RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

WORK PLAN ADDENDUM 023
RCRA Facility Investigation at
Solid Waste Management Unit 13

FINAL
JULY 2008

PREPARED BY:

URS

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CONTRACT NO. W9128F-04-D-0001
DELIVERY ORDER NO. DA02

ATK

Ammunition Systems Group
Energetic Systems Division
Radford Army Ammunition Plant
Route 114, P.O. Box 1
Radford, VA 24143-0100

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August 11, 2008

Mr. William Geiger
RCRA General Operations Branch, Mail Code: 3WC23
Waste and Chemicals Management Division
U. S. Environmental Protection Agency, Region III
1650 Arch Street
Philadelphia, PA 19103-2029

Mr. James L. Cutler, Jr.
Virginia Department of Environmental Quality
629 East Main Street
Richmond, VA 24143-0100

Subject: With Certification, Radford Army Ammunition Plant,
Work Plan Addendum 023 RCRA Facility Investigation at Solid Waste Management Unit 13, Final July 2008
EPA ID# VA1 210020730

Dear Mr. Geiger and Mr. Cutler:

Enclosed is the certification for the subject document that was sent to you on July 28, 2008. Also enclosed is a copy of the transmittal email message.

Please coordinate with and provide any questions or comments to myself at (540) 639-8658, Jerry Redder of my staff (540) 639-7536 or Jim McKenna, ACO Staff (540) 731-5782.

Sincerely,

P.W. Holt

P.W. Holt, Environmental Manager
Alliant Techsystems Inc.

c: Durwood Willis
Virginia Department of Environmental Quality
P. O. Box 10009
Richmond, VA 23240-0009

E. A. Lohman
Virginia Department of Environmental Quality
West Central Regional Office
3019 Peters Creek Road
Roanoke, VA 24019

08-815-128
JMcKenna

Rich Mendoza
U.S. Army Environmental Command
1 Rock Island Arsenal
Bldg 90, 3rd Floor, Room 30A
IMAE-CDN
Rock Island, Illinois 61299

Tom Meyer
Corps of Engineers, Baltimore District
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bc: Administrative File
J. McKenna, ACO Staff
Rob Davie-ACO Staff
M.A. Miano
P.W. Holt
J. J. Redder
Env. File

Coordination: J. McKenna M. A. Miano

08-815-128
JMcKenna

Concerning the following:

Radford Army Ammunition Plant
Work Plan Addendum 023
RCRA Facility Investigation at Solid Waste Management Unit 13
Final July 2008

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

SIGNATURE:
PRINTED NAME: Jon R. Drushal
TITLE: Lieutenant Colonel, US Army
Commanding

SIGNATURE:
PRINTED NAME: Kent Holiday
TITLE: Vice President and General Manager
ATK Energetics Systems

08-815-128
JMcKenna

Greene, Anne

From: McKenna, Jim
Sent: Monday, July 28, 2008 1:48 PM
To: Greene, Anne; beth lohman; dennis.druck@us.army.mil; diane.wisbeck@arcadis-us.com; durwood willis2; Geiger.William@epamail.epa.gov; Redder, Jerome; jim spencer; jlcutler@deq.virginia.gov; Llewellyn, Tim; Mendoza, Richard R Mr CIV USA IMCOM; Parks, Jeffrey N; Timothy.Leahy@shawgrp.com; Tina_Devine@URSCorp.com; Tom.Meyer@nab02.usace.army.mil
Subject: FW: Fed Ex #s for Final WPA 023 - RFI at SWMU 13 (UNCLASSIFIED)

Importance: High

Classification: UNCLASSIFIED
Caveats: NONE

All:

Note the contractor will ship the subject document with a copy of this email to the POCs and tracking numbers below.

James McKenna 7970 3602 8680 2 Paper copies Will Geiger 7960 3694 0976 1 Paper copy and CD Jim Cutler 7970 3604 0603 1 Paper copy and CD Durwood Willis 7970 3604 2499 1 Paper copy and CD Tom Meyer 7970 3604 9368 1 CD Richard Mendoza 7970 3604 7207 1 CD Dennis Druck 7970 3604 5075 1 CD Elizabeth Lohman 7970 3604 4080 1 CD

Thank you for your support of the Radford Army Ammunition Plant Installation Restoration Program.

Jim McKenna

Classification: UNCLASSIFIED
Caveats: NONE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

August 6, 2008

Commander,
Radford Army Ammunition Plant
Attn: SJMRF-OP-EQ (Jim McKenna)
P.O. Box 2
Radford, VA 24141-0099

P.W. Holt
Environmental Manager
Alliant Techsystems, Inc.
Radford Army Ammunition Plant
P.O. Box 1
Radford, VA 24141-0100

Re: Radford Army Ammunition Plant, Va.
Master Work Plan Addendums 023 and 025
Review of the Army's RCRA Work Plan Addendums

Dear Mr. McKenna and Ms. Holt:

The U.S. Environmental Protection Agency (EPA) and the Virginia Department of Environmental Quality (VDEQ) have reviewed the U.S. Army's (Army's) July, 2007 submittal of the Final Work Plan Addendum 023 for Solid Waste Management Unit (SWMU) 13, and May, 2008 submittal of the Final Work Plan Addendum 025 for RAAP-047. Based upon our reviews, the Work Plans are approved, and in accordance with Part II. (E) (5) of RFAAP's Corrective Action Permit, can now be considered final.

If you have any questions, please call me at 215-814-3413, or Jim Cutler at 804-698-4498. Thanks.

Sincerely,

William Geiger
RCRA Project Manager
General Operations Branch (3WC23)

cc: Jim Cutler, VDEQ

Response to Comments (6/20/2008)
EPA/VDEQ Comments for Radford Army Ammunition Plant's Work Plan Addendum 023, RCRA Facility Investigation at Solid Waste Management Unit 13(February 2008) – Comments Received via E-mail 4/17/2008

GENERAL COMMENTS

There is concern that previous soil results from within the OBG which indicated potential risk (over industrial screening levels) will be overlooked, since it appears that current performance monitoring deals only with soil data that has been collected under the permit. The previous data should be discussed as part of the RFI and assimilated into corrective action activities already underway as a result of groundwater exceedances. Radford should also provide groundwater information collected under the Subpart X permit in the RFI report, including groundwater elevation results, sampling results, etc.

RFAAP Response: The status of ongoing corrective action and monitoring activities at the OBG under the Subpart X permit with for soil and groundwater will be included in the RFI for informational purposes. Data obtained during previous and ongoing investigations within the OBG will not be utilized for nature and extent assessment or risk assessments for the RFI.

The Site Screening Process Report, May 2007, SSP Report Text and Screening Tables for SWMU [Solid Waste Management Unit] 13, included as Appendix D.1.1, ruled out dioxins/furans as contaminants of potential concern (COPC) based on the results of only a single surface soil sample (13SB9A). One sample is inadequate to exclude an analyte class from further consideration. Given the nature of activities at the adjacent open burning ground and the potential for the generation of dioxins/furans as a result of these activities, additional samples should be collected for these constituents to assure an adequate dioxin/furan data set for site characterization and risk assessment. Please revise the Work Plan Addendum to propose additional sampling for dioxins/furans, or provide adequate justification for not further assessing these constituents.

RFAAP Response: In addition to the surface soil sample collected as part of the SSP and analyzed for dioxin/furans, soil samples were collected semi-annually (2007) from two locations (SB-1 and SB2) within the study area as shown on Figure 1-10 and analyzed for dioxin/furans as a component of the Subpart X permit for the OBG. As presented in Table 1-4, the detected concentrations of dioxin/furan TEQs for these samples were below both the industrial and residential RBCs. Given that the detected concentrations for dioxin/furans for a total of five samples were below applicable screening levels, no additional sampling for dioxin/furans is proposed. In addition, due to the nature of the operations at the open burning grounds, potential areas containing dioxin/furans would be co-located with lead which is an indicator compound from burning activities; therefore, additional analysis for dioxin/furans is not propsed.

SPECIFIC COMMENTS

1. **Table 1-2, Detected Analytes for SWMU 13 – Sediment:** A note at the bottom of the table indicates that the "chromium MCL [maximum contaminant level] is for

total" chromium. However, since MCLs apply to drinking water and not sediment, it appears that reference to the chromium MCL is incorrect. Please revise Table 1-2 to provide the appropriate reference for the chromium value.

RFAAP Response: Reference will be revised to "Chromium VI RBC value was used."

2. **Section 1.4.2, Mechanisms of Contaminant Release, Page 1-10:** This section notes that leaching of chemicals to subsurface soil and groundwater is a potential release mechanism at the site. Also, potential releases to the New River (surface water and sediment) could also occur from the discharge of groundwater containing dissolved phase constituents associated with the open burning ground. Figure 1-14, Conceptual Site Diagram, does not include these potential release mechanisms. It is noted that these release mechanisms will not be evaluated quantitatively during the current investigation, but the Conceptual Site Diagram still needs to show that these release mechanisms are possible at the site. For clarity and completeness, please revise Figure 1-14 to include all potential release mechanisms at the site. Notes can be added to the figure to show what release mechanisms will be evaluated quantitatively.

   RFAAP Response: See attached revised Figure 1-14.

3. **Section 1.5.1.2, Sediment and Surface Water – New River, Page 1-11:** The second to last sentence of this section states, "A qualitative assessment of potential future impacts from soil within the SWMU 13 RFI study area to the New River will be conducted as part of the RFI." The Work Plan Addendum does not further describe this qualitative assessment, or indicate what it will entail. To assure that impacts to the New River will be adequately assessed, please revise the Work Plan Addendum to fully describe the tasks associated with the qualitative assessment that will be conducted.

   RFAAP Response: Section 1.5.1.2 will be revised to include a more detailed description of tasks included in the qualitative assessment with the following: "The release mechanism of concern with regard to the New River is deposition of soil via runoff from the site; therefore, an assessment of the nature and extent of site contaminants in conjunction with the type, quality, and percentage of ground cover for the study area will be conducted to qualitatively determine the potential for impacts."

4. **Section 1.5.1.2, Sediment and Surface Water – New River, Page 1-11**: It is noted that no additional sampling of the New River is planned for the RCRA Facility Investigation, but the rationale for exclusion of surface water and sediment samples does not appear to be adequately supported. It is stated that data gaps identified in the SSP Report were filled in 2006 during the SWMU 54 New River Study. However, the 2006 sampling event identified explosive constituents (2,4-dinitrotoluene and 2,4,6-trinitrotoluene) above BTAG sediment screening values in two sediment samples collected in the near vicinity of the SWMU 13 RFI Study Area (Page 1-9). Since these samples were collected after the SSP Report was completed, they were

not included in the human health or ecological risk screenings. Please revise the Work Plan Addendum to address how the explosives detected in sediment adjacent to the site will be adequately characterized and potential human health and ecological risks associated with these detections will be assessed. Ensure the revised discussion addresses that additional sediment sampling for explosives may be warranted.

RFAAP Response: 2,4-Dinitrotoluene was detected a concentration of 1.4 mg/kg above the BTAG screening value (0.0416 mg/kg) in sample NR-SED-8 located crossgradient from SWMU 13 on the southern river bank and 2,4,6-Trinitrotoluene was detected at a concentration of 0.38 mg/kg above the BTAG screening value (0.092 mg/kg) at NR-SED-10 located slightly downstream from SWMU 13. These detections were "J"-flagged as estimated concentrations between the reporting limit and minimum detection limit. Due to the low, estimated concentrations of the explosives detected in the samples and the lack of detection of explosives in the 21 additional samples collected within the river, these detections are not indicative of significant impacts to the river. In addition, attributing chemicals detected in sediment samples to a specific source (such as the SWMU 13 study area) or sources is not possible for this RFI given the complex transient flow and depositional patterns in the river, and therefore, it is recommended that these data be used holistically as part of any overall evaluations of the facility and potential receptors conducted for the RCRA Corrective Action Permit.

5. **Section 1.6.1, Soil Sampling, Page 1-13:** Samples for semi-volatile organic compounds (SVOCs), explosives, and target analyte list (TAL) metals will be collected from 10 of the approximately 77 sampling point locations. The Work Plan Addendum indicates that these locations will be selected in the field, but has not included the criteria which will be used for selecting these 10 sampling points. Further, any samples collected for SVOC and explosives analysis should also be adequate to define both the horizontal and vertical extent of benzo(a)pyrene and nitroglycerin contamination, identified during the previous investigation. Figure 1-11, SSP Investigation Sampling Locations, identifies several sampling locations at which benzo(a)pyrene and nitroglycerin exceeded residential soil risk-based screening concentrations (RBCs). Please revise the Work Plan Addendum to describe how the 10 sampling point locations for SVOC, explosives, and TAL metals will be selected. Also, please discuss how the 10 proposed samples will adequately define the extent of benzo(a)pyrene and nitroglycerin contamination.

RFAAP Response: Rather than select the 10 sampling point locations in the field, the proposed additional sample locations for SVOCs, explosives, and metals are shown on the attached revised Figure 1-15. The selected locations reflect the objectives of verifying previous results, providing additional spatial data across the site to characterize site conditions, and providing sufficient data to characterize mean concentrations for risk assessment, while recognizing that lead will be used as the primary indicator to evaluate impacts from historical open burning ground activities and delineate the nature and extent of contamination.

Given the consistently lower level concentrations of benzo(a)pyrene detected across the site (non detect to 190 µg/kg) at levels typical found in many industrial or urbanized developed areas, additional soil sampling (within specific areas) beyond the 20 samples (from 10 locations) is not proposed to attempt a nature and extent delineation down to non-detect levels below the residential RBC. This approach is considered appropriate given that the levels and mean concentrations of benzo(a)pyrene detected (below industrial RBC) are unlikely to pose a significant risk under the most reasonably anticipated future land use scenario (industrial), and the fact that lead in soil is expected to drive risk and remedial action decisions at this site.

Given the low estimated concentrations of nitroglycerin detected above the adjusted residential RBC *but 3 to 6 times lower than the unadjusted residential RBC*, additional sampling (within specific areas) beyond the 20 samples (from 10 locations) is not proposed to attempt a nature and extent delineation down to levels below the adjusted residential RBC in all areas of the site. This approach is considered appropriate given that the mean concentrations of nitroglycerin detected are unlikely to pose a significant risk under the most reasonably anticipated future land use scenario (industrial), and the fact that lead in soil will drive risk and remedial action decisions at this site.

6. **Section 1.6.1, Soil Sampling, Page 1-13:** Only two depth intervals are proposed for the 10 sampling point locations for which SVOCs, explosives, and TAL metals will be analyzed. The rationale for limiting the sampling to a surface sample and a sample collected from 2 to 3 feet below ground surface (bgs) has not been provided. Sampling intervals should be sufficient to characterize the vertical extent of contamination. Please revise the Work Plan Addendum to address this concern.

   RFAAP Response: Given the shallow depth of investigation at the site, the Work Plan Addendum will be modified to propose that the subsurface samples for SVOCs, explosives, and TAL metals be collected from the terminal depth of each boring rather than 2 to 3 ft bgs, which will provide information to characterize the vertical extent of contamination. The planned maximum depth of soil sampling is 6 ft bgs based on the results of the SSP investigation and site conditions encountered. Boring termination may be shallower at locations proximate to the New River due to the anticipated shallower depth of groundwater.

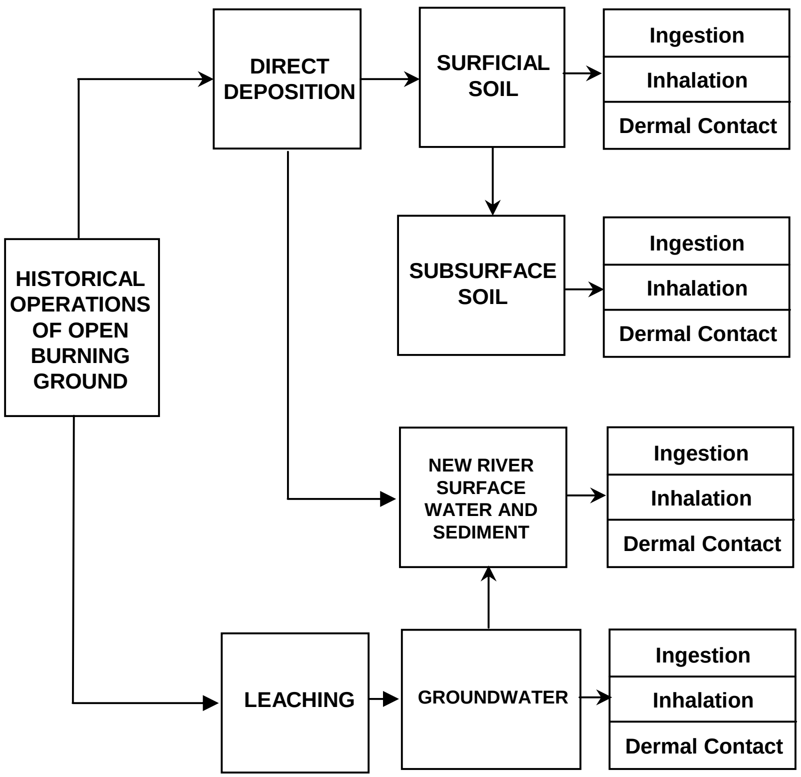
7. **Section 1.6.1, Soil Sampling, Page 1-13:** It is noted that the proposed borings will be completed with a hand auger, but this method does not appear to be included in the attached standard operating procedures (SOPs). SOP 20.11, Drilling Method and Procedures, included in Appendix A, does not appear to address hand augering. Please revise the Work Plan Addendum to include an SOP for hand augering. It should also be noted that Appendix D.1.1, Site Screening Process Report, May 2007, SSP Report Text and Screening Tables For SWMU 13, indicates in Section 4.5.1, Soil, on page 4-6, in the last sentence of this section, that, "The use of hand augers resulted in shallower than anticipated refusal depths." Please revise the Work Plan Addendum to address how shallow auger refusal depths will be addressed should this phenomenon be encountered again during the proposed investigation.

RFAAP Response: Appendix A includes SOP 30.1 which addresses hand auger procedures (and core samplers) and the collection of soil samples. SOP 20.11 will be removed based on sample collection method. Due to access issues and the slope of the study area, hand augers or soil cores will be used to collect soil samples. Given that the results of the SSP investigation indicated elevated lead concentrations (above 400 mg/kg) at depths shallower than the terminal depths of hand auger borings, the expected shallow depth to groundwater on the side slopes of the site (less than 2 ft to 10 ft depending on proximity to the river), and the primary release mechanism resulting in impacts to the study area)from surficial deposition from historical activities related to the OBG), the achievable depth for sampling using hand augers or soil corers is considered adequate for the proposed sampling plan. If refusal is encountered at a shallow and unexpected depth, soil digging bars, a slide hammer, or other similar device will be used to deepen the boring or verify refusal on bedrock. As appropriate, soil borings may be slightly offset to verify conditions or reach proposed target depths.

8. Table 2-2, Contractor and Subcontractor Key Points of Contact, Page 2-3: TriMatrix Laboratories is identified as the subcontractor for analytical laboratory services, but the Work Plan Addendum does not state whether TriMatrix Laboratories will also perform the physical soil testing. Since all subcontractors should be identified in this Quality Assurance Plan Addendum, please revise Table 2-2, if necessary, to document the contact information for the laboratory which will perform the physical soil testing.

RFAAP Response: Physical soil testing including Atterberg limits, moisture content, pH, and cation exchange capacity will be performed by URS' laboratory in Totowa, New Jersey. Total organic carbon testing will be performed by Trimatrix. See attached revised Table 2-2.

PRIMARY SOURCE	RELEASE MECHANISMS	PATHWAY	EXPOSURE ROUTE	RECEPTORS
				CURRENT/FUTURE · FUTURE



Surficial Soil

Exposure Route	MAINTENANCE WORKER	ADOLESCENT TRESPASSER	TERRESTRIAL BIOTA	CONSTRUCTION WORKER	COMMERCIAL/ INDUSTRIAL WORKER	ADULT RESIDENT	CHILD RESIDENT
Ingestion	●	●	●	●	●	●	●
Inhalation	●	●	●	●	●	●	●
Dermal Contact	●	●	●	●	●	●	●

Subsurface Soil

Exposure Route	MAINTENANCE WORKER	ADOLESCENT TRESPASSER	TERRESTRIAL BIOTA	CONSTRUCTION WORKER	COMMERCIAL/ INDUSTRIAL WORKER	ADULT RESIDENT	CHILD RESIDENT
Ingestion				●		●	●
Inhalation				●		●	●
Dermal Contact				●		●	●

New River Surface Water and Sediment

Exposure Route	MAINTENANCE WORKER	ADOLESCENT TRESPASSER	AQUATIC BIOTA	CONSTRUCTION WORKER	COMMERCIAL/ INDUSTRIAL WORKER	ADULT RESIDENT	CHILD RESIDENT
Ingestion		○	○	○	○	○	○
Inhalation		○	○	○	○	○	○
Dermal Contact		○	○	○	○	○	○

Groundwater

Exposure Route	MAINTENANCE WORKER	ADOLESCENT TRESPASSER	TERRESTRIAL BIOTA	CONSTRUCTION WORKER	COMMERCIAL/ INDUSTRIAL WORKER	ADULT RESIDENT	CHILD RESIDENT
Ingestion				○	○	○	○
Inhalation				○	○	○	○
Dermal Contact				○	○	○	○

● POTENTIALLY COMPLETE PATHWAY EVALUATED QUANTITATIVELY

○ POTENTIALLY COMPLETE PATHWAY EVALUATED QUALITATIVELY

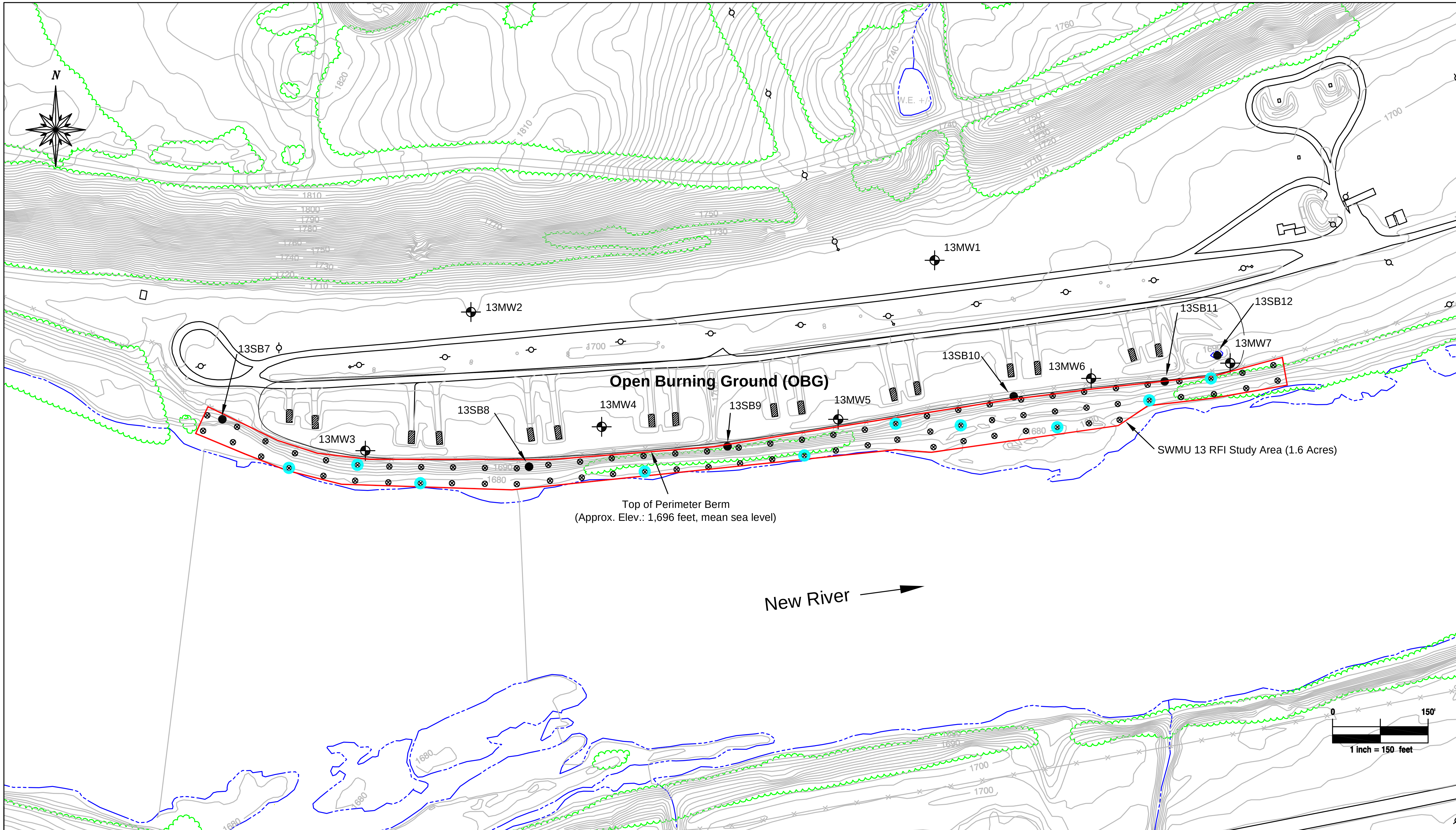
FIGURE 1-14

Conceptual Site Diagram

Date: January2008	URS Project #: 11656367
Prepared by: DBC	Approved by: JOS
Scale: Not to Scale	File Name: Fig.1-14 CSD

SWMU 13
RCRA Facility Investigation
Radford Army Ammunition Plant
Radford, Virginia

URS Group, Inc.
5540 Falmouth Street,
Suite 201
Richmond, VA 23230



Legend

	Topographic Contour Line (feet, mean sea level)		Monitoring Well Location		Light/Electric Pole
	Surface Water		Proposed Sample Location (Lead)		Vegetation
	OBG Boundary		Proposed Sample Location (TCL Metals, SVOCs, Explosives, and Nitroglycerin)		Burning Pan
	Study Area Boundary		SSP Sample Locations		

FIGURE 1-15

RFI Proposed Sampling Locations

Date: January 2008	URS Project #: 11656367
Prepared by: DBC	Approved by: JOS
Scale: 1 inch = 150 feet	File Name: Fig.1-15 RFI Prop.Locs

SWMU 13

RCRA Facility Investigation
Radford Army Ammunition Plant
Radford, Virginia

URS
URS Group, Inc.
5540 Falmouth Street
Suite 201
Richmond, Virginia 23230

EPA/VDEQ Comments for Radford Army Ammunition Plant's Work Plan Addendum 023, RCRA Facility Investigation at Solid Waste Management Unit 13, dated February 2008

GENERAL COMMENTS

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DEPARTMENT OF THE ARMY
US ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE
5158 BLACKHAWK ROAD
ABERDEEN PROVING GROUND MD 21010-5403

8 FEB 2008

MCHB-TS-REH

MEMORANDUM FOR Office of Environmental Quality, Radford Army Ammunition Plant (SJMRF-OP-EQ/Mr. Jim McKenna), P.O. Box 2, Radford, VA 24143-0002

SUBJECT: Review of Document Titled: "Internal Draft Work Plan Addendum 023, RCRA Facility Investigation at Solid Waste Management Unit 13, Radford Army Ammunition Plant, Virginia, January 2008"

1. The U.S. Army Center for Health Promotion and Preventive Medicine reviewed without comment the subject document on behalf of the Office of The Surgeon General pursuant to Army Regulation 200-1 (Environmental Protection and Enhancement).

2. The document was reviewed by Mr. Dennis Druck, Environmental Health Risk Assessment Program. He can be reached at DSN 584-2953, commercial (410) 436-2953 or electronic mail "dennis.druck@us.army.mil".

FOR THE COMMANDER:

JEFFREY S. KIRKPATRICK
Director, Health Risk Management

CF:
HQDA (DASG-PPM-NC)
IMCOM, NERO (IMNE-PWD-E)
USACE (CEHNC-CX-ES)
USAEC (IMAE-CD/Mr. Rich Mendoza)

ATK

Ammunition Systems Group
Energetic Systems Division
Radford Army Ammunition Plant
Route 114, P.O. Box 1
Radford, VA 24143-0100

www.atk.com

February 8, 2008

Mr. William Geiger
RCRA General Operations Branch, Mail Code: 3WC23
Waste and Chemicals Management Division
U. S. Environmental Protection Agency, Region III
1650 Arch Street
Philadelphia, PA 19103-2029

Mr. James L. Cutler, Jr.
Virginia Department of Environmental Quality
629 East Main Street
Richmond, VA 24143-0100

Subject: With Certification, Radford Army Ammunition Plant,
Work Plan Addendum 023, RCRA Facility Investigation at Solid Waste Management Unit 13
Draft February 2008
EPA ID# VA1 210020730

Dear Mr. Geiger and Mr Cutler:

Enclosed is the certification for the subject document that was sent to you on February 7, 2008. Also enclosed is a copy of the transmittal email message.

Please coordinate with and provide any questions or comments to myself at (540) 639-8658, Jerry Redder of my staff (540) 639-7536 or Jim McKenna, ACO Staff (540) 639-8641.

Sincerely,

Phillip Jordan for

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08-815-23
JMcKenna

Concerning the following:

Radford Army Ammunition Plant
Work Plan Addendum 023
RCRA Facility Investigation at Solid Waste Management Unit 13
Draft February 2008

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

SIGNATURE:
PRINTED NAME: for Jon R. Drushal
TITLE: Lieutenant Colonel, US Army
Commanding

SIGNATURE:
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08-815-23
JMcKenna

Greene, Anne

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Cc: Lee_Mareck@URSCorp.com
Subject: draft WPA 023 RFI at SWMU 13 & FedEx Numbers (UNCLASSIFIED)

Importance: High

Classification: UNCLASSIFIED
Caveats: NONE

All:

Note the contractor will ship the subject document with a copy of this email to the POCs and tracking numbers below.

The certification letter will follow from Radford AAP under separate cover.

Will Geiger 7988 6924 3067 3 Paper copies and CD Jim Cutler 7904 4256 3780 Paper copy and CD Durwood Willis 7997 9824 6515 Paper copy and CD Tom Meyer 7997 9826 2350 CD Richard Mendoza 7914 9461 0050 CD Dennis Druck 7904 4258 2741 CD Elizabeth Lohman 7904 4258 7824 CD

Thank you for your support of the Radford AAP Installation Program

Jim McKenna

Classification: UNCLASSIFIED
Caveats: NONE

PREFACE

A two-stage approach has been developed to facilitate and streamline Resource Conservation and Recovery Act (RCRA) site investigations at Radford Army Ammunition Plant (RFAAP) pursuant to the Permit for Corrective Action and Waste Minimization (October, 2000). The approach consists of a single facility-wide Master Work Plan and multiple site-specific Work Plan Addenda.

The Master Work Plan provides comprehensive discussions of standard procedures, protocol, and methodologies that are to be followed during execution of field investigations at RCRA sites within the RFAAP. The Master Work Plan is a generic plan designed to streamline site-specific Work Plan Addenda development, review, and approval.

Each Work Plan Addendum describes the site-specific information for each RCRA site, providing detailed data on past site operations, potential chemicals of concern, sampling strategy, etc. Each addendum, through reference to the Master Work Plan, is developed as a concise document, focused on site-specific investigations.

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MASTER WORK PLAN ADDENDUM 023
RCRA FACILITY INVESTIGATION AT SWMU 13

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LIST OF ABBREVIATIONS AND ACRONYMS

ºC.....................Degrees Celsius
% ....Percent
2,4-DNT..........2,4-Dinitrotoluene
2,4,6-TNT 2,4,6-Trinitrotoluene
AES.................Atomic Emission Spectroscopy
AL ....Action Level
ASTM ....ASTM International
bgs...................Below Ground Surface
BTAG..............Biological Technical Assistance Group
CAP.................Corrective Action Plan
CFR.................Code of Federal Regulations
CLP ....Contract Laboratory Program
cm/sec ....Centimeter per second
CMS................Corrective Measures Study
CN...................Cyanide
COD................Chemical Oxygen Demand
COPC..............Chemical of Potential Concern
COPEC............Chemical of Potential Ecological Concern
COR ....Contracting Officer's Representative
CSM................Conceptual Site Model
DAF ....Dilution Attenuation Factor
DNT ....Dinitrotoluene
dBA.................Decibels on the A-Weighted Scale
DOD................Department of Defense
DQO................Data Quality Objective
ECD ....Electron Capture Detector
ELCD..............Electrolytic Conductivity Detector
EPIC................Environmental Photographic Interpretation Center
ERIS................Environmental Restoration Information System
ft.......................Feet
ft/ft ....Feet per foot
ft/yr..................Feet per year
g ....Gram
GC...................Gas Chromatograph
GC/ECD..........Gas Chromatograph/Electron Capture Detector
GC/MS............Gas Chromatograph/Mass Spectrometer
GM..................Clayey/Silty Gravel
GPS ....Groundwater Protection Standards
HAZCOM ....Hazard Communication
HHRA ....Human Health Risk Assessment
HPLC ....High Performance Liquid Chromatography
HSA ....Horseshoe Area
HSP ....Health and Safety Plan
HSPA ....Health and Safety Plan Addendum
HTRW.............Hazardous, Toxic, and Radioactive Waste
I-RBC..............Industrial Risk-Based Concentration

LIST OF ABBREVIATIONS AND ACRONYMS (CONTINUED)

ICP ....Inductively Coupled Plasma
ICP-MS ....Inductively Coupled Plasma-Mass Spectrometry
IDM................Investigation-Derived Material
MCL................Maximum Contaminant Level
MDC ....Maximum Detected Concentration
MDL................Method Detection Limit
µL ....Microliter
m ....Micrometer
mg/kg ....Milligram per kilogram
MHSP..............Master Health and Safety Plan
mL ....Milliliter
MMA ....Main Manufacturing Area
MQAP ....Master Quality Assurance Plan
MS...................Mass Spectrometer
MS/MSD ....Matrix Spike/Matrix Spike Duplicate
MSDS..............Material Safety Data Sheet
msl...................Mean Sea Level
MWP ....Master Work Plan
NELAP............National Environmental Laboratory Accreditation Program
NFA ....No Further Action
nm ....Nanometer
OBG ....Open Burning Ground
OSHA..............Occupational Safety and Health Administration
PAH ....Polynuclear Aromatic Hydrocarbon
PCB ....Polychlorinated Biphenyl
PETN ....Pentaerythritol Tetranitrate
PID ....Photoionization Detector
PM...................Project Manager
PPE..................Personal Protective Equipment
ppm ....Parts Per Million
QA...................Quality Assurance
QC ....Quality Control
QA/QC ....Quality Assurance/Quality Control
QAP ....Quality Assurance Plan
QAPA..............Quality Assurance Plan Addendum
QSM................Quality Systems Manual
R......................Rinse Blank
R-RBC ....Residential Risk-Based Concentration
RBC ....Risk-Based Concentration
RCRA..............Resource Conservation and Recovery Act
RFA.................RCRA Facility Assessment
RFAAP............Radford Army Ammunition Plant
RFI ....RCRA Facility Investigation
RL ....Reporting Limit

LIST OF ABBREVIATIONS AND ACRONYMS (CONTINUED)

SHSO..............Site Health and Safety Officer
SLERA............Screening Level Ecological Risk Assessment
SM...................Silty Sand
SMP................Soil Monitoring Program
SOP.................Standard Operating Procedure
SOW................Statement of Work
SSL..................Soil Screening Level
SSP..................Site Screening Process
SVOC..............Semi-volatile Organic Compound
SWMU............Solid Waste Management Unit
T......................Trip Blank
T-RBC.............Tap Water Risk-Based Concentration
TAL.................Target Analyte List
TCDD.............Tetrachlorodibenzodioxin
TCL.................Target Compound List
TCLP..............Toxicity Characteristic Leaching Procedure
TOC................Total Organic Carbon
TWA...............Time Weighted Average
UCL................Upper Confidence Limit
UPL.................Upper Prediction Limit
URS.................URS Group, Inc.
USACE...........United States Army Corps of Engineers
USEPA............United States Environmental Protection Agency
UV...................Ultraviolet
VI....................Verification Investigation
VOC................Volatile Organic Compound
VDEQ.............Virginia Department of Environmental Quality
WPA................Work Plan Addendum

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1.0 WORK PLAN ADDENDUM

In accordance with Contract Number W9128F-04-D-001, Delivery Order No. DA02, URS Group, Inc. (URS) has been tasked by the United States Army Corps of Engineers (USACE), Baltimore District to perform a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) for Solid Waste Management Unit (SWMU) 13, located in the Main Manufacturing Area (MMA) at the Radford Army Ammunition Plant (RFAAP), Radford, Virginia (Figure 1-1). The SWMU 13 RFI study area is an approximate 1.6 acre area located outside the current operational area of the open burning ground (OBG) between the OBG perimeter berm and the New River (Figure 1-2). Previous investigations have been conducted at the OBG, which has been in operation since 1941 and was first identified as an area of concern in the RFA (USEPA 1987), but since 2005 the OBG is regulated under a RCRA Subpart X permit issued by the Virginia Department of Environmental Quality (VDEQ). The SWMU 13 RFI study area is the area adjacent to the OBG not addressed under the RCRA Subpart X Permit. The SMWU 13 RFI Work Plan is presented as Work Plan Addendum (WPA) 023, and incorporates, by reference, the elements of the RFAAP Master Work Plan (MWP) (URS 2003).

1.1 INTRODUCTION

The objective of this RFI is to assess the nature and extent of chemicals in soil located in the SWMU 13 RFI study area and evaluate potential risks to human health and the environment including potential future impacts to the New River (Figure 1-2). Investigations will focus on soil conditions in this area and evaluate soil within the SWMU 13 RFI study area as a potential source for future impacts to the New River. Groundwater in the area of OBG is currently being evaluated under the facility's Subpart X permit issued by the Virginia Department of Environmental Quality (VDEQ) in October 2005. Groundwater monitoring and any required corrective action for groundwater will be addressed under the facility's Subpart X permit; therefore, groundwater will not be further investigated or addressed under this RFI. Soil sampling and any required corrective action within the OBG also will be addressed under the facility's Subpart X permit; therefore, the soil located within the OBG will not be further investigated or addressed under this RFI. The SWMU 13 RFI study area is the area adjacent to the OBG not addressed under the RCRA Subpart X Permit.

The additional investigation for this RFI will be to fill data gaps identified during the site screening process (SSP) investigation conducted in 2003 (URS 2007) as follows:

- Further assessing contaminant sources and the nature and extent of chemicals in soil within the SWMU 13 RFI study area;
- Assessing the fate of detected chemicals;
- Evaluating potential risks to human health and the environment;
- Provide data to support the completion of a Corrective Measures Study (CMS); and
- If possible, reaching a final decision regarding what potential future action is warranted at the SWMU 13 RFI study area.

The proposed RFI field program is designed to meet the above project objectives and to provide sufficient data for completion of an RFI/CMS Report including a human health risk assessment (HHRA) and screening level ecological risk assessment (SLERA). Proposed field activities include: site surveying and soil sampling.

This site-specific WPA provides the rationale and methods for planned field activities at the SWMU 13 RFI study area in support of the RFI. Consistent with the MWP, this addendum is composed of the following sections:

- Section 1.0, WPA 023 – SWMU 13;
- Section 2.0, Quality Assurance Plan (QAP) Addendum (QAPA);
- Section 3.0, Health and Safety Plan (HSP) Addendum (HSPA); and
- Section 4.0, References.

This WPA references sections and Standard Operating Procedures (SOPs) contained in the MWP for the investigation at the SWMU 13 RFI study area. Relevant SOPs are included in Appendix A of this WPA. The MWP will be kept on the site and referenced during field activities.

Table 1-1 lists the specific MWP investigative activities planned. The investigative activities performed as part of this WPA will be conducted in accordance with the MWP and the SOPs contained therein and included herein as Appendix A.

Changes to the approved WPA will be documented using the Work Plan Revision Form (Form E-1; Appendix E). Revisions must be reviewed and approved by the USACE Contracting Officer's Representative (COR) and the RFAAP designee prior to implementation. Project personnel will be required to read this WPA and to sign and date a Worker Acknowledgement Form (Form E-2; Appendix E). The Site Health and Safety Officer (SHSO) will retain this form on the site during investigative activities. Appropriate health and safety precautions will be taken due to the potential for exposure to or handling of hazardous materials, energetics, and/or their degradation compounds.

1.2 SITE BACKGROUND – ENVIRONMENTAL SETTING

Section 3.0 of the MWP presents information regarding the environmental setting of the RFAAP. This section of the WPA presents project-specific environmental setting information derived from a review of background data including previous investigation, soil boring logs, and physical testing results.

1.2.1 Physiography

The SWMU 13 RFI study area is located in the western section of the Horseshoe Area (HSA) between the perimeter berm of the OBG and the north bank of the New River. This area is approximately 1,700 feet (ft) long and 40 to 60 ft wide or approximately 1.6 acres; it slopes moderately to steeply from an elevation of approximately 1,690 ft above mean sea level (msl) to 1,680 ft msl (Figure 1-2). The SWMU 13 RFI study area is vegetated with tall grass and stands of trees, and it is located in the 100-year flood plain of the New River.

SWMU 13 RFI Study Area – Looking Towards New River

1.2.2 Tanks/Structures

The SWMU 13 RFI study area is undeveloped. A berm and the installation perimeter fence are located between the study area and the OBG to the north. The OBG is equipped with eight pairs of burning pad. Each burning pad contains a metal burning pan, approximately 18 ft long by 6 ft wide by 1 ft deep, and a mobile temporary storage unit (wheeled covers to prevent rainwater accumulation in the pans. Waste material is burned in the pans. An office trailer is located east of the OBG.

1.2.3 Surface Water

The SWMU 13 RFI study area is located adjacent to the New River. The OBG has several features to control and prevent runoff of storm water outside of the unit including a perimeter berm, drainage ditches, and a storm water retention basin (Figure 1-3). Other manholes, catch basins, storm drains, or drainageways are not located in the site area. Any storm water runoff from the SWMU 13 RFI study area is expected to flow south toward the New River. The heavy vegetative cover within the study area will allow for infiltration of precipitation.

1.2.4 Soil and Geology

The SWMU 13 RFI study area is underlain by Wheeling sandy loam soil. This soil has moderate permeability and medium to strong acidity (IT 2001a). Five soil borings (13SB7 through 13SB11) have been completed within the SWMU 13 RFI study area for the SSP investigation. Approximately 4 to 13 ft of alluvial soil and fill material overlie carbonate bedrock of the Elbrook Formation. The primary soil type encountered at the site was fine to medium silty sand (SM). An approximate one foot layer of silty/clayey gravel (GM) was encountered at the termination depth of two borings. Boring refusal occurred at depths ranging from ranging from approximately 4 to 13 ft below ground surface (bgs). Physical testing of two representative soil samples at the site indicated clayey gravel (GC) and silty sand (SM) soil, with a nearly neutral pH and organic content in the range of 1.1 to 3.5 percent (%). The test sample with an SM classification had a vertical hydraulic conductivity of 1.3E-05 centimeters per second (cm/sec) (Appendix C.2).

1.2.5 Groundwater

A detailed discussion of regional and RFAAP hydrogeology is presented in Section 3.8 of the MWP (URS 2003). Within the OBG, an unconfined aquifer occurs within the lower portion of unconsolidated alluvial terrace deposits underlying the site; groundwater is also present within the underlying bedrock. Depth to groundwater ranges from approximately 12 to 20 ft bgs within the operational area of the OBG and becomes progressively shallower toward the New River due to the sloping ground surface. Groundwater was encountered at the completion depths of SSP borings 13SB7 (12 ft bgs) and 13SB8 (3.7 ft bgs).

Groundwater data presented in the 2006 Annual Groundwater Monitoring Report for the OBG (Draper Aden 2007a) indicates that groundwater flow direction in this area is generally southward toward the New River. An estimated groundwater flow velocity of 21feet per year (ft/year) was calculated across the OBG area for 2006 based on average calculated hydraulic conductivity values of 6.56E-06 ft/second and an average hydraulic gradient of 0.004 ft/ft.

1.2.6 Site Background – History

Open burning of waste and off-specification energetic products has been performed continuously at the OBG since manufacturing operations began at RFAAP in 1941. Open detonation has not been conducted.

A RCRA Subpart X Permit was issued by the VDEQ in October 2005 for open burning at OBG. This unit operated under interim status prior to issuance of the permit.

Material burned at OBG has consisted of waste explosives propellants, and laboratory waste. Three types of propellant wastes have been burned including single base (nitrocellulose), double base (nitrocellulose and nitroglycerin), and triple base (nitrocellulose, nitroglycerin, and nitroguandine), as described in the RCRA Facility Assessment (RFA) conducted in 1987 (USEPA 1987). Burning of other energetic materials or burning-rate modifiers, such as lead, dinitrotoluene (DNT), or other organic and inorganic chemicals was not mentioned in the RFA.

Use of the current eight pairs of burning pads and their appurtenances started in 1985 (Dames & Moore 1992). Previously, wastes were burned in earthen pits (i.e., burn pits) at the same locations currently occupied by the burning pads. Burn residue is visually inspected for untreated energetic material. All untreated energetic material is returned to the pans for treatment. Treated burn residue is transferred to an accumulation area for off site disposal. Composite samples of the burn residue are periodically analyzed for disposal characterization.

The current Subpart X Permit requires the performance of operational and maintenance procedures and actions within the OBG operational area to prevent releases to the environment (soil) from burning activities. Periodic soil sampling is required under the permit to verify that releases to soil have not occurred above established risk-based levels.

The SWMU 13 RFI study area is an approximate 1.6 acre area located outside the current operational area of the open burning ground (OBG) between the OBG perimeter berm and the New River (Figure 1-2). The OBG currently operates under a RCRA Subpart X Permit issued by the Virginia Department of Environmental Quality (VDEQ) in October 2005. The SWMU 13 RFI study area is the area adjacent to the OBG not addressed under the RCRA Subpart X Permit.

1.3 PREVIOUS INVESTIGATIONS

Previous investigations were conducted primarily at the OBG itself, but previous investigations as they relate to the SWMU 13 RFI study area (and adjacent New River) are discussed in the following sections.

1.3.1 Installation Assessment (Aerial Photograph Interpretation) – 1992

The Environmental Photographic Interpretation Center (EPIC), under the direction of the United States Environmental Protection Agency (USEPA), performed an assessment of multiple SWMUs at RFAAP using selected aerial photographs from 1937 to 1986 (USEPA 1992). The photogeologic analysis was performed to locate waste management areas, identify the location of sinkholes that existed prior to the construction of the RFAAP, and map fracture traces.

<u>1949 Aerial Photograph (Figure 1-4)</u>

EPIC first noted activity at the burning ground on a 1949 photograph (USEPA 1992). The western portion of the burning ground had been cleared and appeared to be active, with seven burning pits visible. Apparent earth berms were located between each burn pit. A three sided berm was visible between the western portion and the eastern portion of the burning ground; this area may have been used for staging materials or burning. The eastern portion of the burning ground was mostly vegetated with outlines of potential inactive burn areas visible. A single access road was visible along the northern edge of the burning ground area. The SWMU 13 RFI study area between the burning ground and the New River was vegetated and undeveloped.

1962 Aerial Photograph (Figure 1-5)

The entire burning ground appears to be active in this photograph. Dark-toned areas were noted within several of the burn pit areas. The three-sided berm shown in the 1949 photograph was still apparent in the same configuration. EPIC noted probable light-tone liquid was present in the burning pit area west of the three-sided berm (USEPA 1992). The access road has been modified to include a loop through the burning ground in the same configuration used currently. The center portion of the SWMU 13 RFI study area appeared to have less vegetation than in the 1949 photograph, with more complete vegetative cover still present in other areas.

1971 Aerial Photograph (Figure 1-6)

Eight burning areas were apparent in the photograph with earth berms separating each area. One side of the three-sided center berm observed in the 1962 photograph was still intact. A "light-toned" liquid/material was observed near the remaining berm and "probable liquid" was present along the southern boundary (USEPA 1992). EPIC indicated that the probable liquid was potentially from flooding/precipitation.

1981 Photograph (Figure 1-7)

An interpretation of this photograph was not presented in the EPIC Report. Pit burning was still apparent on this photograph. An earth berm was apparent between the burning ground and the SWMU 13 RFI study area. The SWMU 13 RFI study area between the burning ground and the New River remained undeveloped and was completely vegetated.

1986 Photograph (Figure 1-8)

The method of burning at the burning ground had been changed from "pit burning" to "pan burning" between the 1981 and 1986 photographs. Western and eastern burning areas were apparent, with a center earth berm separating each area. Each burning area had four burning pads with two pans. Buggy paths were visible for each pan. A perimeter earth berm was apparent along the eastern, southern, and west sides of the burning ground. Two areas of "light-toned" material were visible near the northern edge of the burning ground, and several areas of "staining" were visible along the northwestern and southern boundaries. A lagoon was apparent at the eastern edge of the burning ground (USEPA 1992). The SWMU 13 RFI study area between the burning ground and the New River was undeveloped and vegetated.

1.3.2 New River and Tributaries Study – 1997

The objective of the New River and Tributaries Study was to provide data to evaluate migration pathways along the New River and its tributaries at RFAAP to assess potential adverse impacts to human health and the environment (Parsons 1997). Two surface water/sediment stations were sampled in the New River near the SWMU 13 RFI study area including NRSE4/NRSW4 located adjacent to the site area and NRSE14/NRSW14 located downstream of the site area and upstream of SWMU 54 (Figure 1-9). Surface water and sediment samples were analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), explosives, and target analyte list (TAL) metals. Detected analytical results for sediment and surface water are summarized in Tables 1-2 and 1-3, respectively.

Metals and SVOCs were detected in sediment sample NRSE4 collected adjacent to the SWMU 13 RFI study area. Lead was detected in this sample at a concentration (4,415.58 milligrams per kilogram (mg/kg)) above the USEPA Industrial Action Level (AL) of 750 mg/kg, BTAG freshwater sediment screening level (35.8 mg/kg), and facility background point estimates for soil. Chromium was detected at a concentration above its EPA Region III adjusted residential risk-based concentrations (R-RBC), but below its BTAG freshwater sediment screening level and facility background point estimate for soil. SVOC compounds were detected in sample NRSE4 at concentrations below their adjusted R-RBCs, but several phthalate compounds were detected at concentrations above their USEPA Region III BTAG freshwater sediment screening values (Table 1-2).

Metals were detected in sediment sample NRSE14 collected downstream of the SWMU 13 RFI study area. The lead concentration in this sample (104 mg/kg) was below the USEPA residential AL of 400 mg/kg. Levels of aluminum, iron, manganese, thallium, and vanadium detected in sample NRSE14 were above their R-RBC but below facility background point estimates for soil (Table 1-2). Arsenic was detected at a concentration above its EPA Region III adjusted industrial risk-based concentrations (I-RBC), but below its BTAG freshwater sediment screening level and facility background point estimate for soil. Iron, lead, manganese, and zinc were detected at concentrations above their USEPA Region III BTAG freshwater sediment screening levels, but below facility background point estimates for soil with the exception of lead and zinc.

Lead and barium were detected in surface water sample NRSW4 collected adjacent to the SWMU 13 RFI study area at concentrations above their USEPA Region III Biological Technical Assistance Group (BTAG) but below their USEPA Region III human health risk-screening criteria (Table 1-3). Other target analytes were not detected in this sample. Target analytes were not detected in the downstream surface water sample NRSW14.

1.3.3 OBG Soil and Groundwater Monitoring for RCRA Subpart X Permit 2005-2007

Groundwater in the area of OBG is currently being evaluated under the facility's Subpart X permit issued by the Virginia Department of Environmental Quality (VDEQ) in October 2005. Groundwater monitoring and any required corrective action for groundwater will be addressed under the facility's Subpart X permit; therefore, groundwater will not be further investigated or addressed under this RFI.

A component of the permit for the OBG is a *Soil Monitoring Program for the Open Burning Ground* (April 2005), which is intended to monitor the unit for potential impact to surface soil resulting from open burning ground operations. Currently, soil sampling events are conducted semi-annually during the second and fourth quarters. In addition to sampling soil within the operational area, the soil monitoring program (SMP) requires collection of surface soil samples (0 to 0.5 ft bgs) from two locations (SB-1 and SB-2) within the SWMU 13 RFI study area outside and south of the perimeter berm of the OBG (Figure 1-10). The permit requires comparison of soil sample results to industrial-based ALs included in the permit to evaluate whether further actions are required at the site.

As presented in the *2006-2007 Annual Soil Monitoring Report: Open Burning Ground* (Draper Aden, 2007b), soil samples collected from locations SB-1 and SB-2 are analyzed for VOCs by SW-846 Method 8260C, SVOCs by SW-846 Method 8270C, RCRA metals by SW-846 Methods 6010B/7471A, dioxin/furans by SW-846 Method 8290, explosives by SW-846 Method 8330, and nitroglycerin by SW-846 Method 8332 (Draper Aden 2007b). Available sample results for locations SB-1 and SB-2 as of November 1, 2007 are summarized in Table 1-4 for detected compounds. Constituents were not detected in these samples above the ALs specified in the permit and organic constituents were not detected above there adjusted R-RBCs.

One VOC, bromomethane, was detected in 1 of 8 samples at a concentration below its adjusted R-RBC. Explosive compounds 2,4,6-trinitrotoluene, 2-amino-4,6-dinitrotoluene, and 4-amino-2,6-dinitrotoluene were detected in 1 of 8 samples collected at concentrations below their adjusted R-RBCs. Arsenic was detected in one or more samples at concentrations above its adjusted I-RBC, but below its facility background point estimate. Chromium was detected in one or more samples at concentrations above its adjusted R-RBC, but below facility background point estimate. Barium, mercury, and selenium were detected in one or more samples at concentrations below their adjusted R-RBCs. Lead was detected in the samples at concentrations below the residential AL of 400 mg/kg. Dioxin/furans were detected in samples SB-1 and SB-2 at concentrations below the adjusted R-RBC for 2,3,7,8-tetrachlorodibenzodioxin (2,3,7,8-TCDD) expressed as toxicity equivalent quotient, when using the current toxicity equivalency factors (WHO 2005).

1.3.4 Site Screening Process Investigation Report - 2007

The SSP was designed using specific human health and ecological screening processes to assess: 1) whether releases of hazardous substances, pollutants, contaminants, hazardous wastes, or hazardous constituents have occurred to the environment at the sites evaluated, and 2) whether further investigation or action (i.e., risk assessment, RFI, interim action), or no further action (NFA) is appropriate at a site.

The SSP investigation was conducted in September-October 2003 and included completion of one soil boring inside the OBG operational area (13SB12) and completion of five soil borings (13SB7 through 13SB11) within the SWMU 13 RFI study area outside of the OBG operational area (between the perimeter berm of the OBG and the New River) to evaluate for the presence or absence of chemicals in soil.

Figure 1-11 shows the five soil boring locations within the SWMU 13 RFI study area. Three soil samples were collected from each of these borings (surface sample, intermediate depth, and terminal depth), except at 13SB8 where two samples were collected due to apparent groundwater encountered at a depth of 3.7 ft bgs. Soil samples were analyzed for target compound list (TCL) VOCs, TCL SVOCs, polynuclear aromatic hydrocarbons (PAHs), explosives (including nitroglycerin and pentaerythritol tetranitrate [PETN]), and TAL inorganics. One surface soil sample also was analyzed for TCL pesticides, TCL PCBs, herbicides, and TCL dioxin/furans.

Two pairs of surface water and sediment samples were collected from the New River adjacent to the site (Figure 1-12). Sample pair 13SW2/13SE2 was collected at the western end (upstream) of the site. Sample pair 13SW3/13SE3 was collected at the eastern end (downstream) of the site. Sediment and surface water samples were analyzed for TCL VOCs, TCL SVOCs, PAHs, explosives (including nitroglycerin and PETN), perchlorate (surface water), and TAL inorganics.

Two soil samples were collected for physical testing including: percent moisture, grain size, pH, total organic content, specific gravity, and bulk density. One sample was also tested for Atterberg limits and hydraulic conductivity. Analytical results for these samples are presented in Appendix C.2.

Human Health Risk Screening

The human health risk screening portion of the SSP consisted of the following components:

1. Identification of chemicals of potential concern (COPCs) via comparison of maximum detected concentrations (MDCs) to adjusted R-RBCs and I-RBCs;
2. Cumulative human health risk screening;
3. Chemical specific screening for lead and iron;
4. MDC comparison to soil-to-groundwater site screening levels (SSLs) (dilution attenuation factor [DAF] 20); and
5. Metals MDC comparison to background point estimates.

Ecological Risk Screening

The ecological risk screening portion of the SSP consisted of the following components:

1. Problem formulation including identification of chemicals of potential ecological concern (COPECs);
2. Exposure assessment;
3. Ecological effects assessment; and
4. Risk characterization.

Summary of Results

The results of the SSP investigation resulted in the identification of lead as the primary COPC and COPEC requiring further investigation and assessment at the site due to detected concentrations in soil that were above the industrial AL and ecological benchmarks. Benzo(a)pyrene was also identified as a COPC in soil due to detected concentrations above its adjusted R-RBC. Zinc was identified as a COPEC due to its detection above its ecological benchmarks and background point estimate. The SSP resulted in the recommendation of a focused RFI for soil within the SWMU 13 RFI study area and sediment within the adjacent New River. The RFI was to focus on lead in soil and metals in sediment. Refer to Appendix D.1.1 for SWMU 13's SSP text section and screening tables and the SSP Report (URS 2007) for additional detailed information.

Additionally, Appendix D.1.2 includes a revised SSP human health risk screening for surface soil and total soil for the SWMU 13 RFI study area, which excludes data from boring SB-12 located within the OBG operational area. The revised screening, utilizing current RBCs (October 2007), resulted in the identification of the following human health COPCs: metals with lead above its facility background point estimate, benzo(a)pyrene, and nitroglycerin. Figure 1-11 shows the sample results for COPCs identified in the revised human health screening and original COPECs above their background point estimates (inorganics only).

1.3.5 New River Investigation and Sampling for SWMU 54 RFI – 2007

Sediment sampling was conducted in the New River in November 2006 concurrent with the RFI conducted at SWMU 54. Sediment samples were collected from 23 stations in the New River along a reach of approximately 5.9 miles; the reach extended from approximately 3.4 miles upstream of SWMU 54 to a location approximately 2.4 miles downstream of SWMU 54, as shown on Figure 1-12. Sample locations were selected based on a desktop assessment of flood plain and hydrologic data (to identify locations where sediment deposition occurs) and a field reconnaissance by boat conducted by representatives of URS, the Army, EPA, U.S. Fish and Wildlife, and the VDEQ. The purpose of the sediment sampling was to evaluate potential impacts on the New River from historical activities at SWMU 54 and to assess overall sediment quality in the RFAAP area.

Sediment samples were analyzed for explosives and TAL metals along with total organic carbon, pH, and grain size analysis. Eight of the 23 samples were collected upstream of the OBG (NR-SED-1 through NR-SED-8). Three samples were collected adjacent to the SWMU 13 RFI study area (NR-SED-9 through NR-SED-11), two samples (NR-SED-12 and NR-SED-13) were collected downstream of the OBG and upstream of SWMU 54, and nine samples were collected downstream of the OBG, and SWMU 54. Sample results are summarized in Table 1-5. Lead results for the samples are shown on Figure 1-12 and summarized by segment in the following table.

Summary of Lead Sample Results for Sediment

		Lead Concentrations (mg/kg)		
River Segment	**Stations**	**Minimum**	**Maximum**	**Mean**
Upstream of the OBG	NR-SED-1 – NR-SED-8	43	160	87
Adjacent to SWMU 13 RFI Study Area	NR-SED-9 – NR-SED-11	120	280	197
Downstream of the OBG and Upstream of SWMU 54	NR-SED-12 – NR-SED-14	86	100	105
Adjacent to SWMU 54	NR-SED-15	190	190	190
Downstream of the OBG, SWMU 54, and MMA	NR-SED-16 – NR-SED-23	82	500	198
Entire Segment Sampled	NR-SED-1 – NR-SED 23	43	500	147

As shown in Figure 1-12 and in the above table, lead concentrations in New River sediment are below the human health residential AL of 400 mg/kg, with the exception of station NR-SED-16 (500 mg/kg) located downstream of the OBG, SWMU 54, and the RFAAP MMA. The mean concentration of lead for each sub-segment sampled and the entire reach sampled were below 400 mg/kg. Detected lead concentrations in each sample were above the BTAG sediment screening value of 35.8 mg/kg.

2,4-Dinitrotoluene (2,4-DNT) was detected in the sediment sample NR-SED-8 collected across the New River (on the opposite river bank) from the western edge of the OBG at a concentration (1.4 mg/kg) above its BTAG sediment screening value but below its adjusted R-RBC. 2,4,6-Trinitrotoluene (2,4,6-TNT) was detected in sediment sample NR-SED-10 collected adjacent to the SWMU 13 RFI study area at a concentration (0.24 mg/kg) above its BTAG sediment screening value but below its adjusted R-RBC. Explosives were not detected in the other sediment samples collected from the New River.

1.4 CONCEPTUAL SITE MODEL

A refined conceptual site model (CSM) for the SWMU 13 RFI study area is presented on Figure 1-13. The site is an approximate 40 to 60 ft wide area between the operational area of OBG and the New River within the 100 year floodplain. This area is outside of the RFAAP perimeter security fence and slopes moderately to steeply from the outside of the OBG perimeter berm down to the river, with a vertical elevation difference of approximately 10 ft. Thick grass and stands of trees cover the SWMU 13 RFI study area. Subsurface geology consists of fill material and alluvial deposits overlying carbonate bedrock of the Elbrook Formation. Groundwater is present within the lower portion of the alluvial deposits and in underlying bedrock. Groundwater flows south from OBG toward the SWMU 13 RFI study area and the New River.

Potentially affected media include surface soil, subsurface soil, groundwater, and sediment of the New River. Runoff controls within OBG prevent storm water runoff or drainage from the active burning ground from entering the SWMU 13 RFI study area. Within the SWMU 13 RFI study area, depending on the amount of precipitation, stormwater will either infiltrate into soil due to thick vegetative cover or flow downslope toward the New River.

1.4.1 Contaminant Sources

Potential source areas at the SWMU 13 RFI study area consist of impacted soil likely associated with historical operations at the burning ground prior to modification of the burning ground operations to prevent potential releases to the SWMU 13 RFI study area. Other contaminant sources have not been identified in the SWMU 13 RFI study area.

1.4.2 Mechanisms of Contaminant Release

Historical operations at the burning ground may have resulted in impacts to soil in the SWMU 13 RFI study area due to runoff from the burning areas and deposition of particulate matter from burning operations. Chemicals released to surface soil at the site may be transported via stormwater runoff and overland flow to the SWMU 13 RFI study area or to the New River located adjacent to the site. Leaching of chemicals to subsurface soil and groundwater is another potential release mechanism. Potential releases to the New River (surface water and sediment) could also occur from any discharging groundwater containing dissolved phase constituents associated with the OBG. Groundwater in the area of OBG is currently being evaluated under the facility's Subpart X permit issued by the Virginia Department of Environmental Quality (VDEQ) in October 2005 which includes semi-annual compliance groundwater monitoring; therefore, groundwater will not be further investigated or addressed under this RFI. Although historic activities at the burning ground may have impacted the New River via stormwater runoff and discharging of groundwater, this RFI focuses on the existing soil conditions within the SWMU 13 RFI study area and evaluates potential migration pathways to the New River via stormwater runoff from the SWMU 13 RFI study area. Potential release mechanisms and affected media quantitatively assessed as part of this RFI are shown on the conceptual site diagram presented on Figure 1-14.

1.4.3 Exposure Pathways

1.4.3.1 Human Receptors/Pathways

Although current and likely future land-use scenarios are limited to industrial operations, both residential and industrial scenarios will be evaluated. Potential receptors that will be evaluated include current/future maintenance workers, current/future trespasser (due to site's location outside of Installation perimeter fence), future construction workers, future commercial workers, future adult residents, and future child residents. Potentially complete pathways for each receptor are provided in Table 1-6 and pathways to be quantitatively assessed are summarized on Figure 1-14, Conceptual Site Diagram.

1.4.3.2 Ecological Receptors/Pathways

Potential ecological receptors will include terrestrial receptors for soil (Figure 1-14). Receptor categories and species identified for terrestrial soil include: plant communities and soil invertebrate/microbial communities for direct contact, and omnivorous birds (American Robin), carnivorous birds (Red-Tailed Hawk), herbivorous animals (Meadow Vole), omnivorous mammals (Red Fox), and carnivorous mammals (Short-Tailed Shrew) for wildlife. Wildlife profile information for these receptors is summarized in Table 1-7. Also on Table 1-7, note the area use factor used in the refinement of the SLERA was calculated using a site area of 1.6 acres (0.65 hectares) as shown on Figure 1-2. A photographic log for the site is provided in Appendix B.

1.5 DATA GAP ANALYSIS

Based on the results of the previous investigations of soil in the SWMU 13 RFI study area, a focused RFI is recommended to further characterize the nature and extent of lead in soil and further assess the risk to human health and the environment.

1.5.1.1 Soil

Five soil borings (13SB7 through 13SB11) were completed for the SSP in the SWMU 13 RFI study area south of the perimeter berm of the OBG (Figure 1-11). Fourteen soil samples were collected from these borings for analysis of TCL organics and TAL inorganics. Lead was identified as the primary COPC and COPEC requiring further investigation based on the results of the SSP risk screening. Lead was detected at a concentration above its I-RBC and its background point estimate (Figure 1-11). Additional lead sampling is required to further assess its nature and extent of lead in soil, identify any “hot spot” areas with concentrations above the industrial AL, and to provide sufficient data for risk assessment.

The revised SSP human health risk screening for surface soil and total soil for the SWMU 13 RFI study area resulted in the identification of the following human health COPCs: metals with lead above its facility background point estimate, benzo(a)pyrene, and nitroglycerin (Figure 1-11). Additional soil sampling for SVOCs including low level PAHs, explosives including nitroglycein, and metals is planned for the RFI to provide more complete spatial data for these constituents to verify the SSP results, evaluate potential migration pathways to the New River, and to provide sufficient samples to evaluate mean concentrations in soil for the risk assessments.

1.5.1.2 Sediment and Surface Water – New River

Two pairs of surface water and sediment samples were collected for the SSP from the New River adjacent to SWMU 13 RFI study area (Figure 1-12). These samples were analyzed for TCL VOCs, TCL SVOCs (including PAHs), explosives, and TAL inorganics. Metals were the primary COPCs and COPECs identified in the SSP for sediment. Data gaps identified in the SSP were filled in 2006 (SWMU 54 New River Study) by collecting 23 additional sediment samples from the New River at locations upstream, adjacent to, and downstream of the SWMU 13 RFI study area (Figure 1-12). These additional samples were analyzed for TAL metals, explosives, and physical parameters. The objective of this RFI is to assess the nature and extent of chemicals in soil located in the SWMU 13 RFI study area and to evaluate potential risks to human health and the environment including potential future impacts to the New River. A qualitative assessment of potential future impacts from soil within the SWMU 13 RFI study area to the New River will be conducted as part of the RFI. The release mechanism of concern with regard to the New River is deposition of soil via runoff from the site; therefore, an assessment of the nature and extent of site contaminants in conjunction with the type, quality, and percentage of ground cover for the study area will be conducted to qualitatively determine the potential for impacts. No additional sampling of the New River is planned for the RFI.

1.5.1.3 Groundwater

Groundwater in the area of OBG is currently being evaluated under the facility’s Subpart X permit issued by the Virginia Department of Environmental Quality (VDEQ) in October 2005. Groundwater monitoring and any required corrective action for groundwater will be addressed under the facility’s Subpart X permit; therefore, groundwater will not be further investigated or addressed under this RFI.

1.5.1.4 Other

Two subsurface soil samples for the SSP were submitted for physical soil testing. The lack of physical soil test data for surface soil represents a data gap for the RFI.

1.5.1.5 SWMU 13 RFI - Data Gap Analysis and Completion Plan

The following table summarizes the data gaps identified for the RFI, which include the collection of additional chemical data for surface soil and subsurface soil and the collection of physical data for surface soil and subsurface soil to fill the identified data gaps.

Summary of Data Gaps

DATA GAPS			COMPLETION PLAN
Item	**Physical**	**Chemical**	
Soil in SWMU 13 RFI Study Area	Surface Soil Samples	Lead, metals, SVOCs, explosives including nitroglycerin	Collect additional soil samples in a grid across the site to identify lead "hot spots" and nature and extent. Submit selected samples across grid for analysis of metals, SVOCs, and explosives to confirm SSP results and provide additional data for risk assessment.
	Subsurface Soil Samples	Lead, metals, SVOCs, explosives including nitroglycerin	
Sediment: New River	N/A	N/A	Qualitative assessment of potential impacts to the New River from soil within the SWMU 13 RFI study area.
Groundwater	N/A	N/A	Groundwater monitoring and any corrective action is addressed under the Subpart X Permit.
Site-Wide Soil Characteristics	Physical / Geotechnical Properties	pH, oxidation/reduction potential, grain size, Atterberg Limits, moisture content, cation exchange capacity	Collect surface and subsurface soil samples for geotechnical and physical property analysis.

N/A = Not Applicable

1.6 PLANNED FIELD ACTIVITIES

The field program for the SWMU 13 RFI study area is designed to address the data gaps identified and discussed in Section 1.5 and meet the RFI objectives identified in Section 1.0. The selection of the investigation areas and soil sample locations followed SOP 30.7 (Sampling Strategies, included in Appendix A) using a combination of systematic grid sampling and biased sampling.

The MWP is referenced where routine activities will be performed in accordance with the MWP specifications, SOPs, and the Master Health and Safety Plan (URS 2003). Variances to the specifications are documented in this WPA. Table 1-1 identifies the MWP SOPs that will be followed as part of the RFI for field documentation, subsurface investigation, sampling, field evaluations, sample management, data management, and management of investigative derived material, decontamination, and field monitoring. Copies of the SOPs identified in Table 1-1 are included in Appendix A.

1.6.1 Soil Sampling

A soil sampling grid will be established within the SWMU 13 RFI study area to further assess the spatial distribution of lead in soil. Data will be collected on a central aligned rectangular grid to provide coverage across the entire study area. Given the elongated rectangular shape of the site, a rectangular grid will be used rather than a square grid with 50 ft sample spacing in the east to west direction and 20 ft sample spacing in the north to south direction as shown on Figure 1-15. This grid will provide for approximately 77 sample point locations across the site, with two to three rows of samples between the OBG berm and the New River. Sample locations are subject to field conditions.

A surface soil sample ("A" sample) will be collected at each sample point location at a depth of 0 to 0.5 ft bgs below any surface vegetation. Soil borings will be completed at each grid node to collect up to two subsurface soil samples including an intermediate depth sample ("B" sample) from 2 to 3 ft bgs and a terminal depth sample "C" from the completion depth of the boring. It is anticipated that the maximum depth of soil sampling will be 6 ft bgs based on the results of the SSP investigation results and site conditions encountered. Boring termination depths may be shallower at locations proximate to the New River due to the anticipated shallower depth of groundwater. Borings will be completed with a hand auger or soil corer, and soil samples will be collected following SOP 30.1. Soil samples will be submitted for laboratory analysis of lead by SW-846 Method 3050B/6010B.

Additional chemical data for SVOCs, explosives including nitroglycerin, and TAL metals will be collected from 10 of the grid sample locations shown on Figure 1-15. These data will be used to confirm SSP sample results and provide additional data for use in the risk assessments and background evaluations (for metals). One surface sample ("A" samples) and one subsurface sample ("C" sample from the terminal boring depth) will be collected and submitted for analysis of TCL SVOCs by SW-846 Method 8270C, explosives by SW-846 Method 8330, nitroglycerin by SW-846 Method 8332, and TAL metals by SW-846 Methods 6000/7000.

Three representative surface soil samples will be submitted for analysis of total organic carbon (TOC, Walkley-Black Method), grain size analysis (ASTM International [ASTM] Method D 422), Atterberg Limits (ASTM Method D 4318), moisture content (ASTM Method D 2216), pH (ASTM Method D 4972), and cation exchange capacity. Two representative subsurface soil samples also will be analyzed for TOC and cation exchange capacity.

1.6.2 Surveying

Horizontal coordinates and ground surface elevations for sample locations will be obtained using a global positioning system unit with submeter accuracy for horizontal measurements (+1 part per million [ppm]) and vertical measurements (+2 parts per million).

1.6.3 Investigation-Derived Material Handling and Disposal

Activities conducted during this investigation will comply with the relevant Occupational Safety and Health Administration and USEPA regulations regarding the identification, handling, and disposal of non-hazardous and hazardous investigation-derived material (IDM). Activities will be performed in accordance with the Installation safety rules, protocols, and SOP 70.1. Table 1-8 summarizes the suspected nature (hazardous versus non-hazardous) of the materials to be generated during field investigative activities.

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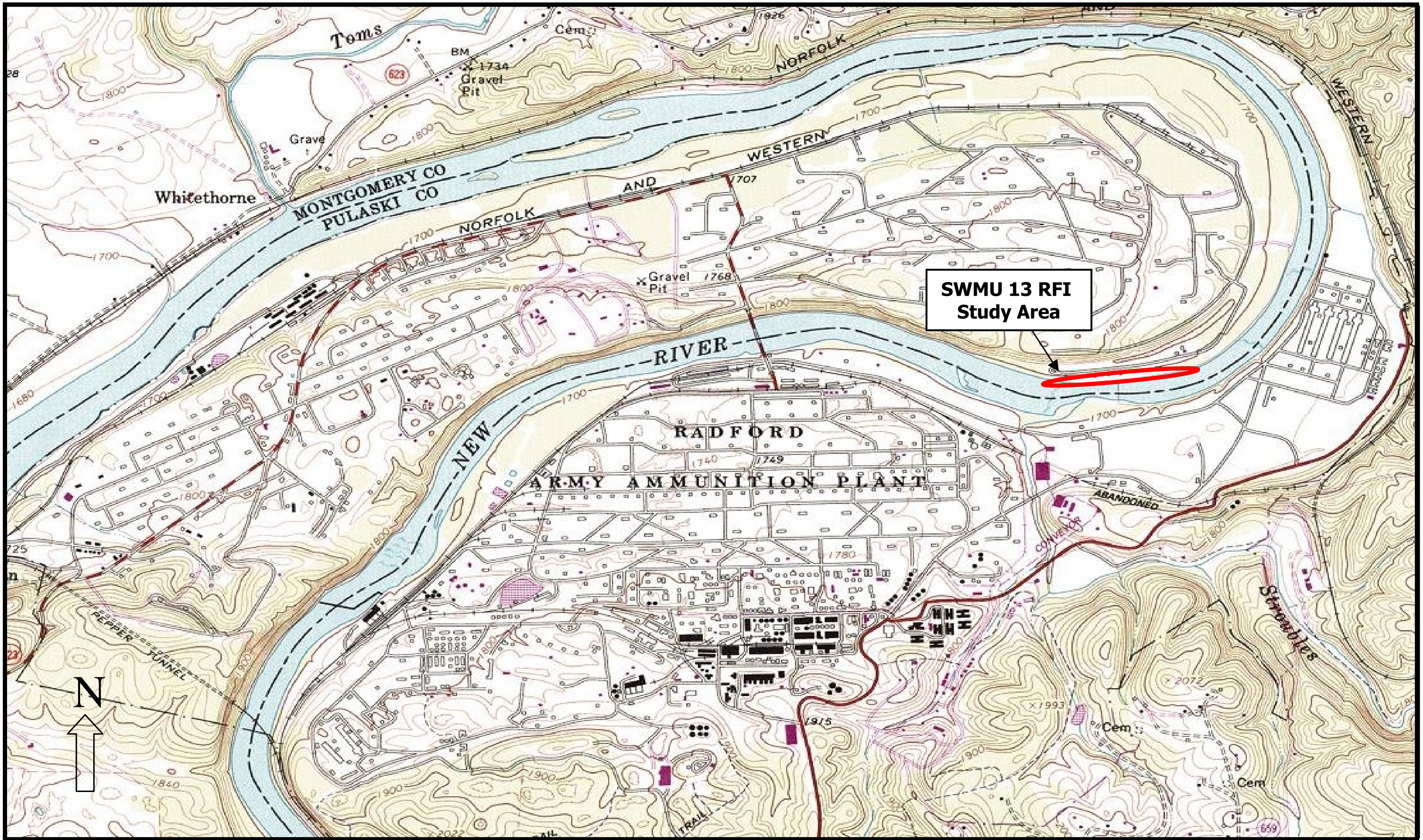

FIGURE 1-1 **Site Location Map**		**SWMU 13** **RCRA Facility Investigation** **Radford Army Ammunition Plant** **Radford, Virginia**
Date: January 2008	**URS Project#:** 11656367	
Prepared by: DBC	**Approved by:** JOS	URS
Scale: 1" = 2000'	**File Name:** Fig.1-1 SiteLayout	**URS Group, Inc.** **5540 Falmouth Street,** **Suite 201** **Richmond, VA 23230**

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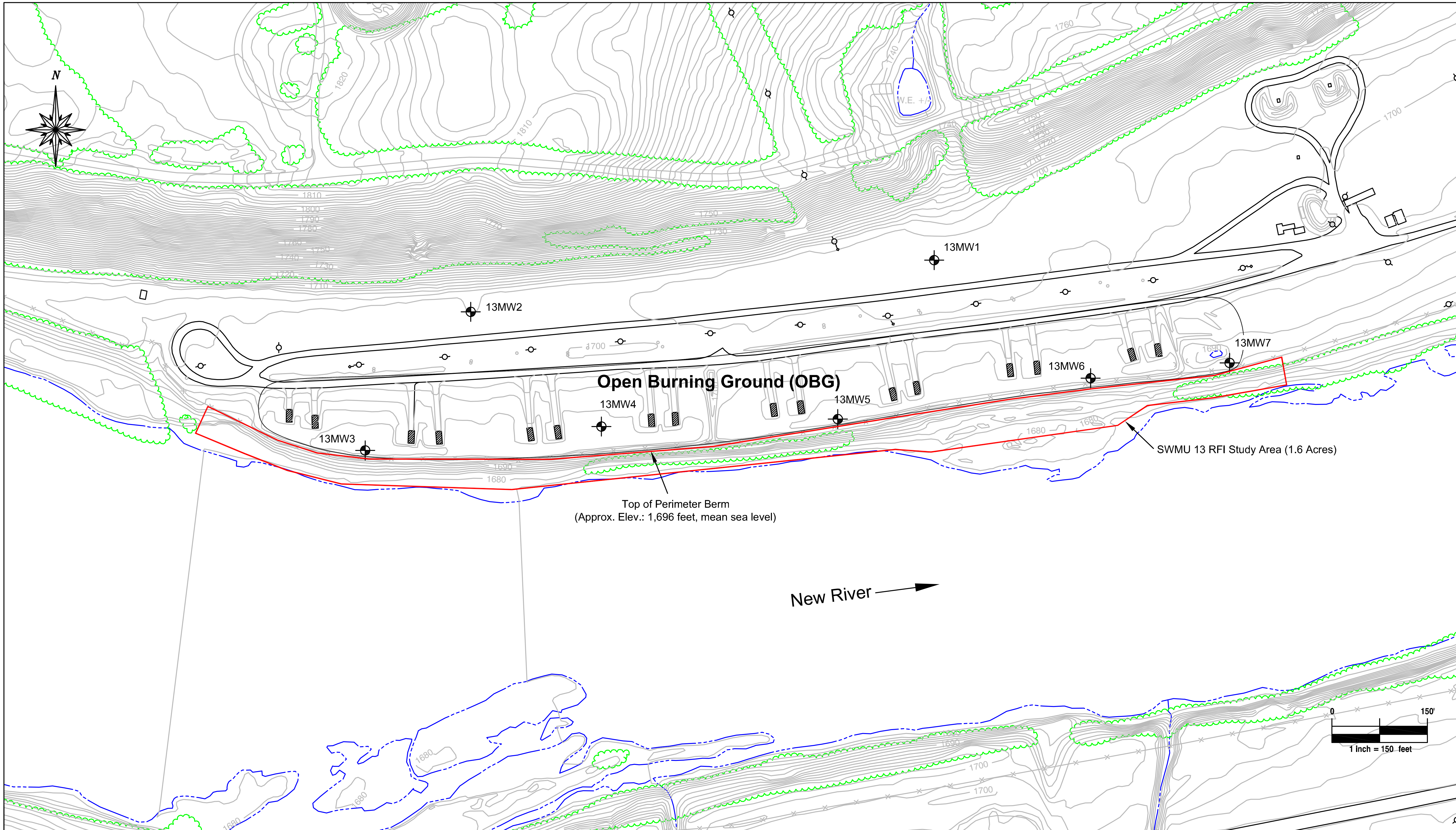

Legend

Topographic Contour Line (feet, mean sea level)	Monitoring Well Location
Surface Water	Vegetation
OBG Boundary	Burning Pan
Study Area Boundary	Light/Electric Pole

FIGURE 1-2

Site Topographic Map

Date: January 2008	URS Project #: 11656367
Prepared by: DBC	Approved by: JOS
Scale: 1 inch = 150 feet	File Name: Fig.1-2 Site Topo

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Radford, Virginia

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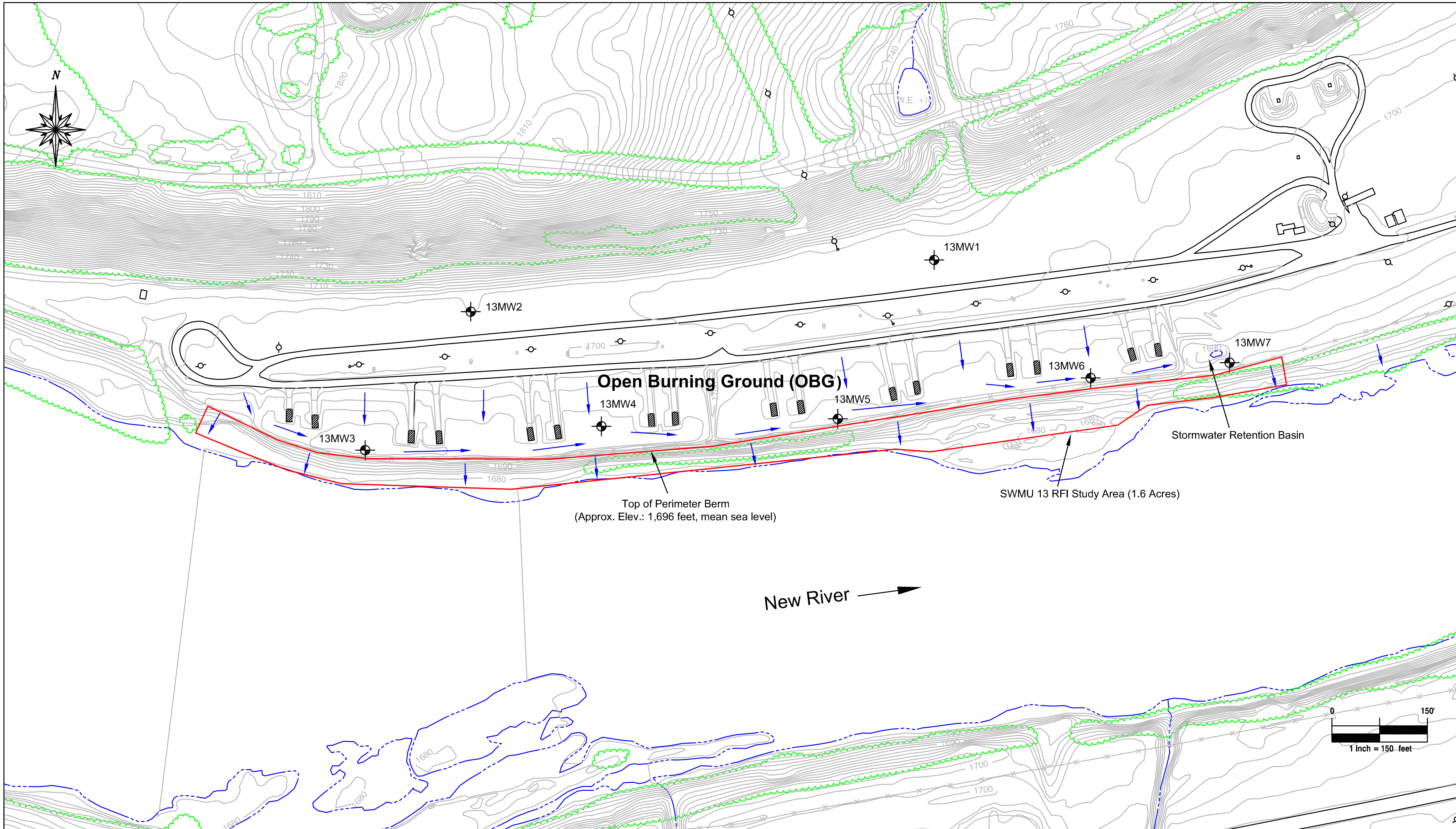
Richmond, Virginia 23230



Legend

- Topographic Contour Line (feet, mean sea level)
- Surface Water
- Study Area Boundary
- Stormwater Flow Direction
- Monitoring Well Location
- Vegetation
- Burning Pan
- Light/Electric Pole

FIGURE 1-3 Surface Water Drainage Map	
Date: January 2008	URS Project #: 11656367
Prepared by: DBC	Approved by: JOS
Scale: 1 inch = 150 feet	File Name: Fig.1-3 SW Drainage

