOC must be remediated to the extent that OHARNG can fully utilize the site for their desired land use. The OHARNG receptors included the National Guard Dust/Fire Control Worker, National Guard Range Maintenance Soldier, and the National Guard Trainee. The most current version of these criteria or facility-wide CUGs is presented in the September 2008 *Draft Facility-Wide Human Health Remediation Goals at the RVAAP* (SAIC, 2008). This document was developed to support the environmental remediation of the remaining AOCs to complete final transfer of the land to OHARNG. The document contains calculated remediation goals that can accelerate the decision-making process for the remaining AOCs, taking advantage of the fact that many of the risk assessment inputs and decisions for the facility have already been agreed to by stakeholders through the application of the CERCLA process as documented in the *HHRAM* (USACE, 2005). Guidance on the application of these CUGs is provided in the June 2009 *Position Paper for the Application and Use of Facility-Wide Human Health Cleanup Goals* (USACE, 2009).

As part of this *DQO report*, Shaw will evaluate concentrations of the screened COPCs identified in surface soil (0 to 1 foot) and subsurface soil as part of the previous investigation activities presented in the *Phase I RI* report (Figure 1-5) to provide a current comparison to the agreed upon CUGs. The sampling assessment data collected during the Phase I RI will be screened to the 10^{-6} cancer risk level or hazard quotient (HQ) equal to 0.1 ($^{1}/_{10}$ the non-cancer risk) as in the *HHRAM* (USACE, 2005) because it is investigation data. Shaw will identify COCs in subsurface soil for the areas subject to remedial action during the IRA through comparison to CUGs and the Sum of Ratios method. The confirmation sampling data collected during the IRA will be screened to the 10^{-5} cancer risk level or HQ equal to 1 as in the *HHRAM* (USACE, 2005).

In accordance with the June 2009 *Position Paper for the Application and Use of Facility-Wide Human Health Cleanup Goals* (USACE, 2009), an Exposure Point Concentration (EPC) is compared to the CUGs to determine COPCs. The EPC is the lower of the maximum detected concentration of a constituent or the 95% Upper Confidence Limit (UCL) of the mean for each constituent. The 95% UCL was calculated using the most recent version of the software program ProUCL (version 4.00.04) released May 2009. The raw output from this program is included in Appendix A. In addition, the Sum of Ratios method was applied to COPCs to identify COCs. The Sum of Ratios method is used to evaluate risk by grouping the COPCs that may affect the same target organ.

3.1.5 Data Presentation

Data summary statistics and screening results for the COPCs and COCs in surface and subsurface soils at ODA1 are presented in the following sections. Screened constituents and identified COPCs and COCs are addressed in the text of this section. For each media, screening

results are presented in data summary tables at the end of this section. Output from the software program used to calculate the 95% UCLs used in the tables are presented in Appendix A.

3.2 Surface Soils

Available surface soil data was primarily generated during the Phase I investigation in 1999. A total of 42 discrete surface soil samples, excluding QC samples and field duplicates, were collected during the Phase I investigation. The samples were collected from areas that were considered potential source areas at ODA1 – the OB/OD area and its surrounding berm, plane storage areas, and the drainage ditch exiting the OB/OD area. Sample locations were selected based on a visual survey of the area conditions, such as areas with debris and/or staining, topographical depressions, areas with distressed or limited vegetation, etc. to ensure appropriate positioning of each sample point. The shallow soil samples were collected from the surface to a depth of 1 foot bgs.

Select areas at ODA1 were subject to removal action under the IRA conducted in 2000 to 2001. Since the IRA activities were focused on removing surface soil from areas where concentrations in samples were greater than earlier versions of human health criteria, select data from the Phase I RI are no longer applicable and a reduced post-IRA surface soil data set better represents current conditions at the site. No surface soil samples were collected during the 2000-2001 IRA.

Therefore, the post-IRA surface soil data set consists of 23 surface soil samples collected during the Phase I RI that are representative of existing conditions at ODA1. The approximate overlay of the IRA removal areas and Phase 1 RI soil sample locations are shown in Figure 3-1. Note that the overlay is only an approximation based on visual alignment of site features as no control points were presented in the IRA report for more accurate alignment.

These 23 samples were analyzed for TAL metals, cyanide, explosives, and propellants. While, 10 percent of the complete data set of Phase 1 RI samples (5 samples) were submitted for VOCs, SVOCs, and PCBs analysis, none of the surface soil samples in the reduced post-IRA data set were analyzed for these parameters. Antimony results in 6 of the 23 surface soil samples were rejected based on data validation criteria from the Phase I RI. Other reported sample results were considered of useable quality.

Three additional samples were collected during the 1996 USACHPPM RRSE investigation. However, the Phase I RI data is more representative of the site conditions so the RRSE investigation data have not been included in the discussion below.

Data summary statistics and screening results to identify COPCs in the reduced post-IRA surface

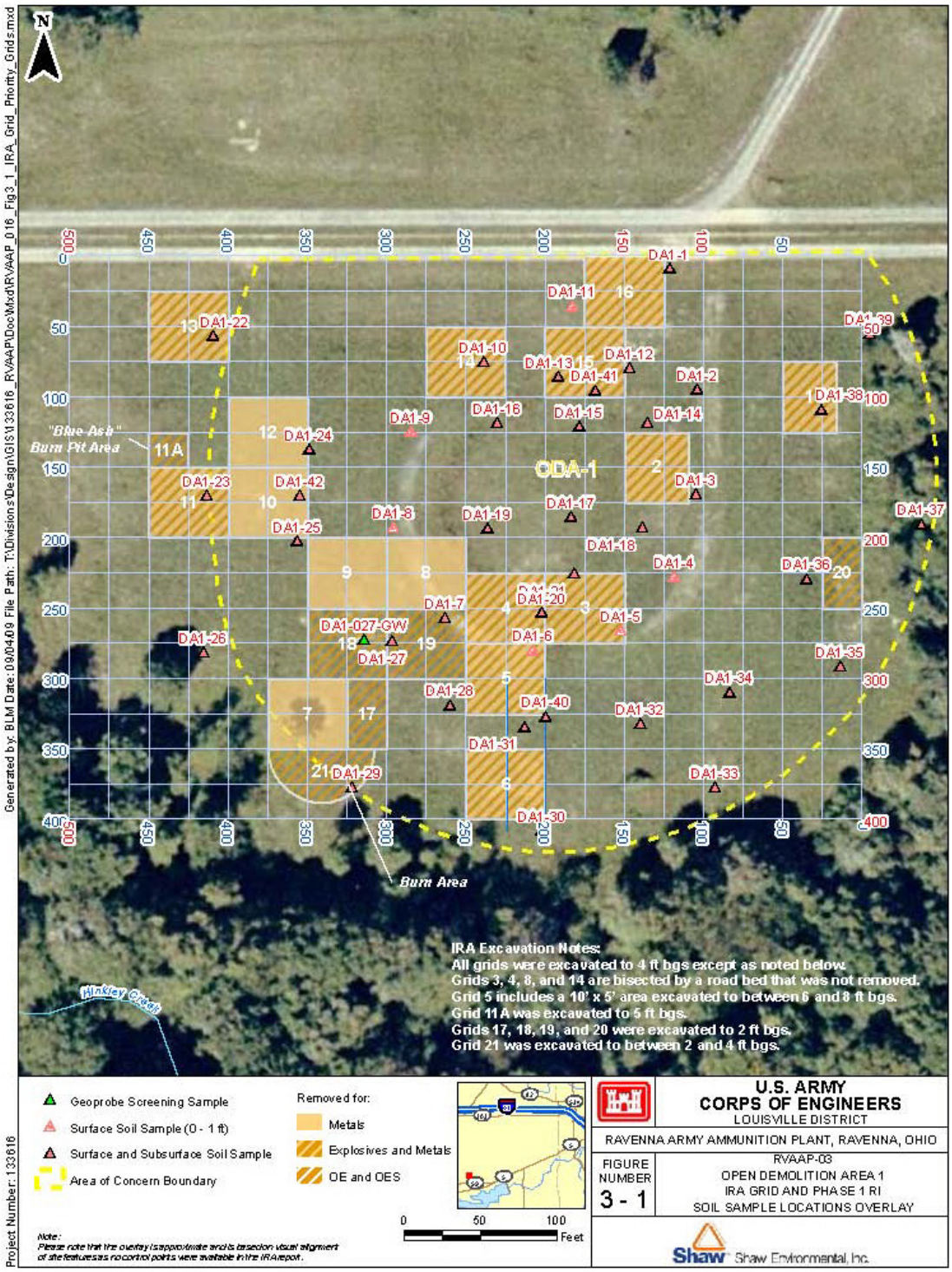


Figure 3-1
Open Demolition Area #1 IRA Grid and Phase I RI Soil Sample Locations Overlay

soil data set are presented in Table 3-1. A comparison of the COPCs retained to the unrestricted land use facility-wide cancer and non-cancer risk CUGs for the Residential Farmer (adult and child) and OHANRG receptors is also presented in Table 3-2. These tables are provided at the end of this section. Output from the software program used to calculate the 95% UCLs used in Table 3-2 are presented in Appendix A.

3.2.1 Inorganics

There were 16 inorganic analytes detected in surface soil samples, 4 of which were identified as COPCs (Table 3-2). None of the detected constituents were considered to be essential nutrients. The maximum concentrations detected for aluminum, antimony, lead, manganese, and selenium were less than the respective RVAAP background values; therefore, these constituents were not retained for comparison to CUGs. Background values have not been developed for cadmium or thallium; therefore, these constituents were retained as COPCs for comparison to CUGs. As the most infrequently detected constituent (antimony) was detected in 2 of 17 samples (11%), the frequency of detection screening does not result in data reduction.

The retained inorganic COPCs with developed CUGs in surface soils were screened against the CUGs for the Residential Farmer (adult and child) and OHARNG Land Use Scenarios. The inorganic constituent was retained as a COPC for further evaluation at the site if the EPC was greater than the CUGs. No CUGs have been developed for beryllium, lead, or selenium; however, beryllium was automatically retained as a COPC for further evaluation since the maximum detected concentration was greater than the background value. The maximum detected concentrations of lead and selenium were not greater than their respective background values.

The discussion below contains a brief summary of the nature and extent for each of the inorganic COPCs where the EPCs were greater than the CUGs for the Residential Farmer or OHARNG receptors. A summary of the accumulated COPCs per sample location that were retained following comparison to the facility-wide CUGs is presented in Table 3-2 at the end of this section.

Residential Farmer (Adult)

For the unrestricted land use scenario, inorganic COPCs identified for the Residential Farmer (adult) consist of arsenic and beryllium. Arsenic was detected at a concentration greater than the background value and the CUGs in 1 surface soil sample (15.6 mg/kg at DA1-034) collected from a sample location in the southeast portion of the site. Beryllium was detected at a concentration greater than the background value (no CUGs for beryllium) in 1 surface soil sample (0.94 mg/kg at DA1-008) collected from a sample location in the west/central portion of the site.

Residential Farmer (Child)

No additional inorganic COPCs were identified for the Residential Farmer (child) beyond the arsenic and beryllium identified for the Residential Farmer (adult). A review of the dispersion of arsenic and beryllium for this receptor indicates that the contaminant distribution is consistent with that reported for the Residential Farmer (adult)..

National Guard Dust/Fire Control Worker

Beryllium was the only COPC in surface soil identified for the National Guard Dust/Fire Control Worker. The distribution of beryllium in surface soil is consistent with that reported for the Residential Farmer (adult).

National Guard Range Maintenance Soldier

In addition to the inorganic COPC (beryllium) identified for the National Guard Dust/Fire Control Worker, arsenic was identified as a COPC for the National Guard Range Maintenance Soldier. The distribution of arsenic and beryllium in surface soil is consistent with that reported for the Residential Farmer (adult).

National Guard Trainee

Four inorganics were identified as COPCs for the National Guard Trainee receptor scenario including arsenic, beryllium, chromium (total), and cobalt. The distribution of arsenic and beryllium in surface soil is consistent with that reported for the Residential Farmer (adult and child). Chromium was detected at concentrations greater than the background value and the CUGs in 5 surface soil samples collected from sample locations in the central portion (DA1-018 and DA1-019), southwest perimeter (DA1-026), southern perimeter (DA1-030), and southwest portion (DA1-034) of the site. Cobalt was detected at concentrations greater than the background value and the CUGs in 3 surface soil samples collected from sample locations in the central portion (DA1-018), southern perimeter (DA1-030), and southwest portion (DA1-034) of the site.

3.2.2 Explosives and Propellants

Two explosives (1,3,5-trinitrobenzene and octhydro-1,3,5,5-tetranitro-1,3,5,7-tetrazocine [HMX]) were detected concurrently in ODA1 surface soils in the post-IRA data set at sampling location DA1-030 located along the southern perimeter of the site. HMX was also detected at surface soil sampling location DA1-003 located along the road bed in the east/central portion of the site. No other explosives or propellants were detected. There are no RVAAP background values for explosives; as such, background is set at zero. The results of the explosives are less than the CUGs for the Residential Farmer (adult and child) and the OHARNG receptors and were not retained as COPCs requiring further evaluation.

3.2.3 Semivolatile Organic Compounds

None of the surface soil samples in the post-IRA data set were analyzed for SVOCs, therefore, no COPC evaluation can be performed. Areas of surface soil where SVOCs were detected in the Phase I RI data set were removed during the IRA. There are no RVAAP background values for SVOCs; as such, background is set at zero.

3.2.4 Volatile Organic Compounds

None of the surface soil samples in the post-IRA data set were analyzed for VOCs, therefore, no COPC evaluation can be performed. Areas of surface soil where VOCs were detected in the Phase I RI data set were removed during the IRA. There are no RVAAP background values or CUGs for VOCs; as such, background is set at zero.

3.2.5 PCBs

None of the surface soil samples in the post-IRA data set were analyzed for PCBs, therefore, no COPC evaluation can be performed. No PCBs were detected in the Phase I RI surface soil data set.

3.2.6 Summary of Surface Soil Samples

For the unrestricted land use scenario, 2 inorganics (arsenic and beryllium) were detected in the surface soil samples of the post-IRA data set and were identified as COPCs requiring further evaluation at the site for both the Residential Farmer (adult and child) receptors. Arsenic and beryllium were each detected as the sole COPCs and only once at concentrations only slightly greater than the background values (arsenic maximum detection of 15.6 mg/kg at DA1-034 with background of 15.4 mg/kg and beryllium maximum detection of 0.94 mg/kg at DA1-008 with background of 0.88 mg/kg).

For the use of the site by the OHARNG, 4 inorganics (arsenic, beryllium, chromium [total], and cobalt) were detected in the surface soil samples and were identified as COPCs requiring further evaluation at the site for the National Guard receptors. However, as noted for the Residential Farmer scenario, arsenic and beryllium were each detected only once at concentrations only slightly greater than the background values. The remaining COPCs (chromium [total] and cobalt) occurred in surface soil samples collected from the southeast portion (DA1-034), southern perimeter (DA1-030), and central portion (DA1-018) of the site. Chromium [total] occurred in as the sole COPC in surface soil samples collected from the southwest perimeter (DA1-026) and central portion (DA1-019) of the site.

It should be noted that surface soil samples collected during the Phase I RI activities were analyzed for total chromium only; whereas, the facility-wide risk-based CUGs developed for the Residential Farmer and OHARNG receptors also provide for comparison to hexavalent chromium. Hexavalent chromium was calculated to have the same CUG criteria as total

chromium for each of the receptors. Therefore, going forward, where chromium is identified as a COPC in surface soil requiring further evaluation, evaluation for hexavalent chromium as a COPC will also be performed.

3.3 Post-IRA Phase I RI Subsurface Soil

Available subsurface soil data was primarily generated during the Phase I investigation in 1999 and the IRA activities in 2000-2001 (discussed separately in Section 3.4). A total of 70 discrete subsurface soil samples, excluding QC samples and field duplicates, were collected during the Phase I investigation. The samples were collected from areas that were considered potential source areas at ODA1 – the OB/OD area and its surrounding berm, plane storage areas, and the drainage ditch exiting the OB/OD area. Sample locations were selected based on a visual survey of the area conditions, such as areas with debris and/or staining, topographical depressions, areas with distressed or limited vegetation, etc. to ensure appropriate positioning of each sample point. Subsurface soil samples were collected from three intervals – 1 to 3 feet bgs, 3 to 5 feet bgs, and 6 to 8 feet bgs.

Select areas at ODA1 were subject to removal action under the IRA conducted in 2000 to 2001. Since the IRA activities were focused on removing subsurface soil (to a depth of 4 feet bgs) from areas where concentrations in samples were greater than earlier versions of human health criteria, select data from the Phase I RI are no longer applicable and a reduced post-IRA subsurface soil data set better represents current conditions at the site. Therefore, the post-IRA subsurface soil data set consists of 42 subsurface soil samples collected during the Phase I RI that are representative of existing conditions at ODA1. The approximate overlay of the IRA removal areas and Phase 1 RI soil sample locations are shown in Figure 3-1. Note that the overlay is only an approximation based on visual alignment of site features as no control points were presented in the IRA report for more accurate alignment.

These 42 samples were analyzed for TAL metals, cyanide, explosives, and propellants. While, 10 percent of the complete data set of Phase 1 RI samples (6 samples) were submitted for VOCs, SVOCs, and PCBs analysis, none of the subsurface soil samples in the reduced post-IRA data set were analyzed for these parameters. Antimony results in 12 and arsenic results in 1 of the 42 subsurface soil samples were rejected based on data validation criteria from the Phase I RI. Other reported sample results were considered of useable quality.

Data summary statistics and screening results to identify COPCs in the reduced post-IRA subsurface soil data set are presented in Table 3-3. A comparison of the COPCs retained to the unrestricted land use facility-wide cancer and non-cancer risk CUGs for the Residential Farmer (adult and child) and National Guard Trainee receptors is presented in Table 3-4. These tables are provided at the end of this section. Output from the software program used to calculate the 95% UCLs used in Table 3-4 are presented in Appendix A.

3.3.1 Inorganics

Twenty-three (23) inorganics were detected in the Phase I RI subsurface soil samples at least once in at least one sample. However, 12 of the 23 detected were screened out during the Phase I RI because they were either considered essential nutrients (calcium, iron, magnesium, potassium, and sodium), the frequency of detection was less than 5% (silver), or there were no detections greater than background values (beryllium, cobalt, manganese, nickel, selenium, and thallium). Background values have not been developed for cadmium; therefore, cadmium was retained for further evaluation. The 11 inorganics remaining after the Phase 1 screening were evaluated as COPCs in the post-IRA data set (Table 3-3). However, after also removing the data for soil samples collected from IRA excavation areas to form the reduced post-IRA data set and repeating the data reduction and screening process, cadmium drops out with a frequency of detection less than 5% (Table 3-4).

The retained inorganic COPCs of the post-IRA data set with developed CUGs in subsurface soils were screened against the CUGs for the Residential Farmer (adult and child) and OHARNG Land Use Scenarios. The inorganic constituent was retained as a COPC for further evaluation at the site if the EPC was greater than the CUGs. No CUGs have been developed for lead; however, lead was automatically retained as a COPC for further evaluation since the maximum detected concentration was greater than the background value.

The discussion below contains a brief summary of the nature and extent for each of the inorganic COPCs where the EPCs were greater than the CUGs for the Residential Farmer or OHARNG receptors. A summary of the accumulated COPCs per sample location that were retained following comparison to the facility-wide CUGs is presented in Table 3-4 at the end of this section.

Residential Farmer (Adult)

For the unrestricted land use scenario, inorganic COPCs identified for the Residential Farmer (adult) consist of arsenic and lead. Arsenic was detected at a concentration greater than the background value and the CUGs in 2 subsurface soil samples (21.1 mg/kg at DA1-019 [1 to 3 feet bgs] and 20.9 mg/kg at DA1-027 [3 to 5 feet bgs]). However, the arsenic concentrations in subsurface soil samples collected in the two deeper intervals (3 to 5 and 6 to 8 feet bgs) at DA1-019 located in the central portion of the site were less than the background value. There were no deeper interval samples collected at DA1-027 located in the southwest portion of the site. Lead was detected only once in DA1-027 (3 to 5 feet bgs) at a concentration only slightly greater than the background (maximum detection of 19.4 mg/kg with background of 19.1 mg/kg).

Residential Farmer (Child)

In addition to the inorganic COPCs identified for the Residential Farmer (adult), aluminum was identified as a COPC for the Residential Farmer (child). The distribution of arsenic and lead in

subsurface soil is consistent with that reported for the Residential Farmer (adult). Aluminum was detected at a concentration greater than the background values and CUGs in one subsurface soil sample collected at DA1-027 (3 to 5 feet bgs) located in the southwest portion of the site.

National Guard Trainee

Four inorganic COPCs were identified for the National Guard Trainee receptor scenario including aluminum, arsenic, lead, and chromium. The distributions of aluminum, arsenic, and lead are consistent with those identified for the Residential Farmer (child) scenario. Chromium was detected at a concentration greater than the background value and CUGs concurrently with aluminum in one subsurface sample collected at DA1-027 (3 to 5 feet bgs) located in the southwest portion of the site

3.3.2 Explosives and Propellants

No explosives or propellants were detected in subsurface soil samples in the post-IRA data set.

3.3.3 Semivolatile Organic Compounds

None of the subsurface soil samples in the post-IRA data set were analyzed for SVOCs, therefore, no COPC evaluation can be performed. Areas of subsurface soil where SVOCs were detected in the Phase I RI data set were removed during the IRA. There are no RVAAP background values for SVOCs; as such, background is set at zero.

3.3.4 Volatile Organic Compounds

None of the subsurface soil samples in the post-IRA data set were analyzed for VOCs, therefore, no COPC evaluation can be performed. Areas of subsurface soil where VOCs were detected in the Phase I RI data set were removed during the IRA. There are no RVAAP background values or CUGs for VOCs; as such, background is set at zero.

3.3.5 PCBs

None of the subsurface soil samples in the post-IRA data set were analyzed for PCBs, therefore, no COPC evaluation can be performed. No PCBs were detected in the 6 subsurface soil samples analyzed in the Phase I RI data set.

3.3.6 Summary of Phase I RI Subsurface Soil Samples

For the unrestricted and OHARNG land use scenarios, aluminum, arsenic, chromium, and lead were identified as the inorganic COPCs in subsurface soil in the post-IRA data set. The extent of arsenic is defined horizontally and vertically with depth at DA1-019 located in the central portion of the site. Aluminum, arsenic, chromium, and lead are not defined with depth below 5 feet bgs at DA1-027 located in the southwest portion of the site or to the west and south.

It should be noted that subsurface soil samples collected during the Phase I RI activities were analyzed for total chromium only; whereas, the facility-wide risk-based CUGs developed for the Residential Farmer and OHARNG receptors also provide for comparison to hexavalent chromium. Hexavalent chromium was calculated to have the same CUG criteria as total chromium for each of the receptors. Therefore, going forward, where chromium is identified as a COPC in subsurface soil requiring further evaluation, evaluation for hexavalent chromium as a COPC will also be performed.

3.4 IRA Subsurface Soil Samples

Following completion of the excavation and removal of soil and MEC debris during the 2000-2001 IRA performed by MKM, composite confirmatory samples were collected from the base of each excavated area and analyzed for TAL metals and explosives. A total of 24 composite subsurface soil samples, excluding QC samples and field duplicates, were collected during the IRA. In addition, 10% of the samples (3) were also analyzed for the RVAAP full suite that included VOCs, SVOCs, cyanide, pesticides, PCBs, and propellants. The majority of composite samples were collected from a depth of 4 feet bgs. Grid 5 includes a 10-feet x 5-feet area excavated to between 6 and 8 feet bgs. Grid 11A was excavated to 5 feet bgs. Grids 17, 18, 19, and 20 were excavated to 2 feet bgs. Grid 21 was excavated to between 2 and 4 feet bgs. A summary of the detections in the samples is presented below and in Table 3-5 at the end of this section. As previously described, this data supercedes a large portion of the subsurface and surface soil data from the Phase I RI because it represents current conditions after soil removal activities. Figure 3-1 presents an overlay of the sampled grids on the ODA1 site.

Data summary statistics and screening results to identify COPCs are presented in Table 3-6. A comparison of the COPCs to the unrestricted land use facility-wide cancer and non-cancer risk CUGs for the Residential Farmer (adult and child) and National Guard Trainee receptors and identification of COCs is presented in Tables 3-7 and 3-8, respectively. These tables are provided at the end of this section. Output from the software program used to calculate the 95% UCLs used in Tables 3-7 and 3-8 are presented in Appendix A.

3.4.1 Inorganics

Each of the 23 inorganics in the analyte list were detected at least once in at least 1 composite subsurface soil sample. Eleven (11) of the detected inorganics were eliminated from further evaluation after the initial data reduction and screening process and the remaining 12 of the detected inorganics were identified as COPCs (Table 3-6). Calcium, iron, magnesium, potassium, and sodium are considered to be essential nutrients and these inorganics were not retained as COPCs requiring further evaluation. The maximum concentrations detected for barium, cobalt, manganese, selenium, thallium, and vanadium were less than background values; therefore, these inorganics were not retained as COPCs requiring further evaluation.

Background values have not been developed for cadmium or silver; therefore, cadmium and silver were retained as COPCs for comparison to CUGs.

The retained inorganic COPCs with developed CUGs in subsurface soils were screened against the CUGs for the Residential Farmer (adult and child) and OHARNG Land Use Scenarios. The inorganic constituent was retained as a COC if the EPC was greater than the CUGs and based on the Sum of Ratios analysis. No CUGs have been developed for beryllium or lead; therefore, beryllium and lead were automatically retained as COCs since the maximum detected concentration of beryllium and lead were greater than the respective background values.

The discussion below contains a brief summary of the inorganic COCs that were identified for the Residential Farmer or OHARNG receptors. A summary of the COC identification process is presented in Tables 3-7 and 3-8 at the end of this section.

Residential Farmer (Adult)

For the unrestricted land use scenario, inorganic COCs identified for the Residential Farmer (adult) consist of aluminum, arsenic, beryllium, copper, and lead. Aluminum was detected at a concentration greater than the background value in 1 subsurface soil sample (Grid 11A) but not greater than the hazard-index CUG. However, aluminum was identified as a COC for the target organs of skin and respiratory system due to the contribution of 10% or greater of the Sum of Ratios. Arsenic was detected at concentrations greater than the background value and the cancer-risk CUG but not greater than the hazard-index CUG in 6 subsurface soil samples collected from excavation grids located southwest/central portion (Grids 3, 5 [2 samples], 9, and 19) and northeast/central portion (Grid 15) of the site. In addition, arsenic contributes greater than 10% to the Sum of Ratios for skin and the respiratory system as a non-cancer risk COC and as a cancer-risk COC. Beryllium was detected at concentrations greater than the background value (no CUGs for beryllium) in 4 subsurface soil samples collected from excavation grids located south/central portion (Grid 3), southwest portion (Grid 17), and northeast/central portion (Grids 14 and 15) of the site. Copper was detected at a concentration greater than the background value and the hazard-index CUG in 1 subsurface soil sample collected from an excavation grid located along the western perimeter (Grid 11A) of the site. In addition, copper contributes greater than 10% to the Sum of Ratios for skin and the respiratory system as a non-cancer risk COC. Lead was detected at concentrations greater than the background value (no CUGs for lead) in 2 subsurface soil samples collected from excavation grids located south/central portion (Grid 3) and western perimeter (Grid 11A) of the site.

Residential Farmer (Child)

No additional inorganic COCs were identified for the Residential Farmer (child) to those identified for the Residential Farmer (adult). Aluminum was detected at a concentration greater than the background value and the hazard-index CUG in 1 subsurface soil sample collected from

an excavation grid located along the western perimeter (Grid 11A) of the site. Arsenic was detected at concentrations greater than the background value and the hazard-index CUG in the same 6 subsurface soil samples identified for the Residential Farmer (adult) receptor. In addition to the COC risks identified for the Residential Farmer (adult) receptor, aluminum contributes greater than 10% to the Sum of Ratios for eyes as a non-cancer risk COC; arsenic for liver and kidneys; and copper for eyes, liver, and kidneys.

National Guard Trainee

Inorganic COCs identified for the National Guard Trainee receptor scenario include aluminum, arsenic, beryllium, chromium, and lead. Aluminum and chromium were detected at concentrations greater than the background values and the hazard-index CUGs in 1 subsurface soil sample collected from an excavation grid located along the western perimeter (Grid 11A) of the site. Aluminum and chromium were both identified as COCs for the target organs of eyes, skin, and respiratory system due to the contribution of 10% or greater of the Sum of Ratios. Similarly, arsenic and chromium were detected at concentrations greater than the background values and the cancer-risk CUGs in 1 subsurface soil sample each and both contribute greater than 10% to the Sum of Ratios as cancer-risk COCs. The maximum concentration of arsenic was detected in the subsurface soil sample collected from Grid 19 located in the southwest/central portion of the site. The distribution of beryllium and lead is as reported for the Residential Farmer (adult) receptor.

3.4.2 Explosives and Propellants

One explosive (2,4,6-trinitrotoluene) and 1 propellant (nitrocellulose) were detected in 1 of 23 and 3 of 3 subsurface soil samples, respectively, during the IRA activities. No other explosives or propellants were detected. There are no RVAAP background values for explosives or propellants. 2,4,6-Trinitrotoluene was detected in the subsurface soil sample collected from Grid 21 located in the southwest portion of the site at a concentration less than the CUGs; therefore this constituent is not retained as a COC. Nitrocellulose was detected in subsurface soil samples collected from Grids 5 (2 samples) and 10 located in the southern and western portions of the site, respectively. No CUGs have been developed for nitrocellulose; therefore, this constituent is automatically retained as a COC.

3.4.3 Semivolatile Organic Compounds

Naphthalene was the only SVOC detected in the 4 subsurface soil samples analyzed. Naphthalene was detected at an estimated concentration below the laboratory reporting limit and below the CUGs; therefore, naphthalene is not retained as a COC.

3.4.4 Volatile Organic Compounds

Four VOCs were detected in the subsurface soil samples in 1 (benzene, ethylbenzene, and xylenes) and 2 (toluene) of the 4 samples analyzed. Benzene, ethylbenzene, toluene, and xylenes were detected in the subsurface soil sample collected from the bottom of the limited 8-feet bgs excavation within Grid 5. Toluene was detected in the subsurface soil sample collected from the bottom of the 4 feet bgs excavation from Grid 5 located in the southern portion of the site. There are no RVAAP background values or CUGs for VOCs; therefore, these constituents are automatically retained as COCs.

3.4.5 PCBs

No PCBs were detected in the 4 subsurface soil samples analyzed.

3.4.6 Summary of IRA Subsurface Soil Samples

For the unrestricted land use scenario, 5 inorganics (aluminum, arsenic, beryllium, copper, and lead), 1 propellant (nitrocellulose), and 4 VOCs (benzene, ethylbenzene, toluene, and xylenes) were detected in the subsurface soil samples and were identified as COCs for the Residential Farmer (adult and child) receptors. The inorganic COCs occurred in subsurface soil samples collected from excavation grids located in the southwest/central portion (Grids 3, 5, 9, and 19), southwest portion (Grid 17), northeast/central portion (Grids 14 and 15), and western perimeter (Grid 11A) of the site. The majority of inorganic COCs were detected concurrently in surface soil samples collected from the south/central portion (Grid 3) and western perimeter (Grid 11A) of the site. Organic COCs occurred in Grid 5 located in the southern portion of the site and Grid 10 located in the western portion of the site.