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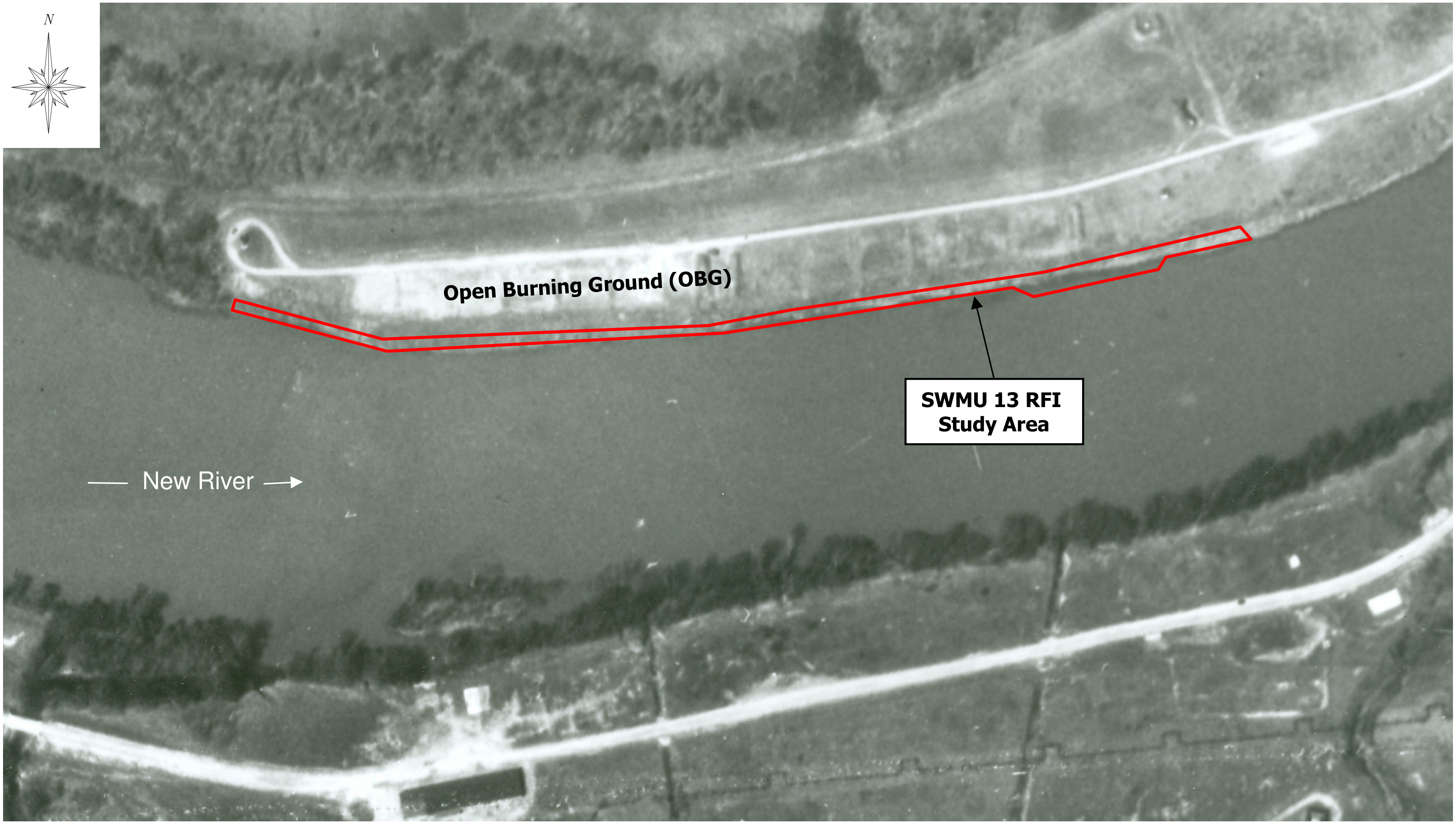

FIGURE 1-4 1949 Aerial	
Date: *January2008*	URS Project #: *11656367*
Prepared by: *DBC*	Approved by: *JOS*
Scale: *Not to Scale*	File Name: *Fig.1-4 1949 Aerial*

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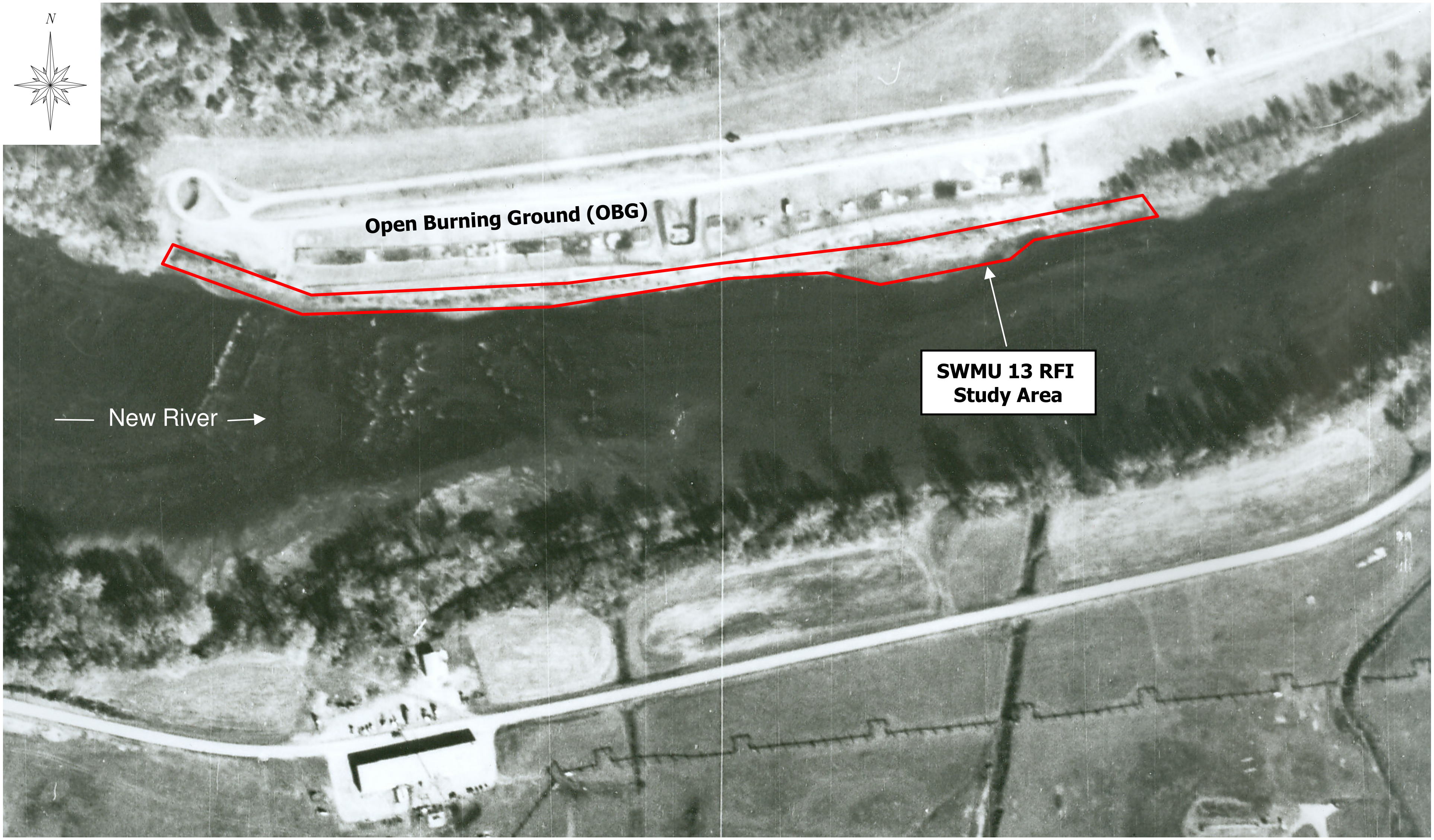

FIGURE 1-5
1962 Aerial

Date: January2008	URS Project #: 11656367
Prepared by: DBC	Approved by: JOS
Scale: Not to Scale	File Name: Fig.1-5 1962 Aerial

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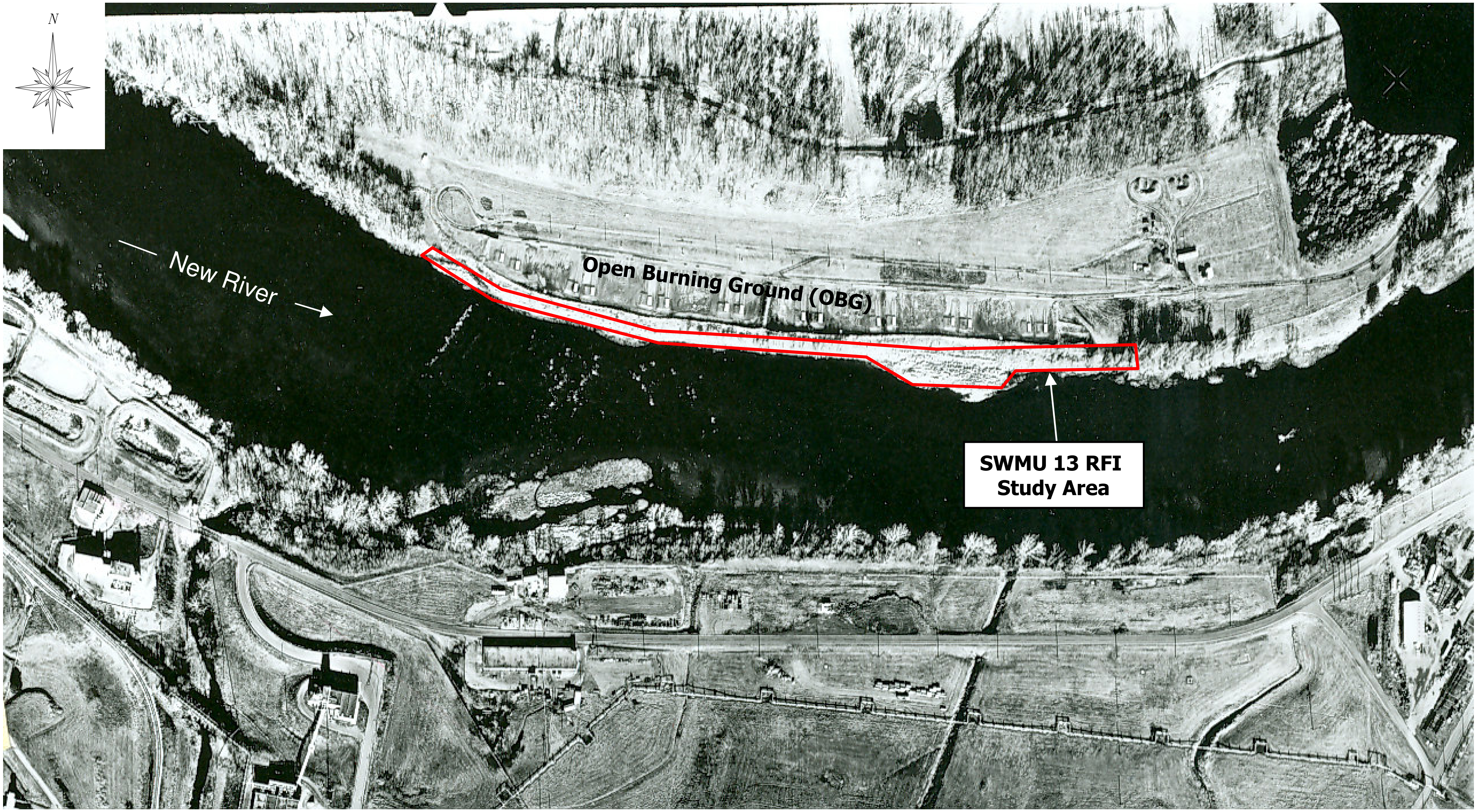

FIGURE 1-6
1971 Aerial

Date: January2008	URS Project #: 11656367
Prepared by: DBC	Approved by: JOS
Scale: Not to Scale	File Name: Fig.1-6 1971 Aerial

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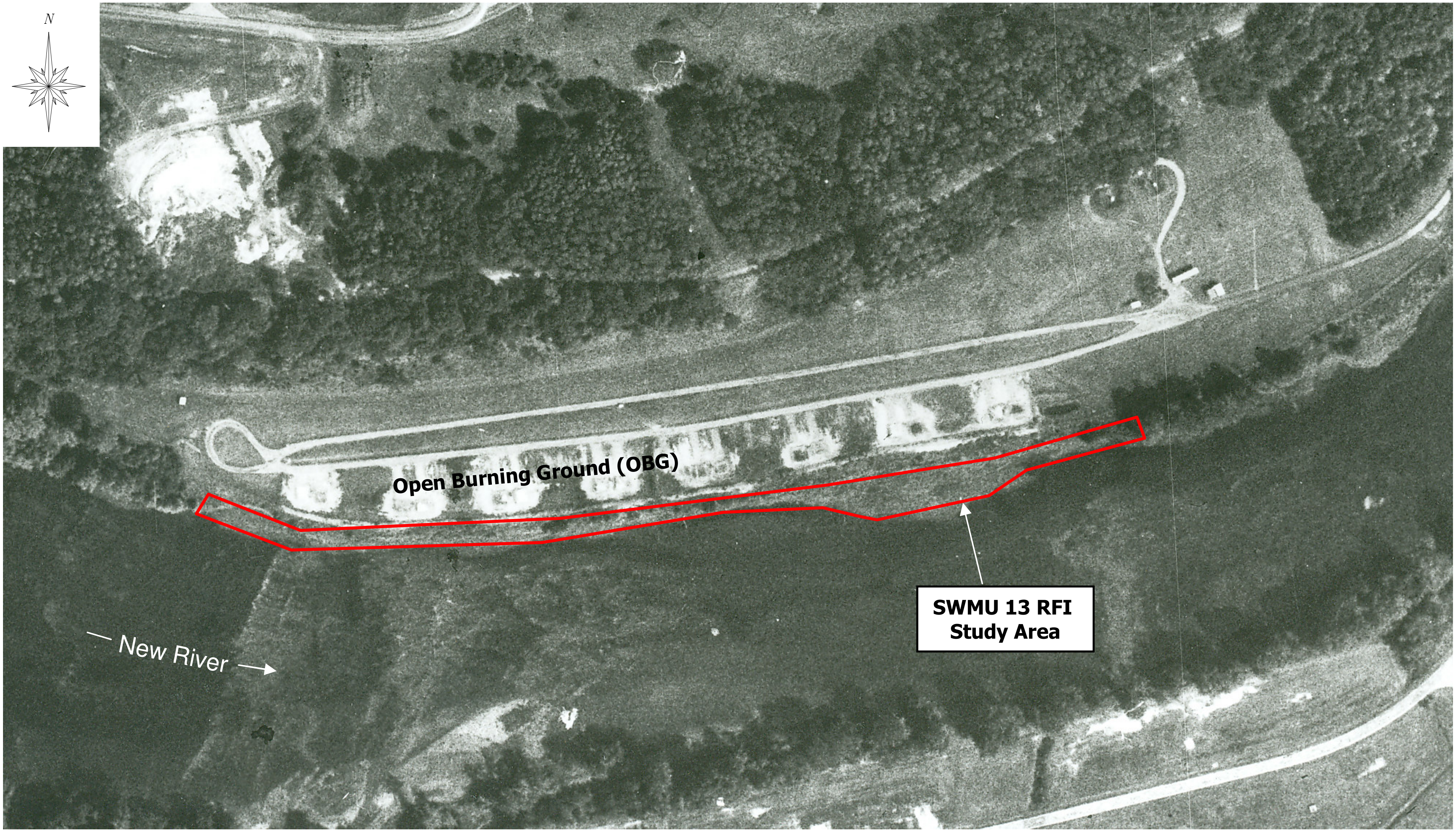

FIGURE 1-7
1981 Aerial

Date: *January2008*	**URS Project #:** *11656367*
Prepared by: *DBC*	**Approved by:** *JOS*
Scale: *Not to Scale*	**File Name:** *Fig.1-7 1981 Aerial*

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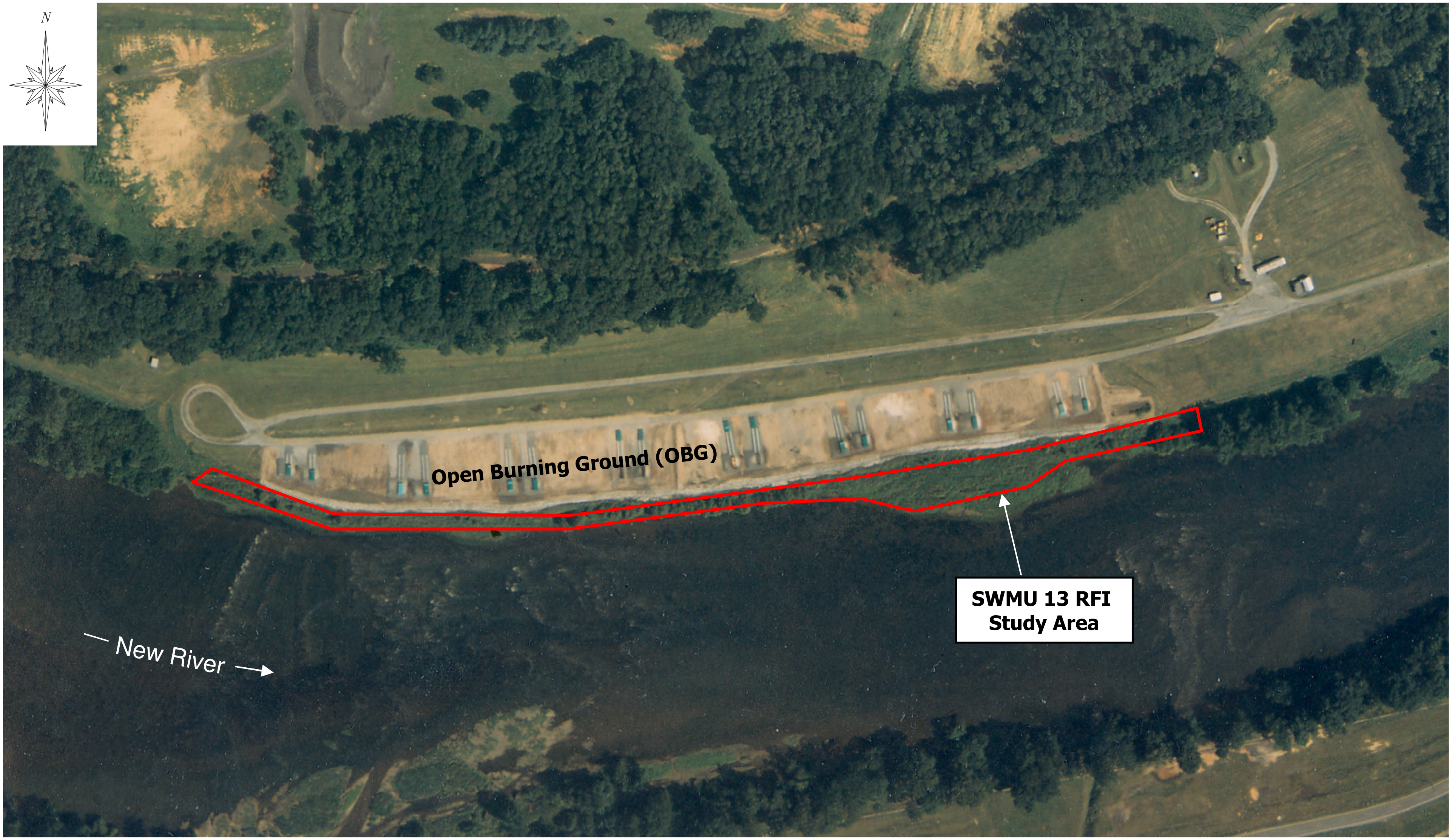

FIGURE 1-8 1986 Aerial		SWMU 13 RCRA Facility Investigation Radford Army Ammunition Plant Radford, Virginia
Date: January2008	URS Project #: 11656367	
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Scale: Not to Scale	File Name: Fig.1-8 1986 Aerial	

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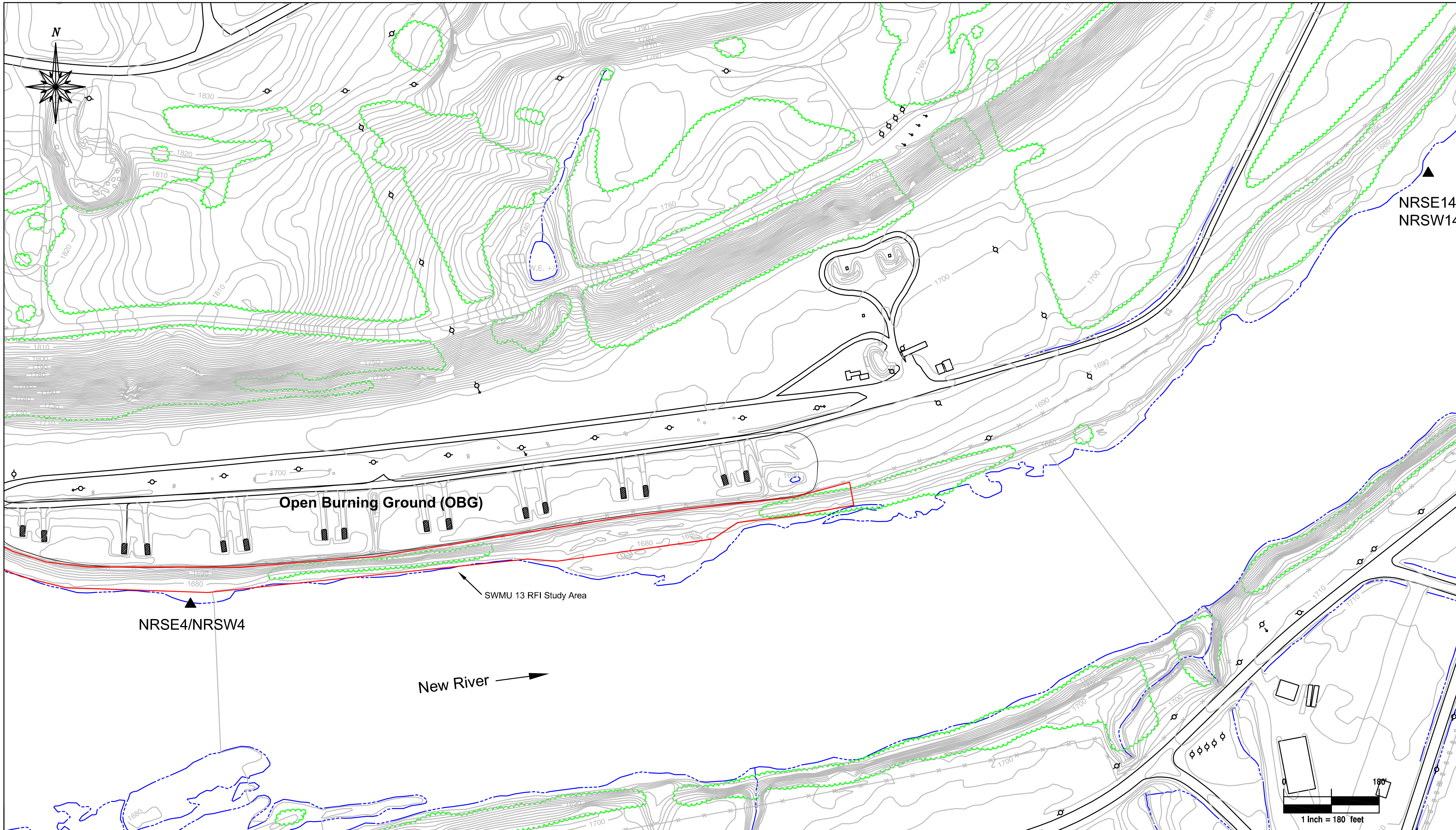

Legend

- Topographic Contour Line (feet, mean sea level)
- Surface Water
- OBG Boundary
- Study Area Boundary
- Vegetation
- Burning Pan
- Light/Electric Pole
- Surface Water/Sediment Sampling Location

FIGURE 1-9
New River and Tributaries Study - 1997
Sample Locations

Date: January 2008	URS Project #: 11656367
Prepared by: DBC	Approved by: JOS
Scale: 1 inch = 180 feet	File Name: Fig.1-9 NR&Trib.Locs

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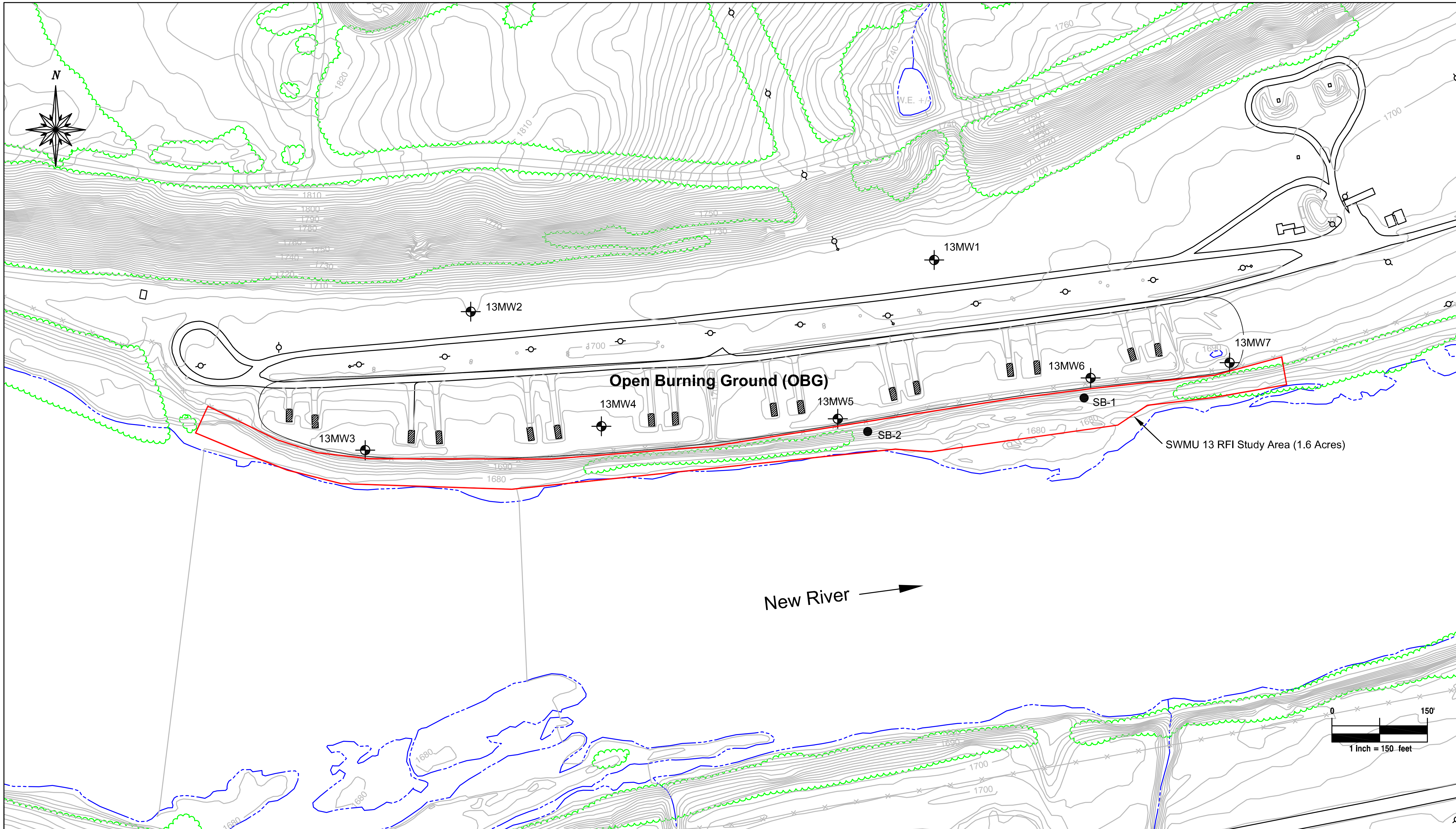

Legend

Topographic Contour Line (feet, mean sea level)	Monitoring Well Location
Surface Water	Soil Boring Location
OBG Boundary	Vegetation
Study Area Boundary	Burning Pan
Light/Electric Pole	

FIGURE 1-10

OBG Groundwater and Soil Monitoring Locations - RCRA Subpart X Permit 2005-2007

Date: January 2008	URS Project #: 11656367
Prepared by: DBC	Approved by: JOS
Scale: 1 inch = 150 feet	File Name: Fig.1-10 RCRA Subpart

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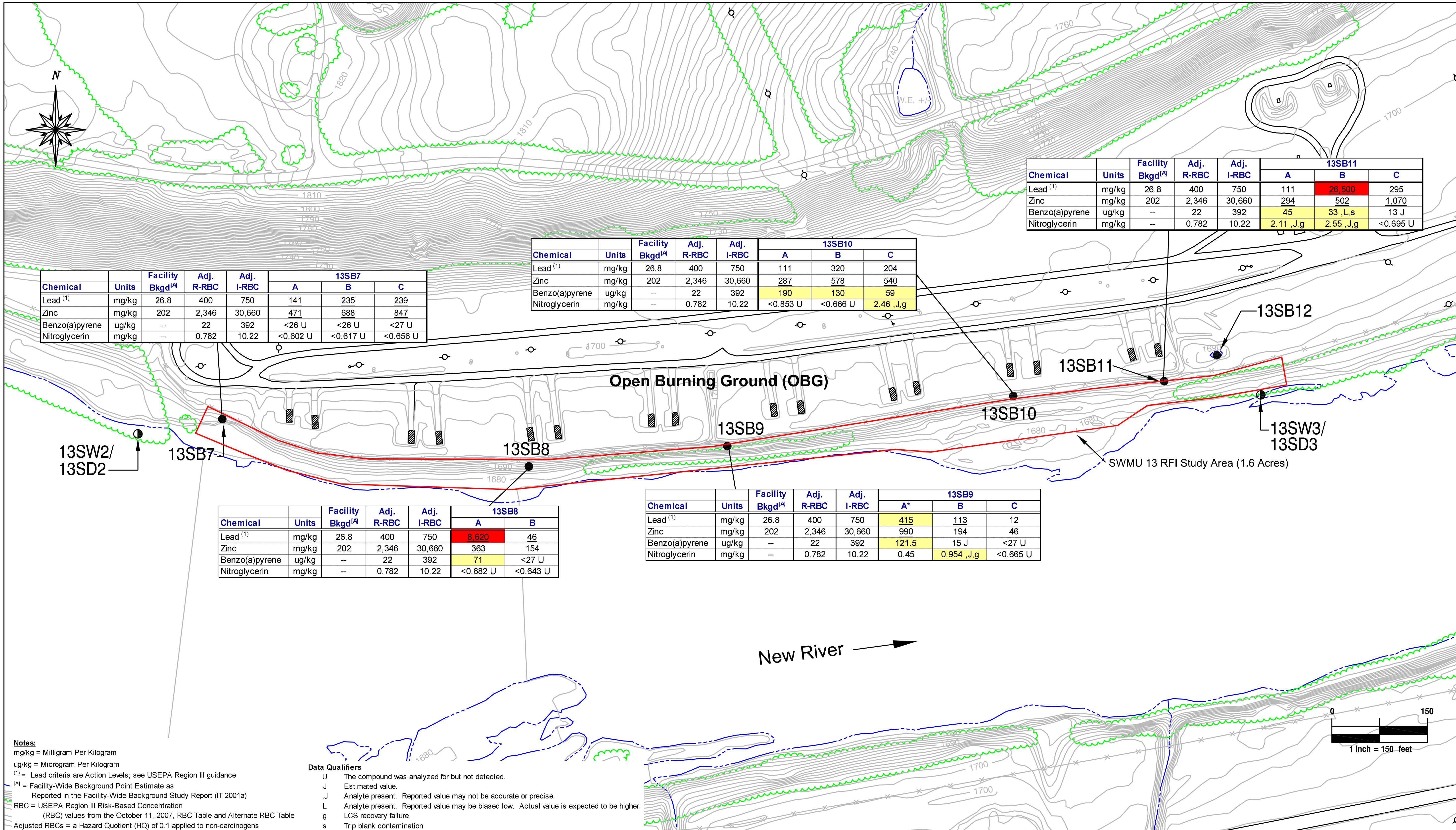


Chemical	Units	Facility Bkgd[A]	Adj. R-RBC	Adj. I-RBC	13SB7 A	13SB7 B	13SB7 C
Lead (1)	mg/kg	26.8	400	750	141	235	239
Zinc	mg/kg	202	2,346	30,660	471	688	847
Benzo(a)pyrene	ug/kg	--	22	392	<26 U	<26 U	<27 U
Nitroglycerin	mg/kg	--	0.782	10.22	<0.602 U	<0.617 U	<0.656 U

Chemical	Units	Facility Bkgd[A]	Adj. R-RBC	Adj. I-RBC	13SB10 A	13SB10 B	13SB10 C
Lead (1)	mg/kg	26.8	400	750	111	320	204
Zinc	mg/kg	202	2,346	30,660	287	578	540
Benzo(a)pyrene	ug/kg	--	22	392	190	130	59
Nitroglycerin	mg/kg	--	0.782	10.22	<0.853 U	<0.666 U	2.46 ,J,g

Chemical	Units	Facility Bkgd[A]	Adj. R-RBC	Adj. I-RBC	13SB11 A	13SB11 B	13SB11 C
Lead (1)	mg/kg	26.8	400	750	111	26,500	295
Zinc	mg/kg	202	2,346	30,660	294	502	1,070
Benzo(a)pyrene	ug/kg	--	22	392	45	33 ,L,s	13 J
Nitroglycerin	mg/kg	--	0.782	10.22	2.11 ,J,g	2.55 ,J,g	<0.695 U

Chemical	Units	Facility Bkgd[A]	Adj. R-RBC	Adj. I-RBC	13SB8 A	13SB8 B
Lead (1)	mg/kg	26.8	400	750	8,620	46
Zinc	mg/kg	202	2,346	30,660	363	154
Benzo(a)pyrene	ug/kg	--	22	392	71	<27 U
Nitroglycerin	mg/kg	--	0.782	10.22	<0.682 U	<0.643 U

Chemical	Units	Facility Bkgd[A]	Adj. R-RBC	Adj. I-RBC	13SB9 A*	13SB9 B	13SB9 C
Lead (1)	mg/kg	26.8	400	750	415	113	12
Zinc	mg/kg	202	2,346	30,660	990	194	46
Benzo(a)pyrene	ug/kg	--	22	392	121.5	15 J	<27 U
Nitroglycerin	mg/kg	--	0.782	10.22	0.45	0.954 ,J,g	<0.665 U

Notes:
mg/kg = Milligram Per Kilogram
ug/kg = Microgram Per Kilogram
(1) = Lead criteria are Action Levels; see USEPA Region III guidance
[A] = Facility-Wide Background Point Estimate as Reported in the Facility-Wide Background Study Report (IT 2001a)
RBC = USEPA Region III Risk-Based Concentration (RBC) values from the October 11, 2007, RBC Table and Alternate RBC Table
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens

Data Qualifiers

U	The compound was analyzed for but not detected.
J	Estimated value.
,J	Analyte present. Reported value may not be accurate or precise.
L	Analyte present. Reported value may be biased low. Actual value is expected to be higher.
g	LCS recovery failure
s	Trip blank contamination

Legend

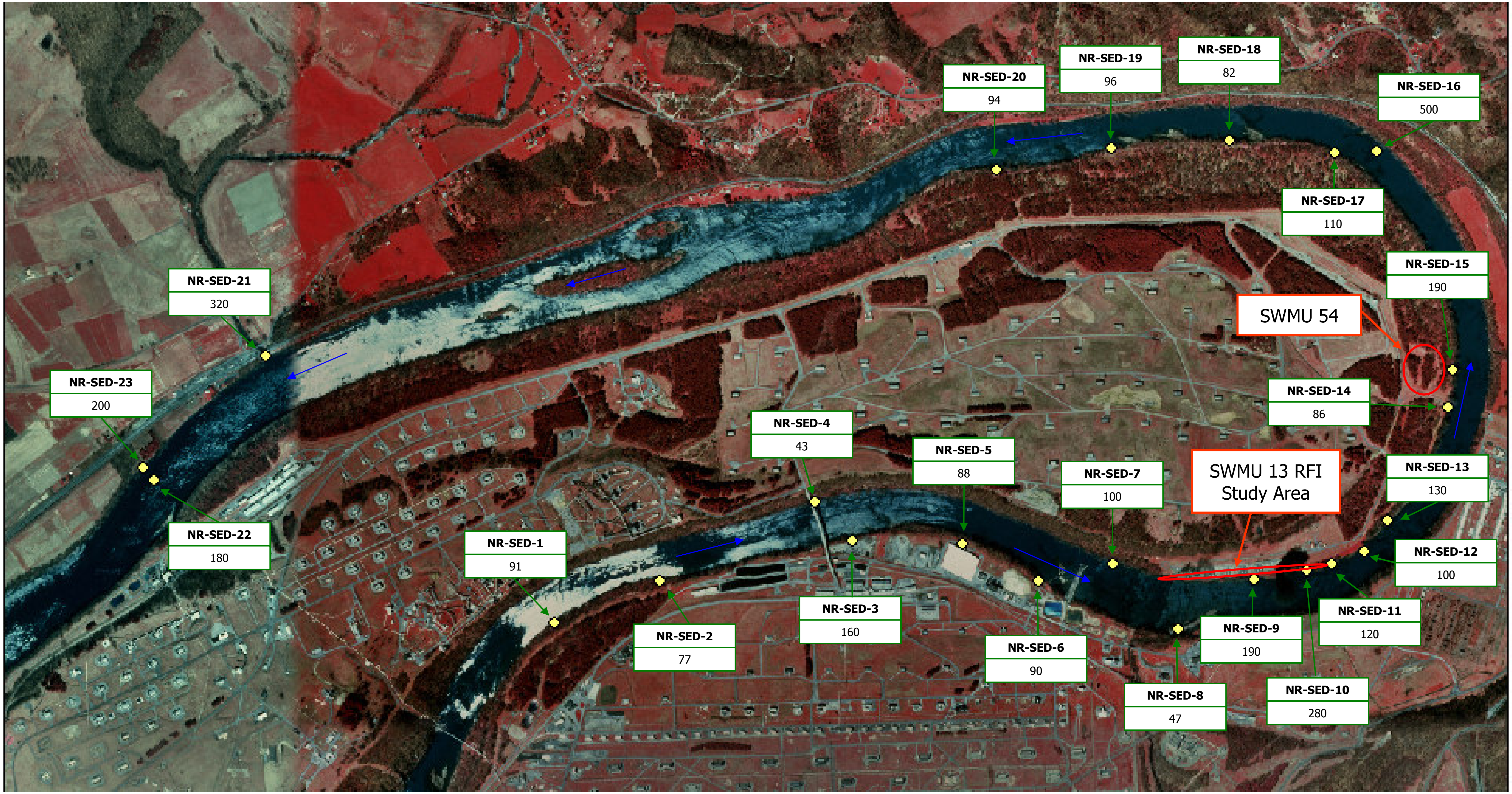
Topographic Contour Line (feet, mean sea level)
Surface Water
Study Area Boundary
Soil Boring Location
Surface Water/Sediment Location
Vegetation
Burning Pan
Light/Electric Pole
= Concentration Exceeds Adjusted Soil Residential RBC
= Concentration Exceeds Adjusted Soil Industrial RBC
underline = Concentration Exceeds Facility-Wide Background Point Estimate

FIGURE 1-11
SSP Investigation Sampling Locations

Date: January 2008
URS Project #: 11656367
Prepared by: DBC
Approved by: JOS
Scale: 1 inch = 150 feet
File Name: Fig.1-11 SSPSamp.Locs

SWMU 13
RCRA Facility Investigation
Radford Army Ammunition Plant
Radford, Virginia

URS Group, Inc.
5540 Falmouth Street
Suite 201
Richmond, Virginia 23230



Legend

◇	Sediment Sampling Location
NR-SED-1	Sampling Location ID
91	Concentration of Lead (mg/kg)
→	Flow Direction

N

FIGURE 1-12

New River Sediment Locations and Lead Results

Date: May 10, 2007	URS Project #: 11656367
Prepared by: TLD/LAM	Reviewed by: JOS
Scale: Not to Scale	File Name: Fig.1-12 NR-SW&SED Res

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Radford Army Ammunition Plant
Radford, Virginia

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Richmond, Virginia 23230

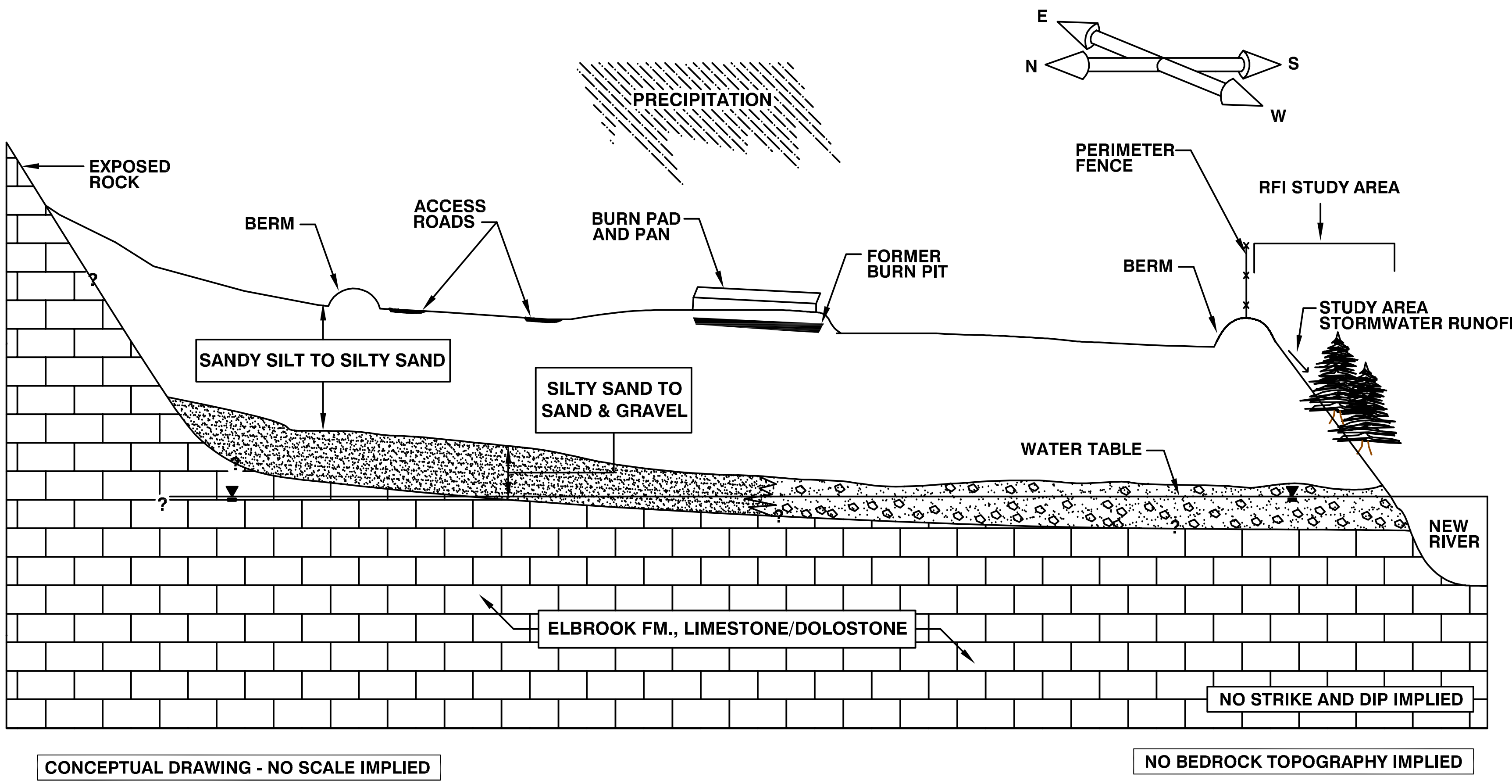
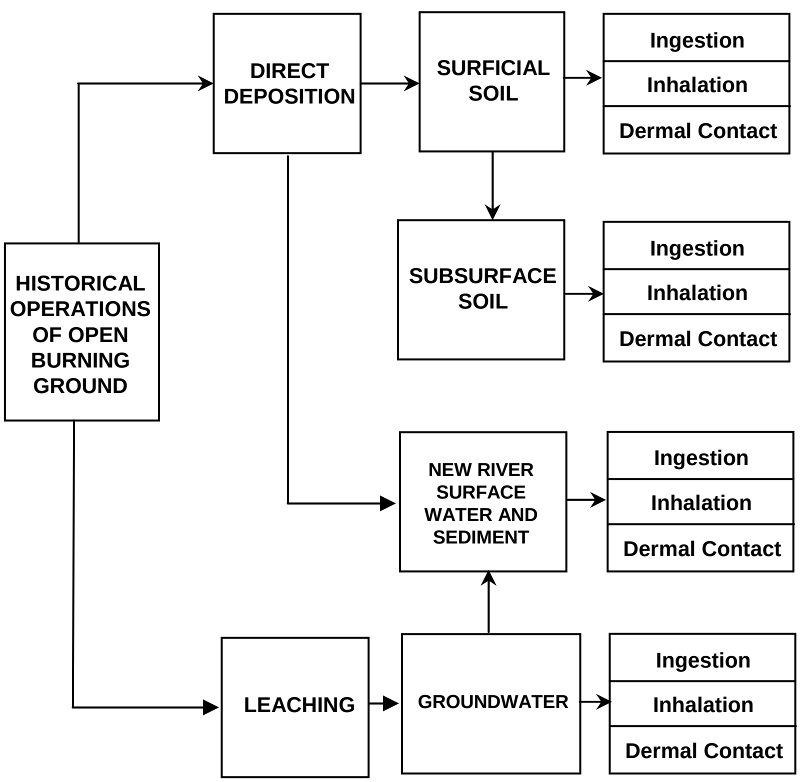


FIGURE 1-13 Conceptual Site Model		**SWMU 13** RCRA Facility Investigation Radford Army Ammunition Plant Radford, Virginia
Date: January 2008	Job Number: 11656367	
Prepared By: DBC	Reviewed By: JOS	URS Group, Inc. 5540 Falmouth Street Suite 201 Richmond, Virginia 23320
Scale: Not to Scale	File Name: Fi.1-13 CSM	

PRIMARY SOURCE	RELEASE MECHANISMS	PATHWAY	EXPOSURE ROUTE	RECEPTORS
				CURRENT/FUTURE · FUTURE



Surficial Soil

Exposure Route	MAINTENANCE WORKER (Current/Future)	ADOLESCENT TRESPASSER (Current/Future)	TERRESTRIAL BIOTA (Current/Future)	CONSTRUCTION WORKER (Future)	COMMERCIAL/ INDUSTRIAL WORKER (Future)	ADULT RESIDENT (Future)	CHILD RESIDENT (Future)
Ingestion	●	●	●	●	●	●	●
Inhalation	●	●	●	●	●	●	●
Dermal Contact	●	●	●	●	●	●	●

Subsurface Soil

Exposure Route	MAINTENANCE WORKER	ADOLESCENT TRESPASSER	TERRESTRIAL BIOTA	CONSTRUCTION WORKER	COMMERCIAL/ INDUSTRIAL WORKER	ADULT RESIDENT	CHILD RESIDENT
Ingestion				●		●	●
Inhalation				●		●	●
Dermal Contact				●		●	●

New River Surface Water and Sediment

Exposure Route	MAINTENANCE WORKER	ADOLESCENT TRESPASSER	AQUATIC BIOTA	CONSTRUCTION WORKER	COMMERCIAL/ INDUSTRIAL WORKER	ADULT RESIDENT	CHILD RESIDENT
Ingestion		○	○	○	○	○	○
Inhalation		○	○	○	○	○	○
Dermal Contact		○	○	○	○	○	○

Groundwater

Exposure Route	MAINTENANCE WORKER	ADOLESCENT TRESPASSER	TERRESTRIAL BIOTA	CONSTRUCTION WORKER	COMMERCIAL/ INDUSTRIAL WORKER	ADULT RESIDENT	CHILD RESIDENT
Ingestion				○	○	○	○
Inhalation				○	○	○	○
Dermal Contact				○	○	○	○

● POTENTIALLY COMPLETE PATHWAY EVALUATED QUANTITATIVELY

○ POTENTIALLY COMPLETE PATHWAY EVALUATED QUALITATIVELY

FIGURE 1-14

Conceptual Site Diagram

Date: *January2008*	URS Project #: *11656367*
Prepared by: *DBC*	Approved by: *JOS*
Scale: *Not to Scale*	File Name: *Fig.1-14 CSD*

SWMU 13
RCRA Facility Investigation
Radford Army Ammunition Plant
Radford, Virginia

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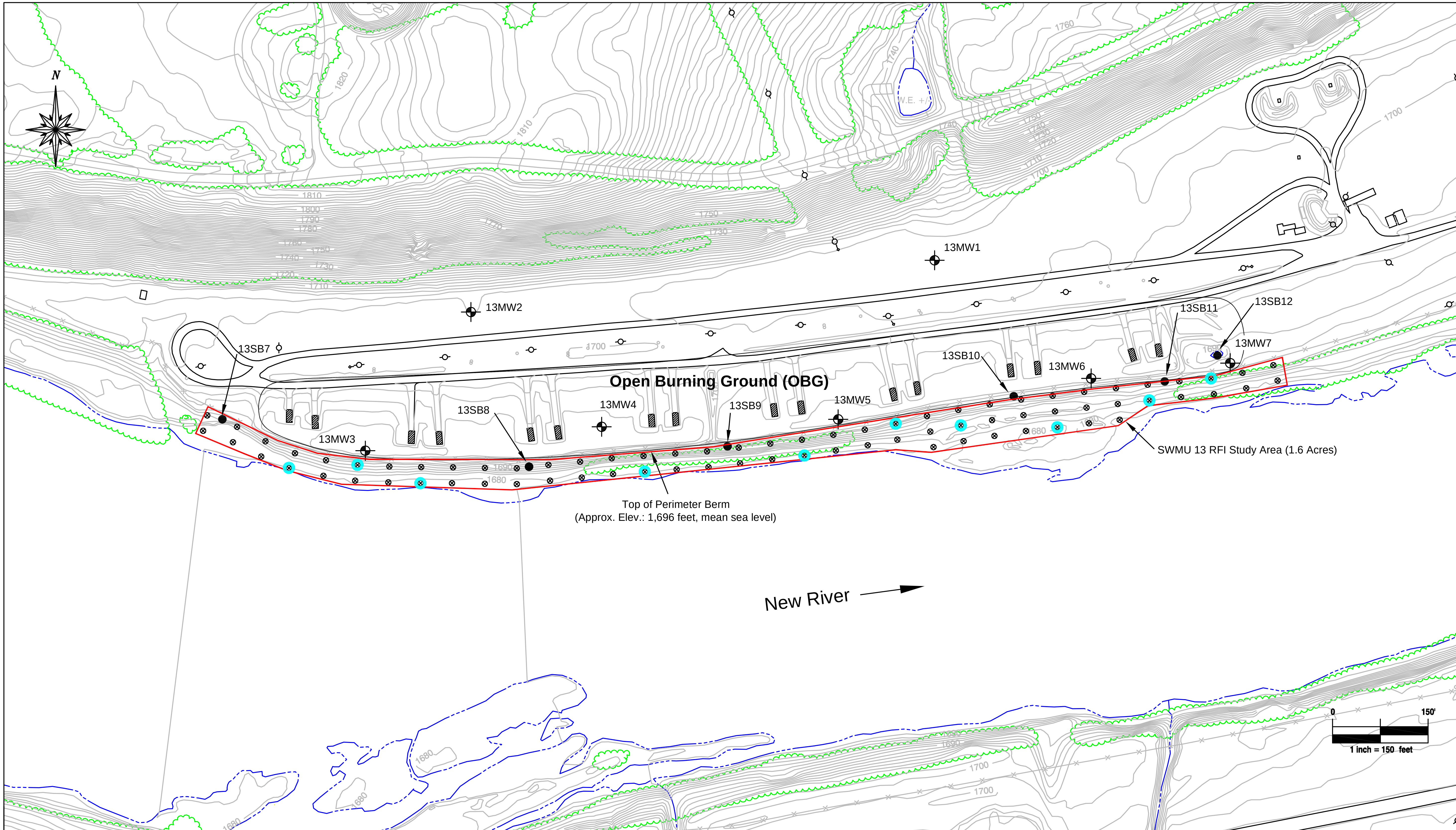

Legend

	Topographic Contour Line (feet, mean sea level)		Monitoring Well Location		Light/Electric Pole
	Surface Water		Proposed Sample Location (Lead)		Vegetation
	OBG Boundary		Proposed Sample Location (TCL Metals, SVOCs, Explosives, and Nitroglycerin)		Burning Pan
	Study Area Boundary		SSP Sample Locations		

FIGURE 1-15

RFI Proposed Sampling Locations

Date: January 2008	URS Project #: 11656367
Prepared by: DBC	Approved by: JOS
Scale: 1 inch = 150 feet	File Name: Fig.1-15 RFI Prop.Locs

SWMU 13

RCRA Facility Investigation
Radford Army Ammunition Plant
Radford, Virginia

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Table 1-1
Applicable MWP Activities and Related SOPs
MWP Addendum 023 – RFI at SWMU 13
Radford Army Ammunition Plant, Radford, Virginia

Subject	**MWP Section**	**SOPs MWP Appendix A and Appendix A to WPA 023**
Installation Description	2.0	Not Applicable
Environmental Setting	3.0	Not Applicable
Documentation	4.3	10.1 Field Logbook 10.2 Surface Water, Groundwater, and Soil/Sediment Field Logbooks 10.3 Boring Logs 10.4 Chain-of-Custody Form
Sample Management	5.1	50.1 Sample Labels 50.2 Sample Packaging
Decontamination Requirements	5.12	80.1 Decontamination
Investigation-Derived Material	5.13	70.1 Investigation-Derived Material
Subsurface Investigation	5.2	30.1 Soil Sampling 30.7 Sampling Strategies 90.1 Photoionization Detector (HNu Model PI-101 and HW-101)

Table 1-2
Detected Analytes for SWMU 13 - Sediment
(Modified from New River and Tributaries Study - Parsons 1997)
MWP Addendum 023 - RFI at SWMU 13
Radford Army Ammunition Plant, Radford, Virginia

Sample ID / Sample Date / Sample Depth (ft bgs)	CAS	C/N	Facility-Wide Background Point Estimate	Adjusted Soil RBC (Residential)	Adjusted Soil RBC (Industrial)	BTAG Sediment Screening Level	NRSE4 7/28/1995 0-0.5		NRSE14 11/22/1996 0-0.5	
							Result	LQ, VQ, r	Result	LQ, VQ, r
TAL Metals (mg/kg)										
Aluminum	7429-90-5	N	40,041	7,821	102,200	--	ND		9,910	
Arsenic	7440-38-2	C	15.8	0.426	1.91	9.8	ND		**3.9**	
Barium	7440-39-3	N	209	1,564	20,440	--	97.14		110	
Beryllium	7440-41-7	N	1.02	15.64	204.4	--	0.99		0.71	
Calcium	7440-70-2	N	--	--	--	--	ND		2,190	
Chromium[1]	7440-47-3	C	65.3	23.46	306.6	43.4	37.53		21	
Cobalt	7440-48-4	N	72.3	--	--	50	ND		10	
Copper	7440-50-8	N	53.5	312.9	4,088	31.6	ND		13.4	
Iron	7439-89-6	N	50,962	5,475	71,540	20,000	ND		30,800	
Lead[2]	7439-92-1	--	26.8	400	750	35.8	**4,415.58**		104	
Magnesium	7439-95-4	--	--	--	--	--	ND		2,600	J
Manganese	7439-96-5	N	2,543	156.4	2,044	460	ND		1,210	J
Nickel	7440-02-0	N	62.8	156.4	2,044	22.7	13.25		10.6	
Potassium	7440-09-7	--	--	--	--	--	ND		1,420	
Silver	7440-22-4	N	--	39.11	511	1	0.1		<2	U
Thallium	7440-28-0	N	2.11	0.548	7.15	--	ND		1.6	
Vanadium	7440-62-2	N	108	7.82	102.2	--	ND		24.7	
Zinc	7440-66-6	N	202	2,346	30,660	121	ND		378	
TCL SVOCs (mg/kg)										
Bis(2-ethylhexyl)phthalate	117-81-7	C	--	45.62	204.4	0.18	6.62		<0.33	U
Diethylphthalate	84-66-2	N	--	6,257	81,760	0.603	6.23		<0.33	U
Dimethylphthalate	131-11-3	--	--	--	--	--	8.31		<0.33	U
Di-n-butylphthalate	84-74-2	N	--	782.1	10,220	6.47	12.99		<0.33	U
Fluoranthene	206-44-0	N	--	312.9	4,088	0.423	0.08		<0.33	U
N-Nitrosodiphenylamine	96-30-6	C	--	130.4	584	--	2.6		<0.33	U

Notes:
CAS = Chemical Abstracts Service
ft bgs = Feet Below Ground Surface
mg/kg = Milligram Per Kilogram
µg/kg = Microgram Per Kilogram
TAL = Target Analyte List
SVOC = Semivolatile Organic Compound
RBC = USEPA Region III Risk-Based Concentration (RBC) values from
the October 11, 2007, RBC Table and Alternate RBC Table
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
C/N = Carcinogenic/Noncarcinogenic per EPA RBC Table (October 2007)
[1] = Chromium VI RBC value was used
[2] = Lead criteria are Action Levels; see USEPA Region III guidance
BTAG = Biological Technical Assistance Group
Sediment - BTAG Sediment Screening Values, 2006

LQ = Laboratory Qualifier
VQ = Validation Qualifier
r = Reason Code
ND = Not Detected

[box] = Concentration exceeds Adjusted Residential RBC
bold = Concentration exceeds Adjusted Industrial RBC
[shaded] = Concentration exceeds BTAG Sediment Screening Level
underline = Concentration exceeds Facility-Wide Background Point Estimate

Table 1-3
Detected Analytes for SWMU 13 - Surface Water
(Modified from New River and Tributaries Study - Parsons 1997)
MWP Addendum 023 - RFI at SWMU 13
Radford Army Ammunition Plant, Radford, Virginia

Sample ID / Sample Date	CAS #	C/N	Adjusted Tap Water RBC	Drinking Water MCL	BTAG Screening Value	NRSW4 7/28/1995	
						Result	LQ, VQ, r
TAL Metals (µg/L)							
Barium	7440-39-9	N	730	2,000	4	26.3	
Lead[1]	7439-92-1	--	15	--	2.5	9.8	
TCL VOCs (µg/L)							
Methylene chloride	75-09-2	C	4.102	--	98.1	ND	

Notes:

CAS = Chemical Abstracts Service
µg/L = Microgram Per Liter
TAL = Target Analyte List
TCL = Target Compound List
VOC = Volatile Organic Compound
LQ = Laboratory Qualifier
VQ = Validation Qualifier
r = Reason Code
ND = Not Detected
RBC = USEPA Region III Risk-Based Concentration (RBC) values from the October 11, 2007, RBC Table and Alternate RBC Table
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
C/N = Carcinogenic/Noncarcinogenic per EPA RBC Table (October 2007)
BTAG = Biological Technical Assistance Group
Water - BTAG Freshwater Screening Values, 2006
[1] = Lead RBC value is Action Level; see USEPA Region III guidance

= Concentration exceeds MCL
= Concentration exceeds Adjusted Tap Water RBC
= Concentration exceeds BTAG Freshwater Screening Level

Table 1-4
Detected Analytes in Semi-Annual OBG Soil Sampling
(Modified from Table 2 of the 2006-2007 Annual Soil Monitoring Report - September 2007)
MWP Addendum 023 - RFI at SWMU 13
Radford Army Ammunition Plant, Radford, Virginia

Sample ID								SB-1				SB-2			
Sample Date	CAS #	C/N	Facility-Wide Background Point Estimate	Adjusted Soil RBC (Residential)	Adjusted Soil RBC (Industrial)	Action Level[5]	QL/RL	11/17/2005	6/9/2006	1/11/2007	6/18/2007	11/17/2005	6/9/2006	1/11/2007	6/18/2007
TAL Metals (mg/kg)															
Arsenic	7440-38-2	C	15.8	0.426	1.91	16	16	3	2.6	3.6	3.2	4.6	2.9	4.3	4
Barium	7440-39-3	N	209	1,564	204,400	72,000	20	125	110	147	97.2	153	79.6	149	83.7
Chromium[1]	7440-47-3	C	65.3	23.46	306.6	3,100	1	21.2	19.8	27.1	19.3	28	14.3	25	16.2
Lead[2]	7439-92-1	--	26.8	400	750	800	3	81.3	66	68.9	149 J	104	128	122	164 J
Mercury[3]	7439-97-6	--	0.13	2.35	30.66	0.13	0.11	<0.11 U	<0.11 U	<0.11 U	<0.11 U	<0.11 U	0.11	<0.11 U	<0.11 U
Selenium	7782-49-2	N	--	39.11	5,110	5,100	0.6	<0.6 U	<0.6 U	<0.6 U	1.2	<0.6 U	<0.6 U	<0.6 U	1.3
TCL VOCs (mg/kg)															
Bromomethane	74-83-9	N	--	1.1E+01	1.4E+03	1.5E+01	0.005	<0.005 UA	<0.005 UA	<0.005 UJ	0.008	<0.005 UA	<0.005 U	<0.005 U	<0.005 U
TCL SVOCs (mg/kg)															
Diethylphthalate	84-66-2	N	--	6.3E+03	8.2E+05	8.2E+05	0.4	<0.4 U	<0.4 U	<0.4 U	<0.4 UJ	<0.4 U	<0.4 U	<0.4 U	0.58
Explosives/Nitroglycerin (mg/kg)															
2,4,6-Trinitrotoluene[4]	118-96-7	N	--	3.9E+00	5.1E+01	9.5E+01	0.4	<0.4 U	<0.4 U	<0.4 U	1.4	<0.4 U	<0.4 U	<0.4 U	<0.4 U
2-Amino-4,6-dinitrotoluene	35572-78-2	N	--	1.6E+01	2.0E+03	2.0E+03	0.25	<0.25 U	<0.25 U	<0.25 U	0.48	<0.25 U	<0.25 U	<0.25 U	<0.25 U
4-Amino-2,6-dinitrotoluene	19406-51-0	--	--	--	--	2.0E+03	0.25	<0.25 U	<0.25 U	<0.25 U	0.41	<0.25 U	<0.25 U	<0.25 U	<0.25 U
Dioxin/Furans (ng/kg)															
2,3,7,8-TCDD TEQ[6]	--	--	--	4.3E+00	1.9E+01	1.9E+01	--	NT	NT	2.159	1.237	NT	NT	1.977	0.625

Notes:

CAS = Chemical Abstracts Service
mg/kg = Milligram Per Kilogram
TAL = Target Analyte List
TCL = Target Compound List
VOC = Volatile Organic Compound
SVOC = Semi-volatile Organic Compound
NT = Not Tested
RBC = USEPA Region III Risk-Based Concentration (RBC) values from the October 11, 2007, RBC Table and Alternate RBC Table
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
C/N = Carcinogenic/Noncarcinogenic per EPA RBC Table (October 2007)
SSL DAF1 = Soil Screening Levels at a Dilution Attenuation Factor of 1
[1] = Chromium VI RBC value was used
[2] = Lead criteria are Action Levels; see USEPA Region III guidance
[3] = Mercuric chloride soil RBC value used
[4] = Noncarcinogenic Residential and Industrial RBC values for 2,4,6-Trinitrotoluene were used for screening
[5] = Action Levels as defined in the Open Burning Ground permit
[6] = 2,3,7,8-TCDD TEQs calculated utilizing revised toxicity equivalency factors (TEFs) (WHO 2005)

QL/RL = Quantitation Limit/Reporting Limit
J = Denotes analyte reported at or above QL/RL and associated result is estimated
U = Denotes analyte not detected at or above QL/RL
UA = Denotes analyte not detected at or above adjusted sample QL/RL
UJ = Denotes analyte not detected at or above QL/RL and QL/RL is estimated

= Concentration exceeds Adjusted Residential RBC

= Concentration exceeds Adjusted Industrial RBC

bold italic = Concentration exceeds Action Level

underline = Concentration exceeds Facility-Wide Background Point Estimate

Table 1-5
Summary of Detected Chemicals in Sediment Analytical Samples
MWP Addendum 023 - RFI at SWMU 13
Radford Army Ammunition Plant, Radford, Virginia

Sample ID / Sample Date / Sample Depth (inches)	CAS #	C/N	Facility-Wide Background Point Estimate(A)	Adjusted Soil RBC (Residential)	Adjusted Soil RBC (Industrial)	BTAG Sediment Screening Level	NR-SED-1 11/8/2006 0-4		MDL	RL	NR-SED-2 11/8/2006 0-4		MDL	RL	NR-SED-3 11/8/2006 0-4		MDL	RL	NR-SED-3-DUP(DUP-3) 11/8/2006 0-4		MDL	RL	NR-SED-4 11/8/2006 0-4		MDL	RL	NR-SED-5 11/8/2006 0-4		MDL	RL
							Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r		
TAL Metals (mg/kg)																														
Aluminum	7429-90-5	N	40,041	7,821	102,200	--	9,800		1.6	10	5,300		1.6	10	8,200		1.6	10	11,000		1.6	10	30,000		1.6	10	17,000		790	5,000
Antimony	7440-36-0	N	--	3.13	40.88	2	0.26	,B,p	0.036	0.2	0.2	J,B,p	0.036	0.2	0.37	,B,p	0.036	0.2	0.33	,B,p	0.036	0.2	0.13	J,B,p	0.036	0.2	0.48	,B,p	0.036	0.2
Arsenic	7440-38-2	C	15.8	0.426	1.91	9.8	2.2	,J,s	0.023	0.1	1.6	,J,s	0.023	0.1	2.5	,J,s	0.023	0.1	2.6	,J,s	0.023	0.1	2.2	,J,s	0.023	0.1	6.1	,J,s	0.023	0.1
Barium	7440-39-3	N	209	1,564	20,440	--	94		0.1	1	62		0.1	1	110		0.1	1	130		0.1	1	240		0.1	1	540		1	10
Beryllium	7440-41-7	N	1.02	15.64	204.4	--	0.69	J	0.016	1	0.48	J	0.016	1	0.56	J	0.016	1	0.87	J	0.016	1	1.4		0.016	1	1.3		0.016	1
Cadmium	7440-43-9	N	0.69	3.91	51.1	0.99	1.2	J	0.5	2	0.71	J	0.5	2	1	J	0.5	2	1.5	J	0.5	2	1.4	J	0.5	2	1.3	J	0.5	2
Calcium	7440-70-2	--	--	--	--	--	1,500		10	50	910		10	50	1,100		10	50	1,500		10	50	4,700		10	50	3,100		10	50
Chromium[1]	7440-47-3	N	65.3	23.46	306.6	43.4	23		0.57	5	15		0.57	5	21		0.57	5	24		0.57	5	44		0.57	5	20		0.57	5
Cobalt	7440-48-4	--	72.3	--	--	50	8.6		0.35	2	5.3		0.35	2	7.1		0.35	2	10		0.35	2	18		0.35	2	8.3		0.35	2
Copper	7440-50-8	N	53.5	312.9	4,088	31.6	15	,J,s	0.022	0.1	8.7	,J,s	0.022	0.1	23	,J,s	0.022	0.1	29	,J,s	0.022	0.1	25	,J,s	0.022	0.1	47	,J,s	0.11	0.5
Iron	7439-89-6	N	50,962	5,475	71,540	20,000	32,000	,J,s	4.6	100	28,000	,J,s	4.6	100	39,000	,J,s	4.6	100	39,000	,J,s	4.6	100	41,000	,J,s	4.6	100	39,000	,J,s	230	5,000
Lead[2]	7439-92-1	--	26.8	400	750	35.8	91		0.21	1	77		0.083	0.4	160		0.21	1	160		0.21	1	43		0.041	0.2	88		0.21	1
Magnesium	7439-95-4	--	--	--	--	--	2,300		3.4	50	1,400		3.4	50	1,700		3.4	50	2,400		3.4	50	6,300		3.4	50	2,200		3.4	50
Manganese	7439-96-5	N	2,543	156.43	2,044	460	930		0.14	1	630		0.14	1	1,400		0.14	1	1,600		0.14	1	1,200		0.14	1	420		0.7	5
Mercury[3]	7439-97-6	--	0.13	2.3	30.7	0.18	0.041	J	0.0077	0.05	0.025	J	0.0077	0.05	0.084		0.0077	0.05	0.13		0.0077	0.05	0.068		0.0077	0.05	0.43		0.0077	0.05
Nickel	7440-02-0	N	62.8	156.43	2,044	22.7	11	,J,s	0.027	0.1	7.9	,J,s	0.027	0.1	13	,J,s	0.027	0.1	13	,J,s	0.027	0.1	22	,J,s	0.027	0.1	13	,J,s	0.027	0.1
Potassium	7440-09-7	--	--	--	--	--	1,200		7.5	50	750		7.5	50	820		7.5	50	1,100		7.5	50	3,300		7.5	50	2,600		7.5	50
Selenium	7782-49-2	N	--	39.11	511	2	0.13	J	0.063	0.2	0.12	J	0.063	0.2	0.14	J	0.063	0.2	0.12	J	0.063	0.2	0.084	J	0.063	0.2	0.63	,L,m	0.063	0.2
Silver	7440-22-4	N	--	39.11	511	1	0.12		0.017	0.1	0.097	J	0.017	0.1	0.2		0.017	0.1	0.22		0.017	0.1	0.16		0.017	0.1	0.18		0.017	0.1
Sodium	7440-23-5	--	--	--	--	--	<100	U	19	100	<100	U	19	100	<100	U	19	100	<100	U	19	100	25	J	19	100	260		19	100
Thallium	7440-28-0	N	2.11	0.548	7.154	--	0.28		0.0085	0.1	0.22		0.0085	0.1	0.58		0.0085	0.1	0.68		0.0085	0.1	0.56		0.0085	0.1	0.55		0.0085	0.1
Vanadium	7440-62-2	N	108	7.821	102.2	--	22	,J,s	0.024	0.1	16	,J,s	0.024	0.1	22	,J,s	0.024	0.1	23	,J,s	0.024	0.1	45	,J,s	0.024	0.1	23	,J,s	0.024	0.1
Zinc	7440-66-6	N	202	2,346	30,660	121	400		0.85	5	300		0.85	5	420		0.85	5	590		0.85	5	180		0.85	5	250		4.3	25
Explosives (mg/kg)																														
2,4,6-Trinitrotoluene	118-96-7	N	--	3.9	51	0.092	<2.5	U	0.051	2.5	<2.5	U	0.051	2.5	<2.5	U	0.051	2.5	<2.5	U	0.051	2.5	<2.5	U	0.051	2.5	<2.5	U	0.051	2.5
2,4-Dinitrotoluene	121-14-2	N	--	15.64	204.4	0.0416	<2.5	U	0.073	2.5	<2.5	U	0.073	2.5	<2.5	U	0.073	2.5	<2.5	U	0.073	2.5	<2.5	U	0.073	2.5	<2.5	U	0.073	2.5

Table 1-5
Summary of Detected Chemicals in Sediment Analytical Samples
MWP Addendum 023 - RFI at SWMU 13
Radford Army Ammunition Plant, Radford, Virginia

Sample ID / Sample Date / Sample Depth (inches)	CAS #	C/N	Facility-Wide Background Point Estimate[A]	Adjusted Soil RBC (Residential)	Adjusted Soil RBC (Industrial)	BTAG Sediment Screening Level	NR-SED-6 11/8/2006 0-4 Result	NR-SED-6 LQ, VQ, r	MDL	RL	NR-SED-7 11/8/2006 0-4 Result	NR-SED-7 LQ, VQ, r	MDL	RL	NR-SED-8 11/8/2006 0-4 Result	NR-SED-8 LQ, VQ, r	MDL	RL	NR-SED-9 11/8/2006 0-4 Result	NR-SED-9 LQ, VQ, r	MDL	RL	NR-SED-9-DUP(DUP-2) 11/8/2006 0-4 Result	NR-SED-9-DUP(DUP-2) LQ, VQ, r	MDL	RL	NR-SED-10 11/8/2006 0-4 Result	NR-SED-10 LQ, VQ, r	MDL	RL
TAL Metals (mg/kg)																														
Aluminum	7429-90-5	N	40,041	7,821	102,200	--	13,000		1.6	10	11,000		1.6	10	6,600		1.6	10	7,900		1.6	10	7,600		1.6	10	22,000		1.6	10
Antimony	7440-36-0	N	--	3.13	40.88	2	0.19	J	0.036	0.2	0.13	J,B,p	0.036	0.2	0.16	J	0.036	0.2	1.1		0.036	0.2	1.7		0.036	0.2	0.66		0.036	0.2
Arsenic	7440-38-2	C	15.8	0.426	1.91	9.8	2.3	,J,s	0.023	0.1	2.1	,J,s	0.023	0.1	2	,J,s	0.023	0.1	1.9	,J,s	0.023	0.1	2.1	,J,s	0.023	0.1	2.5	,J,s	0.023	0.1
Barium	7440-39-3	N	209	1,564	20,440	--	180		0.1	1	120		0.1	1	81		0.1	1	100		0.1	1	110		0.1	1	180		0.1	1
Beryllium	7440-41-7	N	1.02	15.64	204.4	--	0.87	J	0.016	1	0.75	J	0.016	1	0.58	J	0.016	1	0.92	J	0.016	1	0.55	J	0.016	1	1.4		0.016	1
Cadmium	7440-43-9	N	0.69	3.91	51.1	0.99	1.4	J	0.5	2	1.3	J	0.5	2	0.74	J	0.5	2	1.6	J	0.5	2	1.3	J	0.5	2	2.8		0.5	2
Calcium	7440-70-2	--	--	--	--	--	3,000		10	50	3,200		10	50	4,700		10	50	1,600		10	50	1,700		10	50	1,600		10	50
Chromium[1]	7440-47-3	N	65.3	23.46	306.6	43.4	26		0.57	5	23		0.57	5	17		0.57	5	18		0.57	5	16		0.57	5	35		0.57	5
Cobalt	7440-48-4	--	72.3	--	--	50	12		0.35	2	8.7		0.35	2	7.4		0.35	2	8.7		0.35	2	7.8		0.35	2	17		0.35	2
Copper	7440-50-8	N	53.5	312.9	4,088	31.6	20	,J,s	0.022	0.1	12	,J,s	0.022	0.1	13	,J,s	0.022	0.1	16	,J,s	0.022	0.1	21	,J,s	0.022	0.1	24	,J,s	0.022	0.1
Iron	7439-89-6	N	50,962	5,475	71,540	20,000	32,000	,J,s	0.46	10	35,000	,J,s	4.6	100	23,000	,J,s	0.46	10	79,000	,B,p	460	10,000	39,000	,J,s	0.46	10	43,000	,J,s	0.46	10
Lead[2]	7439-92-1	--	26.8	400	750	35.8	90		0.21	1	100		0.21	1	47		0.041	0.2	170		0.21	1	210		0.21	1	280		0.41	2
Magnesium	7439-95-4	--	--	--	--	--	3,500		3.4	50	3,500		3.4	50	3,400		3.4	50	2,000		3.4	50	1,800		3.4	50	3,600		3.4	50
Manganese	7439-96-5	N	2,543	156.43	2,044	460	1,100		0.14	1	1,100		0.14	1	730		0.14	1	800		0.14	1	1,000		0.14	1	1,600		0.14	1
Mercury[3]	7439-97-6	--	0.13	2.3	30.7	0.18	0.44		0.0077	0.05	0.061		0.0077	0.05	0.26		0.0077	0.05	0.041	J	0.0077	0.05	0.058		0.0077	0.05	0.11		0.0077	0.05
Nickel	7440-02-0	N	62.8	156.43	2,044	22.7	13	,J,s	0.027	0.1	12	,J,s	0.027	0.1	10	,J,s	0.027	0.1	10	,J,s	0.027	0.1	8.5	,J,s	0.027	0.1	17	,J,s	0.027	0.1
Potassium	7440-09-7	--	--	--	--	--	1,700		7.5	50	1,500		7.5	50	1,000		7.5	50	850		7.5	50	860		7.5	50	1,800		7.5	50
Selenium	7782-49-2	N	--	39.11	511	2	0.22		0.063	0.2	0.23		0.063	0.2	0.1	J	0.063	0.2	0.15	J	0.063	0.2	0.18	J	0.063	0.2	0.24		0.063	0.2
Silver	7440-22-4	N	--	39.11	511	1	0.16		0.017	0.1	0.13		0.017	0.1	0.098	J	0.017	0.1	0.11		0.017	0.1	0.1		0.017	0.1	0.16		0.017	0.1
Sodium	7440-23-5	--	--	--	--	--	69	J	19	100	<100	U	19	100	<100	U	19	100	<100	U	19	100	<100	U	19	100	<100	U	19	100
Thallium	7440-28-0	N	2.11	0.548	7.154	--	0.4		0.0085	0.1	0.44		0.0085	0.1	0.19		0.0085	0.1	0.46		0.0085	0.1	0.41		0.0085	0.1	0.6		0.0085	0.1
Vanadium	7440-62-2	N	108	7.821	102.2	--	23	,J,s	0.024	0.1	21	,J,s	0.024	0.1	15	,J,s	0.024	0.1	17	,J,s	0.024	0.1	17	,J,s	0.024	0.1	40	,J,s	0.024	0.1
Zinc	7440-66-6	N	202	2,346	30,660	121	350		0.85	5	460		0.85	5	270		0.85	5	550		0.85	5	540		0.85	5	800		0.85	5
Explosives (mg/kg)																														
2,4,6-Trinitrotoluene	118-96-7	N	--	3.9	51	0.092	<2.5	U	0.051	2.5	<2.5	U	0.051	2.5	<2.5	U	0.051	2.5	<2.5	U	0.051	2.5	<2.5	U	0.051	2.5	0.38	J	0.051	2.5
2,4-Dinitrotoluene	121-14-2	N	--	15.64	204.4	0.0416	<2.5	U	0.073	2.5	<2.5	U	0.073	2.5	1.4	J	0.073	2.5	<2.5	U	0.073	2.5	<2.5	U	0.073	2.5	<2.5	U	0.073	2.5

Table 1-5
Summary of Detected Chemicals in Sediment Analytical Samples
MWP Addendum 023 - RFI at SWMU 13
Radford Army Ammunition Plant, Radford, Virginia

Sample ID Sample Date Sample Depth (inches)	CAS #	C/N	Facility-Wide Background Point Estimate[(A)]	Adjusted Soil RBC (Residential)	Adjusted Soil RBC (Industrial)	BTAG Sediment Screening Level	NR-SED-11 11/8/2006 0-4		MDL	RL	NR-SED-12 11/8/2006 0-4		MDL	RL	NR-SED-13 11/8/2006 0-4		MDL	RL	NR-SED-14 11/8/2006 0-4		MDL	RL	NR-SED-15 11/8/2006 0-4		MDL	RL	NR-SED-16 11/8/2006 0-4		MDL	RL
							Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r		
TAL Metals (mg/kg)																														
Aluminum	7429-90-5	N	40,041	7,821	102,200	--	11,000		1.6	10	7,200		1.6	10	9,300		1.6	10	7,200		160	1,000	12,000		1.6	10	21,000		1.6	10
Antimony	7440-36-0	N	--	3.13	40.88	2	0.55		0.036	0.2	0.4		0.036	0.2	0.6		0.036	0.2	0.11	J	0.036	0.2	0.2		0.036	0.2	0.32		0.036	0.2
Arsenic	7440-38-2	C	15.8	0.426	1.91	9.8	1.7	,J,s	0.023	0.1	1.6	,J,s	0.023	0.1	2	,J,s	0.023	0.1	1.6	,L,m	0.023	0.1	2.3	,J,s	0.023	0.1	4.3	,J,s	0.023	0.1
Barium	7440-39-3	N	209	1,564	20,440	--	120		0.1	1	72		0.1	1	91		0.1	1	75		0.1	1	140		0.1	1	220		0.1	1
Beryllium	7440-41-7	N	1.02	15.64	204.4	--	0.77	J	0.016	1	0.52	J	0.016	1	0.77	J	0.016	1	0.61	J	0.016	1	0.97	J	0.016	1	2.2		0.016	1
Cadmium	7440-43-9	N	0.69	3.91	51.1	0.99	1.2	J	0.5	2	1	J	0.5	2	1.1	J	0.5	2	0.95	J	0.5	2	1.6	J	0.5	2	3.6		0.5	2
Calcium	7440-70-2	--	--	--	--	--	2,400		10	50	1,600		10	50	2,200		10	50	1,500	,K,m	10	50	2,200		10	50	3,400		10	50
Chromium[1]	7440-47-3	N	65.3	23.46	306.6	43.4	21		0.57	5	15		0.57	5	18		0.57	5	16		0.57	5	18		0.57	5	21		0.57	5
Cobalt	7440-48-4	--	72.3	--	--	50	9.5		0.35	2	6.2		0.35	2	8.4		0.35	2	5.5		0.35	2	10		0.35	2	16		0.35	2
Copper	7440-50-8	N	53.5	312.9	4,088	31.6	19	,J,s	0.022	0.1	12	,J,s	0.022	0.1	17	,J,s	0.022	0.1	8.6	,J,s	0.022	0.1	13	,J,s	0.022	0.1	20	,J,s	0.022	0.1
Iron	7439-89-6	N	50,962	5,475	71,540	20,000	29,000	,J,s	0.46	10	30,000	,J,s	0.46	10	28,000	,J,s	0.46	10	35,000	,B,p	230	5,000	41,000	,J,s	0.46	10	84,000	,B,p	460	10,000
Lead[2]	7439-92-1	--	26.8	400	750	35.8	120		0.21	1	100		0.21	1	130		0.21	1	86	,L,m	0.21	1	190		0.21	1	500		0.83	4
Magnesium	7439-95-4	--	--	--	--	--	3,400		3.4	50	2,200		3.4	50	2,600		3.4	50	1,900	,K,m	3.4	50	3,100		3.4	50	2,900		3.4	50
Manganese	7439-96-5	N	2,543	156.43	2,044	460	900		0.14	1	640		0.14	1	470		0.14	1	330		0.7	5	1,500		0.14	1	4,400		0.14	1
Mercury[3]	7439-97-6	--	0.13	2.3	30.7	0.18	0.065		0.0077	0.05	0.042	J	0.0077	0.05	0.056		0.0077	0.05	0.033	J	0.0077	0.05	0.048	J	0.0077	0.05	0.11		0.0077	0.05
Nickel	7440-02-0	N	62.8	156.43	2,044	22.7	12	,J,s	0.027	0.1	8.2	,J,s	0.027	0.1	11	,J,s	0.027	0.1	7.9	,J,s	0.027	0.1	12	,J,s	0.027	0.1	17	,J,s	0.027	0.1
Potassium	7440-09-7	--	--	--	--	--	1,600		7.5	50	1,000		7.5	50	1,200		7.5	50	870		7.5	50	1,400		7.5	50	1,400		7.5	50
Selenium	7782-49-2	N	--	39.11	511	2	0.25		0.063	0.2	0.18	J	0.063	0.2	0.41		0.063	0.2	0.16	J,L,m	0.063	0.2	0.2	J	0.063	0.2	0.45		0.063	0.2
Silver	7440-22-4	N	--	39.11	511	1	0.13		0.017	0.1	0.088	J	0.017	0.1	0.15		0.017	0.1	0.081	J	0.017	0.1	0.14		0.017	0.1	0.22		0.017	0.1
Sodium	7440-23-5	--	--	--	--	--	<100	U	19	100	<100	U	19	100	<100	U	19	100	<100	U	19	100	<100	U	19	100	<100	U	19	100
Thallium	7440-28-0	N	2.11	0.548	7.154	--	0.38		0.0085	0.1	0.23		0.0085	0.1	0.31		0.0085	0.1	0.27		0.0085	0.1	0.94		0.0085	0.1	2.3		0.0085	0.1
Vanadium	7440-62-2	N	108	7.821	102.2	--	21	,J,s	0.024	0.1	17	,J,s	0.024	0.1	20	,J,s	0.024	0.1	15	,J,s	0.024	0.1	21	,J,s	0.024	0.1	24	,J,s	0.024	0.1
Zinc	7440-66-6	N	202	2,346	30,660	121	390		0.85	5	390		0.85	5	400		0.85	5	340		4.3	25	750		0.85	5	1,700		0.85	5
Explosives (mg/kg)																														
2,4,6-Trinitrotoluene	118-96-7	N	--	3.9	51	0.092	<2.5	U	0.051	2.5	<2.5	U	0.051	2.5	<2.5	U	0.051	2.5	<2.5	U	0.051	2.5	<2.5	U	0.051	2.5	<2.5	U	0.051	2.5
2,4-Dinitrotoluene	121-14-2	N	--	15.64	204.4	0.0416	<2.5	U	0.073	2.5	<2.5	U	0.073	2.5	<2.5	U	0.073	2.5	<2.5	U	0.073	2.5	<2.5	U	0.073	2.5	<2.5	U	0.073	2.5

Table 1-5
Summary of Detected Chemicals in Sediment Analytical Samples
MWP Addendum 023 - RFI at SWMU 13
Radford Army Ammunition Plant, Radford, Virginia

Sample ID Sample Date Sample Depth (inches)	CAS #	C/N	Facility-Wide Background Point Estimate[(A)]	Adjusted Soil RBC (Residential)	Adjusted Soil RBC (Industrial)	BTAG Sediment Screening Level	NR-SED-17 11/8/2006 0-4		MDL	RL	NR-SED-17-DUP(DUP-1) 11/8/2006 0-4		MDL	RL	NR-SED-18 11/8/2006 0-4		MDL	RL	NR-SED-19 11/8/2006 0-4		MDL	RL	NR-SED-20 11/8/2006 0-4		MDL	RL	NR-SED-21 11/8/2006 0-4		MDL	RL
							Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r		
TAL Metals (mg/kg)																														
Aluminum	7429-90-5	N	40,041	7,821	102,200	--	11,000		1.6	10	9,400		1.6	10	10,000		1.6	10	4,500		1.6	10	7,300		1.6	10	18,000		1.6	10
Antimony	7440-36-0	N	--	3.13	40.88	2	0.47		0.036	0.2	0.45		0.036	0.2	0.21		0.036	0.2	0.18	J	0.036	0.2	0.19	J	0.036	0.2	0.26		0.036	0.2
Arsenic	7440-38-2	C	15.8	0.426	1.91	9.8	2.5	,J,s	0.023	0.1	2.3	,J,s	0.023	0.1	1.8	,J,s	0.023	0.1	1.7	,J,s	0.023	0.1	1.8	,J,s	0.023	0.1	4.4	,J,s	0.023	0.1
Barium	7440-39-3	N	209	1,564	20,440	--	110		0.1	1	110		0.1	1	110		0.1	1	44		0.1	1	84		0.1	1	180		0.1	1
Beryllium	7440-41-7	N	1.02	15.64	204.4	--	0.76	J	0.016	1	0.73	J	0.016	1	0.71	J	0.016	1	0.52	J	0.016	1	0.56	J	0.016	1	1.6		0.016	1
Cadmium	7440-43-9	N	0.69	3.91	51.1	0.99	1.2	J	0.5	2	1.2	J	0.5	2	1.2	J	0.5	2	0.86	J	0.5	2	1	J	0.5	2	2.5		0.5	2
Calcium	7440-70-2	--	--	--	--	--	2,600		10	50	2,400		10	50	2,900		10	50	1,000		10	50	2,100		10	50	11,000		10	50
Chromium[1]	7440-47-3	N	65.3	23.46	306.6	43.4	17		0.57	5	19		0.57	5	24		0.57	5	13		0.57	5	14		0.57	5	20		0.57	5
Cobalt	7440-48-4	--	72.3	--	--	50	9.2		0.35	2	8.4		0.35	2	9.5		0.35	2	4.6		0.35	2	7.4		0.35	2	15		0.35	2
Copper	7440-50-8	N	53.5	312.9	4,088	31.6	19	,J,s	0.022	0.1	17	,J,s	0.022	0.1	13	,J,s	0.022	0.1	7.3	,J,s	0.022	0.1	11	,J,s	0.022	0.1	17	,J,s	0.022	0.1
Iron	7439-89-6	N	50,962	5,475	71,540	20,000	31,000	,J,s	0.46	10	32,000	,J,s	0.46	10	28,000	,J,s	0.46	10	29,000	,J,s	0.46	10	27,000	,J,s	0.46	10	74,000	,B,p	460	10,000
Lead[2]	7439-92-1	--	26.8	400	750	35.8	110		0.21	1	110		0.21	1	82		0.083	0.4	96		0.21	1	94		0.21	1	320		0.41	2
Magnesium	7439-95-4	--	--	--	--	--	2,800		3.4	50	2,800		3.4	50	3,600		3.4	50	1,400		3.4	50	2,600		3.4	50	7,400		3.4	50
Manganese	7439-96-5	N	2,543	156.43	2,044	460	470		0.14	1	700		0.14	1	550		0.14	1	450		0.14	1	730		0.14	1	2,300		0.14	1
Mercury[3]	7439-97-6	--	0.13	2.3	30.7	0.18	0.078		0.0077	0.05	0.063		0.0077	0.05	0.044	J	0.0077	0.05	0.024	J	0.0077	0.05	0.036	J	0.0077	0.05	0.079		0.0077	0.05
Nickel	7440-02-0	N	62.8	156.43	2,044	22.7	12	,J,s	0.027	0.1	11	,J,s	0.027	0.1	12	,J,s	0.027	0.1	6.7	,J,s	0.027	0.1	9.4	,J,s	0.027	0.1	19	,J,s	0.027	0.1
Potassium	7440-09-7	--	--	--	--	--	1,200		7.5	50	1,100		7.5	50	1,600		7.5	50	620		7.5	50	1,000		7.5	50	1,300		7.5	50
Selenium	7782-49-2	N	--	39.11	511	2	0.31		0.063	0.2	0.18	J	0.063	0.2	0.21		0.063	0.2	0.084	J	0.063	0.2	0.18	J	0.063	0.2	0.33		0.063	0.2
Silver	7440-22-4	N	--	39.11	511	1	0.13		0.017	0.1	0.12		0.017	0.1	0.1		0.017	0.1	0.067	J	0.017	0.1	0.11		0.017	0.1	0.2		0.017	0.1
Sodium	7440-23-5	--	--	--	--	--	<100	U	19	100	<100	U	19	100	<100	U	19	100	<100	U	19	100	<100	U	19	100	<100	U	19	100
Thallium	7440-28-0	N	2.11	0.548	7.154	--	0.37		0.0085	0.1	0.35		0.0085	0.1	0.36		0.0085	0.1	0.16		0.0085	0.1	0.25		0.0085	0.1	1.9		0.0085	0.1
Vanadium	7440-62-2	N	108	7.821	102.2	--	20	,J,s	0.024	0.1	20	,J,s	0.024	0.1	21	,J,s	0.024	0.1	14	,J,s	0.024	0.1	18	,J,s	0.024	0.1	23	,J,s	0.024	0.1
Zinc	7440-66-6	N	202	2,346	30,660	121	450		0.85	5	470		0.85	5	370		0.85	5	370		0.85	5	350		0.85	5	940		0.85	5
Explosives (mg/kg)																														
2,4,6-Trinitrotoluene	118-96-7	N	--	3.9	51	0.092	<2.5	U	0.051	2.5	<2.5	U	0.051	2.5	<2.5	U	0.051	2.5	<2.5	U	0.051	2.5	<2.5	U	0.051	2.5	<2.5	U	0.051	2.5
2,4-Dinitrotoluene	121-14-2	N	--	15.64	204.4	0.0416	<2.5	U	0.073	2.5	<2.5	U	0.073	2.5	<2.5	U	0.073	2.5	<2.5	U	0.073	2.5	<2.5	U	0.073	2.5	<2.5	U	0.073	2.5

Table 1-5
Summary of Detected Chemicals in Sediment Analytical Samples
MWP Addendum 023 - RFI at SWMU 13
Radford Army Ammunition Plant, Radford, Virginia

Sample ID / Sample Date / Sample Depth (inches)	CAS #	C/N	Facility-Wide Background Point Estimate[(A)]	Adjusted Soil RBC (Residential)	Adjusted Soil RBC (Industrial)	BTAG Sediment Screening Level	NR-SED-22 11/8/2006 0-4 Result	LQ, VQ, r	MDL	RL	NR-SED-23 11/8/2006 0-4 Result	LQ, VQ, r	MDL	RL
TAL Metals (mg/kg)														
Aluminum	7429-90-5	N	40,041	7,821	102,200	--	14,000		1.6	10	19,000		1.6	10
Antimony	7440-36-0	N	--	3.13	40.88	2	1.9		0.036	0.2	0.26		0.036	0.2
Arsenic	7440-38-2	C	15.8	0.426	1.91	9.8	3.4	,J,s	0.023	0.1	2.7	,J,s	0.023	0.1
Barium	7440-39-3	N	209	1,564	20,440	--	170		0.1	1	180		0.1	1
Beryllium	7440-41-7	N	1.02	15.64	204.4	--	1		0.016	1	1.2		0.016	1
Cadmium	7440-43-9	N	0.69	3.91	51.1	0.99	1.9	J	0.5	2	2.2		0.5	2
Calcium	7440-70-2	--	--	--	--	--	10,000		10	50	3,700		10	50
Chromium[1]	7440-47-3	N	65.3	23.46	306.6	43.4	24		0.57	5	24		0.57	5
Cobalt	7440-48-4	--	72.3	--	--	50	13		0.35	2	15		0.35	2
Copper	7440-50-8	N	53.5	312.9	4,088	31.6	24	,J,s	0.022	0.1	20	,J,s	0.022	0.1
Iron	7439-89-6	N	50,962	5,475	71,540	20,000	39,000	,J,s	0.46	10	36,000	,J,s	0.46	10
Lead[2]	7439-92-1	--	26.8	400	750	35.8	180		0.21	1	200		0.21	1
Magnesium	7439-95-4	--	--	--	--	--	7,600		3.4	50	4,400		3.4	50
Manganese	7439-96-5	N	2,543	156.43	2,044	460	1,900		0.14	1	1,200		0.14	1
Mercury[3]	7439-97-6	--	0.13	2.3	30.7	0.18	0.16		0.0077	0.05	0.09		0.0077	0.05
Nickel	7440-02-0	N	62.8	156.43	2,044	22.7	16	,J,s	0.027	0.1	17	,J,s	0.027	0.1
Potassium	7440-09-7	--	--	--	--	--	1,400		7.5	50	1,600		7.5	50
Selenium	7782-49-2	N	--	39.11	511	2	0.38		0.063	0.2	0.29		0.063	0.2
Silver	7440-22-4	N	--	39.11	511	1	0.45		0.017	0.1	0.2		0.017	0.1
Sodium	7440-23-5	--	--	--	--	--	21	J	19	100	<100	U	19	100
Thallium	7440-28-0	N	2.11	0.548	7.154	--	0.44		0.0085	0.1	0.47		0.0085	0.1
Vanadium	7440-62-2	N	108	7.821	102.2	--	27	,J,s	0.024	0.1	26	,J,s	0.024	0.1
Zinc	7440-66-6	N	202	2,346	30,660	121	550		0.85	5	660		0.85	5
Explosives (mg/kg)														
2,4,6-Trinitrotoluene	118-96-7	N	--	3.9	51	0.092	<2.5	U	0.051	2.5	<2.5	U	0.051	2.5
2,4-Dinitrotoluene	121-14-2	N	--	15.64	204.4	0.0416	<2.5	U	0.073	2.5	<2.5	U	0.073	2.5

Notes:
CAS = Chemical Abstracts Service
ft bgs = Feet Below Ground Surface
mg/kg = Milligram Per Kilogram
TAL = Target Analyte List
TCL = Target Compound List
MDL = Method Detection Limit
RL = Reporting Limit
LQ = Laboratory Qualifier
VQ = Validation Qualifier
r = Reason Code
[(1)] = Chromium VI RBC value was used
[(2)] = Lead criteria are Action Levels; see USEPA Region III guidance
[(3)] = Mercuric chloride soil RBC value used
[A] = Facility-Wide Background Point Estimate as
Reported in the Facility-Wide Background Study Report (IT 2001a)
RBC = USEPA Region III Risk-Based Concentration
(RBC) values from the April 6, 2007,
RBC Table and April 10, 2007, Alternate RBC Table
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
C/N = Carcinogenic per EPA RBC Table (April 2007)
BTAG = Biological Technical Assistance Group
Sediment - BTAG Sediment Screening Values, 2004

= Concentration Exceeds Adjusted Soil Residential RBC
= Concentration Exceeds Adjusted Soil Industrial RBC
underline = Concentration Exceeds Facility-Wide Background Values
= Concentration Exceeds BTAG Screening Level

Laboratory Qualifiers
U The compound was analyzed for but not detected. The reporting limit will be adjusted to reflect any dilution, and for soil, the percent moisture.
J Estimated value.