For the use of the site by the OHARNG, 5 inorganics (aluminum, arsenic, beryllium, chromium (total), and lead), 1 propellant (nitrocellulose), and 4 VOCs (benzene, ethylbenzene, toluene, and xylenes) were detected in the subsurface soil samples and were identified as COCs at the site for the National Guard Trainee receptor. The inorganic COCs occurred in subsurface soil samples collected from excavation grids located in the western perimeter (Grid 11A), southwest portion (Grid 17), southwest/central portion (Grid 19), south/central portion (Grid 3), and northeast/central portion (Grids 14 and 15) of the site. In addition, arsenic was detected as the sole COC and only once (29.3 mg/kg at Grid 19) at a concentration only slightly greater than the background value (19.8 mg/kg) and the cancer-risk CUG (27.8 mg/kg) for the National Guard Trainee. Organic COCs occurred in Grid 5 located in the southern portion of the site and Grid 10 located in the western portion of the site.

It should be noted that subsurface soil samples collected during the IRA activities were analyzed for total chromium only; whereas, the facility-wide risk-based CUGs developed for the Residential Farmer and OHARNG receptors also provide for comparison to hexavalent

chromium. Hexavalent chromium was calculated to have the same CUG criteria as total chromium for each of the receptors. Therefore, going forward, where chromium is identified as a COPC or COC in subsurface soil requiring further evaluation, evaluation for hexavalent chromium as a COPC and COC will also be performed.

3.5 Summary of Results

A review of the sampling program (i.e., Phase I RI and IRA) to date indicates the previous activities have not adequately evaluated the primary media of concern (surface and subsurface soils) at ODA1 and additional information is needed to support selection of an environmental closure remedy for the site. The environmental impact at the site is not defined with depth or to the west, southwest, south, and southeast, particularly in the area of IRA excavation Grid 11A on the western perimeter of the site. In addition, any new areas discovered during a geophysical survey would require additional investigation to support selection of a remedy for soils at the site.

Data gaps exist for 4 inorganic COPCs based on the most conservative risk-based CUGs for surface soil including arsenic, beryllium, chromium (total), and cobalt. While 3 of the 4 COPCs were detected concurrently in the surface soil sample collected from DA1-034 in the southwest portion of the site where the horizontal extent is not defined, the horizontal extent of inorganic COPCs in surface soil is also not defined by current data to the southwest and south of ODA1. The vertical extent of surface soil COPCs is defined with depth in current subsurface soils data. The extent of COPCs in surface soil within the central portion of the site is defined by previous sampling results. Additional surface soil samples will need to be analyzed for VOCs, SVOCs, and PCBs to further evaluate these parameters as COPCs.

Data gaps exist vertically with depth below 5 feet bgs at DA1-027 located in the southwest portion of the site and to the west and south of DA1-027 for 4 inorganic COPCs based on the most conservative risk-based CUGs for subsurface soil including aluminum, arsenic, chromium (total), and lead. The COCs in subsurface soil include aluminum, arsenic, beryllium, chromium (total), copper, lead, nitrocellulose, benzene, ethylbenzene, toluene, and xylenes. The COCs occur across the site with the highest concentrations of multiple inorganics detected in the subsurface soil sample collected from Grid 11A located along the western perimeter of the site. The area of Grid 11A identified as the "Blue Ash" sample requires further evaluation to determine the extent of contamination. Data gaps for the inorganic COCs outside of Grid 11A, namely arsenic, beryllium, and lead, exist vertically with depth in the southwest portion (Grids 17 and 19 [below 2 feet bgs] and Grid 9 [below 4 feet bgs]), southern portion (Grid 5 [below 8 feet bgs]), southwest/central portion (Grid 3 [below 4 feet bgs]), and northeast/central portion (Grids 14 and 15 [below 4 feet bgs]) of the site. Data gaps for inorganic COCs exist horizontally to the north, west, and south of Grid 11A and north and west of Grid 14. Data gaps for the extent

of organic COCs exist horizontally and vertically with depth below 8 feet bgs in the southwest/central portion (Grid 5) and 4 feet bgs in the western perimeter (Grid 10) of the site. Data gaps for VOCs exist in each direction around Grid 5. Data gaps for nitrocellulose exist to the north and south of Grid 10 and to the east and west of Grid 5.

This page intentionally left blank.

Table 3-1
Detected Analytes in Post-IRA Surface Soil Samples at RVAAP-03 Open Demolition Area 1

Detected Analyte	Surface Soil Background Criteria (0-1 feet bgs)	Draft Facility-Wide Cleanup Goals for Surface Soil (0-1 feet bgs)										DA1ss-002-0003-SO	DA1ss-003-0005-SO	DA1ss-004-0007-SO
		Residential Farmer				National Guard								
		Adult		Child		Dust/Fire Control Worker		Range Maintenance		Trainee				
		CR=10^{-6}	HI=0.1	CR=10^{-6}	HI=0.1	CR=10^{-6}	HI=0.1	CR=10^{-6}	HI=0.1	CR=10^{-6}	HI=0.1			
Location												DA1-002	DA1-003	DA1-004
Sample Date												10/19/1999	10/19/1999	10/19/1999
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Inorganics														
Aluminum	17,700	--	52,923	--	7,380	--	1.0E+06	--	778,938	--	3,496	1940	3000	**3610**
Antimony	0.96	--	13.6	--	2.82	--	1,030	--	161	--	175	1.1 U	1.1 U	1.1 U
Arsenic	15.4	0.425	8.21	0.524	2.02	35.7	573	5.76	93	2.78	114	**6.2**	**5.3**	**11**
Barium	88.4	--	8,966	--	1,413	--	8.1E+05	--	129,225	--	351	58.6	177	96.5
Beryllium	0.88	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	0.22 U	0.35 U	0.39 U
Cadmium	NA	1,249	22.3	2,677	6.41	94,527	1,473	25,321	242	10.9	329	0.54 U	0.54 U	0.27
Chromium (total)	17.4	187	90.4	401.5	19.9	14,179	6,666	3,798	1,108	1.64	5.61	**4.3**	**4.4**	**7.2**
Cobalt	10.4	803	820	1,721	131	60,768	74,531	16,278	13,519	7.03	14.0	3.6	2.7	3.1
Copper	17.7	--	2,714	--	311	--	3.4E+05	--	42,486	--	25,368	7.1	8.9	13.6
Lead	26.1	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	10.5	11.2	13.9
Manganese	1,450	--	1,482	--	293	--	116,634	--	20,723	--	35.1	**376**	**531**	**523**
Mercury	0.036	--	16.5	--	2.3	--	1,659	--	230	--	172	0.0078	0.02	0.024
Nickel	21.1	--	1,346	--	155	--	167,541	--	20,971	--	12,639	11.5	9.9	12.5
Selenium	1.4	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	0.54 U	0.54 U	0.54 U
Thallium	NA	--	4.76	--	0.612	--	513	--	68.9	--	47.7	0.21	0.15	0.14
Zinc	61.8	--	19,659	--	2,321	--	1.0E+06	--	301,090	--	187,269	31.9	31.9	43.3
Explosives														
1,3,5-Trinitrobenzene	NA	--	1,528	--	225	--	144,038	--	20,584	--	16,542	0.25 U	0.25 U	0.25 U
HMX	NA	--	1,909	--	359	--	151,363	--	23,265	--	23,464	0.5 U	0.2	0.5 U

Table 3-1
Detected Analytes in Post-IRA Surface Soil Samples at RVAAP-03 Open Demolition Area 1

Detected Analyte	DA1ss-008-0015-SO	DA1ss-009-0017-SO	DA1ss-011-0021-SO	DA1ss-014-0029-SO	DA1ss-015-0032-SO	DA1ss-016-0036-SO	DA1ss-017-0039-SO	DA1ss-018-0042-SO	DA1ss-019-0045-SO
Location	**DA1-008**	**DA1-009**	**DA1-011**	**DA1-014**	**DA1-015**	**DA1-016**	**DA1-017**	**DA1-018**	**DA1-019**
Sample Date	**10/20/1999**	**10/20/1999**	**10/20/1999**	**10/20/1999**	**10/21/1999**	**10/21/1999**	**10/21/1999**	**10/22/1999**	**10/22/1999**
Units	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
Inorganics									
Aluminum	**7240**	1730	2670	**9520**	**14100**	**11400**	**11800**	**16200**	**15000**
Antimony	0.54	1.1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U
Arsenic	**5**	**5.1**	**9.2**	**9.3**	**10.9**	**12.4**	**10.6**	**15.1**	**11.3**
Barium	252	92.1	43.7	58.1	66.2	91.2	35.8	58.3	53.8
Beryllium	0.94	0.15	0.16	0.24	0.28	0.36	0.23	0.7 U	0.28 U
Cadmium	1.1	0.5	0.56 U	0.61 U	0.6 U	0.6 U	0.61 U	0.61 U	0.61 U
Chromium (total)	**4.1**	**3.4**	**5.3**	**12.4**	**17**	**14.6**	**15.3**	**22.6**	**18.8**
Cobalt	3.8	2.8	3.2	**7.6**	**9.4**	**9.5**	5.9	**14**	6.4
Copper	55.2	25.2	12.1	10.8	12.1	40.8	11.9	23.5	20.1
Lead	12.4	8.2	12.4	18.3	16.9	18.7	11.6	16.3	15.7
Manganese	**947**	**519**	**314**	**820**	**543**	**608**	**176**	**242**	**205**
Mercury	0.076	0.023	0.012	0.034 U	0.05	0.0072 U	0.028 U	0.03	0.03
Nickel	15.4	11.8	9.2	10	14.7	13.7	14.3	31.9	15
Selenium	0.55 U	0.55 U	0.56 U	0.61 U	0.88	0.61 U	0.61 U	0.61 U	0.61 U
Thallium	0.22	0.2	0.26	0.35	0.48	0.31	0.33	0.31	0.32
Zinc	63.9	33.9	36.2	52.9	57.7	78.8	41.4	74.2	69.2
Explosives									
1,3,5-Trinitrobenzene	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
HMX	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U

Table 3-1
Detected Analytes in Post-IRA Surface Soil Samples at RVAAP-03 Open Demolition Area 1

Detected Analyte	DA1ss-026-0066-SO	DA1ss-028-073-SO	DA1ss-030-0079-SO	DA1ss-031-0082-SO	DA1ss-032-0085-SO	DA1ss-033-088-SO	DA1ss-034-0091-SO	DA1ss-035-0094-SO	DA1ss-036-0097-SO	DA1ss-037-0100-SO	DA1ss-039-0106-SO
Location	**DA1-026**	**DA1-028**	**DA1-030**	**DA1-031**	**DA1-032**	**DA1-033**	**DA1-034**	**DA1-035**	**DA1-036**	**DA1-037**	**DA1-039**
Sample Date	**10/25/1999**	**10/26/1999**	**10/26/1999**	**10/26/1999**	**10/27/1999**	**10/27/1999**	**10/27/1999**	**11/1/1999**	**11/2/1999**	**11/2/1999**	**11/2/1999**
Units	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
Inorganics											
Aluminum	**14400**	**13000**	**12400**	**12100**	**6940**	**5550**	**16100**	**6580**	**11600**	**8980**	**8850**
Antimony	1.3 R	1.2 R	1.2 R	0.63	1.2 R	1.3 R	1.2 R	1.1 U	1.2 U	1.2 U	1.2 U
Arsenic	**11.4**	**12.4**	**13.5**	**14.4**	**7.9**	**7.9**	**15.6**	**8.8**	**9.6**	**9.9**	**8**
Barium	74.1	72	78.4	55.7	54.9	45.7	114	23.4	70.9	60.6	53.3
Beryllium	0.34 U	0.6 U	0.42 U	0.2 U	0.28 U	0.28 U	0.83 U	0.21 U	0.28 U	0.19 U	0.23 U
Cadmium	0.7	0.6 U	0.61 U	0.62 U	0.6 U	0.63 U	0.61 U	0.57 U	0.62 U	0.62 U	0.61 U
Chromium (total)	**17.8**	**16.8**	**18.1**	**15.8**	**7.9**	**7.3**	**22.7**	**8.6**	**14.5**	**12.5**	**10.8**
Cobalt	**10**	6.1	**12.5**	5.4	6.9	**7.7**	**15.4**	6.9	**8.3**	**9.7**	**9.4**
Copper	70.4	37.7	45.6	69.8	5.8	10.8	22.6	13.2	18.6	11.5	6.9
Lead	19.5	15.6	17.6	19	17	22.2	15.3	8	20.2	16.2	16.1
Manganese	**483**	**138**	**471**	**230**	**667**	**550**	**467**	**227**	**447**	**656**	**644**
Mercury	0.048	0.063	0.038	0.023	0.052	0.13 U	0.022	0.025 U	0.051 U	0.043 U	0.05 U
Nickel	16.7	13.4	27.2	13	7.9	8.6	35.9	11.9	15.5	15.5	10.3
Selenium	1.3	1.2	0.61 U	0.62 U	0.6 U	0.63 U	0.61 U	0.73 U	0.8 U	0.88 U	0.97 U
Thallium	0.51 U	0.43 U	0.4	0.41	0.3	0.36	0.47	0.26	0.41	0.31	0.37
Zinc	186	89.9	90.2	317	36.4	38	72.5	33.8	86.8	47.9	41.4
Explosives											
1,3,5-Trinitrobenzene	0.25 U	0.25 U	6.6	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
HMX	0.5 U	0.5 U	2.6	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U

Notes:

-- = No CUG could be quantified based on lack of approved toxicity value.

CR = Cumulative Risk

feet bgs = feet below ground surface

HI = Hazard Index

mg/kg = milligrams/kilograms

NA = Not applicable

NC = Not calculated

HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine

R = Result rejected through laboratory quality control or validation process.

U = Result not detected at indicated laboratory reporting limit.

1. Shaded box indicates exceedance of RVAAP background concentrations.
2. **Bold type** indicates exceedance of most restrictive risk-based cleanup goal for surface soil from the Draft Facility-Wide Human Health Cleanup Goals for the RVAAP,
3. Table only shows detected compounds.
4. Evaluation (i.e., comparison to background and CUGs) was not applied to rejected or non-detect values.

Table 3-2
Identification of COPCs in Post-IRA Surface Soil at RVAAP-03 Open Demolition Area 1

Detected Analyte	Units	Results > Detection Limit [a]	Maximum Detect	Surface Soil Background Criteria (0-1 feet bgs)	Maximum Detect > Background	Data Reduction and Screening - Retained as COPC?	95% UCL	EPC	Draft Facility-Wide Cleanup Goals for Surface Soil (0-1 feet bgs) [b]									
									Residential Farmer									
									Adult					Child				
									$CR=10^{-6}$	HI=0.1	# Detect > CUG and Bkgd [c]	EPC > CUG?	COPC?	$CR=10^{-6}$	HI=0.1	# Detect > CUG and Bkgd [c]	EPC > CUG?	COPC?
Inorganics																		
Aluminum	mg/kg	23 / 23	16,200	17,700	No	No	NA	NA	--	52,923	NA	NA	No	--	7,380	NA	NA	No
Antimony	mg/kg	2 / 17	0.6	0.96	No	No	NA	NA	--	13.6	NA	NA	No	--	2.82	NA	NA	No
Arsenic	mg/kg	23 / 23	15.6	15.4	Yes	Yes	11.1	11.1	0.425	8.21	1	Yes	Yes	0.524	2.02	1	Yes	Yes
Barium	mg/kg	23 / 23	252	88.4	Yes	Yes	94.4	94.4	--	8,966	0	No	No	--	1,413	0	No	No
Beryllium	mg/kg	7 / 23	0.94	0.88	Yes	Yes	0.29	0.29	NC	NC	1	NA	Yes [d]	NC	NC	1	NA	Yes [d]
Cadmium	mg/kg	4 / 23	1.1	NA	NA	Yes	0.8	0.8	1,249	22.3	0	No	No	2,677	6.41	0	No	No
Chromium (total or hexavalent)	mg/kg	23 / 23	22.7	17.4	Yes	Yes	14.4	14.4	187	90.4	0	No	No	401.5	19.9	2	No	No
Cobalt	mg/kg	23 / 23	15.4	10.4	Yes	Yes	8.7	8.7	803	820	0	No	No	1,721	131	0	No	No
Copper	mg/kg	23 / 23	70	17.7	Yes	Yes	34.3	34.3	--	2,714	0	No	No	--	311	0	No	No
Lead	mg/kg	23 / 23	22	26.1	No	No	NA	NA	NC	NC	NA	NA	No	NC	NC	NA	NA	No
Manganese	mg/kg	23 / 23	947	1,450	No	No	NA	NA	--	1,482	NA	NA	No	--	293	NA	NA	No
Mercury	mg/kg	15 / 23	0.1	0.036	Yes	Yes	0.037	0.037	--	16.5	0	No	No	--	2.3	0	No	No
Nickel	mg/kg	23 / 23	35.9	21.1	Yes	Yes	17.7	17.7	--	1,346	0	No	No	--	155	0	No	No
Selenium	mg/kg	3 / 23	1.3	1.4	No	No	NA	NA	NC	NC	NA	NA	No	NC	NC	NA	NA	No
Thallium	mg/kg	21 / 23	0.5	NA	NA	Yes	0.3	0.3	--	4.76	0	No	No	--	0.612	0	No	No
Zinc	mg/kg	23 / 23	317	61.8	Yes	Yes	129.3	129.3	--	19,659	0	No	No	--	2,321	0	No	No
Explosives																		
1,3,5-Trinitrobenzene	mg/kg	1 / 23	6.6	NA	NA	Yes	NA	6.6	--	1,528	0	No	No	--	225	0	No	No
HMX	mg/kg	2 / 23	2.6	NA	NA	Yes	NA	2.6	--	1,909	0	No	No	--	359	0	No	No

Table 3-2
Identification of COPCs in Post-IRA Surface Soil at RVAAP-03 Open Demolition Area 1

Detected Analyte	Units	Results > Detection Limit [a]	Maximum Detect	Surface Soil Background Criteria (0-1 feet bgs)	Maximum Detect > Background	Data Reduction and Screening - Retained as COPC?	95% UCL	EPC	Draft Facility-Wide Cleanup Goals for Surface Soil (0-1 feet bgs) [b]																
									National Guard																
									Dust/Fire Control Worker					Range Maintenance Soldier						Trainee					
									CR=10^{-6}	HI=0.1	# Detect > CUG and Bkgd [c]	EPC > CUG?	COPC?	CR=10^{-6}	HI=0.1	# Detect > CUG and Bkgd [c]	EPC > CUG?	COPC?	CR=10^{-6}	HI=0.1	# Detect > CUG and Bkgd [c]	EPC > CUG?	COPC?
Inorganics																									
Aluminum	mg/kg	23 / 23	16,200	17,700	No	No	NA	NA	--	1.0E+06	NA	NA	No	--	778,938	NA	NA	No	--	3,496	NA	NA	No		
Antimony	mg/kg	2 / 17	0.6	0.96	No	No	NA	NA	--	1,030	NA	NA	No	--	161	NA	NA	No	--	175	NA	NA	No		
Arsenic	mg/kg	23 / 23	15.6	15.4	Yes	Yes	11.1	11.1	35.7	573	0	No	No	5.76	93	1	Yes	Yes	2.78	114	1	Yes	Yes		
Barium	mg/kg	23 / 23	252	88.4	Yes	Yes	94.4	94.4	--	8.1E+05	0	No	No	--	129,225	0	No	No	--	351	0	No	No		
Beryllium	mg/kg	7 / 23	0.94	0.88	Yes	Yes	0.29	0.29	NC	NC	1	NA	Yes [d]	NC	NC	1	NA	Yes [d]	NC	NC	1	NA	Yes [d]		
Cadmium	mg/kg	4 / 23	1.1	NA	NA	Yes	0.8	0.8	94,527	1,473	0	No	No	25,321	242	0	No	No	10.9	329	0	No	No		
Chromium (total or hexavalent)	mg/kg	23 / 23	22.7	17.4	Yes	Yes	14.4	14.4	14,179	6,666	0	No	No	3,798	1,108	0	No	No	1.64	5.61	5	Yes	Yes		
Cobalt	mg/kg	23 / 23	15.4	10.4	Yes	Yes	8.7	8.7	60,768	74,531	0	No	No	16,278	13,519	0	No	No	7.03	14.0	3	Yes	Yes		
Copper	mg/kg	23 / 23	70	17.7	Yes	Yes	34.3	34.3	--	3.4E+05	0	No	No	--	42,486	0	No	No	--	25,368	0	No	No		
Lead	mg/kg	23 / 23	22	26.1	No	No	NA	NA	NC	NC	NA	NA	No	NC	NC	NA	NA	No	NC	NC	NA	NA	No		
Manganese	mg/kg	23 / 23	947	1,450	No	No	NA	NA	--	116,634	NA	NA	No	--	20,723	NA	NA	No	--	35.1	NA	NA	No		
Mercury	mg/kg	15 / 23	0.1	0.036	Yes	Yes	0.037	0.037	--	1,659	0	No	No	--	230	0	No	No	--	172	0	No	No		
Nickel	mg/kg	23 / 23	35.9	21.1	Yes	Yes	17.7	17.7	--	167,541	0	No	No	--	20,971	0	No	No	--	12,639	0	No	No		
Selenium	mg/kg	3 / 23	1.3	1.4	No	No	NA	NA	NC	NC	NA	NA	No	NC	NC	NA	NA	No	NC	NC	NA	NA	No		
Thallium	mg/kg	21 / 23	0.5	NA	NA	Yes	0.3	0.3	--	513	0	No	No	--	68.9	0	No	No	--	47.7	0	No	No		
Zinc	mg/kg	23 / 23	317	61.8	Yes	Yes	129.3	129.3	--	1.0E+06	0	No	No	--	301,090	0	No	No	--	187,269	0	No	No		
Explosives																									
1,3,5-Trinitrobenzene	mg/kg	1 / 23	6.6	NA	NA	Yes	NA	6.6	--	144,038	0	No	No	--	20,584	0	No	No	--	16,542	0	No	No		
HMX	mg/kg	2 / 23	2.6	NA	NA	Yes	NA	2.6	--	151,363	0	No	No	--	23,265	0	No	No	--	23,464	0	No	No		

Notes:

-- = No CUG could be quantified based on lack of approved toxicity value.
Bkgd = Background
COPC - constituent of potential concern
CR = Cumulative Risk
EPC = exposure point concentration
feet bgs = feet below ground surface
HI = Hazard Index
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
mg/kg = milligrams/kilograms
NA = Not applicable
NC = Not calculated
UCL = upper confidence limit

[a] Total sample count does not include rejected data values.

[b] Cleanup Goals (CUGs) are from the Draft Facility-Wide Human Health Cleanup Goals for the RVAAP prepared by SAIC in September 2008.

[c] The RVAAP background value is the default action level for inorganic COPCs with CUGs less than background.

[d] Detected organics are automatically retained as COPCs where no CUGs have been developed. Inorganics are automatically retained where no CUGs have been developed if the maximum detection is greater than the RVAAP background value.

Table 3-3
Detected Analytes in Phase I RI Post-IRA Subsurface Soil Samples at RVAAP-03 Open Demolition Area 1

Detected Analyte	Subsurface Soil Background Criteria	Draft Facility-Wide Cleanup Goals for Subsurface Soil						DA1ss-002-0004-SO	DA1ss-003-0006-SO	DA1ss-014-0030-SO	DA1ss-014-0031-SO	DA1ss-015-0033-SO	DA1ss-015-0034-SO
		Residential Farmer				National Guard							
		Adult		Child		Trainee							
		CR=10^{-6}	HI=0.1	CR=10^{-6}	HI=0.1	CR=10^{-6}	HI=0.1						
Location								**DA1-002**	**DA1-003**	**DA1-014**	**DA1-014**	**DA1-015**	**DA1-015**
Depth (feet bgs)								**1 to 3**	**1 to 3**	**1 to 3**	**3 to 5**	**1 to 3**	**3 to 5**
Sample Date								**10/19/1999**	**10/19/1999**	**10/20/1999**	**10/20/1999**	**10/21/1999**	**10/21/1999**
Units	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
Inorganics													
Aluminum	19,500	--	52,923	--	7,380	--	3,496	**8520**	**7150**	**14600**	**15300**	**14000**	**17000**
Antimony	0.96	--	13.6	--	2.82	--	175	1.2 U	1.1 U	0.78	0.96	0.79	1.2 U
Arsenic	19.8	0.425	8.21	0.524	2.02	2.78	114	**8.3**	**10.6**	**15.9**	**15.3**	**17**	**18**
Barium	124	--	8,966	--	1,413	--	351	43.9	26.1	85.8	90.9	42.3	78.3
Cadmium	NA	1,249	22.3	2,677	6.41	10.9	329	0.58 U	0.56 U	0.59 U	0.6 U	0.58 U	0.59 U
Chromium (total)	27.2	187	90.4	401.5	19.9	1.64	5.61	**11.7**	**10.1**	**19.5**	**22**	**19.1**	**22.2**
Copper	32.3	--	2,714	--	311	--	25,368	9.2	13.3	23.5	22.8	24	26.3
Lead	19.1	NC	NC	NC	NC	NC	NC	10.6	10.5	15.2	13.9	14.5	15.1
Mercury	0.044	--	16.5	--	2.27	--	172	0.037	0.024	0.035	0.015	0.034	0.021
Vanadium	37.6	--	156	--	44.9	--	2,304	15.6	13.9	23.6	24	21	25.9
Zinc	93.3	--	19,659	--	2,321	--	187,269	36.3	35.6	58.9	70.5	59.4	70.4

Table 3-3
Detected Analytes in Phase I RI Post-IRA Subsurface Soil Samples at RVAAP-03 Open Demolition Area 1

Detected Analyte	DA1ss-016-0037-SO	DA1ss-016-0038-SO	DA1ss-017-0040-SO	DA1ss-017-0041-SO	DA1ss-018-0043-SO	DA1ss-018-0044-SO	DA1ss-018-0160-SO	DA1ss-019-0046-SO	DA1ss-019-0047-SO	DA1ss-019-0161-SO	DA1ss-020-0162-SO	DA1ss-021-0163-SO
Location	**DA1-016**	**DA1-016**	**DA1-017**	**DA1-017**	**DA1-018**	**DA1-018**	**DA1-018**	**DA1-019**	**DA1-019**	**DA1-019**	**DA1-020**	**DA1-021**
Depth (feet bgs)	**1 to 3**	**3 to 5**	**1 to 3**	**3 to 5**	**1 to 3**	**3 to 5**	**6 to 8**	**1 to 3**	**3 to 5**	**6 to 8**	**6 to 8**	**6 to 8**
Sample Date	**10/21/1999**	**10/21/1999**	**10/21/1999**	**10/21/1999**	**10/22/1999**	**10/22/1999**	**10/22/1999**	**10/22/1999**	**10/22/1999**	**10/22/1999**	**10/22/1999**	**10/24/1999**
Units	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
Inorganics												
Aluminum	**12700**	**8430**	**10700**	**11300**	**12600**	**10700**	**7850**	**16300**	**9130**	**13800**	**16900**	**13500**
Antimony	1.2 U	1.2 U	1.2 U	1.3 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.3 U
Arsenic	**17**	**14.3**	**15.1**	**15.1**	**17.5**	**16.3**	**16.6**	**21.1**	**16**	**17.8**	**13.1**	**18.8**
Barium	74.4	64.5	43.5	69.7	77.5	52.9	55.9	59.7	52.2	65.2	104	79.7
Cadmium	0.59 U	0.6 U	0.6 U	0.63 U	0.61 U	0.62 U	0.62 U	0.62 U	0.62 U	0.61 U	0.61 U	0.63 U
Chromium (total)	**19.4**	**13.2**	**15.7**	**17.2**	**18.8**	**17**	**13.4**	**22.4**	**14.1**	**20.7**	**25.2**	**18.8**
Copper	20.9	20.1	20.3	20.6	22.1	21.2	22	28	19.6	18.7	22.7	20.4
Lead	13.4	11.9	13.6	11.8	15.4	13.9	14.1	17.5	13.4	13.1	13.9	14.1
Mercury	0.021 U	0.0078 U	0.054	0.018 U	0.014	0.0066	0.12 U	0.038	0.12 U	0.025	0.014	0.13 U
Vanadium	21.1	13.9	16.5	18.7	19.1	17.7	13.6	23.9	15.3	21.7	25.8	20.5
Zinc	65.4	56.8	53.8	60.8	66.2	63.7	66.4	72.3	56.6	66.1	80.1	71.1

Table 3-3
Detected Analytes in Phase I RI Post-IRA Subsurface Soil Samples at RVAAP-03 Open Demolition Area 1

Detected Analyte	DA1ss-026-0067-SO	DA1ss-026-0068-SO	DA1ss-027-0071-SO	DA1ss-028-0074-SO	DA1ss-028-0075-SO	DA1ss-030-0080-SO	DA1ss-031-0083-SO	DA1ss-031-0084-SO	DA1ss-032-0086-SO	DA1ss-032-0087-SO	DA1ss-033-0089-SO	DA1ss-033-0090-SO
Location	**DA1-026**	**DA1-026**	**DA1-027**	**DA1-028**	**DA1-028**	**DA1-030**	**DA1-031**	**DA1-031**	**DA1-032**	**DA1-032**	**DA1-033**	**DA1-033**
Depth (feet bgs)	**1 to 3**	**3 to 5**	**3 to 5**	**1 to 3**	**3 to 5**	**1 to 3**	**1 to 3**	**3 to 5**	**1 to 3**	**3 to 5**	**1 to 3**	**3 to 5**
Sample Date	**10/25/1999**	**10/25/1999**	**10/20/1999**	**10/26/1999**	**10/26/1999**	**10/26/1999**	**10/26/1999**	**10/26/1999**	**10/27/1999**	**10/27/1999**	**10/27/1999**	**10/27/1999**
Units	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
Inorganics												
Aluminum	**13900**	**15000**	**28600**	**14100**	**12500**	**14400**	**13300**	**11600**	**10400**	**14200**	**10500**	**9530**
Antimony	1.2 R	1.2 R	1.3	1.2 R	1.2 R	1.2 R	1.2 R	1.2 R	1.1 U	1.2 R	1.2 R	1.3 R
Arsenic	**15.8**	**16.7**	**20.9**	**16.6**	**17.3**	**14.7**	**15.8**	**13.5**	**11.6**	15.2 R	**12.7**	**12.2**
Barium	67.4	89.4	107	99.5	79	78	71.8	90.4	35.8	107	68.9	56.9
Cadmium	0.61 U	0.62 U	0.59 U	0.6 U	0.61 U	0.6 U	0.59 U	0.61 U	0.56 U	0.59 U	0.59 U	0.64 U
Chromium (total)	**20**	**22.6**	**34.7**	**20**	**19.9**	**22.2**	**18.7**	**19.5**	**13.2**	**21.6**	**15.3**	**14.9**
Copper	23.9	24.1	35.3	23	24.2	21.3	47.3	25	17.3	22.5	18.9	18.7
Lead	15	14.5	19.4	12.5	13.8	13.1	16.1	12.8	11.5	13.5	11.6	11.4
Mercury	0.0076	0.022	0.0096	0.024	0.018	0.016	0.032	0.015	0.11 U	0.12 U	0.028	0.014
Vanadium	22.8	24.4	39.9	23.5	20.7	24.3	22.1	19.6	18.8	22.7	17.7	17.1
Zinc	68.8	74	97	67.2	74.8	67.7	125	82.9	48.5	74.6	58.1	57.7

Table 3-3
Detected Analytes in Phase I RI Post-IRA Subsurface Soil Samples at RVAAP-03 Open Demolition Area 1

Detected Analyte	DA1ss-034-0092-SO	DA1ss-034-0093-SO	DA1ss-035-0095-SO	DA1ss-035-0096-SO	DA1ss-036-0098-SO	DA1ss-036-0099-SO	DA1ss-037-0101-SO	DA1ss-037-0102-SO	DA1ss-039-0107-SO	DA1ss-039-0108-SO	DA1ss-041-0164-SO	DA1ss-042-0165-SO
Location	**DA1-034**	**DA1-034**	**DA1-035**	**DA1-035**	**DA1-036**	**DA1-036**	**DA1-037**	**DA1-037**	**DA1-039**	**DA1-039**	**DA1-041**	**DA1-042**
Depth (feet bgs)	**1 to 3**	**3 to 5**	**1 to 3**	**3 to 5**	**1 to 3**	**3 to 5**	**1 to 3**	**3 to 5**	**1 to 3**	**3 to 5**	**6 to 8**	**6 to 8**
Sample Date	**10/27/1999**	**10/27/1999**	**11/1/1999**	**11/1/1999**	**11/2/1999**	**11/2/1999**	**11/2/1999**	**11/2/1999**	**11/2/1999**	**11/2/1999**	**11/3/1999**	**11/3/1999**
Units	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
Inorganics												
Aluminum	**9730**	**6370**	**7140**	**12400**	**14000**	**8720**	**8740**	**8070**	**12300**	**10300**	**10500**	**14800**
Antimony	1.2 R	1.2 R	1.2 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U	1.2 U	1.2 U	1.3 U	1.2 U
Arsenic	**17.9**	**13.7**	**12.2**	**12.5**	**15.1**	**9.1**	**9.5**	**12.7**	**11.7**	**11.3**	**14.1**	**14.5**
Barium	62.1	35.1	38.7	74.9	103	54.2	43.3	172	59.3	65	61.2	73.7
Cadmium	0.6 U	0.62 U	0.58 U	0.62 U	0.61 U	0.59 U	0.55 U	0.27	0.59 U	0.58 U	0.64 U	0.62 U
Chromium (total)	**15.6**	**10.8**	**10.2**	**19.2**	**20.8**	**14**	**10.2**	**11**	**16.8**	**15.8**	**16.6**	**21.7**
Copper	22.8	18.9	16.7	19.4	22.5	14.7	11	22	14.4	18.6	20.6	22.4
Lead	13.4	11.2	9.5	12.8	13.9	8.7	11.6	14	11.5	10.8	12.1	13.5
Mercury	0.037	0.12 U	0.024 U	0.026 U	0.033 U	0.023 U	0.028 U	0.02 U	0.02 U	0.019 U	0.037 U	0.043 U
Vanadium	17.2	11.6	13.4	19.3	22.5	14.3	16.5	17.1	22.1	17.8	17.5	24.5
Zinc	59.4	51.2	45.8	69.6	74.9	47.1	41.9	56.1	47.1	57.9	64.4	74.3

Notes:

-- = No CUG could be quantified based on lack of approved toxicity value.

CR = Cumulative Risk

feet bgs = feet below ground surface

HI = Hazard Index

mg/kg = milligrams/kilograms

NA = Not applicable

NC = Not calculated

R = Result rejected through laboratory quality control or validation process.

U = Result not detected at indicated laboratory reporting limit.

1. Shaded box indicates exceedance of RVAAP background concentrations.
2. **Bold type** indicates exceedance of most restrictive risk-based cleanup goal for surface soil from the Draft Facility-Wide Human Health Cleanup Goals for the RVAAP, SAIC, Septemb
3. Table only shows detected compounds.
4. Evaluation (i.e., comparison to background and CUGs) was not applied to rejected or non-detect values.

Table 3-4
Identification of COPCs in Phase I RI Post-IRA Subsurface Soil at RVAAP-03 Open Demolition Area 1

Detected Analyte	Units	Results > Detection Limit [a]	Maximum Detect	Subsurface Soil Background Criteria	Maximum Detect > Background	Data Reduction and Screening - Retained as COPC?	95% UCL	EPC	Draft Facility-Wide Cleanup Goals for Subsurface Soil [b]														
									Residential Farmer									National Guard					
									Adult					Child				Trainee					
									CR=10^{-6}	HI=0.1	# Detect > CUG and Bkgd [c]	EPC > CUG?	COPC?	CR=10^{-6}	HI=0.1	# Detect > CUG and Bkgd [c]	EPC > CUG?	COPC?	CR=10^{-6}	HI=0.1	# Detect > CUG and Bkgd [c]	EPC > CUG?	COPC?
Inorganics																							
Aluminum	mg/kg	42 / 42	28,600	19,500	Yes	Yes	13,166	13,166	--	52,923	0	No	No	--	7,380	1	Yes	Yes	--	3,496	1	Yes	Yes
Antimony	mg/kg	4 / 30	1.3	0.96	Yes	Yes	0.98	1.0	--	13.6	0	No	No	--	2.82	0	No	No	--	175	0	No	No
Arsenic	mg/kg	41 / 41	21.1	19.8	Yes	Yes	15.6	15.6	0.425	8.21	2	Yes	Yes	0.524	2.02	2	Yes	Yes	2.78	114	2	Yes	Yes
Barium	mg/kg	42 / 42	172	124	Yes	Yes	78	78	--	8,966	0	No	No	--	1,413	0	No	No	--	351	0	No	No
Cadmium	mg/kg	1 / 42	0.27	NA	NA	No	NA	0.27	1,249	22.3	NA	NA	No	2,677	6.41	NA	NA	No	10.9	329	NA	NA	No
Chromium (total or hexavalent)	mg/kg	42 / 42	34.7	27.2	Yes	Yes	19.1	19.1	187	90.4	0	No	No	401.5	19.9	1	No	No	1.64	5.61	1	Yes	Yes
Copper	mg/kg	42 / 42	47	32.3	Yes	Yes	23.1	23.1	--	2,714	0	No	No	--	311	0	No	No	--	25,368	0	No	No
Lead	mg/kg	42 / 42	19.4	19.1	Yes	Yes	13.7	13.7	NC	NC	1	NA	Yes [d]	NC	NC	1	NA	Yes [d]	NC	NC	1	NA	Yes [d]
Mercury	mg/kg	23 / 42	0.054	0.044	Yes	Yes	0.023	0.023	--	16.5	0	No	No	--	2.27	0	No	No	--	172	0	No	No
Vanadium	mg/kg	42 / 42	39.9	37.6	Yes	Yes	21.3	21.3	--	156	0	No	No	--	44.9	0	No	No	--	2,304	0	No	No
Zinc	mg/kg	42 / 42	125	93.3	Yes	Yes	68.3	68.3	--	19,659	0	No	No	--	2,321	0	No	No	--	187,269	0	No	No

Notes:

-- = No CUG could be quantified based on lack of approved toxicity value.
Bkgd = Background
COPC - constituent of potential concern
CR = Cumulative Risk
CUG = Cleanup Goal
EPC = exposure point concentration
HI = Hazard Index
mg/kg = milligrams/kilograms
NA = Not applicable
NC = Not calculated
UCL = upper confidence limit

[a] Total sample count does not include rejected data values.
[b] Cleanup Goals (CUGs) are from the Draft Facility-Wide Human Health Cleanup Goals for the RVAAP prepared by SAIC in September 2008.
[c] The RVAAP background value is the default action level for inorganic COPCs with CUGs less than background.
[d] Detected inorganics are automatically retained as COPCs where no CUGs have been developed if the maximum detection is greater than the RVAAP background value.

Table 3-5
Detected Analytes in IRA Subsurface Soil Samples at RVAAP-03 Open Demolition Area 1

Detected Analyte	Subsurface Soil Background Criteria	Draft Facility-Wide Cleanup Goals for Subsurface Soil						OD1gd-001-0001-SO	OD1gd-002-0001-SO	OD1gd-003-0001-SO	OD1gd-004-0001-SO	OD1gd-005-0001-SO
		Residential Farmer				National Guard						
		Adult		Child		Trainee						
		CR=10^{-5}	HI=1	CR=10^{-5}	HI=1	CR=10^{-5}	HI=1					
Location								**Grid 1**	**Grid 2**	**Grid 3**	**Grid 4**	**Grid 5**
Depth (feet bgs)								**4**	**4**	**4**	**4**	**4** [a]
Sample Date								**10/25/2000**	**10/27/2000**	**10/30/2000**	**10/30/2000**	**11/16/2000**
Units	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
Inorganics												
Aluminum	19,500	--	529,229	--	73,798	--	34,960	13800	11500	17000	15500	9790
Antimony	0.96	--	136	--	28.2	--	1,753	0.24 U	0.25	0.26 U	0.47	0.32
Arsenic	19.8	4.25	82.1	5.24	20.2	27.8	1,140	**13.3**	**14.2**	**23.1**	**17.0**	**20.8**
Barium	124	--	89,656	--	14,129	--	3,506	68.4	56.4	65.4	94.8	67.9
Beryllium	0.88	NC	NC	NC	NC	NC	NC	0.66	0.65	1.0	0.54	0.62
Cadmium	NA	12,491	223	26,767	64.1	109	3,292	0.15	0.16 U	0.14 U	0.13 U	0.17 U
Calcium	35,500	NC	NC	NC	NC	NC	NC	7680	1010	1230	1740	1400
Chromium	27.2	1,874	904	4,015	199	16.4	56	**18.4**	16.1	**20.1**	**19.0**	14.7
Cobalt	23.2	8,030	8,198	17,207	1,313	70.3	140	7.7	8.6	12.7	10.4	7.4
Copper	32.3	--	27,138	--	3,106	--	253,680	18.8	17.0	30.6	17.0	19.2
Iron	35,200	--	190,104	--	23,125	--	1.0E+06	**24000**	23000	**35900**	**24600**	22800
Lead	19.1	NC	NC	NC	NC	NC	NC	11.1	12	21.2	15.5	11.4
Magnesium	2,790	NC	NC	NC	NC	NC	NC	3940	3120	3560	3710	2790
Manganese	3,030	--	14,817	--	2,927	--	351	228	284	282	**374**	261
Mercury	0.044	--	165	--	22.7	--	1,722	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U
Nickel	60.7	--	13,463	--	1,552	--	126,391	21	22.3	26.6	25.3	21.9
Potassium	3,350	NC	NC	NC	NC	NC	NC	2550	1670	2240	2090	1220
Selenium	1.5	NC	NC	NC	NC	NC	NC	0.16 U	0.37 U	0.43 U	0.43 U	0.42 U
Silver	NA	--	3,240	--	386	--	31,049	0.36 U	0.40 U	0.34 U	0.33 U	0.42 U
Sodium	145	NC	NC	NC	NC	NC	NC	111	79.1 U	1010	944	801
Thallium	0.91	--	47.6	--	6.12	--	477	0.2	0.15 U	0.17 U	0.17 U	0.16 U
Vanadium	37.6	--	1,558	--	449	--	23,045	23.9	18.2	27.3	25	16.8
Zinc	93.3	--	196,589	--	23,209	--	1.0E+06	55.9	50.7	64.4	55.3	53.6
Explosives/Propellants												
2,4,6-Trinitrotoluene	NA	328	211	284	36.5	4,643	2,488	0.1 U	0.1 U	0.1 U	0.098 U	0.099 U
Nitrocellulose	NA	NC	NC	NC	NC	NC	NC	NT	NT	NT	NT	1.0
VOCs												
Benzene	NA	NC	NC	NC	NC	NC	NC	NT	NT	NT	NT	0.006 U
Ethylbenzene	NA	NC	NC	NC	NC	NC	NC	NT	NT	NT	NT	0.006 U
Toluene	NA	NC	NC	NC	NC	NC	NC	NT	NT	NT	NT	0.002
Xylene (total)	NA	NC	NC	NC	NC	NC	NC	NT	NT	NT	NT	0.006 U
SVOCs												
Naphthalene	NA	--	3,678	--	1,215	--	15,407	NT	NT	NT	NT	0.400 U

Table 3-5
Detected Analytes in IRA Subsurface Soil Samples at RVAAP-03 Open Demolition Area 1

Detected Analyte	OD1gd-005-0002-SO	OD1gd-006-0001-SO	OD1gd-007-0001-SO	OD1gd-008-0001-SO	OD1gd-009-0001-SO	OD1gd-010-0001-SO	OD1gd-011-0001-SO	OD1gd-011a-Blue Ash	OD1gd-012-0001-SO	OD1gd-013-0001-SO	OD1gd-014-0001-SO
Location	**Grid 5**	**Grid 6**	**Grid 7**	**Grid 8**	**Grid 9**	**Grid 10**	**Grid 11**	**Grid 11a**	**Grid 12**	**Grid 13**	**Grid 14**
Depth (feet bgs)	**8** [a]	**4**	**4**	**4**	**4**	**4**	**4**	**5**	**4**	**4**	**4**
Sample Date	**11/16/2000**	**10/27/2000**	**7/18/2001**	**7/10/2001**	**6/21/2001**	**6/28/2001**	**6/13/2001**	**7/6/2001**	**6/20/2001**	**11/20/2000**	**11/13/2000**
Units	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg** [b]	**mg/kg**
Inorganics											
Aluminum	13100	14600	13800	9950	12300	14700	14000	**252000**	12500	13500	14500
Antimony	0.55	0.61	0.29 U	0.24 U	0.28 U	0.28 U	0.27 U	9.2	0.29 U	0.29 U	0.29 U
Arsenic	**24.6**	**15.8**	**11.9**	**17.1**	**26.4**	**17.4**	**11.1**	4.7 U	**9.3**	1.2	**18.2**
Barium	71.7	68.1	93.7	60.1	59.1	81.0	74.7	93.5	66.6	80.8	110
Beryllium	0.72	0.76	0.73	0.53	0.62	0.72	0.78	0.47 U	0.61	0.83	0.97
Cadmium	0.17 U	0.18 U	0.22 U	0.14 U	0.19 U	0.23 U	0.20 U	25.9	0.18 U	0.20 U	0.15 U
Calcium	6360	17100	5240	1090	1060	1700	11500	213	952	2110	2070
Chromium	**19.6**	**20.3**	**20.5**	14.7	**16.9**	**19.5**	**20.1**	**249**	**16.5**	**19.7**	**20.8**
Cobalt	12.9	10.5	12.7	10	9.2	13.6	11.8	1.4	9.9	11.4	10.7
Copper	22.2	22.5	20.9	18.8	22.5	22.0	23.7	**74200**	19.4	22.0	20.7
Iron	**29900**	**28800**	**31200**	**25100**	**26700**	**28400**	**29700**	2100	**24600**	**29300**	**29400**
Lead	16.9	13.4	13.2	13.6	14.5	15.1	15.2	2370	18.5	13	15.1
Magnesium	5430	5360	4990	2940	3220	3930	4950	486	3020	4410	4330
Manganese	**381**	285	**369**	322	277	**432**	**396**	204	293	**364**	291
Mercury	0.04 U	0.04 U	0.024	0.0083	0.04 U	0.018	0.012	0.011	0.04 U	0.04 U	0.04 U
Nickel	31.1	28.1	30.1	20.7	22.5	28.6	28.6	156	22.7	31.7	30.7
Potassium	2290	2720	2100	1160	1700	2100	2390	41.3	1810	2010	2030
Selenium	0.43 U	0.45 U	0.96	0.44	0.48 U	0.57 U	0.50 U	0.59 U	0.46 U	0.48	0.37 U
Silver	0.43 U	0.45 U	0.55 U	0.36 U	0.48 U	0.57 U	0.50 U	4.6	0.46 U	0.50 U	0.37 U
Sodium	902	965	130	93.9	117	80.6	127	118 U	135	895	889
Thallium	0.16 U	0.18 U	0.19 U	0.16 U	0.22	0.19 U	0.22	0.24 U	0.19 U	0.19 U	0.19 U
Vanadium	21.9	22.6	22.5	16.8	20.8	22.8	22.8	7.5	21.3	22.7	23.3
Zinc	66.1	63.5	68.7	53.5	56.9	63.4	64.7	**32100**	53.2	62.8	60.3
Explosives/Propellants											
2,4,6-Trinitrotoluene	0.1 U	0.099 U	0.1 U	0.099 U	0.098 U	0.098 U	0.098 U	0.1 U	0.1 U	0.1 U	0.1 U
Nitrocellulose	0.98	NT	NT	NT	NT	0.49	NT	NT	NT	NT	NT
VOCs											
Benzene	0.066	0.006 U	NT	NT	NT	0.006 U	NT	NT	NT	NT	NT
Ethylbenzene	0.130	0.006 U	NT	NT	NT	0.006 U	NT	NT	NT	NT	NT
Toluene	0.180	0.006 U	NT	NT	NT	0.006 U	NT	NT	NT	NT	NT
Xylene (total)	0.610	0.006 U	NT	NT	NT	0.006 U	NT	NT	NT	NT	NT
SVOCs											
Naphthalene	0.120	0.410 U	NT	NT	NT	0.400 U	NT	NT	NT	NT	NT

Table 3-5
Detected Analytes in IRA Subsurface Soil Samples at RVAAP-03 Open Demolition Area 1

Detected Analyte	OD1gd-015-0001-SO	OD1gd-016-0001-SO	OD1gd-017-0001-SO	OD1gd-018-0001-SO	OD1gd-019-0001-SO	OD1gd-020-0001-SO	OD1gd-021-0001-SO
Location	**Grid 15**	**Grid 16**	**Grid 17**	**Grid 18**	**Grid 19**	**Grid 20**	**Grid 21**
Depth (feet bgs)	**4**	**4**	**2**	**2**	**2**	**2**	**2 to 4 [c]**
Sample Date	**11/30/2000**	**7/6/2001**	**12/11/2000**	**7/12/2001**	**12/11/2000**	**6/5/2001**	**7/23/2001**
Units	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
Inorganics							
Aluminum	13900	13800	16000	12300	13300	14300	16100
Antimony	0.27	0.26 U	0.37	0.33 U	0.28	0.29 U	0.33 U
Arsenic	**27.4**	**15.0**	**10.7**	**16.4**	**29.3**	**10.1**	**8.2**
Barium	98.9	81.8	84.5	90.1	78.9	67.9	73.3
Beryllium	0.90	0.75	0.93	0.73	0.85	0.73	0.58
Cadmium	0.16 U	0.17 U	0.14 U	0.56	0.13 U	0.20 U	0.24
Calcium	1760	2270	2100	1410	1680	1510	579
Chromium	**20.1**	**19.3**	**22.6**	**18.2**	**19.4**	**18.6**	**17.8**
Cobalt	13.2	12.5	11.1	16.2	12.0	8.7	8.6
Copper	25.3	20.8	22.9	32.0	21.6	18.4	94.8
Iron	**30800**	**27900**	**30600**	**30000**	**29400**	**24200**	23100
Lead	13.3	11.8	16.8	19.0	13.8	11.2	14.3
Magnesium	4470	4070	5230	3830	4360	3440	3630
Manganese	**416**	**361**	282	**386**	344	350	303
Mercury	0.04 U	0.018	0.04 U	0.017	0.04 U	0.014	0.055
Nickel	34.5	29.1	33.8	27.0	29.6	20.8	19.4
Potassium	1700	1910	2170	2040	2270	2060	1530
Selenium	0.40 U	0.41 U	0.34 U	0.40	0.32 U	0.50 U	0.97
Silver	0.40 U	0.41 U	0.34 U	0.42 U	0.32 U	0.50 U	0.18
Sodium	79.7 U	83.0	1030	70.7	911	97.9	53.3
Thallium	0.16 U	0.17	0.18	0.22 U	0.16 U	0.19 U	0.22 U
Vanadium	22.3	21.8	25.4	19.6	21.0	24.3	25.0
Zinc	68.3	59.6	64.0	89.8	62.9	55.2	103
Explosives/Propellants							
2,4,6-Trinitrotoluene	0.099 U	0.098 U	0.1 U	0.099 U	0.1 U	0.1 U	0.180
Nitrocellulose	NT	NT	NT	NT	NT	NT	NT
VOCs							
Benzene	NT	NT	NT	NT	NT	NT	NT
Ethylbenzene	NT	NT	NT	NT	NT	NT	NT
Toluene	NT	NT	NT	NT	NT	NT	NT
Xylene (total)	NT	NT	NT	NT	NT	NT	NT
SVOCs							
Naphthalene	NT	NT	NT	NT	NT	NT	NT

Table 3-5
Detected Analytes in IRA Subsurface Soil Samples at RVAAP-03 Open Demolition Area 1

Notes:

-- = No CUG could be quantified based on lack of approved toxicity value.
CR = Cumulative Risk
feet bgs = feet below ground surface
HI = Hazard Index
mg/kg = milligrams/kilograms
NA = Not applicable
NC = Not calculated
NT = Not tested
SVOCs = Semivolatile Organic Compounds
U = Result not detected at indicated laboratory reporting limit.
VOCs = Volatile Organic Compounds

1. Shaded box indicates exceedance of RVAAP background concentrations.
2. **Bold type** indicates exceedance of most restrictive risk-based cleanup goal for surface soil from the Draft Facility-Wide Human Health Cleanup Goals for the RVAAP, SAIC, September 2008.
3. Table only shows detected compounds.
4. Evaluation (i.e., comparison to background and CUGs) was not applied to non-detect values.
[a] A 10-ft x 5-ft section of Grid 5 was excavated to between 6 and 8 ft bgs while the remainder of the 50-ft x 50-ft grid was excavted to 4 ft bgs.
[b] Reporting limits for non-detects in the Grid 13 sample are approximated as the analytical data for Grid 13 was not included in the IRA report.
[c] Grid 21 was excavated to between 2 and 4 ft bgs.

Table 3-6
Identification of COPCs in IRA Subsurface Soil at RVAAP-03 Open Demolition Area 1

Detected Analyte	Units	Results > Detection Limit	Maximum Detect	Subsurface Soil Background Criteria	Maximum Detect > Background	Data Reduction and Screening - Retained as COPC?
Inorganics						
Aluminum	mg/kg	23 / 23	252,000	19,500	Yes	Yes
Antimony	mg/kg	9 / 23	9.2	0.96	Yes	Yes
Arsenic	mg/kg	22 / 23	29.3	19.8	Yes	Yes
Barium	mg/kg	23 / 23	110	124	No	No
Beryllium	mg/kg	22 / 23	1.0	0.88	Yes	Yes
Cadmium	mg/kg	4 / 23	25.9	NA	NA	Yes
Calcium	mg/kg	23 / 23	17,100	35,500	No	No [a]
Chromium	mg/kg	23 / 23	249	27.2	Yes	Yes
Cobalt	mg/kg	23 / 23	16.2	23.2	No	No
Copper	mg/kg	23 / 23	74,200	32.3	Yes	Yes
Iron	mg/kg	23 / 23	35,900	35,200	Yes	No [a]
Lead	mg/kg	23 / 23	2,370	19.1	Yes	Yes
Magnesium	mg/kg	23 / 23	5,430	2,790	Yes	No [a]
Manganese	mg/kg	23 / 23	432	3,030	No	No
Mercury	mg/kg	9 / 23	0.06	0.044	Yes	Yes
Nickel	mg/kg	23 / 23	156	60.7	Yes	Yes
Potassium	mg/kg	23 / 23	2,720	3,350	No	No [a]
Selenium	mg/kg	5 / 23	1.0	1.5	No	No
Silver	mg/kg	2 / 23	4.60	NA	NA	Yes
Sodium	mg/kg	20 / 23	1,030	145	Yes	No [a]
Thallium	mg/kg	5 / 23	0.22	0.91	No	No
Vanadium	mg/kg	23 / 23	27.3	37.6	No	No
Zinc	mg/kg	23 / 23	32,100	93.3	Yes	Yes
Explosives/Propellants						
2,4,6-Trinitrotoluene	mg/kg	1 / 23	0.180	NA	NA	Yes
Nitrocellulose	mg/kg	3 / 3	1.0	NA	NA	Yes
VOCs						
Benzene	mg/kg	1 / 4	0.066	NA	NA	Yes
Ethylbenzene	mg/kg	1 / 4	0.130	NA	NA	Yes
Toluene	mg/kg	2 / 4	0.180	NA	NA	Yes
Xylene (total)	mg/kg	1 / 4	0.610	NA	NA	Yes
SVOCs						
Naphthalene	mg/kg	1 / 4	0.120	NA	NA	Yes

Notes:

COPC - constituent of potential concern

mg/kg = milligrams/kilograms

NA = Not applicable

SVOCs = Semivolatile Organic Compounds

VOCs = Volatile Organic Compounds

[a] Eliminated as a COPC based on the essential nutrient screen.

Table 3-7
Identification of Carcinogenic COCs in IRA Subsurface Soil at RVAAP-03 Open Demolition Area 1

COPCs	Units	Maximum Detect	95% UCL	EPC	Draft Facility-Wide Cleanup Goals for Subsurface Soil [a]											
					Residential Farmer						Residential Farmer					
					Adult						Child					
					CR=10^{-5}	# Detect > CR and Bkgd [b]	Ratio of EPC to CR	COC?	% of Sum	COC?	CR=10^{-5}	# Detect > CR and Bkgd [b]	Ratio of EPC to CR	COC?	% of Sum	COC?
Inorganics																
Aluminum	mg/kg	252,000	69,211	69,211	--	NA	NA	NA	NA	No	--	NA	NA	NA	NA	No
Antimony	mg/kg	9.2	5.64	5.64	--	NA	NA	NA	NA	No	--	NA	NA	NA	NA	No
Arsenic	mg/kg	29.3	18.84	18.84	4.25	6	4.43	Yes	99	Yes	5.24	6	3.60	Yes	99	Yes
Beryllium	mg/kg	1	0.786	0.786	NC	NA	NA	Yes [c]	NA	NA	NC	NA	NA	Yes [c]	NA	NA
Cadmium	mg/kg	25.9	NA	25.9	12,491	0	0.002	No	0.05	No	26,767	0	0.001	No	0.03	No
Chromium	mg/kg	249	72.45	72.45	1,874	0	0.04	No	0.86	No	4,015	0	0.02	No	0.5	No
Copper	mg/kg	74,200	17,308	17,308	--	NA	NA	NA	NA	No	--	NA	NA	NA	NA	No
Lead	mg/kg	2,370	563.4	563.4	NC	NA	NA	Yes [c]	NA	NA	NC	NA	NA	Yes [c]	NA	NA
Mercury	mg/kg	0.055	0.0364	0.0364	--	NA	NA	NA	NA	No	--	NA	NA	NA	NA	No
Nickel	mg/kg	156	42.06	42.06	--	NA	NA	NA	NA	No	--	NA	NA	NA	NA	No
Silver	mg/kg	4.60	NA	4.60	--	NA	NA	NA	NA	No	--	NA	NA	NA	NA	No
Zinc	mg/kg	32,100	7,528	7,528	--	NA	NA	NA	NA	No	--	NA	NA	NA	NA	No
Explosives/Propellants																
2,4,6-Trinitrotoluene	mg/kg	0.180	NA	0.180	328	0	0.001	No	0.01	No	284	0	0.001	No	0.02	No
Nitrocellulose	mg/kg	1.0	NA	1.0	NC	NA	NA	Yes [c]	NA	NA	NC	NA	NA	Yes [c]	NA	NA
VOCs																
Benzene	mg/kg	0.066	NA	0.066	NC	NA	NA	Yes [c]	NA	NA	NC	NA	NA	Yes [c]	NA	NA
Ethylbenzene	mg/kg	0.130	NA	0.130	NC	NA	NA	Yes [c]	NA	NA	NC	NA	NA	Yes [c]	NA	NA
Toluene	mg/kg	0.180	NA	0.180	NC	NA	NA	Yes [c]	NA	NA	NC	NA	NA	Yes [c]	NA	NA
Xylene (total)	mg/kg	0.610	NA	0.610	NC	NA	NA	Yes [c]	NA	NA	NC	NA	NA	Yes [c]	NA	NA
SVOCs																
Naphthalene	mg/kg	0.120	NA	0.120	--	NA	NA	Yes [c]	NA	NA	--	NA	NA	Yes [c]	NA	NA
					Sum of Ratios		4.47				Sum of Ratios		3.62			

Table 3-7
Identification of Carcinogenic COCs in IRA Subsurface Soil at RVAAP-03 Open Demolition Area 1

COPCs	Units	Maximum Detect	95% UCL	EPC	Draft Facility-Wide Cleanup Goals for Subsurface Soil [a] National Guard Trainee CR=10^{-5}	# Detect > CR and Bkgd [b]	Ratio of EPC to CR	COC?	% of Sum	COC?
Inorganics										
Aluminum	mg/kg	252,000	69,211	69,211	--	NA	NA	NA	NA	No
Antimony	mg/kg	9.2	5.64	5.64	--	NA	NA	NA	NA	No
Arsenic	mg/kg	29.3	18.84	18.84	27.8	1	0.68	No	13	Yes
Beryllium	mg/kg	1	0.786	0.786	NC	NA	NA	Yes [c]	NA	NA
Cadmium	mg/kg	25.9	NA	25.9	109	0	0.24	No	4	No
Chromium	mg/kg	249	72.45	72.45	16.4	1	4.42	Yes	83	Yes
Copper	mg/kg	74,200	17,308	17,308	--	NA	NA	NA	NA	No
Lead	mg/kg	2,370	563.4	563.4	NC	NA	NA	Yes [c]	NA	NA
Mercury	mg/kg	0.055	0.0364	0.0364	--	NA	NA	NA	NA	No
Nickel	mg/kg	156	42.06	42.06	--	NA	NA	NA	NA	No
Silver	mg/kg	4.60	NA	4.60	--	NA	NA	NA	NA	No
Zinc	mg/kg	32,100	7,528	7,528	--	NA	NA	NA	NA	No
Explosives/Propellants										
2,4,6-Trinitrotoluene	mg/kg	0.180	NA	0.180	4,643	0	0.00004	No	0.001	No
Nitrocellulose	mg/kg	1.0	NA	1.0	NC	NA	NA	Yes [c]	NA	NA
VOCs										
Benzene	mg/kg	0.066	NA	0.066	NC	NA	NA	Yes [c]	NA	NA
Ethylbenzene	mg/kg	0.130	NA	0.130	NC	NA	NA	Yes [c]	NA	NA
Toluene	mg/kg	0.180	NA	0.180	NC	NA	NA	Yes [c]	NA	NA
Xylene (total)	mg/kg	0.610	NA	0.610	NC	NA	NA	Yes [c]	NA	NA
SVOCs										
Naphthalene	mg/kg	0.120	NA	0.120	--	NA	NA	Yes [c]	NA	NA

Sum of Ratios: 5.33

Table 3-7
Identification of Carcinogenic COCs in IRA Subsurface Soil at RVAAP-03 Open Demolition Area 1

Notes:

-- = No CUG could be quantified based on lack of approved toxicity value.
Bkgd = Background
COC = constituent of concern
COPC = constituent of potential concern
CR = Cumulative Risk
EPC = Exposure Point Concentration
mg/kg = milligrams/kilograms
NA = Not applicable
NC = Not calculated
SVOCs = Semivolatile Organic Compounds
UCL = Upper Confidence Level
VOCs = Volatile Organic Compounds

[a] Cleanup Goals (CUGs) are from the Draft Facility-Wide Human Health Cleanup Goals for the RVAAP prepared by SAIC in September 2008.

[b] The RVAAP background value is the default action level for inorganic COPCs with CUGs less than background.

[c] Detected organics are automatically retained as COCs where no CUGs have been developed. Inorganics are automatically retained where no CUGs have been developed if the maximum detection is greater than the RVAAP background value.