Validation Qualifiers
B Not detected substantially above the level reported in laboratory or field blanks.
J Analyte present. Reported value may not be accurate or precise.
K Analyte present. Reported value may be biased high. Actual value is expected to be lower.
L Analyte present. Reported value may be biased low. Actual value is expected to be higher.
UJ Not detected, quantitation limit may be inaccurate or imprecise.

Reason Codes
Inorganics and Conventionals
m MS/MSD recovery failure
p Preparation blank contamination
s Serial dilution failure

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Table 1-6
Selection of Exposure Pathways
MWP Addendum 023 - RFI at SWMU 13
Radford Army Ammunition Plant, Radford, Virginia

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Surface Soil	Surface Soil	Surface Soil	Maintenance Worker	Adult	Ingestion	Quant	Receptor could ingest surface soil from the site while conducting routine maintenance activities (i.e., mowing lawns).
						Dermal Absorption	Quant	Receptor could come into contact with surface soil from the site while conducting routine maintenance activities (i.e., mowing lawns).
				Adolescent Trespasser	Adolescent	Ingestion	Quant	Receptor could contact surface soil while trespassing on site.
						Dermal Absorption	Quant	Receptor could come into contact with surface soil while trespassing on site.
		Air	Ambient Air Above Surface Soil (Particulates)[1]	Maintenance Worker	Adult	Inhalation	Quant	Receptor could inhale particulates from ambient air above the surface soil.
				Adolescent Trespasser	Adolescent	Inhalation	Quant	Receptor could inhale particulates from ambient air above the surface soil.
	Subsurface Soil	Subsurface Soil	Subsurface Soil	Maintenance Worker	Adult	Ingestion	None	Receptor is not likely to ingest subsurface soil from the site since maintenance does not include excavation.
						Dermal Absorption	None	Receptor is not likely to come in contact with subsurface soil from the site since maintenance does not include excavation.
				Adolescent Trespasser	Adolescent	Ingestion	None	Receptor is unlikely to ingest subsurface soil while trespassing on site.
						Dermal Absorption	None	Receptor is unlikely come into contact with subsurface soil while trespassing on site.
		Air	Ambient Air Above Subsurface Soil (Particulates)[2]	Maintenance Worker	Adult	Inhalation	None	Receptor is not likely to inhale particulates from ambient air above the subsurface soil since maintenance activities do not include excavation.
				Adolescent Trespasser	Adolescent	Inhalation	None	Receptor is not likely to ingest subsurface soil from the site.
Future	Surface Soil	Surface Soil	Surface Soil	Commerical/Industrial Worker	Adult	Ingestion	Quant	Receptor could ingest surface soil while working on site.
						Dermal Absorption	Quant	Receptor could contact surface soil while working on site.
				Construction Worker	Adult	Ingestion	Quant	Receptor could ingest surface soil from the site during construction activities.
						Dermal Absorption	Quant	Receptor could come into contact with surface soil from the site during construction activities.
				Resident	Child	Ingestion	Quant	Receptor could ingest surface soil while living on site.
						Dermal Absorption	Quant	Receptor could come into contact with surface soil while living on site.
					Adult	Ingestion	Quant	Receptor could ingest surface soil while living on site.
						Dermal Absorption	Quant	Receptor could come into contact with surface soil while living on site.
					Child/Adult	Ingestion	Quant	The cancer risk estimates for the adult resident (24 years) and child resident (6 years) are added together (30 years) to address lifetime exposure to surface soil. The non-cancer hazard evaluations are treated separately for child and adult resident.
						Dermal Absorption	Quant	
		Air	Ambient Air Above Surface Soil (Particulates)[1]	Commerical/Industrial Worker	Adult	Inhalation	Quant	Receptor could inhale particulates from ambient air above the surface soil while working on site.
				Construction Worker	Adult	Inhalation	Quant	Receptor could inhale particulates from ambient air above the surface soil.
				Resident	Child	Inhalation	Quant	Receptor could inhale particulates from ambient air above the surface soil while living on site.
					Adult	Inhalation	Quant	Receptor could inhale particulates from ambient air above the surface soil while living on site.
					Child/Adult	Inhalation	Quant	The cancer risk estimates for the adult resident (24 years) and child resident (6 years) are added together (30 years) to address lifetime exposure to surface soil. The non-cancer hazard evaluations are treated separately for child and adult resident.
			Upward Migration of Vapors from Soil (Indoors)[1]	Commercial/Industrial Worker	Adult	Inhalation	None	Receptor is unlikely to inhale VOCs from soil via vapor intrusion into building.
				Resident	Adult	Inhalation	None	Receptor is not likely to inhale VOCs from soil via vapor intrusion into residence.
					Child	Inhalation	None	Receptor is not likely to inhale VOCs from soil via vapor intrusion into residence.

Table 1-6
Selection of Exposure Pathways
MWP Addendum 023 - RFI at SWMU 13
Radford Army Ammunition Plant, Radford, Virginia

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Future Cont.	Subsurface Soil	Subsurface Soil	Subsurface Soil	Commerical/Industrial Worker	Adult	Ingestion	Quant	Receptor could ingest subsurface soil when mixed with surface soil from construction of a commercial/industrial facility.
						Dermal Absorption	Quant	Receptor could contact subsurface soil when mixed with surface soil from construction of a commercial/industrial facility.
				Construction Worker	Adult	Ingestion	Quant	Receptor could ingest subsurface soil from the site while during construction activities.
						Dermal Absorption	Quant	Receptor could come into contact with subsurface soil from the site during construction activities.
				Resident	Child	Ingestion	Quant	Receptor could ingest subsurface soil when mixed with surface soil from construction of a residence.
						Dermal Absorption	Quant	Receptor could come in contact with subsurface soil when mixed with surface soil from construction of a residence.
					Adult	Ingestion	Quant	Receptor could ingest subsurface soil when mixed with surface soil from construction of a residence.
						Dermal Absorption	Quant	Receptor could come in contact with subsurface soil when mixed with surface soil from construction of a residence.
					Child/Adult	Ingestion	Quant	The cancer risk estimates for the adult resident (24 years) and child resident (6 years) are added together (30 years) to address lifetime exposure to subsurface soil. The non-cancer hazard evaluations are treated separately for child and adult resident.
						Dermal Absorption	Quant	
		Air	Ambient Air Above Subsurface Soil (Particulates)[1]	Commerical/Industrial Worker	Adult	Inhalation	Quant	Receptor could inhale particulates from ambient air above the subsurface soil when mixed with surface soil from construction of a commercial/industrial facility.
				Construction Worker	Adult	Inhalation	Quant	Receptor could inhale particulates from ambient air above the subsurface soil during construction activities.
				Resident	Child	Inhalation	Quant	Receptor could inhale particulates from ambient air above the subsurface soil when mixed with surface soil from construction of a residence.
					Adult	Inhalation	Quant	Receptor could inhale particulates from ambient air above the subsurface soil when mixed with surface soil from constuction of a residence.
					Child/Adult	Inhalation	Quant	The cancer risk estimates for the adult resident (24 years) and child resident (6 years) are added together (30 years) to address lifetime exposure to subsurface soil. The non-cancer hazard evaluations are treated separately for child and adult resident.
			Upward Migration of Vapors from Soil (Indoors)[1]	Commercial/Industrial Worker	Adult	Inhalation	None	Receptor is not likely to inhale VOCs from soil via vapor intrusion into building.
				Resident	Adult	Inhalation	None	Receptor is not likely to inhale VOCs from soil via vapor intrusion into residence.
					Child	Inhalation	None	Receptor is not likely to inhale VOCs from soil via vapor intrusion into residence.

Notes:
[1] VOCs are not chemicals of interest for the site; therefore, the vapors pathway is not assessed quantitatively.

Table 1-7
Wildlife Receptor Profiles
Screening Level Ecological Risk Assessment
MWP Addendum 023 - RFI at SWMU 13
Radford Army Ammunition Plant, Radford, Virginia

							Preliminary Assessment					Refined Assessment					
Representative Species			Composition of Diet[1] (%)				Minimum Body Weight[1]	Maximum Body Weight[1]	Maximum Food Ingestion Rate[2]	Maximum Substrate Ingestion Rate[1]		Average Body Weight[1]	Average Food Ingestion Rate[2]	Average Substrate Ingestion Rate[1]	Home Range (ha)	Proportion of Year Species Active	AUFs
Food-web Classification	Common Name	Scientific Name	Plants (incl. fungi)	Inverte-brates	Small mammals	Fish	kg	kg	kg dw/day	% of dry intake	kg dry wt./day	kg	kg dw/day	kg dry wt./day			Site Area (0.65) hectares
Birds																	
soil-probing invertivore	American robin	*Turdus migratorius*	62%	38%			0.0635	0.103	0.020	5%	0.001	0.077	0.016	0.0008	0.48	1	1
large carnivore	Red-tailed hawk	*Buteo jamaicensis*			100%		0.957	1.235	0.063	0%	0	1.134	0.059	0	250	1	0.0026
Mammals																	
small herbivore	Meadow vole	*Microtus pennsylvanicus*	100%				0.017	0.0524	0.010	2.4%	0.00024	0.037	0.008	0.00019	0.037	1	1
medium carnivore	Red fox	*Vulpes vulpes*	17%	4%	79%		2.95	7.04	0.342	2.8%	0.0096	4.53	0.238	0.0067	96	1	0.0068
small invertivore	Short-tailed shrew	*Blarina brevicauda*	14%	86%			0.0125	0.0225	0.003	10%	0.00031	0.015	0.002	0.00021	0.39	1	1

Notes:
kg = Kilogram
kg dw/day = Kilogram Dry-weight per Day
L/day = Liter per Day
AUF = Area Use Factor

[1]Wildlife Exposure Factors Handbook. U.S. Environmental Protection Agency (EPA). 1993. Office of Research and Development. 2 Volumes. EPA/600/R93/187a&b. December.
[2] Estimated food intake rate (kg [dw]/day) calculated as follows:
FI ((kg/day) = 0.0687 $Wt.^{0.882}$ for mammals (red fox and short-tailed shrew)
FI ((g/day) = 0.577 $Wt.^{0.727}$ for herbivores (meadow vole)
FI ((g/day) = 0.301 $Wt.^{0.751}$ for non-passerine birds (red-tailed hawk)
FI ((g/day) = 0.398 $Wt.^{0.850}$ for passerine birds (american robin)
The soil ingestion rate for the american robin set equal to 38% of the american woodcock value (0.34*10.4%=4%), based on a robin diet of 38% invertbrates.

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Table 1-8
Handling and Disposal of Investigation-Derived Materials
MWP Addendum 023 - RFI at SWMU 13
Radford Army Ammunition Plant, Radford, Virginia

Area	Material	Description	Quantity	Concern	Action	Expected Nature of Material
SWMU 13	Soil Cuttings	From soil borings	Approx. 3 55-gal drums	COCs	TCLP, Explosives, Paint Filter Liquids, and pH	Non-hazardous. Concentrations are not expected to exceed TCLP limits.
SWMU 13	Decontamination water	Aqueous IDM	Approx. 2 55-gal drums	IDM	TCLP, COD, pH, explosives	Non-hazardous. Concentrations are not expected to exceed TCLP, or pH limits.
SWMU 13	PPE	Miscellaneous IDM	Approx. 2 55-gal drums	IDM	Evaluate Soil and Water Results	Non-hazardous. Will be disposed of as IDM.

Notes:
SWMU = Solid Waste Management Unit
Approx. = Approximately
COC = Chemical of Concern
IDM = Investigation-Derived Material
TCLP = Toxicity Characteristics Leaching Procedure
COD = Chemical Oxygen Demand
PPE = Personal Protective Equipment and Clothing
gal = Gallon

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2.0 QUALITY ASSURANCE PLAN ADDENDUM

2.1 INTRODUCTION

This QAPA establishes function-specific responsibilities and authorities to ensure data quality for investigative activities at RFAAP. The project objectives will be met through the execution of the SOPs included in the MWP and appended to this document. The applicable SOPs are referenced below. Specific quality control (QC) requirements include development of Data Quality Objectives (DQOs), performance of internal QC checks, and execution of appropriate analytical procedures during investigative activities. This QAPA is designed to be used in conjunction with the master quality assurance plan (MQAP). Table 2-1 provides a list of general quality assurance (QA) measures that will be implemented as specified in the MQAP.

Table 2-1

Quality Assurance Measures Discussed in the MQAP

Quality Assurance Measure	Section in MQAP	SOP No. (MWP Appendix A and Appendix A of WPA 023)
Project Organization and Responsibilities	2.0	--
Lines of Authority	2.2	--
Chemical Data Measurements	3.2	--
Levels of Concern	3.3	--
Site Investigation	4.0/5.0	30.1, 30.7, 50.1, 50.2 70.1, 80.1
Documentation Requirements	5.6	10.1, 10.2, 10.3, 50.1
Chain-of-custody Requirements	5.7	10.4, 50.2
Calibration Procedures	7.0	90.1
Data Reduction, Validation, Reporting, and Management	9.0	--
Corrective Action	10.0	--
Quality Assessments	11.0	--

The distribution list for submittals associated with this RFI is defined in the Facility Permit (USEPA, 2000a). At least six copies of draft documents and three copies of the final plans, reports, notifications, or other documents submitted as part of the RFI for SWMU 13 are to be submitted to the USEPA Regional Administrator, and shall be sent Certified Mail, Return Receipt Requested, overnight mail, or hand-carried to:

USEPA Region III
Federal Facilities Branch (3WC23)
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

In addition, one copy each such submission shall be sent to:

Commonwealth of Virginia
Department of Environmental Quality
Waste Division
629 East Main Street
Richmond, Virginia 23219

Commonwealth of Virginia
Department of Environmental Quality
West Central Regional Office
Executive Office Park, Suite D
5338 Peters Creek Road
Roanoke, VA 24109

Moreover, one or more copies of each such submission shall be sent to:

Tom Meyer
USACE, Baltimore District
ATTN: CENAB-EN-HM (10000-G)
10 South Howard Street
Baltimore, Maryland 21203

Rich Mendoza
U.S. Army Environmental Command
1 Rock Island Arsenal
Bldg 60, 3rd Fl, NW Wing, Room 320
(IMAE-CDN)
Rock Island, Illinois 61299

James McKenna
Radford Army Ammunition Plant
Route 114, Peppers Ferry Road
Building 220
Radford, Virginia 24141-0099

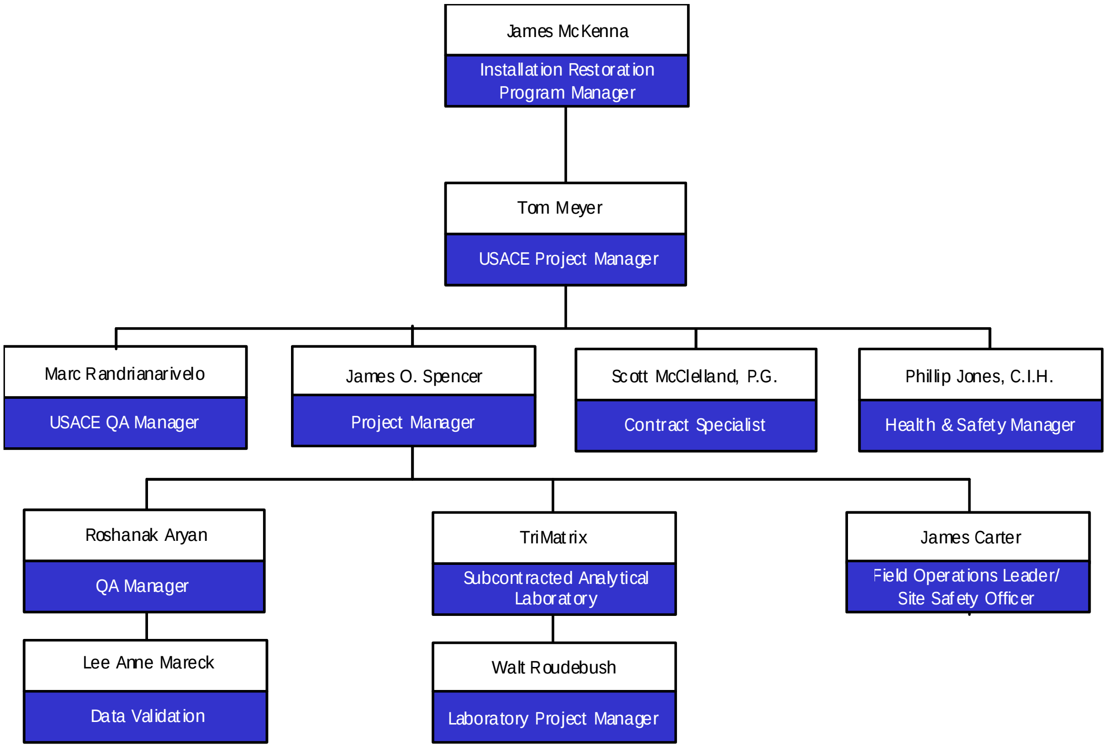
Dennis Druck
USACHPPM
5158 Blackhawk Road
ATTN: MCHB-TS-HER
Aberdeen Proving Ground, MD 21010-5403

2.2 PROJECT ORGANIZATION AND RESPONSIBILITIES

2.2.1 Contractor and Subcontractor Responsibilities

Contractor and subcontractor personnel requirements for implementing the technical, quality, and health and safety programs are described in Section 2.1 of the MQAP. Figure 2-1 presents the identification and the organization of project management personnel.

Figure 2-1
Project Organizational Chart



2.2.2 Key Points of Contact

Table 2-2 provides the names and points of contact for URS personnel and subcontractors.

The Project Manager (PM) is responsible for ensuring that activities are conducted in accordance with contractual specifications, the Statement of Work (SOW), and approved work plans. The PM will also provide technical coordination with the Installation's designated counterpart. The PM is responsible for management of operations conducted for this project. In addition, the PM will ensure that personnel assigned the project, including subcontractors, will review the technical plans prior to initiation of each task associated with the project. The PM will monitor the project budget and schedule and will ensure availability of necessary personnel, equipment, subcontractors, and services. The PM will participate in the development of the field program, evaluation of data, reporting, and the development of conclusions and recommendations.

Table 2-2
Contractor and Subcontractor Key Points of Contact

Contractor	Key Point of Contact
Project Manager, James O Spencer Email: James O Spencer@URSCorp.com	URS Group, Inc. 5540 Falmouth Street, Suite 201 Richmond, Virginia 23230 Tel: 804.474.5420; Fax: 804.965.9764

Contractor	Key Point of Contact
Health and Safety Manager, Phillip Jones Email: Phillip_L_Jones@URSCorp.com	URS Group, Inc. 335 Commerce Drive, Suite 300 Fort Washington, Pennsylvania 19034 Tel: 215.367.2500; Fax: 215.367.1000
Quality Assurance Manager, Roshanak Aryan Email: Roshanak_Aryan@URSCorp.com	URS Group, Inc. 5540 Falmouth Street, Suite 201 Richmond, Virginia 23230 Tel: 804.474.5431; Fax: 804.965.9764
Data Validator, Lee Anne Mareck Email: Lee_Mareck@URSCorp.com	URS Group, Inc. 5540 Falmouth Street, Suite 201 Richmond, Virginia 23230 Tel: 804.474.5444; Fax: 804.965.9764
Field Operations Leader and Site Health and Safety Officer, James Carter Email: James_Carter@URSCorp.com	URS Group, Inc. 5540 Falmouth Street, Suite 201 Richmond, Virginia 23230 Tel: 804.965.9000; Fax: 804.965.9764
Subcontractor	**Key Point of Contact**
Analytical Laboratory Services TriMatrix Laboratories, Inc. Email: RoudebushW@TriMatrixLabs.com	Walt Roudebush 5560 Corporate Exchange Court Grand Rapids, MI 49512 Tel: 616.975.4500; Fax: 616.940.4470
Physical Laboratory Services URS Corporation Email: greg_thomas@urscorp.com	Greg Thomas 45 J. Commerce Way Totowa, NJ 07512 Tel: 973.812.1818; Fax: 973.812.8640

The Field Operations Leader will provide management of the field activities during the fieldwork. The Field Operations Leader is responsible for ensuring that technical matters pertaining to the field-sampling program are addressed. They will participate extensively in data interpretation, report writing, and preparation of deliverables, and will ensure that work is being conducted as specified in the technical plans. In addition, the Field Operations Leader is responsible for field quality assurance/quality control (QA/QC) procedures and for safety-related issues. Prior to initiation of field activities, the Field Operations Leader will conduct a field staff orientation and briefing to acquaint project personnel with the sites and assign field responsibilities.

The Health and Safety Manager will review and internally approve the HSPA that will be tailored to the specific needs of the project in the task specific addendum. In consultation with the PM, the Health and Safety Manager will ensure that an adequate level of personal protection exists for anticipated potential hazards for field personnel. On-site health and safety will be the responsibility of the SHSO who will work in coordination with the PM and the project Health and Safety Manager.

The QA Manager is responsible for ensuring that the QA procedures and objectives in the project-specific work plans are met, reviewing field and analytical data to ensure adherence to QA/QC procedures, and approving the quality of data prior to inclusion in associated reports. This may include the performance of field and laboratory audits during the investigation. In addition, the QA Manager will be responsible for the review, evaluation, and validation of analytical data for the project and will participate in interpreting and presenting analytical data. QC coordination is under the technical guidance of the QA Manager to direct the task leaders on a day-to-day or as-needed basis to ensure the application of QA/QC procedures.

The Data Validator is responsible for analytical data evaluation and review to provide information on analytical data limitations based on specific quality control criteria. Responsibilities of the Data Validator include establishing if data meet the project technical, quality control criteria, assessing the usability and extent of bias of data not meeting the specific technical, and quality criteria. The reviewer will establish a dialogue with the data users prior to and after review to answer questions, assist with interpretation, and to provide the validation reports.

The Contract Specialist is responsible for tracking funds for labor and materials procurement and oversight of the financial status of the project. Responsibilities include:

- Preparation of monthly cost reports and invoices;
- Administration of equipment rental, material purchases, and inventory of supplies;
- Administration and negotiation of subcontracts and interaction with the Administrative Contracting Officer and Procurement Contracting Officer on contract and subcontract issues; and
- Preparation of project manpower estimates and administration of contract documents.

2.3 QUALITY ASSURANCE OBJECTIVES

QA is defined as the overall system of activities for assuring the reliability of data produced. Section 2.1, of this WPA, references investigative, chemical, and regulatory measures associated with the QA Objectives of this project. Conformance with appended SOPs will ensure attainment of QA objectives. The system integrates the quality planning, assessment, and corrective actions of various groups in the organization to provide the independent QA program necessary to establish and maintain an effective system for collection and analysis of environmental samples and related activities. The program encompasses the generation of complete data with its subsequent review, validation, and documentation.

The DQO process is a strategic planning approach to ensure environmental data is of the appropriate type, quantity, and quality for decision-making. Project-specific DQOs are included in Table 2-3 for investigative activities. The overall QA objective is to develop and implement procedures for sample and data collection, shipment, evaluation, and reporting that will allow reviewers to assess whether the field and laboratory procedures meet the criteria and endpoints established in the DQOs. DQOs are qualitative and quantitative statements that outline the decision-making process and specify the data required to support corrective actions. DQOs specify the level of uncertainty that will be accepted in results derived from environmental data. Guidance for the Data Quality Objectives Process (USEPA 2000b), and Guidance for Data Quality Objectives for Hazardous Waste Sites (USEPA 2000c) formed the basis for the DQO process and development of RFAAP data quality criteria and performance specifications.

The DQO process consists of the seven steps specified below.

1. **State the Problem:** Define the problem to focus the study. Specific activities conducted during this process step include (1) the identification of the planning team and the primary decision-maker, (2) the statement of the problem, and (3) the identification of available resources, constraints, and deadlines.

   a) The planning team consists of the RFAAP, USACE, USEPA, VDEQ, the RFAAP operating contractor, and URS; Relative to the implementation of this WPA, the primary decision-maker is RFAAP, in consultation with USACE, USEPA, VDEQ, the RFAAP operating contractor, and URS.

Table 2-3

Summary of Project Data Quality Objectives

DQO Element	Project DQO Summary
Problem Statement	• The nature and extent of lead impacted soil in the SWMU 13 RFI study area has not been completely characterized. • Verify findings of SSP with regard to COPCs in soil. • Additional data is required to assess potential risks to human health and the environment and reach a final decision regarding future action at the site.
Identify Decision/Study Question	• What is the spatial distribution of lead in soil? Are there definable "hot spot" areas in soil where concentrations are above residential and/or industrial ALs? • Are hazardous constituent concentrations in soil at levels above RFAAP background (metals) and human health/ecological risk screening criteria? • Do hazardous constituent concentrations in soil pose an unacceptable risk to human health or the environment considering current and planned future land uses? • Do the hazardous constituent concentrations in soil have a potential to impact the New River adjacent to the site?
Decision Inputs	• Results of site reconnaissance, field investigation data, and chemical analytical data. • USEPA Region III RBCs and ecological risk screening values, and lead action levels for soil
Study Boundaries	• SWMU 13 RFI study area includes the land area between active OBG area and New River. • Sampling grid is designed to confirm study boundaries, characterize spatial distribution of lead in soil, and identify "hot spot" areas where concentrations are above residential and/or industrial ALs
Decision Rule	• Comparison to most recent USEPA Region III ecological screening values. • Comparison to most recent USEPA Region III RBCs and lead action levels.

DQO Element	Project DQO Summary
Tolerable Limits on Decision Errors	• SW-846 Test Methods reporting limits. USEPA Contract Laboratory Program (CLP)-like raw data package suitable for validation (level M3 for organic, level IM2 for inorganic). • MDLs and RLs are established for each analyte within the suite of parameters sought. MDLs and RLs below the action levels will ensure the data meet the DQOs. • Information from previous studies and physical features of the area was used to develop a field sampling plan design that allows for a low probability of decision error.
Optimize the Design for Obtaining Data	• DQO outputs will be reviewed based on the data collection activities; the validity of the data could be verified if necessary based on the review. • Data collection is based upon site-specific characteristics and the end use of the data. • This work plan addendum contains the proposed sampling design program based on the DQOs. Project documentation will be implemented in accordance with the MWP. • Sample locations have been selected to provide information meeting the DQOs. • The central aligned rectangular grid is designed to characterize the spatial distribution of lead in soil and identify “hot spot” areas.

b) The following project objectives have been identified:

i) Collect additional data to characterize the spatial distribution of lead in soil and identify areas where lead concentrations are above residential and industrial ALs.

ii) Collect additional data for SVOCs, explosives including nitroglycerin, and TAL metals to confirm SSP COPC screening results and to provide for additional data for risk assessment and background evaluations (for metals).

iii) Assess current conditions in soil at the SWMU 13 RFI study area and evaluate potential future impacts to the New River from the SWMU 13 RFI study area.

iv) Conduct human health and ecological risk assessments to characterize soil related risks.

v) Reach a decision regarding future action at the site.

c) The RFI project budget has been established, the project team has been identified, and a project schedule has been developed.

2. **Identify the Decision:** Define the decision statement that the study will attempt to resolve. Activities conducted during this step of the process involve (1) identification of the principal study question(s) and (2) definition of resultant alternative actions.

   a) Principal study questions include:

      i) What is the spatial distribution of lead in soil within the SWMU 13 RFI study area? Are there definable "hot spot" areas where lead concentrations are above residential and/or industrial ALs?

      ii) Are hazardous constituent concentrations in soil at levels above RFAAP background (metals) and human health/ecological risk screening criteria?

      iii) Do the hazardous constituent concentrations in soil have a potential to impact the New River adjacent to the site?

      iv) Are concentrations of hazardous constituents present at the site in excess of relevant screening criteria identified in the SSP and do the site conditions pose an unacceptable risk to human health or the environment?

      v) Do hazardous constituent concentrations in soil pose an unacceptable risk to human health or the environment considering current and planned future land uses?

   b) The resultant alternative actions include:

      i) If the nature and extent of hazardous constituents and associated potential human health/environmental risks have been sufficiently characterized to reach a future decision at the site, then the RFI Report will present this information.

      ii) If it is concluded that the nature and extent of hazardous constituents and/or associated potential human health/environmental risks have not been sufficiently characterized to reach a future decision on action at a site, then the RFI Report will present recommendations for additional investigations, further risk assessment, or other actions.

3. **Identify Inputs to the Decision**: Identify information inputs required for resolving the decision statement and assessing which inputs require environmental measures. This step of the process includes identification of the data that will be required to make the decision, identification of the information sources, identification of data required for establishment of study action levels, and confirmation of appropriate field sampling and analytical methods. The type of information that is needed to resolve the decision statement and the sources of this information include the following:

   a) Field investigation data including boring logs and physical testing results for soil;

   b) Chemical analytical data for lead, TAL metals, SVOCs, and explosives;

   c) RBCs in the most recent version of the USEPA Region III RBC Table for soil using the residential and industrial scenarios;

d) USEPA residential and industrial action levels for lead in soil;

e) Most recent USEPA Region III ecological screening values for soil;

f) USEPA RCRA Hazardous Waste Characteristics threshold levels;

g) Method Detection Limits (MDLs) and Reporting Limits (RLs) for the most recent suite of CLP TCL and TAL constituents and other constituents based on the findings of the background data review;

h) Results of an examination of site use, operational history, environmental setting, groundwater and surface water use and characteristics, and soil exposure characteristics;

i) Results of physical testing of soil for geotechnical properties;

j) Details of a visual inspection of the SWMU; and

k) Validated results of chemical analyses performed on site samples.

4. **Define the Boundaries:** Define decision statement spatial and temporal boundaries. This step specifies (1) the spatial boundary, (2) the target population characteristics, applicable geographic areas and associated homogeneous characteristics, and (3) the constraints on sample collection.

   a) The SWMU 13 RFI study area includes the land surface area between the OBG active area and the adjacent area of the New River. The SWMU 13 RFI study area boundary is outside of the current operating area of OBG.

   b) The media that will be investigated include surface soil and subsurface soil in the SWMU 13 RFI study area.

   c) Practical constraints that could interfere with sampling include steep grade, surface vegetation, boring refusal, unknown subsurface conditions, weather, and constraints due to active operations at OBG.

5. **Develop a Decision Rule:** Define (1) the parameters of interest, (2) the action levels, and (3) develop a decision rule.

   a) Parameters of interest include:

      i. Lead, TAL metals, SVOCs including low-level PAHs, and explosives including nitroglycerin;

      ii. Toxicity Characteristic Leaching Procedure (TCLP), pH, explosives, and chemical oxygen demand for investigative derived material;

      iii. Grain-size analysis, Atterberg Limits, moisture content, TOC, hydraulic conductivity, soil porosity, soil bulk density, and pH.

b) Action levels include:

   i. Action levels for risk screening include USEPA Region III RBCs, lead action level for soil, most recent USEPA Region III ecological screening levels, and statistical comparisons of metals data to facility background data;

   ii. In accordance with USEPA Region III guidance, RBCs for non-carcinogenic constituents will be adjusted downward to an HQ of 0.1 to ensure that chemicals with additive effects are not prematurely eliminated during screening; and

   iii. MDLs and RLs, as specified herein, will ensure that data quality is sufficient for its intended use. The selected laboratories are within the CLP network, the proposed laboratories have been validated by USACE for the selected SW-846 Test Methods, and it is assumed that sources of analytical errors will be small and known.

c) Decision rules include:

   i. Constituents of potential concern will be identified by comparing maximum detected concentrations (or a 95% Upper Confidence Limit (UCL) if appropriate) to established action levels in order to decide the need for further evaluation, investigation, or response action;

   ii. Analytical laboratory decision rules are presented in this QAPA and the laboratory QAPs. These include specific action levels and decision rules based on accuracy and precision; and

   iii. Results of site activities will be used to refine the site conceptual model and will be used in the evaluation of remedial alternatives.

6. **Specify Acceptable Limits on Decision Errors:** Specify the decision-maker's tolerable limits on decision errors. This step includes identification of (1) parameter range of interest, (2) decision errors, and (3) potential parameter values and probability tolerance for decision errors.

   a) MDLs and RLs are established for each analyte within the suite of parameters sought. MDLs and RLs below the action levels will ensure the data meet the DQOs. The contract laboratory will provide a CLP-like raw data package (Level IV). Data validation will be conducted based on this QAPA, the MQAP, the Department of Defense (DOD) Quality Systems Manual (QSM), and relevant USEPA Region III guidance.

   b) The main baseline condition decision error is to decide that the true mean concentration of a site-related contaminant does not exceed the action level for further study when in fact the mean concentration exceeds the action level and further action is needed (Type I, false rejection). Conversely, consequences of incorrectly deciding that the true mean concentration of a site-related contaminant is above the action level when in fact the mean concentration is below the action level include spending un-necessary resources to study further or remediate a site with insignificant risk (Type II, false acceptance).

   c) Information from previous studies and physical features of the area was used to develop a field sampling plan design that allows for a low probability of decision error.

7. **Optimize Data Design:** Identify data collection activities commensurate with data quality specifications. This final step in the process consists of (1) reviewing DQO outputs and existing environmental data, (2) developing data collection design alternatives, and (3) documentation of operational details and theoretical assumptions.

    a) DQO outputs will be reviewed based on the data collection activities; the validity of the data could be verified if necessary based on the review;

    b) Data collection is based upon site-specific characteristics and the end use of the data; and

    c) This addendum contains the proposed sampling design program based on the DQOs. Project documentation will be implemented in accordance with the MWP.

2.4 SAMPLE MANAGEMENT

Sample management objectives will be met through adherence to the sample identification procedures (identification convention), documentation requirements, and chain-of-custody procedures in the MWP.

2.4.1 Number and Type

Table 2-4 provides an itemization of the sample identifiers, sample depths (if applicable), and analytical parameters for environmental samples proposed during this investigation.

2.4.2 Sample Container, Preservation Method, and Holding Time Requirements

Table 2-5 identifies analytical parameters, container and preservation requirements, and holding times.

2.4.3 Sample Identification

The sample identification number will conform to past nomenclature at SWMU 13. The identification will consist of an alphanumeric designation related to the sampling location, media type, and sequential order according to the sampling event. The identification number will not exceed thirty-two characters for entry into Environmental Restoration Information System (ERIS). Samples will be coded in the following order to ensure a unique identification.

- Site Location Code: The first two characters will be the SWMU number (i.e., 13 for SWMU 13).

- Sample/Media Type: The next two characters will be the sample/media types. In this case, the characters will be SB for soil borings.

- Sampling Location Number: The next one or two characters will be the number of the sampling location (e.g., 3, 4, 5).

- The sample from the zero to six inches bgs interval will be designated with an “A” after the boring number. The sample collected from intermediate depths of the borings will be designated with a “B” following the boring number. Samples collected from the termination depth of the boring will be designated with a “C.”

- Duplicate: Duplicate samples will be identified with a “DUP” designation followed by a numeric designation corresponding to the sequence of duplicates collected (e.g., DUP-1). A record of the sample that corresponds to the duplicate will be kept in the field logbook. In this manner, duplicates will be submitted as blind duplicates, eliminating the potential for laboratory bias in analysis.

Sample Identification Examples:

1) An intermediate depth subsurface soil sample collected from boring location fourteen at SWMU 13 would be identified as sample 13SB14B (for SWMU 13, soil boring fourteen, and "B" which stands for the soil at an intermediate depth at that location).
2) QC Samples: QC samples will be identified by date (month, day, year), followed by QC sample type, and sequential order number at one digit. The QC sample types include Matrix Spike, Matrix Spike Duplicate (MS/MSD), Rinse Blank (R), and Trip Blank (T).

2.4.4 Documentation

SOPs 10.1 and 10.2 in Appendix A and Section 9.8 of the MQAP specify documentation protocols.

2.5 ANALYTICAL PROCEDURES

TriMatrix Laboratories Inc. will perform offsite analytical analyses for SVOCs, explosives, metals, and TOC. Analytical methods to be used and associated MDLs and RLs are identified in Tables 2-6, 2-7, and 2-8. Laboratory analyses will be in accordance with USEPA SW-846 Test Methods for the analysis of the following:

- SVOCs including low-level PAHS;
- Explosives including nitroglycerin;
- TAL metals (including lead); and
- TOC.

Samples of IDM will be characterized for disposal purposes by analyzing for the following:

- TCLP – Complete List for solid and TCLP metals for aqueous;
- pH;
- Chemical Oxygen Demand (aqueous, by USEPA Method 410.4);
- Explosives for solid (SW-846 Methods 8330 and 8332);
- Reactivity (ATK internal visual method and percent explosive content); and
- Paint Filter Test (solid).

Table 2-4
Summary of Proposed Sample Identifiers, Depths, and Analytical Methods
MWP Addendum 023 - RFI at SWMU 13
Radford Army Ammunition Plant, Radford, Virginia

		Chemical Analysis										Physical Analysis					
Sample ID	**Depth (ft bgs)**	**TAL Metals (Soil/Aqueous QC) SW-846 6010B/6020/7470A/7471A**	**Lead EPA 6010B**	**PCBs SW-846 82082**	**SVOCs SW-846 8270C**	**Explosives SW-846 8330**	**Nitroglycerin SW-846 8332**	**TCLP Full List**	**Chemical Oxygen Demand EPA 410.4**	**pH (corrosivity) SW-846 9040B**	**Paint Filter Test SW-846 9095**	**Total Organic Carbon Walkley-Black Method**	**Grain Size ASTM D422**	**Atterburg Limits ASTM D4318**	**Moisture Content ASTM D2216**	**pH ASTM D4972**	**Cation Exchange Capacity**
Soil Borings																	
Lead Soil Grid																	
13SB13A - 13SB90A	0-0.5		X														
13SB13B - 13SB90B	2-3		X														
13SB13C - 13SB90C	5-6		X														
Soil Investigation(1)																	
13SB13A	0-0.5	X			X	X	X					X	X	X	X	X	X
13SB13C	5-6	X			X	X	X										
13SB14A	0-0.5	X			X	X	X										
13SB14C	5-6	X			X	X	X										
13SB15A	0-0.5	X			X	X	X					X	X	X	X	X	X
13SB15C	5-6	X			X	X	X										
13SB16A	0-0.5	X			X	X	X										
13SB16C	5-6	X			X	X	X					X					X
13SB17A	0-0.5	X			X	X	X										
13SB17C	5-6	X			X	X	X										
13SB18A	0-0.5	X			X	X	X					X	X	X	X	X	X
13SB18C	5-6	X			X	X	X										
13SB19A	0-0.5	X			X	X	X										
13SB19C	5-6	X			X	X	X										
13SB20A	0-0.5	X			X	X	X										
13SB20C	5-6	X			X	X	X					X					X
13SB21A	0-0.5	X			X	X	X										
13SB21C	5-6	X			X	X	X										
13SB22A	0-0.5	X			X	X	X										
13SB22C	5-6	X			X	X	X										
Quality Control Samples																	
DUP-1	TBD	X			X	X	X										
DUP-2	TBD	X			X	X	X										
DUP-3 through DUP-24	TBD		X														
MS/MSD	TBD	X			X	X	X										
MS/MSD (12 samples)	TBD		X														
EQB1	N/A	X			X	X	X										
EQB2 through EQB18	N/A		X														

Notes:
SB = Soil Boring
ft bgs = Feet Below Ground Surface
TAL = Target Analyte List
TBD = To Be Determined
SVOC = Semi-volatile Organic Compound
PCB =Polychlorinated Biphenyl
TCLP = Toxicity Characteristic Leaching Procedure
MS/MSD = Matrix Spike/ Matrix Spike Duplicate
IDM = Investigation-Derived Material
QC = Quality Control
DUP = Duplicate
EQB = Equipment Blank
N/A = Not Applicable
(1) = Chemical samples will be collected from 10 lead grid boring locations. Specific sample numbers will be determined during field activities. See Figure 1-15 for locations.

Table 2-5
Summary of Sample Container, Preservation Method, and Holding Time Requirements
MWP Addendum 023 - RFI at SWMU 13
Radford Army Ammunition Plant, Radford, Virginia

PARAMETER	SAMPLE CONTAINER		PRESERVATION METHODS	HOLDING TIMES
	Quantity	Type		
SOLID SAMPLES				
TCL Semi-volatile Organic Compounds	1	500-mL wide-mouth glass container, Teflon®-lined cap	Cool to 4 ± 2 °C	Extraction: 14 days Analysis: 40 days
Explosives	1	250-mL wide-mouth glass container, Teflon®-lined cap	Cool to 4 ± 2 °C	Extraction: 14 days Analysis: 40 days
TAL Metals/Lead	1	250-mL wide mouth polyethylene container, Teflon®-lined cap	Cool to 4 ± 2 °C	Metals: 6 months Mercury: 28 days
SOLID WASTE CHARACTERIZATION				
TCLP Volatile Organic Compounds	1	125-mL wide-mouth glass vial, Teflon®-lined cap	Cool to 4 ± 2ºC	Leaching: 14 days Analysis: 14 days
TCLP Semi-volatile Organic Compounds (8270C, 8081A, & 8151A)	2	500-mL wide-mouth glass container, Teflon®-lined cap	Cool to 4 ± 2 °C	Leaching: 14 days Extraction: 7 days Analysis: 40 days
TCLP Metals	1	250-mL wide-mouth polyethylene container, Teflon®-lined cap	Cool to 4 ± 2 °C	Leaching: 14 days Analysis: 6 months Mercury analysis: 28 days
Explosives	1	250-mL wide-mouth glass container, Teflon®-lined cap	Cool to 4 ± 2 °C	Extraction: 14 days Analysis: 40 days
Corrosivity, Paint Filter	1	250-mL wide-mouth glass container, Teflon®-lined cap	Cool to 4 ± 2 °C	Corrosivity: 7 days Paint Filter: --
Reactivity (percent explosive material)	1	250-mL wide-mouth glass container, Teflon®-lined cap	--	--
AQUEOUS SAMPLES - QA/QC				
TCL Semi-volatile Organic Compounds	2	1-liter, narrow-mouth amber glass, Teflon®-lined cap	Cool to 4 ± 2 °C	Extraction 7 days Analysis: 40 days
Explosives	2	1-liter, narrow-mouth amber glass, Teflon®-lined cap	Cool to 4 ± 2 °C	Extraction: 7 days Analysis: 40 days
Unflitered TAL Metals (including Lead)	1	500-mL, polyethylene container	HNO_3 to pH<2, Cool to 4 ± 2 °C	ICP: 6 months Mercury: 28 days
AQUEOUS WASTE CHARACTERIZATION AND QA/QC				
TCLP VOCs	3	40-mL, glass vials, Teflon®-lined septum cap, zero headspace	Cool to 4 ± 2 °C	Leaching: 7 days Analysis: 14 days
TCLP SVOCs (8270C, 8081A, & 8151A)	2	1-liter, narrow-mouth amber glass, Teflon®-lined cap	Cool to 4 ± 2 °C	Leaching: 7 days Extraction: 7 days Analysis: 40 days
TAL Metals	1	500-mL, polyethylene container	Cool to 4 ± 2 °C	Leaching: 14 days Analysis: 6 months Mercury analysis: 28 days
Explosives	2	1-liter, narrow-mouth amber glass, Teflon®-lined cap	Cool to 4 ± 2 °C	Extraction: 7 days Analysis: 40 days
Corrosivity	1	125-mL, polyethylene container	Cool to 4 ± 2 °C	7 days
COD	1	250-mL, polyethylene container	H_2SO_4 to pH<2, Cool to 4 ± 2 °C	28 days
pH	1	250-mL, polyethylene container	Cool to 4 ± 2 °C	28 days

Notes:
TAL = Target Analyte List
TCL = Target Compound List
mL = milliliter
°C = Degrees Celsius
ICP = Inductively Coupled Plasma
HNO_3 = Nitric Acid
H_2SO_4 = Sulfuric Acid
HCl = Hydrochloric Acid

Table 2-6
Summary of Analyte Detection Limits and Reporting Limits
TCL SVOCs (by EPA Method 8270C)
Soil and Water Samples
MWP Addendum 023 - RFI at SWMU 13
Radford Army Ammunition Plant, Radford, Virginia

		Laboratory-Specific Method Detection and Reporting Limits				USEPA MCLs	USEPA Region III Risk-Based Concentrations									USEPA Region III BTAG Screening Levels		
		Soil		Water			Tap Water			Soil Industrial			Soil Residential					
Compound	CAS Number	MDL mg/kg	Reporting Limit mg/kg	MDL µg/L	Reporting Limit µg/L	MCL µg/L	C/N	RBC µg/L	Adjusted RBC µg/L	C/N	RBC mg/kg	Adjusted RBC mg/kg	C/N	RBC mg/kg	Adjusted RBC mg/kg	Aqueous Fresh Water µg/L	Soil mg/kg	Sediment mg/kg
1,1'-Biphenyl	92-52-4	0.0042	0.17	0.024	5.0	--	N	3.0E+02	3.0E+01	N	5.1E+04	5.1E+03	N	3.9E+03	3.9E+02	1.4E+01	--	1.2E+00
1,2,4,5-Tetrachlorobenzene	95-94-3	0.0008	0.17	0.025	5.0	--	N	1.1E+01	1.1E+00	N	3.1E+02	3.1E+01	N	2.3E+01	2.3E+00	3.0E+00	1.0E-01	1.1E+00
2,2'-oxybis(1-Chloropropane)	108-60-1	0.0043	0.17	0.047	5.0	--	C	2.6E-01	2.6E-01	C	4.1E+01	4.1E+01	C	9.1E+00	9.1E+00	--	--	--
2,4,5-Trichlorophenol	95-95-4	0.0033	0.17	0.030	5.0	--	N	3.7E+03	3.7E+02	N	1.0E+05	1.0E+04	N	7.8E+03	7.8E+02	--	1.0E-01	--
2,4,6-Trichlorophenol	88-06-2	0.0032	0.17	0.025	5.0	--	C	6.1E+00	3.6E+00	C	2.6E+02	1.0E+02	C	5.8E+01	7.8E+00	4.9E+00	1.0E-01	2.1E-01
2,4-Dichlorophenol	120-83-2	0.0035	0.17	0.022	5.0	--	N	1.1E+02	1.1E+01	N	3.1E+03	3.1E+02	N	2.3E+02	2.3E+01	1.1E+01	1.0E-01	1.2E-01
2,4-Dimethylphenol	105-67-9	0.0099	0.17	0.540	5.0	--	N	7.3E+02	7.3E+01	N	2.0E+04	2.0E+03	N	1.6E+03	1.6E+02	--	1.0E-01	2.9E-02
2,4-Dinitrophenol	51-28-5	0.0052	0.33	0.210	5.0	--	N	7.3E+01	7.3E+00	N	2.0E+03	2.0E+02	N	1.6E+02	1.6E+01	--	1.0E-01	--
2,4-Dinitrotoluene	121-14-2	0.0037	0.17	0.036	5.0	--	N	7.3E+01	7.3E+00	N	2.0E+03	2.0E+02	N	1.6E+02	1.6E+01	4.4E+01	--	4.2E-02
2,6-Dinitrotoluene	606-20-2	0.0013	0.17	0.075	5.0	--	N	3.7E+01	3.7E+00	N	1.0E+03	1.0E+02	N	7.8E+01	7.8E+00	8.1E+01	--	--
2-Chloronaphthalene	91-58-7	0.0025	0.17	0.012	5.0	--	N	4.9E+02	4.9E+01	N	8.2E+04	8.2E+03	N	6.3E+03	6.3E+02	--	--	--
2-Chlorophenol	95-57-8	0.0038	0.17	0.028	5.0	--	N	3.0E+01	3.0E+00	N	5.1E+03	5.1E+02	N	3.9E+02	3.9E+01	2.4E+01	1.0E-01	3.1E-02
2-Methylnaphthalene	91-57-6	0.0031	0.17	0.022	5.0	--	N	2.4E+01	2.4E+00	N	4.1E+03	4.1E+02	N	3.1E+02	3.1E+01	4.7E+00	--	2.0E-02
2-Methylphenol	95-48-7	0.0048	0.17	0.450	5.0	--	N	1.8E+03	1.8E+02	N	5.1E+04	5.1E+03	N	3.9E+03	3.9E+02	1.3E+01	1.0E-01	--
2-Nitroaniline	88-74-4	0.0046	0.17	0.280	5.0	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Nitrophenol	88-75-5	0.0056	0.17	0.038	5.0	--	--	--	--	--	--	--	--	--	--	1.9E+03	--	--
3,3'-Dichlorobenzidine	91-94-1	0.0550	0.17	0.048	5.0	--	C	1.5E-01	1.5E-01	C	6.4E+00	6.4E+00	C	1.4E+00	1.4E+00	4.5E+00	--	1.3E-01
3-Nitroaniline	99-09-2	0.0120	0.17	0.710	5.0	--	--	--	--	--	--	--	--	--	--	--	--	--
4,6-Dinitro-2-methylphenol	534-52-1	0.0045	0.17	0.240	5.0	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Bromophenyl-phenylether	101-55-3	0.0034	0.17	0.039	5.0	--	--	--	--	--	--	--	--	--	--	1.5E+00	--	1.2E+00
4-Chloro-3-Methylphenol	59-50-7	0.0052	0.17	0.024	5.0	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Chloroaniline	106-47-8	0.0014	0.17	0.930	5.0	--	N	1.5E+02	1.5E+01	N	4.1E+03	4.1E+02	N	3.1E+02	3.1E+01	2.3E+02	--	--
4-Chlorophenyl-phenylether	7005-72-3	0.0049	0.17	0.029	5.0	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Methylphenol	106-44-5	0.0064	0.17	0.380	5.0	--	N	1.8E+02	1.8E+01	N	5.1E+03	5.1E+02	N	3.9E+02	3.9E+01	5.4E+02	1.0E-01	6.7E-01
4-Nitroaniline	100-01-6	0.0072	0.17	0.450	5.0	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Nitrophenol	100-02-7	0.0055	0.33	0.440	5.0	--	--	--	--	--	--	--	--	--	--	6.0E+01	1.0E-01	--
Acenaphthene	83-32-9	0.0041	0.17	0.021	5.0	--	N	3.7E+02	3.7E+01	N	6.1E+04	6.1E+03	N	4.7E+03	4.7E+02	5.8E+00	1.0E-01	6.7E-03
Acenaphthylene [1]	208-96-8	0.0036	0.17	0.038	5.0	--	N	1.8E+02	1.8E+01	N	3.1E+04	3.1E+03	N	2.3E+03	2.3E+02	--	1.0E-01	5.9E-03
Acetophenone	98-86-2	0.0052	0.17	0.033	5.0	--	N	6.1E+02	6.1E+01	N	1.0E+05	1.0E+04	N	7.8E+03	7.8E+02	--	--	--
Anthracene	120-12-7	0.0046	0.17	0.030	5.0	--	N	1.8E+03	1.8E+02	N	3.1E+05	3.1E+04	N	2.3E+04	2.3E+03	1.2E-02	1.0E-01	5.7E-02
Atrazine	1912-24-9	0.0069	0.17	0.087	5.0	3.0E+00	C	3.0E-01	3.0E-01	C	1.3E+01	1.3E+01	C	2.9E+00	2.9E+00	1.8E+00	--	6.6E-03
Benzaldehyde	100-52-7	0.0084	0.17	0.056	5.0	--	N	3.7E+03	3.7E+02	N	1.0E+05	1.0E+04	N	7.8E+03	7.8E+02	--	--	--
Benzo(a)anthracene	56-55-3	0.0030	0.17	0.058	5.0	--	C	3.0E-02	3.0E-02	C	3.9E+00	3.9E+00	C	2.2E-01	2.2E-01	1.8E-02	1.0E-01	1.1E-01
Benzo(a)pyrene	50-32-8	0.0057	0.17	0.031	5.0	2.0E-01	C	3.0E-03	3.0E-03	C	3.9E-01	3.9E-01	C	2.2E-02	2.2E-02	1.5E-02	1.0E-01	1.5E-01
Benzo(b)fluoranthene	205-99-2	0.0098	0.17	0.038	5.0	--	C	3.0E-02	3.0E-02	C	3.9E+00	3.9E+00	C	2.2E-01	2.2E-01	--	1.0E-01	--
Benzo(g,h,i)perylene [1]	191-24-2	0.0087	0.17	0.030	5.0	--	N	1.8E+02	1.8E+01	N	3.1E+04	3.1E+03	N	2.3E+03	2.3E+02	--	1.0E-01	1.7E-01
Benzo(k)fluoranthene	207-08-9	0.0022	0.17	0.048	5.0	--	C	3.0E-01	3.0E-01	C	3.9E+01	3.9E+01	C	2.2E+00	2.2E+00	--	1.0E-01	2.4E-01
Bis(2-chloroethoxy)methane	111-91-1	0.0031	0.17	0.022	5.0	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-chloroethyl)ether	111-44-4	0.0048	0.17	0.039	5.0	--	C	9.6E-03	9.6E-03	C	2.6E+00	2.6E+00	C	5.8E-01	5.8E-01	--	--	--
Bis(2-ethylhexyl)phthalate	117-81-7	0.0041	0.17	0.500	5.0	6.0E+00	C	4.8E+00	4.8E+00	C	2.0E+02	2.0E+02	C	4.6E+01	4.6E+01	1.6E+01	--	1.8E-01
Butylbenzylphthalate	85-68-7	0.0047	0.17	0.760	5.0	--	N	7.3E+03	7.3E+02	N	2.0E+05	2.0E+04	N	1.6E+04	1.6E+03	1.9E+01	--	1.1E+01
Caprolactam	105-60-2	0.0130	0.33	0.770	5.0	--	N	1.8E+04	1.8E+03	N	5.1E+05	5.1E+04	N	3.9E+04	3.9E+03	--	--	--
Carbazole	86-74-8	0.0061	0.17	0.032	5.0	--	C	3.3E+00	3.3E+00	C	1.4E+02	1.4E+02	C	3.2E+01	3.2E+01	--	--	--
Chrysene	218-01-9	0.0028	0.17	0.030	5.0	--	C	3.0E+00	3.0E+00	C	3.9E+02	3.9E+02	C	2.2E+01	2.2E+01	--	1.0E-01	1.7E-01
Dibenz(a,h)anthracene	53-70-3	0.0059	0.17	0.019	5.0	--	C	3.0E-03	3.0E-03	C	3.9E-01	3.9E-01	C	2.2E-02	2.2E-02	--	1.0E-01	3.3E-02
Dibenzofuran	132-64-9	0.0032	0.17	0.014	5.0	--	N	3.7E+01	3.7E+00	N	1.0E+03	1.0E+02	N	7.8E+01	7.8E+00	3.7E+00	--	4.2E-01
Diethylphthalate	84-66-2	0.0034	0.17	0.052	5.0	--	N	2.9E+04	2.9E+03	N	8.2E+05	8.2E+04	N	6.3E+04	6.3E+03	2.1E+02	--	6.0E-01
Dimethylphthalate	131-11-3	0.0036	0.17	0.020	5.0	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butylphthalate	84-74-2	0.0088	0.17	0.810	5.0	--	N	3.7E+03	3.7E+02	N	1.0E+05	1.0E+04	N	7.8E+03	7.8E+02	1.9E+01	--	6.5E+00
Di-n-octylphthalate	117-84-0	0.0038	0.17	0.041	5.0	--	--	--	--	--	--	--	--	--	--	2.2E+01	--	--
Fluoranthene	206-44-0	0.0028	0.17	0.033	5.0	--	N	1.5E+03	1.5E+02	N	4.1E+04	4.1E+03	N	3.1E+03	3.1E+02	4.0E-02	1.0E-01	4.2E-01

Table 2-6
Summary of Analyte Detection Limits and Reporting Limits
TCL SVOCs (by EPA Method 8270C)
Soil and Water Samples
MWP Addendum 023 - RFI at SWMU 13
Radford Army Ammunition Plant, Radford, Virginia

Compound	CAS Number	Laboratory-Specific Method Detection and Reporting Limits				USEPA MCLs	USEPA Region III Risk-Based Concentrations									USEPA Region III BTAG Screening Levels		
		Soil		Water			Tap Water			Soil Industrial			Soil Residential					
		MDL	Reporting Limit	MDL	Reporting Limit	MCL		RBC	Adjusted RBC		RBC	Adjusted RBC		RBC	Adjusted RBC	Aqueous Fresh Water	Soil	Sediment
		mg/kg	mg/kg	µg/L	µg/L	µg/L	C/N	µg/L	µg/L	C/N	mg/kg	mg/kg	C/N	mg/kg	mg/kg	µg/L	mg/kg	mg/kg
Fluorene	86-73-7	0.0051	0.17	0.027	5.0	--	N	2.4E+02	2.4E+01	N	4.1E+04	4.1E+03	N	3.1E+03	3.1E+02	3.0E+00	1.0E-01	7.7E-02
Hexachlorobenzene	118-74-1	0.0047	0.17	0.033	5.0	1.0E+00	C	4.2E-02	4.2E-02	C	1.8E+00	1.8E+00	C	4.0E-01	4.0E-01	3.0E-04	--	2.0E-02
Hexachlorobutadiene	87-68-3	0.0039	0.17	0.015	5.0	--	C!/N	8.6E-01	7.3E-01	C!/N	3.7E+01	2.0E+01	C!/N	8.2E+00	1.6E+00	1.3E+00	--	--
Hexachlorocyclopentadiene	77-47-4	0.0038	0.17	0.240	5.0	5.0E+01	N	2.2E+02	2.2E+01	N	6.1E+03	6.1E+02	N	4.7E+02	4.7E+01	--	--	--
Hexachloroethane	67-72-1	0.0051	0.17	0.029	5.0	--	C!/N	4.8E+00	3.7E+00	C!/N	2.0E+02	1.0E+02	C!/N	4.6E+01	7.8E+00	1.2E+01	--	1.0E+00
Indeno(1,2,3-cd)pyrene	193-39-5	0.0039	0.17	0.021	5.0	--	C	3.0E-02	3.0E-02	C	3.9E+00	3.9E+00	C	2.2E-01	2.2E-01	--	1.0E-01	1.7E-02
Isophorone	78-59-1	0.0024	0.17	0.025	5.0	--	C	7.0E+01	7.0E+01	C	3.0E+03	3.0E+03	C	6.7E+02	6.7E+02	--	--	--
Naphthalene	91-20-3	0.0032	0.17	0.022	5.0	--	N	6.5E+00	6.5E-01	N	2.0E+04	2.0E+03	N	1.6E+03	1.6E+02	1.1E+00	1.0E-01	1.8E-01
Nitrobenzene	98-95-3	0.0048	0.17	0.053	5.0	--	N	3.5E+00	3.5E-01	N	5.1E+02	5.1E+01	N	3.9E+01	3.9E+00	--	--	--
N-Nitrosodi-n-propylamine	621-64-7	0.0042	0.17	0.037	5.0	--	C	9.6E-03	9.6E-03	C	4.1E-01	4.1E-01	C	9.1E-02	9.1E-02	--	--	--
N-Nitrosodiphenylamine	86-30-6	0.0048	0.17	0.037	5.0	--	C	1.4E+01	1.4E+01	C	5.8E+02	5.8E+02	C	1.3E+02	1.3E+02	2.1E+02	--	2.7E+00
Pentachlorophenol	87-86-5	0.0044	0.33	0.061	5.0	1.0E+00	C	5.6E-01	5.6E-01	C	2.4E+01	2.4E+01	C	5.3E+00	5.3E+00	5.0E-01	1.0E-01	5.0E-01
Phenanthrene [1]	85-01-8	0.0028	0.17	0.033	5.0	--	N	1.8E+02	1.8E+01	N	3.1E+04	3.1E+03	N	2.3E+03	2.3E+02	4.0E-01	1.0E-01	2.0E-01
Phenol	108-95-2	0.0060	0.17	0.055	5.0	--	N	1.1E+04	1.1E+03	N	3.1E+05	3.1E+04	N	2.3E+04	2.3E+03	4.0E+00	1.0E-01	4.2E-01
Pyrene	129-00-0	0.0032	0.17	0.044	5.0	--	N	1.8E+02	1.8E+01	N	3.1E+04	3.1E+03	N	2.3E+03	2.3E+02	2.5E-02	1.0E-01	2.0E-01

Notes:

CAS = Chemical Abstract Service
mg/kg = Milligram Per kilogram
µg/L = Microgram Per liter
TCL = Target Compound List
VOC = Volatile Organic Compound
MDL = Method Detection Limit
RL = Reporting Limit
Method Detection and Reporting Limits Provided by TriMatrix
-- = No Risk Criteria Available
MCL = Maximum Contaminant Level
BTAG = Biological Technical Assistance Group
Soil - BTAG Screening Draft Values, 1995
Water - BTAG Freshwater Screening Values, 2004
Sediment - BTAG Sediment Screening Values, 2004

RBC = USEPA Region III Risk-Based Concentration
(RBC) values from the October 11, 2007,
RBC Table and Alternate RBC Table
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
C/N = Carcinogenic/Noncarcinogenic status per EPA RBC Table (October 2007)
C = Carcinogenic
C!/N= Carcinogenic RBC/Non-carcinogenic Adjusted RBC taken from Alternate RBC table; see USEPA Region III guidance
N = Non-Carcinogenic
[1] = RBC value for pyrene was used for these compounds

[shaded box] = Reporting limit was not low enough to meet screening criteria - but MDL does

Table 2-7
Summary of Analyte Detection Limits and Reporting Limits
Explosives (EPA Method 8330) and Nitroglycerin (EPA Method 8332)
Soil and Water Samples
MWP Addendum 023 - RFI at SWMU 13
Radford Army Ammunition Plant, Radford, Virginia

		Laboratory-Specific Method Detection and Reporting Limits				USEPA MCLs	USEPA Region III Risk-Based Concentrations									USEPA Region III BTAG Screening Levels		
		Soil		Water		MCL	Tap Water			Soil Industrial			Soil Residential			Aqueous Fresh Water	Soil	Sediment
	CAS	MDL	Reporting Limit	MDL	Reporting Limit			RBC	Adjusted RBC		RBC	Adjusted RBC		RBC	Adjusted RBC			
Compound by Method 8330	Number	mg/kg	mg/kg	µg/L	µg/L	µg/L	C/N	µg/L	µg/L	C/N	mg/kg	mg/kg	C/N	mg/kg	mg/kg	µg/L	mg/kg	mg/kg
1,3,5-Trinitrobenzene	99-35-4	0.200	2.5	0.16	5.0	--	N	1.1E+03	1.1E+02	N	3.1E+04	3.1E+03	N	2.3E+03	2.3E+02	--	--	--
1,3-Dinitrobenzene	99-65-0	0.052	2.5	0.23	5.0	--	N	3.7E+00	3.7E-01	N	1.0E+02	1.0E+01	N	7.8E+00	7.8E-01	--	--	--
2,4,6-Trinitrotoluene	118-96-7	0.051	2.5	0.08	5.0	--	C!/N	2.2E+00	1.8E+00	C!/N	9.5E+01	5.1E+01	C!/N	2.1E+01	3.9E+00	1.0E+02	--	9.2E-02
2,4-Dinitrotoluene	121-14-2	0.073	2.5	0.12	5.0	--	N	7.3E+01	7.3E+00	N	2.0E+03	2.0E+02	N	1.6E+02	1.6E+01	4.4E+01	--	4.2E-02
2,6-Dinitrotoluene	606-20-2	0.099	2.5	0.27	5.0	--	N	3.7E+01	3.7E+00	N	1.0E+03	1.0E+02	N	7.8E+01	7.8E+00	8.1E+01	--	--
2-Amino-4,6-dinitrotoluene[1]	35572-78-2	0.088	2.5	0.20	5.0	--	N	7.3E+01	7.3E+00	N	2.0E+03	2.0E+02	N	1.6E+02	1.6E+01	1.5E+03	--	--
2-Nitrotoluene	88-72-2	0.071	2.5	0.26	5.0	--	N	6.1E+01	6.1E+00	N	1.0E+04	1.0E+03	N	7.8E+02	7.8E+01	--	--	--
3-Nitrotoluene	99-08-1	0.120	2.5	0.22	5.0	--	--	--	--	--	--	--	--	--	--	7.5E+02	--	--
4-Amino-2,6-dinitrotoluene[1]	1946-51-0	0.053	2.5	0.31	5.0	--	N	7.3E+01	7.3E+00	N	2.0E+03	2.0E+02	N	1.6E+02	1.6E+01	--	--	--
4-Nitrotoluene	99-99-0	0.120	2.5	0.15	5.0	--	C	4.2E+00	4.2E+00	C	1.8E+02	1.8E+02	C	4.0E+01	3.1E+01	1.9E+03	--	4.1E+00
HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine)	2691-41-0	0.089	2.5	0.16	5.0	--	N	1.8E+03	1.8E+02	N	5.1E+04	5.1E+03	N	3.9E+03	3.9E+02	1.5E+02	--	--
Nitrobenzene	98-95-3	0.059	2.5	0.18	5.0	--	N	3.5E+00	3.5E-01	N	5.1E+02	5.1E+01	N	3.9E+01	3.9E+00	--	--	--
RDX (Hexahydro-1,3,5-trinitro-1,3,5-triazine)	121-82-4	0.089	2.5	0.06	5.0	--	C	6.1E-01	6.1E-01	C	2.6E+01	2.6E+01	C	5.8E+00	5.8E+00	3.6E+02	--	1.3E-02
Tetryl (Methyl-2,4,6-trinitrophenylnitramine)	479-45-8	0.170	2.5	0.25	5.0	--	N	1.5E+02	1.5E+01	N	4.1E+03	4.1E+02	N	3.1E+02	3.1E+01	--	--	--
Compound by Method 8332																		
Nitroglycerin	55-63-0	0.387	5.0	0.58	5.0	--	N	3.7E+00	3.7E-01	N	1.0E+02	1.0E+01	N	7.8E+00	7.8E-01	1.4E+02	--	--

Notes:

CAS = Chemical Abstract Service
mg/kg = Milligram Per kilogram
µg/L = Microgram Per liter
TCL = Target Compound List
MDL = Method Detection Limit
RL = Reporting Limit
Method Detection and Reporting Limits Provided by TriMatrix
-- = No Risk Criteria Available
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Soil - BTAG Screening Draft Values, 1995
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RBC = USEPA Region III Risk-Based Concentration
(RBC) values from the October 11, 2007,
RBC Table and Alternate RBC Table
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
C/N = Carcinogenic/Noncarcinogenic status per EPA RBC Table (October 2007)
C = Carcinogenic
C!/N= Carcinogenic RBC/Non-carcinogenic Adjusted RBC taken from Alternate RBC table; see USEPA Region III guidance
N = Non-Carcinogenic
[1] = RBC value is for the sum of the isomers called aminodinitrotoluenes

[shaded box] = Reporting limit was not low enough to meet screening criteria - but MDL does

Table 2-8
Summary of Analyte Detection Limits and Reporting Limits
TAL Metals (by EPA Methods 6010, 6020, and 7470)
Soil and Water Samples
MWP Addendum 023 - RFI at SWMU 13
Radford Army Ammunition Plant, Radford, Virginia

		Laboratory-Specific Method Detection and Reporting Limits				USEPA MCLs	USEPA Region III Risk-Based Concentrations									USEPA Region III BTAG Screening Levels		
		Soil		Water			Tap Water			Soil Industrial			Soil Residential					
	CAS	MDL	Reporting Limit	MDL	Reporting Limit	MCL		RBC	Adjusted RBC		RBC	Adjusted RBC		RBC	Adjusted RBC	Aqueous Fresh Water	Soil	Sediment
Compound	Number	mg/kg	mg/kg	µg/L	µg/L	µg/L	C/N	µg/L	µg/L	C/N	mg/kg	mg/kg	C/N	mg/kg	mg/kg	µg/L	mg/kg	mg/kg
Aluminum	7429-90-5	1.6	10	16	50	--	N	3.7E+04	3.7E+03	N	1.0E+06	1.0E+05	N	7.8E+04	7.8E+03	8.7E+01	1.0E+00	--
Antimony	7440-36-0	0.036	0.2	0.73	3	6.0E+00	N	1.5E+01	1.5E+00	N	4.1E+02	4.1E+01	N	3.1E+01	3.1E+00	3.0E+01	4.8E-01	2.0E+00
Arsenic	7440-38-2	0.023	0.1	0.47	2	1.0E+01	C	4.5E-02	4.5E-02	C	1.9E+00	1.9E+00	C	4.3E-01	4.3E-01	5.0E+00	3.3E+02	9.8E+00
Barium	7440-39-3	0.10	1	0.34	2	2.0E+03	N	7.3E+03	7.3E+02	N	2.0E+05	2.0E+04	N	1.6E+04	1.6E+03	4.0E+00	4.4E+02	--
Beryllium	7440-41-7	0.016	1	0.50	2	4.0E+00	N	7.3E+01	7.3E+00	N	2.0E+03	2.0E+02	N	1.6E+02	1.6E+01	6.6E-01	2.0E-02	--
Cadmium	7440-43-9	0.50	2	0.062	0.2	5.0E+00	N	1.8E+01	1.8E+00	N	5.1E+02	5.1E+01	N	3.9E+01	3.9E+00	2.5E-01	2.5E+00	9.9E-01
Calcium	7440-70-2	10	50	52	500	--	--	--	--	--	--	--	--	--	--	1.2E+05	--	--
Chromium (VI)[1]	7440-47-3	0.57	5	0.66	2	1.0E+02	N	1.1E+02	1.1E+01	N	3.1E+03	3.1E+02	N	2.3E+02	2.3E+01	8.5E+01	7.5E-03	4.3E+01
Cobalt	7440-48-4	0.35	2	0.22	1	--	--	--	--	--	--	--	--	--	--	2.3E+01	1.0E+02	5.0E+01
Copper	7440-50-8	0.022	0.1	0.32	1	1.3E+03	N	1.5E+03	1.5E+02	N	4.1E+04	4.1E+03	N	3.1E+03	3.1E+02	9.0E+00	1.5E+01	3.2E+01
Cyanide	57-12-5	0.0356	0.21	0.0022	0.01	2.0E+02	N	7.3E+02	7.3E+01	N	2.0E+04	2.0E+03	N	1.6E+03	1.6E+02	5.0E+00	5.0E-03	1.0E-01
Iron	7439-89-6	0.46	10	3.2	10	--	N	2.6E+04	2.6E+03	N	7.2E+05	7.2E+04	N	5.5E+04	5.5E+03	3.0E+02	1.2E+01	2.0E+04
Lead[2]	7439-92-1	0.041	0.2	0.24	1	1.5E+01	--	--	--	--	7.5E+02	7.5E+02	--	4.0E+02	4.0E+02	2.5E+00	1.0E-02	3.6E+01
Magnesium	7439-95-4	3.4	50	32	100	--	--	--	--	--	--	--	--	--	--	8.2E+04	4.4E+03	--
Manganese (non-food)	7439-96-5	0.14	1	0.74	3	--	N	7.3E+02	7.3E+01	N	2.0E+04	2.0E+03	N	1.6E+03	1.6E+02	1.2E+02	3.3E+02	4.6E+02
Mercury[3]	7439-97-6	0.0077	0.05	0.0367	0.2	2.0E+00	--	--	--	N	3.1E+02	3.1E+01	N	2.3E+01	2.3E+00	1.0E-01	5.8E-02	1.8E-01
Nickel	7440-02-0	0.027	0.1	0.45	2	--	N	7.3E+02	7.3E+01	N	2.0E+04	2.0E+03	N	1.6E+03	1.6E+02	5.2E+01	2.0E+00	2.3E+01
Potassium	7440-09-7	7.5	50	36	200	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	7782-49-2	0.063	0.2	0.73	3	5.0E+01	N	1.8E+02	1.8E+01	N	5.1E+03	5.1E+02	N	3.9E+02	3.9E+01	1.0E+00	1.8E+00	2.0E+00
Silver	7440-22-4	0.017	0.1	0.073	0.3	--	N	1.8E+02	1.8E+01	N	5.1E+03	5.1E+02	N	3.9E+02	3.9E+01	3.2E+00	9.8E-06	1.0E+00
Sodium	7440-23-5	19	100	59	500	--	--	--	--	--	--	--	--	--	--	6.8E+05	--	--
Thallium	7440-28-0	0.0085	0.1	0.14	1	2.0E+00	N	2.6E+00	2.6E-01	N	7.2E+01	7.2E+00	N	5.5E+00	5.5E-01	8.0E-01	1.0E-03	--
Vanadium	7440-62-2	0.024	0.1	0.26	1	--	N	3.7E+01	3.7E+00	N	1.0E+03	1.0E+02	N	7.8E+01	7.8E+00	2.0E+01	5.0E-01	--
Zinc	7440-66-6	0.85	5	0.82	3	--	N	1.1E+04	1.1E+03	N	3.1E+05	3.1E+04	N	2.3E+04	2.3E+03	1.2E+02	1.0E+01	1.2E+02

Notes:

CAS = Chemical Abstract Service
mg/kg = Milligram Per kilogram
µg/L = Microgram Per liter
TAL = Target Analyte List
MDL = Method Detection Limit
RL = Reporting Limit
Method Detection and Reporting Limits Provided by TriMatrix
-- = No Risk Criteria Available
MCL = Maximum Contaminant Level
BTAG = Biological Technical Assistance Group
Soil - BTAG Screening Draft Values, 1995
Water - BTAG Freshwater Screening Values, 2004
Sediment - BTAG Sediment Screening Values, 2004

RBC = USEPA Region III Risk-Based Concentration
(RBC) values from the October 11, 2007,
RBC Table and Alternate RBC Table
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
C/N = Carcinogenic/Noncarcinogenic status per EPA RBC Table (October 2007)
C = Carcinogenic
C!/N= Carcinogenic RBC/Non-carcinogenic Adjusted RBC taken from Alternate RBC table; see USEPA Region III guidance
N = Non-Carcinogenic
[1] = Chromium MCL is for total
[2] = Lead criteria are Action Levels; see USEPA Region III guidance
[3] = Mercuric chloride soil RBC value used

= Reporting limit was not low enough to meet screening criteria - but MDL does

2.5.1 Organics

The following techniques will be used for analysis of organic constituents.

2.5.1.1 SVOCs by SW8270C

The samples are prepared for analysis by gas chromatograph/mass spectrometer (GC/MS) using Method 3510C for aqueous media and Method 3540C for solid media, or other appropriate methods. The semi-volatile compounds are introduced into the GC/MS by injecting the sample extract into a GC with a narrow-bore fused-silica capillary column. The GC column is temperature-programmed to separate the analytes, which are then detected with a MS, connected to the gas chromatograph. Analytes eluted from the capillary column are introduced into the mass spectrometer via a direct connection. Identification of target analytes is accomplished by comparing their mass spectra with the electron impact (or electron impact-like) spectra of authentic standards. Quantitation is accomplished by comparing the response of a major (quantitation) ion relative to an internal standard using a five-point calibration curve.

2.5.1.2 Explosives by SW8330 and SW8332

Test Methods 8330 and SW8332 provide for the analysis of parts per billion levels of certain explosives residues in water, soil, and sediment matrices using high performance liquid chromatography (HPLC) using an ultraviolet (UV) detector. Before use of these methods, sample preparation techniques must be used. Two sample preparation techniques are available:

1) Low-level Salting-out Method with No Evaporation: Aqueous samples of low concentration are extracted by a salting-out extraction procedure with acetonitrile and sodium chloride. The small volume of acetonitrile that remains un-dissolved above the salt water is drawn off and transferred to a smaller volumetric flask. It is back-extracted by vigorous stirring with a specific volume of salt water. After equilibration, the phases are allowed to separate and the small volume of acetonitrile residing in the narrow neck of the volumetric flask is removed using a Pasteur pipette. The concentrated extract is diluted 1:1 with reagent grade water. An aliquot is separated on a C-18 reverse phase column, analyzed at 254 nanometers (nm), and confirmed on a cyanide (CN) reverse phase column. Quantitation is accomplished by comparing the response of a peak within a retention time window to a five-point calibration curve.

2) Soil and sediment samples are air dried at room temperature to a constant weight. Approximately 2 grams (g) are extracted using acetonitrile in an ultrasonic bath for eighteen hours. Five milliliters (mL) of supernatant is combined with five mL of calcium chloride solution and is shaken and left to stand for fifteen minutes. The supernatant is prepared for analysis by filtering through a 0.45 micrometer (µm) Teflon filter. This extract is then separated on a C-18 reverse phase column, determined at 254 nm, and confirmed on a CN reverse phase column. Quantitation is accomplished by comparing the response of a peak within a retention time window to a five-point calibration curve.

2.5.2 Metals

The following techniques will be used for analysis of metals.