Table 3-8
Identification of Non-Carcinogenic COCs in IRA Subsurface Soil at RVAAP-03 Open Demolition Area 1

COPCs	Units	Maximum Detect	95% UCL	EPC	Critical Effect [a]	Target Organ(s) [b]	Draft Facility-Wide Cleanup Goals for Subsurface Soil [c] Residential Farmer Adult HI=1	# Detect > HI and Bkgd [d]	Ratio of EPC to HI	COC?	% of Sum Skin	COC?	% of Sum Resp.Sys.	COC?
Inorganics														
Aluminum	mg/kg	252,000	69,211	69,211	minimal neurotoxicity in offspring	eyes, skin, respiratory system	529,229	0	0.13	No	11	Yes	10	Yes
Antimony	mg/kg	9.2	5.64	5.64	longevity, blood glucose, and cholesterol	eyes, skin, respiratory system, CVS	136	0	0.04	No	4	No	3	No
Arsenic	mg/kg	29.3	18.84	18.84	hyperpigmentation, keratosis, and possible vascular complications	liver, kidney, skin, lungs, lymphatic system	82.1	0	0.23	No	20	Yes	18	Yes
Beryllium	mg/kg	1	0.786	0.786	NL	eyes, skin, respiratory system	NC	NA	NA	Yes [e]	NA	NA	NA	NA
Cadmium	mg/kg	25.9	NA	25.9	significant proteinuria	respiratory system, kidneys, prostate, blood	223	0	0.12	No	NA	NA	9	No
Chromium	mg/kg	249	72.45	72.45	stomach ulcers, convulsions, kidney and liver damage	eyes, skin, respiratory system	904	0	0.08	No	7	No	6	No
Copper	mg/kg	74,200	17,308	17,308	GI, hepatic, and renal effects, abdominal pain, vomiting, diarrhea, hemolysis, hepatic necrosis, hematuria, proteinuria, hypotension, tachycardia, convulsions, coma, and death	eyes, skin, respiratory system, liver, kidneys	27,138	1	0.64	No	55	Yes	50	Yes
Lead	mg/kg	2,370	563.4	563.4	NL	eyes, GI tract, CNS, kidneys, blood, gingival tissue	NC	NA	NA	Yes [e]	NA	NA	NA	NA
Mercury	mg/kg	0.055	0.0364	0.0364	hand tremor, memory disturbance, objective autonomic dysfunction	eyes, skin, respiratory system, CNS, kidneys	165	0	0.0002	No	0.02	No	0.02	No
Nickel	mg/kg	156	42.06	42.06	decreased body and major organ weights	nasal cavities, lungs, skin	13,463	0	0.003	No	0.3	No	0.2	No
Silver	mg/kg	4.60	NA	4.60	GI tract, abdominal pain, diarrhea, vomiting, shock, convulsions, skin, mucous membranes, eyes and death	nasal septum, skin, eyes	3,240	0	0.0014	No	0.1	No	0.1	No
Zinc	mg/kg	32,100	7,528	7,528	copper deficiency and hypochromic microcytic anemia, pulmonary and GI effects	eyes, skin, respiratory system	196,589	0	0.04	No	3	No	3	No
Explosives/Propellants														
2,4,6-Trinitrotoluene	mg/kg	0.180	NA	0.180	liver effects	eyes, skin, respiratory system, blood, liver, CVS, CNS, kidneys	211	0	0.001	No	0.1	No	0.1	No
Nitrocellulose	mg/kg	1.0	NA	1.0	NL	NL	NC	NA	NA	Yes [e]	NA	NA	NA	NA

Table 3-8
Identification of Non-Carcinogenic COCs in IRA Subsurface Soil at RVAAP-03 Open Demolition Area 1

COPCs	Units	Maximum Detect	95% UCL	EPC	Critical Effect [a]	Target Organ(s) [b]	Draft Facility-Wide Cleanup Goals for Subsurface Soil [c] Residential Farmer Adult HI=1	# Detect > HI and Bkgd [d]	Ratio of EPC to HI	COC?	% of Sum Skin	COC?	% of Sum Resp.Sys.	COC?
VOCs														
Benzene	mg/kg	0.066	NA	0.066	decreased lymphocyte count	eyes, skin, respiratory system, blood, CNS, bone marrow	NC	NA	NA	Yes [e]	NA	NA	NA	NA
Ethylbenzene	mg/kg	0.130	NA	0.130	NL	eyes, skin, respiratory system, CNS	NC	NA	NA	Yes [e]	NA	NA	NA	NA
Toluene	mg/kg	0.180	NA	0.180	NL	eyes, skin, respiratory system, CNS, liver, kidneys	NC	NA	NA	Yes [e]	NA	NA	NA	NA
Xylene (total)	mg/kg	0.610	NA	0.610	NL	eyes, skin, respiratory system, CNS, GI tract, blood, liver, kidneys	NC	NA	NA	Yes [e]	NA	NA	NA	NA
SVOCs														
Naphthalene	mg/kg	0.120	NA	0.120	red blood cells, gastrointestinal distress, neurotoxic, hepatic, renal, and ocular effects, decreased mean terminal body weights in males	eyes, skin, blood, liver, kidneys, CNS	3,678	0	0.00003	No	0.003	No	NA	NA

Sum of Ratios	0.93	eyes
Sum of Ratios	1.16	skin
Sum of Ratios	1.28	resp.sys., lungs, nasal
Sum of Ratios	0.04	CVS
Sum of Ratios	0.87	liver
Sum of Ratios	0.98	kidney
Sum of Ratios	0.23	lymphatic system
Sum of Ratios	0.12	prostate
Sum of Ratios	0.12	blood
Sum of Ratios	0.001	CNS

Table 3-8

Identification of Non-Carcinogenic COCs in IRA Subsurface Soil at RVAAP-03 Open Demolition Area 1

COPCs	Units	Maximum Detect	95% UCL	EPC	Draft Facility-Wide Cleanup Goals for Subsurface Soil [c] — Residential Farmer — Child: HI=1	# Detect > HI and Bkgd [d]	Ratio of EPC to HI	COC?	% of Sum Eyes	COC?	% of Sum Skin	COC?	% of Sum Resp.Sys.	COC?	% of Sum Liver	COC?	% of Sum Kidneys	COC?
Inorganics																		
Aluminum	mg/kg	252,000	69,211	69,211	73,798	1	0.94	No	13	Yes	11	Yes	11	Yes	NA	NA	NA	NA
Antimony	mg/kg	9.2	5.64	5.64	28.2	0	0.20	No	3	No	2	No	2	No	NA	NA	NA	NA
Arsenic	mg/kg	29.3	18.84	18.84	20.2	6	0.93	No	NA	NA	11	Yes	11	Yes	14	Yes	13	Yes
Beryllium	mg/kg	1	0.786	0.786	NC	NA	NA	Yes [e]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	mg/kg	25.9	NA	25.9	64.1	0	0.40	No	NA	NA	NA	NA	5	No	NA	NA	6	No
Chromium	mg/kg	249	72.45	72.45	199	1	0.36	No	5	No	4	No	4	No	NA	NA	NA	NA
Copper	mg/kg	74,200	17,308	17,308	3,106	1	5.57	Yes	75	Yes	67	Yes	63	Yes	86	Yes	81	Yes
Lead	mg/kg	2,370	563.4	563.4	NC	NA	NA	Yes [e]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	mg/kg	0.055	0.0364	0.0364	22.7	0	0.002	No	0.02	No	0.02	No	0.02	No	NA	NA	0.02	No
Nickel	mg/kg	156	42.06	42.06	1,552	0	0.03	No	NA	NA	0.3	No	0.3	No	NA	NA	NA	NA
Silver	mg/kg	4.60	NA	4.60	386	0	0.0119	No	0.2	No	0.1	No	0.1	No	NA	NA	NA	NA
Zinc	mg/kg	32,100	7,528	7,528	23,209	1	0.32	No	4	No	4	No	4	No	NA	NA	NA	NA
Explosives/Propellants																		
2,4,6-Trinitrotoluene	mg/kg	0.180	NA	0.180	36.5	0	0.005	No	0.1	No	0.1	No	0.1	No	0.1	No	0.1	No
Nitrocellulose	mg/kg	1.0	NA	1.0	NC	NA	NA	Yes [e]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 3-8
Identification of Non-Carcinogenic COCs in IRA Subsurface Soil at RVAAP-03 Open Demolition Area 1

COPCs	Units	Maximum Detect	95% UCL	EPC	Draft Facility-Wide Cleanup Goals for Subsurface Soil [c] — Residential Farmer — Child: HI=1	# Detect > HI and Bkgd [d]	Ratio of EPC to HI	COC?	% of Sum Eyes	COC?	% of Sum Skin	COC?	% of Sum Resp.Sys.	COC?	% of Sum Liver	COC?	% of Sum Kidneys	COC?
VOCs																		
Benzene	mg/kg	0.066	NA	0.066	NC	NA	NA	Yes [e]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	mg/kg	0.130	NA	0.130	NC	NA	NA	Yes [e]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	mg/kg	0.180	NA	0.180	NC	NA	NA	Yes [e]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Xylene (total)	mg/kg	0.610	NA	0.610	NC	NA	NA	Yes [e]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SVOCs																		
Naphthalene	mg/kg	0.120	NA	0.120	1,215	0	0.0001	No	0.001	No	0.001	No	NA	NA	0.002	Yes	0.001	No

Sum of Ratios	7.42	eyes
Sum of Ratios	8.38	skin
Sum of Ratios	8.78	resp.sys., lungs, nasal
Sum of Ratios	0.20	CVS
Sum of Ratios	6.51	liver
Sum of Ratios	6.92	kidney
Sum of Ratios	0.93	lymphatic system
Sum of Ratios	0.40	prostate
Sum of Ratios	0.41	blood
Sum of Ratios	0.007	CNS

Table 3-8
Identification of Non-Carcinogenic COCs in IRA Subsurface Soil at RVAAP-03 Open Demolition Area 1

COPCs	Units	Maximum Detect	95% UCL	EPC	Draft Facility-Wide Cleanup Goals for Subsurface Soil [c] National Guard Trainee HI=1	# Detect > HI and Bkgd [d]	Ratio of EPC to HI	COC?	% of Sum Eyes	COC?	% of Sum Skin	COC?	% of Sum Resp.Sys.	COC?
Inorganics														
Aluminum	mg/kg	252,000	69,211	69,211	34,960	1	1.98	Yes	59	Yes	59	Yes	59	Yes
Antimony	mg/kg	9.2	5.64	5.64	1,753	0	0.003	No	0	No	0	No	0	No
Arsenic	mg/kg	29.3	18.84	18.84	1,140	0	0.02	No	NA	NA	0	No	0	No
Beryllium	mg/kg	1	0.786	0.786	NC	NA	NA	Yes [e]	NA	NA	NA	NA	NA	NA
Cadmium	mg/kg	25.9	NA	25.9	3,292	0	0.01	No	NA	NA	NA	NA	0.2	No
Chromium	mg/kg	249	72.45	72.45	56	1	1.29	Yes	39	Yes	38	Yes	38	Yes
Copper	mg/kg	74,200	17,308	17,308	253,680	0	0.07	No	2	No	2	No	2	No
Lead	mg/kg	2,370	563.4	563.4	NC	NA	NA	Yes [e]	NA	NA	NA	NA	NA	NA
Mercury	mg/kg	0.055	0.0364	0.0364	1,722	0	0.00002	No	0.001	No	0.001	No	0.001	No
Nickel	mg/kg	156	42.06	42.06	126,391	0	0.0003	No	NA	NA	0	No	0.01	No
Silver	mg/kg	4.60	NA	4.60	31,049	0	0.00015	No	0.004	No	0.004	No	0.004	No
Zinc	mg/kg	32,100	7,528	7,528	1.0E+06	0	0.01	No	0.2	No	0.2	No	0.2	No
Explosives/Propellants														
2,4,6-Trinitrotoluene	mg/kg	0.180	NA	0.180	2,488	0	0.0001	No	0.002	No	0.002	No	0.002	No
Nitrocellulose	mg/kg	1.0	NA	1.0	NC	NA	NA	Yes [e]	NA	NA	NA	NA	NA	NA

Table 3-8
Identification of Non-Carcinogenic COCs in IRA Subsurface Soil at RVAAP-03 Open Demolition Area 1

COPCs	Units	Maximum Detect	95% UCL	EPC	Draft Facility-Wide Cleanup Goals for Subsurface Soil [c] National Guard Trainee HI=1	# Detect > HI and Bkgd [d]	Ratio of EPC to HI	COC?	% of Sum Eyes	COC?	% of Sum Skin	COC?	% of Sum Resp.Sys.	COC?
VOCs														
Benzene	mg/kg	0.066	NA	0.066	NC	NA	NA	Yes [e]	NA	NA	NA	NA	NA	NA
Ethylbenzene	mg/kg	0.130	NA	0.130	NC	NA	NA	Yes [e]	NA	NA	NA	NA	NA	NA
Toluene	mg/kg	0.180	NA	0.180	NC	NA	NA	Yes [e]	NA	NA	NA	NA	NA	NA
Xylene (total)	mg/kg	0.610	NA	0.610	NC	NA	NA	Yes [e]	NA	NA	NA	NA	NA	NA
SVOCs														
Naphthalene	mg/kg	0.120	NA	0.120	15,407	0	0.00001	No	0.0002	No	0.0002	No	NA	NA

Sum of Ratios	3.35	eyes
Sum of Ratios	3.37	skin
Sum of Ratios	3.38	resp.sys., lungs, nasal
Sum of Ratios	0.00	CVS
Sum of Ratios	0.08	liver
Sum of Ratios	0.09	kidney
Sum of Ratios	0.02	lymphatic system
Sum of Ratios	0.01	prostate
Sum of Ratios	0.01	blood
Sum of Ratios	0.0001	CNS

Notes:

Bkgd = Background
CNS = Central Nervous System
COC = constituent of concern
COPC = constituent of potential concern
CVS = Cardiovascular System
EPC = Exposure Point Concentration
feet bgs = feet below ground surface
HI = Hazard Index
mg/kg = milligrams/kilograms
NA = Not applicable
NC = Not calculated
NL = Not listed
UCL = Upper Confidence Limit
VOCs = Volatile Organics
SVOCs = Semivolatile organics

[a] Critical Effect data are from Table 4-2 of the Draft Facility-Wide Human Health Cleanup Goals for the RVAAP prepared by SAIC in September 2008.
[b] Target organ data are from the Pocket Guide to Chemical Hazards, National Institute for Occupational Safety and Health, June 1997.
[c] Cleanup Goals (CUGs) are from the Draft Facility-Wide Human Health Cleanup Goals for the RVAAP prepared by SAIC in September 2008.
[d] The RVAAP background value is the default action level for inorganic COPCs with CUGs less than background.
[e] Detected organics are automatically retained as COCs where no CUGs have been developed. Inorganics are automatically retained where no CUGs have been developed if the maximum detection is greater than the RVAAP background value.

4.0 Sample Design

This section summarizes the data gaps identified during the data evaluation in Section 3.0 and presents the rationale for additional investigation. Data gaps include confirmation and identification of the final ODA1 site boundaries, COPCs in surface soil, and COCs in subsurface soils across the site. A geophysical survey is proposed to address the boundary issue. Additional sampling is proposed to determine the extent of COPCs in surface soil and COCs in subsurface soils. Surface and subsurface soil sampling may also be necessary in the event the geophysical survey results indicate a need to collect additional soil samples. The selection of the areas for biased or random sampling will based on the revised project DQOs, a revised CSM, discussions with Ohio EPA and direction as provided by USACE.

4.1 Geophysical Investigation

4.1.1 Rationale

The removal effort at ODA1 consisted of the removal and disposal of approximately 41 tons of ordnance and explosive scrap from surface and subsurface soils at ODA1. Subsequent site inspections and historical information indicate additional MEC scrap may be located in limited areas outside the current ODA1 boundaries. As a result, a geophysical investigation will be performed over the site to confirm the delineation of ODA1 boundaries. The primary goal of the geophysical investigation is to identify areas of MEC scrap accumulation. The current estimated coverage area of the proposed geophysical survey is presented as Figure 4-1.

4.1.2 Geophysical Investigation Location

The geophysical survey (Figure 4-1) will cover the entire ODA1 area and areas just beyond the perimeter of the AOC boundaries so that any potential "push out" areas can be identified. The proposed survey area may be altered dependent upon field observations made during the execution of work. All changes would be documented and approved by all stakeholders prior to any changes in the proposed survey procedures. Specific geophysical procedures will be presented in a workplan prior to starting the field work. The total survey area is approximately 8.6 acres with an approximate survey depth of 5 feet bgs.

4.1.3 Geophysical Investigation Method

For ODA1, a Geonics EM61-MK2 metal detector will most likely be deployed based on the results of the geophysical prove out (GPO) that will be used to assess and document the performance of the geophysical instrumentation, navigation system, and field deployment form-factor. The GPO will also be used to assess the most optimal data processing techniques and anomaly selection criteria given the local soil, site conditions, and targets of interest at RVAAP.

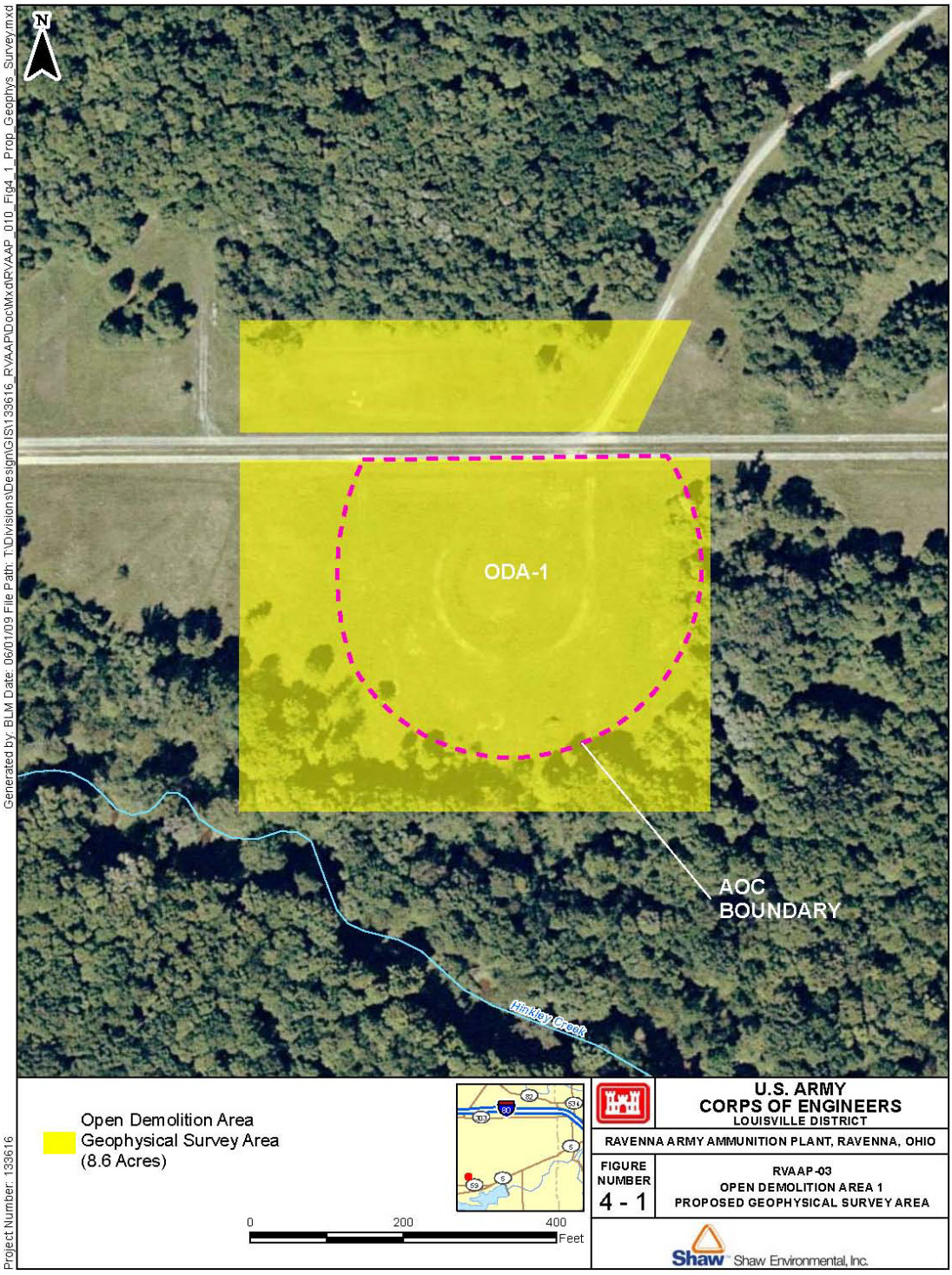


Figure 4-1
Proposed Geophysical Survey Area

The EM61-MKII will be deployed along with a Real-Time Kinematic (RTK) global positioning system (GPS) in open areas, which is ideal for the ODA1 given site conditions.

4.1.4 General Geophysical Survey Procedures

Full coverage mode will be utilized at ODA1 and is discussed further in the *Geophysical Investigation Plan for Sand Creek Disposal Road Landfill (RVAAP-34), Open Demolition Area #1 (RVAAP-03) and Suspected Mustard Agent Burial Site (RVAAP-28)* (Shaw, 2009). Full coverage will be achieved through deployment of the sensor system through the collection of sub-parallel survey lines or swaths with sensor separations of 3.0 feet. The general survey procedures include the following:

- Review the site. The area requiring full coverage will be reviewed through a site walk-over during which the geophysical survey conditions will be reviewed by the site geophysicist;
- Set up the navigational system chosen by the geophysicist at a convenient control point of known location. Confirm location control via checkshots to at least one other control point of known location;
- Place temporary location control QC items in the survey area using the Robotic Total Station (RTS) as needed to document navigation precision. At least one location QC item (either temporary items or semi-permanent grid hubs) will be present in each data set;
- Set up a replicate data line location and collect the pre- and post-survey data line. These data will be compared to insure repeatability of the data collection method;
- The sensors are towed, pulled or pushed at a mean speed less than 3 miles per hour in the GPO (to be verified by analysis of the navigation data for each data set) to minimize sensor bounce and sway;
- Collect and maintain field logs to document the conditions of the data collection. The field logs will include information regarding the data collection area, field conditions, data acquisition parameters, and QC performed;
- Field geophysical data and navigation data will be downloaded to a field personal computer. The electronic files will be organized on an office PC dedicated to geophysical investigation management. Data will be backed-up daily; and
- Review all traverse data and overlay on the survey grid layout or planned traverse lines as QC and to identify any missed areas.

Following the completion of the geophysical investigation and data processing activities for ODA1, the data will be incorporated into a geophysical investigation report.

4.2 Environmental Investigation

Environmental sampling is necessary to determine the extent of COPCs in surface and COCs in subsurface soils that remain after the IRA was completed in 2000. At present, it is uncertain if the geophysical survey will indicate any additional potential source areas outside if the current AOC boundaries at ODA1. The need for additional environmental media sampling will be evaluated after completion of the geophysical survey. In the event the geophysical survey confirms the presence of additional potential source areas, it may be necessary to implement a revised sampling program to assess the environmental media. It is expected that, if encountered, media sampling would be limited to surface and subsurface soils and be consistent with previous investigation programs at ODA1. Any changes to the proposed sample design program for ODA1 will be documented in future CERCLA documents.

4.2.1 Subsurface Soils

4.2.1.1 Rationale

Data gaps exist for 6 inorganic and 5 organic constituents identified as COCs including aluminum, arsenic, beryllium, chromium (total), copper, lead, nitrocellulose, benzene, ethylbenzene, toluene, and xylenes. Additional subsurface soil samples will be necessary to define the vertical extent of these COCs primarily in the west, southwest, and south central portions of the site. The majority of IRA excavation confirmation samples were collected at a depth of 4 feet bgs with the exception of those from a limited area within Grid 5 which were collected from 8 feet bgs, Grid 11A – 5 feet bgs, Grids 17, 18, 19, and 20 - 2 feet bgs, and Grid 21 between 2 and 4 feet bgs.

4.2.1.2 Subsurface Soil Sampling Locations

Subsurface soil samples will be collected from the area of the IRA location of Grid 11A on the western perimeter of the site where data gaps for inorganic COCs exist to the north, west, and south and with depth below 5 feet bgs. Data gaps in subsurface soil also exist vertically with depth at the IRA locations in the southwest portion (Grids 17 and 19 [below 2 feet bgs] and Grid 9 [below 4 feet bgs]), southern portion (Grid 5 [below 8 feet bgs]), southwest/central portion (Grid 3 [below 4 feet bgs]), and northeast/central portion (Grids 14 and 15 [below 4 feet bgs]) of the site. Data gaps for inorganic COCs exist horizontally to the north, west, and south of Grid 11A and north and west of Grid 14.

Propellant and VOC COCs were detected at IRA excavation locations Grids 5 and 10. Data gaps for the extent of organic COCs exist horizontally and vertically with depth below 8 feet bgs in the southwest/central portion (Grid 5) and 4 feet bgs in the western perimeter (Grid 10) of the site. Data gaps for VOCs exist in each direction around Grid 5. Data gaps for nitrocellulose exist to the north and south of Grid 10 and to the east and west of Grid 5.

Subsurface soil samples will be collected continuously from Geoprobe borings to 20 ft bgs. Subsurface soil samples will be collected at 4 foot intervals using the MI sampling approach. In general, 30 increments of soil will be collected from the Geoprobe soil column for each 4-foot interval to generate and MI sample. The intervals and depth of previous subsurface soil sample collection has varied at ODA1. In order to be consistent with the excavation confirmation sampling and potential future use of the data in risk assessments, subsurface soil samples will be collected at intervals that begin/end at 4 ft bgs. Subsurface soil sample collection in areas not previously excavated will begin at 1 ft bgs such that the first interval is 1 to 4 ft bgs and then 4-ft intervals thereafter (1-4, 4-8, 8-12, 12-16, and 16-20 ft bgs). Sample collection in areas previously excavated will begin at the bottom of the excavation (i.e., either 2 or 4 ft bgs) and proceed in 4 ft intervals. The first sample interval for samples beginning at 2 ft bgs will end at 4 ft bgs and continue in 4-ft intervals thereafter (2-4, 4-8, 8-12, 12-16, and 16-20 ft bgs).

4.2.1.3 Sample Analysis

Subsurface soil samples, including QA samples, will be submitted for laboratory analysis for TAL metals and explosives. A minimum of 10 percent of the samples will be analyzed for the RVAAP full suite to include VOCs, SVOCs, pesticides/herbicides, PCBs, and propellants.

4.2.2 Surface Soils

4.2.2.1 Rationale

Data gaps were identified for 4 inorganic COPCs (arsenic, beryllium, chromium [total], and cobalt) in surface soils in the central portion (DA1-008, -018, and -019), southwest perimeter (DA1-026), southern perimeter (DA1-030), southeast portion (DA1-034) of the site. As several of these previous sampling locations in the central portion of the site are bound horizontally by IRA excavation grids or other surface soil samples, data gaps for inorganic COPCs in surface soil exist horizontally along the southwest, south, and southeast perimeter of the site. The COPCs are bound with depth at these Phase I RI sampling locations.

4.2.2.2 Surface Soil Sampling Locations

Surface soil samples will be collected along the southwest, south, and southeast site perimeter or as needed based on the results of the geophysical investigation. Surface soil samples will be collected using the MI approach. Each MI sample will consist of random samples from depths between 0 and 1 foot bgs. In general, 30 random samples will be collected from each identified location.

4.2.2.3 Sample Analysis

Surface soil samples, including QA samples, will be submitted for laboratory analysis for TAL metals and explosives. A minimum of 10 percent of the samples will be analyzed for the RVAAP full suite to include VOCs, SVOCs, pesticides/herbicides, PCBs, and propellants.

This page intentionally left blank.

5.0 Summary of Conclusions

This *DQO Report* has utilized the DQO process provided in the *FSAP* to identify and define data gaps from the previous investigation and IRAs at the site that need to be addressed to support environmental and MEC closure of ODA1. Data results from the *Phase I RI Report* (SAIC, 2001b) and the *Interim Removal Action Report* (MKM, 2004) have been compared to the current RVAAP background values and the current risk-based Draft CUGs for contaminants detected at the site. Based on the available information, additional sampling of media is necessary to support an environmental remedy selection for the AOC as currently delineated. The justification is discussed below.

Given the relatively small size of the site (6 acres), the extent and rationale of media sampling already completed for the site in the Phase I report and the IRA report appears to be insufficient at the site perimeter and with depth. The Phase 1 RI sample locations were selected to assess likely potential source areas based on historical site information, visual site observations, and expected contaminant migration pathways (drainage conveyances, low lying potential ponding areas, etc.). However, a comparison of data to updated CUGs indicates data gaps.

Subsequent removal actions addressed areas exhibiting contaminant concentrations that were considered a concern to human health at that time. Confirmatory sampling taken from subsurface locations and screening results taken from soils that were reused as backfill have also provided additional information to determine areas that require further characterization at depth.

Data gaps were identified for 4 inorganic COPCs in surface soil (arsenic, beryllium, chromium [total], and cobalt) based on the most conservative risk-based CUGs. Additional surface soil samples will need to be analyzed for VOCs, SVOCs, and PCBs to further evaluate these parameters as COPCs. Data gaps were identified for the COCs in subsurface soil including aluminum, arsenic, beryllium, chromium [total], copper, lead, nitrocellulose, benzene, ethylbenzene, toluene, and xylenes.

The results of the Phase I RI indicated that sediment and surface water in Hinkley Creek, the receiving water for stormwater drainages from ODA1, do not appear to have received contamination related to former operations at ODA1. Subsequent discussions with stakeholders (30 December 2008 Data Gaps conference call) indicate that if additional surface water and sediment investigations were determined necessary, they would be performed under activities associated with the NTA site or the facility-wide surface water program.

Only one Geoprobe groundwater sample was collected at ODA1 under the Phase 1 RI. In order to determine whether or not there has been actual impact on the ODA1 groundwater, properly

drilled, installed and sampled monitoring wells would need to be utilized. Groundwater data from a wellpoint is solely used for screening purposes (i.e., any detects are considered minimal values and non-detects do not definitively indicate lack of contamination). Additional groundwater investigation will occur under the NTA site.

The extent of MEC scrap and debris at ODA1 has not been adequately defined based on visual observations at the site. A geophysical investigation will be performed over the current AOC and areas just beyond the perimeter to identify any "push out areas."

6.0 References

MKM Engineers, Inc. (MKM), 2004. Final OE/UXO Removal & Interim Removal Action Report for the Open Demolition Area #1. March 2004.

Science Applications International Corporation (SAIC), 2001a. Final Facility-Wide Sampling and Analysis Plan for Environmental Investigations at the Ravenna Army Ammunition Plant, Ravenna, Ohio. March 2001.

SAIC, 2001b. Final Phase I Remedial Investigation Report for Demolition Area 1 at the Ravenna Army Ammunition Plant, Ravenna, Ohio. December 2001.

SAIC, 2008. Draft Facility-Wide Human Health Cleanup Goals, Ravenna Army Ammunition Plant, Ravenna, Ohio. September 2008.

Shaw Environmental & Infrastructure, Inc. (Shaw), 2008. Data Quality Objective Meeting Minutes for conversation between Shaw, United States Army Corps of Engineers – Louisville District, and Ohio EPA, December 30.

Shaw, 2009. Final Geophysical Investigation Plan for RVAAP-34 Sand Creek Disposal Road Landfill, RVAAP-03 Open Demolition Area #1, and RVAAP-28 Suspected Mustard Agent Burial Site. Final. July 2009.

United States Army Center for Health Promotion and Preventive Medicine (USACHPPM), 1996. Final Preliminary Assessment for Ravenna Army Ammunition Plant, Ravenna, Ohio. February 1996.

United States Army Corps of Engineers (USACE), 2001. Phase II Remedial Investigation for the Winklepeck Burning Grounds at Ravenna Army Ammunition Plant, Ravenna, Ohio. April 2001.

USACE, 2003. Final Ravenna Army Ammunition Plant Facility-Wide Ecological Risk Work Plan. April 21, 2003.

USACE, 2005. RVAAP's Facility-Wide Human Health Risk Assessor Manual, Version 1. 01 December 2005.

USACE, 2009. Position Paper for the Application and Use of Facility-Wide Human Health Cleanup Goals, Ravenna Army Ammunition Plant, Ravenna, Ohio. June 2009.

United States Army Toxic and Hazardous Material Agency (USATHAMA) 1980-1992. Ravenna Army Ammunition Plant Water Quality Surveillance Program (data only).

United States Environmental Protection Agency (USEPA), 1997. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, EPA 540-R-97-006. Interim Final. June 1997.

This page intentionally left blank.

APPENDIX A
PROUCL SOFTWARE PROGRAM OUTPUT

TABLE A-1
Statistical Summary of Detected Analytes in Surface Soil Samples
RVAAP-03 Open Demolition Area 1

Detected Analyte	Frequency of Detection	Range of Detects Minimum mg/kg	Range of Detects Maximum mg/kg	Mean of Detects mg/kg	95% UCL [a] mg/kg	Distribution [a]	Method [a]
Inorganics							
Aluminum	23 / 23	1.73E+03	1.62E+04	9.34E+03	1.10E+04	Normal	Student's-t
Arsenic	23 / 23	5.00E+00	1.56E+01	1.00E+01	1.11E+01	Normal	Student's-t
Barium	23 / 23	2.34E+01	2.52E+02	7.77E+01	9.44E+01	Gamma	Approximate Gamma
Beryllium	7 / 23	1.50E-01	9.40E-01	3.37E-01	2.89E-01	Gamma	KM-t
Cadmium	4 / 23	2.70E-01	1.10E+00	6.43E-01	7.52E-01	Normal	KM (Percentile Bootstrap)
Chromium	23 / 23	3.40E+00	2.27E+01	1.23E+01	1.44E+01	Normal	Student's-t
Cobalt	23 / 23	2.70E+00	1.54E+01	7.40E+00	8.67E+00	Normal	Student's-t
Copper	23 / 23	5.80E+00	7.04E+01	2.41E+01	3.43E+01	Lognormal	H-UCL
Lead	23 / 23	8.00E+00	2.22E+01	1.53E+01	1.67E+01	Normal	Student's-t
Manganese	23 / 23	1.38E+02	9.47E+02	4.69E+02	5.44E+02	Normal	Student's-t
Mercury	15 / 23	7.80E-03	7.60E-02	3.46E-02	3.66E-02	Normal	KM-t
Nickel	23 / 23	7.90E+00	3.59E+01	1.50E+01	1.77E+01	NP	Modified-t
Selenium	3 / 23	8.80E-01	1.30E+00	1.13E+00	9.58E-01	Normal	KM-t
Thallium	21 / 23	1.40E-01	4.80E-01	3.13E-01	3.47E-01	Normal	KM-t
Zinc	23 / 23	3.19E+01	3.17E+02	7.20E+01	1.29E+02	NP	Chebyshev (Mean, Sd)
Insufficient Sample Size for UCL Calculation							
Inorganics							
Antimony	2 / 17	5.40E-01	6.30E-01	5.85E-01			
Explosives/Propellants							
1,3,5-Trinitrobenzene	1 / 23	6.60E+00	6.60E+00	6.60E+00			
HMX	2 / 23	2.00E-01	2.60E+00	1.40E+00			

mg/kg - milligram per kilogram
NP - Nonparametric; distribution is not discernable
UCL - Upper confidence limit

[a] Nature of distribution, statistical method, and 95% Upper Confidence Limit (UCL) determined using ProUCL Version 4.0 (EPA, 2007, ProUCL Version 4.0, Office of Research and Development, Technology Support Center Characterization and Monitoring Branch, Las Vegas, Nevada, April.) on line at http://www.epa.gov/esd/tsc/form.htm.) The recommended UCL was used unless the recommendation was the 97.5% or 99% Chebyshev UCL.

	General UCL Statistics for Data Sets with Non-Detects
User Selected Options	
From File	C:\Documents and Settings\debbi.freer\My Documents\Ravenna\Ravena ss UCL input revb.xls.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum

General Statistics

Number of Valid Observations	23	Number of Distinct Observations	23

Raw Statistics		**Log-transformed Statistics**	
Minimum	1730	Minimum of Log Data	7.456
Maximum	16200	Maximum of Log Data	9.693
Mean	9335	Mean of log Data	8.961
Median	9520	SD of log Data	0.689
SD	4679		
Coefficient of Variation	0.501		
Skewness	-0.24		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.938	Shapiro Wilk Test Statistic	0.864
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data appear Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	11010	95% H-UCL	13572
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	16315
95% Adjusted-CLT UCL	10888	97.5% Chebyshev (MVUE) UCL	19149
95% Modified-t UCL	11002	99% Chebyshev (MVUE) UCL	24716
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	2.577	**Data appear Normal at 5% Significance Level**	
Theta Star	3622		
MLE of Mean	9335		
MLE of Standard Deviation	5815		
nu star	118.6		
Approximate Chi Square Value (.05)	94.42	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	10940
Adjusted Chi Square Value	92.86	95% Jackknife UCL	11010
		95% Standard Bootstrap UCL	10883
Anderson-Darling Test Statistic	0.862	95% Bootstrap-t UCL	10963
Anderson-Darling 5% Critical Value	0.751	95% Hall's Bootstrap UCL	10891
Kolmogorov-Smirnov Test Statistic	0.186	95% Percentile Bootstrap UCL	10867
Kolmogorov-Smirnov 5% Critical Value	0.183	95% BCA Bootstrap UCL	10877
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	13588
		97.5% Chebyshev(Mean, Sd) UCL	15428
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	19042
95% Approximate Gamma UCL	11722		
95% Adjusted Gamma UCL	11919		
Potential UCL to Use		Use 95% Student's-t UCL	11010

Antimony

General Statistics

Number of Valid Data	17	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	15
Number of Missing Values	6	Percent Non-Detects	88.24%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.54	Minimum Detected	-0.616
Maximum Detected	0.63	Maximum Detected	-0.462
Mean of Detected	0.585	Mean of Detected	-0.539
SD of Detected	0.0636	SD of Detected	0.109
Minimum Non-Detect	1.1	Minimum Non-Detect	0.0953
Maximum Non-Detect	1.2	Maximum Non-Detect	0.182
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	17
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	0
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	100.00%

Warning: Data set has only 2 Distinct Detected Values.
This may not be adequate enough to compute meaningful and reliable test statistics and estimates.
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	N/A	Shapiro Wilk Test Statistic	N/A
5% Shapiro Wilk Critical Value	N/A	5% Shapiro Wilk Critical Value	N/A
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.581	Mean	-0.545
SD	0.0286	SD	0.0495
95% DL/2 (t) UCL	0.593	95% H-Stat (DL/2) UCL	0.726
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	N/A
		SD in Log Scale	N/A
		Mean in Original Scale	N/A
		SD in Original Scale	N/A
		95% Percentile Bootstrap UCL	N/A
		95% BCA Bootstrap UCL	N/A
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	N/A	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	N/A		
nu star	N/A		
A-D Test Statistic	N/A	**Nonparametric Statistics**	
5% A-D Critical Value	N/A	Kaplan-Meier (KM) Method	
K-S Test Statistic	N/A	Mean	0.585
5% K-S Critical Value	N/A	SD	0.045
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.045
		95% KM (t) UCL	0.664
Assuming Gamma Distribution		95% KM (z) UCL	0.659
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.693
Minimum	N/A	95% KM (bootstrap t) UCL	0.675
Maximum	N/A	95% KM (BCA) UCL	0.63
Mean	N/A	95% KM (Percentile Bootstrap) UCL	N/A
Median	N/A	95% KM (Chebyshev) UCL	0.781
SD	N/A	97.5% KM (Chebyshev) UCL	0.866
k star	N/A	99% KM (Chebyshev) UCL	1.033
Theta star	N/A		
Nu star	N/A	**Potential UCLs to Use**	
AppChi2	N/A	95% KM (t) UCL	0.664
95% Gamma Approximate UCL	N/A	95% KM (% Bootstrap) UCL	N/A
95% Adjusted Gamma UCL	N/A		

Warning: Recommended UCL exceeds the maximum observation

Note: DL/2 is not a recommended method.

Arsenic

General Statistics

Number of Valid Observations	23	Number of Distinct Observations	21

Raw Statistics		**Log-transformed Statistics**	
Minimum	5	Minimum of Log Data	1.609
Maximum	15.6	Maximum of Log Data	2.747
Mean	10.03	Mean of log Data	2.256
Median	9.9	SD of log Data	0.333
SD	3.07		
Coefficient of Variation	0.306		
Skewness	0.0322		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.968	Shapiro Wilk Test Statistic	0.939
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	11.13	95% H-UCL	11.51
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	13.17
95% Adjusted-CLT UCL	11.09	97.5% Chebyshev (MVUE) UCL	14.52
95% Modified-t UCL	11.13	99% Chebyshev (MVUE) UCL	17.15
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	8.915	**Data appear Normal at 5% Significance Level**	
Theta Star	1.126		
MLE of Mean	10.03		
MLE of Standard Deviation	3.361		
nu star	410.1		
Approximate Chi Square Value (.05)	364.1	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	11.09
Adjusted Chi Square Value	361	95% Jackknife UCL	11.13
		95% Standard Bootstrap UCL	11.06
Anderson-Darling Test Statistic	0.325	95% Bootstrap-t UCL	11.12
Anderson-Darling 5% Critical Value	0.744	95% Hall's Bootstrap UCL	11.15
Kolmogorov-Smirnov Test Statistic	0.0908	95% Percentile Bootstrap UCL	11.08
Kolmogorov-Smirnov 5% Critical Value	0.182	95% BCA Bootstrap UCL	11.13
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	12.83
		97.5% Chebyshev(Mean, Sd) UCL	14.03
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	16.4
95% Approximate Gamma UCL	11.3		
95% Adjusted Gamma UCL	11.4		
Potential UCL to Use		Use 95% Student's-t UCL	11.13

Barium			
General Statistics			
Number of Valid Observations	23	Number of Distinct Observations	23
Raw Statistics		**Log-transformed Statistics**	
Minimum	23.4	Minimum of Log Data	3.153
Maximum	252	Maximum of Log Data	5.529
Mean	77.67	Mean of log Data	4.22
Median	60.6	SD of log Data	0.496
SD	49.08		
Coefficient of Variation	0.632		
Skewness	2.507		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.722	Shapiro Wilk Test Statistic	0.94
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	95.24	95% H-UCL	94.8
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	112.4
95% Adjusted-CLT UCL	100.2	97.5% Chebyshev (MVUE) UCL	127.9
95% Modified-t UCL	96.13	99% Chebyshev (MVUE) UCL	158.4
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	3.456	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
Theta Star	22.47		
MLE of Mean	77.67		
MLE of Standard Deviation	41.78		
nu star	159		
Approximate Chi Square Value (.05)	130.8	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	94.5
Adjusted Chi Square Value	129	95% Jackknife UCL	95.24
		95% Standard Bootstrap UCL	93.91
Anderson-Darling Test Statistic	0.993	95% Bootstrap-t UCL	109.2
Anderson-Darling 5% Critical Value	0.749	95% Hall's Bootstrap UCL	186.3
Kolmogorov-Smirnov Test Statistic	0.165	95% Percentile Bootstrap UCL	94.22
Kolmogorov-Smirnov 5% Critical Value	0.182	95% BCA Bootstrap UCL	101.6
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	122.3
		97.5% Chebyshev(Mean, Sd) UCL	141.6
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	179.5
95% Approximate Gamma UCL	94.38		
95% Adjusted Gamma UCL	95.73		
Potential UCL to Use		Use 95% Approximate Gamma UCL	94.38

Beryllium

General Statistics

Number of Valid Data	23	Number of Detected Data	7
Number of Distinct Detected Data	7	Number of Non-Detect Data	16
		Percent Non-Detects	69.57%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.15	Minimum Detected	-1.897
Maximum Detected	0.94	Maximum Detected	-0.0619
Mean of Detected	0.337	Mean of Detected	-1.283
SD of Detected	0.275	SD of Detected	0.618
Minimum Non-Detect	0.19	Minimum Non-Detect	-1.661
Maximum Non-Detect	0.83	Maximum Non-Detect	-0.186
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	22
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	1
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	95.65%

Warning: There are only 7 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.69	Shapiro Wilk Test Statistic	0.875
5% Shapiro Wilk Critical Value	0.803	5% Shapiro Wilk Critical Value	0.803
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.229	Mean	-1.651
SD	0.179	SD	0.551
95% DL/2 (t) UCL	0.293	95% H-Stat (DL/2) UCL	0.26
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-1.669
		SD in Log Scale	0.443
		Mean in Original Scale	0.215
		SD in Original Scale	0.168
		95% Percentile Bootstrap UCL	0.278
		95% BCA Bootstrap UCL	0.314
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.641	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	0.205		
nu star	22.98		
A-D Test Statistic	0.631	**Nonparametric Statistics**	
5% A-D Critical Value	0.713	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.713	Mean	0.224
5% K-S Critical Value	0.314	SD	0.163
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.0381
		95% KM (t) UCL	0.289
Assuming Gamma Distribution		95% KM (z) UCL	0.286
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.286
Minimum	0.15	95% KM (bootstrap t) UCL	0.364
Maximum	0.94	95% KM (BCA) UCL	0.318
Mean	0.345	95% KM (Percentile Bootstrap) UCL	0.307
Median	0.339	95% KM (Chebyshev) UCL	0.39
SD	0.144	97.5% KM (Chebyshev) UCL	0.462
k star	7.363	99% KM (Chebyshev) UCL	0.603
Theta star	0.0469		
Nu star	338.7	**Potential UCLs to Use**	
AppChi2	297.1	95% KM (t) UCL	0.289
95% Gamma Approximate UCL	0.393		
95% Adjusted Gamma UCL	0.397		

Note: DL/2 is not a recommended method.

Cadmium

General Statistics

Number of Valid Data	23	Number of Detected Data	4
Number of Distinct Detected Data	4	Number of Non-Detect Data	19
		Percent Non-Detects	82.61%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.27	Minimum Detected	-1.309
Maximum Detected	1.1	Maximum Detected	0.0953
Mean of Detected	0.643	Mean of Detected	-0.566
SD of Detected	0.352	SD of Detected	0.592
Minimum Non-Detect	0.54	Minimum Non-Detect	-0.616
Maximum Non-Detect	0.63	Maximum Non-Detect	-0.462
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	21
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	2
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	91.30%

Warning: There are only 4 Distinct Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.981	Shapiro Wilk Test Statistic	0.994
5% Shapiro Wilk Critical Value	0.748	5% Shapiro Wilk Critical Value	0.748
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.359	Mean	-1.096
SD	0.186	SD	0.334
95% DL/2 (t) UCL	0.426	95% H-Stat (DL/2) UCL	0.402
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-0.959
		SD in Log Scale	0.38
		Mean in Original Scale	0.414
		SD in Original Scale	0.191
		95% Percentile Bootstrap UCL	0.482
		95% BCA Bootstrap UCL	0.497
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.218	**Data appear Normal at 5% Significance Level**	
Theta Star	0.527		
nu star	9.745		
A-D Test Statistic	0.191	**Nonparametric Statistics**	
5% A-D Critical Value	0.659	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.659	Mean	0.43
5% K-S Critical Value	0.396	SD	0.191
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.0937
		95% KM (t) UCL	0.591
Assuming Gamma Distribution		95% KM (z) UCL	0.584
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.685
Minimum	0.262	95% KM (bootstrap t) UCL	0.648
Maximum	1.1	95% KM (BCA) UCL	0.735
Mean	0.64	95% KM (Percentile Bootstrap) UCL	0.752
Median	0.646	95% KM (Chebyshev) UCL	0.838
SD	0.225	97.5% KM (Chebyshev) UCL	1.015
k star	6.62	99% KM (Chebyshev) UCL	1.362
Theta star	0.0967		
Nu star	304.5	**Potential UCLs to Use**	
AppChi2	265.1	95% KM (t) UCL	0.591
95% Gamma Approximate UCL	0.736	95% KM (Percentile Bootstrap) UCL	0.752
95% Adjusted Gamma UCL	N/A		

Note: DL/2 is not a recommended method.

Chromium (total or hexavalent)			
General Statistics			
Number of Valid Observations	23	Number of Distinct Observations	23
Raw Statistics		**Log-transformed Statistics**	
Minimum	3.4	Minimum of Log Data	1.224
Maximum	22.7	Maximum of Log Data	3.122
Mean	12.27	Mean of log Data	2.361
Median	12.5	SD of log Data	0.592
SD	6.039		
Coefficient of Variation	0.492		
Skewness	0.0482		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.939	Shapiro Wilk Test Statistic	0.907
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data appear Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	14.43	95% H-UCL	16.36
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	19.6
95% Adjusted-CLT UCL	14.35	97.5% Chebyshev (MVUE) UCL	22.67
95% Modified-t UCL	14.43	99% Chebyshev (MVUE) UCL	28.7
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	3.133	**Data appear Normal at 5% Significance Level**	
Theta Star	3.916		
MLE of Mean	12.27		
MLE of Standard Deviation	6.932		
nu star	144.1		
Approximate Chi Square Value (.05)	117.4	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	14.34
Adjusted Chi Square Value	115.6	95% Jackknife UCL	14.43
		95% Standard Bootstrap UCL	14.29
Anderson-Darling Test Statistic	0.667	95% Bootstrap-t UCL	14.47
Anderson-Darling 5% Critical Value	0.75	95% Hall's Bootstrap UCL	14.42
Kolmogorov-Smirnov Test Statistic	0.17	95% Percentile Bootstrap UCL	14.22
Kolmogorov-Smirnov 5% Critical Value	0.183	95% BCA Bootstrap UCL	14.25
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	17.76
		97.5% Chebyshev(Mean, Sd) UCL	20.13
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	24.8
95% Approximate Gamma UCL	15.06		
95% Adjusted Gamma UCL	15.29		
Potential UCL to Use		Use 95% Student's-t UCL	14.43

Cobalt

General Statistics

Number of Valid Observations	23	Number of Distinct Observations	21

Raw Statistics		**Log-transformed Statistics**	
Minimum	2.7	Minimum of Log Data	0.993
Maximum	15.4	Maximum of Log Data	2.734
Mean	7.404	Mean of log Data	1.883
Median	6.9	SD of log Data	0.516
SD	3.537		
Coefficient of Variation	0.478		
Skewness	0.578		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.943	Shapiro Wilk Test Statistic	0.943
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	8.671	95% H-UCL	9.345
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	11.11
95% Adjusted-CLT UCL	8.712	97.5% Chebyshev (MVUE) UCL	12.69
95% Modified-t UCL	8.685	99% Chebyshev (MVUE) UCL	15.78
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	3.827	**Data appear Normal at 5% Significance Level**	
Theta Star	1.935		
MLE of Mean	7.404		
MLE of Standard Deviation	3.785		
nu star	176		
Approximate Chi Square Value (.05)	146.4	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	8.617
Adjusted Chi Square Value	144.4	95% Jackknife UCL	8.671
		95% Standard Bootstrap UCL	8.586
Anderson-Darling Test Statistic	0.367	95% Bootstrap-t UCL	8.741
Anderson-Darling 5% Critical Value	0.748	95% Hall's Bootstrap UCL	8.767
Kolmogorov-Smirnov Test Statistic	0.122	95% Percentile Bootstrap UCL	8.57
Kolmogorov-Smirnov 5% Critical Value	0.182	95% BCA Bootstrap UCL	8.583
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	10.62
		97.5% Chebyshev(Mean, Sd) UCL	12.01
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	14.74
95% Approximate Gamma UCL	8.906		
95% Adjusted Gamma UCL	9.027		
Potential UCL to Use		Use 95% Student's-t UCL	8.671

Copper

General Statistics

Number of Valid Observations	23	Number of Distinct Observations	21

Raw Statistics		**Log-transformed Statistics**	
Minimum	5.8	Minimum of Log Data	1.758
Maximum	70.4	Maximum of Log Data	4.254
Mean	24.1	Mean of log Data	2.904
Median	13.6	SD of log Data	0.745
SD	19.66		
Coefficient of Variation	0.816		
Skewness	1.36		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.8	Shapiro Wilk Test Statistic	0.939
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	31.14	95% H-UCL	34.26
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	41.1
95% Adjusted-CLT UCL	32.08	97.5% Chebyshev (MVUE) UCL	48.62
95% Modified-t UCL	31.33	99% Chebyshev (MVUE) UCL	63.39
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.722	**Data appear Lognormal at 5% Significance Level**	
Theta Star	14		
MLE of Mean	24.1		
MLE of Standard Deviation	18.36		
nu star	79.19		
Approximate Chi Square Value (.05)	59.69	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	30.84
Adjusted Chi Square Value	58.46	95% Jackknife UCL	31.14
		95% Standard Bootstrap UCL	30.77
Anderson-Darling Test Statistic	0.874	95% Bootstrap-t UCL	33.41
Anderson-Darling 5% Critical Value	0.755	95% Hall's Bootstrap UCL	31.23
Kolmogorov-Smirnov Test Statistic	0.205	95% Percentile Bootstrap UCL	30.93
Kolmogorov-Smirnov 5% Critical Value	0.184	95% BCA Bootstrap UCL	32.03
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	41.97
		97.5% Chebyshev(Mean, Sd) UCL	49.7
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	64.89
95% Approximate Gamma UCL	31.97		
95% Adjusted Gamma UCL	32.64		
Potential UCL to Use		Use 95% H-UCL	34.26

Lead

General Statistics

Number of Valid Observations	23	Number of Distinct Observations	22

Raw Statistics		**Log-transformed Statistics**	
Minimum	8	Minimum of Log Data	2.079
Maximum	22.2	Maximum of Log Data	3.1
Mean	15.34	Mean of log Data	2.697
Median	16.1	SD of log Data	0.274
SD	3.772		
Coefficient of Variation	0.246		
Skewness	-0.376		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.966	Shapiro Wilk Test Statistic	0.92
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	16.69	95% H-UCL	17.12
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	19.25
95% Adjusted-CLT UCL	16.57	97.5% Chebyshev (MVUE) UCL	20.93
95% Modified-t UCL	16.68	99% Chebyshev (MVUE) UCL	24.22
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	13.3	**Data appear Normal at 5% Significance Level**	
Theta Star	1.154		
MLE of Mean	15.34		
MLE of Standard Deviation	4.207		
nu star	611.6		
Approximate Chi Square Value (.05)	555.3	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	16.63
Adjusted Chi Square Value	551.4	95% Jackknife UCL	16.69
		95% Standard Bootstrap UCL	16.61
Anderson-Darling Test Statistic	0.564	95% Bootstrap-t UCL	16.65
Anderson-Darling 5% Critical Value	0.743	95% Hall's Bootstrap UCL	16.58
Kolmogorov-Smirnov Test Statistic	0.182	95% Percentile Bootstrap UCL	16.55
Kolmogorov-Smirnov 5% Critical Value	0.181	95% BCA Bootstrap UCL	16.52
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	18.77
		97.5% Chebyshev(Mean, Sd) UCL	20.25
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	23.16
95% Approximate Gamma UCL	16.9		
95% Adjusted Gamma UCL	17.02		
Potential UCL to Use		Use 95% Student's-t UCL	16.69

Manganese

General Statistics

Number of Valid Observations	23	Number of Distinct Observations	23

Raw Statistics		**Log-transformed Statistics**	
Minimum	138	Minimum of Log Data	4.927
Maximum	947	Maximum of Log Data	6.853
Mean	468.9	Mean of log Data	6.037
Median	483	SD of log Data	0.515
SD	209.2		
Coefficient of Variation	0.446		
Skewness	0.287		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.959	Shapiro Wilk Test Statistic	0.929
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	543.8	95% H-UCL	594.4
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	706.4
95% Adjusted-CLT UCL	543.4	97.5% Chebyshev (MVUE) UCL	806.6
95% Modified-t UCL	544.2	99% Chebyshev (MVUE) UCL	1003
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	4.015	**Data appear Normal at 5% Significance Level**	
Theta Star	116.8		
MLE of Mean	468.9		
MLE of Standard Deviation	234		
nu star	184.7		
Approximate Chi Square Value (.05)	154.3	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	540.6
Adjusted Chi Square Value	152.3	95% Jackknife UCL	543.8
		95% Standard Bootstrap UCL	540
Anderson-Darling Test Statistic	0.591	95% Bootstrap-t UCL	544.9
Anderson-Darling 5% Critical Value	0.748	95% Hall's Bootstrap UCL	546.8
Kolmogorov-Smirnov Test Statistic	0.174	95% Percentile Bootstrap UCL	544
Kolmogorov-Smirnov 5% Critical Value	0.182	95% BCA Bootstrap UCL	542.5
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	659
		97.5% Chebyshev(Mean, Sd) UCL	741.3
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	902.9
95% Approximate Gamma UCL	561.4		
95% Adjusted Gamma UCL	568.8		
Potential UCL to Use		Use 95% Student's-t UCL	543.8

Mercury

General Statistics

Number of Valid Data	23	Number of Detected Data	15
Number of Distinct Detected Data	13	Number of Non-Detect Data	8
		Percent Non-Detects	34.78%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0078	Minimum Detected	-4.854
Maximum Detected	0.076	Maximum Detected	-2.577
Mean of Detected	0.0346	Mean of Detected	-3.526
SD of Detected	0.0194	SD of Detected	0.618
Minimum Non-Detect	0.0072	Minimum Non-Detect	-4.934
Maximum Non-Detect	0.13	Maximum Non-Detect	-2.04
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	23
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	0
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	100.00%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.934	Shapiro Wilk Test Statistic	0.959
5% Shapiro Wilk Critical Value	0.881	5% Shapiro Wilk Critical Value	0.881
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0306	Mean	-3.703
SD	0.0195	SD	0.72
95% DL/2 (t) UCL	0.0375	95% H-Stat (DL/2) UCL	0.0388
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-3.716
		SD in Log Scale	0.6
		Mean in Original Scale	0.0288
		SD in Original Scale	0.0177
		95% Percentile Bootstrap UCL	0.0349
		95% BCA Bootstrap UCL	0.0365
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	2.64	**Data appear Normal at 5% Significance Level**	
Theta Star	0.0131		
nu star	79.21		
A-D Test Statistic	0.264	**Nonparametric Statistics**	
5% A-D Critical Value	0.743	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.743	Mean	0.0295
5% K-S Critical Value	0.223	SD	0.018
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.00416
		95% KM (t) UCL	0.0366
Assuming Gamma Distribution		95% KM (z) UCL	0.0363
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.0365
Minimum	0.00402	95% KM (bootstrap t) UCL	0.0375
Maximum	0.076	95% KM (BCA) UCL	0.0372
Mean	0.0338	95% KM (Percentile Bootstrap) UCL	0.0365
Median	0.031	95% KM (Chebyshev) UCL	0.0476
SD	0.017	97.5% KM (Chebyshev) UCL	0.0555
k star	2.838	99% KM (Chebyshev) UCL	0.0709
Theta star	0.0119		
Nu star	130.6	**Potential UCLs to Use**	
AppChi2	105.2	95% KM (t) UCL	0.0366
95% Gamma Approximate UCL	0.0419	95% KM (Percentile Bootstrap) UCL	0.0365
95% Adjusted Gamma UCL	0.0426		

Note: DL/2 is not a recommended method.

Nickel

General Statistics			
Number of Valid Observations	23	Number of Distinct Observations	22
Raw Statistics		**Log-transformed Statistics**	
Minimum	7.9	Minimum of Log Data	2.067
Maximum	35.9	Maximum of Log Data	3.581
Mean	15.03	Mean of log Data	2.63
Median	13.4	SD of log Data	0.385
SD	7.135		
Coefficient of Variation	0.475		
Skewness	1.966		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.745	Shapiro Wilk Test Statistic	0.893
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	17.59	95% H-UCL	17.43
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	20.22
95% Adjusted-CLT UCL	18.13	97.5% Chebyshev (MVUE) UCL	22.53
95% Modified-t UCL	17.69	99% Chebyshev (MVUE) UCL	27.06
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	5.579	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	2.695		
MLE of Mean	15.03		
MLE of Standard Deviation	6.365		
nu star	256.6		
Approximate Chi Square Value (.05)	220.5	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	17.48
Adjusted Chi Square Value	218.1	95% Jackknife UCL	17.59
		95% Standard Bootstrap UCL	17.42
Anderson-Darling Test Statistic	1.292	95% Bootstrap-t UCL	19.26
Anderson-Darling 5% Critical Value	0.746	95% Hall's Bootstrap UCL	19.01
Kolmogorov-Smirnov Test Statistic	0.243	95% Percentile Bootstrap UCL	17.51
Kolmogorov-Smirnov 5% Critical Value	0.182	95% BCA Bootstrap UCL	17.97
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	21.52
		97.5% Chebyshev(Mean, Sd) UCL	24.33
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	29.84
95% Approximate Gamma UCL	17.5		
95% Adjusted Gamma UCL	17.69		
Potential UCL to Use		Use 95% Student's-t UCL	17.59
		or 95% Modified-t UCL	17.69

Selenium

General Statistics

Number of Valid Data	23	Number of Detected Data	3
Number of Distinct Detected Data	3	Number of Non-Detect Data	20
		Percent Non-Detects	86.96%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.88	Minimum Detected	-0.128
Maximum Detected	1.3	Maximum Detected	0.262
Mean of Detected	1.127	Mean of Detected	0.106
SD of Detected	0.219	SD of Detected	0.206
Minimum Non-Detect	0.54	Minimum Non-Detect	-0.616
Maximum Non-Detect	0.97	Maximum Non-Detect	-0.0305
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	21
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	2
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	91.30%

Warning: There are only 3 Distinct Detected Values in this data set
The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.916	Shapiro Wilk Test Statistic	0.896
5% Shapiro Wilk Critical Value	0.767	5% Shapiro Wilk Critical Value	0.767
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.425	Mean	-0.99
SD	0.291	SD	0.464
95% DL/2 (t) UCL	0.529	95% H-Stat (DL/2) UCL	0.443
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-0.787
		SD in Log Scale	0.432
		Mean in Original Scale	0.504
		SD in Original Scale	0.273
		95% Percentile Bootstrap UCL	0.601
		95% BCA Bootstrap UCL	0.634
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	N/A	**Data appear Normal at 5% Significance Level**	
Theta Star	N/A		
nu star	N/A		
A-D Test Statistic	N/A	**Nonparametric Statistics**	
5% A-D Critical Value	N/A	Kaplan-Meier (KM) Method	
K-S Test Statistic	N/A	Mean	0.912
5% K-S Critical Value	N/A	SD	0.105
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.0269
		95% KM (t) UCL	0.958
Assuming Gamma Distribution		95% KM (z) UCL	0.956
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	1.116
Minimum	N/A	95% KM (bootstrap t) UCL	0.93
Maximum	N/A	95% KM (BCA) UCL	1.3
Mean	N/A	95% KM (Percentile Bootstrap) UCL	N/A
Median	N/A	95% KM (Chebyshev) UCL	1.029
SD	N/A	97.5% KM (Chebyshev) UCL	1.08
k star	N/A	99% KM (Chebyshev) UCL	1.18
Theta star	N/A		
Nu star	N/A	**Potential UCLs to Use**	
AppChi2	N/A	95% KM (t) UCL	0.958
95% Gamma Approximate UCL	N/A	95% KM (Percentile Bootstrap) UCL	N/A
95% Adjusted Gamma UCL	N/A		

Note: DL/2 is not a recommended method.