2.5.2.1 Target Analyte List Metals by ICP SW-846 Test Method 6010B Series

Prior to analysis, samples are prepared by Method 3010A for aqueous media and Method 3050B for solid media, or other appropriate methods. When analyzing groundwater samples for dissolved constituents, acid digestion is not necessary if the samples are filtered and acid preserved before analysis. This method describes multi-elemental determinations by Inductively Coupled Plasma (ICP) - Atomic

Emission Spectroscopy (AES) using sequential or simultaneous optical systems and axial or radial viewing of the plasma. The instrument measures characteristic emission spectra by optical spectrometry. Samples are nebulized and the resulting aerosol is transported to the plasma torch. Element-specific emission spectra are produced by radio frequency inductively coupled plasma. The spectra are dispersed by a grating spectrometer, and photosensitive devices monitor the emission line intensities.

Background correction is required for trace element determination. Background must be measured adjacent to analyte lines on samples during analysis. The position selected for the background-intensity measurement, on either or both sides of the analytical line, will be defined by the complexity of the spectrum adjacent to the analyte line. In one mode of analysis, the position used should be as free as possible from spectral interference and should reflect the same change in background intensity as occurs at the analyte wavelength measured. Background correction is not required in cases of line broadening where a background correction measurement would actually degrade the analytical result. The possibility of additional interferences named in Section 3.0 of Method 3050B should also be recognized and appropriate corrections made; tests for their presence are described in Section 8.5 of Method 3035B. Alternatively, users may choose multivariate calibration methods. In this case, point selections for background correction are superfluous since entire spectral regions are processed.

2.5.2.2 Mercury by SW-846 Test Methods 7470A (aqueous) and 7471A (solid)

Prior to analysis, the liquid, solid, or semi-solid samples must be prepared according to the procedure discussed in the method. Methods 7470A and 7471A, cold-vapor atomic absorption techniques are based on the absorption of radiation at 253.7 nm by mercury vapor. The mercury is reduced to the elemental state and aerated from solution in a closed system. The mercury vapor passes through a cell positioned in the light path of an atomic absorption spectrophotometer. Absorbance (peak height or area) is measured as a function of mercury concentration. Quantitation is accomplished by comparing the response of the peak to a five-point calibration curve.

2.5.2.3 Target Analyte List Metals by ICP SW-846 Test Method 6020 Series

Inductively coupled plasma-mass spectrometry (ICP-MS) is applicable to the determination of sub-ppb concentrations of a large number of elements in water samples and in waste extracts or digests. Prior to analysis, samples that require total ("acid-leachable") values must be digested using appropriate sample preparation methods (such as Methods 3005-3051). Acid digestion prior to filtration and analysis is required for groundwater, aqueous samples, industrial waste, soil, sludge, sediment, and other solid waste for which total (acid-leachable) elements are required. When dissolved constituents are required, samples must be filtered and acid-preserved prior to analysis. No digestion is required prior to analysis for dissolved elements in water samples.

Method 6020 describes the multi-elemental determination of analytes by ICP-MS. The method measures ions produced by a radio frequency inductively coupled plasma. Analyte species originating in a liquid are nebulized and the resulting aerosol transported by argon gas into the plasma torch. The ions produced are entrained in the plasma gas and introduced, by means of an interface, into a mass spectrometer. The ions produced in the plasma are sorted according to their mass-to-charge ratios and quantified with a channel electron multiplier. Interferences must be assessed and valid corrections applied or the data flagged to indicate problems. Interference correction must include compensation for background ions contributed by the plasma gas, reagents, and constituents of the sample matrix.

2.5.3 TOC by Walkley-Black Method

Soil samples will be analyzed for TOC by this method. This is a preferred method for TOC analyses of soil samples since the EPA 9060 or 415.1 techniques designed for aqueous samples may leave unextracted organic carbon in the soil. Organic carbon is determined by an oxidation-reduction reaction in which potassium dichromate is added to a sample, followed by addition of concentrated sulfuric acid. Dichromate (Cr2O7 2-) oxidizes organic carbon to CO_2 in an acidic medium. The reduced dichromate is quantitatively related to oxidized organic carbon. Any remaining Cr2O7 2- is reduced by Fe2+ from the ferrous sulfate titrant. The endpoint at which all Cr2O7 2- has been reduced is indicated by the maroon color of an o-phenanthroline indicator.

2.5.4 Waste Samples

2.5.4.1 TCLP Extraction

For liquid wastes (i.e., those containing less than 0.5% dry solid material), the waste, after filtration through a 0.6 to 0.8-µm glass fiber filter, is defined as the TCLP extract. For wastes containing greater than or equal to 0.5% solids, the liquid, if present, is separated from the solid phase and stored for later analysis; the particle size of the solid phase is reduced, if necessary. The solid phase is extracted with an amount of extraction fluid equal to 20 times the weight of the solid phase. The extraction fluid employed is a function of the alkalinity of the solid phase of the waste. A special extractor vessel is used when testing for volatile analytes. Following extraction, the liquid extract is separated from the solid phase by filtration through a 0.6 to 0.8-µm glass fiber filter. If compatible (i.e., multiple phases will not form on combination), the initial liquid phase of the waste is added to the liquid extract, and these are analyzed together. If incompatible, the liquids are analyzed separately and the results are mathematically combined to yield a volume-weighted average concentration. Extracts are analyzed using the analytical methods described above.

2.5.4.2 VOCs by SW-846 Test Method 8260B (TCLP)

The aqueous samples are prepared for analysis by purge-and-trap Method 5030 and the solid samples are prepared by purge-and-trap Method 5035. The volatile compounds are introduced into the gas chromatograph by the purge-and-trap method or by other methods (Section 1.2 of Method SW8260B). The analytes are introduced directly to a wide-bore capillary column or cryofocused on a capillary pre-column before being flash evaporated to a narrow-bore capillary for analysis. The column is temperature-programmed to separate the analytes, which are then detected with a MS interfaced to the GC. Analytes eluted from the capillary column are introduced into the mass spectrometer via a jet separator or a direct connection. (Wide-bore capillary columns normally require a jet separator, whereas narrow-bore capillary columns may be directly interfaced to the ion source.) Identification of target analytes is accomplished by comparing their mass spectra with the electron impact (or electron impact-like) spectra of authentic standards. Quantitation is accomplished by comparing the response of a major (quantitation) ion relative to an internal standard using a five-point calibration curve.

2.5.4.3 Pesticides by SW8081A (TCLP)

A measured volume or weight of sample (approximately one liter for liquids, and two to 30 g for solids) is extracted using the appropriate matrix-specific sample extraction technique. Liquid samples are extracted at neutral pH with methylene chloride using Method 3520C (continuous liquid-liquid extractor), or other appropriate technique. Solid samples are extracted using Method 3540C (Soxhlet) or other appropriate technique. A variety of cleanup steps may be applied to the extract, depending on the nature of the matrix interferences and the target analytes. Suggested cleanups include alumina (Method 3610), florisil (Method 3620), silica gel (Method 3630), gel permeation chromatography (Method 3640), and sulfur (Method 3660). After cleanup, the extract is analyzed by injecting a one-microliter (µL) sample into a gas chromatograph with a narrow- or wide-bore fused silica capillary column. The GC column is temperature-programmed to separate the analytes. An electron capture detector (ECD) or an electrolytic conductivity detector (ELCD) detects analytes eluted from the capillary column. Quantitation is accomplished by comparing the response of a peak within a retention time window to a five-point calibration curve.

2.5.4.4 Herbicides by SW8151A (TCLP)

Method 8151 provides extraction, derivatization, and gas chromatographic conditions for the analysis of chlorinated acid herbicides in water, soil, and waste samples. Samples are extracted with diethyl ether and then esterified with either diazomethane or pentafluorobenzyl bromide. Organic acids, especially chlorinated acids, cause the most direct interference with the determination by methylation. Phenols, including chlorophenols, may also interfere with this procedure. The determination using pentafluorobenzylation is more sensitive, and more prone to interferences from the presence of organic acids or phenols than by methylation. The derivatives are assessed by gas chromatography with an electron capture detector (GC/ECD). The results are reported as acid equivalents. Quantitation is accomplished by comparing the response of a peak within a retention time window to a five-point calibration curve.

2.5.4.5 Explosives by SW8330 and SW8332

Test Methods 8330 and 8332 provide for the analysis of ppb levels of certain explosives residues in water, soil and sediment matrices using HPLC using a UV detector. Before use of these methods, sample preparation techniques must be used. Two sample preparation techniques are available:

3) Low-level Salting-out Method with No Evaporation: Aqueous samples of low concentration are extracted by a salting-out extraction procedure with acetonitrile and sodium chloride. The small volume of acetonitrile that remains un-dissolved above the salt water is drawn off and transferred to a smaller volumetric flask. It is back-extracted by vigorous stirring with a specific volume of salt water. After equilibration, the phases are allowed to separate and the small volume of acetonitrile residing in the narrow neck of the volumetric flask is removed using a Pasteur pipette. The concentrated extract is diluted 1:1 with reagent grade water. An aliquot is separated on a C-18 reverse phase column, analyzed at 254nm, and confirmed on a CN reverse phase column. Quantitation is accomplished by comparing the response of a peak within a retention time window to a five-point calibration curve.

4) Soil and sediment samples are air dried at room temperature to a constant weight. Approximately 2g are extracted using acetonitrile in an ultrasonic bath for eighteen hours. Five mL of supernatant is combined with five mL of calcium chloride solution and is shaken and left to stand for fifteen minutes. The supernatant is prepared for analysis by filtering through a 0.45 µm Teflon filter. This extract is then separated on a C-18 reverse phase column, determined at 254 nm, and confirmed on a CN reverse phase column. Quantitation is accomplished by comparing the response of a peak within a retention time window to a five-point calibration curve.

2.5.4.6 Corrosivity by SW-846 Test Methods 9040B (aqueous) and 9045C (solid)

The corrosivity of a sample will be based on its pH. The pH of a liquid sample is either analyzed electrometrically using a glass electrode in combination with a reference potential or a combination electrode. The measuring device is calibrated using a series of standard solutions of known pH. For soil/solid waste samples, the sample is mixed with reagent water, and the pH of the resulting aqueous solution is measured.

2.5.4.7 Chemical Oxygen Demand by EPA Method 410.4

Sample, blanks, and standards in sealed tubes are heated in an oven or block digestor in the presence of dichromate at 150 degrees Celsius (^{o}C). After two hours, the tubes are removed from the oven or digestor, cooled, and measured spectrophotometrically at 600 nm.

2.5.4.8 Reactivity

Reactivity of waste samples is assessed by analysis of the sample for explosives by SW-846 Methods 8330 and 8332. Waste material is considered potentially reactive when 10 percent or more explosives by weight are present. A qualitative assessment of samples may also be performed by visual and microscopic methods to identify typical crystalline structures characteristic of the propellants and explosives manufactured at the facility.

2.5.5 Physical/Geotechnical Analysis

As discussed in Section 2.6.1.1, two soil samples will be collected for analysis of physical/geotechnical parameters. A USACE-approved laboratory will conduct analyses. Analyses will be conducted for the following:

- Grain-size analysis (ASTM D 422);
- Atterberg limits (ASTM D 4318);
- Soil moisture content (ASTM D 2216);
- Total organic carbon (Walkley-Black Method);
- pH (ASTM D 4972): and
- Cation Exchange Capacity.

2.6 INTERNAL QUALITY CONTROL CHECK

Internal QC components that will be used by URS during operations at RFAAP are presented below and in Section 8.0 of the MQAP. The internal quality components include the field QC samples and the laboratory QC elements to be followed. Rinse blanks, trip blanks, and field duplicates will be collected during the acquisition of environmental samples at RFAAP. Table 2-9 presents guidelines for the collection of QC samples that will be taken in conjunction with environmental sampling. Field QC acceptance criteria are summarized in Table 2-10.

Table 2-9
Field Quality Control Samples

Control	Purpose of Sample	Collection Frequency
Field Duplicate	Ensure precision in sample homogeneity during collection and analysis	10% of field samples per matrix
Rinse Blank	Ensure the decontamination of sampling equipment has been adequately performed; to assess cross contamination and/or incidental contamination to the sample container	1 per 20 samples per matrix per sample technique
Temperature Blank	Verify sample cooler temperature during transport	1 temperature blank per cooler
Trip Blank	Assess if cross contamination occurs during shipment or storage with aqueous VOC samples	1 trip blank per cooler containing aqueous VOC samples

Table 2-10
Field Quality Control Elements Acceptance Criteria

Item	DQO	Parameter	Frequency of Association	Criteria Goal
Field Duplicate	P	Metals	1 per 10 samples	RPD ≤ 20% Aqueous; difference ± RL* RPD ≤ 35% Solid; difference ± 2xRL*
		Organics	1 per 10 samples	RPD ≤ 40% Aqueous; difference ± RL* RPD ≤ 60% Solid; difference ± 2xRL*
Trip Blank	A,R	VOCs in water	1 per cooler with aqueous VOCs	No target analytes detected greater than the RL
Rinse Blank	A,R	Entire	1 per 20 samples per matrix per equipment type	No target analytes detected greater than the RL
Chain of Custody Forms	R	Entire	Every sample	Filled out correctly to include signatures; no missing or incorrect information.
Representative Sampling Forms	R	Entire	Every sample	Filled out correctly to include signatures; no missing or incorrect information.
Field Logbook	R	Entire	Every sample	Filled out correctly to include analytical parameters; map file data; and applicable coding information.
Field Instrument Calibration Logs	A	Entire	Every measurement	Measurements must have associated calibration reference

Legend: A = Accuracy C = Comparability R = Representativeness P = Precision
*The difference will be evaluated when either of the field duplicate results is less than the reporting limit.

2.6.1 Laboratory Quality Control Elements

The laboratory QC elements are summarized in Table 2-11. Specific laboratory analytical QC criteria and corrective actions are summarized in Tables 2-12 through 2-18 for the parameters specified in Section 2.5.

Table 2-11
Analytical Quality Control Elements of a Quality Assurance Program

Item	DQO	Parameter	Frequency of Association	Criteria Requirement
Analytical Method	C	Entire	Each analysis	Method analyses based on USEPA methods as defined in Section 2.5
Chemical Data Packages	C	Entire	Each lot/batch	Pass peer review and formal QA/QC check.
Laboratory Chain of Custody	R	Entire	Each lot/batch	Custody of sample within laboratory fully accounted for and documented
Laboratory System Controls	A,C,P, R	Entire	During laboratory operations	No deficiencies
Holding Time	A,C,P, R	Entire	Each analysis	No deficiencies (USEPA Region III Modifications)
Method Blanks	A,R	Entire	Each lot/batch	No target analyte detected in the method blanks greater than RL
Laboratory Control Spike	A	Entire	Each lot/batch	Must meet criteria as defined in Tables 2-12 through 2-18
Matrix Spikes and Duplicates	A,P	Entire	Each lot/batch	Must meet criteria as defined in Tables 2-12 through 2-18
Surrogates	A	Entire	Organic fractions, including QC samples	Must meet criteria as defined in Tables 2-12 through 2-15
Serial dilution	A	Metals	Inorganic Fractions, Each lot/batch	Must meet criteria as defined in Table 2-15

Legend: A = Accuracy C = Comparability R = Representativeness P = Precision

Table 2-12
Quality Control Method Criteria for Volatile Organic Compounds by USEPA SW-846 8260B

Procedure	Frequency	Acceptance Criteria		Corrective Action
Initial Calibration 5-pt curve (linear) 6-pt curve (2^{o} order)	Set-up, major maintenance, or for drift correction	RRF > 0.10/0.30 for SPCCs RSD ≤ 30% for CCCs response factors RSD for analytes $\leq$ 15% or r>0.995 (linear) or r^2>0.99 (2^{o} order)		Sample analysis cannot begin until this criterion is met. Data reviewer should review and judge each target compound against the acceptance criteria.
Initial Calibration Verification	Immediately following initial calibration	A second source full compliment target list with a percent recovery = 75-125%		Sample analysis cannot begin until this criterion is met.
Continuing Calibration Check	Every 12 hours	RRF > 0.10/0.30 for SPCCs %Difference for RF of CCCs ±30% from initial calibration. Mean for analytes $\leq$ 20% as no individual target exceeds 40%D		Sample analysis cannot begin until this criterion is met. Data reviewer should review and judge each target compound against the acceptance criteria.
Method Blank	Every day/batch.	No target analytes greater than one half of the RL		Document source of contamination. Re-analysis is required for positive results associated with blank contamination.
Tuning BFB	Prior to calibration and every 12 hours	Must meet tuning criteria		Re-tune, re-calibrate, and re-analyze affected sample analyses.
Laboratory Control Spike	Every batch	Standards Full compliment target list	Laboratory generated control limits not to exceed recovery limits listed in the current version of the DOD QSM	Recoveries indicating a low bias require a re-extraction/reanalysis. Recoveries indicating a high bias require a re-extraction/re-analysis for associated positive field samples. Qualify associated data biased high or biased low as appropriate.
Internal Standards	Every sample	Recommended Standards fluorobenzene chlorobenzene-d_5 1,4-dichlorobenzene-d_4	Retention time ±30 seconds of mid point of initial calibration Area changes within a factor of two (-50% to +100%)	Inspect for malfunction. Demonstrate that system is functioning properly. Reanalyze samples associated with standards outside criteria. A third analytical run may be required at a dilution.
Surrogate	Every sample	Recommended Standards Toluene-d_8 4-Bromofluorobenzene 1,2-Dichloroethane-d_4 Dibromofluoromethane	Laboratory generated control limits not to exceed those listed in the current version of the DOD QSM	If surrogate compounds do not meet criteria, there should be a re-analysis to confirm that the non-compliance is due to the sample matrix effects rather than laboratory deficiencies.
Matrix Spike and Duplicate	1 per 20 per matrix	Standards Full compliment target list	Laboratory generated control limits not to exceed recovery limits listed in the current version of the DOD QSM	If MS/MSD results do not meet criteria, the reviewer should review the data in conjunction with other QC results to identify whether the problem is specific to the QC samples or systematic.

Table 2-13
Quality Control Method Criteria for Semi-volatile Organic Compounds by USEPA SW-846 8270C

Procedure	Frequency	Acceptance Criteria		Corrective Action
Initial calibration 5-pt curve (linear) 6-pt curve (2^o order)	Set-up, major maintenance, or for drift correction	RRF > 0.05 for SPCCs RSD ≤30% for CCC compounds RSD for target analytes ≤ 15% or r>0.995 (linear) or r^2>0.99 (2^o order)		Sample analysis cannot begin until this criterion is met. Data reviewer should review and judge each target compound against the acceptance criteria.
Initial Calibration Verification	Immediately following every initial calibration	A second source full compliment target list with a percent recovery = 80-120%		Sample analysis cannot begin until this criterion is met.
Continuing Calibration Check	12 hours	RRF > 0.05 for SPCCs %Difference for RF of CCCs ±30% from initial calibration Mean for analytes ≤ 20% as no individual target exceeds 40%D		Sample analysis cannot begin until this criterion is met. Data reviewer should review and judge each target compound against the acceptance criteria.
Internal standards	Every sample	Retention time ±30 seconds from mid point of initial calibration Area changes by a factor of two (-50% to +100%)		Inspect for malfunction. Demonstrate that system is functioning properly. Reanalyze samples with internal standards outside criteria.
Tuning DFTPP	12 hours	Must meet tuning criteria.		Re-tune, re-calibrate, and re-analyze affected sample analyses.
Method Blank	Per extraction batch	No target analytes greater than one half of the RL		Document source of contamination. Re-extraction/re-analysis is required for positive results associated with blank contamination.
Laboratory Control Spike	Every batch	Standards Full compliment target list	Laboratory generated control limits not to exceed recovery limits listed in the current version of the DoD QSM	Recoveries indicating a low bias require a re-extraction/reanalysis. Recoveries indicating a high bias require a re-extraction/re-analysis for associated positive field samples. Qualify associated data biased high or biased low as appropriate.
Internal Standards	Every sample	Recommended Standards phenanthrene-d10 chrysene-d12 perylene-d12 1,4-dichlorobenzene-d4 naphthalene-d8 acenaphthalene-d10	Retention time ±30 seconds of mid point of initial calibration Area changes within a factor of two (-50% to +100%)	Inspect for malfunction. Demonstrate that system is functioning properly. Reanalyze samples associated with standards outside criteria. A third analytical run may be required at a dilution.
Surrogate Spikes	Every sample	Recommended Standards nitrobenzene-d_5 2-fluorobiphenyl p-terphenyl-d14 phenol-d5 2,4,6-tribromophenol 2-fluorophenol	Laboratory generated control limits not to exceed limits listed in the current version of the DoD QSM	If two base/neutral or acid surrogates are out of specification, or if one base/neutral or acid extractable surrogate has a recovery of less than 10%, then there should be a re-extraction and re-analysis to confirm that the non-compliance is due to sample matrix effects rather than laboratory deficiencies.
Matrix Spike and Duplicate	1 per 20 samples per matrix	Standards Full compliment target list	Laboratory generated control limits not to exceed recovery limits listed in the current version of the DoD QSM	If MS/MSD results do not meet criteria, the reviewer should review the data in conjunction with other QC results to identify whether the problem is specific to the QC samples or systematic.

Table 2-14
Quality Control Method Criteria for Explosives by USEPA SW-846 8330 and 8332

Procedure	Frequency of QC Procedure	Acceptance Criteria		Corrective Action
Initial Calibration Curve 5-pt curve (linear) 6-pt curve (2o order)	Set-up, major maintenance, or for drift correction for each column used for analysis	%RSD <20% or r>0.995 (linear) or r2>0.99 (2o order)		Sample analysis cannot begin until this criterion is met.
Initial Calibration Verification	Immediately following every initial calibration	A second source full compliment of target list with a percent recovery = 80-120%		Sample analysis cannot begin until this criterion is met.
Continuing Calibration Check	Every ten samples or twelve hours	%D ± 15% of the response factor from the initial curve. The mean may be used as long as no individual target exceeds 30%D		Sample analysis cannot begin until this criterion is met. If criteria are not met, reanalyze the daily standard. If the daily standard fails a second time, initial calibration must be repeated. Data reviewer should review and judge each target compound against the acceptance criteria.
Method Blank	1 per batch	No target analytes detected greater than one half of the RL		Document source of contamination. Re-extraction/re-analysis is required for positive results associated with blank contamination.
Laboratory Control Spike	1 per batch	Standards Full compliment target list	Laboratory generated control limits not to exceed recovery limits listed in the current version of the DOD QSM	Recoveries indicating a low bias require a re-extraction/reanalysis. Recoveries indicating a high bias require a re-extraction/re-analysis for associated positive field samples. Qualify associated data biased high or biased low as appropriate.
Surrogate Spikes	Every sample	Standards A similar compound that is not expected to be found at the site	Laboratory generated control limits not to exceed limits listed in the current version of the DOD QSM	If surrogate compounds do not meet criteria, there should be a re-extraction and re-analysis to confirm that the non-compliance is due to the sample matrix effects rather than laboratory deficiencies.
Matrix Spike and Duplicate	1 per 20 samples per matrix	Standards Full compliment target list	Laboratory generated control limits not to exceed recovery limits listed in the current version of the DOD QSM	If MS/MSD results do not meet criteria, the reviewer should review the data in conjunction with other QC results to identify whether the problem is specific to the QC samples or systematic.
Target Analyte Confirmation	Every positive detection	RPD ≤ 40%		Report the higher of the two concentrations unless a positive bias is apparent and qualify.

Table 2-15
Quality Control Method Criteria for Target Analyte List Metals by USEPA SW-846 6020/ 6010B/7471A/ 7470A/ 9010C/ 9012A

<table>
<tr><th>Procedure</th><th>Frequency of QC Procedure</th><th colspan="2">Acceptance Criteria</th><th>Corrective Action</th></tr>
<tr><td>Tune (MS)</td><td>Daily</td><td colspan="2">Analyzed a minimum of four times with RSD < 5% for analytes in the solution.</td><td>Sample analysis cannot begin until this criterion is met.</td></tr>
<tr><td>Mass Calibration (MS)</td><td>Daily</td><td colspan="2">Difference < 0.1 amu from true value.</td><td>Adjust to the correct value.</td></tr>
<tr><td>Resolution Check (MS)</td><td>Daily</td><td colspan="2">Peak width <0.9 amu at 10% peak height</td><td>Sample analysis cannot begin until this criterion is met.</td></tr>
<tr><td rowspan="4">Initial Calibration Curve
(MS, ICP, Hg, & CN)</td><td rowspan="4">Daily, major maintenance, or to correct drift.</td><td>MS & ICP Option 1: 1-standard and a blank with a low level standard at RL.</td><td>Low level check standard ± 20%.</td><td rowspan="4">The standards for that element must be re-prepared and re-analyzed again.</td></tr>
<tr><td>MS & ICP Option 2: 3-standards and a blank</td><td>r > 0.995 for each element</td></tr>
<tr><td>Hg – 5-standards and a blank</td><td>r > 0.995</td></tr>
<tr><td>CN – 6 standards and a blank</td><td>r > 0.995</td></tr>
<tr><td>Distilled Standards (CN)</td><td>Once per calibration</td><td colspan="2">One high and one low distilled standard within ± 10% of the true value</td><td>Sample analysis cannot begin until this criterion is met.</td></tr>
<tr><td rowspan="3">Initial Calibration Verification (MS, ICP, Hg, & CN)</td><td rowspan="3">Immediately following initial calibration.</td><td colspan="2">MS & ICP - A second source full compliment of target list with a percent recovery = 90-110%</td><td rowspan="3">Sample analysis cannot begin until this criterion is met.</td></tr>
<tr><td colspan="2">Hg – A second source full compliment of target list with a percent recovery = 80-120%</td></tr>
<tr><td colspan="2">CN - A second source full compliment of target list with a percent recovery = 85-115%</td></tr>
<tr><td>Initial Calibration Blank (MS, ICP, Hg, & CN)</td><td>Immediately following initial calibration verification.</td><td colspan="2">No target analytes detected at concentration above 2 X MDL.</td><td>Sample analysis cannot proceed until this criterion is met.</td></tr>
<tr><td>Interference Check (MS & ICP)</td><td>Beginning of each sample analytical run.</td><td colspan="2">Recovery ±20% of true value.</td><td>Terminate the analysis, correct the problem, re-calibrate, re-verify the calibration, and reanalyze associated samples.</td></tr>
<tr><td rowspan="3">Continuing Calibration Check (MS, ICP, Hg, & CN)</td><td rowspan="3">Every 10 samples and end of analytical run.</td><td colspan="2">MS & ICP - Recovery ±10%.</td><td rowspan="3">Reanalyze; if the CCV fails again, stop analysis, the problem corrected, the instrument recalibrated, and the calibration re-verified prior to continuing sample analyses.</td></tr>
<tr><td colspan="2">Hg - Recovery ±20%.</td></tr>
<tr><td colspan="2">CN - Recovery ±15%.</td></tr>
<tr><td>Continuing Calibration Blank (MS, ICP, Hg, & CN)</td><td>Every 10 samples and end of analytical run.</td><td colspan="2">No target analytes detected at concentration above 2 X MDL.</td><td>Sample sequence should not continue until this criterion is met. Demonstrate "clean". Affected samples will be reanalyzed.</td></tr>
<tr><td>Preparation Blank (MS, ICP, Hg, & CN)</td><td>1 per batch per matrix</td><td colspan="2">No target analytes detected at concentration above one half of the RL.</td><td>Document source of contamination. Re-digestion/re-analysis is required for positive results associated with blank contamination, unless DQOs are still met.</td></tr>
</table>

Table 2-15 (Continued)
Quality Control Method Criteria for Target Analyte List Metals by USEPA SW-846 6020/ 6010B/7471A/ 7470A/ 9010C/ 9012A

Procedure	Frequency of QC Procedure	Acceptance Criteria		Corrective Action
Laboratory Control Sample (MS, ICP, Hg, & CN)	1 per batch per matrix	Standards Full compliment target list.	80-120% recovery Soil use generated limits	Recoveries indicating a low bias require a redigestion/ reanalysis. Recoveries indicating a high bias require a redigestion/ reanalysis for associated positive field samples. Qualify data biased high or biased low as appropriate.
Matrix Spike and Duplicate or Sample Duplicate (MS, ICP, Hg, & CN)	1 per 20 samples per matrix	Standards Full compliment target list.	75-125% recovery; ICP & Hg: RPD≤25%; CN: RPD≤20%; MS: [analyte]>100xIDL -RPD≤20%; Soil use generated limits	Qualify associated data biased high or biased low as appropriate.
Post Digestion Spike (PDS) (MS & ICP)	1 per 20 samples per matrix	Standards Full compliment target list.	75-125% recovery	
Serial Dilution (MS & ICP)	1 per 20 samples per matrix	Used to assess new matrices	For sample results > 5x RL for ICP or > 20x RL for MS, %D between diluted and undiluted sample result ≤10%.	Chemical or physical interference indicated. Investigate to identify cause.
Internal Standards (MS)	Every Analytical Sequence	Standards & Blanks	80-120% of initial calibration intensity	Terminate the analysis, correct the problem, re-calibrate, re-verify the calibration, and reanalyze associated samples.
		Samples	30-120% of initial calibration intensity	Reanalyze at consecutive five fold dilutions until criteria is met.

Table 2-16
Quality Control Method Criteria for Pesticides, Herbicides, and PCBs by USEPA SW-846 8081A, 8082, and 8151A

Procedure	Frequency of QC Procedure	Acceptance Criteria		Corrective Action
Initial calibration curve 5-pt curve (linear) 6-pt curve (2o order)	Set-up, major maintenance	%RSD<20% or r>0.995 (linear) or r2>0.99 (2o order)		Sample analysis cannot begin until this criterion is met.
Initial Calibration Verification	Immediately following every initial calibration	A second source full compliment of target list with a percent recovery = 85-115%		Sample analysis cannot begin until this criterion is met.
Continuing Calibration Check	Bracketing samples	%D recovery ± 15% of the response factor from the initial curve or mean with no individual peak >30%		Sample analysis cannot begin until this criterion is met. If criteria are not met, reanalyze the daily standard. If the daily standard fails a second time, initial calibration must be repeated. Data reviewer should review and judge each target compound against the acceptance criteria.
Endrin/4,4-DDT Breakdown	Bracketing samples	endrin degradation ≤15%. 4,4-DDT degradation ≤15%.		If criterion is not met, system must be deactivated and the affected samples reanalyzed.
Instrument Blank	After continuing calibration and highly contaminated samples.	No target analytes detected greater than one half the RL.		Demonstrate "clean". Affected samples will be reanalyzed.
Method Blank	Per extraction batch	No target analytes detected greater than one half the RL.		Document source of contamination. Re-extraction/re-analysis is required for positive results associated with blank contamination.
Laboratory Control Spike	Per extraction batch	Standards Full target list for 8081A and a mix of 1016 & 1260 for 8082	Laboratory generated control limits not to exceed limits listed in the current version of DOD QSM	Recoveries indicating a low bias require a re-extraction/reanalysis. Recoveries indicating a high bias require a re-extraction/re-analysis for associated positive field samples. Qualify associated data biased high or biased low as appropriate.
Surrogate Spikes	Every sample	Standards TCMX and DCB	Laboratory generated control limits not to exceed limits listed in the current version of DOD QSM	Investigate to assess cause, correct the problem, and document actions taken; re-extract and re-analyze sample. Specific method cleanups may be used to eliminate or minimize sample matrix effects. If still out, qualify.

Table 2-16 (Continued)
Quality Control Method Criteria for Pesticides, Herbicides, and PCBs by USEPA SW-846 8081A, 8082, and 8151A

Procedure	Frequency of QC Procedure	Acceptance Criteria		Corrective Action
Matrix Spike and Duplicate	1 per 20 samples per matrix	Standards Full target list for 8081A and a mix of 1016 & 1260 for 8082	Laboratory generated control limits not to exceed limits listed in the current version of DOD QSM	If MS/MSD results do not meet criteria, the reviewer should review the data in conjunction with other QC results to identify whether the problem is specific to the QC samples or systematic. Specific method cleanups may be used to eliminate or minimize sample matrix effects.
Target Analyte Confirmation	Every positive detection	RPD $\leq$ 40%		Report the higher of the two concentrations unless a positive bias is apparent and qualify.

Table 2-17
Quality Control Method Criteria for Total Organic Carbon by Walkley-Black Method (Argonomy, Methods of Soil Analysis 29-3.5.2)

Procedure	Frequency of QC Procedure	Acceptance Criteria	Corrective Action
Calibration (Titration Method)	Before Processing Samples a titration blank must be analyzed	0.5+/- 0.05N	If the titrant normality is not within the QC limit, clean the burette and remake the titrant solution and/or the 1N K2Cr2O7.
Laboratory Duplicate	1 per 20 samples or batch per matrix	RPD = 20%	If the RPD is out side the QC limit, it should be noted in the lab narrative.
Method Blank	1 per 20 samples or batch per matrix	No target analytes detected greater than the RL.	Document source of contamination. Re-extraction/re-analysis is required for positive results associated with blank contamination.
Laboratory Control Sample	1 per 20 samples per matrix	Laboratory generated control limits not to exceed recovery limits of 64-128%	Recoveries indicating a low bias require a re-extraction/reanalysis. Recoveries indicating a high bias require a re-extraction/re-analysis for associated positive field samples. Qualify associated data biased high or biased low as appropriate.
Matrix Spike and Duplicate	1 per 20 samples per batch, per matrix	Laboratory generated control limits not to exceed recovery limits of 68-142%	If MS/MSD results do not meet criteria, the reviewer should review the data in conjunction with other QC results to identify whether the problem is specific to the QC samples or systematic.

Table 2-18
Quality Control Method Criteria for Chemical Oxygen Demand by USEPA Method of Chemical Analysis for Water and Wastes 410.4

Procedure	Frequency of QC Procedure	Acceptance Criteria	Corrective Action
Initial calibration curve 5-pt curve	Major maintenance, instrument modification, per manufacturer's specifications	r>0.995 (linear) or r>0.99 (2^{o} order)	Sample analysis cannot begin until this criterion is met.
Initial Calibration Verification	Immediately following every initial calibration	Recovery ±10% of true value	Sample analysis cannot begin until this criterion is met. If criteria are not met, reanalyze the daily standards. If the ICV fails a second time, initial calibration must be repeated.
Continuing Calibration Check	Every 10 samples, end of analytical run	Recovery ±10% of true value	Sample analysis cannot proceed until this criterion is met. Reanalyze CCC. If the CCC fails second time, the analysis must be terminated, the problem corrected, the instrument re-calibrated, and the calibration re-verified prior to continuing sample analyses.
Continuing Calibration Blank	Every 10 samples, end of analytical run	No target analytes detected greater than the RL.	If not within criteria, terminate the analysis, correct the problem, re-calibrate, and reanalyze each sample analyzed since the last acceptable CCB.
Method Blank	1 per 20 samples or batch per matrix	No target analytes detected greater than the RL.	Document source of contamination. Re-extraction/re-analysis is required for positive results associated with blank contamination.
Laboratory Control Sample	1 per 20 samples per matrix	Laboratory generated control limits not to exceed recovery limits of 60-140% or RPD of 30%	Recoveries indicating a low bias require a re-extraction/reanalysis. Recoveries indicating a high bias require a re-extraction/re-analysis for associated positive field samples. Qualify associated data biased high or biased low as appropriate.
Matrix Spike and Duplicate	1 per 20 samples per batch, per matrix	Laboratory generated control limits not to exceed recovery limits of 60-140% or RPD of 30%	If MS/MSD results do not meet criteria, the reviewer should review the data in conjunction with other QC results to identify whether the problem is specific to the QC samples or systematic.

2.7 DATA COLLECTION AND VALIDATION

Non-CLP SW-846 Test Methods are proposed for analytical work for these WPA and analyses will be conducted by a National Environmental Laboratory Accreditation Program (NELAP) accredited analytical laboratory. Level IV CLP-like raw data will be provided along with the Form 1. Additional discussion as to the laboratory deliverables may be found in Section 9.8.3 of the MQAP. Data will be made available to the USEPA upon request and presented in the RFI Report.

Data validation will be conducted on 100% of the data and documented based on the MQAP Section 9.5, USEPA SW-846 Test Method criteria, DOD QSM, and USEPA Region III guidance. Data qualifiers will follow the USEPA Region III Modifications to the USEPA National Functional Guidelines for Evaluating Inorganic Analysis and USEPA Region III Modifications to the USEPA National Functional Guidelines for Organic Data Review Multi-media, Multi-concentration (OLM01.0-OLM01.9). Verification for organic data will be performed at level M3 and the verification for inorganic data will be performed at level IM2.

Manual data validation will be conducted by an independent, third party data validator not directly associated with the field-sampling program. Ms. Roshanak Aryan, Quality Assurance Manager, will oversee the performance of data validation functions. Data validation will be performed by knowledgeable and experienced individuals who can best perform evaluations within the necessary validation components. The data validator’s qualifications will include experience with each of the elements required for the data verification and validation including ensuring that the measuring system meets the user’s needs, assigning qualifiers to individual data values, assessing the relevancy of performance criteria, and concluding that data can proceed to quality assessment and reporting.

URS will direct the overall data management. Data management activities for the sampling program will be divided between URS and TriMatrix Laboratories. Each firm has the equipment needed to perform the required data management functions. The laboratory will perform data entry and manipulation operations associated with the analysis of raw analytical data and provisions of chemical analysis results by sampling location. These data will be transmitted to URS for evaluation and interpretation. In addition, URS will review boring logs and sample location maps.

3.0 HEALTH AND SAFETY PLAN ADDENDUM

3.1 INTRODUCTION

This site-specific HSPA was developed to provide the requirements for protection of site personnel, including government employees, URS personnel, regulators, subcontractors, and visitors that are expected to be involved with soil boring advancement/sampling at SWMU 13.

This HSPA addresses project-specific hazards, which include physical hazards, biological hazards, and chemical hazards, as identified in Section 3.2.2, below.

This addendum addresses site-specific training, personal protective equipment (PPE), and air monitoring requirements. General health and safety issues that are also applicable to this scope of work are addressed in Master Health and Safety Plan (MHSP), as shown in Table 3-1.

Table 3-1
Health and Safety Issues Discussed in the MHSP

Health and Safety Issue	Section in MHSP
Site Safety and Health Documentation	1.4
Safety Statement	1.5
Health and Safety Personnel and Responsibilities	2.1
Hazard Assessment and Hazard Control	3.0
Training Plan	4.0
Medical Surveillance Plan	5.0
Site Safety and Control	6.0
PPE	7.0
Personnel and Equipment Decontamination	8.0
Monitoring Plan	9.0
Emergency Response and Contingency Plan	10.0

URS, subcontractor personnel, and site visitors will read this HSPA and will be required to follow its protocols as minimum standards. This HSPA is written for the site-specific conditions at SWMU 13 and must be amended if conditions change. A copy of this HSPA will be available at each work site.

The contractor will provide a safe work environment for personnel involved in RFAAP investigative activities. The contractor will emphasize the importance of personnel injury and illness prevention at the work site.

3.2 TRAINING PLAN

Training will be used to review important topics outlined in this addendum and to inform URS personnel and subcontractor personnel of the hazards and control techniques associated with facility-wide conditions.

Site personnel will be informed of the specific PPE that will be worn during field activities. This includes, at a minimum, steel-toed boots, safety glasses (with side shields), gloves, and hardhat. Each field person will also have a respirator on the site, in the event that an emergency occurs and a respirator is necessary for site evacuation, or if the use of a respirator is necessary based on air monitoring results. Prior to initiation of fieldwork, the staff will be required to review the manual *Safety, Security and Environmental Rules for Contractors and Subcontractors* (ATK 2005). Additional training, which will be conducted during daily safety "tailgate" meetings, will include emergency and evacuation procedures, general safety rules, and use of automobiles. Written documentation of safety briefings will be kept on the site.

3.2.1 Hazard Information Training

Hazard information training will be presented to URS and subcontractor personnel to provide a description of the Hazardous, Toxic, and Radioactive Waste (HTRW) with the potential to be found at SWMU 13. Training will also be provided on the potential biological, chemical, and physical hazards to be found at the Installation. The URS SHSO will conduct this training based on information provided by the operating contractor.

3.2.2 Project-Specific Hazard Analysis

The following hazards must be recognized and controlled during applicable investigative activities:

(1) Physical Hazards

- Heat and cold stress – refer to Section 3.2.2 of the MHSP;
- Falls, open excavation, confined-space entry;
- Noise from heavy equipment;
- Cuts, abrasions, and lacerations;
- Manual lifting – refer to Section 3.2.4 of the MHSP;
- Slips, trips, and falls associated with walking through heavily vegetated areas – refer to Section 6.1.1 of the MHSP;
- Heavy equipment – refer to Section 6.1.2.1 of the MHSP; and
- MMA – energized subsurface and overhead power lines.

(2) Biological Hazards (refer to Section 3.3 of the MHSP)

- Insect bites and stings;
- Tick bites;
- Snake, rodent, or other animal bites; and
- Dangerous plants.

(3) Chemical Hazards

- Potential exposure to toxic chemicals; and
- Potential exposure to dangerous fumes in case of a nearby release or spill of acids, resulting in the creation of a fume cloud.

3.2.3 Hearing Conservation Training

Site personnel involved in heavy equipment operation in addition to other operations involving exposure to noise levels exceeding 85 decibels on the A-weighted scale Decibels on the A-Weighted Scale (dBA) eight-hour time-weighted average (TWA) shall be trained according to 29 CFR 1910.95. This training shall address the effects of noise on hearing, the purpose, advantages, disadvantages, and selection of hearing protection devices, and the purpose and explanation of Audiometric test procedures.

3.2.4 Hazard Communication Training

In order to comply with the requirements of the OSHA Hazard Communication (HAZCOM) Standard, 29 CFR 1910.1200, URS will have a written HAZCOM Program in place. The written hazard communication program addresses training (including potential safety and health effects from exposure), labeling, current inventory of hazardous chemicals on the site, and the location and use of Material Safety Data Sheets (MSDSs). The SHSO will arrange HAZCOM training for site personnel at the time of initial site assignment. Whenever a new hazardous substance is introduced into the work area or an employee changes job locations where new chemicals are encountered, supplemental HAZCOM training shall be scheduled and presented. HAZCOM training shall be documented by the SHSO using a HAZCOM Employee Training Record. This documentation and the URS HAZCOM Program will be maintained on the site for the duration of the project, and later incorporated in the employees' personal training file.

3.2.5 Confined Space Entry Training

Confined space entry training will not be required for fieldwork, as there will be no confined spaces entered during this investigation.

3.3 PERSONAL PROTECTIVE EQUIPMENT AND CLOTHING

The minimum and initial level of PPE for these activities will be Level D. The initial selection of PPE is based on a hazard assessment, including the review of existing analytical data and related toxicological information with respect to the proposed field activities. PPE assignments are subject to change based upon site conditions and task variation. The SHSO will review the required level of protection and safety equipment for each task with the sampling crew. The decisions on which protective level is most appropriate will be made by the SHSO.

In accordance with 29 CFR 1910.134, URS personnel working on the site will be required to participate in the written URS respiratory protection program. Personnel slated for fieldwork will have a qualitative fit test performed at least once per year or more frequently as required by law. Site personnel will be trained on the use, limitations, maintenance, inspection, and cleaning of respirators.

3.4 MONITORING PLAN

During sampling activities, the SHSO will monitor the site initially and periodically for potentially hazardous airborne constituents or physical hazards. The SHSO will use a photoionization detector (PID) to detect volatile organic vapors. SOP 90.1 describes the calibration of the PID that the SHSO will conduct daily. The action levels for volatile organic compounds at sustained concentrations in the breathing zone are as follows:

PID Readings	Action
Background plus 5 ppm	Investigate
Five ppm to 25 ppm	Upgrade to Level C (full face air-purifying respirator with organic vapor/acid gas cartridges), and investigate
Greater than 25 ppm	Suspend work, depart area, and investigate
ppm = Parts Per Million	

3.5 EMERGENCY RESPONSE PLAN

Emergency response will follow the protocols set fort in MHSP, Section 10.0. Table 3-2 presents the current emergency telephone numbers applicable to activities performed at RFAAP.

Table 3-2
Emergency Telephone Numbers

Contact	Telephone Number
Emergency Response Services	
Installation Fire Department**	16 (on post)
Installation Security Police**	7325 (on post) (540) 639-7325 (off post)
Installation Safety Department**	7294 (on post) (540) 639-7294 (off post)
Installation Spill Response**	7323, 7324 or 7325 (on post) (540) 639-7323, 7324, or 7325 (off post)
Installation Medical Facility** (RFAAP Hospital)	7323 or 7325 (on post) (540) 639-7323 or 7325 (off post)
Local Police Department	911
New River Valley Medical Center	(540) 731-2000 - General Telephone Number
National Poison Control Center	(800) 222-1222
National Response Center	(800) 424-8802
Regional USEPA Emergency Response	(215) 814-9016
Chemical Manufacturers Association Chemical Referral Center	(800) 262-8200

Directions from the Main Gate:

New River Valley Medical Center
2900 Lamb Circle
Christiansburg, VA 24073

Take Route 114 toward Radford to first traffic light. Take U.S. Route 11 South and go across the bridge over the New River. Turn left after crossing the bridge, continue to Virginia Route 177 South, and turn right. Proceed on VA 177 South and cross over Interstate 81. New River Valley Medical Center is on the left.

** These telephone numbers are referenced from *Safety, Security and Environmental Rules for Contractors and Subcontractors* (ATK 2005).

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U.S. Environmental Protection Agency (USEPA). 2004b. Region III Freshwater BTAG Screening Benchmarks. Biological Technical Assistance Group, 2004.

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APPENDIX A

STANDARD OPERATING PROCEDURES

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Standard Operating Procedures

SOP SERIES	TITLE
10.0	**DOCUMENTATION**
10.1	Field Logbook
10.2	Surface Water, Groundwater, and Soil/Sediment Field Logbooks
10.3	Boring Logs
10.4	Chain-of-Custody Forms
30.0	**SAMPLING**
30.1	Soil Sampling
30.7	Sampling Strategies
50.0	**SAMPLE MANAGEMENT**
50.1	Sample Labels
50.2	Sample Packaging
70.0	**INVESTIGATION-DERIVED MATERIAL**
70.1	Investigation-Derived Material
80.0	**DECONTAMINATION**
80.1	Decontamination
90.0	**AIR MONITORING EQUIPMENT**
90.1	Photoionization Detector (HNu Model PI-101 and HW-101)

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STANDARD OPERATING PROCEDURE 10.1
FIELD LOGBOOK

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for recording daily site investigation activities.

Records should contain sufficient information so that anyone can reconstruct the sampling activity without relying on the collector's memory.

2.0 MATERIALS

- Field Logbook;
- Indelible ink pen; and
- Clear tape.

3.0 PROCEDURE

Information pertinent to site investigations will be recorded in a bound logbook. Each page/form will be consecutively numbered, dated, and signed. All entries will be made in indelible ink, and all corrections will consist of line out deletions that are initialed and dated. If only part of a page is used, the remainder of the page should have an "X" drawn across it. At a minimum, entries in the logbook will include but not be limited to the following:

- Project name (cover);
- Name and affiliation of personnel on site;
- Weather conditions;
- General description of the field activity;
- Sample location;
- Sample identification number;
- Time and date of sample collection;
- Specific sample attributes (e.g., sample collection depth flow conditions or matrix);
- Sampling methodology (grab or composite sample);
- Sample preservation, as applicable;
- Analytical request/methods;
- Associated quality assurance/quality control (QA/QC) samples;
- Field measurements/observations, as applicable; and
- Signature and date of personnel responsible for documentation.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

None.

6.0 REFERENCES

USEPA. 1990. *Sampler's Guide to the Contract Laboratory Program*. EPA/540/P-90/006, Directive 9240.0-06, Office of Emergency and Remedial Response, Washington, DC.

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STANDARD OPERATING PROCEDURE 10.2
SURFACE WATER, GROUNDWATER, AND SOIL/SEDIMENT FIELD LOGBOOKS

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for recording surface water, groundwater, and soil/sediment sampling information, as well as instrument calibration data in field logbooks.

2.0 MATERIAL

- Applicable field logbook (see attached forms); and
- Indelible ink pen.

3.0 PROCEDURE

All information pertinent to surface water, groundwater, or soil/sediment sampling will be recorded in the appropriate logbook. Each page/form of the logbook will be consecutively numbered. All entries will be made with an indelible ink pen. All corrections will consist of line out deletions that are initialed and dated.

3.1 SOIL/SEDIMENT

3.1.1 Field Parameters/Logbook (Form 10.2-a)

1. HIGH CONCENTRATION EXPECTED?: Answer “Yes” or “No.”;
2. HIGH HAZARD?: Answer “Yes” or “No.”;
3. INSTALLATION/SITE: Record the complete name of the installation or site;
4. AREA: Record the area designation of the sample site;
5. INST. NAME: Record the two-letter installation name for Radford Army Ammunition Plant – “RD”;
6. SAMPLE MATRIX CODE: Record the appropriate sample matrix code. Common codes are “SD” for solid - sediment, “SI” for soil - gas, “SL for solid sludge, “SO” for surface other, “SS” for solid – soil, “SW” for surface wipe, “WD” for water – potable, “WG” for water – ground, “WS” water – surface, “WT” – water treated and “WW” water -waste;
7. SITE ID: Record a code up to 20 characters or numbers that is unique to the site;
8. ENV. FIELD SAMPLE IDENTIFIER: Record a code up to 20 characters specific for the sample;
9. DATE: Enter the date the sample was taken;
10. TIME: Enter the time (12-hour or 24-hour clock acceptable as long as internally consistent) the sample was taken;
11. AM PM: Circle “AM” or “PM” to designate morning or afternoon (12-hour clock);
12. SAMPLE PROG: Record “RFI” (RCRA Facility Investigation) or other appropriate sample program;
13. DEPTH (TOP): Record the total depth sampled;
14. DEPTH INTERVAL: Record the intervals at which the plug will be sampled;

15. UNITS: Record the units of depth (feet, meters);
16. SAMPLE MEASUREMENTS: Check the appropriate sampling method;
17. CHK: Check off each container released to a laboratory;
18. ANALYSIS: Record the type of analysis to be performed on each sample container;
19. SAMPLE CONTAINER: Record the sample container type and size;
20. NO.: Record the number of containers;
21. REMARKS: Record any remarks about the sample;
22. TOTAL NUMBER OF CONTAINERS FOR SAMPLE: Record the total number of containers;
23. SITE DESCRIPTION: Describe the location where the sample was collected;
24. SAMPLE FORM: Record the form of the sample (i.e., clay, loam, etc.) using The Unified Soil Classification System (USCS);
25. COLOR: Record the color of the sample as determined from standard Munsell Color Charts;
26. ODOR: Record the odor of the sample or “none”;
27. PID: Record the measured PID values or other similar measurement instrument value;
28. UNUSUAL FEATURES: Record anything unusual about the site or sample;
29. WEATHER/TEMPERATURE: Record the weather and temperature; and
30. SAMPLER: Record your name.

3.1.2 Map File Form (refer to form 10.2-c)

1. SITE ID: Record the Site ID from the field parameter form;
2. POINTER: Record the field sample number for the sample being pointed to;
3. DESCRIPTION/MEASUREMENTS: Describe the location where the sample was taken, along with distances to landmarks;
4. SKETCH/DIMENSIONS: Diagram the surroundings and record the distances to landmarks;
5. MAP REFERENCE: Record which U.S.G.S. Quad Map references the site;
6. COORDINATE DEFINITION: Write the compass directions and the X- and Y-coordinates of the map run;
7. COORDINATE SYSTEM: Write “UTM” (Universal Transverse Mercator);
8. SOURCE: Record the 1-digit code representing the Map Reference;
9. ACCURACY: Give units (e.g., write “1-M” for 1 meter);
10. X-COORDINATE: Record the X-coordinate of the sample site location;
11. Y-COORDINATE: Record the Y-coordinate of the sample site location;
12. UNITS: Record the units used to measure the map sections;
13. ELEVATION REFERENCE: Record whether topography was determined from a map or a topographical survey;
14. ELEVATION SOURCE: Record the 1-digit code representing the elevation reference;

15. ACCURACY: Record the accuracy of the map or survey providing the topographical information;
16. ELEVATION: Record the elevation of the sampling site;
17. UNITS: Write the units in which the elevation is recorded; and
18. SAMPLER: Write your name.

3.2 SURFACE WATER

3.2.1 Field Parameter Logbook (Forms 10.2-b and 10.2-c)

1. CAL REF: Record the calibration reference for the pH meter;
2. pH: Record the pH of the sample;
3. TEMP: Record the temperature of the sample in degrees Celsius;
4. COND: Record the conductivity of the water;
5. Description of site and sample conditions (refer to 10.2-b);
6. Map File Form (refer to Section 3.1.2).

3.3 GROUNDWATER (FORMS 10.2- D)

3.3.1 Field Parameter Logbook (Form 10.2.b)

Refer to Section 3.2.1.

3.3.2 Map File and Purging Forms

1. WELL NO. OR ID: Record the abbreviation appropriate for where the sample was taken. Correct abbreviations can be found on pages 18-21 of the IRDMIS User's Guide for chemical data entry;
2. SAMPLE NO.: Record the reference number of the sample;
3. WELL/SITE DESCRIPTION: Describe the location where the sample was taken, along with distances to landmarks;
4. X-COORD AND Y-COORD: Record the survey coordinates for the sampling site;
5. ELEV: Record the elevation where the sample was taken;
6. UNITS: Record the units the elevation was recorded in;
7. DATE: Record the date in the form MM/DD/YY;
8. TIME: Record the time, including a designation of AM or PM;
9. AIR TEMP.: Record the air temperature, including a designation of C or F (Celsius or Fahrenheit);
10. WELL DEPTH: Record the depth of the well in feet and inches;
11. CASING HEIGHT: Record the height of the casing in feet and inches;
12. WATER DEPTH: Record the depth (underground) of the water in feet and inches;
13. WELL DIAMETER: Record the diameter of the well in inches;
14. WATER COLUMN HEIGHT: Record the height of the water column in feet and inches;
15. SANDPACK DIAM.: Record the diameter of the sandpack. Generally, this will be the same as the bore diameter;

16. EQUIVALENT VOLUME OF STANDING WATER: Use one of the following equations to determine one equivalent volume (EV);

    1 EV = volume in casing + volume in saturated sandpack. Or:

    $1\ EV = [\pi R_w^2 h_w + 0.30p(R_s^2 - R_w^2)h_s] * (0.0043)$

Where:

R_s = radius of sandpack in inches
R_w = radius of well casing in inches
h_s = height of sandpack in inches
h_w = water depth in inches

$0.0043 = gal/in^3$
and filter pack porosity is assumed as 30%, or

Volume in casing =
$(0.0043\ gal/in^3)(p)(12\ in/ft)(R_c^2)(W_h)$

Where:

R_c = radius of casing in inches, and
W_h = water column height in feet

Vol. in sandpack =
(0.0043 gal/in3)(p)(12 in/ft)(Rb2 - Rc2)(Wh)(0.30)

(if Wh is less than the length of the sandpack), or

Vol. in sandpack =
(0.0043 gal/in3)(p)(12 in/ft)(Rb2 - Rc2)(Sh)(0.30)

(if Wh is greater than the length of the sandpack).

where:

Rb = radius of the borehole, and
Sh = length of the sandpack.

Show this calculation in the comments section.

1. PUMP RATE: Record pump rate;
2. TOTAL PUMP TIME: Record total purge time and volume;
3. WELL WENT DRY? Write “YES” or “NO”;
4. PUMP TIME: Record pump time that made the well go dry;
5. VOLUME REMOVED: Record the volume of water (gal) removed before the well went dry;
6. RECOVERY TIME: Record the time required for the well to refill;

7. PURGE AGAIN?: Answer “YES” or “NO”;
8. TOTAL VOL. REMOVED: Record the total volume of water (in gallons) removed from the well;
9. CAL REF.: Record the calibration reference for the pH meter;
10. TIME: Record time started (INITIAL T(0)), 2 times DURING the sampling and the time sampling ended (FINAL);
11. pH: Record the pH at start of sampling (INITIAL), twice DURING the sampling, and at the end of sampling (FINAL);
12. TEMP: Record the water temperature (Celsius) at the start of sampling, twice DURING the sampling, and at the end of sampling (FINAL);
13. COND: Record the conductivity of the water at the start of sampling, twice DURING the sampling, and at the end of sampling (FINAL);
14. D.O.: Record the dissolved oxygen level in the water at the start of sampling, twice DURING the sampling, and at the end of sampling (FINAL);
15. TURBIDITY: Record the readings from the turbidity meter (nephelometer) and units at the start of sampling, twice DURING the sampling, and at the end of sampling (FINAL);
16. ORD: Record the oxidation/reduction (RedOx) potential of the water sample at the start of sampling, twice DURING the sampling, and at the end of sampling (FINAL);
17. HEAD SPACE: Record any positive readings from organic vapor meter reading taken in well headspace before sampling;
18. NAPL: Record the presence and thickness of any non-aqueous phase liquids (LNAPL and DNAPL)
19. COMMENTS: Record any pertinent information not already covered in the form; and
20. SIGNATURE: Sign the form.

3.4 FIELD CALIBRATION FORMS (REFER TO FORM 10.2-E)

1. Record time and date of calibration;
2. Record calibration standard reference number;
3. Record meter ID number;
4. Record initial instrument reading, recalibration reading (if necessary), and final calibration reading on appropriate line;
5. Record value of reference standard (as required);
6. COMMENTS: Record any pertinent information not already covered on form; and
7. SIGNATURE: Sign form.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

None.

6.0 REFERENCE

USEPA. 1991. *User's Guide to the Contract Laboratory Program*. EPA/540/O-91/002, Directive 9240.0-01D, Office of Emergency and Remedial Response, January.

FIELD PARAMETER/LOGBOOK FORM 10.2-a
SOIL AND SEDIMENT SAMPLES

HIGH CONCENTRATION EXPECTED? ____________________ HIGH HAZARD?

INSTALLATION/SITE ____ AREA ____________________

INST NAME ___________ FILE NAME ____

SAMPLE MATRIX CODE _____________ SITE ID ______________________
ENV. FIELD SAMPLE IDENTIFIER ____________________

DATE (MM/DD/YY) __/__/__ TIME ___________ AM PM SAMPLE PROGRAM

DEPTH (TOP) _______ DEPTH INTERVAL _______________ UNIT ______________

SAMPLING METHOD:

SPLIT SPOON ___ AUGER ___ SHELBY TUBE ___ SCOOP ___ OTHER

CHK	ANALYSIS	SAMPLE CONTAINER	NO.	REMARKS

TOTAL NUMBER OF CONTAINERS FOR SAMPLE______

DESCRIPTION OF SITE AND SAMPLE CONDITIONS

SITE DESCRIPTION:____

SAMPLE FORM _______________________ COLOR ________________ ODOR ______________
PID (HNu)______________________ UNUSUAL FEATURES________________________

WEATHER/TEMPERATURE

SAMPLER ____________________

FIELD PARAMETER/LOGBOOK FORM 10.2-b
GROUNDWATER AND SURFACE WATER SAMPLES

HIGH CONCENTRATION EXPECTED? _________________ HIGH HAZARD?

INSTALLATION/SITE _______________________ AREA

INST CODE ___________ FILE NAME ______________________ SITE TYPE

SITE ID ____________________ FIELD SAMPLE NUMBER

DATE (MM/DD/YY) __/__/__ TIME ___________ AM PM SAMPLE PROG.

DEPTH (TOP) __________ DEPTH INTERVAL ____________ UNITS

SAMPLING MEASUREMENTS

CAL REF. _____ pH _____ TEMPERATURE °C _____ CONDUCTIVITY _____ REDOX _____

DISSOLVED OXYGEN ____ TURBIDITY _____ OTHER

CHK	ANALYSIS	SAMPLE CONTAINER	NO.	REMARKS

TOTAL NUMBER OF CONTAINERS FOR SAMPLE______

DESCRIPTION OF SITE AND SAMPLE CONDITIONS

SITE DESCRIPTION____

SAMPLING METHOD____

SAMPLE FORM ___________________ COLOR _________ ODOR ________

PID (HNu)____

UNUSUAL FEATURES_______________________________

WEATHER/TEMPERATURE____ SAMPLER _________________

EXAMPLE MAP FILE LOGBOOK FORM 10.2-c
SURFACE WATER, SOIL, AND SEDIMENT SAMPLES

SITE ID___________________________ POINTER_____________________

DESCRIPTION/MEASUREMENTS____

SKETCH/DIMENSIONS :

MAP REFERENCE____

COORDINATE DEFINITION (X is _________________ Y is ____________)

COORDINATE SYSTEM ________________ SOURCE _________________ ACCURACY____________________

X-COORDINATE ____________ Y-COORDINATE ____________ UNITS__________

ELEVATION REFERENCE____________________________________

ELEVATION SOURCE __________________ ACCURACY _______________ELEVATION___________________

UNITS________________

SAMPLER__________

EXAMPLE MAP FILE AND PURGING LOGBOOK FORM 10.2-d
GROUNDWATER SAMPLES

WELL COORD. OR ID ________________________ SAMPLE NO.______________

WELL/SITE DESCRIPTION____

____

X-COORD. ________ Y-COORD. ________________ ELEV. __________ UNITS

DATE ____/____/____ TIME __________________ AIR TEMP.

WELL DEPTH ______________ FT. ______ IN. CASING HT. _____ FT. _____ IN.

WATER DEPTH _______ FT. ______ IN. WELL DIAMETER _________ IN.

WATER COLUMN HEIGHT ________ FT. ______ IN. SANDPACK DIAM. _____ IN.

EQUIVALENT VOLUME OF STANDING WATER ________________ (GAL) (L)

VOLUME OF BAILER ________ (GAL) (L) or PUMP RATE __________ (GPM) (LPM)

TOTAL NO. OF BAILERS (5 EV) __________ or PUMP TIME _________ MIN.

WELL WENT DRY? [Yes] [No] NUM. OF BAILERS ________ or PUMP TIME

VOL. REMOVED _______________ (GAL) (L) RECOVERY TIME

PURGE AGAIN? [Yes] [No] TOTAL VOL. REMOVED ___________ (GAL) (L)

DATE & TIME	QUANTITY REMOVED	TIME REQ'D	pH	Cond	Temp	ORD	Turb	DO	Character of water (color / clarity / odor / partic.)
(before)									
(during)									
(during)									
(during									
(after)									

COMMENTS____

SIGNATURE____

EXAMPLE FIELD CALIBRATION FORM 10.2-e
FOR pH, CONDUCTIVITY, TEMPERATURE, TURBIDITY,
ORD, AND DISSOLVED OXYGEN METERS

INITIAL CALIBRATION	FINAL CALIBRATION
DATE:	DATE:
TIME:	TIME:

pH METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO:_________________

METER ID____________________

pH STANDARD	INITIAL READING	RECALIB. READING	FINAL READING
7.0			
10.0			
4.0			

CONDUCTIVITY METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO:_________________

METER ID____________________

COND. STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

TEMPERATURE METER CALIBRATION

METER ID____________________

TEMP. STANDARD	INITIAL READING	RECALIB. READING	FINAL READING
ICE WATER			
BOILING WATER			
OTHER _________			

EXAMPLE FIELD CALIBRATION FORM 10.2-e
FOR pH, CONDUCTIVITY, TEMPERATURE, TURBIDITY,
ORD, AND DISSOLVED OXYGEN METERS

TURBIDITY METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO:_________________

METER ID____________________

STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

ORD METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO:_________________

METER ID____________________

STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

DISSOLVED OXYGEN METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO:_________________

METER ID____________________

STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

COMMENTS____

SIGNATURE______________________________________

STANDARD OPERATING PROCEDURE 10.3
BORING LOGS

1.0 INTRODUCTION

The purpose of this standard operating procedure (SOP) is to describe the methods to be followed for classifying soil and rock, as well as preparing borehole logs and other types of soil reports.

2.0 MATERIALS

The following equipment is required for borehole logging:

- HTRW ENG Form 5056-R and 5056A-R boring log forms;
- Daily inspection report forms;
- Chain-of-custody forms;
- Request for analysis forms;
- ASTM D 2488 classification flow chart;
- Soil and/or Rock color chart (i.e., Munsell®);
- Grain size and roundness chart;
- Graph paper;
- Engineer's scale;
- Previous reports and boring logs;
- Pocketknife or putty knife;
- Hand lens;
- Dilute hydrochloric acid (10% volume);
- Gloves;
- Personal protective clothing and equipment, as described in work plan addenda health and safety plan;
- Photoionization detector or other appropriate monitoring equipment per site-specific health and safety plan; and
- Decontamination supplies (SOP 80.1).

3.0 PROCEDURE

Each boring log should fully describe the subsurface environment and the procedures used to obtain this description.

Boring logs should be prepared in the field on USACE Engineer Form 5056-R and 5056-R. Logs should be recorded in the field directly on the boring log form and not transcribed from a field book.

A "site geologist" should conduct borehole logging and soil/rock identification and description or other professional trained in the identification and description of soil/rock.

3.1 BORING LOG INFORMATION

As appropriate, the following information should be recorded on the boring log during the course of drilling and sampling activities:

- Project information including name, location, and project number;
- Each boring and well should be uniquely numbered and located on a sketch map as part of the log;
- Type of exploration;
- Weather conditions including events that could affect subsurface conditions;
- Dates and times for the start and completion of borings, with notations by depth for crew shifts and individual days;
- Depths/heights in feet and in decimal fractions of feet;
- Descriptions of the drilling equipment including rod size, bit type, pump type, rig manufacturer and model, and drilling personnel;
- Drilling sequence and descriptions of casing and method of installation;
- Description and identification of soils in accordance with ASTM Standard D 2488;
- Descriptions of each intact soil sample for the parameters identified in Section 3.2;
- Descriptions and classification of each non-intact sample (e.g., wash samples, cuttings, auger flight samples) to the extent practicable;
- Description and identification of rock;
- Description of rock (core(s)) for the parameters identified in Section 3.7;
- Scaled graphic sketch of the rock core (included or attached to log) according to the requirements identified in Section 3.7;
- Lithologic boundaries, with notations for estimated boundaries;
- Depth of water first encountered in drilling, with the method of first determination (any distinct water level(s) below the first zone will also be noted);
- Interval by depth for each sample taken, classified, and/or retained, with length of sample recovery and sample type and size (diameter and length);
- Blow counts, hammer weight, and length of fall for driven samplers;
- Rate of rock coring and associated rock quality designation (RQD) for intervals cored;
- Drilling fluid pressures, with driller's comments;
- Total depth of drilling and sampling;
- Drilling fluid losses and gains should be recorded;
- Significant color changes in the drilling fluid returned;
- Soil gas or vapor readings with the interval sampled, with information on instrument used and calibration;

- Depth and description of any in-situ test performed; and
- Description of other field tests conducted on soil and rock samples.

3.2 SOIL PARAMETERS FOR LOGGING

In general, the following soil parameters should be included on the boring log when appropriate:

- Identification per ASTM D 2488 with group symbol;
- Secondary components with estimated percentages per ASTM D 2488;
- Color;
- Plasticity per ASTM D 2488;
- Density of non-cohesive soil or consistency of cohesive soil;
- Moisture condition per ASTM D 2488 (dry, moist, or wet);
- Presence of organic material;
- Cementation and HCL reaction testing per ASTM D 2488;
- Coarse-grained particle description per ASTM D 2488 including angularity, shapes, and color;
- Structure per ASTM D 2488 and orientation;
- Odor; and
- Depositional environment and formation, if known.

ASTM D 2488 categorizes soils into 13 basic groups with distinct geologic and engineering properties based on visual-manual identification procedures. The following steps are required to classify a soil sample:

1. Observe basic properties and characteristics of the soil. These include grain size grading and distribution, and influence of moisture on fine-grained soil.
2. Assign the soil an ASTM D 2488 classification and denote it by the standard group name and symbol.
3. Provide a written description to differentiate between soils in the same group if necessary.

Many soils have characteristics that are not clearly associated with a specific soil group. These soils might be near the borderline between groups, based on particle distribution or plasticity characteristics. In such a case, assigning dual group names and symbols (e.g., GW/GC or ML/CL) might be an appropriate method of describing the soil. The two general types of soils, for which classification is performed, coarse- and fine-grained soils, are discussed in the following sections.

3.3 COURSE-GRAINED SOIL IDENTIFICATION

For soils in the coarse-grained soils group, more than half of the material in the soil matrix will be retained by a No. 200 sieve (75-µm).

1. Coarse-grained soils are identified on the basis of the following:
    a) Grain size and distribution;
    b) Quantity of fine-grained material (i.e., silt and clay as a percentage); and

c) Character of fine-grained material.

2. The following symbols are used for classification:

Basic Symbols	Modifying Symbols
G = gravel	W = well graded
S = sand	P = poorly graded
	M = with silty fines
	C = with clayey fines

3. The following basic facts apply to coarse-grained soil classification.

- The basic symbol G is used if the estimated percentage of gravel is greater than that for sand. In contrast, the symbol S is used when the estimated percentage of sand is greater than the percentage of gravel.
- Gravel ranges in size from 3-inch to 1/4-inch (No. 4 sieve) diameter. Sand ranges in size from the No. 4 sieve to No. 200 sieve. The Grain Size Scale used by Engineers (ASTM Standard D 422-63) is the appropriate method to further classify grain size as specified by ASTM D 2488.
- Modifying symbol W indicates good representation of all particle sizes.
- Modifying symbol P indicates that there is an excess or absence of particular sizes.
- The symbol W or P is used only when there are less than 15% fines in a sample.
- Modifying symbol M is used if fines have little or no plasticity (silty).
- Modifying symbol C is used if fines have low to high plasticity (clayey).

Figure 10.03a is a flowchart for identifying coarse-grained soils by ASTM D 2488.

3.4 FINED-GRAINED SOIL IDENTIFICATON

If one-half or more of the material will pass a No. 200 sieve (75 μm), the soil is identified as fine-grained.

1. Fine-grained soils are classified based on dry strength, dilatancy, toughness, and plasticity.
2. Classification of fine-grained soils uses the following symbols:

Basic Symbols	Modifying Symbols
M = silt (non plastic)	L = low liquid limit (lean)
C = clay (plastic)	H = high liquid limit (fat)
O = organic	
Pt = peat	

3. The following basic facts apply to fine-grained soil classification:
   - The basic symbol M is used if the soil is mostly silt, while the symbol C applies if it consists mostly of clay.
4. Use of symbol O (group name OL/OH) indicates that organic matter is present in an amount sufficient to influence soil properties. The symbol Pt indicates soil that consists mostly of organic material.

- Modifying symbols (L and H) are based on the following hand tests conducted on a soil sample:

- — Dry strength (crushing resistance).
- — Dilatancy (reaction to shaking).
- — Toughness (consistency near plastic limit).

- Soil designated ML has little or no plasticity and can be recognized by slight dry strength, quick dilatency, and slight toughness.
- CL indicates soil with slight to medium plasticity, which can be recognized by medium to high dry strength, very slow dilatancy, and medium toughness.

Criteria for describing dry strength per ASTM D 2488 are as follows:

Description	Criteria
None	Dry sample crumbles into powder with pressure of handling
Low	Dry specimen crumbles into powder with some finger pressure
Medium	Dry specimen breaks into pieces or crumbles with considerable finger pressure
High	Dry specimen cannot be broken with finger pressure but will break into pieces between thumb and a hard surface
Very high	Dry specimen cannot be broken between the thumb and a hard surface stiffness

Criteria for describing dilatancy per ASTM D 2488 are as follows:

None	No visible change in the sample
Slow	Water appears slow on the surface of the sample during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly on the surface of the sample during shaking and disappears quickly upon squeezing

Criteria for describing toughness per ASTM D 2488 are as follows:

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit and the thread and lump are weak and soft
Medium	Medium pressure is required to roll the thread to near the plastic limit and the thread and lump have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit and the thread and lump have very high stiffness

Figure 10.03b is a flowchart for identifying fine-grained soils by ASTM D 2488.

3.5 DENSITY AND CONSISTENCY

Relative density for coarse-grained soils and consistency for fine-grained soils can be estimated using standard penetration test blow count data (ASTM D 1586). The number of blows required for each 6 inches of penetration or fraction thereof is recorded. If the sampler is driven less than 18 inches, the number of blows per each complete 6-inch interval and per partial interval is recorded.

For partial increments, the depth of penetration should be recorded to the nearest 1 inch. If the sampler advances below the bottom of the boring under the weight of rods (static) and/or hammer, then this information should be recorded on the log.

The following are some “rule-of-thumb” guidelines for describing the relative density of coarse-grained soils:

Blow Count	Relative Density for Sand
0–4	Very loose
4–10	Loose
10–30	Medium dense
30–50	Dense
>50	Very Dense

The following are some “rule-of-thumb” guidelines for describing the consistency of fine-grained soils:

Blow Count	Consistency for Clays	Description
0–2	Very Soft	Sample sags or slumps under its own weight
2–4	Soft	Sample can be pinched in two between the thumb and forefinger
4–8	Medium Stiff	Sample can be easily imprinted with fingers
8–16	Stiff	Sample can be imprinted only with considerable pressure of fingers
16–32	Very Stiff	Sample can be imprinted very slightly with fingers
>32	Hard	Sample cannot be imprinted with fingers; can be pierced with pencil

3.6 OTHER DESCRIPTIVE INFORMATION

The approximate percentage of gravel, sand, and fines (use a percentage estimation chart) should be recorded per ASTM D 2488 as follows:

Modifiers	Descriptions
Trace	Less than 5%
Few	5%–10%
Little	15%–25%
Some	30%–45%
Mostly	50%–100%

Color/discoloration should be recorded and described using a soil color chart, such as the Munsell® Soil Color Charts. A narrative and numerical description should be given from the color chart, such as Brown 10 YR, 5/3 (Munsell®). Odor should be described if organic or unusual.

Plasticity should be described as follows:

Description	Criteria
Non-plastic	A 1/8-inch thread cannot be rolled at any water content
Low	Thread can barely be rolled and lump cannot be formed when drier than plastic limit.

Medium	Thread is easy to roll; plastic limit can be reached with little effort and lump crumbles when drier than plastic limit.
High	Considerable time is required to reach the plastic limit and lump can be formed without crumbling when drier than plastic limit

Moisture condition should be recorded as dry (absence of moisture), moist (damp but no visible water) or wet (visible free water).

Cementation should be recorded (carbonates or silicates) along with the results of HCL reaction testing. The reaction with HCL should be described as none (no visible reaction), weak (some reaction with slowly forming bubbles) or strong (violent reaction with bubbles forming immediately).

Particle description information for coarse-grained soil should be recorded where appropriate per ASTM D 2488 including maximum particle size, angularity (angular, subangular, subrounded, or rounded), shape (flat, elongated or flat and elongated), and color.

Structure (along with orientation) should be reported using the following ASTM D 2488 descriptions:

Description	Criteria
Stratified	Alternating layers of varying material or color with layers greater than 6 millimeters thick
Laminated	Alternating layers of varying material or color with layers less than 6 millimeters thick
Fissured	Breaks along definite planes of fracture with little resistance
Slickensided	Fracture planes that appear polished or glossy, can be striated
Blocky	Inclusion of small pockets of different soils
Homogeneous	Same color and appearance throughout

3.7 ROCK CORE PARAMETERS FOR LOGGING

In general, the following parameters should be included on the boring log when rock coring is conducted:

- Rock type;
- Formation;
- Modifier denoting variety;
- Bedding/banding characteristics;
- Color;
- Hardness;
- Degree of cementation;
- Texture;
- Structure and orientation;
- Degree of weathering;
- Solution or void conditions;
- Primary and secondary permeability including estimates and rationale; and
- Lost core interval and reason for loss.

A scaled graphic sketch of the core should provided on or attached to the log, denoting by depth, location, orientation, and nature (natural, coring-induced, or for fitting into core box) of all core breaks. Where fractures are too numerous to be shown individually, their location may be drawn as a zone.

The RQD values for each core interval (run) should be calculated and included on the boring log. The method of calculating the RQD is as follows per ASTM D 6032:

RQD = [Σ length of intact core pieces > 100 mm (4-inches)] x 100%/total core length.

3.8 PROCEDURES FOR ROCK CLASSIFICATION

For rock classification record mineralogy, texture, and structural features (e.g., biotite and quartz fine grains, foliated parallel to relict bedding oriented 15 to 20 degrees to core axis, joints coated with iron oxide). Describe the physical characteristics of the rock that are important for engineering considerations such as fracturing (including minimum, maximum, and most common and degree of spacing), hardness, and weathering.

1. The following is to be used as a guide for assessing fracturing:

AEG Fracturing	Spacing
Crushed	up to 0.1 foot
Intense	0.1–0.5 foot
Moderate	0.5 foot–10 feet
Slight	1.0 foot–3.0 feet
Massive	>3.0 feet

2. Record hardness using the following guidelines:

Hardness	Criteria
Soft	Reserved for plastic material
Friable	Easily crumbled by finger pressure
Low	Deeply gouged or carved with pocketknife
Moderate	Readily scratched with knife; scratch leaves heavy trace of dust
Hard	Difficult to scratch with knife; scratch produces little powder and is often faintly visible
Very Hard	Cannot be scratched with knife

3. Describe weathering using the following guidelines:

Weathering	Decomposition	Discoloration	Fracture Condition
Deep	Moderate to complete alteration of minerals feldspars altered to clay, etc.	Deep and thorough	All fractures extensively coated with oxides, carbonates, or clay
Moderate	Slight alteration of minerals, cleavage	Moderate or localized and	Thin coatings or stains

	surface lusterless and stained	intense	
Weak	No megascopic alteration of minerals	Slight and intermittent and localized	Few strains on fracture surfaces
Fresh	Unaltered, cleavage, surface glistening		

3.9 PROCEDURE FOR LOGGING REFUSE

The following procedure applies to the logging of subsurface samples composed of various materials in addition to soil as may be collected from a landfill or other waste disposal site.

1. Observe refuse as it is brought up by the hollow stem auger, bucket auger, or backhoe.

2. If necessary, place the refuse in a plastic bag to examine the sample.

3. Record observations according to the following criteria:

   - Composition (by relative volume), e.g., paper, wood, plastic, cloth, cement, or construction debris. Use such terms as “mostly” or “at least half.” Do not use percentages;
   - Moisture condition: dry, moist, or wet;
   - State of decomposition: highly decomposed, moderately decomposed, slightly decomposed, etc.;
   - Color: obvious mottling and/or degree of mottling;
   - Texture: spongy, plastic (cohesive), friable;
   - Odor;
   - Combustible gas readings (measure down hole and at surface); and
   - Miscellaneous: dates of periodicals and newspapers, ability to read printed materials, degree of drilling effort (easy, difficult, and very difficult).

3.10 SUBMITTAL REQUIREMENTS

Each original boring log should be submitted to the Contracting Officer Representative (CRO) after completion of the boring. When a monitoring well will be installed in a boring, the boring log and well installation diagram should be submitted together.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

Not applicable.

6.0 REFERENCES

ASTM Standard D 422-63 (2002)e1. 2002. *Standard Test Method for Particle-Size Analysis of Soils.*

ASTM Standard D 1586–99 (1999). 1999. *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.*

ASTM Standard D 2488-06. 2006. *Standard Practice for Description and Identification of Soils Visual-Manual Procedure).*

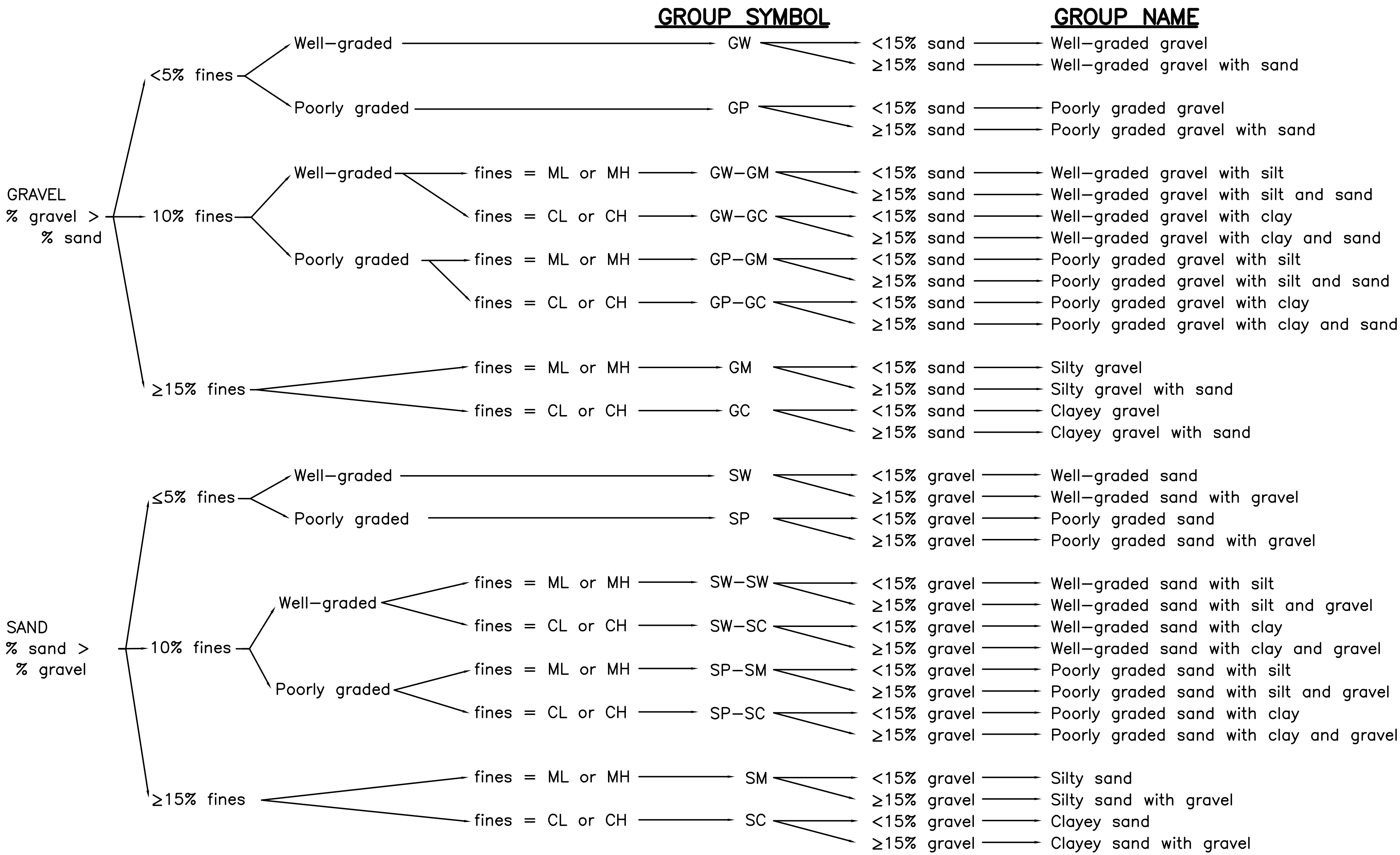
ASTM Standard D 5434-03. 2003. *Guide for Field Logging of Subsurface Explorations of Soil and Rock.*

ASTM Standard D 6032-02 (2006). 2006. *Standard Test Method for Determining Rock Quality Designation (RQD) of Rock Core.*

Compton, R. R. 1962. *Manual of Field Geology*. John Wiley & Sons, Inc., New York.

USACE. 1998. *Monitoring Well Design, Installation, and Documentation at Hazardous, Toxic, and Radioactive Waste Sites.* EM 1110-1-4000, 1, November.

U.S. Department of the Interior. 1989. *Earth Manual*. Water and Power Resources Service, Washington, DC.



NOTE: PERCENTAGES ARE BASED ON ESTIMATING AMOUNTS OF FINES, SAND, AND GRAVEL TO THE NEAREST 5%.

SOURCE: ASTM D 2488

Radford Army Ammuntion Plant		FIGURE 10.03a
Date: October 2007	**Prepared By:** DBC/TLD	**FLOW CHART FOR IDENTIFYING COARSE-GRAINED SOILS**
Scale: N.T.S.	**File Name:** SOP Figure 10.03a_Coarse	

GROUP SYMBOL				GROUP NAME
CL	<30% plus No. 200	<15% plus No. 200		Lean clay
		15 – 25% plus No. 200	% sand ≥ % gravel	Lean clay with sand
			% sand < % gravel	Lean clay with gravel
	≥30% plus No. 200	% sand ≥ % of gravel	<15% gravel	Sandy lean clay
			≥15% gravel	Sandy lean clay with gravel
		% sand < % of gravel	<15% sand	Gravelly lean clay
			≥15% sand	Gravelly lean clay with sand
ML	<30% plus No. 200	<15% plus No. 200		Silt
		15 – 25% plus No. 200	% sand ≥ % gravel	Silt with sand
			% sand < % gravel	Silt with gravel
	≥30% plus No. 200	% sand ≥ % of gravel	< 15% gravel	Sandy silt
			≥ 15% gravel	Sandy silt with gravel
		% sand < % of gravel	< 15% sand	Gravelly silt
			≥ 15% sand	Gravelly silt with sand
CH	<30% plus No. 200	<15% plus No. 200		Fat clay
		15 – 25% plus No. 200	% sand ≥ % gravel	Fat clay with sand
			% sand < % gravel	Fat clay with gravel
	≥30% plus No. 200	% sand ≥ % of gravel	<15% gravel	Sandy fat clay
			≥15% gravel	Sandy fat clay with gravel
		% sand < % of gravel	<15% sand	Gravelly fat clay
			≥15% sand	Gravelly fat clay with sand
MH	<30% plus No. 200	<15% plus No. 200		Elastic silt
		15 – 25% plus No. 200	% sand ≥ % gravel	Elastic silt with sand
			% sand < % gravel	Elastic silt with gravel
	≥30% plus No. 200	% sand ≥ % of gravel	<15% gravel	Sandy elastic silt
			≥15% gravel	Sandy elastic silt with gravel
		% sand < % of gravel	<15% sand	Gravelly elastic silt
			≥15% sand	Gravelly elastic silt with sand
OL/OH	<30% plus No. 200	<15% plus No. 200		Organic soil
		15 – 25% plus No. 200	% sand ≥ % gravel	Organic soil with sand
			% sand < % gravel	Organic soil with gravel
	≥30% plus No. 200	% sand ≥ % of gravel	<15% gravel	Sandy organic soil
			≥15% gravel	Sandy organic soil with gravel
		% sand < % of gravel	<15% sand	Gravelly organic soil
			≥15% sand	Gravelly organic soil with sand

NOTE: PERCENTAGES ARE BASED ON ESTIMATING AMOUNTS OF FINES, SAND, AND GRAVEL TO THE NEAREST 5%.