Thallium

General Statistics

Number of Valid Data	23	Number of Detected Data	21
Number of Distinct Detected Data	17	Number of Non-Detect Data	2
		Percent Non-Detects	8.70%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.14	Minimum Detected	-1.966
Maximum Detected	0.48	Maximum Detected	-0.734
Mean of Detected	0.313	Mean of Detected	-1.212
SD of Detected	0.095	SD of Detected	0.34
Minimum Non-Detect	0.43	Minimum Non-Detect	-0.844
Maximum Non-Detect	0.51	Maximum Non-Detect	-0.673
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	23
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	0
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	100.00%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.974	Shapiro Wilk Test Statistic	0.934
5% Shapiro Wilk Critical Value	0.908	5% Shapiro Wilk Critical Value	0.908
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.306	Mean	-1.233
SD	0.0935	SD	0.332
95% DL/2 (t) UCL	0.34	95% H-Stat (DL/2) UCL	0.367
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-1.215
		SD in Log Scale	0.324
		Mean in Original Scale	0.311
		SD in Original Scale	0.0908
		95% Percentile Bootstrap UCL	0.342
		95% BCA Bootstrap UCL	0.341
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	8.669	**Data appear Normal at 5% Significance Level**	
Theta Star	0.0361		
nu star	364.1		
A-D Test Statistic	0.365	**Nonparametric Statistics**	
5% A-D Critical Value	0.743	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.743	Mean	0.312
5% K-S Critical Value	0.189	SD	0.0922
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.0205
		95% KM (t) UCL	0.347
Assuming Gamma Distribution		95% KM (z) UCL	0.346
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.347
Minimum	0.14	95% KM (bootstrap t) UCL	0.346
Maximum	0.48	95% KM (BCA) UCL	0.345
Mean	0.314	95% KM (Percentile Bootstrap) UCL	0.346
Median	0.32	95% KM (Chebyshev) UCL	0.401
SD	0.0907	97.5% KM (Chebyshev) UCL	0.44
k star	9.582	99% KM (Chebyshev) UCL	0.516
Theta star	0.0328		
Nu star	440.8	**Potential UCLs to Use**	
AppChi2	393.1	95% KM (t) UCL	0.347
95% Gamma Approximate UCL	0.353	95% KM (Percentile Bootstrap) UCL	0.346
95% Adjusted Gamma UCL	0.356		

Note: DL/2 is not a recommended method.

Zinc

General Statistics

Number of Valid Observations	23	Number of Distinct Observations	21

Raw Statistics		**Log-transformed Statistics**	
Minimum	31.9	Minimum of Log Data	3.463
Maximum	317	Maximum of Log Data	5.759
Mean	71.97	Mean of log Data	4.074
Median	52.9	SD of log Data	0.576
SD	63.14		
Coefficient of Variation	0.877		
Skewness	3.113		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.602	Shapiro Wilk Test Statistic	0.867
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	94.57	95% H-UCL	89.18
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	106.7
95% Adjusted-CLT UCL	102.7	97.5% Chebyshev (MVUE) UCL	123.1
95% Modified-t UCL	96	99% Chebyshev (MVUE) UCL	155.3
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	2.312	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	31.12		
MLE of Mean	71.97		
MLE of Standard Deviation	47.33		
nu star	106.4		
Approximate Chi Square Value (.05)	83.56	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	93.62
Adjusted Chi Square Value	82.1	95% Jackknife UCL	94.57
		95% Standard Bootstrap UCL	93.36
Anderson-Darling Test Statistic	1.441	95% Bootstrap-t UCL	129.8
Anderson-Darling 5% Critical Value	0.752	95% Hall's Bootstrap UCL	199.2
Kolmogorov-Smirnov Test Statistic	0.193	95% Percentile Bootstrap UCL	95.2
Kolmogorov-Smirnov 5% Critical Value	0.183	95% BCA Bootstrap UCL	108.5
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	129.3
		97.5% Chebyshev(Mean, Sd) UCL	154.2
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	203
95% Approximate Gamma UCL	91.6		
95% Adjusted Gamma UCL	93.24		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	129.3

TABLE A-2
Statistical Summary of Detected Analytes in Phase I RI Post-IRA Subsurface Soil Samples
RVAAP-03 Open Demolition Area 1

Detected Analyte	Frequency of Detection	Range of Detects Minimum mg/kg	Range of Detects Maximum mg/kg	Mean of Detects mg/kg	95% UCL [a] mg/kg	Distribution [a]	Method [a]
Inorganics							
Aluminum	42 / 42	6.37E+03	2.86E+04	1.22E+04	1.32E+04	Gamma	Approximate Gamma
Antimony	4 / 30	7.80E-01	1.30E+00	9.58E-01	9.83E-01	Normal	KM (Percentile Bootstrap)
Arsenic	41 /41	8.30E+00	2.11E+01	1.48E+01	1.56E+01	Normal	KM - t
Barium	42 / 42	2.61E+01	1.72E+02	7.05E+01	7.75E+01	Gamma	Approximate Gamma
Chromium (total or hexavalent)	42 / 42	1.01E+01	3.47E+01	1.78E+01	1.91E+01	Gamma	Approximate Gamma
Copper	42 / 42	9.20E+00	4.73E+01	2.15E+01	2.31E+01	NP	Modified-t
Lead	42 / 42	8.70E+00	1.94E+01	1.32E+01	1.37E+01	Gamma	Approximate Gamma
Mercury	23 / 42	6.60E-03	5.40E-02	2.35E-02	2.33E-02	Normal	KM - t
Vanadium	42 / 42	1.16E+01	3.99E+01	2.00E+01	2.13E+01	Gamma	Approximate Gamma
Zinc	42 / 42	3.56E+01	1.25E+02	6.42E+01	6.83E+01	Gamma	Approximate Gamma
Insufficient Sample Size for UCL Calculation							
Cadmium	1 / 42	2.70E-01	2.70E-01	2.70E-01			

mg/kg - milligram per kilogram
NP - Nonparametric; distribution is not discernable
UCL - Upper confidence limit

[a] Nature of distribution, statistical method, and 95% Upper Confidence Limit (UCL) determined using ProUCL Version 4.0 (EPA, 2007, ProUCL Version 4.0, Office of Research and Development, Technology Support Center Characterization and Monitoring Branch, Las Vegas, Nevada, April.) on line at http://www.epa.gov/esd/tsc/form.htm.) The recommended UCL was used unless the recommendation was the 97.5% or 99% Chebyshev UCL.

APPENDIX A-2: ProUCL Raw Output
Statistical Summary of Detected Analytes in Phase 1 RI Post IRA Subsurface Soil Samples
RVAAP-03 Open Demolition Area 1

	General UCL Statistics for Data Sets with Non-Detects
User Selected Options	
From File	C:\Documents and Settings\debbi.freer\My Documents\Ravenna\Ravena sbs UCL output tbl rev.xls.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum			
General Statistics			
Number of Valid Observations	42	Number of Distinct Observations	39
Raw Statistics		**Log-transformed Statistics**	
Minimum	6370	Minimum of Log Data	8.759
Maximum	28600	Maximum of Log Data	10.26
Mean	12180	Mean of log Data	9.365
Median	12350	SD of log Data	0.29
SD	3834		
Coefficient of Variation	0.315		
Skewness	1.806		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.834	Shapiro Wilk Test Statistic	0.922
Shapiro Wilk Critical Value	0.942	Shapiro Wilk Critical Value	0.942
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	13176	95% H-UCL	13194
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	14582
95% Adjusted-CLT UCL	13330	97.5% Chebyshev (MVUE) UCL	15627
95% Modified-t UCL	13203	99% Chebyshev (MVUE) UCL	17682
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	11.12	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	1096		
MLE of Mean	12180		
MLE of Standard Deviation	3653		
nu star	933.7		
Approximate Chi Square Value (.05)	863.8	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0443	95% CLT UCL	13153
Adjusted Chi Square Value	861.4	95% Jackknife UCL	13176
		95% Standard Bootstrap UCL	13121
Anderson-Darling Test Statistic	0.456	95% Bootstrap-t UCL	13445
Anderson-Darling 5% Critical Value	0.748	95% Hall's Bootstrap UCL	13764
Kolmogorov-Smirnov Test Statistic	0.0851	95% Percentile Bootstrap UCL	13157
Kolmogorov-Smirnov 5% Critical Value	0.136	95% BCA Bootstrap UCL	13348
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	14759
		97.5% Chebyshev(Mean, Sd) UCL	15875
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	18066
95% Approximate Gamma UCL	13166		
95% Adjusted Gamma UCL	13203		
Potential UCL to Use		Use 95% Approximate Gamma UCL	13166

Antimony			
General Statistics			
Number of Valid Data	30	Number of Detected Data	4
Number of Distinct Detected Data	4	Number of Non-Detect Data	26
Number of Missing Values	12	Percent Non-Detects	86.67%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.78	Minimum Detected	-0.248
Maximum Detected	1.3	Maximum Detected	0.262
Mean of Detected	0.958	Mean of Detected	-0.0657
SD of Detected	0.243	SD of Detected	0.238
Minimum Non-Detect	1.1	Minimum Non-Detect	0.0953
Maximum Non-Detect	1.3	Maximum Non-Detect	0.262
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	29
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	1
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	96.67%
Warning: There are only 4 Distinct Detected Values in this data			
Note: It should be noted that even though bootstrap may be performed on this data set			
the resulting calculations may not be reliable enough to draw conclusions			
It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.			
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.842	Shapiro Wilk Test Statistic	0.863
5% Shapiro Wilk Critical Value	0.748	5% Shapiro Wilk Critical Value	0.748
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.646	Mean	-0.455
SD	0.149	SD	0.178
95% DL/2 (t) UCL	0.692	95% H-Stat (DL/2) UCL	0.709
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-0.158
		SD in Log Scale	0.163
		Mean in Original Scale	0.865
		SD in Original Scale	0.145
		95% Percentile Bootstrap UCL	0.909
		95% BCA Bootstrap UCL	0.911
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	5.831	**Data appear Normal at 5% Significance Level**	
Theta Star	0.164		
nu star	46.65		
A-D Test Statistic	0.439	**Nonparametric Statistics**	
5% A-D Critical Value	0.657	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.657	Mean	0.859
5% K-S Critical Value	0.394	SD	0.115
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.056
		95% KM (t) UCL	0.954
Assuming Gamma Distribution		95% KM (z) UCL	0.951
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.977
Minimum	0.78	95% KM (bootstrap t) UCL	1.031
Maximum	1.3	95% KM (BCA) UCL	0.983
Mean	0.94	95% KM (Percentile Bootstrap) UCL	0.983
Median	0.916	95% KM (Chebyshev) UCL	1.102
SD	0.126	97.5% KM (Chebyshev) UCL	1.208
k star	55.78	99% KM (Chebyshev) UCL	1.415
Theta star	0.0168		
Nu star	3347	**Potential UCLs to Use**	
AppChi2	3213	95% KM (t) UCL	0.954
95% Gamma Approximate UCL	0.979	95% KM (Percentile Bootstrap) UCL	0.983
95% Adjusted Gamma UCL	N/A		
Note: DL/2 is not a recommended method.			

Arsenic

General Statistics

Number of Valid Data	41	Number of Detected Data	41
Number of Distinct Detected Data	34	Number of Non-Detect Data	0
Number of Missing Values	1	Percent Non-Detects	0.00%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	8.3	Minimum Detected	2.116
Maximum Detected	21.1	Maximum Detected	3.049
Mean of Detected	14.78	Mean of Detected	2.672
SD of Detected	2.955	SD of Detected	0.212
Minimum Non-Detect	N/A	Minimum Non-Detect	N/A
Maximum Non-Detect	N/A	Maximum Non-Detect	N/A

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.981	Shapiro Wilk Test Statistic	0.958
5% Shapiro Wilk Critical Value	0.941	5% Shapiro Wilk Critical Value	0.941
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	14.78	Mean	2.672
SD	2.955	SD	0.212
95% DL/2 (t) UCL	15.56	95% H-Stat (DL/2) UCL	15.69
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	N/A
		SD in Log Scale	N/A
		Mean in Original Scale	N/A
		SD in Original Scale	N/A
		95% Percentile Bootstrap UCL	N/A
		95% BCA Bootstrap UCL	N/A
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	22.24	**Data appear Normal at 5% Significance Level**	
Theta Star	0.665		
nu star	1823		
A-D Test Statistic	0.395	**Nonparametric Statistics**	
5% A-D Critical Value	0.747	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.747	Mean	14.78
5% K-S Critical Value	0.138	SD	2.919
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.461
		95% KM (t) UCL	15.56
Assuming Gamma Distribution		95% KM (z) UCL	15.54
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	15.56
Minimum	8.3	95% KM (bootstrap t) UCL	15.56
Maximum	21.1	95% KM (BCA) UCL	15.54
Mean	14.78	95% KM (Percentile Bootstrap) UCL	15.47
Median	15.1	95% KM (Chebyshev) UCL	16.79
SD	2.955	97.5% KM (Chebyshev) UCL	17.66
k star	22.24	99% KM (Chebyshev) UCL	19.37
Theta star	0.665		
Nu star	1823	**Potential UCLs to Use**	
AppChi2	1725	95% KM (t) UCL	15.56
95% Gamma Approximate UCL	15.62	95% KM (Percentile Bootstrap) UCL	15.47
95% Adjusted Gamma UCL	15.65		

Note: DL/2 is not a recommended method.

Barium			
General Statistics			
Number of Valid Observations	42	Number of Distinct Observations	41
Raw Statistics		**Log-transformed Statistics**	
Minimum	26.1	Minimum of Log Data	3.262
Maximum	172	Maximum of Log Data	5.147
Mean	70.48	Mean of log Data	4.192
Median	68.15	SD of log Data	0.362
SD	26.13		
Coefficient of Variation	0.371		
Skewness	1.375		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.886	Shapiro Wilk Test Statistic	0.947
Shapiro Wilk Critical Value	0.942	Shapiro Wilk Critical Value	0.942
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	77.26	95% H-UCL	78.28
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	88.18
95% Adjusted-CLT UCL	78.02	97.5% Chebyshev (MVUE) UCL	95.81
95% Modified-t UCL	77.41	99% Chebyshev (MVUE) UCL	110.8
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	7.517	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	9.376		
MLE of Mean	70.48		
MLE of Standard Deviation	25.71		
nu star	631.4		
Approximate Chi Square Value (.05)	574.1	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0443	95% CLT UCL	77.11
Adjusted Chi Square Value	572.2	95% Jackknife UCL	77.26
		95% Standard Bootstrap UCL	76.88
Anderson-Darling Test Statistic	0.242	95% Bootstrap-t UCL	78.92
Anderson-Darling 5% Critical Value	0.75	95% Hall's Bootstrap UCL	79.39
Kolmogorov-Smirnov Test Statistic	0.0799	95% Percentile Bootstrap UCL	76.95
Kolmogorov-Smirnov 5% Critical Value	0.137	95% BCA Bootstrap UCL	78.31
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	88.05
		97.5% Chebyshev(Mean, Sd) UCL	95.65
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	110.6
95% Approximate Gamma UCL	77.51		
95% Adjusted Gamma UCL	77.77		
Potential UCL to Use		Use 95% Approximate Gamma UCL	77.51

Chromium (total or hexavalent)			
General Statistics			
Number of Valid Observations	42	Number of Distinct Observations	36
Raw Statistics		**Log-transformed Statistics**	
Minimum	10.1	Minimum of Log Data	2.313
Maximum	34.7	Maximum of Log Data	3.547
Mean	17.76	Mean of log Data	2.841
Median	18.75	SD of log Data	0.273
SD	4.801		
Coefficient of Variation	0.27		
Skewness	0.775		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.893	Shapiro Wilk Test Statistic	0.908
Shapiro Wilk Critical Value	0.942	Shapiro Wilk Critical Value	0.942
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	19	95% H-UCL	19.17
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	21.08
95% Adjusted-CLT UCL	19.07	97.5% Chebyshev (MVUE) UCL	22.51
95% Modified-t UCL	19.02	99% Chebyshev (MVUE) UCL	25.32
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	13.21	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	1.344		
MLE of Mean	17.76		
MLE of Standard Deviation	4.885		
nu star	1110		
Approximate Chi Square Value (.05)	1034	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0443	95% CLT UCL	18.98
Adjusted Chi Square Value	1031	95% Jackknife UCL	19
		95% Standard Bootstrap UCL	18.99
Anderson-Darling Test Statistic	0.616	95% Bootstrap-t UCL	19.12
Anderson-Darling 5% Critical Value	0.748	95% Hall's Bootstrap UCL	19.22
Kolmogorov-Smirnov Test Statistic	0.136	95% Percentile Bootstrap UCL	19
Kolmogorov-Smirnov 5% Critical Value	0.136	95% BCA Bootstrap UCL	19.04
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	20.99
		97.5% Chebyshev(Mean, Sd) UCL	22.38
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	25.13
95% Approximate Gamma UCL	19.07		
95% Adjusted Gamma UCL	19.12		
Potential UCL to Use		Use 95% Approximate Gamma UCL	19.07

APPENDIX A-2: ProUCL Raw Output
Statistical Summary of Detected Analytes in Phase 1 RI Post IRA Subsurface Soil Samples
RVAAP-03 Open Demolition Area 1

Copper			
General Statistics			
Number of Valid Observations	42	Number of Distinct Observations	36
Raw Statistics		**Log-transformed Statistics**	
Minimum	9.2	Minimum of Log Data	2.219
Maximum	47.3	Maximum of Log Data	3.857
Mean	21.46	Mean of log Data	3.031
Median	21.25	SD of log Data	0.269
SD	6.034		
Coefficient of Variation	0.281		
Skewness	1.86		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.814	Shapiro Wilk Test Statistic	0.886
Shapiro Wilk Critical Value	0.942	Shapiro Wilk Critical Value	0.942
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	23.02	95% H-UCL	23.12
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	25.4
95% Adjusted-CLT UCL	23.27	97.5% Chebyshev (MVUE) UCL	27.11
95% Modified-t UCL	23.07	99% Chebyshev (MVUE) UCL	30.45
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	13.39	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	1.603		
MLE of Mean	21.46		
MLE of Standard Deviation	5.865		
nu star	1124		
Approximate Chi Square Value (.05)	1048	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0443	95% CLT UCL	22.99
Adjusted Chi Square Value	1045	95% Jackknife UCL	23.02
		95% Standard Bootstrap UCL	22.94
Anderson-Darling Test Statistic	1.608	95% Bootstrap-t UCL	23.43
Anderson-Darling 5% Critical Value	0.748	95% Hall's Bootstrap UCL	24.18
Kolmogorov-Smirnov Test Statistic	0.171	95% Percentile Bootstrap UCL	23.02
Kolmogorov-Smirnov 5% Critical Value	0.136	95% BCA Bootstrap UCL	23.3
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	25.52
		97.5% Chebyshev(Mean, Sd) UCL	27.27
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	30.72
95% Approximate Gamma UCL	23.03		
95% Adjusted Gamma UCL	23.09		
Potential UCL to Use		Use 95% Student's-t UCL	23.02
		or 95% Modified-t UCL	23.07

Lead			
General Statistics			
Number of Valid Observations	42	Number of Distinct Observations	30
Raw Statistics		**Log-transformed Statistics**	
Minimum	8.7	Minimum of Log Data	2.163
Maximum	19.4	Maximum of Log Data	2.965
Mean	13.19	Mean of log Data	2.568
Median	13.4	SD of log Data	0.153
SD	2.018		
Coefficient of Variation	0.153		
Skewness	0.479		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.935	Shapiro Wilk Test Statistic	0.942
Shapiro Wilk Critical Value	0.942	Shapiro Wilk Critical Value	0.942
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	13.72	95% H-UCL	13.75
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	14.56
95% Adjusted-CLT UCL	13.73	97.5% Chebyshev (MVUE) UCL	15.15
95% Modified-t UCL	13.72	99% Chebyshev (MVUE) UCL	16.31
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	40.95	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	0.322		
MLE of Mean	13.19		
MLE of Standard Deviation	2.062		
nu star	3439		
Approximate Chi Square Value (.05)	3304	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0443	95% CLT UCL	13.71
Adjusted Chi Square Value	3300	95% Jackknife UCL	13.72
		95% Standard Bootstrap UCL	13.71
Anderson-Darling Test Statistic	0.445	95% Bootstrap-t UCL	13.74
Anderson-Darling 5% Critical Value	0.747	95% Hall's Bootstrap UCL	13.73
Kolmogorov-Smirnov Test Statistic	0.109	95% Percentile Bootstrap UCL	13.71
Kolmogorov-Smirnov 5% Critical Value	0.136	95% BCA Bootstrap UCL	13.7
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	14.55
		97.5% Chebyshev(Mean, Sd) UCL	15.14
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	16.29
95% Approximate Gamma UCL	13.73		
95% Adjusted Gamma UCL	13.75		
Potential UCL to Use		Use 95% Approximate Gamma UCL	13.73

Mercury			
General Statistics			
Number of Valid Data	42	Number of Detected Data	23
Number of Distinct Detected Data	18	Number of Non-Detect Data	19
		Percent Non-Detects	45.24%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0066	Minimum Detected	-5.021
Maximum Detected	0.054	Maximum Detected	-2.919
Mean of Detected	0.0235	Mean of Detected	-3.881
SD of Detected	0.0118	SD of Detected	0.544
Minimum Non-Detect	0.0078	Minimum Non-Detect	-4.854
Maximum Non-Detect	0.13	Maximum Non-Detect	-2.04
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	42
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	0
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	100.00%
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.943	Shapiro Wilk Test Statistic	0.964
5% Shapiro Wilk Critical Value	0.914	5% Shapiro Wilk Critical Value	0.914
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0253	Mean	-3.911
SD	0.0177	SD	0.697
95% DL/2 (t) UCL	0.0299	95% H-Stat (DL/2) UCL	0.0302
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-4.046
		SD in Log Scale	0.472
		Mean in Original Scale	0.0196
		SD in Original Scale	0.0101
		95% Percentile Bootstrap UCL	0.0222
		95% BCA Bootstrap UCL	0.0225
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	3.487	**Data appear Normal at 5% Significance Level**	
Theta Star	0.00674		
nu star	160.4		
A-D Test Statistic	0.28	**Nonparametric Statistics**	
5% A-D Critical Value	0.749	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.749	Mean	0.0199
5% K-S Critical Value	0.182	SD	0.011
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.00199
		95% KM (t) UCL	0.0233
Assuming Gamma Distribution		95% KM (z) UCL	0.0232
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.0233
Minimum	0.0066	95% KM (bootstrap t) UCL	0.0236
Maximum	0.054	95% KM (BCA) UCL	0.0236
Mean	0.0238	95% KM (Percentile Bootstrap) UCL	0.0233
Median	0.024	95% KM (Chebyshev) UCL	0.0286
SD	0.00969	97.5% KM (Chebyshev) UCL	0.0324
k star	5.187	99% KM (Chebyshev) UCL	0.0398
Theta star	0.0046		
Nu star	435.7	**Potential UCLs to Use**	
AppChi2	388.3	95% KM (t) UCL	0.0233
95% Gamma Approximate UCL	0.0268	95% KM (Percentile Bootstrap) UCL	0.0233
95% Adjusted Gamma UCL	0.0269		
Note: DL/2 is not a recommended method.			

Vanadium

General Statistics			
Number of Valid Observations	42	Number of Distinct Observations	37

Raw Statistics		Log-transformed Statistics	
Minimum	11.6	Minimum of Log Data	2.451
Maximum	39.9	Maximum of Log Data	3.686
Mean	19.98	Mean of log Data	2.968
Median	19.45	SD of log Data	0.233
SD	4.923		
Coefficient of Variation	0.246		
Skewness	1.439		

Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.863	Shapiro Wilk Test Statistic	0.925
Shapiro Wilk Critical Value	0.942	Shapiro Wilk Critical Value	0.942
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	21.26	95% H-UCL	21.28
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	23.14
95% Adjusted-CLT UCL	21.41	97.5% Chebyshev (MVUE) UCL	24.51
95% Modified-t UCL	21.29	99% Chebyshev (MVUE) UCL	27.2
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	17.29	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	1.156		
MLE of Mean	19.98		
MLE of Standard Deviation	4.805		
nu star	1452		
Approximate Chi Square Value (.05)	1365	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0443	95% CLT UCL	21.23
Adjusted Chi Square Value	1362	95% Jackknife UCL	21.26
		95% Standard Bootstrap UCL	21.23
Anderson-Darling Test Statistic	0.401	95% Bootstrap-t UCL	21.47
Anderson-Darling 5% Critical Value	0.747	95% Hall's Bootstrap UCL	21.63
Kolmogorov-Smirnov Test Statistic	0.0905	95% Percentile Bootstrap UCL	21.24
Kolmogorov-Smirnov 5% Critical Value	0.136	95% BCA Bootstrap UCL	21.32
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	23.29
		97.5% Chebyshev(Mean, Sd) UCL	24.73
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	27.54
95% Approximate Gamma UCL	21.26		
95% Adjusted Gamma UCL	21.31		
Potential UCL to Use		Use 95% Approximate Gamma UCL	21.26

Zinc			
General Statistics			
Number of Valid Observations	42	Number of Distinct Observations	40
Raw Statistics		**Log-transformed Statistics**	
Minimum	35.6	Minimum of Log Data	3.572
Maximum	125	Maximum of Log Data	4.828
Mean	64.2	Mean of log Data	4.135
Median	64.9	SD of log Data	0.237
SD	15.7		
Coefficient of Variation	0.245		
Skewness	1.294		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.881	Shapiro Wilk Test Statistic	0.928
Shapiro Wilk Critical Value	0.942	Shapiro Wilk Critical Value	0.942
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	68.28	95% H-UCL	68.49
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	74.52
95% Adjusted-CLT UCL	68.7	97.5% Chebyshev (MVUE) UCL	78.99
95% Modified-t UCL	68.36	99% Chebyshev (MVUE) UCL	87.77
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	17.09	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	3.757		
MLE of Mean	64.2		
MLE of Standard Deviation	15.53		
nu star	1436		
Approximate Chi Square Value (.05)	1349	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0443	95% CLT UCL	68.19
Adjusted Chi Square Value	1346	95% Jackknife UCL	68.28
		95% Standard Bootstrap UCL	68.1
Anderson-Darling Test Statistic	0.593	95% Bootstrap-t UCL	69.06
Anderson-Darling 5% Critical Value	0.747	95% Hall's Bootstrap UCL	70.15
Kolmogorov-Smirnov Test Statistic	0.13	95% Percentile Bootstrap UCL	68.29
Kolmogorov-Smirnov 5% Critical Value	0.136	95% BCA Bootstrap UCL	68.98
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	74.76
		97.5% Chebyshev(Mean, Sd) UCL	79.33
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	88.31
95% Approximate Gamma UCL	68.34		
95% Adjusted Gamma UCL	68.49		
Potential UCL to Use		Use 95% Approximate Gamma UCL	68.34

Table A-3
Statistical Summary of Detected Analytes in IRA Subsurface Soil Samples
RVAAP-03 Open Demolition Area 1

Detected Analyte	Frequency of Detection	Range of Detects Minimum mg/kg	Range of Detects Maximum mg/kg	Mean of Detects mg/kg	95% UCL [a] mg/kg	Distribution [a]	Method [a]
Inorganics							
Aluminum	23 / 23	9.79E+03	2.52E+05	2.40E+04	6.92E+04	NP	Chebyshev (Mean, Sd)
Antimony	9 / 24	2.50E-01	9.20E+00	1.37E+00	5.64E+00	NP	* Chebyshev (Mean, Sd)
Arsenic	22 / 23	1.20E+00	2.93E+01	1.63E+01	1.88E+01	Normal	Student's-t
Barium	23 / 23	5.64E+01	1.10E+02	7.77E+01	8.28E+01	Normal	Student's-t
Beryllium	22 / 23	5.30E-01	1.00E+00	7.37E-01	7.86E-01	Normal	Student's-t
Calcium	23 / 23	2.13E+02	1.71E+04	3.21E+03	5.23E+03	Lognormal	H-UCL
Chromium	23 / 23	1.47E+01	2.49E+02	2.88E+01	7.25E+01	NP	Chebyshev (Mean, Sd)
Cobalt	23 / 23	1.40E+00	1.62E+01	1.06E+01	1.16E+01	Normal	Student's-t
Copper	23 / 23	1.70E+01	7.42E+04	3.25E+03	1.73E+04	NP	* Chebyshev (Mean, Sd)
Iron	23 / 23	2.10E+03	3.59E+04	2.66E+04	3.23E+04	NP	Chebyshev (Mean, Sd)
Lead	23 / 23	1.11E+01	2.37E+03	1.17E+02	5.63E+02	NP	* Chebyshev (Mean, Sd)
Magnesium	23 / 23	4.86E+02	5.43E+03	3.88E+03	4.27E+03	NP	Student's-t
Manganese	23 / 23	2.04E+02	4.32E+02	3.25E+02	3.47E+02	Normal	Student's-t
Mercury	8 / 24	1.80E-03	5.50E-02	1.91E-02	3.64E-02	Gamma	Approximate Gamma
Nickel	23 / 23	1.94E+01	1.56E+02	3.23E+01	4.21E+01	NP	Student's-t
Potassium	23 / 23	4.13E+01	2.72E+03	1.90E+03	2.41E+03	NP	Chebyshev (Mean, Sd)
Selenium	5 / 23	4.00E-01	9.70E-01	5.72E-01	7.92E-01	Normal	Student's-t
Sodium	20 / 23	5.33E+01	1.03E+03	4.72E+02	8.87E+02	NP	* Chebyshev (Mean, Sd)
Thallium	5 / 23	1.70E-01	2.20E-01	1.98E-01	2.20E-01	Normal	Student's-t
Vanadium	23 / 23	7.50E+00	2.73E+01	2.16E+01	2.30E+01	NP	Student's-t
Zinc	23 / 23	5.07E+01	3.21E+04	1.46E+03	7.53E+03	NP	* Chebyshev (Mean, Sd)
Insufficient Sample Size for UCL Calculation							
Inorganics							
Cadmium	4 / 23	1.50E-01	2.59E+01	6.71E+00			
Silver	1 / 23	1.80E-01	1.80E-01	1.80E-01			
Explosives/Propellants							
2,4,6-Trinitrotoluene	1 / 23	1.80E-01	1.80E-01	1.80E-01			
Nitrocellulose	3 / 3	4.90E-01	1.00E+00	8.23E-01			
VOCs							
Toluene	2 / 4	2.00E-03	1.80E-01	9.10E-02			

mg/kg - milligram per kilogram
NP - Nonparametric; distribution is not discernable
UCL - Upper confidence limit

[a] Nature of distribution, statistical method, and 95% Upper Confidence Limit (UCL) determined using ProUCL Version 4.0 (EPA, 2007, ProUCL Version 4.0, Office of Research and Development, Technology Support Center Characterization and Monitoring Branch, Las Vegas, Nevada, April.) on line at http://www.epa.gov/esd/tsc/form.htm.) The recommended UCL was used unless the recommendation was the 97.5% or 99% Chebyshev UCL. In those cases, the 95% Chebyshev UCL was used (*). If more than one UCL was recommended, the more conservative UCL was selected.