SOURCE: ASTM D 2488

Radford Army Ammuntion Plant

Date: October 2007	Prepared By: DBC/TLD
Scale: N.T.S.	File Name: SOP Figure 10.03b_Fine

FIGURE 10.03b

FLOW CHART FOR IDENTIFYING FINE-GRAINED SOILS

STANDARD OPERATING PROCEDURE 10.4
CHAIN-OF-CUSTODY FORM

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for use of the chain-of-custody form. An example is provided as part of this SOP. Other formats with similar levels of detail are acceptable.

2.0 MATERIALS

- Chain-of-custody form; and
- Indelible ink pen.

3.0 PROCEDURE

1. Record the project name and number.
2. Record the project contact's name and phone number.
3. Print sampler's names in "Samplers" block.
4. Enter the Field Sample No.
5. Record the sampling dates for all samples.
6. List the sampling times (military format) for all samples.
7. Indicate, "grab" or "composite" sample with an "X."
8. Record matrix (e.g., aqueous, soil).
9. List the analyses/container volume across top.
10. Enter the total number of containers per Field Sample No. in the "Subtotal" column.
11. Enter total number of containers submitted per analysis requested.
12. State the carrier service and airbill number, analytical laboratory, and custody seal numbers.
13. List any comments or special requests in the "Remarks" section.
14. Sign, date, and time the "Relinquished By" section when the cooler is relinquished to the next party.
15. Upon completion of the form, retain the shipper copy and place the forms and the other copies in a zip seal bag to protect from moisture. Affix the zip seal bag to the inside lid of the sample cooler to be sent to the designated laboratory.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

None.

6.0 REFERENCES

USEPA. 1990. *Sampler's Guide to the Contract Laboratory Program.* EPA/540/P-90/006, Directive 9240.0-06, Office of Emergency and Remedial Response, Washington, DC, December 1990.

USEPA. 1991. *User's Guide to the Contract Laboratory Program..* EPA/540/O-91/002, Directive 9240.0-01D, Office of Emergency and Remedial Response, January 1991.

USEPA. 1998. *EPA Requirements for Quality Assurance Project Plans.* EPA/600/R-98/018, QA/R5, Final, Office of Research and Development, Washington, D.C.

FIGURE 10.4-a
EXAMPLE CHAIN-OF-CUSTODY FORM

Project Number	Project Name				Matrix	A N A L Y S E S									LAB :
Project Contact (Name and Phone Number)															AIRBILL No:
Samplers:															Courier:
Field Sample No.	Date (MM-DD-YY)	Time	Comp	Grab										Subtotal	REMARKS
TOTAL															

Relinquished by:	Date/time	Received by:	Relinquished by:	Date/Time	Received by:
Relinquished by:	Date/time	Received by: (for lab)	Date/Time	Remarks	

STANDARD OPERATING PROCEDURE 30.1
SOIL SAMPLING

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for sampling surface and subsurface soils.

2.0 MATERIALS

- Stainless steel scoop, spoon, trowel, knife, spatula, (as needed);
- Split-spoon, Shelby tube, or core barrel sampler;
- Hand auger or push tube sampler;
- Drill rig and associated equipment (subsurface soil);
- Stainless steel bowls;
- Photoionization detector or other appropriate instrument as specified in site-specific health and safety plan;
- Sampling equipment for collection of volatile organic samples;
- Appropriate sample containers;
- Appropriate sample labels and packaging material.;
- Personal protective equipment and clothing (PPE) per site-specific health and safety plan; and
- Decontamination equipment and supplies (SOP 80.1).

3.0 PROCEDURE

3.1 DOCUMENTATION

Soil sampling information should be recorded in the field logbooks as described in SOPs 10.1 and 10.2.

3.2 SURFICIAL SOIL SAMPLES

The targeted depths for surficial soil samples (surface and near surface) will be specified in the work plan addenda developed for site-specific investigations.

1. All monitoring equipment should be appropriately calibrated before beginning sampling according to the requirements of the work plan addenda and SOP 90.1 or 90.2.
2. All sampling equipment should be appropriately decontaminated before and after use according to the requirements of the work plan addendum and SOP 80.1.
3. Use a spade, shovel, or trowel or other equipment (manufactured from material, which is compatible with the soil to be sampled) to remove any overburden material present (including vegetative mat) to the level specified for sampling.
4. Measure and record the depth at which the sample will be collected with an engineers scale or tape.

5. Remove the thin layer that was in contact with the overburden removal equipment using a clean stainless steel scoop or equivalent and discard it.
6. Begin sampling with the acquisition of any discrete sample(s) for analysis of volatile organic compounds (VOCs), with as little disturbance as possible. VOC samples will not be composited or homogenized.
7. When a sample will not be collected with a core type of sampler (push tube, split spoon, etc.), the sample for VOC analysis will be collected from freshly exposed soil. The method of collection will follow the procedures specified in SOP 30.8 (Methanol Preservation Method) or 30.9 (En Core® Method) based on the requirements of the work plan addenda.
8. Field screen the sample with properly calibrated photoionization detector (PID) or other appropriate instrument. Cut a cross-sectional slice from the core or center of the sample and insert the monitoring instrument(s). Based on the screening results, collect the VOC fraction, as applicable.
9. Collect a suitable volume of sample from the targeted depth with a clean stainless steel scoop (or similar equipment), push tube sampler, or bucket auger
10. For core type of samplers, rough trimming of the sampling location surface should be considered if the sampling surface is not fresh or other waste, different soil strata, or vegetation may contaminate it. Surface layers can be removed using a clean stainless steel, spatula, scoop, or knife. Samples collected with a bucket auger or core type of sampler should be logged per the requirements of SOP 10.3.
11. If homogenization or compositing of the sampling location is not appropriate for the remaining parameters, the sample should be directly placed into appropriate sample containers with a stainless steel spoon or equivalent.
12. If homogenization of the sample location is appropriate or compositing of different locations is desired, transfer the sample to a stainless steel bowl for mixing. The sample should be thoroughly mixed with a clean stainless steel spoon, scoop, trowel, or spatula and then placed in appropriate sample containers per the requirements for containers and preservation specified in work plan addenda. Secure the cap of each container tightly.
13. Appropriately, label the samples (SOP 50.1), complete the chain-of-custody (SOP 10.4), and package the samples for shipping (SOP 50.2).
14. Return any remaining unused soil to the original sample location. If necessary, add clean sand to bring the subsampling areas back to original grade. Replace the vegetative mat over the disturbed areas.

3.3 SUBSURFACE SAMPLES

All sampling equipment should be appropriately decontaminated before and after use according to the requirements of the work plan addendum and SOP 80.1.

1. All monitoring equipment should be appropriately calibrated before sampling according to the requirement of the work plan addendum and SOP 90.1 or SOP 90.2.
2. All sampling equipment should be appropriately decontaminated before and after use according to the requirements of the work plan addendum and SOP 80.1.
3. Collect split-spoon; core barrel, Shelby tube, sonic core or other similar samples during drilling.
4. Upon opening sampler or extruding sample, immediately screen soil for VOCs using a PID or appropriate instrument. If sampling for VOCs, determine the area of highest concentration; use a

stainless steel knife, trowel, or lab spatula to cut the sample; and screen for VOCs with monitoring instrument(s).

5. Log the sample on the boring log before extracting from the sampler per the requirements of SOP 10.3.
6. Any required VOC samples will be collected first followed by the other parameters. VOC samples will not be composited or homogenized and will be collected from the area exhibiting the highest screening level. The method of VOC sample collection will follow the procedures specified in SOP 30.8 (Methanol Preservation Method) or 30.9 (En Core® Method) based on the requirements of the work plan addenda.
7. Field screen the sample with properly calibrated photoionization detector (PID) or other appropriate instrument. Cut a cross-sectional slice from the core or center of the sample and insert the monitoring instrument(s). Based on the screening results, collect the VOC fraction, as applicable.
8. Rough trimming of the sampling location surface should be considered if the sampling surface is not fresh or other waste, different soil strata, or vegetation may contaminate it. Surface layers can be removed using a clean stainless steel, spatula, scoop, or knife.
9. If homogenization or compositing of the sampling location is not appropriate for other parameters, the sample should be directly placed into appropriate sample containers with a stainless steel spoon or equivalent.
10. If homogenization of the sample location is appropriate or compositing of different locations is desired, transfer the sample to a stainless steel bowl for mixing. The sample should be thoroughly mixed with a clean stainless steel spoon, scoop, trowel, or spatula and placed in appropriate sample containers per the requirements for containers and preservation specified in work plan addenda. Secure the cap of each container tightly.
15. Appropriately, label the samples (SOP 50.1), complete the chain-of-custody (SOP 10.4), and package the samples for shipping (SOP 50.2).
16. Discard any remaining sample into the drums used for collection of cuttings.
17. Abandon borings according to procedures outlined in SOP 20.2.

3.4 INVESTIGATION-DERIVED MATERIAL

Investigation-derived material will be managed in accordance with procedures defined in the work plan addenda for the site being investigated and SOP 70.1.

NOTES: If sample recoveries are poor, it may be necessary to composite samples before placing them in jars. In this case, the procedure will be the same except that two split-spoon samples (or other types of samples) will be mixed together. The boring log should clearly state that the samples have been composited, which samples were composited, and why the compositing was done. In addition, VOC fraction should be collected from the first sampling device.

When specified, samples taken for geotechnical analysis (e.g., percent moisture, density, porosity, and grain size) will be undisturbed samples, such as those collected using a thin-walled (Shelby tube) sampler, sonic core sampler, etc.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

Refer to the site-specific health and safety plan.

Soil samples will not include vegetative matter, rocks, or pebbles unless the latter are part of the overall soil matrix.

6.0 REFERENCES

ASTM Standard D 1586-99. 1999. *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.*

ASTM Standard D 1587-00 (2007) e1. 2007. *Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes.*

ASTM Standard D 5633-04. 2004. *Standard Practice for Sampling with a Scoop.*

USACE. 2001. *Requirements for the Preparation of Sampling and Analysis Plans.* EM 200-1-3. 1 February.

STANDARD OPERATING PROCEDURE 30.7
SAMPLING STRATEGIES

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate sampling strategies for sampling various media.

2.0 MATERIALS

- Historical site data;
- Site topography;
- Soil types; and
- Sampled media.

3.0 PROCEDURE

The primary goal of any investigation is to collect samples representative of existing site conditions. Statistics are generally used to ensure samples are as representative as possible. Sampling plans may employ more than one approach to ensure project data quality objectives are adequately addressed. A comparison of sampling strategies is presented in Table 1.

3.1 CLASSICAL STATISTICAL SAMPLING

Classical statistical sampling strategies are appropriately applied to either sites where the source of contamination is known or small sites where the entire area is remediated as one unit. Primary limitations of this sampling approach include (1) inability to address media variability; (2) inadequate characterization of heterogenous sites; and (3) inadequate characterization of sites with unknown contamination characteristics.

3.1.1 Simple Random Sampling

Simple random sampling is generally more costly than other approaches because of the number of samples required for site characterization. This approach is generally used when minimal site information is available and visible signs of contamination are not evident and includes the following features:

- Sampling locations are chosen using random chance probabilities.
- This strategy is most effective when the number of sampling points is large.

3.1.2 Stratified Random Sampling

This sampling approach is a modification to simple random sampling. This approach is suited for large site investigations that encompass a variety of soil types, topographic features, and/or land uses. By dividing the site into homogenous sampling strata based on background and historical data, individual random sampling techniques are applied across the site. Data acquired from each stratum can be used to determine the mean or total contaminant levels and provide these advantages:

- Increased sampling precision results due to sample point grouping and application of random sampling approach.
- Control of variances associated with contamination, location, and topography.

3.1.3 Systematic Grid

The most common statistical sampling strategy is termed either systematic grid or systematic random sampling. This approach is used when a large site must be sampled to characterize the nature and extent of contamination.

Samples are collected at predetermined intervals within a grid pattern according to the following approach:

- Select the first sampling point randomly; remaining sampling points are positioned systematically from the first point.
- Determine the grid design: one or two-dimensional. One-dimensional sample grids may be used for sampling along simple man-made features. Two-dimensional grid systems are ideal for most soil applications.
- Determine the grid type: square or triangular. Sampling is usually performed at each grid-line intersection. Other strategies include sampling within a grid center or obtaining composite samples within a grid.
- Each stratum is sampled based on using the simple random sampling approach but determined using a systematic approach.

3.1.4 Hot-Spot Sampling

Hot spots are small, localized areas of media characterized by high contaminant concentrations. Hot-spot detection is generally performed using a statistical sampling grid. The following factors should be addressed:

- Grid spacing and geometry. The efficiency of hot-spot searches is improved by using a triangular grid. An inverse relationship exists between detection and grid point spacing, e.g., the probability of hot-spot detection is increased as the spacing between grid points is decreased.
- Hot-spot shape/size. The larger the hot spot, the higher the probability of detection. Narrow or semi-circular patterns located between grid sampling locations may not be detected.
- False-negative probability. Estimate the false negative (β-error) associated with hot-spot analysis.

3.1.5 Geostatistical Approach

Geostatistics describe regional variability in sampling and analysis by identifying ranges of correlation or zones of influence. The general two-stage approach includes the following:

- Conducting a sampling survey to collect data defining representative sampling areas.
- Defining the shape, size, and orientation of the systematic grid used in the final sampling event.

3.2 NON-STATISTICAL SAMPLING

3.2.1 Biased Sampling

Specific, known sources of site contamination may be evaluated using biased sampling. Locations are chosen based on existing information.

3.2.2 Judgmental Sampling

This sampling approach entails the subjective selection of sampling locations that appear to be representative of average conditions. Because this method is highly biased, it is suggested that a measure of precision be included through the collection of multiple samples.

4.0 MAINTENANCE

Not applicable.

5.0 REFERENCES

Gilbert, R.O. 1987. *Statistical Methods for Environmental Pollution Monitoring.* John Wiley & Sons, Inc. 320 p.

USACE. 2001. *Requirements for the Preparation of Sampling and Analysis Plans.* EM200-1-3. 1 February.

TABLE 1
SAMPLING STRATEGIES

SAMPLING STRATEGY	DESCRIPTION	APPLICATION	LIMITATIONS
Classical Statistical Sampling Strategies			
Simple Random Sampling	Representative sampling locations are chosen using the theory of random chance probabilities.	Sites where background information is not available and no visible signs of contamination are present.	May not be cost-effective because samples may be located too close together. Does not take into account spatial variability of media.
Stratified Random Sampling	Site is divided into several sampling areas (strata) based on background or site survey information.	Large sites characterized by a number of soil types, topographic features, past/present uses, or manufacturing storage areas.	Often more cost-effective than random sampling. More difficult to implement in the field and analyze results. Does not take into account spatial variability of media.
Systematic Grid Sampling	Most common statistical strategy; involves collecting samples at predetermined, regular intervals within a grid pattern.	Best strategy for minimizing bias and providing complete site coverage. Can be used effectively at sites where no background information exists. Ensures that samples will not be taken too close together.	Does not take into account spatial variability of media.
Hot-Spot Sampling	Systematic grid sampling strategy tailored to search for hot spots.	Sites where background information or site survey data indicate that hot spots may exist.	Does not take into account spatial variability of media. Tradeoffs between number of samples, chance of missing a hot spot, and hot spot size/shape must be weighed carefully.
Geostatistical Approach	Representative sampling locations are chosen based on spatial variability of media. Resulting data are analyzed using kriging, which creates contour maps of the contaminant concentrations and the precision of concentration estimates.	More appropriate than other statistical sampling strategies because it takes into account spatial variability of media. Especially applicable to sites where presence of contamination is unknown.	Previous investigation data must be available and such data must be shown to have a spatial relationship.
Non-Statistical Sampling Strategies			
Biased Sampling	Sampling locations are chosen based on available information.	Sites with known contamination sources.	Contaminated areas can be overlooked if background information or visual signs of contamination do not indicate them. Best used if combined with a statistical approach, depending on the project objectives.
Judgmental Sampling	An individual subjectively selects sampling locations that appear to be representative of average conditions.	Homogenous, well-defined sites.	Not usually recommended due to bias imposed by individual, especially for final investigations.

STANDARD OPERATING PROCEDURE 50.1
SAMPLE LABELS

1.0 SCOPE AND APPLICATION

Every sample will have a sample label uniquely identifying the sampling point and analysis parameters. The purpose of this standard operating procedure (SOP) is to delineate protocols for the use of sample labels. An example label is included as Figure 50.1-A. Other formats with similar levels of detail are acceptable.

2.0 MATERIALS

- Sample label; and
- Indelible marker.

3.0 PROCEDURE

The use of preprinted sample labels is encouraged and should be requested from the analytical support laboratory during planning activities.
As each sample is collected, fill out a sample label ensuring the following information has been collected:

- Project name;
- Sample ID: enter the SWMU number and other pertinent information concerning where the sample was taken. This information should be included in site-specific work plan addenda;
- Date of sample collection;
- Time of sample collection;
- Initials of sampler(s);
- Analyses to be performed (NOTE: Due to number of analytes, details of analysis should be arranged with lab *a priori*); and
- Preservatives (water samples only).

Double-check the label information to make sure it is correct. Detach the label, remove the backing and apply the label to the sample container. Cover the label with clear tape, ensuring that the tape completely encircles the container.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

None.

6.0 REFERENCES

USEPA. 2001 (Reissued May 2006). *EPA Requirements for Quality Assurance Project Plans.* EPA/240/B-01/003, QA/R5, Final, Office of Research and Development, Washington, D.C. March 2001.

FIGURE 50.1-A
SAMPLE LABEL

PROJECT NAME ___________________________

SAMPLE ID ____________________________

DATE: ____/____/____ TIME: _____:_____

ANALYTES: VOC SVOC P/P METALS CN

PAH D/F HERBs ANIONS TPH

ALK TSS

PRESERVATIVE: [HCl] [HNO_3] [NaOH] [H_2SO_4]

SAMPLER: _____________________

STANDARD OPERATING PROCEDURE 50.2
SAMPLE PACKAGING

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for the packing and shipping of samples to the laboratory for analysis.

2.0 MATERIALS

- Waterproof coolers (hard plastic or metal);
- Metal cans with friction-seal lids (e.g., paint cans);
- Chain-of-custody forms;
- Chain-of-custody seals (optional);
- Packing material;
- Sample documentation;
- Ice;
- Plastic garbage bags;
- Clear Tape;
- Zip-top plastic bags; and
- Temperature blanks provided by laboratory for each shipment.

3.0 PROCEDURE

1. Check cap tightness and verify that clear tape covers label and encircles container.
2. Wrap sample container in bubble wrap or closed cell foam sheets. Samples may be enclosed in a secondary container consisting of a clear zip-top plastic bag. Sample containers must be positioned upright and in such a manner that they will not touch during shipment.
3. Place several layers of bubble wrap, or at least 1 in. of vermiculite on the bottom of the cooler. Line cooler with open garbage bag, place all the samples upright inside the garbage bag and tie.
4. Double bag and seal loose ice to prevent melting ice from soaking the packing material. Place the ice outside the garbage bags containing the samples.
5. Pack shipping containers with packing material (closed-cell foam, vermiculite, or bubble wrap). Place this packing material around the sample bottles or metal cans to avoid breakage during shipment.
6. A temperature blank (provided by laboratory) will be included in each shipping container to monitor the internal temperature. Samples should be cooled to 4 degrees C on ice immediately after sampling.
7. Enclose all sample documentation (i.e., Field Parameter Forms, Chain-of-Custody forms) in a waterproof plastic bag and tape the bag to the underside of the cooler lid. If more than one cooler is

being used, each cooler will have its own documentation. Add the total number of shipping containers included in each shipment on the chain-of-custody form.

8. Seal the coolers with signed and dated custody seals so that if the cooler were opened, the custody seal would be broken. Place clear tape over the custody seal to prevent damage to the seal.
9. Tape the cooler shut with packing tape over the hinges and place tape over the cooler drain.
10. Ship all samples via overnight delivery on the same day they are collected if possible.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

5.1 PERMISSIBLE PACKAGING MATERIALS

- Non-absorbent
  - Bubble wrap; and
  - Closed cell foam packing sheets.
- Absorbent
  - Vermiculite.

5.2 NON-PERMISSIBLE PACKAGING MATERIALS

- Paper;
- Wood shavings (excelsior); and
- Cornstarch "peanuts".

6.0 REFERENCES

USEPA. 1990. *Sampler's Guide to the Contract Laboratory Program.* EPA/540/P-90/006, Directive 9240.0-06, Office of Emergency and Remedial Response, Washington, D.C., December 1990.

USEPA. 1991. *User's Guide to the Contract Laboratory Program.* EPA/540/O-91/002, Directive 9240.0-01D, Office of Emergency and Remedial Response. January 1991.

USEPA. 2001 (Reissued May 2006). *EPA Requirements for Quality Assurance Project Plans.* EPA/240/B-01/003, QA/R5, Final, Office of Research and Development, Washington, D.C. March 2001

STANDARD OPERATING PROCEDURE 70.1
INVESTIGATION-DERIVED MATERIAL

1.0 SCOPE AND APPLICATION

Management of investigation-derived material (IDM) minimizes the potential for the spread of waste material onsite or offsite through investigation activities. The purpose of this standard operating procedure (SOP) is to provide general guidelines for appropriate management of potentially contaminated materials derived from the field investigations. Specific procedures related to the transportation and disposal of hazardous waste are beyond the scope of this SOP.

2.0 INTRODUCTION

Investigation derived material (IDM) consists of waste materials that are known or suspected to be contaminated with waste substances through the actions of sample collection or personnel and equipment decontamination. These materials include decontamination solutions, disposable equipment, drill cuttings and fluids, and water from groundwater monitoring well development and purging. To the extent possible, the site manager will attempt to minimize the generation of these materials through careful design of decontamination schemes and groundwater sampling programs. Testing conducted on soil and water investigation-derived material will show if they are also hazardous wastes as defined by RCRA. This will determine the proper handling and ultimate disposal requirements.

The criteria for designating a substance as hazardous waste according to RCRA is provided in 40 CFR 261.3. If IDM meet these criteria, RCRA requirements will be followed for packaging, labeling, transporting, storing, and record keeping as described in 40 CFR 262.34. Those materials that are judged potentially to meet the criteria for a regulated solid or hazardous waste will be placed in DOT-approved 55-gallon steel drums or another type of DOT approved container; based on waste characteristics and volume.

Investigation-derived material will be appropriately placed in containers, labeled, and tested to determine disposal options in accordance with RCRA regulations and Virginia Hazardous Waste Management Regulations.

3.0 INVESTIGATION-DERIVED MATERIAL MANAGEMENT

Procedures that minimize potential for the spread of waste material include minimizing the volume of material generated, material segregation, appropriate storage, and disposal according to RCRA requirements.

3.1 WASTE MINIMIZATION

In the development of work plan addenda, each aspect of the investigation will be reviewed to identify areas where excess waste generation can be eliminated. General procedures that will eliminate waste include avoidance of unnecessary exposure of materials to hazardous material and coordination of sampling schedules to avoid repetitious purging of wells and use of sampling equipment.

3.2 WASTE SEGREGATION

Waste accumulation and management procedures to be used depend upon the type of material generated. For this reason, IDM described below are segregated into separate 55-gallon storage drums or other appropriate DOT containers. Waste materials that are known to be free of potential hazardous waste contamination (such as broken sample bottles or equipment containers and wrappings) must be collected separately for disposal to municipal systems. Large plastic garbage or “lawn and leaf” bags are useful for collecting this trash. Even “clean” sample bottles or Tyvek should be disposed of with care. Although they are not legally a problem, if they are discovered by the public they may cause concern. Therefore, items that are known to be free from contamination but are also known to represent "hazardous or toxic waste" to the public must not be disposed of in any public trash receptacle, such as found at your hotel or park.

3.2.1 Decontamination Solutions

Solutions considered investigation-derived materials range from detergents, organic solvents, and acids used to decontaminate small hand samplers to steam-cleaning rinsate used to wash drill rigs and other large equipment. These solutions are to be placed in 55-gallon drums with bolt-sealed lids or other appropriate DOT approved containers. Residual liquid IDM from decontamination pads will be removed and appropriately placed in container(s) at the end of each field day.

3.2.2 Soil Cuttings and Drilling Muds

Soil cuttings are solid to semi-solid soils generated during trenching activities or drilling for the collection of subsurface soil samples or the installation of monitoring wells. Depending on the type of drilling, drilling fluids known as "muds" may be used to remove soil cuttings. Drilling fluids flushed from the borehole must be directed into a settling section of a mud pit. This allows reuse of the decanted fluids after removal of the settled sediments. Drill cuttings, whether generated with or without drilling fluids, are to be removed with a flat-bottomed shovel and placed in 55-gallon drums with bolt-sealed lids or other appropriate DOT containers, as conditions or volume of IDM dictate.

3.2.3 Well Development and Purge Water

Well development and purge water is removed from monitoring wells to repair damage to the aquifer following well installation, obtain characteristic aquifer groundwater samples, or measure aquifer hydraulic properties. The volume of groundwater to be generated will determine the appropriate container to be used for accumulation of IDM.

For well development and purging, 55-gallon drums are typically an efficient container for accumulation. When larger volumes of water are removed from wells, such as when pumping tests are conducted, the use of large-volume portable tanks such as "Baker Tanks" should be considered for IDM accumulation.

Analytical data for groundwater samples associated with the well development and purge water will be used to assist in characterizing IDM and evaluating disposal options.

3.2.4 Personal Protective Equipment and Disposable Sampling Equipment

Personal protective equipment and clothing (PPE) may include such items as Tyvek coveralls, gloves, booties, and APR cartridges. Disposable sampling equipment may include such items as plastic sheeting, bailers, disposable filters, disposable tubing and paper towels. PPE and disposable sampling equipment that have or may have contacted contaminated media (soil, water, etc.) will be segregated and placed in 55-gallon drums separate from soil and water IDM. Disposition of this type of IDM will be determined by the results of IDM testing of the media in which the PPE and sampling equipment contacted.

3.3 MATERIAL ACCUMULATION

The IDM in containers must be placed in an appropriate designated RCRA container accumulation area at RFAAP, where it is permissible to accumulate such waste. IDM placed into a designated 90-day accumulation area will be properly sealed, labeled and covered. All drums will be placed on pallets.

A secure and controlled waste staging area will be designated by the installation prior the commencement of field sampling activities. Per the facility's requirements as a RCRA large quantity generator, waste accumulation cannot exceed 90 days for materials presumed or shown to be RCRA-designated hazardous wastes; waste which is known not to be RCRA-designated waste should be promptly disposed to municipal waste systems or appropriate facility.

3.3.1 IDM Accumulation Containers

Containers will be DOT-approved (DOT 17H 18/16GA OH unlined) open-head steel drums or other DOT approved container, as appropriate.

Container lids should lift completely off and be secured by a bolt ring (for drum). Order enough containers to accumulate all streams of expected IDM including soil, PPE and disposable sampling equipment, decontamination water, purge water, etc.

Solid and liquid waste streams will not be mixed in a container. PPE and expendable sampling equipment will be segregated from other IDM and placed in different containers than soil. Containers inside containers are not permitted. PPE must be placed directly in a drum not in a plastic bag.

Pallets are often required to allow transport of filled drums to the staging area with a forklift. Normal pallets are 3×4 ft and will hold two to three 55-gallon drums depending on the filled weight. If pallets are required for drum transport or storage, field personnel are responsible for ensuring that the empty drums are placed on pallets before they are filled and that the lids are sealed on with the bolt-tighten ring after the drums are filled. Because the weight of one drum can exceed 500 lbs, under no circumstances should personnel attempt to move the drums by hand.

3.3.2 Container Labeling

Each container that is used to accumulate IDM will be appropriately labeled at the time of accumulation and assigned a unique identification number for tracking purposes. The following information will be written in permanent marker on a drum label affixed on the exterior side at a location at least two-thirds of the way up from the bottom of the drum.

- Facility name.
- Accumulation start date and completion date.
- Site identifier information (SWMU, boring, well, etc.).
- Description of IDM.
- Drum ID No.

4.0 MATERIAL CHARACTERIZATION AND DISPOSAL

IDM will be characterized and tested to determine whether it is a hazardous waste as defined by 40 CFR Part 261 and to determine what disposal options exist in accordance with RCRA regulations and the Virginia Hazardous Waste Management Regulations (VHWMR).

In general, IDM will be considered a hazardous waste if it contains a listed hazardous waste or if the IDM exhibits a characteristic of hazardous waste.

Work plan addenda will identify the appropriate characterization and testing program for IDM based on the following:

- Site-specific conditions related to chemicals of concern, etc.
- The nature and quantity of expected IDM to be generated during site-specific investigations.
- Applicable Federal, State, and local regulations, such as RCRA, VHWMR regulations and policies and procedures, and Army Regulation 200-1.
- RFAAP specific requirements and policies for IDM characterization and disposal at the time of the investigation.

In general, appropriate USEPA SW 846 Test Methods for Evaluating Solid Waste will be used for testing IDM and will be specified in work plan addenda. Other appropriate test methods may be specified by RFAAP in addition to SW 846 Methods that are specific to installation operations, the site of interest (percent explosive content, reactivity, etc.), or requirements for disposal at RFAAP water treatment facilities or publicly owned treatment works.

Responsibility for the final disposal of IDM will be determined before field activities are begun and will be described in work plan addenda. Off-site disposal of IDM will be coordinated with RFAAP (generator) to ensure appropriate disposition. The contractor will coordinate IDM transportation and disposal activities for RFAAP (generator).

At the direction of RFAAP, appropriate waste manifests will be prepared by the USACE contractor or Alliant Techsystems subcontractor for transportation and disposal. Alliant Techsystems or other appropriate RFAAP entity will be listed as the generator and an appointed representative from RFAAP will review and sign the manifest for offsite disposal.

RFAAP will make the final decision on the selection of the transporter, storage, and disposal facility (TSDFs) or recycling facility. RFAAP will provide the contractor a listing of previously used TSDFs for priority consideration. Proposed facilities that are not included on the listing are required to provide a copy of the TSDFs most recent state or federal inspection to the installation. Waste characterization and testing results will be submitted to RFAAP (generator) for review and approval before final disposition of the material.

Hazardous waste: Prior to final disposition, a hazardous waste manifest will be furnished by the TSDF to accompany transport to the disposal facility. Following final disposition, a certificate of disposal will be furnished by the disposal facility. Copies of the manifests and certificates of disposal are to be provided to RFAAP and retained on file by the contractor or subcontractor.

4.0 PRECAUTIONS

- Because the weight of one drum can exceed 500 lbs, under no circumstances should personnel attempt to move drums by hand.
- Refer to the site-specific health and safety plan when managing IDM.

5.0 REFERENCES

Safety Rules for Contractors and Subcontractors, (As Updated). Alliant Techsystems, Incorporated, Radford Army Ammunition Plant.

STANDARD OPERATING PROCEDURE 80.1
DECONTAMINATION

1.0 SCOPE AND APPLICATION

Before leaving the site, all personnel or equipment involved in intrusive sampling or having entered a hazardous waste site during intrusive sampling must be thoroughly decontaminated to prevent adverse health effects and minimize the spread of contamination. Equipment must be decontaminated between sites to preclude cross-contamination. Decontamination water will be free of contaminants as evidenced through either chemical analyses or certificates of analysis. This standard operating procedure (SOP) describes general decontamination requirements for site personnel and sampling equipment. Decontamination procedures for contaminants requiring a more stringent procedure, e.g., dioxins/furans, will be included in site-specific addenda.

2.0 MATERIALS

- Plastic sheeting, buckets or tubs, pressure sprayer, rinse bottles, and brushes;
- U.S. Army Corps of Engineers or installation approved decontamination water source;
- Deionized ultra-filtered, HPLC-grade organic free water (DIUF);
- Non-phosphate laboratory detergent;
- Nitric Acid, 0.1 Normal (N) solution;
- Pesticide-grade solvent, Methanol;
- Aluminum foil;
- Paper towels;
- Plastic garbage bags; and
- Appropriate containers for management of investigation-derived material (IDM).

3.0 PROCEDURE

3.1 SAMPLE BOTTLES

At the completion of each sampling activity the exterior surfaces of the sample bottles must be decontaminated as follows:

- Be sure that the bottle lids are on tight.
- Wipe the outside of the bottle with a paper towel to remove gross contamination.

3.2 PERSONNEL DECONTAMINATION

Review the site-specific health and safety plan for the appropriate decontamination procedures.

3.3 EQUIPMENT DECONTAMINATION

3.3.1 Drilling Rigs

Drilling rigs and associated equipment, such as augers, drill casing, rods, samplers, tools, recirculation tank, and water tank (inside and out), will be decontaminated before site entry, after over-the-road mobilization and immediately upon departure from a site after drilling a hole. Supplementary cleaning will be performed before site entry. There is a likelihood that contamination has accumulated on tires and as spatter or dust en route from one site to the next.

1. Place contaminated equipment in an enclosure designed to contain all decontamination residues (water, sludge, etc.).
2. Steam-clean equipment until all dirt, mud, grease, asphaltic, bituminous, or other encrusting coating materials (with the exception of manufacturer-applied paint) has been removed.
3. Water used will be taken from an approved source.
4. When cross-contamination from metals is a concern, rinse sampling components such as split spoons, geo-punch stems, and augers with nitric acid, 0.1N.
5. Rinse with DIUF water.
6. When semi-volatile and non-volatile organics may be present, rinse the sampling components with pesticide-grade solvent methanol.
7. Double rinse the sampling components with DIUF water.
8. Decontamination residues and fluids will be appropriately managed as IDM per work plan addenda and SOP 80.1.

3.3.2 Well Casing and Screen

Prior to use, well casing and screen materials will be decontaminated. This activity will be performed in the leak proof, decontamination pad, which will be constructed prior to commencement of the field investigation. The decontamination process will include:

- Steam cleaning with approved source water.
- Rinse with DUIF water.
- Air-dry on plastic sheeting.
- Wrap in plastic sheeting to prevent contamination during storage/transit.

3.3.3 Non Dedicated Submersible Pumps Used for Purging and Sampling

1. Scrub the exterior of the pump to remove gross (visible) contamination using appropriate brushes, approved water, and non-phosphate detergent (steam cleaning may be substituted for detergent scrub).
2. Pump an appropriate amount of laboratory detergent solution (minimum 10 gallons) to purge and clean the interior of the pump.
3. Rinse by pumping no less than 10 gallons of approved water to rinse.
4. Rinse the pump exterior with approved decontamination water.
5. When cross-contamination from metals is a concern, rinse the pump exterior with approved nitric acid 0.1N solution.

6. Rinse the pump exterior with DIUF water.
7. When semi-volatile and non-volatile organics may be present, rinse the pump exterior with pesticide-grade solvent methanol.
8. Double rinse the pump exterior with DIUF water.
9. Air-dry on aluminum foil or clean plastic sheeting.
10. Wrap pump in aluminum foil or clean plastic sheeting, or store in a clean, dedicated PVC or PTFE storage container.
11. Solutions and residuals generated from decontamination activities will be managed appropriately as IDM per work plan addenda and SOP 80.1.

3.3.4 Sample Equipment and Measuring Water Level Devices

1. Scrub the equipment to remove gross (visible) contamination using appropriate brush (es), approved water, and non-phosphate detergent.
2. Rinse with approved source water.
3. When cross-contamination from metals is a concern, rinse the sampling equipment with approved nitric acid 0.1N solution.
4. Rinse equipment with DIUF water.
5. When semi-volatile and non-volatile organics may be present, rinse the sampling equipment with pesticide-grade solvent methanol.
6. Double rinse the sampling equipment with DIUF water.
7. Air-dry on aluminum foil or clean plastic sheeting.
8. Wrap in aluminum foil, clean plastic sheeting, or zip top bag or store in a clean, dedicated PVC or PTFE storage container.
9. Solutions and residuals generated from decontamination activities will be managed appropriately as IDM per work plan addenda and SOP 80.1.

3.3.5 Other Sampling and Measurement Probes

Temperature, pH, conductivity, Redox, and dissolved oxygen probes will be decontaminated according to manufacturer's specifications. If no such specifications exist, remove gross contamination and triple-rinse probe with DIUF water.

4.0 PRECAUTIONS

- Manage IDM appropriately according to the requirements specified in work plan addenda.
- Follow appropriate procedures as specified in the site-specific health and safety plan.

5.0 REFERENCES

USACE. 2001. Requirements for the Preparation of Sampling and Analysis Plans. EM 200-1-3. 1 February.

STANDARD OPERATING PROCEDURE 90.1
PHOTOIONIZATION DETECTOR (HNu Model PI–101 and HW–101)

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for field operations with a photoionization detector (HNu Systems Model PI–101 or HW–101). The photoionization detector (PID) detects total ionizables; hence it is used to monitor both organic and inorganic vapors and gases to determine relative concentrations of air contaminants. This information is used to establish level of protection and other control measures such as action levels. The PID cannot effectively detect compounds having ionization potentials above the photon energy level of the lamp used; therefore, methane, which has an ionization potential of 12.98 eV, is undetectable by PIDs because the lamps produce 9.5, 10.2, or 11.7 eV.

Use of brand names in this SOP is in not intended as an endorsement or mandate that a given brand be used. Alternate equivalent brands of detectors, sensors, meters, etc., are acceptable. If alternate equipment is to be used, the contractor shall provide applicable and comparable SOPs for its maintenance and calibration.

2.0 MATERIALS

- HNu Systems Model PI–101 or HW–101 survey probe with 9.5, 10.2, or 11.7 eV lamp;
- Lead-acid gel-cell battery;
- Calibration gas (e.g., isobutylene, 101 ppm) with regulator;
- Tygon tubing;
- Tedlar bag (optional);
- Instrument logbook; and
- Field logbook.

3.0 PROCEDURE

These procedures are to be followed when using the HNu in the field.

3.1 STARTUP

1. Before attaching the probe, check the function switch on the control panel to ensure that it is in the off position. Attach the probe by plugging it into the interface on the top of the readout module.
2. Turn the function switch to the battery check position. The needle on the meter should read within or above the green battery arc on the scale; if not, recharge the battery. If the red indicator light comes on, the battery needs recharging or service may be indicated.
3. Turn the function switch to any range setting. Listen for the hum of the fan motor. Check meter function by holding a solvent-based marker pen near the sample intake. If there is no needle deflection, look briefly into the end of the probe (no more than 1 or 2 sec) to see if the lamp is on; if it is on, it will give a purple glow. Do not stare into the probe any longer than 2 sec. Long-term exposure to UV light can damage the eyes. (See further information in Section 5.)
4. To zero the instrument, turn the function switch to the standby position and rotate the zero adjustment until the meter reads zero. A calibration gas is not needed since this is an electronic zero adjustment. If the span adjustment setting is changed after the zero is set, the zero should be rechecked and adjusted if

necessary. Allow the instrument to warm up for 3–5 min to ensure that the zero reading is stable. If necessary, readjust the zero.

3.2 OPERATIONAL CHECK

Follow the startup procedure in Section 3.1.
With the instrument set on the 0–20 range, hold a solvent-based marker near the probe tip. If the meter deflects upscale, the instrument is working.

3.3 FIELD CALIBRATION PROCEDURE

1. Follow the startup procedures in Section 3.1 and the operational check in Section 3.2.
2. Set the function switch to the range setting for the concentration of the calibration gas.
3. Attach a regulator HNu P/N 101-351 or equivalent (flow = 200 to 300 ml/min) to a disposable cylinder of isobutylene (HNu 101-351 or equivalent). Connect the regulator to the probe of the HNu with a piece of clean Tygon tubing. Turn on the valve of the regulator.
4. After 5 sec, adjust the span dial until the meter reading equals the benzene concentration of the calibration gas used, corrected to its equivalence, which should be marked on the canister (Isobutylene ~0.7X benzene).
5. Record in the field log the instrument ID No., serial No., initial and final span settings, date, time, location, concentration and type of calibration gas used, and the signature of the person who calibrated the instrument.
6. If the HNu does not function or calibrate properly, the project equipment manager is to be notified as soon as possible. Under no circumstances is work requiring monitoring with a PI–101 or HW–101 to be done with a malfunctioning instrument.

3.4 CALIBRATION TO A GAS OTHER THAN ISOBUTYLENE

The HNu may be calibrated to any certified calibration gas. However, after calibration, all subsequent instrument readings will be relative to the calibration gas used. General procedures include the following:

1. Calibrate according to procedure 3.3.
2. Partially fill and flush one-to-two times a gas bag (Tedlar recommended) with the certified National Institute of Standards and Technology (NIST) (formerly NBS) traceable calibration gas. Then fill the bag with 1–3 L of the calibration gas. If the gas is toxic, this must be done in a fume hood.
3. Feed the calibration gas into the probe with the range set for the value of the gas. After 5 sec, adjust the span control until the meter reads the value of the calibration gas.
4. Record the results of the calibration on the calibration/maintenance log and attach a new calibration sticker (if available) or correct the existing sticker to reflect the new calibration data. All subsequent readings will be relative to the new calibration gas.

3.5 OPERATION

1. Follow the startup procedure, operational check, and calibration check (refer to Section 3.1).
2. Set the function switch to the appropriate range. If the concentration of gas vapors is unknown, set the function switch to 0-20 ppm range. Adjust if necessary.
3. Prevent exposing the HNu to excessive moisture, dirt, or contaminant while monitoring the work activity as specified in the Site Health and Safety Plan.

4. When the activity is completed, or at the end of the day, carefully clean the outside of the HNu with a damp disposable towel to remove all visible dirt. Return the HNu to a secure area and place on charge. Charge after each use; the lead acid batteries cannot be ruined by over charging.
5. With the exception of the probe's inlet and exhaust, the HNu can be wrapped in clear plastic to prevent it from becoming contaminated and to prevent water from getting inside in the event of precipitation. If the instrument becomes contaminated, make sure to take necessary steps to decontaminate it. Call the Equipment Administrator if necessary; under no circumstances should an instrument be returned from the field in a contaminated condition.

4.0 MAINTENANCE

Calibration/maintenance logs are to be filled in completely whenever a PI-101 or HW-101 receives servicing. This is true of both contractor-owned and rental instruments.

The equipment manager should be called to arrange for a fresh instrument when necessary. The contractor's equipment facility is responsible for arranging all repairs that cannot be performed by the project equipment manager.

4.1 ROUTINE SERVICE

The PID's performance is affected by a number of factors. These include but are not limited to the decay of the UV lamp output over time and the accumulation of dust and other particulate material and contaminates on the lamp and in the ion chamber. Because of these factors, the PID should not be left in the field for a period of more than 2 weeks before being replaced with a fresh instrument. If a site is going to be inactive for a period of more than a week, all monitoring instruments are to be returned to the project equipment manager or his trained designee for servicing and/or reassignment. The following procedures are to be performed at the designated intervals for routine service.

Procedure	Frequency
Operational check	Before use and at instrument return
Field calibration	Before use and at instrument return
Full calibration	Bi-weekly (return instrument to equipment manager for replacement with a fresh unit)
Clean UV lamp and	Bi-weekly or as needed ion chamber
Replace UV Lamp	As needed

4.1.1 UV Lamp and Ion Chamber Cleaning

During periods of analyzer operation, dust and other foreign materials are drawn into the probe forming deposits on the surface of the UV lamp and in the ion chamber. This condition is indicated by meter readings that are low, erratic, unstable, non-repeatable, or drifting and show apparent moisture sensitivity. These deposits interfere with the ionization process and cause erroneous readings. Check for this condition regularly to ensure that the HNu is functioning properly. If the instrument is malfunctioning, call your equipment manager to arrange to have a fresh replacement.

4.1.2 Lamp eV Change

If different applications for the analyzer would require different eV lamps, separate probes, each with its own eV lamp, must be used. A single readout assembly will serve for any of the probes (9.5, 10.2, and 11.7 eV). A change in probe will require resetting of the zero control and recalibrating the instrument. The 11.7 eV lamp will detect more compounds than either of the two lower eV lamps. However, the 11.7 eV probe needs more frequent calibration; it burns out much faster than the lower eV lamps.

5.0 PRECAUTIONS

- The HNu PI–101 and HW–101 are designed to sample air or vapors only. *Do not allow any liquids or low boiling vapors to get into the probe or meter assembly.*
- High concentrations of any gas can cause erroneous readings. High humidity can also cause the instrument readings to vary significantly from the actual concentration of gases or vapors present. This is true even through the HNu cannot react to water vapor.
- High humidity, dust, and exposure to concentrations of low boiling vapors will contaminate the ion chamber, causing a steady decrease in sensitivity.
- Continued exposure to ultraviolet light generated by the light source can be harmful to eyesight. If a visual check of the UV lamp is performed *do not look at the light source from a distance closer than 6 inches with unprotected eyes.* Use eye protection (UV-blocking sunglasses or safety glasses). Only look briefly—never more than about 2 sec.
- Place the instrument on charge after each use; the lead batteries cannot be ruined by over charging.
- If at any time the instrument does not check out or calibrate properly in the field, the equipment manager is to be notified immediately and a replacement obtained for the malfunctioning instrument. Under no circumstances should fieldwork requiring continuous air monitoring for organic vapors and/or gases be done with a malfunctioning Hnu or without a HNu or an approved comparable instrument.

6.0 REFERENCES

Manufacturer's Equipment Manual.

APPENDIX B

SITE PHOTOGRAPHS

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PHOTO 1: Typical vegetation in RFI Study area.


PHOTO 2: Slope of RFI study area looking from fence adjacent to HWMU 13 towards the New River.

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APPENDIX C

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APPENDIX C.1

SITE SCREENING PROCESS INVESTIGATION BORING LOGS

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Project: Radford Army Ammunition Plant- SSP	Log of Borehole 13SB8
Project Location: Radford, Virginia	
Project Number: 09604-317	Sheet 1 of 1

Date(s) Drilled	10-09-03 1515-1530	Logged By	J. Spangler	Reviewed By	C. Lawrence
Drilling Method	Hand Auger	Drilling Contractor	URS Group, Inc.	Total Depth of Borehole	3.9 feet
Drill Rig Type	NA	Drill Bit Size/Type	3-inch Hand Auger	Ground Surface Elevation	
Groundwater Level(s)	3.7 ft bgs during drilling	Sampling Method	Stainless-Steel 3-inch Hand Auger	Hammer Data	NA
Borehole Backfill	Bentonite Pellets	Comments			

Elevation, feet	Downhole Depth, feet	SAMPLES Type	Number	Recovery (feet)	PID (ppm)	Graphic Log	Lithologic Log (USCS Code)	MATERIAL DESCRIPTION	FIELD NOTES
	0			1.0				5YR 4/4 reddish brown, Silty Sand, fine, moist, loose, micaceous	Sample 13SB8A collected 0.0-1.0 ft bgs
	1			1.0	ND			Increasing moisture with depth	
	2			1.0			SM	Rounded Gravel, fine to coarse, 2.0-3.0 ft bgs	
	3			0.9	ND			Groundwater at 3.7 ft bgs	Sample 13SB8B collected 3.5-3.7 ft bgs
	4							Boring Refusal 3.9 ft bgs	
	5								
	6								
	7								
	8								
	9								
	10								

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Report: ENV_12AS_CLEVELAND+/-USCS; File: RFAAP_SSP.GPJ; 12/8/2003 13SB8

Project: Radford Army Ammunition Plant- SSP **Project Location: Radford, Virginia** **Project Number: 09604-317**	**Log of Borehole 13SB9** Sheet 1 of 1

Date(s) Drilled	**10-09-03 1350-1430**	Logged By	**J. Spangler**	Reviewed By	**C. Lawrence**
Drilling Method	**Hand Auger**	Drilling Contractor	**URS Group, Inc.**	Total Depth of Borehole	**4.0 feet**
Drill Rig Type	**NA**	Drill Bit Size/Type	**3-inch Hand Auger**	Ground Surface Elevation	
Groundwater Level(s)	**NA**	Sampling Method	**Stainless-Steel 3-inch Hand Auger**	Hammer Data	**NA**
Borehole Backfill	**Bentonite Pellets**	Comments			

Elevation, feet	Downhole Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Recovery (feet)	SAMPLES PID (ppm)	Graphic Log	Lithologic Log (USCS Code)	MATERIAL DESCRIPTION	FIELD NOTES
	0						SM	5YR 3/3 dark reddish brown, Silty Sand, very fine, moist, micaceous, loose	Sample 13SB9A, MS, MSD, and SBD9 collected 0.0-1.0 ft bgs
	1						SM	7.5YR 4/6 strong brown, Silty Sand, fine to medium, moist	Sample 13SB9B collected 1.5-2.0 ft bgs
	3						GM	Silty Gravel with sand, moist	Sample 13SB9C collected 3.5-4.0 ft bgs
	4							Boring Refusal 4.0 ft bgs	
	5								
	6								
	7								
	8								
	9								
	10								

Report: ENV_12AS_CLEVELAND+/-USCS; File: RFAAP_SSP.GPJ; 12/8/2003 13SB9

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Log of Borehole 13SB10

Project: Radford Army Ammunition Plant- SSP
Project Location: Radford, Virginia
Project Number: 09604-317

Date(s) Drilled	10-09-03 1300-1330	Logged By	J. Spangler	Reviewed By	C. Lawrence
Drilling Method	Hand Auger	Drilling Contractor	URS Group, Inc.	Total Depth of Borehole	4.8 feet
Drill Rig Type	NA	Drill Bit Size/Type	3-inch Hand Auger	Ground Surface Elevation	
Groundwater Level(s)	NA	Sampling Method	Stainless-Steel 3-inch Hand Auger	Hammer Data	NA
Borehole Backfill	Bentonite Pellets	Comments			

Elevation, feet	Downhole Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Recovery (feet)	SAMPLES PID (ppm)	Graphic Log	Lithologic Log (USCS Code)	MATERIAL DESCRIPTION	FIELD NOTES
	0			1.0				10YR 3/3 dark brown, Silty Sand, fine, dry to slightly moist, loose, micaceous	Sample 13SB10A collected 0.0-1.0 ft bgs
	1			1.0	ND			7.5YR 4/4 brown, 1.0-2.0 ft bgs	
	2			1.0			SM	10YR 3/4 dark yellowish brown, 2.0-3.0 ft bgs	Sample 13SB10B collected 2.5-3.0 ft bgs
	3			1.0	ND			Silt and moisture increases with depth	
								3.5-4.8 ft bgs, 10YR 3/4 dark yellowish brown, moist	
	4			0.8					Sample 13SB10C collected 4.5-4.8 ft bgs
	5							Boring Refusal 4.8 ft bgs	
	6								
	7								
	8								
	9								
	10								

Project: Radford Army Ammunition Plant- SSP Project Location: Radford, Virginia Project Number: 09604-317	Log of Borehole 13SB11 Sheet 1 of 1

Date(s) Drilled	10-09-03 1215-1245	Logged By	J. Spangler	Reviewed By	C. Lawrence
Drilling Method	Hand Auger	Drilling Contractor	URS Group, Inc.	Total Depth of Borehole	8.6 feet
Drill Rig Type	NA	Drill Bit Size/Type	3-inch Hand Auger	Ground Surface Elevation	
Groundwater Level(s)	NA	Sampling Method	Stainless-Steel 3-inch Hand Auger	Hammer Data	NA
Borehole Backfill	Bentonite Pellets	Comments			

Elevation, feet	Downhole Depth, feet	SAMPLES Type	Number	Recovery (feet)	PID (ppm)	Graphic Log	Lithologic Log (USCS Code)	MATERIAL DESCRIPTION	FIELD NOTES
	0			1.0			ML	7.5YR 4/4 brown, Sandy Silt, very fine, slightly moist, loose, micaceous	Sample 13SB11A collected 0.0-1.0 ft bgs
	1			1.0	ND		SM	7.5YR 4/2 brown, Silty Sand with gravel	
	2			1.0			SM	7.5YR 4/2 brown, Silty Sand Metal fragment/wire found 2.5 ft bgs	
	3			1.0	ND				
	4			1.0					Sample 13SB11B collected 4.5-5.0 ft bgs
	5			1.0	ND		SC	7.5YR 5/6 strong brown, Clay Sand, silty, very fine, slightly moist, plastic	
	6			1.0			SM	5YR 4/6 yellowish red, Silty Sand, very fine, slightly moist, micaceous, loose	
	7			1.0	ND		ML	5YR 4/6 yellowish red, Silt, trace medium sand, soft, micaceous, cohesive	
	8			0.6					Sample 13SB11C collected 8.0-8.5 ft bgs
	9							Boring Refusal 8.6 ft bgs	
	10								

Project: Radford Army Ammunition Plant- SSP	Log of Borehole 13SB12
Project Location: Radford, Virginia	
Project Number: 09604-317	Sheet 1 of 1

Date(s) Drilled	10-09-03 1045-1115	Logged By	J. Spangler	Reviewed By	C. Lawrence
Drilling Method	Hand Auger	Drilling Contractor	URS Group, Inc.	Total Depth of Borehole	4.0 feet
Drill Rig Type	NA	Drill Bit Size/Type	3-inch Hand Auger	Ground Surface Elevation	
Groundwater Level(s)	NA	Sampling Method	Stainless-Steel 3-inch Hand Auger	Hammer Data	NA
Borehole Backfill	Bentonite Pellets	Comments	Boring located inside settling lagoon		

Elevation, feet	Downhole Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Recovery (feet)	SAMPLES PID (ppm)	Graphic Log	Lithologic Log (USCS Code)	MATERIAL DESCRIPTION	FIELD NOTES
	0			1.0				7.5YR 4/4 brown, Sand, medium, trace silt, moist, loose	Sample 13SB12A collected 0.0-1.0 ft bgs
	1			1.0	ND		SP/SM	sand grades to fine with increasing silt 1.0-2.0 ft bgs 1.0-2.0 ft bgs, micaceous	
	2			1.0				7.5YR 2.5/1 black, Silt with trace fine sand, very moist	Sample 13SB12B and SBD8 collected 2.0-3.0 ft bgs
	3			1.0	ND		ML	3.0-4.0 ft bgs, Color grades to 7.5YR 3/1 very dark gray; sand grades fine to coarse Groundwater at 4.0 ft bgs	Sample 13SB12C collected 3.5-4.0 ft bgs
	4							Boring terminated at 4.0 ft bgs	
	5								
	6								
	7								
	8								
	9								
	10								

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Project: Radford Army Ammunition Plant- SSP	Log of Borehole 13SB7
Project Location: Radford, Virginia	
Project Number: 09604-317	Sheet 1 of 1

Date(s) Drilled	10-09-03 0940-1015	Logged By	J. Spangler	Reviewed By	C. Lawrence
Drilling Method	Geoprobe - Direct Push Technology	Drilling Contractor	Richard Simmons Drilling	Total Depth of Borehole	12.7 feet
Drill Rig Type	Tractor- mounted Geoprobe	Drill Bit Size/Type	4 ft x 2 in Rectractable Macrocore Sampler	Ground Surface Elevation	
Groundwater Level(s)	12.5 ft bgs during drilling	Sampling Method	4 ft x 2 in Macrocore Sampler with Liner	Hammer Data	NA
Borehole Backfill	Bentonite Pellets	Comments			

Elevation, feet	Downhole Depth, feet	SAMPLES Type	Number	Recovery (feet)	PID (ppm)	Graphic Log	Lithologic Log (USCS Code)	MATERIAL DESCRIPTION	FIELD NOTES
	0				ND		SM	7.5YR 3/3 dark brown, Silty Sand, very fine, slightly moist, loose, micaceous, homogeneous	Sample 13SB7A collected 0.0-1.0 ft bgs
	1				ND				
	2		1	3.6	ND				
	3				ND				
	4				ND				
	5				ND		SP	7.5YR 4/4 brown, Sand, medium, slightly moist, loose	Sample 13SB7B collected 5.0-6.0 ft bgs
	6		2	2.7	ND		SM	7.5YR 3/4 dark brown, Silty Sand, very fine, moist, micaceous, loose to moderately dense	
	7				ND				
	8				ND				
	9				ND				
	10		3	4.0	ND			Decomposed wood chips at 10.9 ft bgs	Sample 13SB7C, MS, MSD collected 10.0-12.0 ft bgs
	11				ND		SM	7.5YR 4/4 brown, Silty Sand, fine, moist	
	12		4	0.3	ND		GC	7.5YR 4/4 brown, Silty Gravel, moist Groundwater at 12.5 ft bgs ∇	
	13							Boring Refusal 12.7 ft bgs	
	14								
	15								

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APPENDIX C.2

PHYSICAL SOIL SAMPLE RESULTS

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Radford Army Ammunition Plant
LABORATORY TESTING DATA SUMMARY

BORING NO.	DEPTH (ft)	IDENTIFICATION TESTS: WATER CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLAS. IND.	USCS SYMB. (1)	SIEVE MINUS NO. 200 (%)	HYDROMETER % MINUS 2 µm (%)	ORGANIC CONTENT (burnoff) (%)	pH Distilled Water	pH 0.01 M CaCl Solution	TOTAL UNIT WEIGHT (pcf)	DRY UNIT WEIGHT (pcf)	SPECIFIC GRAVITY	PERMEABILITY (cm/sec)	REMARKS
13SB10	2-3	29.6		np		SM	28.6		3.5	6.9	6.6	115.9	89.4	2.688	1.3E-5	
13SB7	12.7	16.0				GC	13.3		1.1	6.3	6.2	130.0	112.0	2.711		
37SB1	6-6.5	21.8	22	18	4	SC-SM	43.0		1.5	6.3	6.0	130.1	106.8	2.677	1.6E-7	
37SB2	15.5-16	17.0				SM	33.7		1.6	5.1	5.4	122.7	104.9	2.746	2.3E-4	
38SB1	7	20.9				SM	34.8		1.7	7.1	6.6	125.8	104.1	2.713		
38SB2	15.5	3.7				SM	13.8		1.1	6.8	6.3	116.0	111.9	2.702	2.0E-3	
46SB1	14.5	24.5	32	18	14	SC	50.0	23	2.2	5.7	5.9	127.5	102.4	2.729	3.0E-8	
46SB2	9.5-10	20.4				SM	26.9		1.8	6.2	5.7	123.4	102.5	2.735		
57SB2	7.5-8	28.4				CL-ML	70.2		2.6	5.6	3.9	94.1	73.3	2.701		
57SB3	16.5-17	46.4	83	29	54	CH	89.6	46	3.6	5.3	*	106.4	72.7	2.694	1.8E-7	
68SB2	18-18.5	30.4				CL-ML	54.9		1.5	6.8	6.2	100.2	76.8	2.680		
68SB3	7-7.5	35.8	49	29	20	ML	75.9	26	3.6	5.2	3.8	115.4	85.0	2.744	1.9E-6	
69SB1	11-12	34.1	34	19	15	CL	74.1		3.3	9.5	7.8	128.2	95.6	2.688		
69SB3	7.5-8.5	32.7				CL	77.7		3.5	7.1	6.0	117.7	88.7	2.707	6.6E-9	
ASB1	22-24	36.6	63	30	33	CH	58.8		3.6	4.2	3.8	115.6	84.7	2.735		
ASB2	14-16	43.4	56	35	21	MH	78.4		2.5	4.3	3.9	110.2	76.8	2.662	6.7E-7	
FSB1	18.5-19	30.6	47	20	27	CL	79.2	30	1.4	7.1	*	119.2	91.2	2.628	8.6E-8	
FSB2	7.5-8	15.6				SM	19.9		1.4	6.8	6.3	111.0	96.1	2.807		
QSB1	9.5-10	26.4	31	21	10	CL	52.6		1.8	6.4	6.5	123.8	97.9	2.717	1.2E-7	
QSB2	24	6.2				GP	3.9		0.6	6.4	6.2	121.6	114.6	2.692		

Note: (1) CS symbol based on visual observation and Sieve and Atterberg limits reported.

Prepared by: RV Reviewed by: CMJ Date: 12/01/2003

TABLE ________
Radford Army Ammunition Plant
SUMMARY OF LABORATORY PERMEABILITY TESTS PERFORMED ON RECONSTITUTED SAMPLES

BORING NO.	SAMPLE NO.	DEPTH (ft)	WATER CONTENTS INITIAL / PRE-TEST (%)	TOTAL UNIT WGTS INITIAL / PRE-TEST (pcf)	DRY UNIT WGTS INITIAL / PRE-TEST (pcf)	STRESSES EFFECTIVE / BACK PRESSURE (psi)	DURING CONSOL. TIME / VOLUMETRIC STRAIN (days, %)	DURING TEST PERMEANT / INITIAL GRADIENT	COEFFICIENT OF PERM. K, (@ 20 C) (cm/sec)	REMARKS
13SB10		2-3	29.6	115.9	89.4	5.0	over night	tap water	1.3E-5	P6775
			33.2	122.9	92.3	100.0	3.2	18		
37SB1		6-6.5	21.8	130.1	106.8	5.0	over night	tap water	1.6E-7	P6776
			20.5	131.7	109.3	100.0	2.3	21		
37SB2		15.5-16	17.0	122.7	104.9	5.0	over night	tap water	2.3E-4	P6779
			23.9	130.3	105.2	100.0	0.3	4		
38SB2		15.5	3.7	116.0	111.9	5.0	over night	tap water	2.0E-3	P6785
			18.2	133.7	113.1	100.0	1.1	1		
46SB1		14.5	24.5	127.5	102.4	5.0	over night	tap water	3.0E-8	P6782
			24.4	127.8	102.8	100.0	0.4	23		
57SB3		16.5-17	46.4	106.4	72.7	5.0	over night	tap water	1.8E-7	P6783
			48.3	108.4	73.0	100.0	0.5	21		
68SB3		7-7.5	35.8	115.4	85.0	5.0	over night	tap water	1.9E-6	P6780
			36.5	116.8	85.6	100.0	0.8	18		not recon.
69SB3		7.5-8.5	32.7	117.7	88.7	5.0	over night	tap water	6.6E-9	P6773
			32.2	121.4	91.8	100.0	3.4	39		
ASB2		14-16	43.4	110.2	76.8	5.0	over night	tap water	6.7E-7	P6774
			42.0	111.4	78.4	100.0	2.1	16		
FSB-1		18.5-19.0	30.6	119.2	91.2	5.0	over night	tap water	8.6E-8	P6784
			28.8	120.8	93.8	100.0	2.7	23		
QSB1		9.5-10	26.4	123.8	97.9	5.0	over night	tap water	1.2E-7	P6781
			24.6	126.7	101.7	100.0	3.7	22		

PERMEABILITY TEST: FALLING HEAD - CONSTANT VOLUME U-TUBE
ASTM D 5084 - 90

Project No.: 31737767 BORING: 13SB10 Test No.: P6775
Project Name: Radford Army Ammunition Plant SAMPLE: DEPTH (ft): 2-3

Specimen - Apparatus set-up - Test Information Cell No. 5 Apparatus No. 4 Stage No.: 2

Preliminary Length/Area Calculations

Lo =	3.035	in	Lo=	7.709	cm
dLc=	0.032	in	Ao =	19.83	cm^2
Lc=	3.003	in	Vo =	152.91	cm^3
			Lc=	7.628	cm
dVc = 3 Vo * (dLc/Lo)			dVc=	4.84	cm^3
			Vc =	148.07	cm^3
Sc =	0.393	cm^{-1}	Ac=	19.412	cm^2

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or
	x	with stones or		Stones with filter paper or top + bottom
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination
3) During saturation: Water flushed up sides of specimen to remove ai	x	No		Yes
4) During consolidation:	x	Top and bottom drainage or		Top / Bottom only
5) Direction of permeant :	x	Up during or		Down during permeation
6) Permeant: water used	x	Tap		Distilled
or		Demineralized		0.005 N calcium sulfate (CaSO4)

Equations Used

Kt = - 0.0000750 * Sc/dT(min) * ln (ho/hf)

RT = (-0.02452*(ave. temp in C) + 1.495)

K @ 20 ºC = RT * Kt TubeC= 1.3181

Consol Stage- Trial No.	Temp. º C	Date	Time hr	min	sec	Initial σ_c psi	Ub psi	U-tube Reading Head (cm) (cc)	Tail (cm) (cc)	Flow in/out gradient	Permeability Preliminary Final at 20ºC cm/sec Dev. from Ave.
initial	22.2	10/31/03	00	00	00	105.0	100.0	57.00	46.37	1.01	1.35E-05
final	22.2	10/31/03	00	01	30			53.00	47.63		1.28E-05
1	RT = 0.951	dT =	1.50 min			σ'_c =	0.7 ksf	0.298	0.295	io= 17.5	0%
initial	22.2	10/31/03	00	00	00	105.0	100.0	57.00	46.37	1.01	1.35E-05
final	22.2	10/31/03	00	01	30			53.00	47.63		1.28E-05
2	RT = 0.951	dT =	1.50 min			σ'_c =	0.7 ksf	0.298	0.295	io= 17.5	0%
initial	22.2	10/31/03	00	00	00	105.0	100.0	57.00	46.37	1.01	1.35E-05
final	22.2	10/31/03	00	01	30			53.00	47.63		1.28E-05
3	RT = 0.951	dT =	1.50 min			σ'_c =	0.7 ksf	0.298	0.295	io= 17.5	0%
initial	22.2	10/31/03	00	00	00	105.0	100.0	57.00	46.37	1.01	1.35E-05
final	22.2	10/31/03	00	01	30			53.00	47.63		1.28E-05
4	RT = 0.951	dT =	1.50 min			σ'_c =	0.7 ksf	0.298	0.295	io= 17.5	0%

TEST SUMMARY

Final Specimen and Test Conditions

Lc =	7.628	cm	ε_{axial} =	1.1%
Ac =	19.415	cm^2		
Vc=	148.09	cm^3	ε_{vol} =	3.2%
Sc =	0.393	cm^{-1}	Sc = Lc / Ac , final	

	w (%)	γ_τ (pcf)	γ_d (pcf)	S (%)
Initial	29.62	115.9	89.4	83.8
PreTest	33.17	122.9	92.3	100.0

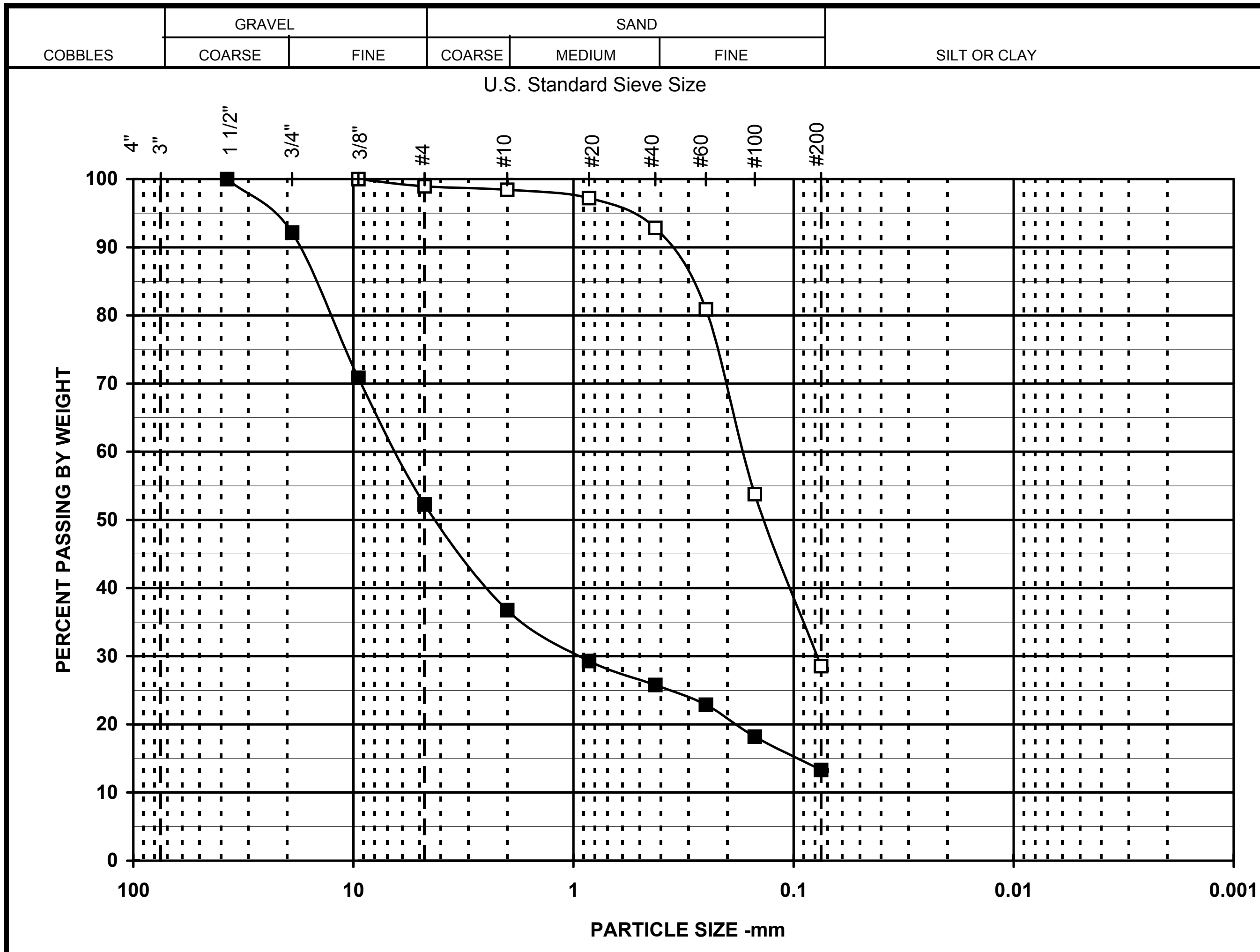
HYDRAULIC CONDUCTIVITY SUMMARY

Averages for trials: 1-4

ave K @ 20 ºC: **1.28E-05** cm/sec

(i_o)ave = 17.5

Tested By: DT Reviewed By: G. Thomas



Symbol	□	■	○
Boring	13SB10	13SB7	
Sample			
Spec			
Depth	2-3	12.7	
% +3"			
% Gravel	1.1	47.7	
% SAND	70.3	39.0	
% FINES	28.6	13.3	
% -2µ			
Cc			
Cu			
LL			
PL	np		
PI			
USCS	SM	GC	
w (%)		16.0	

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"		100.0	
3/4"		92.1	
3/8"	100.0	70.9	
4	98.9	52.3	
10	98.4	36.7	
20	97.2	29.3	
40	92.9	25.8	
60	80.9	22.9	
100	53.8	18.2	
200	28.6	13.3	

SYMBOL	DESCRIPTION AND REMARKS
□	brown m-f SAND, some silt, trace f. gravel, c. sand.
■	brown c-f sandy GRAVEL, some clay.
○	

PARTICLE SIZE DISTRIBUTION

Radford Army Ammunition Plant

Project No. 31737767	December 2003	Figure

URS Corporation

APPENDIX D

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APPENDIX D.1

SITE SCREENING PROCESS REPORT – MAY 2007

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APPENDIX D.1.1

SSP REPORT TEXT AND SCREENING TABLES FOR SWMU 13

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4.0 SWMU 13 – WASTE PROPELLANT BURNING GROUND

4.1 SITE BACKGROUND – ENVIRONMENTAL SETTING

Physiography

SWMU 13 – August 2002 – Looking West

SWMU 13 is an active 20-acre unit located in the southeastern portion of the HSA. The SWMU is situated on the 100-year flood plain on the northern bank of the New River. Earthen berms surround the site on the southern (riverward), eastern (downstream), and western (upstream) sides.

Excluding the berms, topography slopes to the south toward the river with an elevation of approximately 1,700 ft mean sea level (msl) in the northern (landward) portion and approximately 1,695 ft msl in the southern (riverward) part (Figure 4-1). Topography south (riverward) of the site is moderately to steeply sloping towards the New River, which is located approximately 50 ft from the site. The New River flows east prior to turning north around the HSA.

The RFAAP perimeter fence runs along the crest of the southern earthen berm between the site and the New River. To the north, two parallel asphalt access roads border the SWMU. Steep, densely wooded slopes terminate the flood plain area north of the access roads and west of the SWMU. The site appears to have been constructed by leveling an existing fluvial terrace/floodplain along the New River during the early 1940s (USEPA 1987).

SWMU 13 consists of eight pairs of burning pads (Figure 4-2). Each burning pad contains a metal burning pan, approximately 18 ft long by 6 ft wide by 1 ft deep, and a mobile temporary storage unit (wheeled covers to prevent rainwater accumulation in the pans). A maximum of 1,000 pounds of waste is burned in a pan at a time.

Tanks/Structures

An office trailer is present east of the site in addition to the burning pads and the RFAAP perimeter fence. Other tanks or structures are not located in or near the site.

Surface Water

The site is surrounded on three sides by berms to protect it from New River floods. Storm-water runoff inside of the site initially flows southward toward the river and then eastward along the southern (riverside) berm finally discharging into a settling lagoon located at the eastern perimeter. Excavated below grade, the settling lagoon is approximately 35 ft long by 20 ft wide and is neither bermed nor lined. The settling lagoon discharges directly to the New River via VPDES Outfall 017.

Soil and Geology

The site is underlain by the Wheeling sandy loam soil. This soil has moderate permeability and medium-to-strong acidity (IT 2001a). The geology of SWMU 13 was previously explored during an RFI conducted by Dames & Moore in 1992, through the drilling of 22 soil borings and installation of seven monitoring wells. Additional investigations were conducted for the SSP outside of the current site operating area: 1) south of the berm and fence bordering the site to the south (borings 13SB7, 13SB8, 13SB9, 13SB10, and 13SB11) and 2) east of the berm bordering the site to the east within the settling lagoon (boring 13SB12).

Approximately 13 to 22 ft of unconsolidated soil (fill material and alluvial deposits) is present above carbonate bedrock of the Elbrook Formation. The alluvial deposits generally thicken toward the New River and consist of micaceous reddish brown sandy clay/sandy silt (CL/ML) and/or silty sand (SM). In the southern half of the site, 2 to 6 ft of yellowish brown silty gravel (GM) overlies bedrock.

Physical soil testing of two representative soil samples at the site during the SSP investigation indicated acidic GC and SM soil, with organic content in the range of 1.1 to 3.5%, and a vertical hydraulic conductivity of 1.3E-05 cm/sec for the SM sample (Table 3-1).

Groundwater

An unconfined aquifer is present within unconsolidated soil (alluvium) and in underlying bedrock at depths ranging from approximately 12 to 20 ft bgs. The thickness of the unconfined aquifer within the alluvium increases toward the New River (3+ ft thick). RFI data indicated that groundwater flow at the site is toward the south and the New River (Dames & Moore, 1992a). Perched water was encountered at a depth of 4 ft below the bottom of the settling lagoon, which was dry at the time of boring completion.

4.2 SITE BACKGROUND - HISTORY

Open burning of waste and off-specification energetic products has been performed continuously at SWMU 13 since manufacturing operations began in 1941. Open detonation has not been conducted. The site is an interim status RCRA Subpart X treatment unit; a Part B application was submitted in 1988, and an updated Part B application was submitted to VDEQ in 2000.

Material open burned at the site has consisted of waste explosives, propellants, and laboratory wastes. According to the RFA (USEPA 1987), three types of propellant waste have been burned at the site including single base (nitrocellulose), double base (nitrocellulose and nitroglycerin), and triple base (nitrocellulose, nitroglycerin, and nitroguanidine). Burning of other energetic materials or burning-rate modifiers, such as lead, dinitrotoluene (DNT), or other organic and inorganic chemicals, was not mentioned in the RFA.

Use of the current eight pairs of burning pads and their appurtenances started in 1985 (Dames and Moore 1992a). Previously, wastes were burned in earthen pits (i.e., burn pits) at the same locations currently occupied by the burning pads. After burning, residue is removed from the pans, and the surrounding areas are inspected for burn residue. Burn residue is then moved to the designated accumulation area, inspected, and unburned energetic material returned to the pans for re-burning. A composite sample of burn residue is analyzed approximately every two months for disposal characterization (ATK 2002).

During the 1987 USEPA RFA site visit, various signs of releases were evident and included remnants of incompletely combusted propellant throughout the area and several hundred charred containers described as “scintillation vials” at the mouth of the culvert pipe to the settling lagoon (USEPA 1987). RFAAP personnel were unaware of the use of such “vials” either past or present, and scintillation measurements have not been made at RFAAP. These “vials” may have been sampling containers. Neither incompletely combusted propellant nor “scintillation vials” were observed during the URS site visit in August 2002.

4.3 PREVIOUS INVESTIGATIONS

Five environmental assessments have included the site as part of their study area including: a Soil Sampling Study (1987), RFI Program (1992), EPIC Aerial Photo Report (1992), New River and Tributaries Study (1997), and Current Conditions Report (2002).

4.3.1 Soil Sampling Study at the RFAAP Open Burning Ground – 1987

In 1987, the US Army Environmental Hygiene Agency (USAEHA) conducted a Soil Sampling Study at the site. The site was divided into 28 sections and one soil sample was collected from each section for analysis of explosives and leachable metals (Figure 4-2). USAEHA reported that the western half of the site appeared to be relatively free of impacted soil. Levels of trinitrotoluene (TNT), ranging from 5.7 to 10,900 mg/kg, were detected in samples collected from the eastern half (Sections 17 through 22 and Section 24). The soil sample collected from Sampling Section 19 also contained comparable levels of 2,6-dinitrotoluene (2,6-DNT) and 2,4-dinitrotoluene (2,4-DNT).

4.3.2 SWMU 13 RFI Program – 1992

In August 1991, Dames and Moore performed an RFI Program at SWMU 13 to evaluate potential impact to soil, sediment, surface water, and groundwater (Dames and Moore 1992a).

<u>Soil</u>

Four soil borings (13SB3 through 13SB6) were drilled near the boundaries of the site to collect samples to evaluate the extent of potentially impacted soil (Figures 4-3 and 4-4). Easternmost and westernmost borings 13SB3 and 13SB6 were located outside of the perimeter berms. The two southern borings (13SB4 and 13SB5) were located inside of the riverside berm. Soil borings 13SB1 and 13SB2 were drilled north of the access road to collect background soil samples. Samples for chemical analysis were collected from each boring at three depths (0.5, 5, and 10 ft bgs).

In addition, 24 composite soil samples for chemical analysis were collected from borings (13SC1 through 13SC8) adjacent to the burn pits (Figure 4-3 and 4-4) at depths of 0.5 ft (“A”), 5 ft (“B”), and 10 ft (“C”). Samples for VOC analyses were not composited. Four surface soil samples (13SS1 through 13SS4) were also collected from the drainage ditch. The soil samples were analyzed for metals, explosives, VOCs, SVOCs, and TCLP metals. Analytical results for the soil samples are summarized in Table 4-1.

Thallium concentrations in 17 soil samples were above the background point estimate and the adjusted I-RBC. Lead concentrations in seven soil samples were above the background point estimate and the EPA lead screening level of 400 mg/kg. The concentration of 2,4-DNT in surface soil sample 13SS4 was above the adjusted R-RBC. 2,4,6-trinitrotoluene (2,4,6-TNT) was detected in surface soil samples 13SB6 and 13SS1at concentration above the adjusted R-RBC and in surface soil sample 13SS2 at a concentration above the adjusted I-RBC. 1,3-Dinitrobenzene was detected in surface soil sample 13SS1D (duplicate) at a concentration above the adjusted R-RBC (Table 4-1).

<u>Sediment</u>

Two samples (13SE1 and 13SE2) were collected from the top 12 inches of sediment in the settling basin (Figure 4-4). One sample was collected adjacent to the influent pipe (13SE1) and the second (13SE2) was collected near the eastern end. The sediment samples were analyzed for metals, explosives, VOCs, and SVOCs. Analytical results for the sediment samples are summarized in Table 4-1.

Lead concentrations in 13SE1 and 13SE2 were above the EPA lead screening level of 400 mg/kg. Thallium was detected in sample 13SE2 at a concentration above the background point estimate and the adjusted I-RBC. 2,4,6-TNT was detected in sample 13SE2 at a concentration above the adjusted R-RBC (Table 4-1).

<u>Surface Water</u>

One surface water sample (13SW1) was collected from the settling basin for analysis of metals, explosives, VOCs, and SVOCs (Table 4-2). Chemicals detected in 13SW1 at concentrations above the adjusted T-RBC included: aluminum, arsenic, barium, chromium, iron, manganese, and vanadium, 2,4,6-TNT, 2,4-DNT, and 2,6-DNT. Lead was detected in sample 13SW1 at a concentration above the EPA lead action level of 15 µg/L. Aluminum, chromium, copper, iron, lead, and zinc were detected in sample 13SW1 at a concentration above Draft BTAG screening levels.

4.3.3 Review of EPIC Aerial Photo Report

Activity within the site area was first noted on a 1949 photograph that reportedly showed that the western portion of the site had "been cleared, and seven burning pits (not annotated) divided by earthen berms are visible", but "do not appear dark-toned at this time" (USEPA 1992). USEPA could not conclude from the photograph if actual burning activities were ongoing.

Review of the 1962 photograph indicated that: "The entire area now appears to be active. Dark-toned areas (not annotated) are visible where it appears burning has taken place" (USEPA 1992). A three-sided berm was present in the center of the site, and USEPA reported that burning might have occurred within this bermed area. The photograph also showed that an area of "probable light-toned liquid" was present west of the aforementioned berm (USEPA 1992).

The 1971 photograph indicated that the burning pits had been divided by berms into eight burning areas. The photo also showed that the three-sided berm area seen in the 1962 photo had one side intact. A "light-toned" liquid/material was observed near the remaining berm and "probable liquid" was present along the southern boundary (USEPA 1992).

The 1986 photograph was interpreted to indicate that the "pit burning" method had changed to "pan burning" method using eight cells with two burning pans each. Two areas of "light-toned" material were visible near the northern edge of the site, and several areas of "staining" were visible along the northwestern and southern boundaries. The settling basin was apparently visible for the first time as a "lagoon" at the eastern edge of the SWMU (USEPA 1992).

4.3.4 New River and Tributaries Study – 1997

The objective of the New River and Tributaries Study was to provide data to evaluate migration pathways along the New River and its tributaries at RFAAP to assess potential adverse impacts to human health and the environment (Parsons 1997). One sediment sample (NRSE4) was collected from the New River near the site for analysis of VOCs, SVOCs, pesticides, PCBs, and TAL metals to assess potential impacts from the site. Chemical concentrations in the sediment sample were below their adjusted RBCs. Lead and chromium were detected at concentrations above their Draft BTAG screening levels.

One surface water sample (NRSW4) was collected from the New River near the site for analysis of VOCs, SVOCs, pesticides, PCBs, and TAL metals to assess potential impacts to surface water from the site (Figure 4-3). Chemical concentrations in the surface water sample were below their adjusted T-RBCs and MCLs.

4.3.5 Current Conditions Report – 2002

The Current Conditions Report was performed to develop a conceptual model of the geology and hydrogeology of the HSA at RFAAP. The work included: a geologic and hydrogeologic data review, detailed geologic features mapping, a groundwater elevation measurement survey, a spring survey, river flow measurements, and a review of groundwater geochemical data. The conceptual model is intended to support the development of future investigation activities.

As described in the Current Conditions Report, seven monitoring wells (13MW1 through 13MW7) were to be sampled quarterly at SWMU 13. Bis (2-ethylhexyl) phthalate was detected at concentrations above the MCL in samples collected from each of the monitoring wells, except 13MW6. Ammonia, aluminum, arsenic, iron, and manganese were detected in groundwater samples at concentrations above their adjusted T-RBCs (IT 2001b).

4.4 WORK PLAN DATA GAP ANALYSIS

It was agreed at the Installation Action Plan workshop (2003) and subsequent discussions with USEPA, that the focus of SSP investigative activities at SWMU 13 would be outside of the active operational areas, specifically, the area between the New River and the earthen berm that borders the southern portion of the active operational area. The data gap analysis presented in Section of 1.6.5 WPA 016 indicated a lack of samples in this area and at adjacent locations in the New River (URS 2003b). The following data gaps were identified:

- TCL VOCs - surface soil, subsurface soil, sediment, and surface water;
- TCL SVOCs/PAHs - surface soil, subsurface soil, sediment, and surface water;
- TCL PCBs and pesticides - surface soil;
- Explosives - surface soil, subsurface soil, sediment, and surface water;
- TAL inorganics - surface soil, subsurface soil, sediment, and surface water;
- Dioxins/furans - surface soil;
- Perchlorate - surface water; and
- Site-specific physical soil testing data.

4.5 SSP FIELD ACTIVITIES

4.5.1 Soil

Six borings (13SB7 through 13SB12) were advanced outside of the current operational area at the site to evaluate for the presence or absence of chemicals in surface and subsurface soil (Figure 4-1). Each of these borings was located between the New River and the earthen berm that borders the active operating area, except for 13SB12, which was located within the settling lagoon east of the berm.

Boring 13SB7 was advanced using a tractor mounted, direct-push Geoprobe® unit, while the remaining five borings were advanced using a hand auger. Each of the borings was advanced to refusal, except for 13SB12, which was terminated at the depth of encountered groundwater. Groundwater was encountered at the completion depth of borings 13SB7, 13SB8, and 13SB12. As summarized below, discrete samples were collected from surface, intermediate zone, and terminal zone for the borings with the exception of 13SB8 from which two samples were collected due to groundwater encountered at a depth of 3.7 ft bgs.

SWMU 13 SSP Soil Sample and Boring Information

Boring ID	Total Depth of Boring (ft bgs)	Surface Sample ID	Sample Depth (ft)	Intermediate Sample ID	Sample Depth (ft)	Terminal Sample ID	Sample Depth (ft)
13SB7	12.7	13SB7A	0.0 - 1.0	13SB7B	5.0 - 6.0	13SB7C	10.0 - 12.0
13SB8	3.9	13SB8A	0.0 - 1.0	13SB8B	3.5 - 3.7	Not Collected	
13SB9	4.0	13SB9A	0.0 - 1.0	13SB9B	1.5 - 2.0	13SB9C	3.5 - 4.0
13SB10	4.8	13SB10A	0.0 - 1.0	13SB10B	2.5 - 3.0	13SB10C	4.5 – 4.8
13SB11	8.6	13SB11A	0.0 - 1.0	13SB11B	4.5 - 5.0	13SB11C	8.0 – 8.5
13SB12	4.0	13SB12A	0.5	13SB12B	2.0 - 3.0	13SB12C	3.5 - 4.0

Soil samples were analyzed for TCL VOCs, TCL SVOCs, PAHs, explosives (including nitroglycerin and PETN), and TAL inorganics. Surface soil sample 13SB9A was also analyzed for TCL pesticides, TCL PCBs, TCL herbicides, and dioxin/furans. SSP analytical results for soil samples (detected chemicals) are summarized in Table 4-3.