APPENDIX A-3 : ProUCL Raw Output
Statistical Summary of Detected Analytes in IRA Subsurface Soil Samples
RVAAP-03 Open Demolition Area 1

	General UCL Statistics for Full Data Sets
User Selected Options	
From File	C:\Documents and Settings\debbi.freer\My Documents\Ravenna\Ravena Tbl 3-5 UCL inputt.xls.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

APPENDIX A-3 : ProUCL Raw Output
Statistical Summary of Detected Analytes in IRA Subsurface Soil Samples
RVAAP-03 Open Demolition Area 1

Aluminum

General Statistics			
Number of Valid Observations	23	Number of Distinct Observations	20

Raw Statistics		Log-transformed Statistics	
Minimum	9790	Minimum of Log Data	9.189
Maximum	252000	Maximum of Log Data	12.44
Mean	24010	Mean of log Data	9.64
Median	13800	SD of log Data	0.625
SD	49731		
Coefficient of Variation	2.071		
Skewness	4.786		

Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.245	Shapiro Wilk Test Statistic	0.41
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	41817	95% H-UCL	24662
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	29607
95% Adjusted-CLT UCL	52124	97.5% Chebyshev (MVUE) UCL	34419
95% Modified-t UCL	43541	99% Chebyshev (MVUE) UCL	43870
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.125	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	21349		
MLE of Mean	24010		
MLE of Standard Deviation	22641		
nu star	51.73		
Approximate Chi Square Value (.05)	36.21	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	41067
Adjusted Chi Square Value	35.27	95% Jackknife UCL	41817
		95% Standard Bootstrap UCL	40617
Anderson-Darling Test Statistic	6.603	95% Bootstrap-t UCL	381948
Anderson-Darling 5% Critical Value	0.765	95% Hall's Bootstrap UCL	201301
Kolmogorov-Smirnov Test Statistic	0.48	95% Percentile Bootstrap UCL	44743
Kolmogorov-Smirnov 5% Critical Value	0.186	95% BCA Bootstrap UCL	55550
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	69211
		97.5% Chebyshev(Mean, Sd) UCL	88769
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	127187
95% Approximate Gamma UCL	34300		
95% Adjusted Gamma UCL	35215		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	69211

APPENDIX A-3 : ProUCL Raw Output
Statistical Summary of Detected Analytes in IRA Subsurface Soil Samples
RVAAP-03 Open Demolition Area 1

Antimony

General Statistics

Number of Valid Observations	9	Number of Distinct Observations	9
Number of Missing Values	12		

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.25	Minimum of Log Data	-1.386
Maximum	9.2	Maximum of Log Data	2.219
Mean	1.369	Mean of log Data	-0.637
Median	0.37	SD of log Data	1.118
SD	2.939		
Coefficient of Variation	2.147		
Skewness	2.989		

Warning: There are only 9 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.429	Shapiro Wilk Test Statistic	0.654
Shapiro Wilk Critical Value	0.829	Shapiro Wilk Critical Value	0.829
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	3.191	95% H-UCL	3.947
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	2.408
95% Adjusted-CLT UCL	4.024	97.5% Chebyshev (MVUE) UCL	3.062
95% Modified-t UCL	3.354	99% Chebyshev (MVUE) UCL	4.347
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.503	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	2.722		
MLE of Mean	1.369		
MLE of Standard Deviation	1.93		
nu star	9.053		
Approximate Chi Square Value (.05)	3.359	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0231	95% CLT UCL	2.981
Adjusted Chi Square Value	2.67	95% Jackknife UCL	3.191
		95% Standard Bootstrap UCL	2.913
Anderson-Darling Test Statistic	1.977	95% Bootstrap-t UCL	31.53
Anderson-Darling 5% Critical Value	0.76	95% Hall's Bootstrap UCL	17.56
Kolmogorov-Smirnov Test Statistic	0.442	95% Percentile Bootstrap UCL	3.302
Kolmogorov-Smirnov 5% Critical Value	0.291	95% BCA Bootstrap UCL	4.287
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	5.64
		97.5% Chebyshev(Mean, Sd) UCL	7.488
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	11.12
95% Approximate Gamma UCL	3.689		
95% Adjusted Gamma UCL	4.641		
Potential UCL to Use		Use 99% Chebyshev (Mean, Sd) UCL	11.12

Recommended UCL exceeds the maximum observation

APPENDIX A-3 : ProUCL Raw Output
Statistical Summary of Detected Analytes in IRA Subsurface Soil Samples
RVAAP-03 Open Demolition Area 1

Arsenic

General Statistics

Number of Valid Observations	22	Number of Distinct Observations	22
Number of Missing Values	1		

Raw Statistics		**Log-transformed Statistics**	
Minimum	1.2	Minimum of Log Data	0.182
Maximum	29.3	Maximum of Log Data	3.378
Mean	16.3	Mean of log Data	2.653
Median	16.1	SD of log Data	0.659
SD	6.934		
Coefficient of Variation	0.426		
Skewness	0.0942		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.975	Shapiro Wilk Test Statistic	0.754
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data appear Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	18.84	95% H-UCL	24.04
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	28.77
95% Adjusted-CLT UCL	18.76	97.5% Chebyshev (MVUE) UCL	33.68
95% Modified-t UCL	18.84	99% Chebyshev (MVUE) UCL	43.32
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	3.291	**Data appear Normal at 5% Significance Level**	
Theta Star	4.951		
MLE of Mean	16.3		
MLE of Standard Deviation	8.983		
nu star	144.8		
Approximate Chi Square Value (.05)	118	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	18.73
Adjusted Chi Square Value	116.2	95% Jackknife UCL	18.84
		95% Standard Bootstrap UCL	18.69
Anderson-Darling Test Statistic	0.611	95% Bootstrap-t UCL	18.92
Anderson-Darling 5% Critical Value	0.747	95% Hall's Bootstrap UCL	18.65
Kolmogorov-Smirnov Test Statistic	0.116	95% Percentile Bootstrap UCL	18.77
Kolmogorov-Smirnov 5% Critical Value	0.186	95% BCA Bootstrap UCL	18.68
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	22.74
		97.5% Chebyshev(Mean, Sd) UCL	25.53
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	31
95% Approximate Gamma UCL	20		
95% Adjusted Gamma UCL	20.31		
Potential UCL to Use		Use 95% Student's-t UCL	18.84

APPENDIX A-3 : ProUCL Raw Output
Statistical Summary of Detected Analytes in IRA Subsurface Soil Samples
RVAAP-03 Open Demolition Area 1

Barium

General Statistics			
Number of Valid Observations	23	Number of Distinct Observations	22

Raw Statistics		Log-transformed Statistics	
Minimum	56.4	Minimum of Log Data	4.032
Maximum	110	Maximum of Log Data	4.7
Mean	77.72	Mean of log Data	4.338
Median	74.7	SD of log Data	0.178
SD	14.06		
Coefficient of Variation	0.181		
Skewness	0.531		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.958	Shapiro Wilk Test Statistic	0.973
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	82.76	95% H-UCL	83.11
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	90.34
95% Adjusted-CLT UCL	82.89	97.5% Chebyshev (MVUE) UCL	95.81
95% Modified-t UCL	82.81	99% Chebyshev (MVUE) UCL	106.5
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	28.64	**Data appear Normal at 5% Significance Level**	
Theta Star	2.713		
MLE of Mean	77.72		
MLE of Standard Deviation	14.52		
nu star	1318		
Approximate Chi Square Value (.05)	1234	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	82.54
Adjusted Chi Square Value	1229	95% Jackknife UCL	82.76
		95% Standard Bootstrap UCL	82.41
Anderson-Darling Test Statistic	0.314	95% Bootstrap-t UCL	83.19
Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL	82.78
Kolmogorov-Smirnov Test Statistic	0.136	95% Percentile Bootstrap UCL	82.29
Kolmogorov-Smirnov 5% Critical Value	0.181	95% BCA Bootstrap UCL	82.78
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	90.5
		97.5% Chebyshev(Mean, Sd) UCL	96.03
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	106.9
95% Approximate Gamma UCL	82.97		
95% Adjusted Gamma UCL	83.36		
Potential UCL to Use		Use 95% Student's-t UCL	82.76

APPENDIX A-3 : ProUCL Raw Output
Statistical Summary of Detected Analytes in IRA Subsurface Soil Samples
RVAAP-03 Open Demolition Area 1

Beryllium

General Statistics

Number of Valid Observations	22	Number of Distinct Observations	18
Number of Missing Values	1		

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.53	Minimum of Log Data	-0.635
Maximum	1	Maximum of Log Data	0
Mean	0.737	Mean of log Data	-0.321
Median	0.73	SD of log Data	0.18
SD	0.134		
Coefficient of Variation	0.181		
Skewness	0.398		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.959	Shapiro Wilk Test Statistic	0.971
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.786	95% H-UCL	0.79
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.861
95% Adjusted-CLT UCL	0.786	97.5% Chebyshev (MVUE) UCL	0.915
95% Modified-t UCL	0.786	99% Chebyshev (MVUE) UCL	1.02
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	27.93	**Data appear Normal at 5% Significance Level**	
Theta Star	0.0264		
MLE of Mean	0.737		
MLE of Standard Deviation	0.139		
nu star	1229		
Approximate Chi Square Value (.05)	1148	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	0.784
Adjusted Chi Square Value	1143	95% Jackknife UCL	0.786
		95% Standard Bootstrap UCL	0.784
Anderson-Darling Test Statistic	0.262	95% Bootstrap-t UCL	0.786
Anderson-Darling 5% Critical Value	0.741	95% Hall's Bootstrap UCL	0.787
Kolmogorov-Smirnov Test Statistic	0.108	95% Percentile Bootstrap UCL	0.785
Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	0.785
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.861
		97.5% Chebyshev(Mean, Sd) UCL	0.915
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1.02
95% Approximate Gamma UCL	0.788		
95% Adjusted Gamma UCL	0.792		
Potential UCL to Use		Use 95% Student's-t UCL	0.786

APPENDIX A-3 : ProUCL Raw Output
Statistical Summary of Detected Analytes in IRA Subsurface Soil Samples
RVAAP-03 Open Demolition Area 1

Cadmium

General Statistics

Number of Valid Observations	4	Number of Distinct Observations	4
Number of Missing Values	19		

Warning: This data set only has 4 observations!

Data set is too small to compute reliable and meaningful statistics and estimates!

The data set for variable Cadmium was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!

If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

APPENDIX A-3 : ProUCL Raw Output
Statistical Summary of Detected Analytes in IRA Subsurface Soil Samples
RVAAP-03 Open Demolition Area 1

Calcium

General Statistics

Number of Valid Observations	23	Number of Distinct Observations	23

Raw Statistics		**Log-transformed Statistics**	
Minimum	213	Minimum of Log Data	5.361
Maximum	17100	Maximum of Log Data	9.747
Mean	3207	Mean of log Data	7.575
Median	1700	SD of log Data	0.971
SD	4031		
Coefficient of Variation	1.257		
Skewness	2.472		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.638	Shapiro Wilk Test Statistic	0.927
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	4650	95% H-UCL	5227
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	6046
95% Adjusted-CLT UCL	5053	97.5% Chebyshev (MVUE) UCL	7349
95% Modified-t UCL	4723	99% Chebyshev (MVUE) UCL	9908
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.021	**Data appear Lognormal at 5% Significance Level**	
Theta Star	3140		
MLE of Mean	3207		
MLE of Standard Deviation	3173		
nu star	46.98		
Approximate Chi Square Value (.05)	32.25	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	4590
Adjusted Chi Square Value	31.37	95% Jackknife UCL	4650
		95% Standard Bootstrap UCL	4583
Anderson-Darling Test Statistic	1.602	95% Bootstrap-t UCL	6032
Anderson-Darling 5% Critical Value	0.767	95% Hall's Bootstrap UCL	6023
Kolmogorov-Smirnov Test Statistic	0.293	95% Percentile Bootstrap UCL	4717
Kolmogorov-Smirnov 5% Critical Value	0.186	95% BCA Bootstrap UCL	5254
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	6871
		97.5% Chebyshev(Mean, Sd) UCL	8456
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	11570
95% Approximate Gamma UCL	4672		
95% Adjusted Gamma UCL	4804		
Potential UCL to Use		Use 95% H-UCL	5227

APPENDIX A-3 : ProUCL Raw Output
Statistical Summary of Detected Analytes in IRA Subsurface Soil Samples
RVAAP-03 Open Demolition Area 1

Chromium

General Statistics

Number of Valid Observations	23	Number of Distinct Observations	20

Raw Statistics		**Log-transformed Statistics**	
Minimum	14.7	Minimum of Log Data	2.688
Maximum	249	Maximum of Log Data	5.517
Mean	28.78	Mean of log Data	3.039
Median	19.4	SD of log Data	0.551
SD	48.05		
Coefficient of Variation	1.67		
Skewness	4.783		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.249	Shapiro Wilk Test Statistic	0.387
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	45.98	95% H-UCL	30.81
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	36.78
95% Adjusted-CLT UCL	55.93	97.5% Chebyshev (MVUE) UCL	42.26
95% Modified-t UCL	47.65	99% Chebyshev (MVUE) UCL	53.01
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.514	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	19		
MLE of Mean	28.78		
MLE of Standard Deviation	23.39		
nu star	69.66		
Approximate Chi Square Value (.05)	51.44	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	45.26
Adjusted Chi Square Value	50.31	95% Jackknife UCL	45.98
		95% Standard Bootstrap UCL	45.31
Anderson-Darling Test Statistic	6.599	95% Bootstrap-t UCL	323.6
Anderson-Darling 5% Critical Value	0.758	95% Hall's Bootstrap UCL	209
Kolmogorov-Smirnov Test Statistic	0.473	95% Percentile Bootstrap UCL	48.83
Kolmogorov-Smirnov 5% Critical Value	0.184	95% BCA Bootstrap UCL	59.19
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	72.45
		97.5% Chebyshev(Mean, Sd) UCL	91.34
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	128.5
95% Approximate Gamma UCL	38.97		
95% Adjusted Gamma UCL	39.85		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	72.45

APPENDIX A-3 : ProUCL Raw Output
Statistical Summary of Detected Analytes in IRA Subsurface Soil Samples
RVAAP-03 Open Demolition Area 1

Cobalt

General Statistics

Number of Valid Observations	23	Number of Distinct Observations	21

Raw Statistics		**Log-transformed Statistics**	
Minimum	1.4	Minimum of Log Data	0.336
Maximum	16.2	Maximum of Log Data	2.785
Mean	10.57	Mean of log Data	2.29
Median	10.7	SD of log Data	0.468
SD	2.915		
Coefficient of Variation	0.276		
Skewness	-1.175		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.917	Shapiro Wilk Test Statistic	0.617
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data appear Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	11.62	95% H-UCL	13.38
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	15.78
95% Adjusted-CLT UCL	11.41	97.5% Chebyshev (MVUE) UCL	17.87
95% Modified-t UCL	11.59	99% Chebyshev (MVUE) UCL	21.97
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	6.483	**Data appear Normal at 5% Significance Level**	
Theta Star	1.631		
MLE of Mean	10.57		
MLE of Standard Deviation	4.153		
nu star	298.2		
Approximate Chi Square Value (.05)	259.2	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	11.57
Adjusted Chi Square Value	256.6	95% Jackknife UCL	11.62
		95% Standard Bootstrap UCL	11.55
Anderson-Darling Test Statistic	1.637	95% Bootstrap-t UCL	11.45
Anderson-Darling 5% Critical Value	0.745	95% Hall's Bootstrap UCL	11.44
Kolmogorov-Smirnov Test Statistic	0.207	95% Percentile Bootstrap UCL	11.51
Kolmogorov-Smirnov 5% Critical Value	0.182	95% BCA Bootstrap UCL	11.4
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	13.22
		97.5% Chebyshev(Mean, Sd) UCL	14.37
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	16.62
95% Approximate Gamma UCL	12.16		
95% Adjusted Gamma UCL	12.29		
Potential UCL to Use		Use 95% Student's-t UCL	11.62

APPENDIX A-3 : ProUCL Raw Output
Statistical Summary of Detected Analytes in IRA Subsurface Soil Samples
RVAAP-03 Open Demolition Area 1

Copper

General Statistics			
Number of Valid Observations	23	Number of Distinct Observations	19

Raw Statistics		Log-transformed Statistics	
Minimum	17	Minimum of Log Data	2.833
Maximum	74200	Maximum of Log Data	11.21
Mean	3250	Mean of log Data	3.488
Median	22	SD of log Data	1.719
SD	15467		
Coefficient of Variation	4.759		
Skewness	4.796		

Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.216	Shapiro Wilk Test Statistic	0.341
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	8788	95% H-UCL	535.6
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	369.2
95% Adjusted-CLT UCL	12001	97.5% Chebyshev (MVUE) UCL	474.8
95% Modified-t UCL	9325	99% Chebyshev (MVUE) UCL	682.3
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.172	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	18860		
MLE of Mean	3250		
MLE of Standard Deviation	7829		
nu star	7.927		
Approximate Chi Square Value (.05)	2.693	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	8555
Adjusted Chi Square Value	2.476	95% Jackknife UCL	8788
		95% Standard Bootstrap UCL	8522
Anderson-Darling Test Statistic	8.436	95% Bootstrap-t UCL	13715233
Anderson-Darling 5% Critical Value	0.908	95% Hall's Bootstrap UCL	6117732
Kolmogorov-Smirnov Test Statistic	0.539	95% Percentile Bootstrap UCL	9700
Kolmogorov-Smirnov 5% Critical Value	0.202	95% BCA Bootstrap UCL	12933
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	17308
		97.5% Chebyshev(Mean, Sd) UCL	23390
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	35338
95% Approximate Gamma UCL	9567		
95% Adjusted Gamma UCL	10404		
Potential UCL to Use		Use 99% Chebyshev (Mean, Sd) UCL	35338

APPENDIX A-3 : ProUCL Raw Output
Statistical Summary of Detected Analytes in IRA Subsurface Soil Samples
RVAAP-03 Open Demolition Area 1

Iron

General Statistics			
Number of Valid Observations	23	Number of Distinct Observations	21

Raw Statistics		Log-transformed Statistics	
Minimum	2100	Minimum of Log Data	7.65
Maximum	35900	Maximum of Log Data	10.49
Mean	26587	Mean of log Data	10.11
Median	28400	SD of log Data	0.55
SD	6284		
Coefficient of Variation	0.236		
Skewness	-2.736		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.719	Shapiro Wilk Test Statistic	0.409
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	28837	95% H-UCL	36226
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	43236
95% Adjusted-CLT UCL	27943	97.5% Chebyshev (MVUE) UCL	49660
95% Modified-t UCL	28712	99% Chebyshev (MVUE) UCL	62279
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	5.746	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	4627		
MLE of Mean	26587		
MLE of Standard Deviation	11091		
nu star	264.3		
Approximate Chi Square Value (.05)	227.7	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	28742
Adjusted Chi Square Value	225.2	95% Jackknife UCL	28837
		95% Standard Bootstrap UCL	28714
Anderson-Darling Test Statistic	3.852	95% Bootstrap-t UCL	28219
Anderson-Darling 5% Critical Value	0.746	95% Hall's Bootstrap UCL	28173
Kolmogorov-Smirnov Test Statistic	0.357	95% Percentile Bootstrap UCL	28387
Kolmogorov-Smirnov 5% Critical Value	0.182	95% BCA Bootstrap UCL	28109
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	32298
		97.5% Chebyshev(Mean, Sd) UCL	34770
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	39624
95% Approximate Gamma UCL	30867		
95% Adjusted Gamma UCL	31204		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	32298

APPENDIX A-3 : ProUCL Raw Output
Statistical Summary of Detected Analytes in IRA Subsurface Soil Samples
RVAAP-03 Open Demolition Area 1

Lead

General Statistics			
Number of Valid Observations	23	Number of Distinct Observations	22
Raw Statistics		**Log-transformed Statistics**	
Minimum	11.1	Minimum of Log Data	2.407
Maximum	2370	Maximum of Log Data	7.771
Mean	117	Mean of log Data	2.884
Median	14.3	SD of log Data	1.079
SD	491.2		
Coefficient of Variation	4.2		
Skewness	4.796		

Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.22	Shapiro Wilk Test Statistic	0.353
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	292.8	95% H-UCL	58.63
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	65.47
95% Adjusted-CLT UCL	394.8	97.5% Chebyshev (MVUE) UCL	80.45
95% Modified-t UCL	309.9	99% Chebyshev (MVUE) UCL	109.9
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.339	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	344.6		
MLE of Mean	117		
MLE of Standard Deviation	200.7		
nu star	15.61		
Approximate Chi Square Value (.05)	7.689	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	285.4
Adjusted Chi Square Value	7.288	95% Jackknife UCL	292.8
		95% Standard Bootstrap UCL	280.7
Anderson-Darling Test Statistic	8.02	95% Bootstrap-t UCL	24415
Anderson-Darling 5% Critical Value	0.836	95% Hall's Bootstrap UCL	7966
Kolmogorov-Smirnov Test Statistic	0.541	95% Percentile Bootstrap UCL	321.7
Kolmogorov-Smirnov 5% Critical Value	0.195	95% BCA Bootstrap UCL	424.9
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	563.4
		97.5% Chebyshev(Mean, Sd) UCL	756.5
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1136
95% Approximate Gamma UCL	237.5		
95% Adjusted Gamma UCL	250.5		
Potential UCL to Use		Use 99% Chebyshev (Mean, Sd) UCL	1136

APPENDIX A-3 : ProUCL Raw Output
Statistical Summary of Detected Analytes in IRA Subsurface Soil Samples
RVAAP-03 Open Demolition Area 1

Magnesium

General Statistics			
Number of Valid Observations	23	Number of Distinct Observations	23

Raw Statistics		Log-transformed Statistics	
Minimum	486	Minimum of Log Data	6.186
Maximum	5430	Maximum of Log Data	8.6
Mean	3879	Mean of log Data	8.192
Median	3930	SD of log Data	0.479
SD	1079		
Coefficient of Variation	0.278		
Skewness	-1.19		

Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.91	Shapiro Wilk Test Statistic	0.608
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	4265	95% H-UCL	4947
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	5848
95% Adjusted-CLT UCL	4189	97.5% Chebyshev (MVUE) UCL	6635
95% Modified-t UCL	4256	99% Chebyshev (MVUE) UCL	8181
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	6.27	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	618.6		
MLE of Mean	3879		
MLE of Standard Deviation	1549		
nu star	288.4		
Approximate Chi Square Value (.05)	250.1	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	4249
Adjusted Chi Square Value	247.5	95% Jackknife UCL	4265
		95% Standard Bootstrap UCL	4236
Anderson-Darling Test Statistic	1.563	95% Bootstrap-t UCL	4220
Anderson-Darling 5% Critical Value	0.745	95% Hall's Bootstrap UCL	4203
Kolmogorov-Smirnov Test Statistic	0.196	95% Percentile Bootstrap UCL	4235
Kolmogorov-Smirnov 5% Critical Value	0.182	95% BCA Bootstrap UCL	4182
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	4860
		97.5% Chebyshev(Mean, Sd) UCL	5284
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	6118
95% Approximate Gamma UCL	4474		
95% Adjusted Gamma UCL	4520		
Potential UCL to Use		Use 95% Student's-t UCL	4265
		or 95% Modified-t UCL	4256

APPENDIX A-3 : ProUCL Raw Output
Statistical Summary of Detected Analytes in IRA Subsurface Soil Samples
RVAAP-03 Open Demolition Area 1

Manganese

General Statistics

Number of Valid Observations	23	Number of Distinct Observations	22

Raw Statistics		**Log-transformed Statistics**	
Minimum	204	Minimum of Log Data	5.318
Maximum	432	Maximum of Log Data	6.068
Mean	325.4	Mean of log Data	5.768
Median	322	SD of log Data	0.193
SD	60.25		
Coefficient of Variation	0.185		
Skewness	-0.106		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.965	Shapiro Wilk Test Statistic	0.952
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	347	95% H-UCL	350.3
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	383
95% Adjusted-CLT UCL	345.8	97.5% Chebyshev (MVUE) UCL	407.9
95% Modified-t UCL	347	99% Chebyshev (MVUE) UCL	456.7
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	25.37	**Data appear Normal at 5% Significance Level**	
Theta Star	12.83		
MLE of Mean	325.4		
MLE of Standard Deviation	64.61		
nu star	1167		
Approximate Chi Square Value (.05)	1089	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	346.1
Adjusted Chi Square Value	1083	95% Jackknife UCL	347
		95% Standard Bootstrap UCL	346
Anderson-Darling Test Statistic	0.441	95% Bootstrap-t UCL	347.4
Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL	346.1
Kolmogorov-Smirnov Test Statistic	0.127	95% Percentile Bootstrap UCL	345.6
Kolmogorov-Smirnov 5% Critical Value	0.181	95% BCA Bootstrap UCL	344.8
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	380.2
		97.5% Chebyshev(Mean, Sd) UCL	403.9
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	450.4
95% Approximate Gamma UCL	348.8		
95% Adjusted Gamma UCL	350.6		
Potential UCL to Use		Use 95% Student's-t UCL	347

APPENDIX A-3 : ProUCL Raw Output
Statistical Summary of Detected Analytes in IRA Subsurface Soil Samples
RVAAP-03 Open Demolition Area 1

Mercury

General Statistics

Number of Valid Observations	8	Number of Distinct Observations	8
Number of Missing Values	15		

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.0018	Minimum of Log Data	-6.32
Maximum	0.055	Maximum of Log Data	-2.9
Mean	0.0191	Mean of log Data	-4.28
Median	0.0155	SD of log Data	0.967
SD	0.0159		
Coefficient of Variation	0.83		
Skewness	1.92		

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.8	Shapiro Wilk Test Statistic	0.878
Shapiro Wilk Critical Value	0.818	Shapiro Wilk Critical Value	0.818
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.0297	95% H-UCL	0.0751
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.0517
95% Adjusted-CLT UCL	0.0324	97.5% Chebyshev (MVUE) UCL	0.0652
95% Modified-t UCL	0.0304	99% Chebyshev (MVUE) UCL	0.0917
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.145	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	0.0167		
MLE of Mean	0.0191		
MLE of Standard Deviation	0.0178		
nu star	18.32		
Approximate Chi Square Value (.05)	9.622	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0195	95% CLT UCL	0.0283
Adjusted Chi Square Value	8.078	95% Jackknife UCL	0.0297
		95% Standard Bootstrap UCL	0.0276
Anderson-Darling Test Statistic	0.418	95% Bootstrap-t UCL	0.0411
Anderson-Darling 5% Critical Value	0.727	95% Hall's Bootstrap UCL	0.0766
Kolmogorov-Smirnov Test Statistic	0.223	95% Percentile Bootstrap UCL	0.0292
Kolmogorov-Smirnov 5% Critical Value	0.298	95% BCA Bootstrap UCL	0.0309
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.0435
		97.5% Chebyshev(Mean, Sd) UCL	0.0541
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.0749
95% Approximate Gamma UCL	0.0364		
95% Adjusted Gamma UCL	0.0433		
Potential UCL to Use		Use 95% Approximate Gamma UCL	0.0364

APPENDIX A-3 : ProUCL Raw Output
Statistical Summary of Detected Analytes in IRA Subsurface Soil Samples
RVAAP-03 Open Demolition Area 1

Nickel

General Statistics			
Number of Valid Observations	23	Number of Distinct Observations	22

Raw Statistics		Log-transformed Statistics	
Minimum	19.4	Minimum of Log Data	2.965
Maximum	156	Maximum of Log Data	5.05
Mean	32.27	Mean of log Data	3.345
Median	28.1	SD of log Data	0.409
SD	27.34		
Coefficient of Variation	0.847		
Skewness	4.586		

Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.359	Shapiro Wilk Test Statistic	0.613
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	42.06	95% H-UCL	36.41
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	42.47
95% Adjusted-CLT UCL	47.47	97.5% Chebyshev (MVUE) UCL	47.55
95% Modified-t UCL	42.96	99% Chebyshev (MVUE) UCL	57.54
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	3.548	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	9.093		
MLE of Mean	32.27		
MLE of Standard Deviation	17.13		
nu star	163.2		
Approximate Chi Square Value (.05)	134.7	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	41.64
Adjusted Chi Square Value	132.8	95% Jackknife UCL	42.06
		95% Standard Bootstrap UCL	41.38
Anderson-Darling Test Statistic	3.594	95% Bootstrap-t UCL	73.53
Anderson-Darling 5% Critical Value	0.749	95% Hall's Bootstrap UCL	82.62
Kolmogorov-Smirnov Test Statistic	0.338	95% Percentile Bootstrap UCL	43.6
Kolmogorov-Smirnov 5% Critical Value	0.182	95% BCA Bootstrap UCL	49.69
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	57.12
		97.5% Chebyshev(Mean, Sd) UCL	67.87
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	88.99
95% Approximate Gamma UCL	39.1		
95% Adjusted Gamma UCL	39.65		
Potential UCL to Use		Use 95% Student's-t UCL	42.06
		or 95% Modified-t UCL	42.96

APPENDIX A-3 : ProUCL Raw Output
Statistical Summary of Detected Analytes in IRA Subsurface Soil Samples
RVAAP-03 Open Demolition Area 1

Potassium

General Statistics

Number of Valid Observations	23	Number of Distinct Observations	21

Raw Statistics		**Log-transformed Statistics**	
Minimum	41.3	Minimum of Log Data	3.721
Maximum	2720	Maximum of Log Data	7.908
Mean	1904	Mean of log Data	7.408
Median	2040	SD of log Data	0.83
SD	553.7		
Coefficient of Variation	0.291		
Skewness	-1.808		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.855	Shapiro Wilk Test Statistic	0.431
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	2103	95% H-UCL	3504
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	4170
95% Adjusted-CLT UCL	2048	97.5% Chebyshev (MVUE) UCL	4987
95% Modified-t UCL	2095	99% Chebyshev (MVUE) UCL	6592
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	3.183	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	598.3		
MLE of Mean	1904		
MLE of Standard Deviation	1067		
nu star	146.4		
Approximate Chi Square Value (.05)	119.4	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	2094
Adjusted Chi Square Value	117.7	95% Jackknife UCL	2103
		95% Standard Bootstrap UCL	2090
Anderson-Darling Test Statistic	3.343	95% Bootstrap-t UCL	2068
Anderson-Darling 5% Critical Value	0.75	95% Hall's Bootstrap UCL	2070
Kolmogorov-Smirnov Test Statistic	0.299	95% Percentile Bootstrap UCL	2082
Kolmogorov-Smirnov 5% Critical Value	0.183	95% BCA Bootstrap UCL	2050
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	2408
		97.5% Chebyshev(Mean, Sd) UCL	2625
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	3053
95% Approximate Gamma UCL	2334		
95% Adjusted Gamma UCL	2369		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	2408

APPENDIX A-3 : ProUCL Raw Output
Statistical Summary of Detected Analytes in IRA Subsurface Soil Samples
RVAAP-03 Open Demolition Area 1

Selenium

General Statistics

Number of Valid Observations	5	Number of Distinct Observations	5
Number of Missing Values	18		

Raw Statistics		Log-transformed Statistics	
Minimum	0.4	Minimum of Log Data	-0.916
Maximum	0.97	Maximum of Log Data	-0.0305
Mean	0.572	Mean of log Data	-0.613
Median	0.48	SD of log Data	0.351
SD	0.231		
Coefficient of Variation	0.404		
Skewness	1.849		

Warning: A sample size of 'n' = 5 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!