Two soil samples were collected from 13SB7 (12.7 ft bgs) and 13SB10 (2-3 ft bgs) for physical testing of percent moisture, grain size, pH, TOC, specific gravity, and bulk density. Additional testing was conducted on sample 13SB10 including Atterberg limits and hydraulic conductivity. Analytical results for these samples are summarized in Table 3-1 and the complete results are provided in Appendix E.

Deviations to WPA 016 (URS 2003a) were necessary to adjust to field conditions encountered at the site. Due to access constraints for the Geoprobe, borings 13SB8 through 13SB12 were advanced using a hand auger. The use of hand augers resulted in shallower than anticipated refusal depths.

4.5.2 Sediment and Surface Water

Two pairs of surface water and sediment samples were collected from the New River adjacent to the site. Sample pair 13SW2 (surface water)/13SE2 (sediment) was collected at the western end (upstream) of the site. Sample pair 13SW3/13SE3 was collected at the eastern end (downstream) of the site at the probable point of entry for surface water runoff from the settling lagoon. The surface water and sediment samples were analyzed for TCL VOCs, TCL SVOCs, PAHs, explosives (including nitroglycerin), perchlorate (surface water), and TAL inorganics. SSP analytical results for sediment and surface water samples (detected chemicals) are summarized in Tables 4-4 and 4-5.

4.6 HUMAN HEALTH RISK SCREENING

4.6.1 Soil

4.6.1.1 Identification of COPCs

Tables 4-6 and 4-7 present the results of COPC evaluations for surface soil and total soil, respectively. Table 4-8 summarizes the dioxin/furan data and calculations for the total 2,3,7,8-TCDD equivalent concentration used for COPC screening. COPCs identified for surface soil and subsurface soil included:

- *TAL metals:* aluminum (NSV), antimony, arsenic, chromium, cobalt (NSV), iron, lead, manganese, thallium, and vanadium;
- *VOC TICs:* 1 compound (NSV);
- *TCL SVOCs:* DNT Mix, 4-chloro-3-methylphenol (NSV), benzo(a)pyrene, dibenzofuran (NSV), and dimethlyphthalate (NSV); and
- *SVOC TICs:* 16 compounds (NSVs) for surface soil, and 30 compounds (NSVs) for total soil.

4.6.1.2 Cumulative Risk Screen

Table 4-9 presents the results of the cumulative risk screening for surface soil. Tables 4-10 and 4-11 present the results of the cumulative risk screening for total soil. A summary of the results for SWMU 13 is presented below.

Cumulative Human Health Risk Screening Results for SWMU 13 - Soil

	Surface Soil			Total Soil		
Residential Excess Cancer Risk	Fail	1.E-05	As, benzo(a)pyrene, DNT Mix	Fail	2.E-05	As, benzo(a)pyrene, DNT Mix
Industrial Excess Cancer Risk	Pass	2.E-06	--	Pass	2.E-06	--
Residential Noncarcinogenic	Fail	3	As, Cr, Fe, Mn, Tl, V, 2,4-DNT	Fail	3	Sb, As, Cr, Fe, Mn, Tl, V, 2,4-DNT
Industrial Noncarcinogenic	Pass	0.3	--	Pass	0.2	--

Cumulative human health risk screens passed with the exception of the residential (carcinogenic and noncarcinogenic) scenarios for surface soil and total soil.

Noncarcinogenic residential cumulative risk screenings for surface soil and total soil resulted in HIs of 3, which exceeded the EPA target HI of 1. Due to multiple chemicals contributing to an HI greater than 1, the HIs have been segregated based on the primary target organs for chronic exposure. The following tables present the results of the HI segregation using data obtained from Oak Ridge National Laboratory's Risk Assessment Information System (RAIS), which includes data from various sources such as USEPA and the ATSDR.

HI Segregation for Target Organs – SWMU 13 -Surface Soil

Target Organ	As	Cr	Fe	Mn	V	Tl	2,4-DNT	Total HI
Skin	0.1	--	--	--	--	--	--	0.1
Central Nervous System (CNS)	0.1	--	--	0.8	--	--	0.005	***1***
Cardiovascular (CV)	0.1	--	2	--	--	--	--	***2***
Blood	--	--	--	--	0.5	--	--	***0.5***
Liver	--	--	2	--	--	0.2	0.005	***2***
Kidney	--	--	2	--	0.5	0.2	0.005	***2***
Gastrointestional (GI)	--	0.2	--	--	0.5	--	--	***0.7***
Reproductive	--	--	--	0.8	--	--	0.005	***0.8***

HI segregation for surface soil resulted in values equal to or higher than the cumulative SSP HI threshold of 0.5 for a target organs including: the CNS, CV, blood, liver, kidney, GI, and reproductive.

HI Segregation for Target Organs – SWMU 13 - Total Soil

Target Organ	Sb	As	Cr	Fe	Mn	Tl	V	2,4-DNT	2,6-DNT	Total HI
Skin	--	0.1	--	--	--	--	--	--	--	0.1
CNS	--	0.1	--	--	0.7	--	--	0.007	0.003	***1***
CV	--	0.1	--	1	--	--	--	--	--	***1***
Blood	--	--	--	--	--	0.2	0.4	0.007	0.003	***0.0.6***
Liver	--	--	--	1	--	0.2	--	0.007	0.003	***1***
Kidney	--	--	--	1	--	--	0.3	--	--	***1***
GI	0.04	--	0.1	--	--	--	0.4	--	--	***0.5***
Reproductive	--	--	--	--	0.7	--	--	--	--	***0.7***

HI segregation for total soil resulted in values equal to or higher than the cumulative SSP HI threshold of 0.5 for a target organs including: the CNS, CV, blood, liver, kidney, GI, and reproductive.

4.6.1.3 Lead and Iron Screening

The MDCs for lead in surface soil (8,620 mg/kg) and total soil (26,500 mg/kg) were above the lead screening level of 400 mg/kg, and therefore, the potential risk associated with lead was evaluated using the IEUBK model (USEPA 2004a). The results of the modeling presented in Appendix G predicted that the probability of children expected to have blood levels of 10 microgram per deciliter or greater exceeded the SSP threshold of 5%.

Iron concentrations at the site for surface soil and total soil resulted in HQs greater than the iron SSP threshold HQ of 0.5 for the residential scenario, and therefore, the site required further characterization for iron through a margin of exposure evaluation. Appendix H presents the margin of exposure evaluation for surface soil and total soil. A summary of the results for SWMU 13 is presented below.

Iron Margin of Exposure Evaluation – Future Child Resident

	Surface Soil			**Total Soil**		
		Estimated Site Intake	Exposure Screening Level		Estimated Site Intake	Exposure Screening Level
RDA Screen (mg/day)	Pass	7.0	10	Pass	6.5	10
Provisional Reference Dose (RfD) Screen (mg/kg-day)	Pass	0.46	0.66	Pass	0.43	0.66

The site passed the margin of exposure evaluation for iron in soil. In addition, the MDCs for iron in surface soil and total soil were below the background point estimate.

4.6.1.4 Comparison to Generic SSLs

MDC comparisons to generic SSLs (DAF 20) for detected chemicals indicated that TCE and 1,3-dinitrobenzene exceeded their SSLs (Table 4-12).

4.6.1.5 Comparison to Site-Specific SSLs

TCE concentrations in samples collected from boring 13SB11 exceeded the site-specific SSL of 2 µg/kg calculated using the average total organic carbon (TOC) value from the two physical soil samples collected at the site during the SSP (Appendix F). 1,3-Dinitrobenzene exceeded its site-specific SSL of 0.07 mg/kg in intermediate sample 13SB12B (Appendix F).

4.6.1.6 COPC Comparison to Background

MDCs for metals COPCs were below their background point estimates with the exception of lead (Table 4-13).

4.6.2 Sediment

4.6.2.1 Identification of COPCs

Table 4-14 presents the results COPC evaluations for sediment. COPCs identified for sediment included:

- *TAL metals:* aluminum (NSV), arsenic, chromium, cobalt (NSV), iron, manganese, and vanadium;
- *TCL SVOCs:* benzo(a)pyrene, dibenz(a,h)anthracene, and dimethylphthalate (NSV); and
- *SVOC TICs:* 6 compounds (NSVs).

4.6.2.2 Cumulative Risk Screen

Table 4-15 presents the results of the cumulative risk screening for sediment. A summary of the screening results for SWMU 13 is presented below.

Cumulative Human Health Risk Screening Results for SWMU 13 - Sediment

	Sediment	
Residential Excess Cancer Risk	Fail	1.E-05
Industrial Excess Cancer Risk	Pass	2.E-06
Residential Noncarcinogenic	Fail	3
Industrial Noncarcinogenic	Pass	0.2

The cumulative risk screen passed for sediment with the exception of the residential scenario (carcinogenic and noncarcinogenic).

Noncarcinogenic residential cumulative risk screening for sediment resulted in an HI of 3, which exceeded the EPA target HI of 1. COPCs contributing to the cumulative HI in decreasing order are iron, manganese, vanadium, chromium, and arsenic. Due to multiple chemicals contributing to an HI greater than 1, the HI was segregated based on the primary target organs for chronic exposure. The following tables present the results of the HI segregation using data obtained from Oak Ridge National Laboratory's

Risk Assessment Information System (RAIS), which includes data from various sources such as USEPA and the ATSDR.

HI Segregation for Target Organs – SWMU 13 -Sediment

Target Organ	As	Cr	Fe	Mn	V	Total HI
Skin	0.2	--	--	--	--	0.2
CNS	0.2	--	--	0.5	--	***0.7***
CV	0.2	--	2	--	--	***2***
Blood	--	--	--	--	0.5	***0.5***
Liver	--	--	2	--	--	***2***
Kidney	--	--	2	--	0.5	***3***
GI	--	0.2	--	--	0.5	***0.7***
Reproductive	--	--	--	0.5	--	***0.5***

HI segregation for surface soil resulted in values equal to or higher than the cumulative SSP HI threshold of 0.5 for a target organs including: the CNS, CV, blood, liver, kidney, GI, and reproductive.

4.6.2.3 Lead and Iron Screening

The MDC for lead in sediment at the site was 259 mg/kg, which was below lead screening level of 400 mg/kg, and therefore, further characterization for lead was not required.

Iron concentrations at the site for sediment (evaluated as soil) resulted in an HQ greater than the iron SSP threshold HQ of 0.5 for the residential scenario, and therefore, the site required further characterization for iron through a margin of exposure evaluation. Appendix H presents the margin of exposure evaluation for sediment. A summary of the results for SWMU 13 is presented below.

Iron Margin of Exposure Evaluation – Future Child Resident

	Sediment (as Soil)		
		Estimated Site Intake	Exposure Screening Level
RDA Screen (mg/day)	Pass	6.6	10
Provisional Reference Dose (RfD) Screen (mg/kg-day)	Pass	0.44	0.66

The site passed the margin of exposure evaluation for iron in sediment (evaluated as soil).

4.6.2.4 Comparison to Generic SSLs

The MDC comparisons to generic SSLs (DAF 20) for detected chemicals in sediment indicated that TCE exceeded its generic SSL (Table 4-16). Sediment specific geotechnical data were not available to calculate a site-specific SSL.

4.6.3 Surface Water

4.6.3.1 Identification of COPCs

Table 4-17 presents the results of the COPC evaluations for surface water. COPCs identified for surface water included:

- *TAL metals:* aluminum (NSV), thallium; and
- *SVOC TICs:* 9 compounds (NSVs).

4.6.3.2 Cumulative Risk Screen

Table 4-18 presents the results of the cumulative risk screening for surface water. A summary of the screening results for SWMU 13 is presented below.

Cumulative Human Health Risk Screening Results for SWMU 13 – Surface Water

	Surface Water	
Tap Water Excess Cancer Risk	Pass	N/A
Tap Water Noncarcinogenic	Pass	0.1

The cumulative human health risk screening passed for surface water at SWMU 13.

4.6.3.3 Lead and Iron Screening

The MDC for lead in surface water at the site was 0.9 micrograms per liter (μg/L), which was below the lead action level of 15 μg/L; therefore, further characterization for lead was not required.

Iron concentrations at the site for surface water resulted in HQs less than the iron SSP threshold HQ of 0.5, and therefore, further characterization for iron was not required (Table 4-18).

4.6.3.4 Comparisons to ARARs

The MDC comparisons to MCLs and Virginia Water Quality Criteria Values with respect to human health indicated no detected chemicals exceeded these criteria (Table 4-17).

4.6.3.5 Human Health Risk Screening Summary

COPCs with screening values were limited to metals, benzo(a)pyrene, and DNT mixture in soil; metals, benzo(a)pyrene, and dibenz(a,h)anthracene in sediment; and metals in surface water. The cumulative risk screens passed with the exception of residential carcinogenic and noncarcinogenic scenarios for surface soil, total soil, and sediment.

Failure of the residential carcinogenic cumulative risk screening for surface and total soil is due to the concentrations of arsenic, benzo(a)pyrene, and dinitrotoluene mix in the soil. As a result of the arsenic MDC being below its background point estimate, the site related risk for surface soil and total soil are

7.E-06 and 8.E-08, respectively, which is below a cumulative excess risk of 1.E-05; and therefore, these constituents are not of concern at the site.

Noncarcinogenic residential risk screening failed for surface soil and total soil due to metals concentrations below background point estimates. These screening results are not a concern given that the elevated HI (>1) is due to metals background levels in soil (HI of 3.4 for surface soil and HI of 3.0 for total soil). In addition, the single metal COPC without an established background point estimate (antimony) had an MDC below its unadjusted RBC (HQ <0.04).

Failure of the residential carcinogenic cumulative risk screening for sediment is due to the concentrations of arsenic, benzo(a)pyrene, and dibenz(ah)anthracene. As a result of the arsenic MDC being below its background point estimate, the site related risk for sediment is 5.E-06, which is below a cumulative excess risk of 1.E-05; and therefore, these constituents are not of concern at the site.

Noncarcinogenic residential risk screening failed for sediment due to metal concentrations, which were in the range of background point estimates for soil. This screening result is not considered a concern given the lack of COPCs other than metals and concentrations in sediments that are comparable with background levels found in soil at RFAAP.

The site failed both tiers of lead screening for soil (point comparison and IEUBK modeling) indicating that further evaluations will be required at the site. Lead screening for sediment and surface water passed. Iron concentrations in surface soil, total soil, and sediment required a margin of exposure evaluation. Surface soil, total soil, and sediment passed the margin of exposure evaluation for iron. The iron screening for surface water passed (HQ<0.5).

Generic SSL exceedances were limited to 1,3-dinitrobenzene in soil and TCE in soil and sediment. TCE concentrations in the soil boring closest to the settling lagoon also exceeded site-specific SSLs. The TCE SSL exceedance in one sediment sample is not considered a concern based on the lack of TCE detections in surface water, the low concentration detected, and likely dilution effects associated with surface water of the New River.

The 1,3-Dinitrobenzene concentration detected in soil exceeded the calculated site-specific SSL; this exceedance is not considered a concern due to its single detection in one intermediate sample (duplicate sample) of 11 subsurface samples analyzed at the site at a low estimated concentration below the laboratory RL.

4.7 ECOLOGICAL RISK SCREENING

4.7.1 Problem Formulation

4.7.1.1 Ecological Site Characterization

An overview of the site physiography, water resources, geology, and soil for SWMU 13 is presented in Section 4.1. The site is a 20-acre gravel area located within the 100-year floodplain of the New River in the southeastern portion of the HSA. The area is bordered by the river to the south and the HSA in the other directions. The site is currently operational and contains eight pairs of metal burning pads used for burning of waste and off-specification energetic products. The area is surrounded by earthen berms to the south, east, and west.

Terrestrial Habitat

Terrestrial habitat within the site is generally disturbed owing to physical operations and limited to grass areas that are maintained. Gravel substrate in a large portion of the area limits vegetation density and substrate quality. Consequently, grasses provide the cover type and shrubs or tree species are not established. Vegetation along the fringe of the site consists of transitional herbaceous species typical of disturbed communities.

The limited terrestrial habitat at the site is not likely to support a diverse and abundant wildlife community. Given its gravelly substrate and frequent disturbance related to site activities, few species would be expected to extensively utilize terrestrial areas of the site. Potential wildlife utilizing the site includes passerine bird and small mammalian species common to RFAAP grasslands (Virginia Department of Game and Inland Fisheries 1999). Wildlife species were not observed at the site during the site reconnaissance. While the reconnaissance represents one snapshot in time, it does provide evidence concerning the limited potential for wildlife use at this site.

Aquatic Habitat

The New River represents aquatic habitat located approximately 50 ft down a moderate to steep slope from the site. At Radford, Virginia, the New River drains approximately 2,700 acres. It had an annual mean discharge of approximately 2,200 cubic feet per second in 2001 (USGS 2004). The New River supports a diversity of aquatic species including fish, aquatic invertebrates, amphibians, reptiles, and piscivorous birds (IT 2001a).

Threatened, rare, or endangered species were not observed in terrestrial areas of the site during the site reconnaissance. The New River was not surveyed during the reconnaissance to identify potential aquatic threatened, rare, or endangered species. A complete discussion of threatened, rare and endangered species potentially occurring within the entire RFAAP site is provided in Section 3.3.3.

4.7.1.2 Ecological Conceptual Site Model

The ECSM for the terrestrial component and aquatic component of the site are presented on Figures 3-1 and 3-2, respectively. Surface soil is a potential exposure medium of concern based on historical activities at the site. Potential chemical transport to the New River may have resulted in the migration of site-related chemicals to associated aquatic habitats. Based on the site characterization and data, the following complete exposure pathways exist:

- Terrestrial receptor exposure to surface soil; and
- Aquatic receptor exposure to sediment and surface water.

Detected chemical occurrence and distribution tables are presented in Table 4-19, 4-22, and 4-24 for surface soil, sediment, and surface water, respectively. In addition, Tables 4-21, 4-23, and 4-25 summarize the nondetected chemicals for soil, sediment, and surface water, respectively. Potential ecological receptors may be exposed to COPECs in the soil, sediment, and surface water through the following exposure routes:

Soil

- Direct contact/absorption from soil;
- Direct ingestion of soil;
- Incidental ingestion of soil; and
- Direct ingestion of biota with accumulated COPECs.

Sediment

- Direct contact/absorption from sediment;
- Direct ingestion of sediment;
- Incidental ingestion of sediment; and
- Direct ingestion of biota with accumulated COPECs.

Surface Water

- Direct contact/absorption from surface water;
- Direct ingestion of surface water;
- Incidental ingestion of surface water; and
- Direct ingestion of biota with accumulated COPECs.

Terrestrial and aquatic receptors of concern selected to represent species in the major trophic levels likely to use the site and the adjacent New River include:

Terrestrial

- Plants;
- Soil invertebrate/microbial community;
- Omnivorous birds (American robin; *Turdus migratorius*);
- Carnivorous birds (Red-tailed hawk; *Buteo jamaicensis*);
- Herbivorous mammals (Meadow vole; *Microtus pennsylvanicus*);
- Omnivorous mammals (Red fox; *Vulpes vulpes*); and
- Carnivorous mammals (Short-tailed shrew; *Blarina brevicauda*).

Relevant assessment and measurement endpoints for the terrestrial pathway are identified in Section 3.3.6.1.

Aquatic

- Benthic community;
- Fish Community;
- Omnivorous Bird [e.g., Mallard (*Anas platyrhynchos*)];
- Piscivorous Bird [e.g., Belted Kingfisher (*Ceryle alcyon*)]; and
- Semi-Aquatic Mammals [e.g., Raccoon, (*Procyon lotor*).

Relevant assessment and measurement endpoints for the aquatic pathway are identified below:

Assessment and Measurement Endpoints for Aquatic Pathway– SWMU 13

Assessment Endpoints	Measurement Endpoints
• Survival, growth, and reproduction of benthic community in New River	• Compare MDCs for sediment/surface water COPECs to refinement screening values
• Survival, growth, and reproduction of fish community in New River	• Compare MDCs for sediment/surface water COPECs to refinement screening values

Assessment Endpoints	Measurement Endpoints
• Survival, growth, and reproduction of invertivorous waterfowl in New River	• Compare MDCs for sediment/surface water COPECs to NOAELs and LOAELs associated with effects on growth, reproduction, or survival of terrestrial wildlife
• Survival, growth, and reproduction of piscivorous birds in New River	• Compare MDCs for sediment/surface water COPECs to NOAELs and LOAELs associated with effects on growth, reproduction, or survival of terrestrial wildlife
• Survival, growth, and reproduction of omnivorous and piscivorous mammals in New River	• Compare MDCs for sediment/surface water COPECs to NOAELs and LOAELs associated with effects on growth, reproduction, or survival of terrestrial wildlife

4.7.2 Preliminary Exposure Estimate and Risk Characterization

The preliminary exposure estimate and ecological effects evaluation considers the most conservative risk scenario. Highly conservative assumptions are used to estimate COPEC exposure to terrestrial receptors and aquatic receptors for pathways to be quantitatively evaluated. Conservative TRVs are used to evaluate the ecological effects of exposure using the two approaches discussed below.

4.7.2.1 Preliminary Exposure Estimate and Ecological Effects Evaluation

<u>Direct Contact Approach</u>

The maximum soil and sediment concentrations for detected chemicals are used as the preliminary exposure estimate concentrations to develop a conservative risk scenario for the direct contact pathway to soil invertebrates and the benthic community.

<u>Dose Rate Modeling Approach</u>

In the dose rate modeling approach, the maximum COPEC concentrations for detected bioaccumulative chemicals, along with assumptions of maximum ingestion rate, minimum body weight, 100% area use, and 100% bioavailability are used in the conservative risk scenario as the preliminary exposure estimate for soil, sediment, and surface water and compared to the calculated TRVs.

4.7.2.2 Preliminary Risk Characterization

<u>Terrestrial Pathways</u>

***Terrestrial Plants* -** Qualitative characterization of vegetative communities common to grassed areas at RFAAP is provided in Section 3.3.7.3. Stressed or dead vegetation was not observed in the site area during the site reconnaissance that could be attributed to chemical stress. Reduced plant density is likely due to poor physical substrate quality or ongoing operational activities at the site, and not a response to COPEC concentrations in the surface soil.

Soil Invertebrates and Microbial Communities –Direct contact HQs calculated for soil are presented in Tables 4-26, respectively, for detected chemicals.

Of the detected chemicals for which ecological screening values were available, the concentrations of aluminum, chromium, iron, lead, manganese, zinc, cyanide, benzo(a)anthracene, benzo(a)pyrene, benzo(b)flouranthene, chrysene, fluoranthene, phenanthrene, and pyrene resulted in HQ values that were greater than 1 (Table 4-26). However, MDCs for aluminum, chromium, iron, and manganese were below their background point estimates (Table 4-27).

A separate exposure assessment was conducted for dioxin/furan congeners to evaluate whether surface soil concentrations pose a threat to soil invertebrates. The 2,3,7,8-TCDD equivalent concentration as presented in Table 4-20 of 2.39 picograms per gram (pg/g) is below the BTAG screening value of 10,000 pg/g for 2,3,7,8-TCDD.

***Terrestrial Wildlife* -** Quantitative risk characterization for terrestrial wildlife is limited to direct ingestion of biota and incidental ingestion of soil. The ECSM identifies a potentially complete direct contact exposure pathway to herbivorous and omnivorous mammals; however, there is insufficient information to quantify this pathway. This pathway is likely secondary to the direct ingestion pathway; therefore, it should not substantially alter the risk characterization.

The risk to each potential terrestrial wildlife receptor is summarized in Tables 4-28 and 4-29 (dioxins) and characterized as follows:

Receptor	**NOAEL Only Exceedances**	**NOAEL and LOAEL Exceedances**
American Robin	cadmium, dioxins	chromium, lead, selenium, zinc
Red-tailed Hawk	chromium	lead, zinc
Meadow Vole	lead	none
Red Fox	arsenic, selenium, benzo(g,h,i)perylene	lead, mercury, zinc
Short-tailed Shrew	arsenic, cadmium	lead, selenium, zinc

<u>Aquatic Pathways</u>

Benthic Communities - The direct contact HQs calculated for benthic communities are presented in Tables 4-30 and 4-31.

In sediment, for the detected chemicals for which ecological screening values were available, the concentrations of antimony, cadmium, copper, iron, lead, manganese, zinc, cyanide, acenaphthylene, and indeno(1,2,3-cd)pyrene resulted in HQ values greater than 1.

For surface water, for the detected chemicals for which ecological screening values were available, the concentration of dissolved barium resulted in HQ value greater than 1.

Aquatic Wildlife - Quantitative risk characterization is limited to direct ingestion of biota and incidental ingestion of sediment. The risk to each potential aquatic wildlife receptor at the site is summarized in Table 4-32 and characterized as follows:

Receptor	NOAEL Only Exceedances	NOAEL and LOAEL Exceedances
Mallard Duck	zinc	none
Belted Kingfisher	zinc	lead, selenium
Raccoon	arsenic	none

4.7.3 Refined Exposure Estimate, Ecological Effects Evaluation, and Risk Characterization

4.7.3.1 Refined Exposure Estimate and Ecological Effects Evaluation - Dose Modeling

Refined exposure estimates and ecological effects were not developed for direct contact assessment because an appropriate 95% UCL could not be calculated using the available data.

Refined exposure estimates and ecological effects were not developed for terrestrial wildlife receptors (surface soil) and aquatic wildlife receptors given the elevated results of the human health screening for lead and the lead HQs calculated for the American Robin and Meadow Vole.

4.7.3.2 Exposure and Risk Uncertainty Analysis

A discussion of potential risk and exposure uncertainty is provided in Section 3.3.9. Based on this assessment, while factors such as lack of TSV and wildlife profile assumptions may create limited uncertainty, the overall result of the conservative nature of the process has produced a conservative assessment of potential ecological risks associated with the site.

4.7.3.3 Background Concentrations of Metals

The results of the background comparison for the site are provided in Table 4-14 and discussed in the ecological risk summary.

4.7.4 Ecological Risk Screening Summary

Due to the results of the ecological risk screening, additional ecological risk evaluations for metals will be conducted for the terrestrial and aquatic wildlife as part of future evaluations for the site (outside the current operating area of SWMU 13).

4.8 CONCEPTUAL SITE MODEL

A refined CSM for SWMU 13 is presented on Figure 4-5. The CSM focuses on migration pathways from the current operating area (burning ground) to areas south and east of the operating area located outside of the earthen berm. The earthen berm is located along the southern and eastern perimeter of the active burning ground and is approximately 50 ft north of the New River.

With the current operating area, the land surface slopes gently southward toward the New River. Topography south of the earthen berm slopes moderately to steeply toward the New River. The New River flows east past SWMU 13 prior to turning north around the HSA.

Subsurface geology at the site consists of fill material and alluvial deposits overlying carbonate bedrock of the Elbrook Formation. Groundwater is present in the lower part of the alluvium and in the underlying bedrock at a depth of approximately 12 to 20 ft bgs. Groundwater flows southward across SWMU 13 toward the New River where local discharge of groundwater occurs.

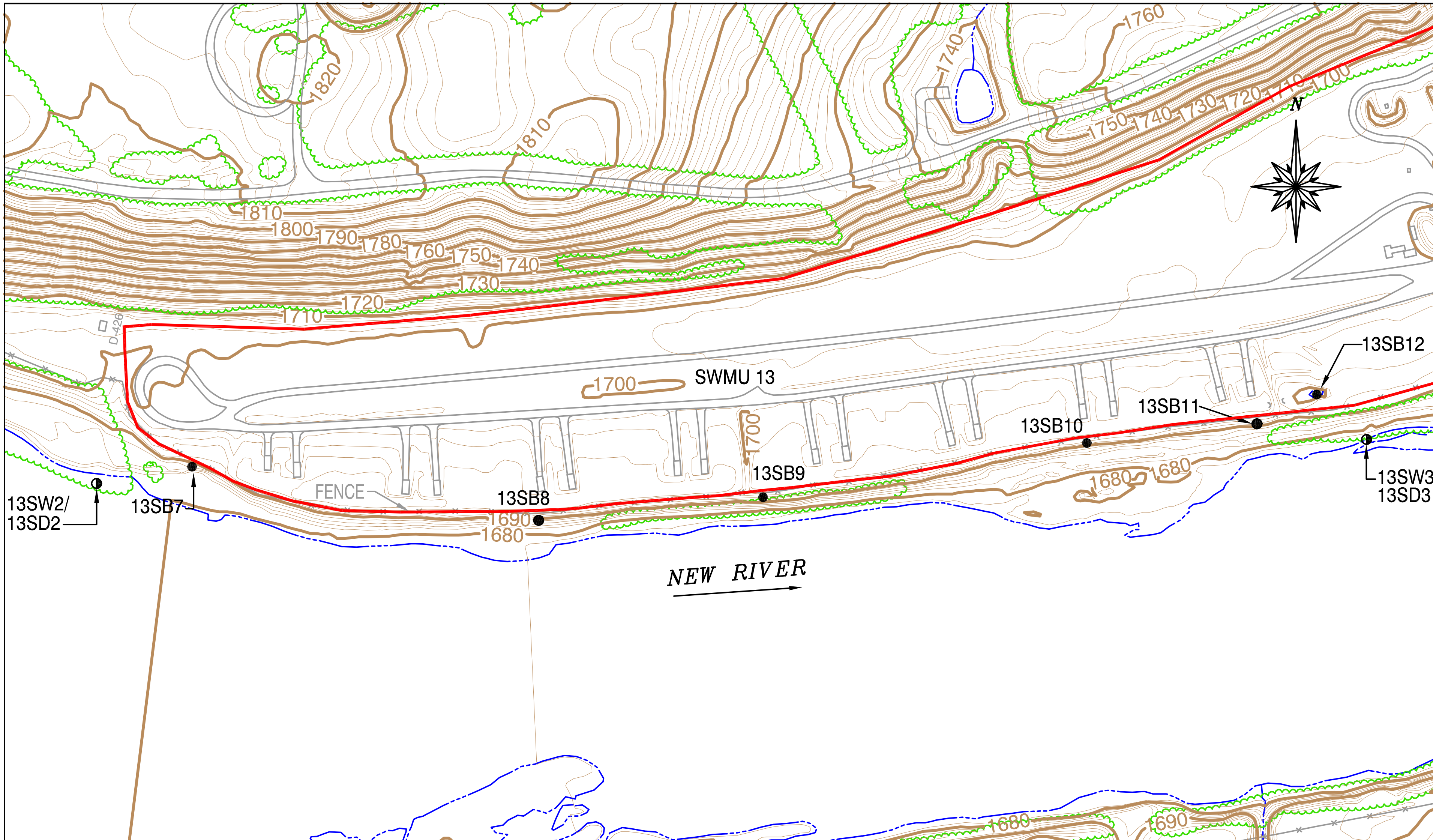
Potentially affected media include surface and subsurface soil, surface water, and groundwater. COPCs identified in soil and sediment with screening values include metals and PAHs. Thallium was identified as a COPC in surface water (New River).

Although current and likely future land-use scenarios are limited to industrial operations, both residential and industrial scenarios are evaluated. SWMU 13 is enclosed by a fence along its perimeter and by the Installation perimeter fence, and, therefore, potential receptors are limited to site workers (more conservative than trespasser scenario), future construction workers, and terrestrial biota.

Direct deposition is considered a potential release mechanism to surface soil within the current operating area and past burning operations may have affected soil outside of the earthen berm. Site workers, construction workers, and terrestrial biota could contact surface soil. Leaching of chemicals is considered a potential release mechanism to subsurface soil that may be contacted by potential future construction workers. Leaching of chemicals is considered a potential release mechanism to groundwater. In addition, the area associated with the settling lagoon may have been affected by storm water runoff from the operational area. Storm water transport of surficial materials to the settling lagoon is shown as resulting in a surface soil exposure pathway.

4.9 RECOMMENDATION FOR FUTURE ACTION

Based on the results of the SSP screening, further investigation of the nature and extent of lead in soil outside of the current operating area (south of the earthen berm) is recommended. This assessment should include completion of a human health risk assessment, SLERA, and an evaluation of the need for future actions. The SLERA should also include an assessment of metals concentrations in sediment in the New River and associated risk to aquatic receptors. In addition, current groundwater data for SWMU 13 (collected as part of the Facility's open burning permit with the VDEQ) will be reviewed and assessed as part of the RFI.



Legend

- Soil Sampling Location
- Surface Water/Sediment Sampling Location
- Approximate SWMU Boundary
- Vegetation
- Water

0 200'

1 inch = 200 feet

(SOURCE: MODIFIED FROM HERCULES, INC., 1992)

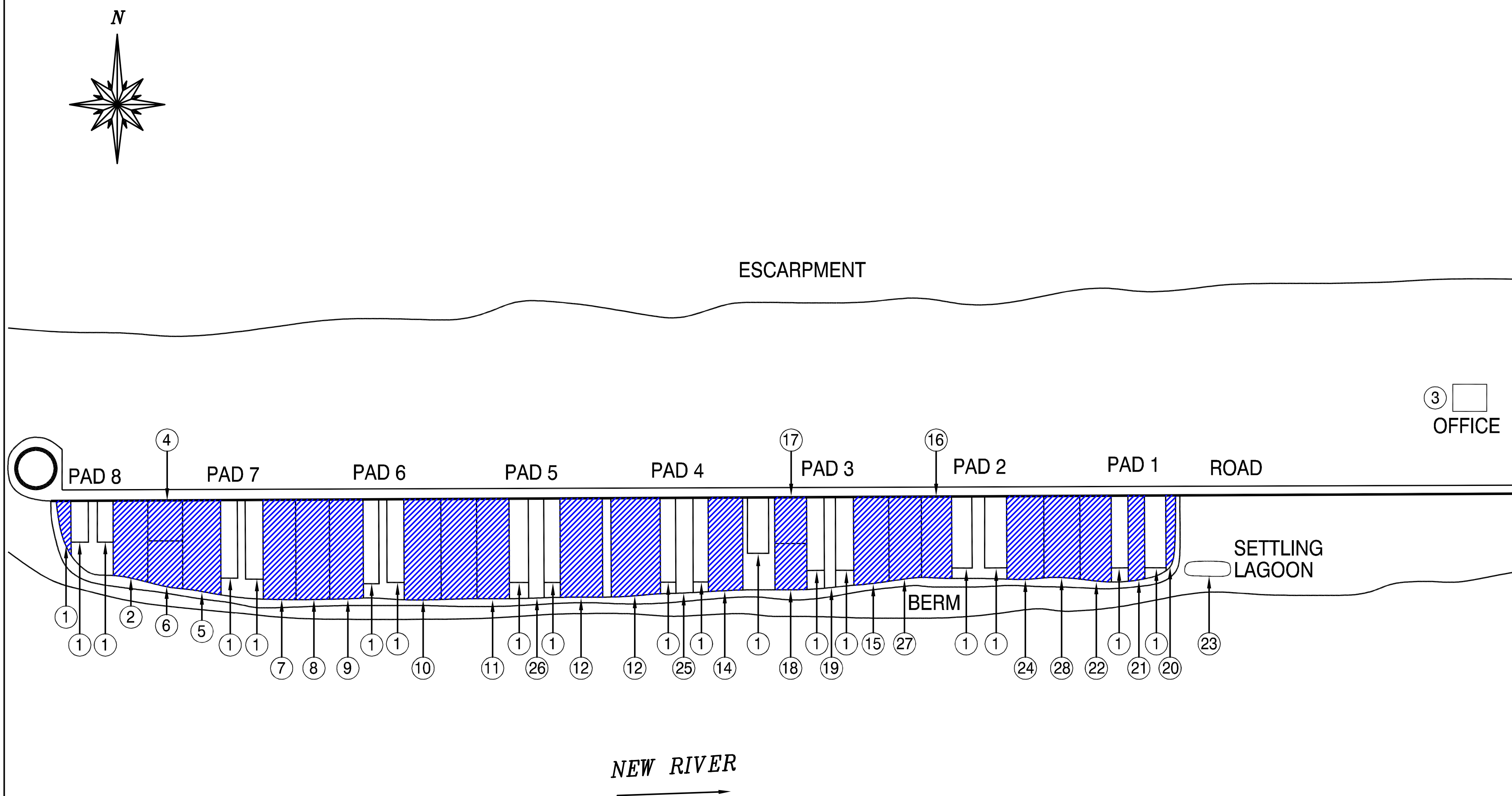
RFAAP

SSP REPORT

Date:	Prepared By:
June 2004	*KDC/TDH*
Scale:	**File Name:**
1"=200'	*15900619*

FIGURE 4-1

SSP SAMPLING LOCATION MAP SWMU 13



Legend

Sampled Area and Sample Number

3

(SOURCE: MODIFIED FROM USAEHA, 1987)

0 200'

1 inch = 200 feet

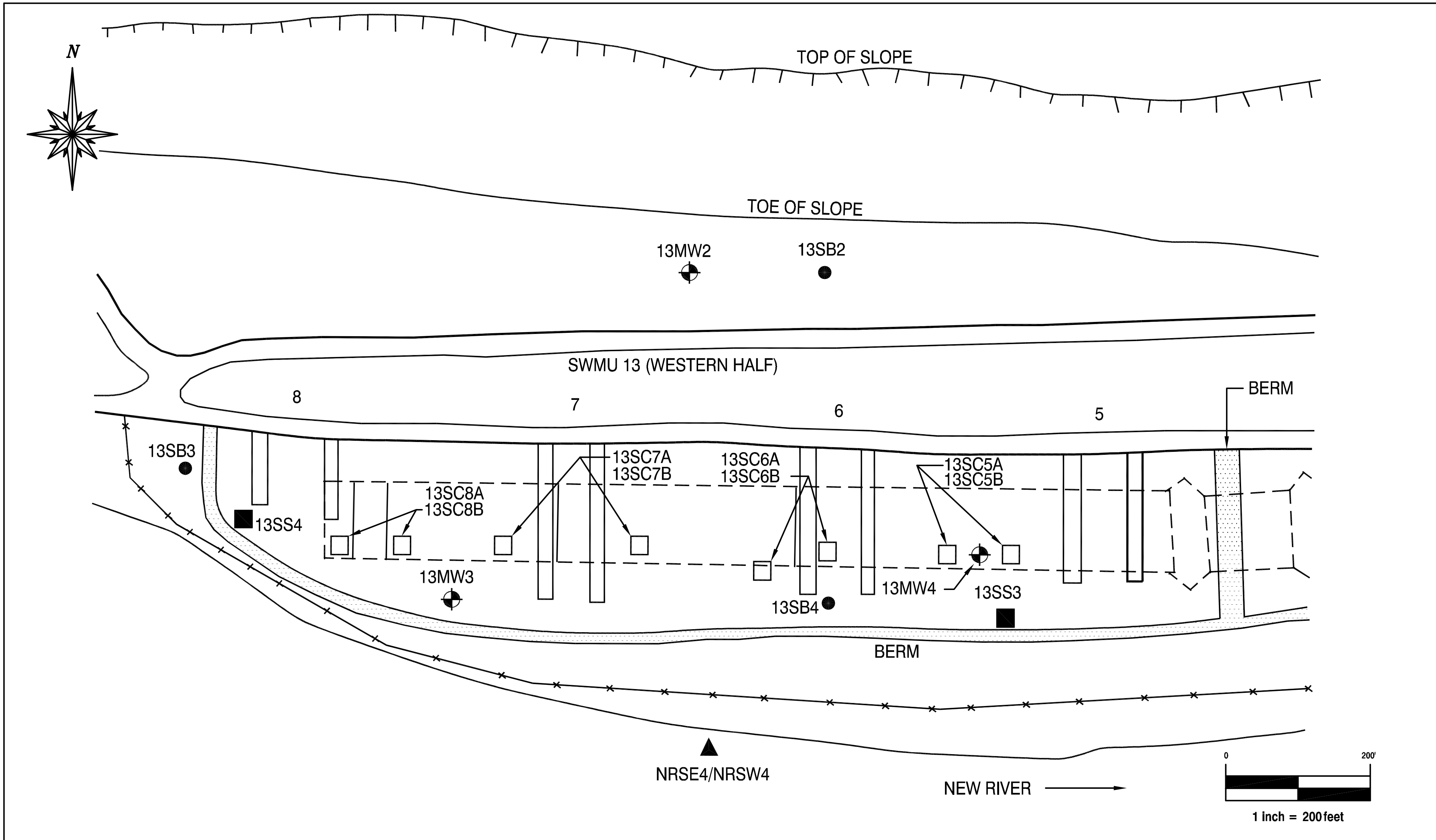
RFAAP

SSP REPORT

Date: June 2004	**Prepared By:** KDC/TDH
Scale: 1"=200'	**File Name:** 15900619

FIGURE 4-2

PREVIOUS INVESTIGATION SAMPLING LOCATIONS SWMU 13



Legend

- Soil Sampling Location
- Monitoring Well
- Soil Composite Sample
- Soil Boring
- Original Burning Pads Outline
- Surface Water/Sediment Sample

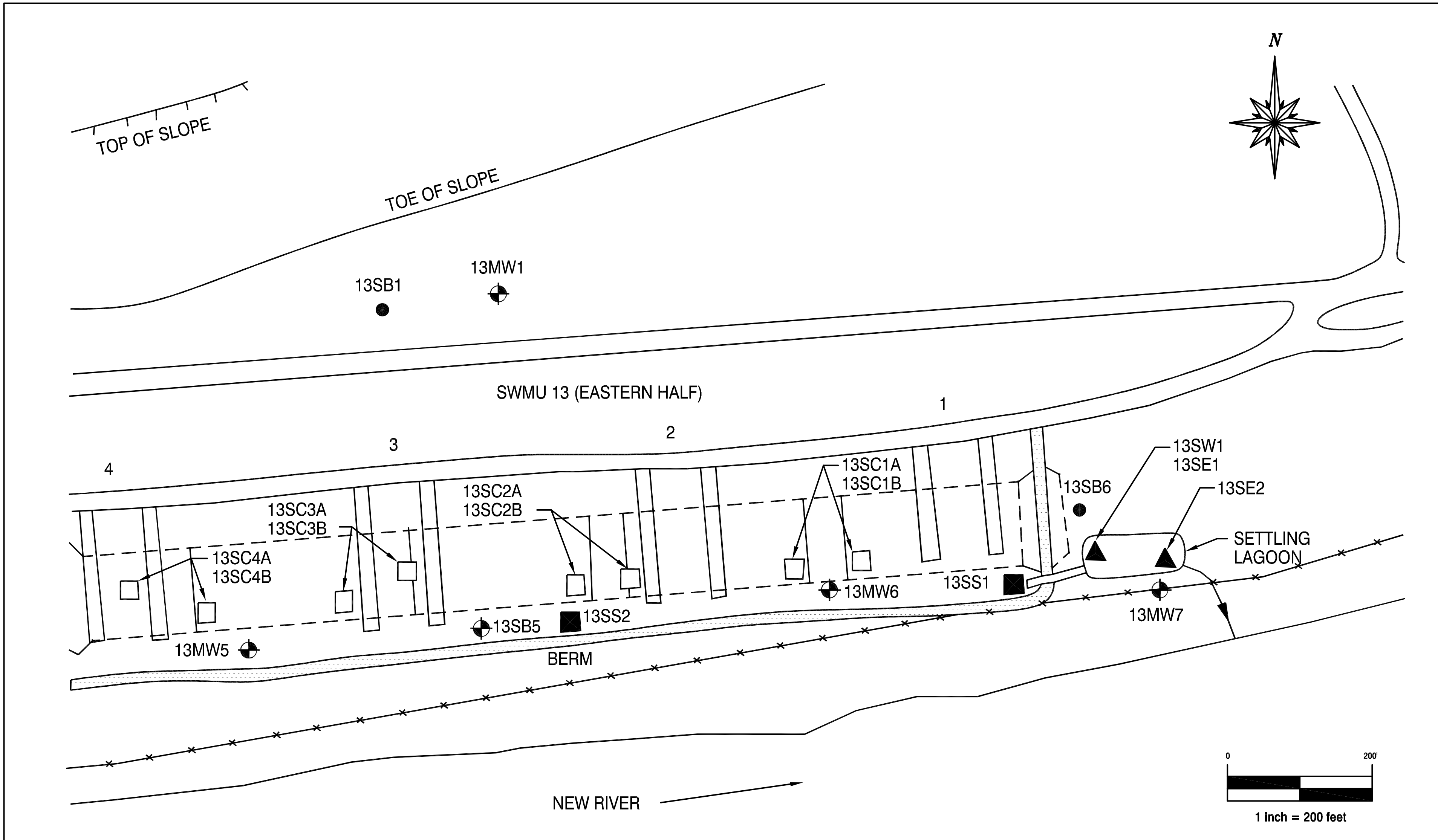
(SOURCE: FROM DAMES & MOORE, 1992b)

RFAAP
SSP REPORT

Date:	Prepared By:
June 2004	*KDC/TDH*
Scale:	**File Name:**
1"=200'	*15900619*

FIGURE 4-3

MONITORING WELL, BORINGS, AND SAMPLE LOCATIONS WESTERN HALF SWMU 13



Legend

Soil Sampling Location	Original Burning Pads Outline
Monitoring Well	Surface Water/Sediment Sample
Soil Composite Sample	
Soil Boring	

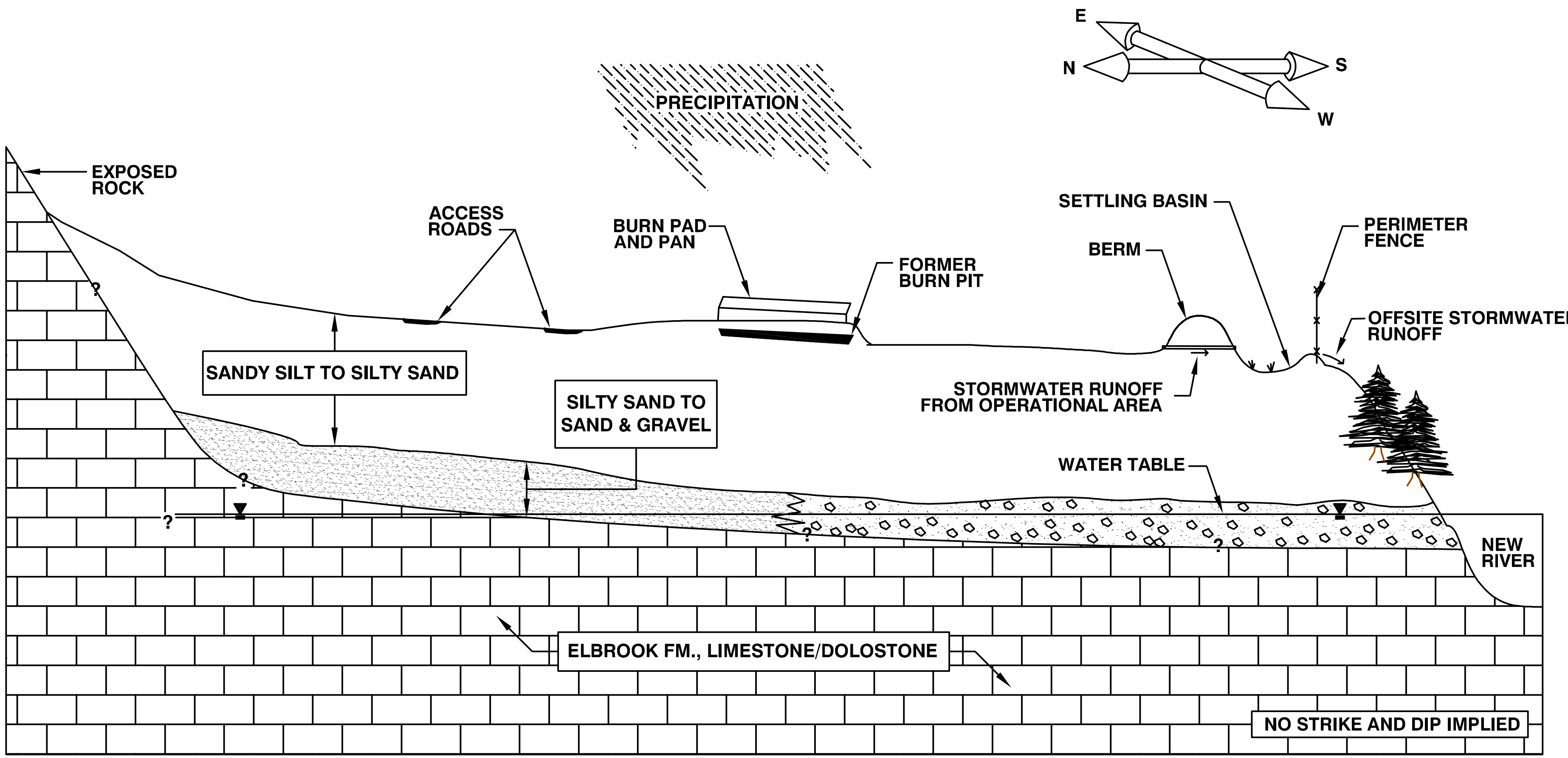
(SOURCE: FROM DAMES & MOORE, 1992b)

RFAAP
SSP REPORT

Date: *June 2004*	**Prepared By:** *KDC/TDH*
Scale: *1"=200'*	**File Name:** *15900619*

FIGURE 4-4

MONITORING WELLS, BORINGS, AND SAMPLE LOCATIONS EASTERN HALF SWMU 13



CONCEPTUAL DRAWING - NO SCALE IMPLIED

NO BEDROCK TOPOGRAPHY IMPLIED

RFAAP
SSP REPORT

Date: June 2004	Prepared By: KDC/TDH
Scale: Not to Scale	File Name: 15900619

FIGURE 4-5

CONCEPTUAL SITE MODEL SWMU 13

Table 4-1
Summary of Analytical Data for Soil Samples Collected at SWMU 13
Modified from Dames and Moore SWMU 13 RFI Investigation Report
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

SITE ID		13SB1	13SB1	13SB1	13SB2D	13SB2	13SB2	13SB2				Facility-
FIELD ID		RFIS*1	RFIS*2	RFIS*3	RFIS*19	RFIS*4	RFIS*5	RFIS*6	Adjusted	Adjusted	Draft	Wide
SAMPLE DATE		20-Aug-91	20-Aug-91	20-Aug-91	26-Aug-91	26-Aug-91	26-Aug-91	26-Aug-91	Soil	Soil	BTAG	Background
DEPTH (ft bgs)		0.5	5.0	10.0	0.5	0.5	5.0	10.0	Industrial	Residential	Screening	Point
MATRIX	PQLs	CSO	CSO	CSO	CSO	CSO	CSO	CSO	RBC	RBC	Level	Estimates(A)
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
TAL Metals												
Aluminum	14.1	14,000	12,000	19,100	12,900	12,500	11,400	16,600	102,200	7,821	1	40,041
Arsenic	30	1.2B	0.72B	1.1B	1.9B	1.4B	0.966B	1.26B	1.91	0.43	328	15.8
Barium	1	228	195	246	185	177	125	151	7,154	548	440	209
Beryllium	0.2	3.02	2.60	3.77	2.01	1.75	1.68	1.81	204	15.6	0.02	1.02
Cadmium	2	<0.7	<0.7	<0.7	<0.7	1.15	<0.7	<0.7	102	7.8	3	0.69
Calcium	100	2530	1970	2700	2850	2730	2040	2150	--	--	--	--
Chromium(1)	4	28.4	25.4	34.5	25.9	25.9	22.6	29.7	307	23.5	0.0075	65.3
Cobalt	3	14.1	14.5	18.6	11.9	11.6	11.2	16.5	2,044	156	100	72.3
Copper	7	12.7	12.4	17.7	15.4	11.3	8.17	12.4	4,088	313	15	53.5
Iron	1000	23,400	22,900	30,300	23,000	20,300	17,900	25,000	30,660	2,346	12	50,962
Lead(2)	2	33.6	16.8	20.4	98.6	65.7	<10.5	17.8	750	400	0.01	26.8
Magnesium	50	4,310	4,330	5,470	4,030	3,900	3,630	4,840	--	--	4,400	--
Manganese(3)	0.275	922	795	939	897	749	517	692	2,044	156	330	2,543
Mercury(4)	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	31	2.3	0.058	0.13
Nickel	3	19	17.2	23.4	15.9	15.9	14.3	19.3	2,044	156	2	62.8
Potassium	37.5	1,460	1300B	1,690	1,880	1,670	1,210B	1,580	--	--	--	--
Silver	4	0.968	0.94	1.21	0.86	0.704	0.825	1.05	511	39.1	0.000098	--
Sodium	150	302B	302B	305B	268B	297B	290B	289B	--	--	--	--
Thallium	20	<6.62	<6.62	<6.62	<6.62	<6.62	<6.62	<6.62	7.15	0.548	0.001	2.11
Vanadium	0.775	37.9	36.7	51.3	34.2	32.3	31	43.2	102	7.8	0.5	108
Zinc	30.2	129	95.8	108	297	223	70.1	86.9	30,660	2,346	10	202

Table 4-1 (Continued)
Summary of Analytical Data for Soil Samples Collected at SWMU 13
Modified from Dames and Moore SWMU 13 RFI Investigation Report
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

SITE ID FIELD ID SAMPLE DATE DEPTH (ft bgs) MATRIX UNITS	PQLs mg/kg	13SB1 RFIS*1 20-Aug-91 0.5 CSO mg/kg	13SB1 RFIS*2 20-Aug-91 5.0 CSO mg/kg	13SB1 RFIS*3 20-Aug-91 10.0 CSO mg/kg	13SB2D RFIS*19 26-Aug-91 0.5 CSO mg/kg	13SB2 RFIS*4 26-Aug-91 0.5 CSO mg/kg	13SB2 RFIS*5 26-Aug-91 5.0 CSO mg/kg	13SB2 RFIS*6 26-Aug-91 10.0 CSO mg/kg	Adjusted Soil Industrial RBC mg/kg	Adjusted Soil Residential RBC mg/kg	Draft BTAG Screening Level mg/kg	Facility-Wide Background Point Estimates(A) mg/kg
Explosives												
1,3,5-Trinitrobenzene	0.488	<0.488	<0.488	<0.488	<0.488	<0.488	<0.488	<0.488	3,066	235	--	--
1,3-Dinitrobenzene	0.496	<0.496	<0.496	<0.496	<0.496	<0.496	<0.496	<0.496	10.2	0.782	--	--
2,4,6-Trinitrotoluene	0.456	<0.456	<0.456	<0.456	<0.456	<0.456	<0.456	<0.456	95	21.3	--	--
2,4-Dinitrotoluene	0.424	<0.424	<0.424	<0.424	<0.424	<0.424	<0.424	<0.424	204	16	--	--
2,6-Dinitrotoluene	0.524	<0.524	<0.524	<0.524	<0.524	<0.524	<0.524	<0.524	102	7.82	--	--
HMX	0.666	<0.666	<0.666	<0.666	<0.666	<0.666	<0.666	<0.666	5,110	391	--	--
Volatiles												
1,1,1-Trichloroethane	0.005	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.005	28,616	2,190	0.3	--
Acetone	0.1	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	91,980	7039	--	--
Toluene	0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	20,440	1,564	0.1	--
Trichloroethylene	0.005	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	7.15	1.60	0.3	--
Trichlorofluoromethane	0.005	<0.006	<0.006	<0.006	<0.006	<0.006	0.006	<0.006	30,660	2,346	--	--
Semi-Volatiles												
2,4-Dinitrotoluene	0.3	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	204	16	--	--
2,6-Dinitrotoluene	0.3	<0.085	<0.085	<0.085	<0.085	<0.085	<0.085	<0.085	102	7.82	--	--
Bis(2-ethylhexyl)Phthalate	0.3	<0.62	<0.62	<0.62	<0.62	<0.62	<0.62	<0.62	410	46	--	--
Di-N-Butyl Phthalate	0.3	<0.061	<0.061	<0.061	<0.061	<0.061	<0.061	<0.061	10,220	782	--	--
Diethyl Phthalate	0.3	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	81,760	6,257	--	--
N-Nitrosodiphenylamine	0.3	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	0.5	0.01	--	--

Table 4-1 (Continued)
Summary of Analytical Data For Soil Samples Collected at SWMU 13
Modified from Dames and Moore RFI Investigation Report
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

SITE ID		13SB3	13SB3	13SB3	13SB4	13SB4	13SB4	13SB5				Facility-Wide
FIELD ID		RFIS*7	RFIS*8	RFIS*9	RFIS*10	RFIS*11	RFIS*12	RFIS*13	Adjusted	Adjusted	Draft	Background
SAMPLE DATE		26-Aug-91	26-Aug-91	26-Aug-91	28-Aug-91	28-Aug-91	28-Aug-91	22-Aug-91	Soil	Soil	BTAG	Point
DEPTH (ft bgs)		0.5	5.0	10.0	0.5	5.0	10.0	0.5	Industrial	Residential	Screening	Estimates[(A)]
MATRIX	PQLs	CSO	CSO	CSO	CSO	CSO	CSO	CSO	RBC	RBC	Level	
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
TAL Metals												
Aluminum	14.1	14,200	8,900	7,910	3,280B	8,120	14,100	8,840	102,200	7,821	1	40,041
Arsenic	30	**3.08**	0.436B	0.391B	0.961B	0.535B	0.92B	1.09B	1.91	0.43	328	15.8
Barium	0.2	199	96.5	74.8	43.7	98.7	175	104	7,154	548	440	209
Beryllium	0.2	<u>2.42</u>	<u>1.57</u>	<u>1.11</u>	<0.5	<u>1.31</u>	<u>2.11</u>	<u>1.54</u>	204	15.6	0.02	1.02
Cadmium	2	<u>0.958</u>	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	102	7.8	3	0.69
Calcium	100	2240	1920	1540	16200	1830	2930	3810	--	--	--	--
Chromium[(1)]	4	24.0	19.0	16.2	8.51	18.1	30	20	307	23.5	0.0075	65.3
Cobalt	3	13.9	8.63	7.01	2.64	8.01	13.1	8.02	2,044	156	100	72.3
Copper	7	16.7	6.62B	4.98B	<u>99.5</u>	7.99	12.2	11.5	4,088	313	15	53.5
Iron	1000	**38,500**	13,600	11,500B	6,570B	13,100	20,300	13,900	30,660	2,346	12	50,962
Lead[(2)]	2	<u>258</u>	<10.5	<10.5	<u>367</u>	13.7	17.9	<u>110</u>	750	400	0.01	26.8
Magnesium	50	3,100	2,910	2,470	3,670	2,730	3,950	3,100	--	--	4,400	--
Manganese[(3)]	0.275	1,650	369	282B	161B	360	690	437	2,044	156	330	2,543
Mercury[(4)]	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	31	2.3	0.058	0.13
Nickel	3	16.7	12.4	9.58	3.98	11.1	18.3	11.8	2,044	156	2	62.8
Potassium	37.5	1610	1110B	1020B	707B	978B	1150B	1420	--	--	--	--
Silver	4	0.971	0.74	0.719	<0.589	0.686	0.957	0.811	511	39.1	0.000098	--
Sodium	150	272B	307B	322B	272B	333B	322B	300B	--	--	--	--
Thallium	20	<6.62	<6.62	<6.62	<6.62	<6.62	<6.62	<6.62	7.15	0.548	0.001	2.11
Vanadium	0.775	38.5	23.2	21	11.3	21.4	34.4	22.7	102	7.8	0.5	108
Zinc	30.2	<u>821</u>	59.2	46.2	72.5	59.5	91.3	93.5	30,660	2,346	10	202

Table 4-1 (Continued)
Summary of Analytical Data For Soil Samples Collected at SWMU 13
Modified from Dames and Moore RFI Investigation Report
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

SITE ID		13SB3	13SB3	13SB3	13SB4	13SB4	13SB4	13SB5				Facility-
FIELD ID		RFIS*7	RFIS*8	RFIS*9	RFIS*10	RFIS*11	RFIS*12	RFIS*13	Adjusted	Adjusted	Draft	Wide
SAMPLE DATE		26-Aug-91	26-Aug-91	26-Aug-91	28-Aug-91	28-Aug-91	28-Aug-91	22-Aug-91	Soil	Soil	BTAG	Background
DEPTH (ft bgs)		0.5	5.0	10.0	0.5	5.0	10.0	0.5	Industrial	Residential	Screening	Point
MATRIX	PQLs	CSO	CSO	CSO	CSO	CSO	CSO	CSO	RBC	RBC	Level	Estimates[(A)]
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
Explosives												
1,3,5-Trinitrobenzene	0.488	<0.488	<0.488	<0.488	<0.488	<0.488	<0.488	<0.488	3,066	235	--	--
1,3-Dinitrobenzene	0.496	<0.496	<0.496	<0.496	<0.496	<0.496	<0.496	<0.496	10.2	0.782	--	--
2,4,6-Trinitrotoluene	0.456	<0.456	<0.456	<0.456	<0.456	<0.456	<0.456	<0.456	95	21.3	--	--
2,4-Dinitrotoluene	0.424	<0.424	<0.424	<0.424	<0.424	<0.424	<0.424	<0.424	204	16	--	--
2,6-Dinitrotoluene	0.524	<0.524	<0.524	<0.524	<0.524	<0.524	<0.524	<0.524	102	7.82	--	--
HMX	0.666	<0.666	<0.666	<0.666	<0.666	<0.666	<0.666	<0.666	5,110	391	--	--
Volatiles												
1,1,1-Trichloroethane	0.005	<0.004	<0.004	<0.004	<0.004B	<0.004B	<0.004B	<0.004	28,616	2,190	0.3	--
Acetone	0.1	<0.017	<0.017	<0.017	<0.017B	<0.017B	<0.017B	<0.017	91,980	7039	--	--
Toluene	0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	20,440	1,564	0.1	--
Trichloroethylene	0.005	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	7.15	1.60	0.3	--
Trichlorofluoromethane	0.005	<0.006	<0.006	<0.006	<0.006B	<0.006B	<0.006B	<0.006B	30,660	2,346	--	--
Semi-Volatiles												
2,4-Dinitrotoluene	0.3	<0.07	<0.14	<0.14	1.76	<0.14	<0.14	<0.14	204	16	--	--
2,6-Dinitrotoluene	0.3	<0.425	<0.085	<0.085	<0.425	<0.085	<0.085	<0.085	102	7.82	--	--
Bis(2-ethylhexyl)Phthalate	0.3	<3.1	<0.62	8.67	<3.1	<0.62	<0.62	<0.62	410	46	--	--
Di-N-Butyl Phthalate	0.3	<0.305	<0.061	<0.061	11.7	<0.061	<0.061	0.337	10,220	782	--	--
Diethyl Phthalate	0.3	<1.2	<0.24	<0.24	4.73	<0.24	<0.24	<0.24	81,760	6,257	--	--
N-Nitrosodiphenylamine	0.3	<0.95	<0.19	<0.19	1.29	<0.19	<0.19	<0.19	0.5	0.01	--	--

Table 4-1 (Continued)
Summary of Analytical Data For Soil Samples Collected at SWMU 13
Modified from Dames and Moore RFI Investigation Report
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

SITE ID		13SB5	13SB5	13SB6	13SB6	13SB6	13SC1	13SC1				Facility-
FIELD ID		RFIS*14	RFIS*15	RFIS*16	RFIS*17	RFIS*18	RFIS*21	RFIS*22	Adjusted	Adjusted	Draft	Wide
SAMPLE DATE		22-Aug-91	22-Aug-91	21-Aug-91	21-Aug-91	21-Aug-91	20-Aug-91	20-Aug-91	Soil	Soil	BTAG	Background
DEPTH (ft bgs)		5.0	10.0	0.5	5.0	10.0	0.5	5.0	Industrial	Residential	Screening	Point
MATRIX	PQLs	CSO	CSO	CSO	CSO	CSO	CSO	CSO	RBC	RBC	Level	Estimates(A)
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
TAL Metals												
Aluminum	14.1	8,270	16,400	10,100	8,080	10,800	8,420	8,430	102,200	7,821	1	40,041
Arsenic	30	<0.25B	<0.5B	1.11B	0.562B	0.507B	0.509B	0.684B	1.91	0.43	328	15.8
Barium	1	94.5	188	128	108	133	118	157	7,154	548	440	209
Beryllium	0.2	1.35	2.46	1.40	1.43	1.51	1.35	1.79	204	15.6	0.02	1.02
Cadmium	2	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	102	7.8	3	0.69
Calcium	100	1480	3330	2520	2200	2370	1750	1990	--	--	--	--
Chromium(1)	4	17.6	32.8	21.7	17.2	22.2	19	20.7	307	23.5	0.0075	65.3
Cobalt	3	8.11	14.7	9.11	7.88	10.6	8.92	10.2	2,044	156	100	72.3
Copper	7	5.89B	12.2	11.1	15	8.41	6.83B	8.24	4,088	313	15	53.5
Iron	1000	12,200B	21,900	17,800	12,600	16,200	14,200	16,100	30,660	2,346	12	50,962
Lead(2)	2	<10.5	17.3	108	<10.5	<10.5	<10.5	<10.5	750	400	0.01	26.8
Magnesium	50	2,660	4,370	2,800	2,680	3,320	2,820	3,020	--	--	4,400	--
Manganese(3)	0.275	332	586	643	363	468	514	580	2,044	156	330	2,543
Mercury(4)	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	31	2.3	0.058	0.13
Nickel	3	11.2	21.2	12.2	11.1	14.5	11.9	13.4	2,044	156	2	62.8
Potassium	37.5	1390B	1,450	1,480	1,060B	1,290B	1,080B	915B	--	--	--	--
Silver	150	0.685	1.2	0.764	<0.589	0.89	0.67	0.717	511	39.1	0.000098	--
Sodium	4	273B	381B	261B	313B	300B	629B	463B	--	--	--	--
Thallium	20	<6.62	<6.62	<6.62	<6.62	<6.62	<6.62	<6.62	7.15	0.548	0.001	2.11
Vanadium	0.775	21	38.9	27.1	20.7	27.5	22.7	24.4	102	7.8	0.5	108
Zinc	30.2	60.2	97.8	213	62.8	72	67.6	72.4	30,660	2,346	10	202

Table 4-1 (Continued)
Summary of Analytical Data For Soil Samples Collected at SWMU 13
Modified from Dames and Moore RFI Investigation Report
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

SITE ID		13SB5	13SB5	13SB6	13SB6	13SB6	13SC1	13SC1				Facility-
FIELD ID		RFIS*14	RFIS*15	RFIS*16	RFIS*17	RFIS*18	RFIS*21	RFIS*22	Adjusted	Adjusted	Draft	Wide
SAMPLE DATE		22-Aug-91	22-Aug-91	21-Aug-91	21-Aug-91	21-Aug-91	20-Aug-91	20-Aug-91	Soil	Soil	BTAG	Background
DEPTH (ft bgs)		5.0	10.0	0.5	5.0	10.0	0.5	5.0	Industrial	Residential	Screening	Point
MATRIX	PQLs	CSO	CSO	CSO	CSO	CSO	CSO	CSO	RBC	RBC	Level	Estimates(A)
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
Explosives												
1,3,5-Trinitrobenzene	0.488	<0.488	<0.488	<0.488	<0.488	<0.488	<0.488	<0.488	3,066	235	--	--
1,3-Dinitrobenzene	0.496	<0.496	<0.496	<0.496	<0.496	<0.496	<0.496	<0.496	10.2	0.782	--	--
2,4,6-Trinitrotoluene	0.456	<0.456	<0.456	29C	<0.456	<0.456	<0.456	<0.456	95	21.3	--	--
2,4-Dinitrotoluene	0.424	<0.424	<0.424	0.761C	<0.424	<0.424	<0.424	<0.424	204	16	--	--
2,6-Dinitrotoluene	0.524	<0.524	<0.524	<0.524	<0.524	<0.524	<0.524	<0.525	102	7.82	--	--
HMX	0.666	<0.666	0.945C	<0.666	<0.666	<0.666	0.744C	<0.666	5,110	391	--	--
Volatiles												
1,1,1-Trichloroethane	0.005	<0.004	<0.004	<0.004	<0.004B	0.005	<0.004	<0.004	28,616	2,190	0.3	--
Acetone	0.1	<0.017	<0.017	<0.017	<0.017B	<0.017	<0.017	<0.017	91,980	7039	--	--
Toluene	0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	20,440	1,564	0.1	--
Trichloroethylene	0.005	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	7.15	1.60	0.3	--
Trichlorofluoromethane	0.005	<0.006B	<0.006B	<0.006	<0.006B	<0.006	<0.006B	<0.006	30,660	2,346	--	--
Semi-Volatiles												
2,4-Dinitrotoluene	0.3	<0.14	<0.14	0.943	<0.14	<0.14	<0.14	<0.14	204	16	--	--
2,6-Dinitrotoluene	0.3	<0.085	<0.085	0.747	<0.085	<0.085	<0.085	<0.085	102	7.82	--	--
Bis(2-ethylhexyl)Phthalate	0.3	<0.62	<0.62	<0.62	<0.62	7.45	<0.62	<0.62	410	46	--	--
Di-N-Butyl Phthalate	0.3	<0.061	<0.061	0.194	<0.061	<0.061	<0.061	<0.061	10,220	782	--	--
Diethyl Phthalate	0.3	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	81,760	6,257	--	--
N-Nitrosodiphenylamine	0.3	<0.19	<0.19	0.64	<0.19	<0.19	<0.19	<0.19	0.5	0.01	--	--

Table 4-1 (Continued)
Summary of Analytical Data For Soil Samples Collected at SWMU 13
Modified from Dames and Moore RFI Investigation Report
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

SITE ID FIELD ID SAMPLE DATE DEPTH (ft bgs) MATRIX UNITS	PQLs mg/kg	13SC1 RFIS*23 20-Aug-91 10.0 CSO mg/kg	13SC2 RFIS*24 21-Aug-91 0.5 CSO mg/kg	13SC2 RFIS*25 21-Aug-91 5.0 CSO mg/kg	13SC2 RFIS*26 21-Aug-91 10.0 CSO mg/kg	13SC3 RFIS*27 21-Aug-91 0.5 CSO mg/kg	13SC3 RFIS*28 21-Aug-91 5.0 CSO mg/kg	13SC3 RFIS*29 21-Aug-91 10.0 CSO mg/kg	Adjusted Soil Industrial RBC mg/kg	Adjusted Soil Residential RBC mg/kg	Draft BTAG Screening Level mg/kg	Facility-Wide Background Point Estimates(A) mg/kg
TAL Metals												
Aluminum	14.1	10,400	8,960	10,300	11,000	4,110B	9,610	8,750	102,200	7,821	1	40,041
Arsenic	30	0.403B	0.623B	0.569B	0.826B	0.612B	0.736B	0.534B	1.91	0.43	328	15.8
Barium	1	128	132	135	175	76	143	131	7,154	548	440	209
Beryllium	0.2	<u>1.61</u>	<u>1.49</u>	<u>1.34</u>	<u>1.88</u>	0.945	<u>1.37</u>	<u>1.28</u>	204	15.6	0.02	1.02
Cadmium	2	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	102	7.8	3	0.69
Calcium	100	2050	1900	2040	2180	4580	1860	1610	--	--	--	--
Chromium(1)	4	23.7	20.5	22.0	27.2	12.2	21.4	20.0	307	23.5	0.0075	65.3
Cobalt	3	10.4	9.27	10.2	12.4	4.85	10.30	10.5	2,044	156	100	72.3
Copper	7	8.28	9.22	12.7	12.9	23.7	10.1	9.38	4,088	313	15	53.5
Iron	1000	16,200	15,400	16,300	19,600	9,720B	16,000	15,900	30,660	2,346	12	50,962
Lead(2)	2	<10.5	<u>55.6</u>	<10.5	<10.5	<u>320</u>	<10.5	<10.5	750	400	0.01	26.8
Magnesium	50	3,290	3,000	3,420	3,680	2,970	3,180	3,110	--	--	4,400	--
Manganese(3)	0.275	511	518	513	672	319	306	500	2,044	156	330	2,543
Mercury(4)	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	31	2.3	0.058	0.13
Nickel	3	14.1	12.7	14.9	16.6	6.46	13.7	12.3	2,044	156	2	62.8
Potassium	37.5	1,070B	1,610	1,170B	946B	897B	1,970	1,090B	--	--	--	--
Silver	150	0.829	0.858	0.842	<0.589	<0.589	0.81	0.755	511	39.1	0.000098	--
Sodium	4	470B	287B	374B	384B	245B	306B	457B	--	--	--	--
Thallium	20	<6.62	<6.62	<6.62	**<u>9.82</u>**	<6.62	**<u>12</u>**	<6.62	7.15	0.548	0.001	2.11
Vanadium	0.775	27	24.7	27.2	32.5	14	26	26.5	31	2.3	0.5	108
Zinc	30.2	73.5	94.7	73.5	80.6	156	77.2	70.8	30,660	2,346	10	202

Table 4-1 (Continued)
Summary of Analytical Data For Soil Samples Collected at SWMU 13
Modified from Dames and Moore RFI Investigation Report
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

SITE ID / FIELD ID / SAMPLE DATE / DEPTH (ft bgs) / MATRIX / UNITS	PQLs mg/kg	13SC1 RFIS*23 20-Aug-91 10.0 CSO mg/kg	13SC2 RFIS*24 21-Aug-91 0.5 CSO mg/kg	13SC2 RFIS*25 21-Aug-91 5.0 CSO mg/kg	13SC2 RFIS*26 21-Aug-91 10.0 CSO mg/kg	13SC3 RFIS*27 21-Aug-91 0.5 CSO mg/kg	13SC3 RFIS*28 21-Aug-91 5.0 CSO mg/kg	13SC3 RFIS*29 21-Aug-91 10.0 CSO mg/kg	Adjusted Soil Industrial RBC mg/kg	Adjusted Soil Residential RBC mg/kg	Draft BTAG Screening Level mg/kg	Facility-Wide Background Point Estimates(A) mg/kg
Explosives												
1,3,5-Trinitrobenzene	0.488	<0.488	<0.488	<0.488	<0.488	2.9C	<0.488	<0.488	3,066	235	--	--
1,3-Dinitrobenzene	0.496	<0.496	<0.496	<0.496	<0.496	<0.496	<0.496	<0.496	10.2	0.782	--	--
2,4,6-Trinitrotoluene	0.456	<0.456	<0.456	<0.456	<0.456	0.515C	<0.456	<0.456	95	21.3	--	--
2,4-Dinitrotoluene	0.424	<0.424	<0.424	<0.424	<0.424	<0.424	<0.424	<0.424	204	16	--	--
2,6-Dinitrotoluene	0.524	<0.524	<0.524	<0.524	<0.524	1.33C	<0.524	<0.524	102	7.82	--	--
HMX	0.666	<0.666	0.945	<0.666	<0.666	<0.666	<0.666	<0.666	5,110	391	--	--
Volatiles												
1,1,1-Trichloroethane	0.005	0.005	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	28,616	2,190	0.3	--
Acetone	0.1	0.025	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	91,980	7039	--	--
Toluene	0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	20,440	1,564	0.1	--
Trichloroethylene	0.005	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	7.15	1.60	0.3	--
Trichlorofluoromethane	0.005	<0.006	<0.006	<0.006	<0.006	<0.006B	<0.006B	<0.006B	30,660	2,346	--	--
Semi-Volatiles												
2,4-Dinitrotoluene	0.3	<0.14	<0.14	<0.14	<0.14	1.76	<0.14	<0.14	204	16	--	--
2,6-Dinitrotoluene	0.3	<0.085	<0.085	<0.085	<0.085	2.42	<0.085	<0.085	102	7.82	--	--
Bis(2-ethylhexyl)Phthalate	0.3	<0.62	<0.62	<0.62	<0.62	<0.62	<0.62	<0.62	410	46	--	--
Di-N-Butyl Phthalate	0.3	<0.061	<0.061	<0.061	<0.061	0.329	<0.061	<0.061	10,220	782	--	--
Diethyl Phthalate	0.3	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	<0.24	81,760	6,257	--	--
N-Nitrosodiphenylamine	0.3	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	0.5	0.01	--	--

Table 4-1 (Continued)
Summary of Analytical Data For Soil Samples Collected at SWMU 13
Modified from Dames and Moore RFI Investigation Report
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

SITE ID		13SC4	13SC4	13SC4	13SC5	13SC5	13SC5	13SC6				Facility-
FIELD ID		RFIS*30	RFIS*31	RFIS*32	RFIS*33	RFIS*34	RFIS*35	RFIS*36	Adjusted	Adjusted	Draft	Wide
SAMPLE DATE		22-Aug-91	22-Aug-91	22-Aug-91	26-Aug-91	26-Aug-91	26-Aug-91	27-Aug-91	Soil	Soil	BTAG	Background
DEPTH (ft bgs)		0.5	5.0	10.0	0.5	5.0	10.0	0.5	Industrial	Residential	Screening	Point
MATRIX	PQLs	CSO	CSO	CSO	CSO	CSO	CSO	CSO	RBC	RBC	Level	Estimates(A)
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
TAL Metals												
Aluminum	14.1	4,600	6,890	7,670	9,030	12,800	11,500	2,870B	102,200	7,821	1	40,041
Arsenic	30	1.59B	0.392B	0.463B	0.568B	0.979B	0.669B	0.423B	1.91	0.43	328	15.8
Barium	1	77.1	117	127	136	187	172	36.8B	7,154	548	440	209
Beryllium	0.2	0.886	1.40	1.50	1.16	1.95	1.90	<0.5	204	15.6	0.02	1.02
Cadmium	2	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	102	7.8	3	0.69
Calcium	100	23300	1530	1490	1730	2920	2290	5280	--	--	--	--
Chromium(1)	4	12.0	17.3	18.2	22.3	28.2	25.5	8.68	307	23.5	0.0075	65.3
Cobalt	3	4.92	8.94	9.35	9.71	12.3	12.6	2.64	2,044	156	100	72.3
Copper	7	66.9	8.43B	8.66B	12	12.5	10.9	71.3	4,088	313	15	53.5
Iron	1000	9,980B	14,000	14,500	15,800	21,400	18,700	6,080B	30,660	2,346	12	50,962
Lead(2)	2	406	<10.5	<10.5	76.7	17.4	14.9	293	750	400	0.01	26.8
Magnesium	50	11,600	2,770	2,890	2,970	4,060	3,580	2,750	--	--	4,400	--
Manganese(3)	0.275	352	423	424	535	571	477	126B	2,044	156	330	2,543
Mercury(4)	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	0.098	<0.05	31	2.3	0.058	0.13
Nickel	3	5.79	11.1	11.4	13.3	18.3	15.8	3.5	2,044	156	2	62.8
Potassium	37.5	1,150B	931B	1,000B	1,380	1,110B	1,080B	693B	--	--	--	--
Silver	150	<0.589	<0.589	0.731	0.77	0.871	0.885	<0.589	511	39.1	0.000098	--
Sodium	4	293B	388B	335B	237B	263B	313B	228B	--	--	--	--
Thallium	20	**12.8**	**9.82**	<6.62	**9.7**	**13.9**	**15.8**	<6.62	7.15	0.548	0.001	2.11
Vanadium	0.775	16.4	22.4	24.1	26.8	35.8	31.3	11.6	31	2.3	0.5	108
Zinc	30.2	153	63.2	61	167	93.1	82.3	61.9	30,660	2,346	10	202

Table 4-1 (Continued)
Summary of Analytical Data For Soil Samples Collected at SWMU 13
Modified from Dames and Moore RFI Investigation Report
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

SITE ID FIELD ID SAMPLE DATE DEPTH (ft bgs) MATRIX UNITS	PQLs mg/kg	13SC4 RFIS*30 22-Aug-91 0.5 CSO mg/kg	13SC4 RFIS*31 22-Aug-91 5.0 CSO mg/kg	13SC4 RFIS*32 22-Aug-91 10.0 CSO mg/kg	13SC5 RFIS*33 26-Aug-91 0.5 CSO mg/kg	13SC5 RFIS*34 26-Aug-91 5.0 CSO mg/kg	13SC5 RFIS*35 26-Aug-91 10.0 CSO mg/kg	13SC6 RFIS*36 27-Aug-91 0.5 CSO mg/kg	Adjusted Soil Industrial RBC mg/kg	Adjusted Soil Residential RBC mg/kg	Draft BTAG Screening Level mg/kg	Facility-Wide Background Point Estimates(A) mg/kg
Explosives												
1,3,5-Trinitrobenzene	0.488	<0.488	<0.488	<0.488	<0.488	<0.488	<0.488	<0.488	3,066	235	--	--
1,3-Dinitrobenzene	0.496	<0.496	<0.496	<0.496	<0.496	<0.496	<0.496	<0.496	10.2	0.782	--	--
2,4,6-Trinitrotoluene	0.456	<0.456	<0.456	<0.456	<0.456	<0.456	<0.456	0.918C	95	21.3	--	--
2,4-Dinitrotoluene	0.424	<0.424	<0.424	<0.424	<0.424	<0.424	<0.424	<0.424	204	16	--	--
2,6-Dinitrotoluene	0.524	<0.524	<0.524	<0.524	<0.524	<0.524	<0.524	<0.524	102	7.82	--	--
HMX	0.666	<0.666	0.945	<0.666	<0.666	<0.666	<0.666	<0.666	5,110	391	--	--
Volatiles												
1,1,1-Trichloroethane	0.005	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	28,616	2,190	0.3	--
Acetone	0.1	<0.017	0.025	<0.017	<0.017	<0.017	<0.017	<0.017	91,980	7039	--	--
Toluene	0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	20,440	1,564	0.1	--
Trichloroethylene	0.005	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	7.15	1.60	0.3	--
Trichlorofluoromethane	0.005	<0.006B	<0.006B	<0.006	<0.006	0.007	<0.006	<0.006	30,660	2,346	--	--
Semi-Volatiles												
2,4-Dinitrotoluene	0.3	0.385	<0.14	<0.14	<0.14	<0.14	<0.14	4.6	204	16	--	--
2,6-Dinitrotoluene	0.3	3.3	<0.085	<0.085	<0.085	<0.085	<0.085	<0.425	102	7.82	--	--
Bis(2-ethylhexyl)Phthalate	0.3	<0.62	<0.62	<0.62	<0.62	<0.62	<0.62	<3.1	410	46	--	--
Di-N-Butyl Phthalate	0.3	0.974	<0.061	<0.061	<0.061	<0.061	<0.061	5.18	10,220	782	--	--
Diethyl Phthalate	0.3	1.94	<0.24	<0.24	<0.24	<0.24	<0.24	2.9	81,760	6,257	--	--
N-Nitrosodiphenylamine	0.3	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.95	0.5	0.01	--	--

Table 4-1 (Continued)
Summary of Analytical Data For Soil Samples Collected at SWMU 13
Modified from Dames and Moore RFI Investigation Report
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

SITE ID / FIELD ID / SAMPLE DATE / DEPTH (ft bgs) / MATRIX / UNITS	PQLs mg/kg	13SC6 RFIS*37 27-Aug-91 5.0 CSO mg/kg	13SC6 RFIS*38 27-Aug-91 10.0 CSO mg/kg	13SC7 RFIS*39 28-Aug-91 0.5 CSO mg/kg	13SC7 RFIS*40 28-Aug-91 5.0 CSO mg/kg	13SC7 RFIS*41 28-Aug-91 10.0 CSO mg/kg	13SC8 RFIS*42 29-Aug-91 0.5 CSO mg/kg	13SC8 RFIS*43 29-Aug-91 5.0 CSO mg/kg	Adjusted Soil Industrial RBC mg/kg	Adjusted Soil Residential RBC mg/kg	Draft BTAG Screening Level mg/kg	Facility-Wide Background Point Estimates[(A)] mg/kg
TAL Metals												
Aluminum	14.1	8,440	7,480	5,630	6,060	5,750	9,830	4,860	102,200	7,821	1	40,041
Arsenic	30	0.579B	0.643B	0.695B	0.415B	0.506B	2.4B	0.388B	1.91	0.43	328	15.8
Barium	1	127	107	74.4	103	88.6	214	69.1	7,154	548	440	209
Beryllium	0.2	1.29	1.16	1.26	1.50	1.26	2.82	1.21	204	15.6	0.02	1.02
Cadmium	2	<0.7	<0.7	<0.7	<0.7	<0.7	0.904	<0.7	102	7.8	3	0.69
Calcium	100	1,670	1,410	11,700	1,630	1,160	18,700	905	--	--	--	--
Chromium[(1)]	4	23.2	18.0	13.8	16.2	14.9	22.6	13.20	307	23.5	0.0075	65.3
Cobalt	3	8.78	9.77	5.42	8.0	7.7	12.0	6.62	2,044	156	100	72.3
Copper	7	11.1	7.72B	38.3	16.8	7.38B	43.9	4.62B	4,088	313	15	53.5
Iron	1000	14,300	14,900	12,300B	12,700B	12,200B	**34,100**	10,200B	30,660	2,346	12	50,962
Lead[(2)]	2	<10.5	<10.5	210	<10.5	<10.5	575	<10.5	750	400	0.01	26.8
Magnesium	50	2,980	2,900	4,950	2,490	2,330	8,360	2,050	--	--	4,400	--
Manganese[(3)]	0.275	423	428	339	395	349	1,490	267	2,044	156	330	2,543
Mercury[(4)]	0.1	<0.05	<0.05	<0.05	0.161	<0.05	0.106	0.081	31	2.3	0.058	0.13
Nickel	3	15.1	11.5	8.22	9.66	9.06	13	7.77	2,044	156	2	62.8
Potassium	37.5	1,180B	863B	1,130B	800B	761B	1,830	1,310	--	--	--	--
Silver	150	0.68	<0.589	<0.589	<0.589	<0.589	0.889	<0.589	511	39.1	0.000098	--
Sodium	4	266B	254B	245B	253B	239B	301B	223B	--	--	--	--
Thallium	20	**11.7**	**16.9**	**9.63**	**9.47**	**10.8**	**25.8**	<6.62	7.15	0.548	0.001	2.11
Vanadium	0.775	24.5	23.9	18.3	20.8	19.5	37	15.7	102	7.8	0.5	108
Zinc	30.2	62.5	59	88.4	52.8	48.5	723	43.1	30,660	2,346	10	202

Table 4-1 (Continued)
Summary of Analytical Data For Soil Samples Collected at SWMU 13
Modified from Dames and Moore RFI Investigation Report
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

SITE ID FIELD ID SAMPLE DATE DEPTH (ft bgs) MATRIX UNITS	PQLs mg/kg	13SC6 RFIS*37 27-Aug-91 5.0 CSO mg/kg	13SC6 RFIS*38 27-Aug-91 10.0 CSO mg/kg	13SC7 RFIS*39 28-Aug-91 0.5 CSO mg/kg	13SC7 RFIS*40 28-Aug-91 5.0 CSO mg/kg	13SC7 RFIS*41 28-Aug-91 10.0 CSO mg/kg	13SC8 RFIS*42 29-Aug-91 0.5 CSO mg/kg	13SC8 RFIS*43 29-Aug-91 5.0 CSO mg/kg	Adjusted Soil Industrial RBC mg/kg	Adjusted Soil Residential RBC mg/kg	Draft BTAG Screening Level mg/kg	Facility-Wide Background Point Estimates[(A)] mg/kg
Explosives												
1,3,5-Trinitrobenzene	0.488	<0.488	<0.488	<0.488	<0.488	<0.488	<0.488	<0.488	3,066	235	--	--
1,3-Dinitrobenzene	0.496	<0.496	<0.496	<0.496	<0.496	<0.496	<0.496	<0.496	10.2	0.782	--	--
2,4,6-Trinitrotoluene	0.456	<0.456	<0.456	<0.456	<0.456	<0.456	<0.456	<0.456	95	21.3	--	--
2,4-Dinitrotoluene	0.424	<0.424	<0.424	<0.424	<0.424	<0.424	<0.424	<0.424	204	16	--	--
2,6-Dinitrotoluene	0.524	<0.524	<0.524	<0.524	<0.524	<0.524	<0.524	<0.524	102	7.82	--	--
HMX	0.666	<0.666	<0.666	<0.666	<0.666	<0.666	<0.666	<0.666	5,110	391	--	--
Volatiles												
1,1,1-Trichloroethane	0.005	<0.004	0.004	<0.004B	<0.004B	<0.004B	<0.004B	<0.004B	28,616	2,190	0.3	--
Acetone	0.1	<0.017	0.017	<0.017B	<0.017B	<0.017B	<0.017B	<0.017B	91,980	7039	--	--
Toluene	0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	20,440	1,564	0.1	--
Trichloroethylene	0.005	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	7.15	1.60	0.3	--
Trichlorofluoromethane	0.005	<0.006	<0.006	<0.006B	<0.006B	<0.006B	<0.006	<0.006	30,660	2,346	--	--
Semi-Volatiles												
2,4-Dinitrotoluene	0.3	<0.14	<0.14	<0.07	<0.14	<0.14	<0.14	<0.14	204	16	--	--
2,6-Dinitrotoluene	0.3	<0.085	<0.085	<0.425	<0.085	<0.085	<0.085	<0.085	102	7.82	--	--
Bis(2-ethylhexyl)Phthalate	0.3	<0.62	<0.62	<3.1	<0.62	<0.62	<0.62	<0.62	410	46	--	--
Di-N-Butyl Phthalate	0.3	<0.061	<0.061	0.581	<0.061	<0.061	<0.061	<0.061	10,220	782	--	--
Diethyl Phthalate	0.3	<0.24	<0.24	1.23	<0.24	<0.24	<0.24	<0.24	81,760	6,257	--	--
N-Nitrosodiphenylamine	0.3	<0.19	<0.19	<0.95	<0.19	<0.19	<0.19	<0.19	0.5	0.01	--	--

Table 4-1 (Continued)
Summary of Analytical Data For Soil Samples Collected at SWMU 13
Modified from Dames and Moore RFI Investigation Report
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

SITE ID FIELD ID SAMPLE DATE DEPTH (ft bgs) MATRIX UNITS	PQLs mg/kg	13SC8 RFIS*44 29-Aug-91 10.0 CSO mg/kg	13SE1 RFIS*52 9-Oct-91 1.0 CSE mg/kg	13SE2 RFIS*53 9-Oct-91 1.0 CSE mg/kg	13SS1 RFIS*47 9-Oct-91 0.5 CSO mg/kg	13SS1D RFIS*51 9-Oct-91 0.5 CSO mg/kg	13SS2 RFIS*48 9-Oct-91 0.5 CSO mg/kg	13SS3 RFIS*49 29-Aug-91 0.5 CSO mg/kg	13SS4 RFIS*50 27-Aug-91 0.5 CSO mg/kg	Adjusted Soil Industrial RBC mg/kg	Adjusted Soil Residential RBC mg/kg	Draft BTAG Screening Level (Soil/Sediment) mg/kg	Facility-Wide Background Point Estimates[(A)] mg/kg
TAL Metals													
Aluminum	14.1	5,800	9,230B	29,100	7,890B	8,160B	5,840B	6,460	13,000	102,200	7,821	1/--	40,041
Arsenic	30	0.549B	1.91B	**4.2**	2.06B	1.78B	1.25B	1.1B	2.71B	1.91	0.43	328/0.057	15.8
Barium	1	79.4	131	351	128	132	110	102	225	7,154	548	440/--	209
Beryllium	0.2	0.878	<0.5	1.36	<0.5	<0.5	<0.5	1.27	2.52	204	15.6	0.02/--	1.02
Cadmium	2	<0.7	<0.7	1.45	<0.7	1.23	<0.7	<0.7	<0.7	102	7.8	2.5/1.2	0.69
Calcium	100	987	17,500B	9,300B	4,050B	5,730B	6,700B	3700	8580	--	--	--	--
Chromium[(1)]	4	14.4	21.9B	53.4	24.4B	30.5B	14.4B	21.60	25.4	307	23.5	0.0075/0.005	65.3
Cobalt	3	7.02	8.36	24.40	7.56	7.26	4.81	7.39	17.3	2,044	156	100/--	72.3
Copper	7	6.07B	64.60	99.4	59.60	69.9	26.3	108	55.4	4,088	313	15/34	53.5
Iron	1000	11600B	16,200	**39,700**	16,100	15,200	11,000	12,600B	28,000	30,660	2,346	12/--	50,962
Lead[(2)]	2	<10.5	475	731	986	**1,050**	478	762	376	750	400	0.01/46.7	26.8
Magnesium	50	2,310	8,540	9,310	2,270B	2,780B	4,030B	2,730	6,870	--	--	4,400/--	--
Manganese[(3)]	0.275	289	531	1,320	729	474	314	379	1,570	2,044	156	330/--	2,543
Mercury[(4)]	0.1	<0.05	<0.05	0.124	<0.05	0.064	<0.05	0.064	<0.05	31	2.3	0.058/0.15	0.13
Nickel	3	8.6	12	33.3	11.2	14.7	7.36B	12.6	14.7	2,044	156	2/20.9	62.8
Potassium	37.5	1390	1,850	4,880	1,340B	1,410B	1,010B	1,490	2,210	--	--	--	--
Silver	150	<0.589	<0.589	1.03	<0.589	<0.589	<0.589	<0.589	0.793	511	39.1	0.000098/1	--
Sodium	4	266B	342B	428B	326B	335B	452B	284B	261B	--	--	--	--
Thallium	20	**9.82**	<6.62	**14.1**	<6.62	<6.62	<6.62	**16.0**	**26.9**	7.15	0.548	0.001/--	2.11
Vanadium	0.775	18.8	24.2B	64.8	19.1B	19.4B	16.2B	19.5	45.9	102	7.8	0.5/--	108
Zinc	30.2	50.4	390	646	525	507	196	264	375	30,660	2,346	10/150	202

Table 4-1 (Continued)
Summary of Analytical Data For Soil Samples Collected at SWMU 13
Modified from Dames and Moore RFI Investigation Report
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

SITE ID		13SC8	13SE1	13SE2	13SS1	13SS1D	13SS2	13SS3	13SS4	Adjusted Soil Industrial RBC	Adjusted Soil Residential RBC	Draft BTAG Screening Level (Soil/Sediment)	Facility-Wide Background Point Estimates(A)
FIELD ID		RFIS*44	RFIS*52	RFIS*53	RFIS*47	RFIS*51	RFIS*48	RFIS*49	RFIS*50				
SAMPLE DATE		29-Aug-91	9-Oct-91	9-Oct-91	9-Oct-91	9-Oct-91	9-Oct-91	29-Aug-91	27-Aug-91				
DEPTH (ft bgs)		10.0	1.0	1.0	0.5	0.5	0.5	0.5	0.5				
MATRIX	PQLs	CSO	CSE	CSE	CSO	CSO	CSO	CSO	CSO				
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
Explosives													
1,3,5-Trinitrobenzene	0.488	<0.488	1.87C	<0.488	<0.488	<0.488	6.86C	<0.488	<0.488	3,066	235	--	--
1,3-Dinitrobenzene	0.496	<0.496	<0.496	<0.496	<0.496	0.858C	<0.496	<0.496	<0.496	10.2	0.782	--	--
2,4,6-Trinitrotoluene	0.456	<0.456	2.35C	3.94C	4.03C	2.13C	**130C**	<0.456	<0.456	95	21.3	--	--
2,4-Dinitrotoluene	0.424	<0.424	1.26C	1.45C	1.84C	2.15C	10.4C	<0.424	<0.424	204	16	--	--
2,6-Dinitrotoluene	0.524	<0.524	1.26C	<0.524	1.28C	1.33C	4.65C	<0.524	<0.524	102	7.82	--	--
HMX	0.666	<0.666	<0.666	<0.666	<0.666	<0.666U	<0.666	<0.666	<0.666	5,110	391	--	--
Volatiles													
1,1,1-Trichloroethane	0.005	<0.004B	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.005	28,616	2,190	0.3/0.031	--
Acetone	0.1	<0.017B	<0.017B	<0.017B	<0.017	<0.017	<0.017	<0.017	0.025	91,980	7039	--	--
Toluene	0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	20,440	1,564	0.1/--	--
Trichloroethylene	0.005	<0.003	<0.003	<0.003	0.019	0.009	<0.003	<0.003	<0.003	7.15	1.60	0.3/--	--
Trichlorofluoromethane	0.005	<0.006	<0.006B	<0.006B	<0.006	<0.006	<0.006	<0.006	<0.006	30,660	2,346	--	--
Semi-Volatiles													
2,4-Dinitrotoluene	0.3	<0.14	6.14	<1.4	3.44	2.03	11.5	1.17	37.5	204	16	--	--
2,6-Dinitrotoluene	0.3	<0.085	3.61	<0.85	2.02	1.99	5.64	<0.425	1.84	102	7.82	--	--
Bis(2-ethylhexyl)Phthalate	0.3	<0.62	<6.2B	<6.2B	<3.1B	<3.1B	<3.1B	<3.1	<3.1	410	46	--/1.3	--
Di-N-Butyl Phthalate	0.3	<0.061	6.15	1.59	6.88	6.78	27.6	5.86	31.3	10,220	782	--/1.4	--
Diethyl Phthalate	0.3	<0.24	3.72	1.2	13.9	27.3	11.6	17.7	1.89	81,760	6,257	--/0.2	--
N-Nitrosodiphenylamine	0.3	<0.19	4.07	<1.9	2.28	3.74	1.27	1.16	6.21	0.5	0.01	--/0.028	--

Table 4-1 (Continued)
Summary of Analytical Data For Soil Samples Collected at SWMU 13
Modified from Dames and Moore RFI Investigation Report
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

Notes:

B = Analyte was detected in corresponding method blank; values are flagged if the sample concentration is less than 10 times the method blank concentration for common laboratory constituents and 5 times for all other constituents

BTAG = USEPA Region III Draft, Biological Technical Assistance Group Screening Level

C = Indicates that analysis was confirmed using a second column.