If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 5 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set,

the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.787	Shapiro Wilk Test Statistic	0.862
Shapiro Wilk Critical Value	0.762	Shapiro Wilk Critical Value	0.762
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.792	95% H-UCL	0.897
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.956
95% Adjusted-CLT UCL	0.833	97.5% Chebyshev (MVUE) UCL	1.124
95% Modified-t UCL	0.807	99% Chebyshev (MVUE) UCL	1.453

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	3.892	**Data appear Normal at 5% Significance Level**	
Theta Star	0.147		
MLE of Mean	0.572		
MLE of Standard Deviation	0.29		
nu star	38.92		
Approximate Chi Square Value (.05)	25.63	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0086	95% CLT UCL	0.742
Adjusted Chi Square Value	21.04	95% Jackknife UCL	0.792
		95% Standard Bootstrap UCL	0.725
Anderson-Darling Test Statistic	0.509	95% Bootstrap-t UCL	1.429
Anderson-Darling 5% Critical Value	0.679	95% Hall's Bootstrap UCL	1.598
Kolmogorov-Smirnov Test Statistic	0.261	95% Percentile Bootstrap UCL	0.75
Kolmogorov-Smirnov 5% Critical Value	0.358	95% BCA Bootstrap UCL	0.792
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1.023
		97.5% Chebyshev(Mean, Sd) UCL	1.218
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1.601
95% Approximate Gamma UCL	0.869		
95% Adjusted Gamma UCL	1.058		
Potential UCL to Use		Use 95% Student's-t UCL	0.792

APPENDIX A-3 : ProUCL Raw Output
Statistical Summary of Detected Analytes in IRA Subsurface Soil Samples
RVAAP-03 Open Demolition Area 1

Silver

General Statistics

Number of Valid Observations	1	Number of Distinct Observations	1
Number of Missing Values	22		

Warning: This data set only has 1 observations!

Data set is too small to compute reliable and meaningful statistics and estimates!

The data set for variable Silver was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!

If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

APPENDIX A-3 : ProUCL Raw Output
Statistical Summary of Detected Analytes in IRA Subsurface Soil Samples
RVAAP-03 Open Demolition Area 1

Sodium

General Statistics

Number of Valid Observations	20	Number of Distinct Observations	20
Number of Missing Values	3		

Raw Statistics		**Log-transformed Statistics**	
Minimum	53.3	Minimum of Log Data	3.976
Maximum	1030	Maximum of Log Data	6.937
Mean	472.3	Mean of log Data	5.586
Median	132.5	SD of log Data	1.174
SD	425.2		
Coefficient of Variation	0.9		
Skewness	0.247		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.725	Shapiro Wilk Test Statistic	0.778
Shapiro Wilk Critical Value	0.905	Shapiro Wilk Critical Value	0.905
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	636.7	95% H-UCL	1159
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1166
95% Adjusted-CLT UCL	634.3	97.5% Chebyshev (MVUE) UCL	1452
95% Modified-t UCL	637.6	99% Chebyshev (MVUE) UCL	2015
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.891	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	530		
MLE of Mean	472.3		
MLE of Standard Deviation	500.3		
nu star	35.65		
Approximate Chi Square Value (.05)	22.99	**Nonparametric Statistics**	
Adjusted Level of Significance	0.038	95% CLT UCL	628.7
Adjusted Chi Square Value	22.18	95% Jackknife UCL	636.7
		95% Standard Bootstrap UCL	626.5
Anderson-Darling Test Statistic	2.342	95% Bootstrap-t UCL	643.1
Anderson-Darling 5% Critical Value	0.768	95% Hall's Bootstrap UCL	615.1
Kolmogorov-Smirnov Test Statistic	0.303	95% Percentile Bootstrap UCL	617.9
Kolmogorov-Smirnov 5% Critical Value	0.199	95% BCA Bootstrap UCL	633.1
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	886.7
		97.5% Chebyshev(Mean, Sd) UCL	1066
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1418
95% Approximate Gamma UCL	732.5		
95% Adjusted Gamma UCL	759		
Potential UCL to Use		Use 99% Chebyshev (Mean, Sd) UCL	1418

Recommended UCL exceeds the maximum observation

Thallium

General Statistics

Number of Valid Observations	5	Number of Distinct Observations	4
Number of Missing Values	14		

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.17	Minimum of Log Data	-1.772
Maximum	0.22	Maximum of Log Data	-1.514
Mean	0.198	Mean of log Data	-1.625
Median	0.2	SD of log Data	0.117
SD	0.0228		
Coefficient of Variation	0.115		
Skewness	-0.228		

Warning: There are only 4 Distinct Values in this data

There are insufficient Distinct Values to perform some GOF tests and bootstrap methods.

Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values to compute bootstrap methods.

However, results obtained using 4 to 9 distinct values may not be reliable.

It is recommended to have 10-15 or more observations for accurate and meaningful bootstrap results.

Warning: A sample size of 'n' = 5 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!

If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.884	Shapiro Wilk Test Statistic	0.886
Shapiro Wilk Critical Value	0.762	Shapiro Wilk Critical Value	0.762
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.22	95% H-UCL	0.224
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.243
95% Adjusted-CLT UCL	0.214	97.5% Chebyshev (MVUE) UCL	0.263
95% Modified-t UCL	0.22	99% Chebyshev (MVUE) UCL	0.301
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	37.23	**Data appear Normal at 5% Significance Level**	
Theta Star	0.00532		
MLE of Mean	0.198		
MLE of Standard Deviation	0.0325		
nu star	372.3		
Approximate Chi Square Value (.05)	328.6	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0086	95% CLT UCL	0.215
Adjusted Chi Square Value	310.4	95% Jackknife UCL	0.22
		95% Standard Bootstrap UCL	0.212
Anderson-Darling Test Statistic	0.39	95% Bootstrap-t UCL	0.219
Anderson-Darling 5% Critical Value	0.678	95% Hall's Bootstrap UCL	0.213
Kolmogorov-Smirnov Test Statistic	0.257	95% Percentile Bootstrap UCL	0.212
Kolmogorov-Smirnov 5% Critical Value	0.357	95% BCA Bootstrap UCL	0.212
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.242
		97.5% Chebyshev(Mean, Sd) UCL	0.262
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.299
95% Approximate Gamma UCL	0.224		
95% Adjusted Gamma UCL	0.237		
Potential UCL to Use		Use 95% Student's-t UCL	0.22

APPENDIX A-3 : ProUCL Raw Output
Statistical Summary of Detected Analytes in IRA Subsurface Soil Samples
RVAAP-03 Open Demolition Area 1

Vanadium

General Statistics			
Number of Valid Observations	23	Number of Distinct Observations	20
Raw Statistics		**Log-transformed Statistics**	
Minimum	7.5	Minimum of Log Data	2.015
Maximum	27.3	Maximum of Log Data	3.307
Mean	21.55	Mean of log Data	3.045
Median	22.5	SD of log Data	0.256
SD	4.009		
Coefficient of Variation	0.186		
Skewness	-2.052		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.824	Shapiro Wilk Test Statistic	0.653
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	22.98	95% H-UCL	23.95
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	26.78
95% Adjusted-CLT UCL	22.54	97.5% Chebyshev (MVUE) UCL	28.98
95% Modified-t UCL	22.92	99% Chebyshev (MVUE) UCL	33.31
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	17.69	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	1.218		
MLE of Mean	21.55		
MLE of Standard Deviation	5.124		
nu star	813.5		
Approximate Chi Square Value (.05)	748.4	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	22.92
Adjusted Chi Square Value	743.8	95% Jackknife UCL	22.98
		95% Standard Bootstrap UCL	22.92
Anderson-Darling Test Statistic	1.919	95% Bootstrap-t UCL	22.7
Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL	22.65
Kolmogorov-Smirnov Test Statistic	0.249	95% Percentile Bootstrap UCL	22.77
Kolmogorov-Smirnov 5% Critical Value	0.181	95% BCA Bootstrap UCL	22.57
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	25.19
		97.5% Chebyshev(Mean, Sd) UCL	26.77
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	29.86
95% Approximate Gamma UCL	23.42		
95% Adjusted Gamma UCL	23.57		
Potential UCL to Use		Use 95% Student's-t UCL	22.98
		or 95% Modified-t UCL	22.92

APPENDIX A-3 : ProUCL Raw Output
Statistical Summary of Detected Analytes in IRA Subsurface Soil Samples
RVAAP-03 Open Demolition Area 1

Zinc

General Statistics

Number of Valid Observations	23	Number of Distinct Observations	23

Raw Statistics		**Log-transformed Statistics**	
Minimum	50.7	Minimum of Log Data	3.926
Maximum	32100	Maximum of Log Data	10.38
Mean	1456	Mean of log Data	4.407
Median	62.9	SD of log Data	1.311
SD	6680		
Coefficient of Variation	4.587		
Skewness	4.796		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.217	Shapiro Wilk Test Statistic	0.31
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	3848	95% H-UCL	443.7
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	439.7
95% Adjusted-CLT UCL	5236	97.5% Chebyshev (MVUE) UCL	551.3
95% Modified-t UCL	4080	99% Chebyshev (MVUE) UCL	770.4
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.244	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	5967		
MLE of Mean	1456		
MLE of Standard Deviation	2948		
nu star	11.23		
Approximate Chi Square Value (.05)	4.723	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	3747
Adjusted Chi Square Value	4.42	95% Jackknife UCL	3848
		95% Standard Bootstrap UCL	3689
Anderson-Darling Test Statistic	8.513	95% Bootstrap-t UCL	1284755
Anderson-Darling 5% Critical Value	0.873	95% Hall's Bootstrap UCL	625244
Kolmogorov-Smirnov Test Statistic	0.553	95% Percentile Bootstrap UCL	4241
Kolmogorov-Smirnov 5% Critical Value	0.199	95% BCA Bootstrap UCL	5639
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	7528
		97.5% Chebyshev(Mean, Sd) UCL	10155
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	15315
95% Approximate Gamma UCL	3462		
95% Adjusted Gamma UCL	3700		
Potential UCL to Use		Use 99% Chebyshev (Mean, Sd) UCL	15315

2,4,6-Trinitrotoluene

General Statistics

Number of Valid Observations	1	Number of Distinct Observations	1
Number of Missing Values	22		

Warning: This data set only has 1 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Nitrobenzene was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Nitrocellulose

General Statistics

Number of Valid Observations	3	Number of Distinct Observations	3
Number of Missing Values	8		

Warning: This data set only has 3 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Nitrocellulose was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Toluene

General Statistics

Number of Valid Observations	2	Number of Distinct Observations	2
Number of Missing Values	4		

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Toluene was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

APPENDIX B
COMMENT RESPONSE TABLE

Draft Data Quality Objectives Report for Open Demolition Area 1 (RVAAP-03)
Ravenna Army Ammunition Plant, Ravenna, Ohio
Comment Response Table
Revision 1

Cmt. No.	Page or Sheet	Comment	Recommendation	Response
OHARNG - Katie Elgin (August 26, 2009)				
1	Document Distribution	"National Guard Bureau (OHARNG)" We are not National Guard Bureau. Please list as OHARNG-Camp Ravenna on the Document Distribution list.		The distribution list will be revised as requested.
2	Figure 1-2 RVAAP Facility Map	Please highlight the correct AOC area. Delete Load Line text and leader lines to the load lines.		The figure will be revised as requested.
3	Pg 1-5, Lines 6 and 11	Please delete all references to RTLS.		The text will be revised as requested by replacing 'RTLS' with 'Camp Ravenna.'
4	Pg 1-5, Line 15	"The ODA1 AOC is an estimated 6 acre parcel located within the National Advisory Committee for Aeronautics Test Area (NTA) (RVAAP-38) that was used primarily for the open burning and open detonation of munitions, explosives and associated materials." Here it sounds like NACA was used for OB/OD activities. Please revise.	Suggested text: "ODA1 is approximately 6 acres and was formerly used for the open burning and open detonation of munitions, explosives, and associated materials. ODA1 is located within the National Advisory Committee for Aeronautics (NACA) Test Area (NTA) (RVAAP-38)."	The text will be revised as requested.
5	Pg 1-5, Line 20	"Recent visual inspections of the site indicate that OB/OD activities associated with the ODA1 may have also been conducted in small areas within the NTA plane storage area adjacent to ODA1." What recent visual inspections? Conducted by whom?		The recent visual inspections were conducted by Ohio EPA in July 2008 and referenced in an August 18, 2009 letter to the RVAAP Facility Manager. The information was relayed to Shaw during the December 30, 2008 data gaps conference call attended by Ohio EPA, Shaw, and USACE. The text will be revised as follows: "Historical information and visual inspections conducted in 2008 indicate that the boundaries of ODA1 may not have been fully defined. MEC/MD has been observed in areas outside of the previously remediated areas and north of the former NACA crash strip."

Draft Data Quality Objectives Report for Open Demolition Area 1 (RVAAP-03)
Ravenna Army Ammunition Plant, Ravenna, Ohio
Comment Response Table
Revision 1

Cmt. No.	Page or Sheet	Comment	Recommendation	Response
6	Pg 1-14, Line 15	"Also, at the time of MKM's report, approximately 8 cubic yards of VOC impacted soils remained at the site pending removal from the site." Does this still remain onsite? Please indicate the disposition.		According to MKM's 2004 IRA Report, the 8 cy was temporarily staged in Building G-3 within Load Line 4 until sufficient additional volume could be collected to make a full truckload for offsite disposal. URS removed staged soils from Load Line 4 for offsite disposal in 2008 and the manifest is on file at RVAAP. The following sentence will be added to the text: "The 8 cubic yards was transported offsite for disposal by URS in 2008."
7	Pg 5-1, Line 25	"The Phase I RI conclusions indicate that ODA1 is not a source for impact to sediments and surface water based on its location within NTA and the topography over which …" How is the location of ODA1 in NTA relate to the impact on sediments and surface water? I think what you meant here is that it is far from a surface water body. Please revise.		The text will be revised as requested by replacing the identified sentence with the following: "The results of the Phase I RI indicated that sediment and surface water in Hinkley Creek, the receiving water for stormwater drainages from ODA1, do not appear to have received contamination related to former operations at ODA1." The definition of 'significant' is presented in prior sections of the DQO Report as summarized from the Phase I RI.
8	Pg 5-1, Line 6	"… have been compared to the current RVAAP background values and the current most restrictive risk based Draft CUGs for contaminants detected at the site." What does 'most restrictive risked based CUGs' mean? Recommend deleting 'most restrictive'.		The most restrictive risk-based CUG refers to the lowest value of the risk-based CUGs for each land use scenario and all of the receptors for each constituent. The text will be revised as requested where the term appears in Sections 2 and 5.
Ohio EPA - Eileen T. Mohr (August 31, 2009)				
9	Fig 1-2	LLs 1-4 are highlighted.	Remove highlighting from LL1-4 and highlight ODA1 instead.	The figure will be revised as requested.

Draft Data Quality Objectives Report for Open Demolition Area 1 (RVAAP-03)
Ravenna Army Ammunition Plant, Ravenna, Ohio
Comment Response Table
Revision 1

Cmt. No.	Page or Sheet	Comment	Recommendation	Response
10	1-5/36	Clarification requested.	Is there any text in the Phase I that indicates why the particular sampling intervals were chosen?	The Phase I RI does not provide a rationale for the subsurface soil sample intervals. The associated SAP (*Final Sampling and Analysis Plan Addendum No. 1 for the Phase I RI of Demolition Area 1 at RVAAP*, October 1999, SAIC for USACE) wherein the sampling rationale may be provided, is not available for review electronically on REIMS or www.rvaap.org. The Phase I RI does state that the 0 to 1 ft bgs sampling interval for surface soils was selected "for compatibility with DQOs for the risk screening and any future baseline risk assessment." Presumably, the subsurface soil sampling intervals were selected for the same risk assessment compatibility purpose. However, the 5-6 ft bgs interval was likely skipped in favor of the 6-8 ft bgs sampling interval to fulfill the stated Phase I RI objective of assessing soils to a depth of 8 ft bgs.

Draft Data Quality Objectives Report for Open Demolition Area 1 (RVAAP-03)
Ravenna Army Ammunition Plant, Ravenna, Ohio
Comment Response Table
Revision 1

Cmt. No.	Page or Sheet	Comment	Recommendation	Response
11	1-6/1	Clarification requested.	If I remember correctly, only one well point was installed at ODA1. Groundwater data from a wellpoint is solely used for screening purposes, i.e., any detects are considered minimal values and non-detects do not definitively indicate lack of contamination. Add information to the text that the data referenced in this section is solely from one well point and what wellpoint data represents.	The text will be revised as requested by adding the following after the first sentence in the identified paragraph: "The one groundwater sample collected under the Phase I RI was obtained using direct-push boring techniques. Groundwater obtained from well points at RVAAP is solely used for screening purposes. Specifically, any detects are considered minimal values and non-detects do not definitively indicate lack of contamination. Groundwater data that is used at RVAAP for the purpose of evaluation, risk assessment, etc., must be obtained from properly installed, developed and sampled monitoring wells."
12	1-6/36	The text references a detect of RDX at HC-2 on one occasion.	Please provide the date.	The water quality surveillance program was performed annually from 1980 through 1992. The one-time maximum detect of RDX occurred at HC-2 (4.8 µg/L). This RDX concentration is less than the CUGs for surface water for each of the receptor scenarios presented in the September 2008 *Draft Facility-Wide Human Health Remediation Goals at the RVAAP* (SAIC, 2008). The text will be revised to include the USATHAMA report reference which includes the years of data collection.
13	1-6/23	Clarification requested.	If I remember correctly, only one well point was installed at ODA1. Groundwater data from a wellpoint is solely used for screening purposes, i.e., any detects are considered minimal values and non-detects do not definitively indicate lack of contamination. Add information to the text that the data referenced in this section is solely from one well point and what wellpoint data represents.	The identified line is on Page 1-9. The text will be revised as requested by inserting the text from Comment No. 11 after the second sentence in the opening paragraph of Section 1.3.1.3.

Draft Data Quality Objectives Report for Open Demolition Area 1 (RVAAP-03)
Ravenna Army Ammunition Plant, Ravenna, Ohio
Comment Response Table
Revision 1

Cmt. No.	Page or Sheet	Comment	Recommendation	Response
14	1-10/ 21-26	The text references aluminum and chromium. Only aluminum was discussed.	Add a discussion of chromium.	The text will be revised as requested by inserting the following sentence into the identified paragraph: "The only chromium result greater than background (18.1 mg/kg) occurred at station DA1-046 at HC-2 (18.8 mg/kg)."
15	1-10/ 34	Text change requested.	Change text to read: "…indicating the contaminants are not related to ODA1."	The text will be revised as requested.
16	1-14/ 15-17	Update requested.	Please provide an update as to the disposition of the 8 cu yds of VOC-contaminated soil.	The soil was transported offsite for disposal in 2008. Refer to Comment No. 6.
17	Fig 1-7	Update requested.	Can you color code the figure's grids? That is, different colors for: environmental; MEC; and environmental/MEC grids?	The figure will be revised as requested.
18	2-2/19-21	Text revision requested.	Only one well point was installed at ODA1. Groundwater data from a wellpoint is solely used for screening purposes, i.e., any detects are considered minimal values and non-detects do not definitively indicate lack of contamination. Add information to the text that the data referenced in this section is solely from one well point and what wellpoint data represents. Additionally, monitoring wells for the area would be installed as part of the NTA.	The text will be revised as requested by inserting the text from Comment No. 11 in the identified paragraph.
19	2-2/27-29	Text revision requested. Remove the original sentence.	Add the following: "Consequently, additional environmental sampling for surface and subsurface soils will be required if the MEC debris is found to extend beyond the current boundaries."	The text will be revised as requested.
20	2-2/29-31	Text revision requested. Remove the original sentence.	Add the following: "Additional surface water, sediment, and groundwater sampling related to the ODA1 area will be conducted as part of the NTA PBA08."	The text will be revised as requested replacing "PBA08" with "and facility-wide sampling programs." This language was reviewed with Ohio EPA on Friday, September 11, 2009 on a conference call with Ohio EPA, Derek Kinder (USACE), Dave Cobb (Shaw), and Andrea Steele (Shaw).
21	2-3/4	Text revision requested.	Revise text to read: "…data would be of sufficient…"	The text will be revised as requested.

Draft Data Quality Objectives Report for Open Demolition Area 1 (RVAAP-03)
Ravenna Army Ammunition Plant, Ravenna, Ohio
Comment Response Table
Revision 1

Cmt. No.	Page or Sheet	Comment	Recommendation	Response
22	2-3/30-31	Text revision requested.	The Phase I RI did not determine the extent of the contamination. Remove "and extent" from the text.	The text will be revised as requested.
23	2-4/11-13	Text revision requested.	Revise text to read: "Ecological screening values or benchmarks used in the SLERA must be pre-approved by USACE and Ohio EPA.	The text will be revised as requested.
24	3-1/3-6	Clarification requested.	Clarify that ambient concentrations = sitewide background.	The sentence will be revised to read as follows: "In general, the evaluation and screening methodology will initially compare constituents present at ambient concentrations *(i.e., RVAAP-wide background)* from those present at concentrations that indicate potential impacts related to historical operations at ODA1."
25	3-1/7-8	Text change requested.	Revise text to read: "….and child) and the desired use of the land by OHARNG."	The text will be revised as requested.
26	3-1/ 17-19	Text revision requested. Remove the original sentence.	Add the following: "Groundwater is not considered since any wells in this area will be installed as part of the NTA characterization and ultimately addressed on a facility-wide basis."	The text will be revised as follows: "Groundwater is not considered since any wells in this area will ultimately be addressed on a facility-wide basis."
27	3-1/33-34	Text clarification requested.	The text indicates that the IRA samples were composites and not subject to the frequency of detection screen. Add text that indicates how the data were screened.	Phase I RI and IRA data were subject to background and essential nutrients screening before the CUG screening. The frequency of detection screen is the only screen that does not apply to composite samples (i.e., IRA samples) and there is no alternate method for composite samples. The text will not be revised as a result of this comment.
28	Fig 3-1	Update requested.	Ca n you color code the figure's grids? That is, different colors for: environmental; MEC; and environmental/MEC grids?	The figure will be revised as requested.

Draft Data Quality Objectives Report for Open Demolition Area 1 (RVAAP-03)
Ravenna Army Ammunition Plant, Ravenna, Ohio
Comment Response Table
Revision 1

Cmt. No.	Page or Sheet	Comment	Recommendation	Response
29	3-6/21-22	Clarification requested.	What was done with selenium? If the detected concentration was greater than the background, it should have been retained as a COPC (if it passed the frequency of detection screen also). The sentence prior says there is no background established for selenium, which means it was automatically set to zero. So…. If there was any detect at all it should have been > zero.	The original sentence contained a typo. The sentence will be revised to read as follows: "The maximum detected concentration of selenium was not *greater* than the background value." Therefore, selenium was not retained as a COPC for further evaluation. There is a background value for selenium. The sentence prior states that there are no *CUGs* for selenium.
30	3-6/36	The text indicates that there are no CUGs for lead.	This needs clarification, as it sounds like we are not cleaning up for lead. At CBP, the cleanup # used was 400 mg/kg.	There are no CUGs for lead in surface soil identified in the September 2008 *Draft Facility-Wide Human Health Remediation Goals at the RVAAP* (SAIC, 2008) which, at the direction of Ohio EPA (30 December 2008 conference call) is the source for CUGs in this DQO Report. Lead is automatically retained as a COPC for further evaluation at ODA1 because there are no CUGs developed for lead. No text revision will be made as a result of this comment. Shaw can include an evaluation of other accepted CUGs in this DQO Report at the direction of USACE and Ohio EPA.
31	3-7/35	Text addition requested.	Revise text to read: ".. explosives; as such, background is set at zero."	The text will be revised as requested.
32	3-8/7	Text addition requested.	Revise text to read: "….SVOCs; as such, background is set at zero."	The text will be revised as requested.
33	3-8/12	Text addition requested.	Revise text to read: "….VOCs; as such, background is set at zero."	The text will be revised as requested.
34	3-9/19-20	Clarification requested.	Is there any text in the Phase I that indicates why the particular sampling intervals were chosen?	Refer to Comment No. 10.
35	3-10/23	Question.	Should this be COC instead of COPC?	The post-IRA subsurface soil data was evaluated to the level of COPC only. No text change will be made as a result of this comment.

Draft Data Quality Objectives Report for Open Demolition Area 1 (RVAAP-03)
Ravenna Army Ammunition Plant, Ravenna, Ohio
Comment Response Table
Revision 1

Cmt. No.	Page or Sheet	Comment	Recommendation	Response
36	3-10/34	Text addition requested.	Revise text to read: "….SVOCs; as such, background is set at zero."	The text will be revised as requested.
37	3-11/5	Text addition requested.	Revise text to read: "….VOCs; as such, background is set at zero."	The text will be revised as requested.
38	3-14/ 28-33	Clarification requested.	It sounds like the inorganic results from Grid 11A were removed from the data set, because it was determined to be an "outlier." Please provide the basis for making the determination that this was an outlier. I am not sure that I agree. Particularly, as the text on the next page indicates that the environmental impact in the area of Grid 11A is not defined with depth to the W and SW. My inclination is to say that this is a valid data point and needs to be utilized in determining COPCs. Should the SE direction also be added based upon the last paragraph on page 3-15?	The data set was evaluated without the data from Grid 11A as an alternative scenario. The purpose of evaluating this alternative scenario was similar to that for performing a frequency of detection screening (which did not apply to these composited samples) in identifying and highlighting those constituents that only appear infrequently in a data set. Because the area of Grid 11A remains a data gap for other COPCs as identified in Section 4, we agree that it can not be eliminated from the analysis as an outlier. The text will be revised as requested to remove this alternative scenario and follow through the COPC and COC evaluation with the data set inclusive of Grid 11A. The last paragraph on page 3-15 describes general data gaps for the entire AOC. The data gaps associated with the *local* area of Grid 11A are identified in Section 4.2.1.2 (page 4-4, lines 21-23) and they include areas to the north, west and south as well as with depth. The extent to the SE of Grid 11A is bound by subsurface data from Grid 11 and the Phase I RI location DA1-23. No text change will be made as a result of this comment.

Draft Data Quality Objectives Report for Open Demolition Area 1 (RVAAP-03)
Ravenna Army Ammunition Plant, Ravenna, Ohio
Comment Response Table
Revision 1

Cmt. No.	Page or Sheet	Comment	Recommendation	Response
39	3-15/10	Clarification requested.	It sounds like the inorganic results from Grid 11A were removed from the data set, because it was determined to be an "outlier." Please provide the basis for making the determination that this was an outlier. I am not sure that I agree. Particularly, as the text later on this page indicates that the environmental impact in the area of Grid 11A is not defined with depth to the W and SW. My inclination is to say that this is a valid data point and needs to be utilized in determining COPCs.	Refer to Comment No. 38.
40	3-15/ 27-30	This section discusses the fact that the environmental impact is not determined to the W and SW of Grid 11A.	a. this point lends credence to the fact that the data from Grid 11A should not be dropped as an "outlier." b. based upon the text in line 35 below, add SE to the direction in line 28 where the environmental impact has not been defined.	a. Refer to Comment No. 38. b. The text will be revised as requested by revising the identified sentence to read as follows: "The environmental impact at the site is not defined with depth or to the west, southwest, *south, and southeast*, particularly in the area of IRA excavation Grid 11A on the western perimeter of the site."
41	Table 3-3	Revision requested.	Add detection limits to the revised table.	Tables 3-1 and 3-3 will be revised as requested by inserting the reporting limits for non-detects only with the 'U' qualifier.
42	Table 3-5	Revision requested.	Add detection limits to the revised table.	The table will be revised as requested by inserting the reporting limits for non-detects only with the 'U' qualifier.
43	4-4/33-35 thru 4-5/2	Discussion required.	Need to discuss the sampling intervals presented in the DQO report.	This comment was discussed on Friday, September 11, 2009 on a conference call attended by Ohio EPA, Derek Kinder (USACE), Dave Cobb (Shaw), and Andrea Steele (Shaw). The subsurface soil MI sampling approach with 4-ft intervals was discussed during the review of the Sand Creek DQO Report with Dave Crispo and Derek Kinder. The method identified in this ODA1 DQO Report is consistent with that previously

Cmt. No.	Page or Sheet	Comment	Recommendation	Response
				agreed to for Sand Creek. The actual intervals within the 1 to 20 ft bgs sample column will be established based on previous sample intervals at ODA1 and potential future data use. Previous subsurface soil sample intervals and depths for ODA1 have included 1-3, 2, 3-5, 4, and 6-8 ft bgs. Future land use at ODA1 may be for the National Guard which may include the training scenario and exposure risk evaluation with digging in soil to a depth of 4 ft bgs. Therefore, it is significant to have data at the 4 ft bgs interval for use in future risk assessments. The paragraph in question will be replaced with the following: "Subsurface soil samples will be collected continuously from Geoprobe borings to 20 ft bgs. Subsurface soil samples will be collected at 4 foot intervals using the MI sampling approach. In general, 30 increments of soil will be collected from the Geoprobe soil column for each 4-foot interval to generate and MI sample. The intervals and depth of previous subsurface soil sample collection has varied at ODA1. In order to be consistent with the excavation confirmation sampling and potential future use of the data in risk assessments, subsurface soil samples will be collected at intervals that begin/end at 4 ft bgs. Subsurface soil sample collection in areas not previously excavated will begin at 1 ft bgs such that the first interval is 1 to 4 ft bgs and then 4-ft intervals thereafter (1-4, 4-8, 8-12, 12-16, and 16-20 ft bgs).

Cmt. No.	Page or Sheet	Comment	Recommendation	Response
				Sample collection in areas previously excavated will begin at the bottom of the excavation (i.e., either 2 or 4 ft bgs) and proceed in 4 ft intervals. The first sample interval for samples beginning at 2 ft bgs will end at 4 ft bgs and continue in 4-ft intervals thereafter (2-4, 4-8, 8-12, 12-16, and 16-20 ft bgs)."
44	4-5/17	Text clarification.	Looking at line 14 above, shouldn't this read S, SW and SE perimeter?	The text will be revised as requested.
45	5-1/30-31	Text revision requested.	Revise text to read: "…or the facility-wide surface water program."	The text will be revised as requested.
46	5-1/32	Text revision requested.	Revise text to read: "Groundwater will be addressed under the NTA and RVAAP facility wide program."	The text will be revised as requested.
47	5-1/33 thru 5-2/2	Text revision requested.	Revise text to read: "Only one geoprobe groundwater sample was collected at ODA1 under the Phase 1. In order to determine whether or not there has been actual impact on the ODA1 groundwater, properly drilled, installed and sampled monitoring wells would need to be utilized. Groundwater data from a wellpoint is solely used for screening purposes, i.e., any detects are considered minimal values and non-detects do not definitively indicate lack of contamination. Additional groundwater investigation will occur under the NTA area of concern under the PBA-08 contract."	Related to Comment Nos. 11 and 13, the text will be revised with the exclusion of "under the PBA-08 contract." This language was reviewed with Ohio EPA on Friday, September 11, 2009 on a conference call with Ohio EPA, Derek Kinder (USACE), Dave Cobb (Shaw), and Andrea Steele (Shaw).