CSE = Chemical sediment

CSO = Chemical soil

ft bgs = Feet below ground surface

mg/kg = milligrams per kilograms

PQL = Practical quantitation limit; the lowest concentration that can be reliably detected at a defined level of precision for a given analytical method

RBC = Risk-Based Concentration

USEPA = United States Environmental Protection Agency

USEPA Region III Risk-Based Concentration (RBC) values from the April 14, 2004, RBC Table

Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens

TAL = Target Analyte List

< = Concentration is reported as less than the certified reporting limit

(A) = Facility-Wide Background Point Estimate as Reported in the Facility-Wide Background Study Report (IT 2001a)

(1) = Chromium VI RBC value used

(2) = Lead criteria are Action Levels; see USEPA Region III guidance

(3) = Manganese-nonfood RBC value used

(4) = Mercuric chloride RBC value used

bold = Concentration exceeds Industrial RBC

[double box] = Concentration exceeds Residential RBC

[shaded] = Concentration exceeds Draft BTAG Screening Level

underline = Concentration exceeds Facility-Wide Background Point Estimate

Table 4-2
Summary of Analytical Surface Water Data Collected at SWMU 13
Modified from Dames and Moore SWMU 13 RFI Investigation Report
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

SITE ID		13SW1			
FIELD ID		RDWA*11	Adjusted		Draft
SAMPLE DATE		15-Jan-92	Tap		BTAG
DEPTH (ft bgs)		0.0	Water	MCL	Screening
MATRIX	PQLs	CSW	RBC		Level
UNITS	µg/L	µg/L	µg/L	µg/L	µg/L
TAL Metals					
Aluminum	141	47,500	3,650	--	25
Arsenic	10	2.99	0.045	10	48
Barium	20	495	256	2,000	10,000
Calcium	500	22,200	--	--	--
Chromium(1)	10	78.8	11.0	100	2
Cobalt	70	30.6	73.0	--	35,000
Copper	60	143	146	1,300 (AL)	6.5
Iron	38.1	59,700	1,100	--	320
Lead	10	500	--	15 (AL)	3.2
Magnesium	500	12,400	--	--	--
Manganese(2)	2.75	1,940	73	--	14,500
Nickel	50	43.8	73	--	160
Potassium	375	13,600	--	--	--
Sodium	500	1,830	--	--	--
Vanadium	40	89.9	3.7	--	10,000
Zinc	50	893	1,095	--	30
Explosives					
1,3,5-Trinitrobenzene	0.449	1.18	110	--	--
2,4,6-Trinitrotoluene	0.635	32.9	1.83	--	--
2,4-Dinitrotoluene	0.064	15.8	7.3	--	230
2,6-Dinitrotoluene	0.074	3.71	3.65	--	--
Cyclotetramethylene-tetranitramine	1.21	12.8	183	--	--
Volatiles					
Carbon Disulfide	5	1.25	104	--	2
Semi-Volatiles					
2,4-Dinitrotoluene	10	13.6	7.3	--	230
2,6-Dinitrotoluene	10	2.39	3.65	--	230

Notes:

BTAG = USEPA Region III, Biological Technical Assistance Group Screening Level
CSW = Chemical Surface Water
ft bgs = Feet below ground surface
MCL = Maximum Contaminant Level
PQL = Practical quanitation limit; the lowest concentration that can be reliably detected at a defined level of precision for a given analytical method
RBC = Risk-Based Concentration
USEPA = United States Environmental Protection Agency
USEPA Region III Risk-Based Concentration (RBC) values from the April 14, 2004, RBC Table
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
TAL = Target Analyte List
µg/L = Microgram Per Liter
(AL) = Action Level
(1) = Chromium VI RBC value used
(2) = Manganese-nonfood RBC value used

[bold box] = Concentration exceeds Tap Water RBC
[double box] = Concentration exceeds lead action level
[grey shading] = Concentration exceeds Draft BTAG Screening Level

Table 4-3
Detected Analytes for SWMU 13 (Soil)
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

Sample ID / Sample Date / Sample Depth (ft bgs)	CAS #	C/N	Facility-Wide Background Point Estimate[A]	Adjusted Soil RBC (Residential)	Adjusted Soil RBC (Industrial)	SSL DAF 20	Draft BTAG Screening Level	13SB7A 10/9/2003 0-1		MDL	RL	13SB7B 10/9/2003 5-6		MDL	RL	13SB7C 10/9/2003 10-12		MDL	RL	13SB8A 10/9/2003 0-1		MDL	RL	13SB8B 10/9/2003 3.5-3.7		MDL	RL	13SB9A 10/9/2003 0-1		MDL	RL
								Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r		
TAL Metals (mg/kg)																															
Aluminum	7429-90-5	--	40,041	--	--	--	1	14,000		1.83	50	13,900		1.83	50	21,400		1.83	50	12,600		1.83	50	7,650		1.83	50	20,400		1.83	50
Antimony	7440-36-0	N	--	3.13	40.9	13.2	0.48	<0.5	U	0.0518	0.5	0.12	J,B,p	0.0518	0.5	0.085	J,B,p	0.0518	0.5	0.069	J,B,p	0.0518	0.5	<0.5	U	0.0518	0.5	0.095	J,B,p	0.0518	0.5
Arsenic	7440-38-2	C	15.8	0.43	1.9	0.026	328	***2.5***		0.0232	0.4	***3.5***		0.0232	0.4	***2.4***		0.0232	0.4	***2.4***		0.0232	0.4	***0.65***		0.0232	0.4	***2.7***		0.0232	0.4
Barium	7440-39-3	N	209	1,564	20,440	6,015	440	170		0.106	5	199		0.106	5	208		0.106	5	124		0.106	5	66		0.106	5	175		0.106	5
Beryllium	7440-41-7	N	1.02	15.64	204.4	1,154	0.02	1		0.167	1	0.98	J	0.167	1	1.3		0.167	1	0.66	J	0.0333	1	<1	U	0.0391	1	1.2		0.167	1
Cadmium	7440-43-9	N	0.69	3.91	51.1	27.4	2.5	1.3		0.182	1	1.5		0.182	1	1.3		0.182	1	0.91	J	0.182	1	0.72	J	0.182	1	2.2		0.182	1
Calcium	7440-70-2	--	--	--	--	--	--	2,290	,J,m	16.6	250	2,650	,J,m	16.6	250	2,310	,J,m	16.6	250	3,290	,J,m	16.6	250	1,750	,J,m	16.6	250	1,890	,J,m	16.6	250
Chromium [1]	7440-47-3	N	65.3	23.46	306.6	42.05	0.0075	28	,J,m	0.912	5	30	,J,m	0.912	5	37	,J,m	0.912	5	28	,J,m	0.912	5	19	,J,m	0.912	5	36	,J,m	0.912	5
Cobalt	7440-48-4	--	72.3	--	--	--	100	9	,J,s	0.208	1	13	,J,s	0.208	1	13	,J,s	0.208	1	10	,J,s	0.208	1	6	,J,s	0.208	1	13	,J,s	0.208	1
Copper	7440-50-8	N	53.5	312.86	4,088	10,518	15	13	,J,s	0.368	2	16	,J,s	0.368	2	19	,J,s	0.368	2	18	,J,s	0.368	2	8.3	,J,s	0.368	2	25	,J,s	0.368	2
Iron	7439-89-6	N	50,962	2,346	30,660	--	12	31,000		42.4	200	41,600		42.4	200	41,900		42.4	200	29,200		42.4	200	12,400		21.2	100	36,500		42.4	200
Lead [2]	7439-92-1	--	26.8	400	750	--	0.01	141		0.545	25	235		1.09	50	239		1.09	50	8,620		21.8	1000	46		0.0218	1	434		1.09	50
Magnesium	7439-95-4	--	--	--	--	--	4,400	3,370	,J,m	3.21	250	3,140	,J,m	3.21	250	3,940	,J,m	3.21	250	3,240	,J,m	3.21	250	2,160	,J,m	3.21	250	3,690	,J,m	3.21	250
Manganese	7439-96-5	N	2,543	156.43	2,044	951.9	330	1,040		1.32	25	***1,650***		1.32	25	***1,380***		1.32	25	***1,160***		1.32	25	270		0.264	5	***1,240***		1.32	25
Mercury [3]	7439-97-6	--	0.13	2.35	30.66	--	0.058	0.027	J	0.0077	0.1	0.038	J	0.0077	0.1	0.034	J	0.0077	0.1	0.033	J	0.0077	0.1	0.0087	J	0.0077	0.1	0.043	J	0.0077	0.1
Nickel	7440-02-0	N	62.8	156.43	2,044	--	2	14		0.0356	0.5	13		0.0356	0.5	19		0.0356	0.5	14		0.0356	0.5	7.8		0.0356	0.5	19		0.0356	0.5
Potassium	7440-09-7	--	--	--	--	--	--	1,670		5	100	1,320		5	100	1,890		5	100	1,480		5	100	939		5	100	1,980		5	100
Selenium	7782-49-2	N	--	39.11	511	18.98	1.8	0.57	J	0.0502	1	0.7	J	0.0502	1	0.84	J	0.0502	1	0.66	J	0.0502	1	0.35	J	0.0502	1	0.93	J	0.0502	1
Silver	7440-22-4	N	--	39.11	511	31.03	0.0000098	0.084	J	0.0044	3	0.096	J	0.0044	3	0.11	J	0.0044	3	0.14	J	0.0044	3	0.45	J	0.0044	3	0.12	J	0.0044	3
Sodium	7440-23-5	--	--	--	--	--	--	58	J	18.1	100	46	J	18.1	100	53	J	18.1	100	40	J	18.1	100	63	J	18.1	100	44	J	18.1	100
Thallium	7440-28-0	N	2.11	0.55	7.2	3.6	0.001	0.52	,B,x	0.027	0.5	0.69	,B,x	0.027	0.5	0.86	,B,x	0.027	0.5	0.36	J,B,x	0.027	0.5	0.14	J,B,x	0.027	0.5	0.78	,B,x	0.027	0.5
Vanadium	7440-62-2	N	108	7.82	102.2	730.1	0.5	24		0.207	1	24		0.207	1	36		0.207	1	23		0.207	1	15		0.207	1	37		0.207	1
Zinc	7440-66-6	N	202	2,346	30,660	13,622	10	471		5.17	40	688		5.17	40	847		5.17	40	363		2.59	20	154		2.59	20	1,010		12.9	100
TCL VOCs (µg/kg)																															
1,2,4-Trichlorobenzene	120-82-1	N	--	7.8E+04	1.0E+06	2.4E+03	100	<6.1	U	0.492	6.1	<6.2	U	0.492	6.2	<6.3	U,UJ,m	0.517	6.3	<6.5	U	0.533	6.5	<6.5	U	0.533	6.5	<6.4	U	0.533	6.4
2-Butanone	78-93-3	N	--	4.7E+06	6.1E+07	2.9E+04	--	38		6	24	37		6	25	29	,J,d	6.3	25	30		6.5	26	25	J	6.5	26	41		6.5	26
Acetone	67-64-1	N	--	7.0E+06	9.2E+07	2.2E+04	--	140	,B,z	6	24	130	,B,z	6	25	110	B,B,z	6.3	25	120		6.5	26	77	,B,z	6.5	26	140		6.5	26
Benzene	71-43-2	C	--	1.2E+04	5.2E+04	1.9E+00	100	<6.1	U	0.632	6.1	<6.2	U	0.632	6.2	<6.3	U,UJ,m	0.664	6.3	<6.5	U	0.685	6.5	<6.5	U	0.685	6.5	<6.4	U	0.685	6.4
cis-1,2-Dichloroethene	156-59-2	N	--	7.8E+04	1.0E+06	--	300	<6.1	U	0.852	6.1	<6.2	U	0.852	6.2	<6.3	U	0.895	6.3	<6.5	U	0.923	6.5	<6.5	U	0.923	6.5	<6.4	U	0.923	6.4
Methylene chloride	75-09-2	C	--	8.5E+04	3.8E+05	1.9E+01	300	6.4	J,B,z	3.37	24	6.8	J,B,z	3.37	25	7.2	J,B,z	3.54	25	4.1	J	3.65	26	5.6	J	3.65	26	5.7	J	3.65	26
Tetrachloroethene	127-18-4	C	--	1.2E+03	5.3E+03	4.7E+00	300	<6.1	U	0.736	6.1	<6.2	U	0.736	6.2	<6.3	U,UJ,m	0.772	6.3	<6.5	U	0.797	6.5	<6.5	U	0.797	6.5	<6.4	U	0.797	6.4
Toluene	108-88-3	N	--	6.3E+05	8.2E+06	2.7E+04	100	<6.1	U	0.557	6.1	<6.2	U	0.557	6.2	<6.3	U,UJ,m	0.585	6.3	0.66	J	0.603	6.5	<6.5	U	0.603	6.5	2.7	J	0.603	6.4
Trichloroethene	79-01-6	C	--	1.6E+03	7.2E+03	2.6E-01	300	<6.1	U	0.812	6.1	<6.2	U	0.812	6.2	<6.3	U	0.853	6.3	<6.5	U	0.88	6.5	<6.5	U	0.88	6.5	<6.4	U	0.88	6.4
VOC TICs (µg/kg)																															
Ethyl Ether	60-29-7	N	--	1.6E+06	2.0E+07	8.5E+03	--	NI				NI				NI				NI				NI				NI			
Hexanal	66-25-1	--	--	--	--	--	--	13	E,NJ,t	0	1	NI				NI				NI				NI				NI			
TCL SVOCs (µg/kg)																															
2-Methylnaphthalene	91-57-6	N	--	3.1E+04	4.1E+05	4.4E+03	--	<210	U	3.29	210	<210	U	3.29	210	<220	U	3.56	220	22	J	3.56	220	<220	U	3.56	220	<220	U	3.56	220
2,4-Dinitrotoluene	121-14-2	N	--	1.6E+04	2.0E+05	5.7E+02	--	<210	U	3.78	210	<210	U	3.78	210	<220	U	4.1	220	<220	U	4.1	220	<220	U	4.1	220	220	J	4.1	220
2,6-Dinitrotoluene	606-20-2	N	--	7.8E+03	1.0E+05	2.5E+02	--	<210	U	33.2	210	<210	U	33.2	210	<220	U	36	220	<220	U	36	220	<220	U	36	220	<220	U	36	220
Dinitrotoluene Mix	--	C	--	9.4E+02	4.2E+03	--	--	ND				ND				ND				ND				ND				220			
4-Chloro-3-Methylphenol	59-50-7	--	--	--	--	--	--	19	J	6.25	210	16	J	6.25	210	8	J	6.77	220	<220	U	6.77	220	24	J	6.77	220	25	J	6.77	220
Acenaphthene	83-32-9	N	--	4.7E+05	6.1E+06	1.0E+05	100	<210	U	2.06	210	<210	U	2.06	210	<220	U	2.24	220	19	J	2.24	220	<220	U	2.24	220	10	J	2.24	220
Acenaphthylene [4]	208-96-8	N	--	2.3E+05	3.1E+06	--	100	<210	U	1.8	210	<210	U	1.82	210	<220	U	1.95	220	2	J	1.95	220	<220	U	1.95	220	7	J	1.95	220
Anthracene	120-12-7	N	--	2.3E+06	3.1E+07	4.7E+05	100	<210	U	5.54	210	<210	U	5.54	210	<220	U	6.01	220	37	J	6.01	220	<220	U	6.01	220	25	J	6.01	220
Benzo(a)anthracene	56-55-3	C	--	2.2E+02	3.9E+03	4.8E+02	100	<210	U	16	210	<210	U	16	210	<220	U	17.3	220	100	J	17.3	220	<220	U	17.3	220	200	J	17.3	220
Benzo(a)pyrene	50-32-8	C	--	2.2E+01	3.9E+02	1.2E+02	100	18	J	6.85	210	11	J	6.85	210	<220	U	7.42	220	120	J	7.42	220	21	J	7.42	220	***140***	J	7.42	220
Benzo(b)fluoranthene	205-99-2	C	--	2.2E+02	3.9E+03	1.5E+03	100	25	J,J,l	11.7	210	17	J,J,l	11.7	210	<220	U	12.7	220	180	J	12.7	220	36	J	12.7	220	240		12.7	220
Benzo(g,h,i)perylene [4]	191-24-2	N	--	2.3E+05	3.1E+06	--	100	11	J,J,l	10.5	210	<210	U	10.5	210	<220	U	11.3	220	72	J	11.3	220	14	J	11.3	220	46	J	11.3	220
Benzo(k)fluoranthene	207-08-9	C	--	2.2E+03	3.9E+04	1.5E+04	100	<210	U	16.1	210	<210	U	16.1	210	<220	U	17.4	220	68	J	17.4	220	<220	U	17.4	220	93	J	17.4	220
Bis(2-ethylhexyl)phthalate	117-81-7	C	--	4.6E+04	2.0E+05	2.9E+06	--	19	J,B,z	2.48	210	18	J,B,z	2.48	210	17	J,B,z	2.69	220	35	J	2.69	220	190	J	2.69	220	43	J	2.69	220
Butylbenzylphthalate	85-68-7	N	--	1.6E+06	2.0E+07	1.7E+07	--	6	J	5.38	210	<210	U	5.38	210	<220	U	5.82	220	<220	U	5.82	220	6	J	5.82	220	<220	U	5.82	220
Carbazole	86-74-8	C	--	3.2E+04	1.4E+05	4.7E+02	--	<210	U	7.32	210	<210	U	7.32	210	<220	U	7.93	220	<220	U	7.93	220	<220	U	7.93	220	<220	U	7.93	220
Chrysene	218-01-9	C	--	2.2E+04	3.9E+05	4.8E+04	100	24	J	12.2	210	16	J	12.2	210	<220	U	13.3	220	140	J	13.3	220	25	J	13.3	220	220		13.3	220
Dibenz(a,h)anthracene	53-70-3	C	--	2.2E+01	3.9E+02	4.6E+02	100	<210	U	7.08	210	<210	U	7.08	210	<220	U	7.67	220	18	J	7.67	220	<220	U	7.67	220	13	J	7.67	220
Dibenzofuran	132-64-9	--	--	--	--	--	--	<210	U	3.79	210	<210	U	3.79	210	<220	U	4.11	220	13	J	4.11	220	<220	U	4.11	220	<220	U	4.11	220
Diethylphthalate	84-66-2	N	--	6.3E+06	8.2E+07	4.5E+05	--	9	J,J,l	2.28	210	8	J,J,l	2.28	210	6	J,J,l	2.47	220	33	J	2.47	220	40	J	2.47	220	230		2.47	220
Dimethylphthalate	131-11-3	--	--	--	--	--	--	<210	U	3.97	210	<210	U	3.97	210	<220	U	4.3	220	<220	U	4.3	220	<220	U	4.3	220	18	J	4.3	220
Di-n-butylphthalate	84-74-2	N	--	7.8E+05	1.0E+07	5.0E+06	--	70	J,B,z	4.58	210	85	J,B,z	4.58	210	120	J,B,z	4.97	220	62	J	4.97	220	190	J	4.97	220	580		4.97	220
Fluoranthene	206-44-0	N	--	3.1E+05	4.1E+06	6.3E+06	100	9	J	2.82	210	<210	U	2.82	210	<220	U	3.06	220	370		3.06	220	35	J	3.06	220	260		3.06	220
Fluorene	86-73-7	N	--	3.1E+05	4.1E+06	1.4E+05	100	<210	U	2.02	210	<210	U	2.02	210	<220	U	2.18	220	20	J	2.18	220	<220	U	2.18	220	6	J	2.18	220
Indeno(1,2,3-cd)pyrene	193-39-5	C	--	2.2E+02	3.9E+03	4.2E+03	100	10	J,J,l	4.7	210	<210	U	4.7	210	<220	U	5.1	220	73	J	5.1	220	12	J	5.1	220	43	J	5.1	220
Naphthalene	91-20-3	N	--	1.6E+05	2.0E+06	1.5E+02	100	<210	U	3.3	210	<210	U	3.3	210	<220	U	3.58	220	10	J	3.58	220	<220	U	3.58	220	<220	U	3.58	220
N-Nitrosodiphenylamine	86-30-6	C	--	1.3E+05	5.8E+05	7.6E+02	--	<210	U	5.7	210	<210	U	5.7	210	<220	U	6.18	220	21	J	6.18	220	<220	U	6.18	220	25	J	6.18	220
Phenanthrene[4]	85-01-8	N	--	2.3E+05	3.1E+06	--	100	4	J	2.76	210	<210	U	2.76	210	<220	U	2.9	220	130	J	2.99	220	10	J	2.99	220	79	J	2.99	220
Pyrene	129-00-0	N	--	2.3E+05	3.1E+06	6.8E+05	100	6	J	1.78	210	<210	U	1.78	210	<220	U	1.92	220	260		1.92	220	32	J	1.92	220	230		1.92	220
SVOC TICs (µg/kg)																															
(Z)-9-Octadecenamide	301-02-0	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
1-Heneicosanol	15594-90-8	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
1,1'-Biphenyl, (1,1-dimethylethoxy)-	72101-19-0	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
1,1'-Biphenyl, bis(1-methylethyl)-	69009-90-1	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
1,2-Benzenedicarboxylicacid, bis(2-methy	84-69-5	--	--	--	--	--	--	NI				140	E,NJ,t	0	100	200	E,NJ,t	0	100	120	E,NJ,t	0	100	NI				670	E,NJ,t	0	100
1,2-Benzenedicarboxylic acid, butyl 2-me	17851-53-5	--	--	--	--	--	--	69	E,NJ,t	0	10	NI				NI				NI				320	E,NJ,t	0	10	NI			
1,2-Benzenedicarboxylic acid, butyl cycl	84-64-0	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
2-Ethyl-hexanoic Acid	149575	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
2,4,6-Triallyloxy-1,3,5-triazine	101-37-1	--	--	--	--	--	--	50	E,B,x	0	100	42	E,B,x	0	100	36	E,B,x	0	100	NI				NI				75	E,NJ,t	0	100
4,4,6a,6b,8a,11,11,14b-Octamethyl-1,4,4a	10001-946-24	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
7H-Dibenzo (a,g) carbazole	207841	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
9-Octadecenoic acid, (E)-	112-79-8	--	--	--	--	--	--	NI				NI				NI				NI				74	E,NJ,t	0	10	NI			

Table 4-3
Detected Analytes for SWMU 13 (Soil)
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

Sample ID Sample Date Sample Depth (ft bgs)	CAS #	C/N	Facility-Wide Background Point Estimate[A]	Adjusted Soil RBC (Residential)	Adjusted Soil RBC (Industrial)	SSL DAF 20	Draft BTAG Screening Level	13SB7A 10/9/2003 0-1		MDL	RL	13SB7B 10/9/2003 5-6		MDL	RL	13SB7C 10/9/2003 10-12		MDL	RL	13SB8A 10/9/2003 0-1		MDL	RL	13SB8B 10/9/2003 3.5-3.7		MDL	RL	13SB9A 10/9/2003 0-1		MDL	RL
								Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r		
Benzene, 2-methyl-1,3,5-trinitro-	118-96-7	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
Benzeneamine, 2-nitro-N-phenyl-	119-75-5	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
Bis(2-ethylhexyl)maleate	142-16-5	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
Butyl Ester Octadecanioc	123955	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
Cholesterol	57-88-5	--	--	--	--	--	--	NI				NI				NI				120	E,NJ,t	0	10	NI				NI			
Erucylamide	112-84-5	--	--	--	--	--	--	300	E,B,x	0	10	NI				120	E,B,x	0	10	220	E,B,x	0	10	890	E,NJ,t	0	10	570	E,NJ,t	0	10
Ethanol, 2-(hexadecyloxy)-	2136-71-2	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
Ether, bis(p-tert-butylphenyl)	24085-65-2	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
.Gamma.-sitosterol	83-47-6	--	--	--	--	--	--	NI				NI				NI				780	E,NJ,t	0	10	76	E,NJ,t	0	10	160	E,NJ,t	0	10
Octacosane	630-02-4	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
Perylene	198-55-0	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
Stigmast-4-en-3-one	1058-61-3	--	--	--	--	--	--	NI				NI				NI				240	E,NJ,t	0	10	NI				NI			
Stigmasterol, 22,23-dihydro-	10002-142-07	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
Taraxerol	127220	--	--	--	--	--	--	NI				NI				NI				290	E,NJ,t	0	10	NI				NI			
Tetradecanamide	638-58-4	--	--	--	--	--	--	NI				NI				NI				NI				60	E,NJ,t	0	10	NI			
Triacetin	102761	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
Triphenyl Phosphate	115-86-6	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
Urea, N,N'-dimethyl-N,N'-diphenyl-	611927	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
Vitamin E	10191-41-0	--	--	--	--	--	--	NI				NI				NI				160	E,NJ,t	0	10	NI				NI			
PAHs (µg/kg)																															
Acenaphthene	83-32-9	N	--	4.7E+05	6.1E+06	1.0E+05	100	<120	U	11.3	120	<130	U	12.2	130	<130	U	12.2	130	<130	U	12.2	130	<130	U	12.2	130	17	J	12.2	130
Anthracene	120-12-7	N	--	2.3E+06	3.1E+07	4.7E+05	100	<26	U	0.84	26	1	J	0.91	26	<27	U	0.91	27	12	J	0.91	27	<27	U	0.91	27	38		0.91	27
Benzo(a)anthracene	56-55-3	C	--	2.2E+02	3.9E+03	4.8E+02	100	2.1	J	0.96	26	3.9	J	1.04	26	<27	U	1.04	27	49		1.04	27	3.1	J	1.04	27	130		1.04	27
Benzo(a)pyrene	50-32-8	C	--	2.2E+01	3.9E+02	1.2E+02	100	<26	U	1.2	26	<26	U	1.3	26	<27	U	1.3	27	71		1.3	27	<27	U	1.3	27	***170***		1.3	27
Benzo(b)fluoranthene	205-99-2	C	--	2.2E+02	3.9E+03	1.5E+03	100	<26	U	1.56	26	<26	U	1.69	26	<27	U	1.69	27	54		1.69	27	<27	U	1.69	27	120		1.69	27
Benzo(g,h,i)perylene[(4)]	191-24-2	N	--	2.3E+05	3.1E+06	--	100	<26	U	15	26	<26	U	16.3	26	<27	U	16.3	27	120		16.3	27	<27	U	16.3	27	540	,J,f	16.3	27
Benzo(k)fluoranthene	207-08-9	C	--	2.2E+03	3.9E+04	1.5E+04	100	<26	U	1.2	26	<26	U	1.3	26	<27	U	1.3	27	32		1.3	27	<27	U	1.3	27	77		1.3	27
Chrysene	218-01-9	C	--	2.2E+04	3.9E+05	4.8E+04	100	2.6	J	1.44	26	6.5	J	1.56	26	<27	U	1.56	27	57		1.56	27	3.5	J	1.56	27	150		1.56	27
Dibenz(a,h)anthracene	53-70-3	C	--	2.2E+01	3.9E+02	4.6E+02	100	<26	U	1.68	26	<26	U	1.82	26	<27	U	1.82	27	2.3	J	1.82	27	<27	U	1.82	27	<27	U	1.82	27
Fluoranthene	206-44-0	N	--	3.1E+05	4.1E+06	6.3E+06	100	5	J	2.04	26	3.3	J	2.21	26	<27	U	2.21	27	120		2.21	27	7.9	J	2.21	27	290	,J,f	2.21	27
Fluorene	86-73-7	N	--	3.1E+05	4.1E+06	1.4E+05	100	<26	U	1.56	26	<26	U	1.69	26	<27	U	1.69	27	<27	U	1.69	27	<27	U	1.69	27	11	J	1.69	27
Indeno(1,2,3-cd)pyrene	193-39-5	C	--	2.2E+02	3.9E+03	4.2E+03	100	<26	U	0.84	26	<26	U	0.91	26	<27	U	0.91	27	53		0.91	27	<27	U	0.91	27	100		0.91	27
Phenanthrene[(4)]	85-01-8	N	--	2.3E+05	3.1E+06	--	100	2.1	J	0.72	26	1.8	J	0.78	26	<27	U	0.78	27	43		0.78	27	2.9	J	0.78	27	130		0.78	27
Pyrene	129-00-0	N	--	2.3E+05	3.1E+06	6.8E+05	100	3.6	J	1.08	26	3	J	1.17	26	<27	U	1.17	27	97		1.17	27	8.8	J	1.17	27	240	,J,f	1.17	27
Explosives (mg/kg)																															
1,3-Dinitrobenzene	99-65-0	N	--	7.8E-01	1.0E+01	3.7E-02	--	<0.5	U	0.159	0.5	<0.5	U	0.159	0.5	<0.5	U	0.159	0.5	<0.5	U	0.159	0.5	<0.5	U	0.159	0.5	<0.5	U	0.159	0.5
2,4-Dinitrotoluene	121-14-2	N	--	1.6E+01	2.0E+02	5.7E-01	--	<0.5	U	0.142	0.5	<0.5	U	0.142	0.5	<0.5	U	0.142	0.5	<0.5	U	0.142	0.5	<0.5	U	0.142	0.5	<0.5	U	0.142	0.5
Dinitrotoluene Mix	--	C	--	9.4E-01	4.2E+00	--	--	ND				ND				ND				ND				ND				ND			
2,4,6-Trinitrotoluene	118-96-7	C	--	3.9E+00	5.1E+01	--	--	<0.5	U	0.167	0.5	<0.5	U	0.167	0.5	<0.5	U	0.167	0.5	<0.5	U	0.167	0.5	<0.5	U	0.167	0.5	<0.5	U	0.167	0.5
RDX (Hexahydro-1,3,5-trinitro-1,3,5-tria	121-82-4	C	--	5.8E+00	2.6E+01	--	--	<0.5	U,UJ,c	0.131	0.5	<0.5	U,UJ,c	0.131	0.5	<0.5	U,UJ,c	0.131	0.5	<0.5	U	0.131	0.5	<0.5	U	0.131	0.5	<0.5	U,UJ,c	0.131	0.5
Nitroglycerin/PETN (mg/kg)																															
Nitroglycerin	55-63-0	N	--	1.3E+02	1.7E+03	--	--	<0.602	U	0.195	0.602	<0.617	U	0.2	0.617	<0.656	U	0.213	0.656	<0.682	U	0.221	0.682	<0.643	U	0.208	0.643	<0.682	U	0.221	0.682
Cyanide (mg/kg)																															
Cyanide	57-12-5	N	--	1.6E+02	2.0E+03	1.5E+02	0.005	0.07	J	0.0356	0.5	0.18	J	0.0356	0.5	<0.5	U	0.0356	0.5	0.25	J	0.0356	0.5	<0.5	U	0.0356	0.5	0.35	J	0.0356	0.5
Dioxins/Furans (pg/g)																															
1,2,3,7,8-PeCDD	40321-76-4	--	--	--	--	--	--	NT				NT				NT				NT				NT				0.656	J	0.332	6.21
1,2,3,4,7,8-HxCDD	39227-28-6	--	--	--	--	--	--	NT				NT				NT				NT				NT				0.735	J	0.268	6.21
1,2,3,6,7,8-HxCDD	57653-85-7	--	--	--	--	--	--	NT				NT				NT				NT				NT				2.24	J,J,l	0.456	6.21
1,2,3,7,8,9-HxCDD	19408-74-3	C	--	1.0E-01	4.6E-01	--	--	NT				NT				NT				NT				NT				2.33	J,J,l	0.559	6.21
1,2,3,4,6,7,8-HpCDD	35822-46-9	--	--	--	--	--	--	NT				NT				NT				NT				NT				50		0.423	6.21
OCDD	3268-87-9	--	--	--	--	--	--	NT				NT				NT				NT				NT				1,520	,J,f	1.12	12.4
2,3,7,8-TCDF	51207-31-9	--	--	--	--	--	--	NT				NT				NT				NT				NT				0.784	J	0.153	1.24
1,2,3,7,8-PeCDF	57117-41-6	--	--	--	--	--	--	NT				NT				NT				NT				NT				0.45	J	0.193	6.21
2,3,4,7,8-PeCDF	57117-31-4	--	--	--	--	--	--	NT				NT				NT				NT				NT				0.574	J	0.232	6.21
1,2,3,4,7,8-HxCDF	70648-26-9	--	--	--	--	--	--	NT				NT				NT				NT				NT				0.681	J	0.229	6.21
1,2,3,6,7,8-HxCDF	57117-44-9	--	--	--	--	--	--	NT				NT				NT				NT				NT				0.534	J	0.116	6.21
2,3,4,6,7,8-HxCDF	60851-34-5	--	--	--	--	--	--	NT				NT				NT				NT				NT				0.494	J	0.451	6.21
1,2,3,4,6,7,8-HpCDF	67562-39-4	--	--	--	--	--	--	NT				NT				NT				NT				NT				5.11	J	0.489	6.21
1,2,3,4,7,8,9-HpCDF	55673-89-7	--	--	--	--	--	--	NT				NT				NT				NT				NT				0.46	J	0.436	6.21
OCDF	39001-02-0	--	--	--	--	--	--	NT				NT				NT				NT				NT				11.2	J	0.709	12.4
Total TCDDs	41903-57-5	--	--	--	--	--	--	NT				NT				NT				NT				NT				1.08	J	0.117	6.21
Total PeCDDs	36088-22-9	--	--	--	--	--	--	NT				NT				NT				NT				NT				3.82	J	0.332	6.21
Total HxCDDs	34465-46-8	--	--	--	--	--	--	NT				NT				NT				NT				NT				21.6		0.268	6.21
Total HpCDDs	37871-00-4	--	--	--	--	--	--	NT				NT				NT				NT				NT				96.8		0.423	6.21
Total TCDFs	55722-27-5	--	--	--	--	--	--	NT				NT				NT				NT				NT				7.11		0.153	6.21
Total PeCDFs	30402-15-4	--	--	--	--	--	--	NT				NT				NT				NT				NT				4.85	J	0.193	6.21
Total HxCDFs	55684-94-1	--	--	--	--	--	--	NT				NT				NT				NT				NT				8.31		0.116	6.21
Total HpCDFs	38998-75-3	--	--	--	--	--	--	NT				NT				NT				NT				NT				13		0.436	6.21
Percent Solids (%)																															
Percent Solids		--	--	--	--	--	--	82		0.1	0.1	80		0.1	0.1	79		0.1	0.1	77		0.1	0.1	78		0.1	0.1	78		0.1	0.1

Table 4-3
Detected Analytes for SWMU 13 (Soil)
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

Sample ID / Sample Date / Sample Depth (ft bgs)	CAS #	C/N	Facility-Wide Background Point Estimate[A]	Adjusted Soil RBC (Residential)	Adjusted Soil RBC (Industrial)	SSL DAF 20	Draft BTAG Screening Level	13SB9A-DUP(SBD9) 10/9/2003 0-1		MDL	RL	13SB9B 10/9/2003 1.5-2		MDL	RL	13SB9C 10/9/2003 3.5-4		MDL	RL	13SB10A 10/9/2003 0-1		MDL	RL	13SB10B 10/9/2003 2.5-3		MDL	RL	13SB10C 10/9/2003 4.5-4.8		MDL	RL
								Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r		
TAL Metals (mg/kg)																															
Aluminum	7429-90-5	--	40,041	--	--	--	1	18,600		1.83	50	16,200		1.83	50	4,250		1.83	50	10,900		1.83	50	14,100		1.83	50	17,500		1.83	50
Antimony	7440-36-0	N	--	3.13	40.9	13.2	0.48	0.1	J,B,p	0.0518	0.5	<0.5	U	0.0518	0.5	<0.5	U	0.0518	0.5	0.19	J,B,p	0.0518	0.5	3		0.0518	0.5	0.78		0.0518	0.5
Arsenic	7440-38-2	C	15.8	0.43	1.9	0.026	328	**2.4**		0.0232	0.4	**1.1**		0.0232	0.4	**0.12**	J	0.0232	0.4	**2.5**		0.0232	0.4	**3.9**		0.0232	0.4	**3.6**		0.0232	0.4
Barium	7440-39-3	N	209	1,564	20,440	6,015	440	178		0.106	5	121		0.106	5	29		0.106	5	111		0.106	5	160		0.106	5	142		0.106	5
Beryllium	7440-41-7	N	1.02	15.64	204.4	1,154	0.02	1.1		0.167	1	<1	U	0.0391	1	<1	U	0.0391	1	0.85	J	0.167	1	0.97	J	0.167	1	0.89	J	0.0333	1
Cadmium	7440-43-9	N	0.69	3.91	51.1	27.4	2.5	2.4		0.182	1	1.2		0.182	1	1.1		0.182	1	1.1		0.182	1	1.5		0.182	1	1		0.182	1
Calcium	7440-70-2	--	--	--	--	--	--	2,070	,J,m	16.6	250	1,490	,J,m	16.6	250	1,300	,J,m	16.6	250	4,570	,J,m	16.6	250	2,240	,J,m	16.6	250	1,820	,J,m	16.6	250
Chromium (1)	7440-47-3	N	65.3	23.46	306.6	42.05	0.0075	34	,J,m	0.912	5	31	,J,m	0.912	5	11	,B,x	0.912	5	27	,J,m	0.912	5	35	,J,m	0.912	5	35	,J,m	0.912	5
Cobalt	7440-48-4	--	72.3	--	--	--	100	13	,J,s	0.208	1	9.8	,J,s	0.208	1	3.9	,J,s	0.208	1	11	,J,s	0.208	1	12	,J,s	0.208	1	14	,J,s	0.208	1
Copper	7440-50-8	N	53.5	312.86	4,088	10,518	15	26	,J,s	0.368	2	13	,J,s	0.368	2	2.5	,J,s	0.368	2	16	,J,s	0.368	2	44	,J,s	0.368	2	34	,J,s	0.368	2
Iron	7439-89-6	N	50,962	2,346	30,660	--	12	35,900		42.4	200	20,400		42.4	200	5,330		4.24	20	25,700		42.4	200	37,500		42.4	200	39,600		42.4	200
Lead (2)	7439-92-1	--	26.8	400	750	--	0.01	396		1.09	50	113		0.545	25	12		0.0218	1	111		0.545	25	320		1.09	50	204		0.545	25
Magnesium	7439-95-4	--	--	--	--	--	4,400	3,690	,J,m	3.21	250	2,970	,J,m	3.21	250	1,210	,J,m	3.21	250	3,850	,J,m	3.21	250	2,890	,J,m	3.21	250	3,230	,J,m	3.21	250
Manganese	7439-96-5	N	2,543	156.43	2,044	951.9	330	**1,390**		1.32	25	689		0.264	5	59		0.264	5	853		0.264	5	**1,310**		1.32	25	**1,150**		1.32	25
Mercury (3)	7439-97-6	--	0.13	2.35	30.66	--	0.058	0.043	J	0.0077	0.1	0.027	J	0.0077	0.1	<0.1	U	0.0077	0.1	0.04	J	0.0077	0.1	0.089	J	0.0077	0.1	0.083	J	0.0077	0.1
Nickel	7440-02-0	N	62.8	156.43	2,044	--	2	17		0.0356	0.5	17		0.0356	0.5	3.8		0.0356	0.5	14		0.0356	0.5	16		0.0356	0.5	16		0.0356	0.5
Potassium	7440-09-7	--	--	--	--	--	--	1,910		5	100	1,490		5	100	548		5	100	1,540		5	100	1,200		5	100	1,410		5	100
Selenium	7782-49-2	N	--	39.11	511	18.98	1.8	0.84	J	0.0502	1	0.72	J	0.0502	1	0.23	J	0.0502	1	0.67	J	0.0502	1	0.77	J	0.0502	1	0.96	J	0.0502	1
Silver	7440-22-4	N	--	39.11	511	31.03	0.0000098	0.12	J	0.0044	3	0.06	J	0.0044	3	0.023	J,B,p	0.0044	3	0.085	J	0.0044	3	0.18	J	0.0044	3	0.11	J	0.0044	3
Sodium	7440-23-5	--	--	--	--	--	--	45	J	18.1	100	54	J	18.1	100	69	J	18.1	100	36	J	18.1	100	52	J	18.1	100	48	J	18.1	100
Thallium	7440-28-0	N	2.11	0.55	7.2	3.6	0.001	0.95	,B,x	0.027	0.5	0.25	J,B,x	0.027	0.5	0.047	J,B,x	0.027	0.5	0.32	J,B,x	0.027	0.5	0.45	J,B,x	0.027	0.5	0.5	,B,x	0.027	0.5
Vanadium	7440-62-2	N	108	7.82	102.2	730.1	0.5	35		0.207	1	30		0.207	1	11		0.207	1	22		0.207	1	25		0.207	1	30		0.207	1
Zinc	7440-66-6	N	202	2,346	30,660	13,622	10	969		12.9	100	194		2.59	20	46		0.517	4	287		2.59	20	578		5.17	40	540		5.17	40
TCL VOCs (µg/kg)																															
1,2,4-Trichlorobenzene	120-82-1	N	--	7.8E+04	1.0E+06	2.4E+03	100	<6.2	U	0.492	6.2	<6.8	U	0.574	6.8	<6.4	U	0.533	6.4	0.96	J	0.574	7	<6.5	U	0.533	6.5	<6.8	U	0.574	6.8
2-Butanone	78-93-3	N	--	4.7E+06	6.1E+07	2.9E+04	--	33		6	25	400		7	27	24	J	6.5	26	39		7	28	39		6.5	26	36		7	27
Acetone	67-64-1	N	--	7.0E+06	9.2E+07	2.2E+04	--	130		6	25	140		7	27	31	,B,z	6.5	26	320		7	28	180	,B,z	6.5	26	160	,B,z	7	27
Benzene	71-43-2	C	--	1.2E+04	5.2E+04	1.9E+00	100	<6.2	U	0.632	6.2	<6.8	U	0.738	6.8	<6.4	U	0.685	6.4	<7	U	0.738	7	<6.5	U	0.685	6.5	<6.8	U	0.738	6.8
cis-1,2-Dichloroethene	156-59-2	N	--	7.8E+04	1.0E+06	--	300	<6.2	U	0.852	6.2	<6.8	U	0.994	6.8	<6.4	U	0.923	6.4	<7	U	0.994	7	<6.5	U	0.923	6.5	<6.8	U	0.994	6.8
Methylene chloride	75-09-2	C	--	8.5E+04	3.8E+05	1.9E+01	300	5.7	J	3.37	25	5.5	J	3.93	27	5	J	3.65	26	11	J,B,z	3.93	28	6.6	J,B,z	3.65	26	7.4	J,B,z	3.93	27
Tetrachloroethene	127-18-4	C	--	1.2E+03	5.3E+03	4.7E+00	300	<6.2	U	0.736	6.2	<6.8	U	0.858	6.8	<6.4	U	0.797	6.4	<7	U	0.858	7	<6.5	U	0.797	6.5	<6.8	U	0.858	6.8
Toluene	108-88-3	N	--	6.3E+05	8.2E+06	2.7E+04	100	0.69	J	0.557	6.2	<6.8	U	0.65	6.8	<6.4	U	0.603	6.4	3.5	J	0.65	7	1	J	0.603	6.5	<6.8	U	0.65	6.8
Trichloroethene	79-01-6	C	--	1.6E+03	7.2E+03	2.6E-01	300	<6.2	U	0.812	6.2	<6.8	U	0.948	6.8	<6.4	U	0.88	6.4	<7	U	0.948	7	<6.5	U	0.88	6.5	<6.8	U	0.948	6.8
VOC TICs (µg/kg)																															
Ethyl Ether	60-29-7	N	--	1.6E+06	2.0E+07	8.5E+03	--	NI				NI				NI				NI				NI				NI			
Hexanal	66-25-1	--	--	--	--	--	--	NI				8.6	E,NJ,t	0	1	NI				350	E,NJ,t	0	1	9	E,NJ,t	0	1	NI			
TCL SVOCs (µg/kg)																															
2-Methylnaphthalene	91-57-6	N	--	3.1E+04	4.1E+05	4.4E+03	--	<210	U	3.29	210	<230	U	3.84	230	<220	U	3.56	220	4	J	3.84	240	4	J	3.56	220	<230	U	3.84	230
2,4-Dinitrotoluene	121-14-2	N	--	1.6E+04	2.0E+05	5.7E+02	--	23	J	3.78	210	<230	U	4.41	230	<220	U	4.1	220	<240	U	4.41	240	51	J	4.1	220	<230	U	4.41	230
2,6-Dinitrotoluene	606-20-2	N	--	7.8E+03	1.0E+05	2.5E+02	--	<210	U	33.2	210	<230	U	38.8	230	<220	U	36	220	<240	U	38.8	240	<220	U	36	220	<230	U	38.8	230
Dinitrotoluene Mix	--	C	--	9.4E+02	4.2E+03	--	--	23				ND				ND				ND				51				ND			
4-Chloro-3-Methylphenol	59-50-7	--	--	--	--	--	--	8	J	6.25	210	<230	U	7.29	230	<220	U	6.77	220	15	J	7.29	240	<220	U	6.77	220	<230	U	7.29	230
Acenaphthene	83-32-9	N	--	4.7E+05	6.1E+06	1.0E+05	100	7	J	2.06	210	<230	U	2.41	230	<220	U	2.24	220	9	J	2.41	240	4	J	2.24	220	<230	U	2.41	230
Acenaphthylene (4)	208-96-8	N	--	2.3E+05	3.1E+06	--	100	3	J	1.8	210	<230	U	2.1	230	<220	U	1.95	220	4	U	2.1	240	6	J	1.95	220	6	J	2.1	230
Anthracene	120-12-7	N	--	2.3E+06	3.1E+07	4.7E+05	100	18	J	5.54	210	<230	U	6.47	230	<220	U	6.01	220	26	J	6.47	240	16	J	6.01	220	22	J	6.47	230
Benzo(a)anthracene	56-55-3	C	--	2.2E+02	3.9E+03	4.8E+02	100	140	J	16	210	22	J	18.6	230	<220	U	17.3	220	89	J	186	240	73	J	17.3	220	50	J	1.86	230
Benzo(a)pyrene	50-32-8	C	--	2.2E+01	3.9E+02	1.2E+02	100	120	J	6.85	210	22	J	7.99	230	<220	U	4.72	220	72	J	7.99	240	95	J	7.42	220	82	J	7.99	230
Benzo(b)fluoranthene	205-99-2	C	--	2.2E+02	3.9E+03	1.5E+03	100	170	J	11.7	210	25	J	13.7	230	<220	U	12.7	220	120	J	13.7	240	150	J	12.7	220	140	J	13.7	230
Benzo(g,h,i)perylene (4)	191-24-2	N	--	2.3E+05	3.1E+06	--	100	58	J	10.5	210	15	J	12.2	230	<220	U	11.3	220	34	J	12.2	240	60	J	11.3	220	46	J	12.2	230
Benzo(k)fluoranthene	207-08-9	C	--	2.2E+03	3.9E+04	1.5E+04	100	85	J	16.1	210	<230	U	18.8	230	<220	U	17.4	220	49	J	18.8	240	64	J	17.4	220	48	J	18.8	230
Bis(2-ethylhexyl)phthalate	117-81-7	C	--	4.6E+04	2.0E+05	2.9E+06	--	33	J	2.48	210	24	J	2.9	230	15	J	2.69	220	450		2.9	240	200	J	2.69	220	31	J	2.9	230
Butylbenzylphthalate	85-68-7	N	--	1.6E+06	2.0E+07	1.7E+07	--	<210	U	5.38	210	<230	U	6.27	230	<220	U	5.82	220	38	J	6.27	240	<220	U	5.82	220	9	J	6.27	230
Carbazole	86-74-8	C	--	3.2E+04	1.4E+05	4.7E+02	--	37	J	7.32	210	<230	U	8.54	230	<220	U	7.93	220	<240	U	8.54	240	<220	U	7.93	220	<230	U	8.54	230
Chrysene	218-01-9	C	--	2.2E+04	3.9E+05	4.8E+04	100	160	J	12.2	210	30	J	14.3	230	<220	U	13.3	220	120	J	14.3	240	100	J	13.3	220	83	J	14.3	230
Dibenz(a,h)anthracene	53-70-3	C	--	2.2E+01	3.9E+02	4.6E+02	100	18	J	7.08	210	<230	U	8.26	230	<220	U	7.67	220	<240	U	8.26	240	16	J	7.67	220	13	J	8.26	230
Dibenzofuran	132-64-9	--	--	--	--	--	--	<210	U	3.79	210	<230	U	4.42	230	<220	U	4.11	220	6	J	4.42	240	<220	U	4.11	220	<230	U	4.42	230
Diethylphthalate	84-66-2	N	--	6.3E+06	8.2E+07	4.5E+05	--	44	J	2.28	210	8	J	2.66	230	3	J	2.47	220	110	J	2.66	240	240		2.47	220	71	J	2.66	230
Dimethylphthalate	131-11-3	--	--	--	--	--	--	<210	U	3.97	210	<230	U	4.63	230	<220	U	4.3	220	140	J	4.63	240	<220	U	4.3	220	<230	U	4.63	230
Di-n-butylphthalate	84-74-2	N	--	7.8E+05	1.0E+07	5.0E+06	--	430		4.58	210	270		5.35	230	180	J	4.97	220	470		5.35	240	470		4.97	220	450		5.35	230
Fluoranthene	206-44-0	N	--	3.1E+05	4.1E+06	6.3E+06	100	190	J	2.82	210	37	J	3.29	230	<220	U	3.06	220	350		3.29	240	90	J	3.06	220	29	J	3.29	230
Fluorene	86-73-7	N	--	3.1E+05	4.1E+06	1.4E+05	100	4	J	2.02	210	<230	U	2.35	230	<220	U	2.18	220	12	J	2.35	240	4	J	2.18	220	<230	U	2.35	230
Indeno(1,2,3-cd)pyrene	193-39-5	C	--	2.2E+02	3.9E+03	4.2E+03	100	52	J	4.7	210	10	J	5.49	230	<220	U	5.1	220	32	J	5.49	240	54	J	5.1	220	45	J	5.49	230
Naphthalene	91-20-3	N	--	1.6E+05	2.0E+06	1.5E+02	100	<210	U	3.3	210	<230	U	3.85	230	<220	U	3.58	220	<240	U	3.85	240	<220	U	3.58	220	<230	U	3.85	230
N-Nitrosodiphenylamine	86-30-6	C	--	1.3E+05	5.8E+05	7.6E+02	--	46	J	5.7	210	<230	U	6.65	230	<220	U	6.18	220	<240	U	6.65	240	120	J	6.18	220	<230	U	6.65	230
Phenanthrene(4)	85-01-8	N	--	2.3E+05	3.1E+06	--	100	60	J	2.76	210	17	J	3.22	230	<220	U	2.99	220	170	J	3.22	240	43	J	2.99	220	14	J	3.22	230
Pyrene	129-00-0	N	--	2.3E+05	3.1E+06	6.8E+05	100	170	J	1.78	210	33	J	2.07	230	3	J	1.92	220	260		2.07	240	83	J	1.92	220	29	J	2.07	230
SVOC TICs (µg/kg)																															
(Z)-9-Octadecenamide	301-02-0	--	--	--	--	--	--	NI				83	E,NJ,t	0	100	NI				NI				NI				NI			
1-Heneicosanol	15594-90-8	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
1,1'-Biphenyl, (1,1-dimethylethoxy)-	72101-19-0	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
1,1'-Biphenyl, bis(1-methylethyl)-	69009-90-1	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
1,2-Benzenedicarboxylicacid, bis(2-methy	84-69-5	--	--	--	--	--	--	NI				420	E,NJ,t	0	100	NI				NI				NI				530	E,NJ,t	0	100
1,2-Benzenedicarboxylic acid, butyl 2-me	17851-53-5	--	--	--	--	--	--	NI				NI				350	E,NJ,t	0	10	530	E,NJ,t	0	10	47	E,NJ,t	0	10	NI			
1,2-Benzenedicarboxylic acid, butyl cycl	84-64-0	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
2-Ethyl-hexanoic Acid	149575	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
2,4,6-Triallyloxy-1,3,5-triazine	101-37-1	--	--	--	--	--	--	45	E,B,x	0	100	45	E,NJ,t	0	100	NI				NI				150	E,NJ,t	0	100	NI			
4,4,6a,6b,8a,11,11,14b-Octamethyl-1,4,4a	10001-946-24	--	--	--	--	--	--	NI				NI				NI				710	E,NJ,t	0	100	NI				NI			
7H-Dibenzo (a,g) carbazole	207841	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
9-Octadecenoic acid, (E)-	112-79-8	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			

Table 4-3
Detected Analytes for SWMU 13 (Soil)
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

Sample ID / Sample Date / Sample Depth (ft bgs)	CAS #	C/N	Facility-Wide Background Point Estimate[A]	Adjusted Soil RBC (Residential)	Adjusted Soil RBC (Industrial)	SSL DAF 20	Draft BTAG Screening Level	13SB9A-DUP(SBD9) 10/9/2003 0-1		MDL	RL	13SB9B 10/9/2003 1.5-2		MDL	RL	13SB9C 10/9/2003 3.5-4		MDL	RL	13SB10A 10/9/2003 0-1		MDL	RL	13SB10B 10/9/2003 2.5-3		MDL	RL	13SB10C 10/9/2003 4.5-4.8		MDL	RL
								Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r		
Benzene, 2-methyl-1,3,5-trinitro-	118-96-7	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
Benzeneamine, 2-nitro-N-phenyl-	119-75-5	--	--	--	--	--	--	NI				NI				NI				NI				71	E,NJ,t	0	10	NI			
Bis(2-ethylhexyl)maleate	142-16-5	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
Butyl Ester Octadecanioc	123955	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
Cholesterol	57-88-5	--	--	--	--	--	--	NI				NI				NI				470	E,NJ,t	0	10	NI				NI			
Erucylamide	112-84-5	--	--	--	--	--	--	NI				NI				NI				400	E,B,x	0	10	900	E,NJ,t	0	10	180	E,B,x	0	10
Ethanol, 2-(hexadecyloxy)-	2136-71-2	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
Ether, bis(p-tert-butylphenyl)	24085-65-2	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
.Gamma.-sitosterol	83-47-6	--	--	--	--	--	--	NI				NI				NI				2,400	E,NJ,t	0	10	NI				NI			
Octacosane	630-02-4	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
Perylene	198-55-0	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
Stigmast-4-en-3-one	1058-61-3	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
Stigmasterol, 22,23-dihydro-	10002-142-07	--	--	--	--	--	--	160	E,NJ,t	0	10	NI				NI				NI				NI				NI			
Taraxerol	127220	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
Tetradecanamide	638-58-4	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
Triacetin	102761	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
Triphenyl Phosphate	115-86-6	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
Urea, N,N'-dimethyl-N,N'-diphenyl-	611927	--	--	--	--	--	--	48	E,NJ,t	0	100	NI				NI				NI				NI				NI			
Vitamin E	10191-41-0	--	--	--	--	--	--	NI				NI				NI				600	E,NJ,t	0	10	NI				NI			
PAHs (µg/kg)																															
Acenaphthene	83-32-9	N	--	4.7E+05	6.1E+06	1.0E+05	100	<130	U	12.2	130	<140	U	13.2	140	<130	U	12.2	130	14	J	13.2	140	<130	U	12.2	130	<140	U	13.2	140
Anthracene	120-12-7	N	--	2.3E+06	3.1E+07	4.7E+05	100	15	J	0.91	26	4.2	J	0.98	29	<27	U	0.91	27	38		0.98	30	14	J	0.91	27	6.1	J	0.98	29
Benzo(a)anthracene	56-55-3	C	--	2.2E+02	3.9E+03	4.8E+02	100	61		1.04	26	12	J	1.12	29	1.4	J	1.04	27	140		1.12	30	56		1.04	27	18	J	1.12	29
Benzo(a)pyrene	50-32-8	C	--	2.2E+01	3.9E+02	1.2E+02	100	73		1.3	26	15	J	1.4	29	<27	U	1.3	27	***190***		1.4	30	130		1.3	27	59		1.4	29
Benzo(b)fluoranthene	205-99-2	C	--	2.2E+02	3.9E+03	1.5E+03	100	56		1.69	26	10	J	1.82	29	<27	U	1.69	27	140		1.82	30	91		1.69	27	47		1.82	29
Benzo(g,h,i)perylene[4]	191-24-2	N	--	2.3E+05	3.1E+06	--	100	240	,J,f	16.3	26	<29	U	17.5	29	<27	U	16.3	27	260		17.5	30	290		16.3	27	140		17.5	29
Benzo(k)fluoranthene	207-08-9	C	--	2.2E+03	3.9E+04	1.5E+04	100	36		1.3	26	6	J	1.4	29	<27	U	1.3	27	80		1.4	30	52		1.3	27	20	J	1.4	29
Chrysene	218-01-9	C	--	2.2E+04	3.9E+05	4.8E+04	100	74		1.56	26	15	J	1.68	29	1.7	J	1.56	27	150		1.68	30	80		1.56	27	33		1.68	29
Dibenz(a,h)anthracene	53-70-3	C	--	2.2E+01	3.9E+02	4.6E+02	100	<26	U	1.82	26	<29	U	1.96	29	<27	U	1.82	27	5.2	J	1.96	30	8	J	1.82	27	5.3	J	1.96	29
Fluoranthene	206-44-0	N	--	3.1E+05	4.1E+06	6.3E+06	100	120	,J,f	2.21	26	30		2.38	29	3.8	J	2.21	27	470		2.38	30	64		2.21	27	12	J	2.38	29
Fluorene	86-73-7	N	--	3.1E+05	4.1E+06	1.4E+05	100	<26	U	1.69	26	<29	U	1.82	29	<27	U	1.69	27	17	J	1.82	30	<27	U	1.69	27	<29	U	1.82	29
Indeno(1,2,3-cd)pyrene	193-39-5	C	--	2.2E+02	3.9E+03	4.2E+03	100	46		0.91	26	9.4	J	0.98	29	<27	U	0.91	27	130		0.98	30	110		0.91	27	58		0.98	29
Phenanthrene[4]	85-01-8	N	--	2.3E+05	3.1E+06	--	100	50		0.78	26	14	J	0.84	29	1.8	J	0.78	27	210		0.84	30	27		0.78	27	7	J	0.84	29
Pyrene	129-00-0	N	--	2.3E+05	3.1E+06	6.8E+05	100	110	,J,f	1.17	26	27	J	1.26	29	5.1	J	1.17	27	320		1.26	30	50		1.17	27	9.5	J	1.26	29
Explosives (mg/kg)																															
1,3-Dinitrobenzene	99-65-0	N	--	7.8E-01	1.0E+01	3.7E-02	--	<0.5	U	0.159	0.5	<0.5	U	0.159	0.5	<0.5	U	0.159	0.5	<0.5	U	0.159	0.5	<0.5	U	0.159	0.5	<0.5	U	0.159	0.5
2,4-Dinitrotoluene	121-14-2	N	--	1.6E+01	2.0E+02	5.7E-01	--	<0.5	U	0.142	0.5	<0.5	U	0.142	0.5	<0.5	U	0.142	0.5	<0.5	U	0.142	0.5	<0.5	U	0.142	0.5	<0.5	U	0.142	0.5
Dinitrotoluene Mix	--	C	--	9.4E-01	4.2E+00	--	--	ND				ND				ND				ND				ND				ND			
2,4,6-Trinitrotoluene	118-96-7	C	--	3.9E+00	5.1E+01	--	--	<0.5	U	0.167	0.5	<0.5	U	0.167	0.5	<0.5	U	0.167	0.5	<0.5	U	0.167	0.5	<0.5	U	0.167	0.5	<0.5	U	0.167	0.5
RDX (Hexahydro-1,3,5-trinitro-1,3,5-tria	121-82-4	C	--	5.8E+00	2.6E+01	--	--	<0.5	U,UJ,c	0.131	0.5	<0.5	U,UJ,c	0.131	0.5	<0.5	U,UJ,c	0.131	0.5	<0.5	U,UJ,c	0.131	0.5	<0.5	U,UJ,c	0.131	0.5	<0.5	U,UJ,c	0.131	0.5
Nitroglycerin/PETN (mg/kg)																															
Nitroglycerin	55-63-0	N	--	1.3E+02	1.7E+03	--	--	0.793		0.238	0.733	0.954	,J,g	0.214	0.66	<0.665	U	0.215	0.665	<0.853	U	0.276	0.853	<0.666	U	0.216	0.666	2.46	,J,g	0.225	0.693
Cyanide (mg/kg)																															
Cyanide	57-12-5	N	--	1.6E+02	2.0E+03	1.5E+02	0.005	0.26	J	0.0356	0.5	0.12	J	0.0356	0.5	<0.5	U	0.0356	0.5	0.17	J	0.0356	0.5	0.22	J	0.0356	0.5	0.11	J	0.0356	0.5
Dioxins/Furans (pg/g)																															
1,2,3,7,8-PeCDD	40321-76-4	--	--	--	--	--	--	<6.97	U	0.373	6.97	NT				NT				NT				NT				NT			
1,2,3,4,7,8-HxCDD	39227-28-6	--	--	--	--	--	--	0.477	J	0.301	6.97	NT				NT				NT				NT				NT			
1,2,3,6,7,8-HxCDD	57653-85-7	--	--	--	--	--	--	1.04	J,J,l	0.512	6.97	NT				NT				NT				NT				NT			
1,2,3,7,8,9-HxCDD	19408-74-3	C	--	1.0E-01	4.6E-01	--	--	1.37	J,J,l	0.628	6.97	NT				NT				NT				NT				NT			
1,2,3,4,6,7,8-HpCDD	35822-46-9	--	--	--	--	--	--	40.6		0.474	6.97	NT				NT				NT				NT				NT			
OCDD	3268-87-9	--	--	--	--	--	--	2,900	E,J,q	1.26	13.9	NT				NT				NT				NT				NT			
2,3,7,8-TCDF	51207-31-9	--	--	--	--	--	--	0.194		0.132	1.39	NT				NT				NT				NT				NT			
1,2,3,7,8-PeCDF	57117-41-6	--	--	--	--	--	--	<6.97	U	0.217	6.97	NT				NT				NT				NT				NT			
2,3,4,7,8-PeCDF	57117-31-4	--	--	--	--	--	--	<6.97	U	0.261	6.97	NT				NT				NT				NT				NT			
1,2,3,4,7,8-HxCDF	70648-26-9	--	--	--	--	--	--	0.276	J	0.257	6.97	NT				NT				NT				NT				NT			
1,2,3,6,7,8-HxCDF	57117-44-9	--	--	--	--	--	--	0.243	J	0.13	6.97	NT				NT				NT				NT				NT			
2,3,4,6,7,8-HxCDF	60851-34-5	--	--	--	--	--	--	<6.97	U	0.507	6.97	NT				NT				NT				NT				NT			
1,2,3,4,6,7,8-HpCDF	67562-39-4	--	--	--	--	--	--	2.14	J	0.549	6.97	NT				NT				NT				NT				NT			
1,2,3,4,7,8,9-HpCDF	55673-89-7	--	--	--	--	--	--	<6.97	U	0.489	6.97	NT				NT				NT				NT				NT			
OCDF	39001-02-0	--	--	--	--	--	--	4.35	J	0.796	13.9	NT				NT				NT				NT				NT			
Total TCDDs	41903-57-5	--	--	--	--	--	--	0.132	J	0.132	6.97	NT				NT				NT				NT				NT			
Total PeCDDs	36088-22-9	--	--	--	--	--	--	2.57	J	0.373	6.97	NT				NT				NT				NT				NT			
Total HxCDDs	34465-46-8	--	--	--	--	--	--	10.5		0.301	6.97	NT				NT				NT				NT				NT			
Total HpCDDs	37871-00-4	--	--	--	--	--	--	93.9		0.474	6.97	NT				NT				NT				NT				NT			
Total TCDFs	55722-27-5	--	--	--	--	--	--	1.07	J,B,x	0.172	6.97	NT				NT				NT				NT				NT			
Total PeCDFs	30402-15-4	--	--	--	--	--	--	0.921	J	0.217	6.97	NT				NT				NT				NT				NT			
Total HxCDFs	55684-94-1	--	--	--	--	--	--	2.18	J	0.13	6.97	NT				NT				NT				NT				NT			
Total HpCDFs	38998-75-3	--	--	--	--	--	--	4.88	J	0.489	6.97	NT				NT				NT				NT				NT			
Percent Solids (%)																															
Percent Solids		--	--	--	--	--	--	80		0.1	0.1	73		0.1	0.1	78		0.1	0.1	71		0.1	0.1	77		0.1	0.1	73		0.1	0.1

Table 4-3
Detected Analytes for SWMU 13 (Soil)
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

Sample ID / Sample Date / Sample Depth (ft bgs)	CAS #	C/N	Facility-Wide Background Point Estimate[A]	Adjusted Soil RBC (Residential)	Adjusted Soil RBC (Industrial)	SSL DAF 20	Draft BTAG Screening Level	13SB11A 10/9/2003 0-1		MDL	RL	13SB11B 10/9/2003 4.5-5		MDL	RL	13SB11C 10/9/2003 8-8.5		MDL	RL	13SB12A 10/9/2003 0-1		MDL	RL	13SB12B 10/9/2003 2-3		MDL	RL	13SB12B-DUP(SBD8) 10/9/2003 2-3		MDL	RL
								Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r		
TAL Metals (mg/kg)																															
Aluminum	7429-90-5	--	40,041	--	--	--	1	19,800		1.83	50	10,800		1.83	50	20,900		1.83	50	6,630		1.83	50	9,910		1.83	50	8,930		1.83	50
Antimony	7440-36-0	N	--	3.13	40.9	13.2	0.48	0.27	J,B,p	0.0518	0.5	4.7		0.0518	0.5	0.62		0.0518	0.5	1.1		0.0518	0.5	1.1		0.0518	0.5	1.3		0.0518	0.5
Arsenic	7440-38-2	C	15.8	0.43	1.9	0.026	328	***2.2***		0.0232	0.4	***2.8***		0.0232	0.4	***4.7***		0.0232	0.4	***1.6***		0.0232	0.4	***1.2***		0.0232	0.4	***1.2***		0.0232	0.4
Barium	7440-39-3	N	209	1,564	20,440	6,015	440	171		0.106	5	143		0.106	5	211		0.106	5	78		0.106	5	106		0.106	5	102		0.106	5
Beryllium	7440-41-7	N	1.02	15.64	204.4	1,154	0.02	1		0.167	1	0.65	J	0.0333	1	1.2		0.167	1	<1	U	0.0391	1	<1	U	0.0391	1	<1	U	0.0391	1
Cadmium	7440-43-9	N	0.69	3.91	51.1	27.4	2.5	1.2		0.182	1	1.2		0.182	1	2.7		0.182	1	1.1		0.182	1	1.4		0.182	1	1.6		0.182	1
Calcium	7440-70-2	--	--	--	--	--	--	4,020	,J,m	16.6	250	2,120	,J,m	16.6	250	2,970	,J,m	16.6	250	12,400	,J,m	16.6	250	4,820	,J,m	16.6	250	4,640	,J,m	16.6	250
Chromium [1]	7440-47-3	N	65.3	23.46	306.6	42.05	0.0075	38	,J,m	0.912	5	29	,J,m	0.912	5	39	,J,m	0.912	5	18	,J,m	0.912	5	27	,J,m	0.912	5	26	,J,m	0.912	5
Cobalt	7440-48-4	--	72.3	--	--	--	100	13	,J,s	0.208	1	9.4	,J,s	0.208	1	16	,J,s	0.208	1	5.1	,J,s	0.208	1	6.4	,J,s	0.208	1	6.3	,J,s	0.208	1
Copper	7440-50-8	N	53.5	312.86	4,088	10,518	15	26	,J,s	0.368	2	98	,J,s	1.84	5	33	,J,s	0.368	2	45	,J,s	0.368	2	37	,J,s	0.368	2	36	,J,s	0.368	2
Iron	7439-89-6	N	50,962	2,346	30,660	--	12	32,600		42.4	200	33,800		42.4	200	48,600		42.4	200	14,800		21.2	100	15,000		21.2	100	14,700		21.2	100
Lead [2]	7439-92-1	--	26.8	400	750	--	0.01	111		0.545	25	26,500		109	5000	295		1.09	50	176		0.545	25	325		1.09	50	318		1.09	50
Magnesium	7439-95-4	--	--	--	--	--	4,400	4,650	,J,m	3.21	250	2,520	,J,m	3.21	250	3,940	,J,m	3.21	250	5,330	,J,m	3.21	250	3,270	,J,m	3.21	250	3,050	,J,m	3.21	250
Manganese	7439-96-5	N	2,543	156.43	2,044	951.9	330	***1,140***		1.32	25	942		0.264	5	***1,700***		6.6	125	301		0.264	5	280		0.264	5	291		0.264	5
Mercury [3]	7439-97-6	--	0.13	2.35	30.66	--	0.058	0.052	J	0.0077	0.1	0.045	J	0.0077	0.1	0.071	J	0.0077	0.1	0.016	J	0.0077	0.1	0.041	J	0.0077	0.1	0.035	J	0.0077	0.1
Nickel	7440-02-0	N	62.8	156.43	2,044	--	2	17		0.0356	0.5	12		0.0356	0.5	21		0.0356	0.5	8.3		0.0356	0.5	11		0.0356	0.5	9.6		0.0356	0.5
Potassium	7440-09-7	--	--	--	--	--	--	2,680		5	100	1,280		5	100	1,720		5	100	1,050		5	100	1,420		5	100	1,290		5	100
Selenium	7782-49-2	N	--	39.11	511	18.98	1.8	0.86	J	0.0502	1	0.53	J	0.0502	1	1.5		0.0502	1	0.32	J	0.0502	1	0.39	J	0.0502	1	0.41	J	0.0502	1
Silver	7440-22-4	N	--	39.11	511	31.03	0.0000098	0.1	J	0.0044	3	0.26	J	0.0044	3	0.15	J	0.0044	3	0.059	J	0.0044	3	0.027	J,B,p	0.0044	3	0.03	J,B,p	0.0044	3
Sodium	7440-23-5	--	--	--	--	--	--	51	J	18.1	100	63	J	18.1	100	64	J	18.1	100	102		18.1	100	252		18.1	100	88	J	18.1	100
Thallium	7440-28-0	N	2.11	0.55	7.2	3.6	0.001	0.42	J,B,x	0.027	0.5	0.45	J,B,x	0.027	0.5	0.68	,B,x	0.027	0.5	0.13	J,B,x	0.027	0.5	0.23	J,B,x	0.027	0.5	0.15	J,B,x	0.027	0.5
Vanadium	7440-62-2	N	108	7.82	102.2	730.1	0.5	34		0.207	1	18		0.207	1	34		0.207	1	14		0.207	1	17		0.207	1	17		0.207	1
Zinc	7440-66-6	N	202	2,346	30,660	13,622	10	294		5.17	40	502		5.17	40	1,070		12.9	100	214		2.59	20	377		5.17	40	426		5.17	40
TCL VOCs (µg/kg)																															
1,2,4-Trichlorobenzene	120-82-1	N	--	7.8E+04	1.0E+06	2.4E+03	100	<6.5	U	0.533	6.5	<5.7	U	0.451	5.7	<6.5	U	0.533	6.5	<6.4	U	0.533	6.4	<7	U	0.574	7	<7.5	U	0.615	7.5
2-Butanone	78-93-3	N	--	4.7E+06	6.1E+07	2.9E+04	--	45		6.5	26	32		5.5	23	40		6.5	26	26		6.5	26	25	J	7	28	27	J	7.5	30
Acetone	67-64-1	N	--	7.0E+06	9.2E+07	2.2E+04	--	240		6.5	26	150	,B,z	5.5	23	200	,B,z	6.5	26	49	B,B,z	6.5	26	55	B,B,z	7	28	62	B,B,z	7.5	30
Benzene	71-43-2	C	--	1.2E+04	5.2E+04	1.9E+00	100	0.91	J	0.685	6.5	1.5	J	0.58	5.7	1.5	J	0.685	6.5	<6.4	U	0.685	6.4	<7	U	0.738	7	1	J	0.791	7.5
cis-1,2-Dichloroethene	156-59-2	N	--	7.8E+04	1.0E+06	--	300	<6.5	U	0.923	6.5	1.9	J	0.781	5.7	4.2	J	0.923	6.5	<6.4	U	0.923	6.4	<7	U	0.994	7	<7.5	U	1.07	7.5
Methylene chloride	75-09-2	C	--	8.5E+04	3.8E+05	1.9E+01	300	7.3	J,B,z	3.65	26	6.1	J,B,z	3.09	23	5.8	J,B,z	3.65	26	4.7	J,B,z	3.65	26	6.9	J,B,z	3.93	28	6.1	J,B,z	4.22	30
Tetrachloroethene	127-18-4	C	--	1.2E+03	5.3E+03	4.7E+00	300	<6.5	U	0.797	6.5	<5.7	U	0.674	5.7	<6.5	U	0.797	6.5	<6.4	U	0.797	6.4	<7	U	0.858	7	<7.5	U	0.92	7.5
Toluene	108-88-3	N	--	6.3E+05	8.2E+06	2.7E+04	100	1.9	J	0.603	6.5	1.4	J	0.51	5.7	1.1	J	0.603	6.5	1.2	J	0.603	6.4	<7	U	0.65	7	<7.5	U	0.696	7.5
Trichloroethene	79-01-6	C	--	1.6E+03	7.2E+03	2.6E-01	300	***9.6***		0.88	6.5	***31***		0.745	5.7	***57***		0.88	6.5	<6.4	U	0.88	6.4	<7	U	0.948	7	<7.5	U	1.02	7.5
VOC TICs (µg/kg)																															
Ethyl Ether	60-29-7	N	--	1.6E+06	2.0E+07	8.5E+03	--	NI				NI				NI				NI				NI				NI			
Hexanal	66-25-1	--	--	--	--	--	--	NI				8.9	E,NJ,t	0	1	4.7	E,NJ,t	0	1	NI				NI				NI			
TCL SVOCs (µg/kg)																															
2-Methylnaphthalene	91-57-6	N	--	3.1E+04	4.1E+05	4.4E+03	--	5	J	3.56	220	<190	U	3.01	190	<220	U	3.56	220	<220	U	3.56	220	<240	U	3.84	240	<250	U	4.11	250
2,4-Dinitrotoluene	121-14-2	N	--	1.6E+04	2.0E+05	5.7E+02	--	35	J	4.1	220	87	J	3.47	190	<220	U	4.1	220	***710***		4.1	220	***700***		4.41	240	***1,500***		9.45	510
2,6-Dinitrotoluene	606-20-2	N	--	7.8E+03	1.0E+05	2.5E+02	--	<220	U	36	220	32	J	30.5	190	<220	U	36	220	210	J	36	220	61	J	38.8	240	56	J	41.6	250
Dinitrotoluene Mix	--	C	--	9.4E+02	4.2E+03	--	--	35				119				ND				920				761				1,556			
4-Chloro-3-Methylphenol	59-50-7	--	--	--	--	--	--	9	J	6.77	220	13	J	5.73	190	<220	U	6.77	220	19	J	6.77	220	18	J	7.29	240	23	J	7.82	250
Acenaphthene	83-32-9	N	--	4.7E+05	6.1E+06	1.0E+05	100	8	J	2.24	220	<190	U	1.89	190	<220	U	2.24	220	<220	U	2.24	220	<240	U	2.41	240	<250	U	2.58	250
Acenaphthylene [4]	208-96-8	N	--	2.3E+05	3.1E+06	--	100	2	J	1.95	220	2	J	1.65	190	<220	U	1.95	220	<220	U	1.95	220	<240	U	2.1	240	<250	U	2.25	250
Anthracene	120-12-7	N	--	2.3E+06	3.1E+07	4.7E+05	100	15	J	6.01	220	<190	U	5.08	190	<220	U	6.01	220	<220	U	6.01	220	<240	U	6.47	240	<250	U	6.93	250
Benzo(a)anthracene	56-55-3	C	--	2.2E+02	3.9E+03	4.8E+02	100	51	J	17.3	220	<190	U	14.6	190	<220	U	17.3	220	<220	U	17.3	220	<240	U	18.6	240	<250	U	20	250
Benzo(a)pyrene	50-32-8	C	--	2.2E+01	3.9E+02	1.2E+02	100	44	J	7.42	220	7	J	6.28	190	14	J	7.42	220	<220	U	7.42	220	<240	U	7.99	240	<250	U	8.57	250
Benzo(b)fluoranthene	205-99-2	C	--	2.2E+02	3.9E+03	1.5E+03	100	78	J	12.7	220	13	J	10.7	190	24	J	12.7	220	13	J	12.7	220	<240	U	13.7	240	<250	U	14.6	250
Benzo(g,h,i)perylene [4]	191-24-2	N	--	2.3E+05	3.1E+06	--	100	25	J	11.3	220	<190	U	9.59	190	17	J	11.3	220	<220	U	11.3	220	<240	U	12.2	240	<250	U	13.1	250
Benzo(k)fluoranthene	207-08-9	C	--	2.2E+03	3.9E+04	1.5E+04	100	28	J	17.4	220	<190	U	14.7	190	<220	U	17.4	220	<220	U	17.4	220	<240	U	18.8	240	<250	U	20.1	250
Bis(2-ethylhexyl)phthalate	117-81-7	C	--	4.6E+04	2.0E+05	2.9E+06	--	59	J	2.69	220	380		2.28	190	540		2.69	220	71	J	2.69	220	360		2.9	240	300		3.11	250
Butylbenzylphthalate	85-68-7	N	--	1.6E+06	2.0E+07	1.7E+07	--	13	J	5.82	220	24	J	4.93	190	40	J	5.82	220	<220	U	5.82	220	<240	U	6.27	240	<250	U	6.72	250
Carbazole	86-74-8	C	--	3.2E+04	1.4E+05	4.7E+02	--	<220	U	7.93	220	<190	U	6.71	190	<220	U	7.93	220	<220	U	7.93	220	<240	U	8.54	240	<250	U	9.15	250
Chrysene	218-01-9	C	--	2.2E+04	3.9E+05	4.8E+04	100	57	J	13.3	220	<190	U	11.2	190	16	J	13.3	220	<220	U	13.3	220	<240	U	14.3	240	<250	U	15.3	250
Dibenz(a,h)anthracene	53-70-3	C	--	2.2E+01	3.9E+02	4.6E+02	100	<220	U	7.67	220	<190	U	6.49	190	<220	U	7.67	220	<220	U	7.67	220	<240	U	8.26	240	<250	U	8.85	250
Dibenzofuran	132-64-9	--	--	--	--	--	--	<220	U	4.11	220	<190	U	3.48	190	<220	U	4.11	220	<220	U	4.11	220	<240	U	4.42	240	<250	U	4.74	250
Diethylphthalate	84-66-2	N	--	6.3E+06	8.2E+07	4.5E+05	--	93	J	2.47	220	39	J	2.09	190	6	J	2.47	220	950		2.47	220	2,200		5.32	480	2,400		5.7	510
Dimethylphthalate	131-11-3	--	--	--	--	--	--	<220	U	4.3	220	550		3.64	190	<220	U	4.3	220	<220	U	4.3	220	32	J	4.63	240	<250	U	4.97	250
Di-n-butylphthalate	84-74-2	N	--	7.8E+05	1.0E+07	5.0E+06	--	360		4.97	220	600		4.2	190	320		4.97	220	680		4.97	220	1,300	,J,f	10.7	480	1,900	,J,f	11.5	510
Fluoranthene	206-44-0	N	--	3.1E+05	4.1E+06	6.3E+06	100	150	J	3.06	220	12	J	2.59	190	16	J	3.06	220	25	J	3.06	220	<240	U	3.29	240	21	J	3.53	250
Fluorene	86-73-7	N	--	3.1E+05	4.1E+06	1.4E+05	100	6	J	2.18	220	<190	U	1.85	190	<220	U	2.18	220	<220	U	2.18	220	<240	U	2.35	240	<250	U	2.52	250
Indeno(1,2,3-cd)pyrene	193-39-5	C	--	2.2E+02	3.9E+03	4.2E+03	100	22	J	5.1	220	5	J	4.31	190	16	J	5.1	220	<220	U	5.1	220	<240	U	5.49	240	<250	U	5.88	250
Naphthalene	91-20-3	N	--	1.6E+05	2.0E+06	1.5E+02	100	4	J	3.58	220	<190	U	3.03	190	<220	U	3.58	220	<220	U	3.58	220	<240	U	3.85	240	<250	U	4.13	250
N-Nitrosodiphenylamine	86-30-6	C	--	1.3E+05	5.8E+05	7.6E+02	--	200	J	6.18	220	***950***		5.23	190	<220	U	6.18	220	630		6.18	220	***900***		6.65	240	700		7.13	250
Phenanthrene [4]	85-01-8	N	--	2.3E+05	3.1E+06	--	100	63	J	2.99	220	9	J	2.53	190	7	J	2.99	220	15	J	2.99	220	<240	U	3.22	240	9	J	3.45	250
Pyrene	129-00-0	N	--	2.3E+05	3.1E+06	6.8E+05	100	110	J	1.92	220	11	J	1.63	190	14	J	1.92	220	21	J	1.92	220	<240	U	2.07	240	16	J	2.22	250
SVOC TICs (µg/kg)																															
(Z)-9-Octadecenamide	301-02-0	--	--	--	--	--	--	NI				NI				NI				120	E,NJ,t	0	100	NI				NI			
1-Heneicosanol	15594-90-8	--	--	--	--	--	--	220	E,NJ,t	0	100	NI				NI				NI				NI				NI			
1,1'-Biphenyl, (1,1-dimethylethoxy)-	72101-19-0	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
1,1'-Biphenyl, bis(1-methylethyl)-	69009-90-1	--	--	--	--	--	--	NI				NI				NI				NI				NI				66	E,NJ,t	0	10
1,2-Benzenedicarboxylicacid, bis(2-methy	84-69-5	--	--	--	--	--	--	360	E,NJ,t	0	100	430	E,NJ,t	0	100	NI				290	E,NJ,t	0	100	270	E,NJ,t	0	100	400	E,NJ,t	0	100
1,2-Benzenedicarboxylic acid, butyl 2-me	17851-53-5	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
1,2-Benzenedicarboxylic acid, butyl cycl	84-64-0	--	--	--	--	--	--	NI				NI				310	E,NJ,t	0	1	NI				NI				NI			
2-Ethyl-hexanoic Acid	149575	--	--	--	--	--	--	NI				NI				NI				NI				180	E,NJ,t	0	1,000	140	E,NJ,t	0	1,000
2,4,6-Triallyloxy-1,3,5-triazine	101-37-1	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
4,4,6a,6b,8a,11,11,14b-Octamethyl-1,4,4a	10001-946-24	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
7H-Dibenzo (a,g) carbazole	207841	--	--	--	--	--	--	NI				NI				NI				NI				280	E,NJ,t	0	100	NI			
9-Octadecenoic acid, (E)-	112-79-8	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			

Table 4-3
Detected Analytes for SWMU 13 (Soil)
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

Sample ID / Sample Date / Sample Depth (ft bgs)	CAS #	C/N	Facility-Wide Background Point Estimate[A]	Adjusted Soil RBC (Residential)	Adjusted Soil RBC (Industrial)	SSL DAF 20	Draft BTAG Screening Level	13SB11A 10/9/2003 0-1		MDL	RL	13SB11B 10/9/2003 4.5-5		MDL	RL	13SB11C 10/9/2003 8-8.5		MDL	RL	13SB12A 10/9/2003 0-1		MDL	RL	13SB12B 10/9/2003 2-3		MDL	RL	13SB12B-DUP(SBD8) 10/9/2003 2-3		MDL	RL
								Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r		
Benzene, 2-methyl-1,3,5-trinitro-	118-96-7	--	--	--	--	--	--	280	E,NJ,t	0	10	NI				NI				350	E,NJ,t	0	10	260	E,NJ,t	0	10	160	E,NJ,t	0	10
Benzeneamine, 2-nitro-N-phenyl-	119-75-5	--	--	--	--	--	--	NI				150	E,NJ,t	0	10	NI				280	E,NJ,t	0	10	900	E,NJ,t	0	10	600	E,NJ,t	0	10
Bis(2-ethylhexyl)maleate	142-16-5	--	--	--	--	--	--	NI				120	E,NJ,t	0	100	140	E,NJ,t	0	100	NI				NI				NI			
Butyl Ester Octadecanioc	123955	--	--	--	--	--	--	130	E,NJ,t	0	10	NI				NI				NI				NI				NI			
Cholesterol	57-88-5	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
Erucylamide	112-84-5	--	--	--	--	--	--	140	E,B,x	0	10	510	E,NJ,t	0	10	180	E,B,x	0	10	330	E,B,x	0	10	NI				440	E,B,x	0	10
Ethanol, 2-(hexadecyloxy)-	2136-71-2	--	--	--	--	--	--	390	E,NJ,t	0	10	NI				NI				NI				NI				NI			
Ether, bis(p-tert-butylphenyl)	24085-65-2	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
.Gamma.-sitosterol	83-47-6	--	--	--	--	--	--	500	E,NJ,t	0	10	NI				NI				NI				NI				NI			
Octacosane	630-02-4	--	--	--	--	--	--	NI				NI				NI				NI				180	E,NJ,t	0	10	NI			
Perylene	198-55-0	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
Stigmast-4-en-3-one	1058-61-3	--	--	--	--	--	--	140	E,NJ,t	0	10	NI				NI				NI				NI				NI			
Stigmasterol, 22,23-dihydro-	10002-142-07	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
Taraxerol	127220	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
Tetradecanamide	638-58-4	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
Triacetin	102761	--	--	--	--	--	--	NI				NI				NI				140	E,NJ,t	0	10	1,300	E,NJ,t	0	10	1,000	E,NJ,t	0	10
Triphenyl Phosphate	115-86-6	--	--	--	--	--	--	NI				110	E,NJ,t	0	3,300	NI				NI				NI				200	E,NJ,t	0	3,300
Urea, N,N'-dimethyl-N,N'-diphenyl-	611927	--	--	--	--	--	--	NI				NI				NI				910	E,NJ,t	0	100	NI				100	E,NJ,t	0	100
Vitamin E	10191-41-0	--	--	--	--	--	--	NI				NI				NI				NI				NI				NI			
PAHs (µg/kg)																															
Acenaphthene	83-32-9	N	--	4.7E+05	6.1E+06	1.0E+05	100	<130	U	12.2	130	<110	U,UL,s	10.3	110	<130	U	12.2	130	<130	U	12.2	130	<140	U	13.2	140	<150	U	14.1	150
Anthracene	120-12-7	N	--	2.3E+06	3.1E+07	4.7E+05	100	6.6	J	0.91	27	8.7	J,L,s	0.77	24	1.1	J	0.91	27	<27	U	0.91	27	<30	U	0.98	30	<31	U	1.05	31
Benzo(a)anthracene	56-55-3	C	--	2.2E+02	3.9E+03	4.8E+02	100	31		1.04	27	24	,L,s	0.88	24	4.1	J	1.04	27	3.8	J	1.04	27	1.7	J	1.12	30	6.4	J	1.2	31
Benzo(a)pyrene	50-32-8	C	--	2.2E+01	3.9E+02	1.2E+02	100	45		1.3	27	33	,L,s	1.1	24	13	J	1.3	27	6.5	J	1.3	27	<30	U	1.4	30	8	J	1.5	31
Benzo(b)fluoranthene	205-99-2	C	--	2.2E+02	3.9E+03	1.5E+03	100	32		1.69	27	21	J,L,s	1.43	24	8.8	J	1.69	27	4.9	J	1.69	27	<30	U	1.82	30	6.7	J	1.95	31
Benzo(g,h,i)perylene[(4)]	191-24-2	N	--	2.3E+05	3.1E+06	--	100	82		16.3	27	77	,L,s	13.8	24	46		16.3	27	<27	U	16.3	27	<30	U	17.5	30	21	J	18.8	31
Benzo(k)fluoranthene	207-08-9	C	--	2.2E+03	3.9E+04	1.5E+04	100	20	J	1.3	27	15	J,L,s	1.1	24	4.5	J	1.3	27	<27	U	1.3	27	<30	U	1.4	30	<31	U	1.5	31
Chrysene	218-01-9	C	--	2.2E+04	3.9E+05	4.8E+04	100	37		1.56	27	40	,L,s	1.32	24	7.6	J	1.56	27	2.4	J	1.56	27	<30	U	1.68	30	6.7	J	1.8	31
Dibenz(a,h)anthracene	53-70-3	C	--	2.2E+01	3.9E+02	4.6E+02	100	<27	U	1.82	27	<24	U,UL,s	1.54	24	<27	U	1.82	27	<27	U	1.82	27	<30	U	1.96	30	<31	U	2.1	31
Fluoranthene	206-44-0	N	--	3.1E+05	4.1E+06	6.3E+06	100	73		2.21	27	<24	U,UL,s	1.87	24	6.5	J	2.21	27	9.2	J	2.21	27	7.4	J	2.38	30	16	J	2.55	31
Fluorene	86-73-7	N	--	3.1E+05	4.1E+06	1.4E+05	100	<27	U	1.69	27	12	J,L,s	1.43	24	<27	U	1.69	27	<27	U	1.69	27	<30	U	1.82	30	<31	U	1.95	31
Indeno(1,2,3-cd)pyrene	193-39-5	C	--	2.2E+02	3.9E+03	4.2E+03	100	37		0.91	27	21	J,L,s	0.77	24	16	J	0.91	27	5.9	J	0.91	27	<30	U	0.98	30	6.8	J	1.05	31
Phenanthrene[(4)]	85-01-8	N	--	2.3E+05	3.1E+06	--	100	26	J	0.78	27	110	,L,s	0.66	24	3.4	J	0.78	27	2.5	J	0.78	27	2.2	J	0.84	30	2.7	J	0.9	31
Pyrene	129-00-0	N	--	2.3E+05	3.1E+06	6.8E+05	100	59		1.17	27	79	,L,s	0.99	24	5.6	J	1.17	27	6.4	J	1.17	27	3.9	J	1.26	30	10	J	1.35	31
Explosives (mg/kg)																															
1,3-Dinitrobenzene	99-65-0	N	--	7.8E-01	1.0E+01	3.7E-02	--	<0.5	U	0.159	0.5	<0.5	U	0.159	0.5	<0.5	U	0.159	0.5	<0.5	U	0.159	0.5	<0.5	U	0.159	0.5	0.32	J	0.159	0.5
2,4-Dinitrotoluene	121-14-2	N	--	1.6E+01	2.0E+02	5.7E-01	--	<0.5	U	0.142	0.5	<0.5	U	0.142	0.5	<0.5	U	0.142	0.5	0.39	J	0.142	0.5	0.19	J	0.142	0.5	<0.5	U	0.142	0.5
Dinitrotoluene Mix	--	C	--	9.4E-01	4.2E+00	--	--	ND				ND				ND				0.39				0.19				ND			
2,4,6-Trinitrotoluene	118-96-7	C	--	3.9E+00	5.1E+01	--	--	0.43	J	0.167	0.5	<0.5	U	0.167	0.5	<0.5	U	0.167	0.5	0.27	J	0.167	0.5	0.55		0.167	0.5	0.56		0.167	0.5
RDX (Hexahydro-1,3,5-trinitro-1,3,5-tria	121-82-4	C	--	5.8E+00	2.6E+01	--	--	<0.5	U,UJ,c	0.131	0.5	<0.5	U,UJ,c	0.131	0.5	<0.5	U,UJ,c	0.131	0.5	<0.5	U,UJ,c	0.131	0.5	0.29	J,J,c	0.131	0.5	<0.5	U,UJ,c	0.131	0.5
Nitroglycerin/PETN (mg/kg)																															
Nitroglycerin	55-63-0	N	--	1.3E+02	1.7E+03	--	--	2.11	,J,g	0.223	0.688	2.55	,J,g	0.212	0.654	<0.695	U	0.225	0.695	8.48		0.216	0.666	4.05		0.256	0.79	67.4		0.462	1.43
Cyanide (mg/kg)																															
Cyanide	57-12-5	N	--	1.6E+02	2.0E+03	1.5E+02	0.005	0.22	J	0.0356	0.5	0.35	J	0.0356	0.5	0.25	J	0.0356	0.5	0.18	J	0.0356	0.5	0.39	J	0.0356	0.5	0.23	J	0.0356	0.5
Dioxins/Furans (pg/g)																															
1,2,3,7,8-PeCDD	40321-76-4	--	--	--	--	--	--	NT				NT				NT				NT				NT				NT			
1,2,3,4,7,8-HxCDD	39227-28-6	--	--	--	--	--	--	NT				NT				NT				NT				NT				NT			
1,2,3,6,7,8-HxCDD	57653-85-7	--	--	--	--	--	--	NT				NT				NT				NT				NT				NT			
1,2,3,7,8,9-HxCDD	19408-74-3	C	--	1.0E-01	4.6E-01	--	--	NT				NT				NT				NT				NT				NT			
1,2,3,4,6,7,8-HpCDD	35822-46-9	--	--	--	--	--	--	NT				NT				NT				NT				NT				NT			
OCDD	3268-87-9	--	--	--	--	--	--	NT				NT				NT				NT				NT				NT			
2,3,7,8-TCDF	51207-31-9	--	--	--	--	--	--	NT				NT				NT				NT				NT				NT			
1,2,3,7,8-PeCDF	57117-41-6	--	--	--	--	--	--	NT				NT				NT				NT				NT				NT			
2,3,4,7,8-PeCDF	57117-31-4	--	--	--	--	--	--	NT				NT				NT				NT				NT				NT			
1,2,3,4,7,8-HxCDF	70648-26-9	--	--	--	--	--	--	NT				NT				NT				NT				NT				NT			
1,2,3,6,7,8-HxCDF	57117-44-9	--	--	--	--	--	--	NT				NT				NT				NT				NT				NT			
2,3,4,6,7,8-HxCDF	60851-34-5	--	--	--	--	--	--	NT				NT				NT				NT				NT				NT			
1,2,3,4,6,7,8-HpCDF	67562-39-4	--	--	--	--	--	--	NT				NT				NT				NT				NT				NT			
1,2,3,4,7,8,9-HpCDF	55673-89-7	--	--	--	--	--	--	NT				NT				NT				NT				NT				NT			
OCDF	39001-02-0	--	--	--	--	--	--	NT				NT				NT				NT				NT				NT			
Total TCDDs	41903-57-5	--	--	--	--	--	--	NT				NT				NT				NT				NT				NT			
Total PeCDDs	36088-22-9	--	--	--	--	--	--	NT				NT				NT				NT				NT				NT			
Total HxCDDs	34465-46-8	--	--	--	--	--	--	NT				NT				NT				NT				NT				NT			
Total HpCDDs	37871-00-4	--	--	--	--	--	--	NT				NT				NT				NT				NT				NT			
Total TCDFs	55722-27-5	--	--	--	--	--	--	NT				NT				NT				NT				NT				NT			
Total PeCDFs	30402-15-4	--	--	--	--	--	--	NT				NT				NT				NT				NT				NT			
Total HxCDFs	55684-94-1	--	--	--	--	--	--	NT				NT				NT				NT				NT				NT			
Total HpCDFs	38998-75-3	--	--	--	--	--	--	NT				NT				NT				NT				NT				NT			
Percent Solids (%)																															
Percent Solids		--	--	--	--	--	--	77		0.1	0.1	88		0.1	0.1	77		0.1	0.1	78		0.1	0.1	71		0.1	0.1	67		0.1	0.1

Sample ID / Sample Date / Sample Depth (ft bgs)	CAS #	C/N	Facility-Wide Background Point Estimate[A]	Adjusted Soil RBC (Residential)	Adjusted Soil RBC (Industrial)	SSL DAF 20	Draft BTAG Screening Level	13SB12C 10/9/2003 3.5-4 Result	LQ, VQ, r	MDL	RL
TAL Metals (mg/kg)											
Aluminum	7429-90-5	--	40,041	--	--	--	1	15,000		1.83	50
Antimony	7440-36-0	N	--	3.13	40.9	13.2	0.48	1.5		0.0518	0.5
Arsenic	7440-38-2	C	15.8	0.43	1.9	0.026	328	***2.2***		0.0232	0.4
Barium	7440-39-3	N	209	1,564	20,440	6,015	440	161		0.106	5
Beryllium	7440-41-7	N	1.02	15.64	204.4	1,154	0.02	<1	U	0.0391	1
Cadmium	7440-43-9	N	0.69	3.91	51.1	27.4	2.5	2.3		0.182	1
Calcium	7440-70-2	--	--	--	--	--	--	3,840	,J,m	16.6	250
Chromium (1)	7440-47-3	N	65.3	23.46	306.6	42.05	0.0075	34	,J,m	0.912	5
Cobalt	7440-48-4	--	72.3	--	--	--	100	9.9	,J,s	0.208	1
Copper	7440-50-8	N	53.5	312.86	4,088	10,518	15	94	,J,s	0.368	2
Iron	7439-89-6	N	50,962	2,346	30,660	--	12	18,700		21.2	100
Lead (2)	7439-92-1	--	26.8	400	750	--	0.01	1,140		4.36	200
Magnesium	7439-95-4	--	--	--	--	--	4,400	3,980	,J,m	3.21	250
Manganese	7439-96-5	N	2,543	156.43	2,044	951.9	330	272		0.264	5
Mercury (3)	7439-97-6	--	0.13	2.35	30.66	--	0.058	0.13		0.0077	0.1
Nickel	7440-02-0	N	62.8	156.43	2,044	--	2	17		0.0356	0.5
Potassium	7440-09-7	--	--	--	--	--	--	2,150		5	100
Selenium	7782-49-2	N	--	39.11	511	18.98	1.8	0.67	J	0.0502	1
Silver	7440-22-4	N	--	39.11	511	31.03	0.0000098	0.063	J	0.0044	3
Sodium	7440-23-5	--	--	--	--	--	--	95	J	18.1	100
Thallium	7440-28-0	N	2.11	0.55	7.2	3.6	0.001	0.29	J,B,x	0.027	0.5
Vanadium	7440-62-2	N	108	7.82	102.2	730.1	0.5	26		0.207	1
Zinc	7440-66-6	N	202	2,346	30,660	13,622	10	476		5.17	40
TCL VOCs (µg/kg)											
1,2,4-Trichlorobenzene	120-82-1	N	--	7.8E+04	1.0E+06	2.4E+03	100	<8.1	U,UJ,i	0.656	8.1
2-Butanone	78-93-3	N	--	4.7E+06	6.1E+07	2.9E+04	--	<32	U	8	32
Acetone	67-64-1	N	--	7.0E+06	9.2E+07	2.2E+04	--	63	B,B,z	8	32
Benzene	71-43-2	C	--	1.2E+04	5.2E+04	1.9E+00	100	<8.1	U	0.843	8.1
cis-1,2-Dichloroethene	156-59-2	N	--	7.8E+04	1.0E+06	--	300	<8.1	U	1.14	8.1
Methylene chloride	75-09-2	C	--	8.5E+04	3.8E+05	1.9E+01	300	<32	U	4.5	32
Tetrachloroethene	127-18-4	C	--	1.2E+03	5.3E+03	4.7E+00	300	<8.1	U	0.981	8.1
Toluene	108-88-3	N	--	6.3E+05	8.2E+06	2.7E+04	100	<8.1	U	0.742	8.1
Trichloroethene	79-01-6	C	--	1.6E+03	7.2E+03	2.6E-01	300	<8.1	U	1.08	8.1
VOC TICs (µg/kg)											
Ethyl Ether	60-29-7	N	--	1.6E+06	2.0E+07	8.5E+03	--	28	Q,NJ,t	0	100
Hexanal	66-25-1	--	--	--	--	--	--	NI			
TCL SVOCs (µg/kg)											
2-Methylnaphthalene	91-57-6	N	--	3.1E+04	4.1E+05	4.4E+03	--	<270	U	4.38	270
2,4-Dinitrotoluene	121-14-2	N	--	1.6E+04	2.0E+05	5.7E+02	--	65	J	5.04	270
2,6-Dinitrotoluene	606-20-2	N	--	7.8E+03	1.0E+05	2.5E+02	--	<270	U	44.3	270
Dinitrotoluene Mix	--	C	--	9.4E+02	4.2E+03	--	--	65			
4-Chloro-3-Methylphenol	59-50-7	--	--	--	--	--	--	24	J	8.34	270
Acenaphthene	83-32-9	N	--	4.7E+05	6.1E+06	1.0E+05	100	3	J	2.75	270
Acenaphthylene (4)	208-96-8	N	--	2.3E+05	3.1E+06	--	100	<270	U	2.4	270
Anthracene	120-12-7	N	--	2.3E+06	3.1E+07	4.7E+05	100	<270	J	7.39	270
Benzo(a)anthracene	56-55-3	C	--	2.2E+02	3.9E+03	4.8E+02	100	25	J	21.3	270
Benzo(a)pyrene	50-32-8	C	--	2.2E+01	3.9E+02	1.2E+02	100	21	J	9.14	270
Benzo(b)fluoranthene	205-99-2	C	--	2.2E+02	3.9E+03	1.5E+03	100	40	J	15.6	270
Benzo(g,h,i)perylene (4)	191-24-2	N	--	2.3E+05	3.1E+06	--	100	<270	U	14	270
Benzo(k)fluoranthene	207-08-9	C	--	2.2E+03	3.9E+04	1.5E+04	100	22	J	21.4	270
Bis(2-ethylhexyl)phthalate	117-81-7	C	--	4.6E+04	2.0E+05	2.9E+06	--	1,000		3.31	270
Butylbenzylphthalate	85-68-7	N	--	1.6E+06	2.0E+07	1.7E+07	--	<270	U	7.17	270
Carbazole	86-74-8	C	--	3.2E+04	1.4E+05	4.7E+02	--	<270	U	9.76	270
Chrysene	218-01-9	C	--	2.2E+04	3.9E+05	4.8E+04	100	24	J	16.3	270
Dibenz(a,h)anthracene	53-70-3	C	--	2.2E+01	3.9E+02	4.6E+02	100	<270	U	9.44	270
Dibenzofuran	132-64-9	--	--	--	--	--	--	<270	U	5.06	270
Diethylphthalate	84-66-2	N	--	6.3E+06	8.2E+07	4.5E+05	--	940		3.04	270
Dimethylphthalate	131-11-3	--	--	--	--	--	--	<270	U	5.3	270
Di-n-butylphthalate	84-74-2	N	--	7.8E+05	1.0E+07	5.0E+06	--	650		6.11	270
Fluoranthene	206-44-0	N	--	3.1E+05	4.1E+06	6.3E+06	100	59	J	3.76	270
Fluorene	86-73-7	N	--	3.1E+05	4.1E+06	1.4E+05	100	4	J	2.69	270
Indeno(1,2,3-cd)pyrene	193-39-5	C	--	2.2E+02	3.9E+03	4.2E+03	100	10	J	6.27	270
Naphthalene	91-20-3	N	--	1.6E+05	2.0E+06	1.5E+02	100	15	J	4.4	270
N-Nitrosodiphenylamine	86-30-6	C	--	1.3E+05	5.8E+05	7.6E+02	--	480		7.6	270
Phenanthrene(4)	85-01-8	N	--	2.3E+05	3.1E+06	--	100	52	J	3.68	270
Pyrene	129-00-0	N	--	2.3E+05	3.1E+06	6.8E+05	100	54	J	2.37	270
SVOC TICs (µg/kg)											
(Z)-9-Octadecenamide	301-02-0	--	--	--	--	--	--	NI			
1-Heneicosanol	15594-90-8	--	--	--	--	--	--	NI			
1,1'-Biphenyl, (1,1-dimethylethoxy)-	72101-19-0	--	--	--	--	--	--	360	E,NJ,t	0	1,000
1,1'-Biphenyl, bis(1-methylethyl)-	69009-90-1	--	--	--	--	--	--	NI			
1,2-Benzenedicarboxylicacid, bis(2-methy	84-69-5	--	--	--	--	--	--	460	E,NJ,t	0	100
1,2-Benzenedicarboxylic acid, butyl 2-me	17851-53-5	--	--	--	--	--	--	NI			
1,2-Benzenedicarboxylic acid, butyl cycl	84-64-0	--	--	--	--	--	--	NI			
2-Ethyl-hexanoic Acid	149575	--	--	--	--	--	--	NI			
2,4,6-Triallyloxy-1,3,5-triazine	101-37-1	--	--	--	--	--	--	NI			
4,4,6a,6b,8a,11,11,14b-Octamethyl-1,4,4a	10001-946-24	--	--	--	--	--	--	NI			
7H-Dibenzo (a,g) carbazole	207841	--	--	--	--	--	--	NI			
9-Octadecenoic acid, (E)-	112-79-8	--	--	--	--	--	--	NI			

Table 4-3
Detected Analytes for SWMU 13 (Soil)
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

Sample ID / Sample Date / Sample Depth (ft bgs)	CAS #	C/N	Facility-Wide Background Point Estimate[A]	Adjusted Soil RBC (Residential)	Adjusted Soil RBC (Industrial)	SSL DAF 20	Draft BTAG Screening Level	13SB12C 10/9/2003 3.5-4 Result	LQ, VQ, r	MDL	RL
Benzene, 2-methyl-1,3,5-trinitro-	118-96-7	--	--	--	--	--	--	NI			
Benzeneamine, 2-nitro-N-phenyl-	119-75-5	--	--	--	--	--	--	250	E,NJ,t	0	10
Bis(2-ethylhexyl)maleate	142-16-5	--	--	--	--	--	--	NI			
Butyl Ester Octadecanioc	123955	--	--	--	--	--	--	NI			
Cholesterol	57-88-5	--	--	--	--	--	--	NI			
Erucylamide	112-84-5	--	--	--	--	--	--	NI			
Ethanol, 2-(hexadecyloxy)-	2136-71-2	--	--	--	--	--	--	NI			
Ether, bis(p-tert-butylphenyl)	24085-65-2	--	--	--	--	--	--	830	E,NJ,t	0	100
.Gamma.-sitosterol	83-47-6	--	--	--	--	--	--	NI			
Octacosane	630-02-4	--	--	--	--	--	--	NI			
Perylene	198-55-0	--	--	--	--	--	--	NI			
Stigmast-4-en-3-one	1058-61-3	--	--	--	--	--	--	NI			
Stigmasterol, 22,23-dihydro-	10002-142-07	--	--	--	--	--	--	NI			
Taraxerol	127220	--	--	--	--	--	--	NI			
Tetradecanamide	638-58-4	--	--	--	--	--	--	NI			
Triacetin	102761	--	--	--	--	--	--	240	E,NJ,t	0	10
Triphenyl Phosphate	115-86-6	--	--	--	--	--	--	NI			
Urea, N,N'-dimethyl-N,N'-diphenyl-	611927	--	--	--	--	--	--	NI			
Vitamin E	10191-41-0	--	--	--	--	--	--	NI			
PAHs (µg/kg)											
Acenaphthene	83-32-9	N	--	4.7E+05	6.1E+06	1.0E+05	100	<160	U	15	160
Anthracene	120-12-7	N	--	2.3E+06	3.1E+07	4.7E+05	100	11	J	1.12	34
Benzo(a)anthracene	56-55-3	C	--	2.2E+02	3.9E+03	4.8E+02	100	32	J	1.28	34
Benzo(a)pyrene	50-32-8	C	--	2.2E+01	3.9E+02	1.2E+02	100	<34	U	1.6	34
Benzo(b)fluoranthene	205-99-2	C	--	2.2E+02	3.9E+03	1.5E+03	100	<34	U	2.08	34
Benzo(g,h,i)perylene[(4)]	191-24-2	N	--	2.3E+05	3.1E+06	--	100	37		20	34
Benzo(k)fluoranthene	207-08-9	C	--	2.2E+03	3.9E+04	1.5E+04	100	<34	U	1.6	34
Chrysene	218-01-9	C	--	2.2E+04	3.9E+05	4.8E+04	100	<34	U	1.92	34
Dibenz(a,h)anthracene	53-70-3	C	--	2.2E+01	3.9E+02	4.6E+02	100	<34	U	2.24	34
Fluoranthene	206-44-0	N	--	3.1E+05	4.1E+06	6.3E+06	100	130		2.72	34
Fluorene	86-73-7	N	--	3.1E+05	4.1E+06	1.4E+05	100	<34	U	2.08	34
Indeno(1,2,3-cd)pyrene	193-39-5	C	--	2.2E+02	3.9E+03	4.2E+03	100	17	J	1.12	34
Phenanthrene [(4)]	85-01-8	N	--	2.3E+05	3.1E+06	--	100	80		0.96	34
Pyrene	129-00-0	N	--	2.3E+05	3.1E+06	6.8E+05	100	99		1.44	34
Explosives (mg/kg)											
1,3-Dinitrobenzene	99-65-0	N	--	7.8E-01	1.0E+01	3.7E-02	--	<0.5	U	0.159	0.5
2,4-Dinitrotoluene	121-14-2	N	--	1.6E+01	2.0E+02	5.7E-01	--	<0.5	U	0.142	0.5
Dinitrotoluene Mix	--	C	--	9.4E-01	4.2E+00	--	--	ND			
2,4,6-Trinitrotoluene	118-96-7	C	--	3.9E+00	5.1E+01	--	--	0.54		0.167	0.5
RDX (Hexahydro-1,3,5-trinitro-1,3,5-tria	121-82-4	C	--	5.8E+00	2.6E+01	--	--	<0.5	U,UJ,c	0.131	0.5
Nitroglycerin/PETN (mg/kg)											
Nitroglycerin	55-63-0	N	--	1.3E+02	1.7E+03	--	--	2.54		0.265	0.818
Cyanide (mg/kg)											
Cyanide	57-12-5	N	--	1.6E+02	2.0E+03	1.5E+02	0.005	0.11	J	0.0356	0.5
Dioxins/Furans (pg/g)											
1,2,3,7,8-PeCDD	40321-76-4	--	--	--	--	--	--	NT			
1,2,3,4,7,8-HxCDD	39227-28-6	--	--	--	--	--	--	NT			
1,2,3,6,7,8-HxCDD	57653-85-7	--	--	--	--	--	--	NT			
1,2,3,7,8,9-HxCDD	19408-74-3	C	--	1.0E-01	4.6E-01	--	--	NT			
1,2,3,4,6,7,8-HpCDD	35822-46-9	--	--	--	--	--	--	NT			
OCDD	3268-87-9	--	--	--	--	--	--	NT			
2,3,7,8-TCDF	51207-31-9	--	--	--	--	--	--	NT			
1,2,3,7,8-PeCDF	57117-41-6	--	--	--	--	--	--	NT			
2,3,4,7,8-PeCDF	57117-31-4	--	--	--	--	--	--	NT			
1,2,3,4,7,8-HxCDF	70648-26-9	--	--	--	--	--	--	NT			
1,2,3,6,7,8-HxCDF	57117-44-9	--	--	--	--	--	--	NT			
2,3,4,6,7,8-HxCDF	60851-34-5	--	--	--	--	--	--	NT			
1,2,3,4,6,7,8-HpCDF	67562-39-4	--	--	--	--	--	--	NT			
1,2,3,4,7,8,9-HpCDF	55673-89-7	--	--	--	--	--	--	NT			
OCDF	39001-02-0	--	--	--	--	--	--	NT			
Total TCDDs	41903-57-5	--	--	--	--	--	--	NT			
Total PeCDDs	36088-22-9	--	--	--	--	--	--	NT			
Total HxCDDs	34465-46-8	--	--	--	--	--	--	NT			
Total HpCDDs	37871-00-4	--	--	--	--	--	--	NT			
Total TCDFs	55722-27-5	--	--	--	--	--	--	NT			
Total PeCDFs	30402-15-4	--	--	--	--	--	--	NT			
Total HxCDFs	55684-94-1	--	--	--	--	--	--	NT			
Total HpCDFs	38998-75-3	--	--	--	--	--	--	NT			
Percent Solids (%)											
Percent Solids		--	--	--	--	--	--	62		0.1	0.1

Notes:

CAS = Chemical Abstracts Service
ft bgs = Feet Below Ground Surface
mg/kg = Milligram Per Kilogram
µg/kg = Microgram Per Kilogram
pg/g = Picogram Per Gram
TAL = Target Analyte List
TCL = Target Compound List
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound
PAH = Polynuclear Aromatic Hydrocarbon
TIC = Tentatively Identified Compound
NA = Not Applicable
MDL = Method Detection Limit
RL = Reporting Limit
NT = Not Tested
NI = Not Identified
LQ = Laboratory Qualifier
VQ = Validation Qualifier
r = Reason Code
[(1)] = Chromium VI RBC value was used
[(2)] = Lead criteria are Action Levels; see USEPA Region III guidance
[(3)] = Mercuric chloride soil RBC value used
[(4)] = RBC value for pyrene was used for these compounds

[A] = Facility-Wide Background Point Estimate as Reported in the Facility-Wide Background Study Report (IT 2001a)
RBC = USEPA Region III Risk-Based Concentration (RBC) values from the October 31, 2006, RBC Table and October 10, 2006, Alternate RBC Table
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
C = Carcinogenic per EPA RBC Table (October 2006)
N = Noncarcinogenic per EPA RBC Table (October 2006)
SSL DAF20 = Soil Screening Levels at a Dilution Attenuation Factor of 20
BTAG = Biological Technical Assistance Group Screening Level, Draft 1995

= Concentration Exceeds Adjusted Soil Residential RBC
= Concentration Exceeds Adjusted Soil Industrial RBC
underline = Concentration Exceeds Site Background Values
bold italic = Concentration Exceeds SSL DAF20
= Concentration Exceeds BTAG Screening Level

Laboratory Qualifiers
- U The compound was analyzed for but not detected.
- J Estimated value.
- B Analyte found in associated blank as well as in the sample.
- E Concentration exceeded the upper level of the calibration range of the instrument for that specific analysis. For TICs, compound not present in calibration standard, calculated using total peak areas ion chromatographs and response factor of 1.
- Q Not estimated. TIC detected in sample, quantified using a response factor from the initial calibration.

Validation Qualifiers
- B Not detected substantially above the level reported in laboratory or field blanks.
- N Tentative Identification. Consider present. Special methods may be needed to confirm its presence or absence in future sampling efforts.
- J Analyte present. Reported value may not be accurate or precise.
- UJ Not detected, quantitation limit may be inaccurate or imprecise.

Reason Codes

GC/MS Organics
- c Calibration failure; poor (RRF) or unstable (%D) response
- d MS/MSD or LCS/LCSD RPD imprecision
- f Field duplicate imprecision
- i Tuning Failure or poor mass spectrometer performance
- l MS/MSD recovery failure
- m Internal standard failure
- s Surrogate failure
- t Tentatively identified Compound
- x Field and/or equipment blank contamination
- z Method blank and/or storage blank contamination

GC and HPLC Organics
- c Calibration failure; poor or unstable (%D) response
- d MS/MSD or LCS/LCSD RPD imprecision
- f Field duplicate imprecision
- g Dual column confirmation imprecision
- i LCS recovery failure
- l MS/MSD recovery failure
- p Concentration exceeded the linear range
- s No confirmation column
- x Trip blank contamination
- z Method blank and/or storage blank contamination

Inorganics and Conventionals
- c Calibration failure
- m MS/MSD recovery failure
- p Preparation blank contamination
- s Serial dilution failure
- x CRDL standard recovery failure

Table 4-4
Detected Analytes for SWMU 13 (Sediment)
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

Sample ID / Sample Date / Sample Depth (ft bgs)	CAS	C/N	Facility-Wide Background Point Estimate[A]	Adjusted Soil RBC (Residential)	Adjusted Soil RBC (Industrial)	SSL DAF 20	Draft BTAG Screening Level	13SD2 10/10/2003 Result	LQ, VQ, r	MDL	RL	13SD3 10/10/2003 Result	LQ, VQ, r	MDL	RL	13SD3-DUP(SDD1) 10/10/2003 Result	LQ, VQ, r	MDL	RL
TAL Metals (mg/kg)																			
Aluminum	7429-90-5	--	40,041	--	--	--	--	9,870		1.83	50	23,400		5.1	500	19,600		1.83	50
Antimony	7440-36-0	N	--	3.13	40.9	13.2	2	0.18	J	0.0518	0.5	3.5		0.0518	0.5	1.9		0.0518	0.5
Arsenic	7440-38-2	C	15.8	0.43	1.91	0.026	9.8	***3.3***		0.0232	0.4	***3.4***		0.0232	0.4	3.7		0.0232	0.4
Barium	7440-39-3	N	209	1,564	20,440	6,015	--	101		0.106	5	169		0.106	5	131		0.106	5
Beryllium	7440-41-7	N	1.02	15.64	204.4	1,154	--	0.83	J	0.167	1	1.3		0.167	1	1.3		0.167	1
Cadmium	7440-43-9	N	0.69	3.91	51.1	27.4	0.99	0.57	J	0.182	1	1		0.182	1	0.94	J	0.182	1
Calcium	7440-70-2	--	--	--	--	--	--	1,270	,K,m	16.6	250	2,080	,K,m	16.6	250	1,620	,K,m	16.6	250
Chromium (1)	7440-47-3	N	65.3	23.46	306.6	42.05	43.4	27		0.912	5	40		0.912	5	31		0.912	5
Cobalt	7440-48-4	--	72.3	--	--	--	50	9.9		0.208	1	13		0.208	1	12		0.208	1
Copper	7440-50-8	N	53.5	312.86	4,088	10,518	31.6	14		0.368	2	36		0.368	2	31		0.368	2
Iron	7439-89-6	N	50,962	2,346	30,660	--	20,000	34,600		71.6	1,000	37,100		71.6	1,000	32,000		71.6	1,000
Lead (2)	7439-92-1	--	26.8	400	750	--	35.8	132		0.545	25	247		1.09	50	271		1.09	50
Magnesium	7439-95-4	--	--	--	--	--	--	2,130	,K,m	3.21	250	3,870	,K,m	3.21	250	3,030	,K,m	3.21	250
Manganese	7439-96-5	N	2,543	156.43	2,044	951.9	460	720		0.264	5	544		0.264	5	644		0.264	5
Mercury (3)	7439-97-6	--	0.13	2.35	30.66	--	0.18	0.033	J	0.0077	0.1	0.13		0.0077	0.1	0.11		0.0077	0.1
Nickel	7440-02-0	N	62.8	156.43	2,044	--	23	12		0.0356	0.5	19		0.0356	0.5	18		0.0356	0.5
Potassium	7440-09-7	--	--	--	--	--	--	1,020		5	100	1,950		5	100	1,520		5	100
Selenium	7782-49-2	N	--	39.11	511	18.98	2	0.85	J	0.0502	1	1.2		0.0502	1	1.2		0.0502	1
Silver	7440-22-4	N	--	39.11	511	31.03	1	0.12	J	0.0044	3	0.12	J	0.0044	3	0.14	J	0.0044	3
Sodium	7440-23-5	--	--	--	--	--	--	53	J	8.92	100	52	J	8.92	100	38	J	8.92	100
Thallium	7440-28-0	N	2.11	0.55	7.2	3.6	--	0.46	J	0.027	0.5	0.52		0.027	0.5	0.49	J	0.027	0.5
Vanadium	7440-62-2	N	108	7.82	102.2	730.1	--	19		0.207	1	44		0.207	1	32		0.207	1
Zinc	7440-66-6	N	202	2,346	30,660	13,622	121	442		3.35	40	541		3.35	40	541		3.35	40
TCL VOCs (µg/kg)																			
2-Butanone	78-93-3	N	--	4.7E+06	6.1E+07	2.9E+04	--	42		7.5	31	31		7.5	29	30	J	8	32
Acetone	67-64-1	N	--	7.0E+06	9.2E+07	2.2E+04	--	180	,J,m	7.5	31	80	,B,z	7.5	29	59	,B,z	8	32
cis-1,2-Dichloroethene	156-59-2	N	--	7.8E+04	1.0E+06	--	--	<7.7	U,UJ,m	1.07	7.7	11		1.07	7.4	8		1.14	7.9
Methylene chloride	75-09-2	C	--	8.5E+04	3.8E+05	1.9E+01	--	<31	U,UJ,m	4.22	31	<29	U	4.22	29	6.6	J	4.5	32
Tetrachloroethene	127-18-4	C	--	1.2E+03	5.3E+03	4.7E+00	468	<7.7	U,UJ,m	0.92	7.7	***5***	J	0.92	7.4	2.1	J	0.981	7.9
Toluene	108-88-3	N	--	6.3E+05	8.2E+06	2.7E+04	--	1.1	J,J,m	0.696	7.7	1.8	J	0.696	7.4	1	J	0.742	7.9
Trichloroethene	79-01-6	C	--	1.6E+03	7.2E+03	2.6E-01	96.9	<7.7	U,UJ,m	1.02	7.7	***64***		1.02	7.4	***38***		1.08	7.9
TCL SVOCs (µg/kg)																			
2-Methylnaphthalene	91-57-6	N	--	3.1E+04	4.1E+05	4.4E+03	20.2	12	J	4.11	260	7	J	4.11	250	<270	U	4.38	270
Acenaphthene	83-32-9	N	--	4.7E+05	6.1E+06	1.0E+05	6.7	5	J	2.58	260	<250	U	2.58	250	<270	U	2.75	270
Acenaphthylene (4)	208-96-8	N	--	2.3E+05	3.1E+06	--	5.9	<260	U	2.25	260	9	J	2.25	250	3	J	2.4	270
Anthracene	120-12-7	N	--	2.3E+06	3.1E+07	4.7E+05	57.2	<260	U,UJ,m	6.93	260	44	J	6.93	250	12	J	7.39	270
Benzo(a)anthracene	56-55-3	C	--	2.2E+02	3.9E+03	4.8E+02	108	33	J	20	260	86	J	20	250	30	J	21.3	270
Benzo(a)pyrene	50-32-8	C	--	2.2E+01	3.9E+02	1.2E+02	150	42	J	8.57	260	140	J	8.57	250	53	J	9.14	270
Benzo(b)fluoranthene	205-99-2	C	--	2.2E+02	3.9E+03	1.5E+03	--	64	J	14.6	260	190	J	14.6	250	86	J	15.6	270
Benzo(g,h,i)perylene (4)	191-24-2	N	--	2.3E+05	3.1E+06	--	170	35	J	13.1	260	110	J	13.1	250	27	J	14	270
Benzo(k)fluoranthene	207-08-9	C	--	2.2E+03	3.9E+04	1.5E+04	240	27	J	20.1	260	92	J	20.1	250	36	U	21.4	270
Bis(2-ethylhexyl)phthalate	117-81-7	C	--	4.6E+04	2.0E+05	2.9E+06	180	28	J,J,m	3.11	260	41	J	3.11	250	35	J	3.31	270
Chrysene	218-01-9	C	--	2.2E+04	3.9E+05	4.8E+04	166	37	J	15.3	260	220	J	15.3	250	64	J	16.3	270
Dibenz(a,h)anthracene	53-70-3	C	--	2.2E+01	3.9E+02	4.6E+02	33	15	J	8.85	260	42	J	8.85	250	<270	U	9.44	270
Diethylphthalate	84-66-2	N	--	6.3E+06	8.2E+07	4.5E+05	603	14	J,J,d	2.85	260	18	J	2.85	250	22	J	3.04	270
Dimethylphthalate	131-11-3	--	--	--	--	--	--	<260	U	4.97	260	1,400	,J,f	4.97	250	<270	U,UJ,f	5.3	270
Di-n-butylphthalate	84-74-2	N	--	7.8E+05	1.0E+07	5.0E+06	6,470	69	J	5.73	260	130	J	5.73	250	110	J	6.11	270
Fluoranthene	206-44-0	N	--	3.1E+05	4.1E+06	6.3E+06	423	56	J,J,m	3.53	260	34	J	3.53	250	26	J	3.76	270
Fluorene	86-73-7	N	--	3.1E+05	4.1E+06	1.4E+05	77.4	5	J	2.52	260	4	J	2.52	250	<270	U	2.69	270
Indeno(1,2,3-cd)pyrene	193-39-5	C	--	2.2E+02	3.9E+03	4.2E+03	17	31	J	5.88	260	100	J	5.88	250	30	J	6.27	270
Naphthalene	91-20-3	N	--	1.6E+05	2.0E+06	1.5E+02	176	<260	U	4.13	260	5	J	4.13	250	<270	U	4.4	270
Phenanthrene (4)	85-01-8	N	--	2.3E+05	3.1E+06	--	204	34	J	3.45	260	29	J	3.45	250	14	J	3.68	270
Pyrene	129-00-0	N	--	2.3E+05	3.1E+06	6.8E+05	195	51	J	2.22	260	37	J	2.22	250	23	J	2.37	270
SVOC TICs (µg/kg)																			
(Z)-9-Octadecenamide	301-02-0	--	--	--	--	--	--	66	E,NJ,t	0	100	NI				NI			
1,2-Benzenedicarboxylicacid, bis(2-methy	84-69-5	--	--	--	--	--	--	NI				300	E,NJ,t	0	100	170	E,NJ,t	0	100
1,2-Benzenedicarboxylic acid, butyl 2-me	17851-53-5	--	--	--	--	--	--	91	E,NJ,t	0	10	NI				NI			
Benzeneamine, 2-nitro-N-phenyl-	119-75-5	--	--	--	--	--	--	NI				350	E,NJ,t	0	10	60	E,NJ,t	0	10
Erucylamide	112-84-5	--	--	--	--	--	--	NI				400	E,NJ,t	0	10	NI			
Perylene	198-55-0	--	--	--	--	--	--	NI				170	E,NJ,t	0	100	57	E,NJ,t	0	100

Table 4-4
Detected Analytes for SWMU 13 (Sediment)
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

Sample ID Sample Date Sample Depth (ft bgs)	CAS	C/N	Facility-Wide Background Point Estimate[A]	Adjusted Soil RBC (Residential)	Adjusted Soil RBC (Industrial)	SSL DAF 20	Draft BTAG Screening Level	13SD2 10/10/2003		MDL	RL	13SD3 10/10/2003		MDL	RL	13SD3-DUP(SDD1) 10/10/2003		MDL	RL
								Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r		
PAHs (µg/kg)																			
Anthracene	120-12-7	N	--	2.3E+06	3.1E+07	4.7E+05	57	3.8	J	1.05	32	9.4	J	1.05	31	<33	U	1.12	33
Benzo(a)anthracene	56-55-3	C	--	2.2E+02	3.9E+03	4.8E+02	108	21	J	1.2	32	30	J	1.2	31	<33	U	1.28	33
Benzo(a)pyrene	50-32-8	C	--	2.2E+01	3.9E+02	1.2E+02	150	26	J	1.5	32	49		1.5	31	<33	U	1.6	33
Benzo(b)fluoranthene	205-99-2	C	--	2.2E+02	3.9E+03	1.5E+03	--	23	J	1.95	32	36		1.95	31	<33	U	2.08	33
Benzo(g,h,i)perylene (4)	191-24-2	N	--	2.3E+05	3.1E+06	--	170	40		18.8	32	88		18.8	31	<33	U	20	33
Benzo(k)fluoranthene	207-08-9	C	--	2.2E+03	3.9E+04	1.5E+04	240	12	J	1.5	32	24	J	1.5	31	<33	U	1.6	33
Chrysene	218-01-9	C	--	2.2E+04	3.9E+05	4.8E+04	166	19	J	1.8	32	84		1.8	31	2.6	J	1.92	33
Dibenz(a,h)anthracene	53-70-3	C	--	2.2E+01	3.9E+02	4.6E+02	33	<32	U	2.1	32	6.2	J	2.1	31	<33	U	2.24	33
Fluoranthene	206-44-0	N	--	3.1E+05	4.1E+06	6.3E+06	423	48		2.55	32	19	J	2.55	31	<33	U	2.72	33
Indeno(1,2,3-cd)pyrene	193-39-5	C	--	2.2E+02	3.9E+03	4.2E+03	17	18	J	1.05	32	45		1.05	31	<33	U	1.12	33
Phenanthrene (4)	85-01-8	N	--	2.3E+05	3.1E+06	--	204	16	J	0.9	32	5.2	J	0.9	31	<33	U	0.96	33
Pyrene	129-00-0	N	--	2.3E+05	3.1E+06	6.8E+05	195	45		1.35	32	14	J	1.35	31	<33	U	1.44	33
Cyanide (mg/kg)																			
Cyanide	57-12-5	N	--	1.6E+02	2.0E+03	1.5E+02	0.1	0.07	J	0.0356	0.5	0.2	J	0.0356	0.5	0.39	J	0.0356	0.5
Percent Solids (%)																			
Percent Solids	--	--	--	--	--	--	--	65		0.1	0.1	68		0.1	0.1	63		0.1	0.1

Notes:

CAS = Chemical Abstracts Service
ft bgs = Feet Below Ground Surface
mg/kg = Milligram Per Kilogram
µg/kg = Microgram Per Kilogram
TAL = Target Analyte List
TCL = Target Compound List
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound
PAH = Polynuclear Aromatic Hydrocarbon
TIC = Tentatively Identified Compound
C = Carcinogenic per EPA RBC Table (April 2004)
N = Noncarcinogenic per EPA RBC Table (April 2004)
NA = Not Applicable
MDL = Method Detection Limit
RL = Reporting Limit
NI = Not Identified
LQ = Laboratory Qualifier
VQ = Validation Qualifier
r = Reason Code
(1) = Chromium VI RBC value was used
(2) = Lead criteria are Action Levels; see USEPA Region III guidance
(3) = Mercuric chloride soil RBC value used
(4) = RBC value for pyrene was used for these compounds

[A] = Facility-Wide Background Point Estimate as
Reported in the Facility-Wide Background Study Report (IT 2001a)
RBC = USEPA Region III Risk-Based Concentration
(RBC) values from the October 31, 2006,
RBC Table and October 10, 2006, Alternate RBC Table
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
C = Carcinogenic per EPA RBC Table (October 2006)
N = Noncarcinogenic per EPA RBC Table (October 2006)
SSL DAF20 = Soil Screening Level at a Dilution Attenuation Factor of 20
BTAG = Biological Technical Assistance Group Screening Level, 2004

[double-bordered box] = Concentration Exceeds Adjusted Soil Residential RBC
[bold-bordered box] = Concentration Exceeds Adjusted Soil Industrial RBC
underline = Concentration Exceeds Site Background Values
bold italic = Concentration Exceeds SSL DAF20
[shaded box] = Concentration Exceeds BTAG Screening Level

Laboratory Qualifiers

U	The compound was analyzed for but not detected. The reporting limit will be adjusted to reflect any dilution, and for soil, the percent moisture.
J	Estimated value.
E	Concentration exceeded the upper level of the calibration range of the instrument for that specific analysis. For TICs, compound not present in calibration standard, calculated using total peak areas ion chromatographs and response factor of 1.

Validation Qualifiers

U	Not detected. The associated number indicates the approximate sample concentration necessary to be detected.
B	Not detected substantially above the level reported in laboratory or field blanks.
N	Tentative Identification. Consider present. Special methods may be needed to confirm its presence or absence in future sampling efforts.
J	Analyte present. Reported value may not be accurate or precise.
K	Analyte present. Reported value may be biased high. Actual value is expected to be lower.
UJ	Not detected, quantitation limit may be inaccurate or imprecise.

Reason Codes

GC/MS Organics

d	MS/MSD or LCS/LCSD RPD imprecision
f	Field duplicate imprecision
m	Internal standard failure
z	Method blank and/or storage blank contamination

GC and HPLC Organics

d	MS/MSD or LCS/LCSD RPD imprecision
f	Field duplicate imprecision
m	Air bubble (> 6 mm or ¼ inch) in VOC vials
z	Method blank and/or storage blank contamination

Inorganics and Conventionals

m	MS/MSD recovery failure

Table 4-5
Detected Analytes for SWMU 13 (Surface Water)
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

Sample ID / Sample Date	CAS	C/N	Adjusted Tap Water RBC	MCL	BTAG Screening Values	Units	13SW2 10/10/2003 Result	13SW2 LQ, VQ, r	MDL	RL	13SW3 10/10/2003 Result	13SW3 LQ, VQ, r	MDL	RL	SWD1 10/10/2003 Result	SWD1 LQ, VQ, r	MDL	RL
TAL Metals (µg/L)																		
Aluminum	7429-90-5	N	--	--	87	µg/L	74	J	18.7	100	66	J	18.7	100	53	J	18.7	100
Antimony	7440-36-0	N	1.46	6	30	µg/L	<1	U	0.552	1	0.7	J	0.552	1	<1	U	0.552	1
Antimony, Dissolved	7440-36-0		1.46		30	µg/L	<2	U	0.552	2	0.8	J	0.552	2	<2	U	0.552	2
Barium	7440-39-3	N	730	2,000	4	µg/L	22		1.82	10	21		1.82	10	21		1.82	10
Barium, Dissolved	7440-39-3		730		4	µg/L	18		1.82	10	18		1.82	10	17		1.82	10
Calcium	7440-70-2	--	--		116,000	µg/L	13,000		170	2,500	13,000		170	2,500	13,000		170	2,500
Calcium, Dissolved	7440-70-2		--	--	116,000	µg/L	13,000		170	2,500	13,000		170	2,500	13,000		170	2,500
Chromium	7440-47-3	N	10.95	100	85	µg/L	0.8	J,B,p	0.554	1	0.8	J,B,p	0.554	1	0.6	J,B,p	0.554	1
Chromium, Dissolved	7440-47-3		10.95		85	µg/L	<2	U	0.554	2	0.6	J	0.554	2	0.8	J	0.554	2
Iron	7439-89-6	N	1,095	--	300	µg/L	190		2.95	100	180		2.95	100	170		2.95	100
Iron, Dissolved	7439-89-6		1,095		300	µg/L	37	J	2.95	100	38	J	2.95	100	36	J	2.95	100
Lead	7439-92-1	--	--	15	2.5	µg/L	0.6	J,B,p	0.281	1	0.9	J,B,p	0.281	1	0.9	J,B,p	0.281	1
Magnesium	7439-95-4	--	--	--	82,000	µg/L	5,700		57.4	500	5,400		57.4	500	5,300		57.4	500
Magnesium, Dissolved	7439-95-4	--	--		82,000	µg/L	5,600		57.4	500	5,500		57.4	500	5,400		57.4	500
Manganese	7439-96-5	N	73	--	120	µg/L	27		3.16	10	30		3.16	10	24		3.16	10
Manganese, Dissolved	7439-96-5		73		120	µg/L	10		3.16	10	7.9	J	3.16	10	4.3	J	3.16	10
Nickel	7440-02-0	N	73	--	52	µg/L	0.96	J	0.41	1	0.8	J	0.41	1	0.8	J	0.41	1
Nickel, Dissolved	7440-02-0		73		52	µg/L	1.1	J	0.41	2	1	J	0.41	2	0.8	J	0.41	2
Potassium	7440-09-7	--	--	--	53,000	µg/L	1,800		59.7	200	1,900		59.7	200	1,800		59.7	200
Potassium, Dissolved	7440-09-7		--		53,000	µg/L	1,600		59.7	200	1,600		59.7	200	1,700		59.7	200
Sodium	7440-23-5	--	--	--	680,000	µg/L	5,100	,J,s	76.9	500	5,100	,J,s	76.9	500	5,000	,J,s	76.9	500
Sodium, Dissolved	7440-23-5		--		680,000	µg/L	5,100		76.9	500	5,100		76.9	500	5,000		76.9	500
Thallium	7440-28-0	N	0.256	2	0.8	µg/L	<1	U	0.208	1	0.3	J	0.208	1	0.24	J	0.208	1
Zinc	7440-66-6	N	1,095	--	120	µg/L	5.5	J	4.55	20	<20	U	4.55	20	<20	U	4.55	20
TCL SVOCs (µg/L)						µg/L												
Bis(2-ethylhexyl)phthalate	117-81-7	C	4.78	--	16	µg/L	0.34	J,B,z	0.149	5	0.31	J,B,z	0.149	5	0.33	J,B,z	0.149	5
Butylbenzylphthalate	85-68-7	N	730	--	19	µg/L	0.11	J,B,z	0.015	5	0.11	J,B,z	0.015	5	0.11	J,B,z	0.015	5
Diethylphthalate	84-66-2	N	2,920	--	210	µg/L	0.11	J,B,z	0.074	5	<5	U	0.074	5	<5	U	0.074	5
SVOC TICs (µg/L)						µg/L												
(M) 1-Eicosanol	629969	--	--	--	--	µg/L	0.91	E,NJ,t	0	1	0.89	E,NJ,t	0	1	0.78	E,NJ,t	0	1
(Z)-9-Octadecenamide	301-02-0	--	--	--	--	µg/L	NI				NI				10.37	E,NJ,t	0	0.1
1-HEXACOSANOL	506-52-5	--	--	--	--	µg/L	NI				NI				NI			
1-Hexadecanol	36653-82-4	--	--	--	--	µg/L	0.51	E,NJ,t	0	0.01	NI				NI			
1,2-Benzenedicarboxylicacid, bis(2-methy	84-69-5	--	--	--	--	µg/L	0.84	E,NJ,t	0	0.01	NI				0.52	E,NJ,t	0	0.01
1,2-Benzenedicarboxylic acid, butyl 2-me	17851-53-5	--	--	--	--	µg/L	NI				0.51	E,NJ,t	0	0.01	NI			
2,4,6-Triallyloxy-1,3,5-triazine	101-37-1	--	--	--	--	µg/L	1.63	E,NJ,t	0	0.1	1.2	E,NJ,t	0	0.1	NI			
Docosane, 11-butyl-	629-97-0	--	--	--	--	µg/L	NI				0.49	E,NJ,t	0	0.01	NI			
Eicosane	112-95-8	--	--	--	--	µg/L	0.54	E,NJ,t	0	1000	NI				NI			
Erucylamide	112-84-5	--	--	--	--	µg/L	20.79	E,NJ,t	0	0.1	9.63	E,NJ,t	0	0.1	NI			

Notes:

CAS = Chemical Abstracts Service
µg/L = Microgram Per Liter
TAL = Target Analyte List
TCL = Target Compound List
MDL = Method Detection Limit
RL = Reporting Limit
NI = Not Identified
LQ = Laboratory Qualifier
VQ = Validation Qualifier
r = Reason Code
SVOC = Semivolatile Organic Compound
TIC = Tentatively Identified Compound
RBC = USEPA Region III Risk-Based Concentration (RBC) values from the October 31, 2006, RBC Table and October 10, 2006, Alternate RBC Table
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
C = Carcinogenic per EPA RBC Table (October 2006)
N = Noncarcinogenic per EPA RBC Table (October 2006)
MCL = Maximum Contaminant Level
BTAG = Biological Technical Assistance Group Screening Level, 2004

= Exceeded Adjusted T-RBC
= Exceeds MCL
= Concentration Exceeds BTAG Screening Level

Laboratory Qualifiers

U The compound was analyzed for but not detected. The reporting limit will be adjusted to reflect any dilution, and for soil, the percent moisture.
J Estimated value.
E Concentration exceeded the upper level of the calibration range of the instrument for that specific analysis. For TICs, compound not present in calibration standard, calculated using total peak areas ion chromatographs and response factor of 1.

Validation Qualifiers

B Not detected substantially above the level reported in laboratory or field blanks.
N Tentative Identification. Consider present. Special methods may be needed to confirm its presence or absence in future sampling efforts.
J Analyte present. Reported value may not be accurate or precise.

Reason Codes

GC/MS Organics
t Tentatively identified Compound
z Method blank and/or storage blank contamination
GC and HPLC Organics
z Method blank and/or storage blank contamination
Inorganics and Conventionals
p Preparation blank contamination
s Serial dilution failure

Table 4-6
HHRS COPC Selection (Surface Soil) for SWMU 13
SSP Report
Radford Army Ammunition Plant, Radford, VA

CAS #	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	C/N	Adjusted RBC Residential	Adjusted RBC Industrial	COPC Flag (Y/N)	Rationale for Selection or Deletion
	TAL Metals (mg/kg)												
7429905	Aluminum	6,630	19,800	mg/kg	13SB11A	6/6	1.83 - 1.83	19,800	--	--	--	Y	NSV
7440360	Antimony	0.07	1.1	mg/kg	13SB12A	5/6	0.0518 - 0.0518	1.1	N	3	40.9	N	BSL
7440382	Arsenic	1.6	2.6	mg/kg	13SB9A	6/6	0.0232 - 0.0232	3	C	0.43	1.91	Y	***ARES/IND***
7440393	Barium	78	177	mg/kg	13SB9A	6/6	0.106 - 0.106	177	N	1,564	20,440	N	BSL
7440417	Beryllium	0.66	1.15	mg/kg	13SB9A	5/6	0.0333 - 0.167	1.15	N	16	204	N	BSL
7440439	Cadmium	0.91	2.3	mg/kg	13SB9A	6/6	0.182 - 0.182	2.3	N	3.91	51	N	BSL
7440702	Calcium	1,980	12,400	mg/kg	13SB12A	6/6	16.6 - 16.6	12,400	--	Nutrient	Nutrient	N	Nutrient
7440473	Chromium[1]	18	38	mg/kg	13SB11A	6/6	0.912 - 0.912	38	N	23.5	307	Y	**ARES**
7440484	Cobalt	5.1	13	mg/kg	13SB11A	6/6	0.208 - 0.208	13	--	--	--	Y	NSV
7440508	Copper	13	45	mg/kg	13SB12A	6/6	0.368 - 0.368	45	N	313	4,088	N	BSL
7439896	Iron	14,800	36,200	mg/kg	13SB9A	6/6	21.2 - 42.4	36,200	N	2,346	30,660	Y	***ARES/IND***
7439921	Lead[2]	111	8,620	mg/kg	13SB8A	6/6	0.545 - 21.8	8,620	--	400	750	Y	***ARES/IND***
7439954	Magnesium	3,240	5,330	mg/kg	13SB12A	6/6	3.21 - 3.21	5,330	--	Nutrient	Nutrient	N	Nutrient
7439965	Manganese	301	1,315	mg/kg	13SB9A	6/6	0.264 - 1.32	1,315	N	156	2,044	Y	**ARES**
7439976	Mercury[3]	0.02	0.05	mg/kg	13SB11A	6/6	0.0077 - 0.0077	0.05	--	0.8	10	N	BSL
7440020	Nickel	8.3	18.00	mg/kg	13SB9A	6/6	0.0356 - 0.0356	18	N	156.43	2,044	N	BSL
7440097	Potassium	1,050	2,680	mg/kg	13SB11A	6/6	5 - 5	2,680	--	Nutrient	Nutrient	N	Nutrient
7782492	Selenium	0.32	0.89	mg/kg	13SB9A	6/6	0.0502 - 0.0502	0.89	N	39	511	N	BSL
7440224	Silver	0.06	0.14	mg/kg	13SB8A	6/6	0.0044 - 0.0044	0.14	N	39	511	N	BSL
7440235	Sodium	36	102	mg/kg	13SB12A	6/6	18.1 - 18.1	102	--	Nutrient	Nutrient	N	Nutrient
7440280	Thallium	0.13	0.87	mg/kg	13SB9A	6/6	0.027 - 0.027	0.87	N	0.55	7.15	Y	**ARES**
7440622	Vanadium	14	36	mg/kg	13SB9A	6/6	0.207 - 0.207	36	N	7.82	102	Y	**ARES**
7440666	Zinc	214	990	mg/kg	13SB9A	6/6	2.59 - 12.9	990	N	2,346	30,660	N	BSL
	TCL VOCs (µg/kg)												
120821	1,2,4-Trichlorobenzene	9.6E-01	9.6E-01	µg/kg	13SB10A	1/6	0.492 - 0.574	9.6E-01	N	7.8E+04	1.0E+06	N	BSL
78933	2-Butanone	2.6E+01	4.5E+01	µg/kg	13SB11A	6/6	6 - 7	4.5E+01	N	4.7E+06	6.1E+07	N	BSL
67641	Acetone	4.9E+01	3.2E+02	µg/kg	13SB10A	6/6	6 - 7	3.2E+02	N	7.0E+06	9.2E+07	N	BSL
71432	Benzene	9.1E-01	9.1E-01	µg/kg	13SB11A	1/6	0.632 - 0.738	9.1E-01	C	1.2E+04	5.2E+04	N	BSL
108883	Toluene	6.6E-01	3.5E+00	µg/kg	13SB10A	5/6	0.557 - 0.65	3.5E+00	N	6.3E+05	8.2E+06	N	BSL
79016	Trichloroethene	9.6E+00	9.6E+00	µg/kg	13SB11A	1/6	0.812 - 0.948	9.6E+00	C	1.6E+03	7.2E+03	N	BSL
	VOC TICs (µg/kg)												
66251	Hexanal	1.3E+01	3.5E+02	µg/kg	13SB10A	2/6	0 - 0	3.5E+02	--	--	--	Y	NSV
	TCL SVOCs (µg/kg)												
91576	2-Methylnaphthalene	4.0E+00	2.2E+01	µg/kg	13SB8A	3/6	3.29 - 3.84	2.2E+01	N	3.1E+04	4.1E+05	N	BSL
121142	2,4-Dinitrotoluene	3.5E+01	7.1E+02	µg/kg	13SB12A	3/6	3.78 - 4.41	7.1E+02	N	1.6E+04	2.0E+05	N	BSL
606202	2,6-Dinitrotoluene	2.1E+02	2.1E+02	µg/kg	13SB12A	1/6	33.2 - 38.8	2.1E+02	N	7.8E+03	1.0E+05	N	BSL
--	Dinitrotoluene Mix	3.5E+01	9.2E+02	µg/kg	13SB12A	2/6	0 - 0	9.2E+02	C	9.4E+02	4.2E+03	N	BSL
59507	4-Chloro-3-Methylphenol	9.0E+00	1.9E+01	µg/kg	13SB7A	5/6	6.25 - 7.29	1.9E+01	--	--	--	Y	NSV
83329	Acenaphthene	8.0E+00	1.9E+01	µg/kg	13SB8A	4/6	2.06 - 2.41	1.9E+01	N	4.7E+05	6.1E+06	N	BSL
208968	Acenaphthylene[4]	2.0E+00	5.0E+00	µg/kg	13SB9A	4/6	1.8 - 2.1	5.0E+00	N	2.3E+05	3.1E+06	N	BSL
120127	Anthracene	1.5E+01	3.7E+01	µg/kg	13SB8A	4/6	5.54 - 6.47	3.7E+01	N	2.3E+06	3.1E+07	N	BSL
56553	Benzo(a)anthracene	5.1E+01	1.7E+02	µg/kg	13SB9A	4/6	16 - 186	1.7E+02	C	2.2E+02	3.9E+03	N	BSL
50328	Benzo(a)pyrene	1.8E+01	1.3E+02	µg/kg	13SB9A	5/6	6.85 - 7.99	1.3E+02	C	2.2E+01	3.9E+02	Y	**ARES**
205992	Benzo(b)fluoranthene	1.3E+01	2.1E+02	µg/kg	13SB9A	6/6	11.7 - 13.7	2.1E+02	C	2.2E+02	3.9E+03	N	BSL
191242	Benzo(g,h,i)perylene[4]	1.1E+01	7.2E+01	µg/kg	13SB8A	5/6	10.5 - 12.2	7.2E+01	N	2.3E+05	3.1E+06	N	BSL
207089	Benzo(k)fluoranthene	2.8E+01	8.9E+01	µg/kg	13SB9A	4/6	16.1 - 18.8	8.9E+01	C	2.2E+03	3.9E+04	N	BSL
117817	Bis(2-ethylhexyl)phthalate	1.9E+01	4.5E+02	µg/kg	13SB10A	6/6	2.48 - 2.9	4.5E+02	C	4.6E+04	2.0E+05	N	BSL
85687	Butylbenzylphthalate	6.0E+00	3.8E+01	µg/kg	13SB10A	3/6	5.38 - 6.27	3.8E+01	N	1.6E+06	2.0E+07	N	BSL
86748	Carbazole	2.1E+01	2.1E+01	µg/kg	13SB9A	1/6	7.32 - 8.54	2.1E+01	C	3.2E+04	1.4E+05	N	BSL
218019	Chrysene	2.4E+01	1.9E+02	µg/kg	13SB9A	5/6	12.2 - 14.3	1.9E+02	C	2.2E+04	3.9E+05	N	BSL
53703	Dibenz(a,h)anthracene	1.6E+01	1.8E+01	µg/kg	13SB8A	2/6	7.08 - 8.26	1.8E+01	C	2.2E+01	3.9E+02	N	BSL
132649	Dibenzofuran	6.0E+00	1.3E+01	µg/kg	13SB8A	2/6	3.79 - 4.42	1.3E+01	--	--	--	Y	NSV
84662	Diethylphthalate	9.0E+00	9.5E+02	µg/kg	13SB12A	6/6	2.28 - 2.66	9.5E+02	N	6.3E+06	8.2E+07	N	BSL
131113	Dimethylphthalate	1.0E+01	1.4E+02	µg/kg	13SB10A	2/6	3.97 - 4.63	1.4E+02	--	--	--	Y	NSV
84742	Di-n-butylphthalate	6.2E+01	6.8E+02		13SB12A	6/6	4.58 - 5.35	6.8E+02	N	7.8E+05	1.0E+07	N	BSL
206440	Fluoranthene	9.0E+00	3.7E+02	µg/kg	13SB8A	6/6	2.82 - 3.29	3.7E+02	N	3.1E+05	4.1E+06	N	BSL
91203	Naphthalene	4.0E+00	1.0E+01	µg/kg	13SB8A	2/6	3.3 - 3.85	1.0E+01	N	1.6E+05	2.0E+06	N	BSL
85018	Phenanthrene[4]	4.0E+00	1.7E+02	µg/kg	13SB10A	6/6	2.76 - 3.22	1.7E+02	N	2.3E+05	3.1E+06	N	BSL
129000	Pyrene	6.0E+00	2.6E+02	µg/kg	13SB8A	6/6	1.78 - 2.07	2.6E+02	N	2.3E+05	3.1E+06	N	BSL

Table 4-6
HHRS COPC Selection (Surface Soil) for SWMU 13
SSP Report
Radford Army Ammunition Plant, Radford, VA

CAS #	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	C/N	Adjusted RBC Residential	Adjusted RBC Industrial	COPC Flag (Y/N)	Rationale for Selection or Deletion
	SVOC TICs (µg/kg)												
15594908	1-Heneicosanol	2.2E+02	2.2E+02	µg/kg	13SB11A	1/6	0 - 0	2.2E+02	--	--	--	Y	NSV
101371	2,4,6-Triallyloxy-1,3,5-triazine	5.0E+01	6.0E+01	µg/kg	13SB9A	2/6	0 - 0	6.0E+01	--	--	--	Y	NSV
1000194624	4,4,6a,6b,8a,11,11,14b-Octamethyl-1,4,4a	7.1E+02	7.1E+02	µg/kg	13SB10A	1/6	0 - 0	7.1E+02	--	--	--	Y	NSV
0118967	Benzene, 2-methyl-1,3,5-trinitro-	2.8E+02	3.5E+02	µg/kg	13SB12A	2/6	0 - 0	3.5E+02	--	--	--	Y	NSV
119755	Benzeneamine, 2-nitro-N-phenyl-	2.8E+02	2.8E+02	µg/kg	13SB12A	1/6	0 - 0	2.8E+02	--	--	--	Y	NSV
123955	Butyl Ester Octadecanioc	1.3E+02	1.3E+02	µg/kg	13SB11A	1/6	0 - 0	1.3E+02	--	--	--	Y	NSV
57885	Cholesterol	1.2E+02	4.7E+02	µg/kg	13SB10A	2/6	0 - 0	4.7E+02	--	--	--	Y	NSV
112845	Erucylamide	1.4E+02	5.7E+02	µg/kg	13SB9A	6/6	0 - 0	5.7E+02	--	--	--	Y	NSV
2136712	Ethanol, 2-(hexadecyloxy)-	3.9E+02	3.9E+02	µg/kg	13SB11A	1/6	0 - 0	3.9E+02	--	--	--	Y	NSV
83476	.Gamma.-sitosterol	1.6E+02	2.4E+03	µg/kg	13SB10A	4/6	0 - 0	2.4E+03	--	--	--	Y	NSV
1058613	Stigmast-4-en-3-one	1.4E+02	2.4E+02	µg/kg	13SB8A	2/6	0 - 0	2.4E+02	--	--	--	Y	NSV
1000214207	Stigmasterol, 22,23-dihydro-	1.6E+02	1.6E+02	µg/kg	13SB9A	1/6	0 - 0	1.6E+02	--	--	--	Y	NSV
127220	Taraxerol	2.9E+02	2.9E+02	µg/kg	13SB8A	1/6	0 - 0	2.9E+02	--	--	--	Y	NSV
102761	Triacetin	1.4E+02	1.4E+02	µg/kg	13SB12A	1/6	0 - 0	1.4E+02	--	--	--	Y	NSV
611927	Urea, N,N'-dimethyl-N,N'-diphenyl-	4.8E+01	9.1E+02	µg/kg	13SB12A	2/6	0 - 0	9.1E+02	--	--	--	Y	NSV
10191410	Vitamin E	1.6E+02	6.0E+02	µg/kg	13SB10A	2/6	0 - 0	6.0E+02	--	--	--	Y	NSV
	PAHs (µg/kg)												
83329	Acenaphthene	1.4E+01	1.7E+01	µg/kg	13SB9A	2/6	11.3 - 13.2	1.7E+01	N	4.7E+05	6.1E+06	N	BSL
120127	Anthracene	6.6E+00	3.8E+01	µg/kg	13SB10A	4/6	0.84 - 0.98	3.8E+01	N	2.3E+06	3.1E+07	N	BSL
56553	Benzo(a)anthracene	2.1E+00	1.4E+02	µg/kg	13SB10A	6/6	0.96 - 1.12	1.4E+02	C	2.2E+02	3.9E+03	N	BSL
50328	Benzo(a)pyrene	6.5E+00	1.9E+02	µg/kg	13SB10A	5/6	1.2 - 1.4	1.9E+02	C	2.2E+01	3.9E+02	Y	**ARES**
205992	Benzo(b)fluoranthene	4.9E+00	1.4E+02	µg/kg	13SB10A	5/6	1.56 - 1.82	1.4E+02	C	2.2E+02	3.9E+03	N	BSL
191242	Benzo(g,h,i)perylene[4]	8.2E+01	3.9E+02	µg/kg	13SB9A	4/6	15 - 17.5	3.9E+02	N	2.3E+05	3.1E+06	N	BSL
207089	Benzo(k)fluoranthene	2.0E+01	8.0E+01	µg/kg	13SB10A	4/6	1.2 - 1.4	8.0E+01	C	2.2E+03	3.9E+04	N	BSL
218019	Chrysene	2.4E+00	1.5E+02	µg/kg	13SB10A	6/6	1.44 - 1.68	1.5E+02	C	2.2E+04	3.9E+05	N	BSL
53703	Dibenz(a,h)anthracene	2.3E+00	5.2E+00	µg/kg	13SB10A	2/6	1.68 - 1.96	5.2E+00	C	2.2E+01	3.9E+02	N	BSL
206440	Fluoranthene	5.0E+00	4.7E+02	µg/kg	13SB10A	6/6	2.04 - 2.38	4.7E+02	N	3.1E+05	4.1E+06	N	BSL
86737	Fluorene	5.9E+00	1.7E+01	µg/kg	13SB10A	2/6	1.56 - 1.82	1.7E+01	N	3.1E+05	4.1E+06	N	BSL
193395	Indeno(1,2,3-cd)pyrene	5.9E+00	1.3E+02	µg/kg	13SB10A	5/6	0.84 - 0.98	1.3E+02	C	2.2E+02	3.9E+03	N	BSL
85018	Phenanthrene[4]	2.1E+00	2.1E+02	µg/kg	13SB10A	6/6	0.72 - 0.84	2.1E+02	N	2.3E+05	3.1E+06	N	BSL
129000	Pyrene	3.6E+00	3.2E+02	µg/kg	13SB10A	6/6	1.08 - 1.26	3.2E+02	N	2.3E+05	3.1E+06	N	BSL
	Explosives (mg/kg)												
121142	2,4-Dinitrotoluene	3.9E-01	3.9E-01	mg/kg	13SB12A	1/6	0.142 - 0.142	3.9E-01	N	1.6E+01	2.0E+02	N	BSL
--	Dinitrotoluene Mix	3.9E-01	3.9E-01	mg/kg	13SB12A	1/6	0 - 0	3.9E-01	C	9.4E-01	4.2E+00	N	BSL
118967	2,4,6-Trinitrotoluene	2.7E-01	4.3E-01	mg/kg	13SB11A	2/6	0.167 - 0.167	4.3E-01	C	3.9E+00	5.1E+01	N	BSL
	Nitroglycerin/PETN (mg/kg)												
55630	Nitroglycerin	4.5E-01	8.5E+00	mg/kg	13SB12A	3/6	0.195 - 0.276	8.5E+00	N	1.3E+02	1.7E+03	N	BSL
	Cyanide (mg/kg)												
57125	Cyanide	7.0E-02	3.1E-01	mg/kg	13SB9A	6/6	0.0356 - 0.0356	3.1E-01	N	1.6E+02	2.0E+03	N	BSL
	Dioxins/Furans (mg/g)												
1746016	Total 2,3,7,8-TCDD Equivalents	--	--	mg/kg	13SB9A	1/1	--	2.1E-06	C	4.6E-06	1.9E-05	N	BSL

Notes:

CAS = Chemical Abstracts Service
COPC = Chemical of Potential Concern
mg/kg = Milligram Per Kilogram
µg/kg = Microgram Per Kilogram
TAL = Target Analyte List
TCL = Target Compound List
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound
PAH = Polynuclear Aromatic Hydrocarbon
TIC = Tentatively Identified Compound

[1] = Chromium VI RBC value was used
[2] = Lead criteria are Action Levels; see USEPA Region III guidance
[3] = Mercuric chloride soil RBC value used
[4] = RBC value for pyrene was used for these compounds

RBC = USEPA Region III Risk-Based Concentration (RBC) values from the October 31, 2006, RBC Table and October 10, 2006, Alternate RBC Table
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
C = Carcinogenic per EPA RBC Table (October 2006)
N = Noncarcinogenic per EPA RBC Table (October 2006)

ARES = Above Residential RBC
ARES/IND = Above Residential RBC/Industrial RBC
BSL = Below Residential/Industrial RBC Screening Levels
NSV = No Screening Value Available

Table 4-7
HHRS COPC Selection (Total Soil) for SWMU 13
SSP Report
Radford Army Ammunition Plant, Radford, VA

CAS #	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	C/N	Adjusted RBC Residential	Adjusted RBC Industrial	COPC Flag (Y/N)	Rationale for Selection or Deletion
	TAL Metals (mg/kg)												
7429905	Aluminum	4,250	21,400	mg/kg	13SB7C	17/17	1.83 - 1.83	21,400	--	--	--	Y	NSV
7440360	Antimony	0.07	4.7	mg/kg	13SB11B	13/17	0.0518 - 0.0518	4.7	N	3	40.9	Y	**ARES**
7440382	Arsenic	0.12	4.7	mg/kg	13SB11C	17/17	0.0232 - 0.0232	5	C	0.43	1.91	Y	***ARES/IND***
7440393	Barium	29	211	mg/kg	13SB11C	17/17	0.106 - 0.106	211	N	1,564	20,440	N	BSL
7440417	Beryllium	0.65	1.30	mg/kg	13SB7C	11/17	0.0333 - 0.167	1.30	N	16	204	N	BSL
7440439	Cadmium	0.72	2.7	mg/kg	13SB11C	17/17	0.182 - 0.182	2.7	N	3.91	51	N	BSL
7440702	Calcium	1,300	12,400	mg/kg	13SB12A	17/17	16.6 - 16.6	12,400	--	Nutrient	Nutrient	N	Nutrient
7440473	Chromium[1]	11	39	mg/kg	13SB11C	17/17	0.912 - 0.912	39	N	23.5	307	Y	**ARES**
7440484	Cobalt	3.90	16	mg/kg	13SB11C	17/17	0.208 - 0.208	16	--	--	--	Y	NSV
7440508	Copper	2.50	98	mg/kg	13SB11B	17/17	0.368 - 1.84	98	N	313	4,088	N	BSL
7439896	Iron	5,330	48,600	mg/kg	13SB11C	17/17	4.24 - 42.4	48,600	N	2,346	30,660	Y	***ARES/IND***
7439921	Lead[2]	12.00	26,500	mg/kg	13SB11B	17/17	0.0218 - 109	26,500	--	400	750	Y	***ARES/IND***
7439954	Magnesium	1,210	5,330	mg/kg	13SB12A	17/17	3.21 - 3.21	5,330	--	Nutrient	Nutrient	N	Nutrient
7439965	Manganese	59	1,700	mg/kg	13SB11C	17/17	0.264 - 6.6	1,700	N	156	2,044	Y	**ARES**
7439976	Mercury[3]	0.01	0.13	mg/kg	13SB12C	16/17	0.0077 - 0.0077	0.13	--	0.8	10	N	BSL
7440020	Nickel	3.80	21.00	mg/kg	13SB11C	17/17	0.0356 - 0.0356	21	N	156	2,044	N	BSL
7440097	Potassium	548	2,680	mg/kg	13SB11A	17/17	5 - 5	2,680	--	Nutrient	Nutrient	N	Nutrient
7782492	Selenium	0.23	1.5	mg/kg	13SB11C	17/17	0.0502 - 0.0502	1.5	N	39.11	511	N	BSL
7440224	Silver	0.02	0.45	mg/kg	13SB8B	17/17	0.0044 - 0.0044	0.45	N	39.11	511	N	BSL
7440235	Sodium	36	170	mg/kg	13SB12B - DUP AVG	17/17	18.1 - 18.1	170	--	Nutrient	Nutrient	N	Nutrient
7440280	Thallium	0.05	0.87	mg/kg	13SB9A	17/17	0.027 - 0.027	0.87	N	0.55	7.15	Y	**ARES**
7440622	Vanadium	11	36	mg/kg	13SB7C	17/17	0.207 - 0.207	36	N	7.82	102	Y	**ARES**
7440666	Zinc	46	1,070	mg/kg	13SB11C	17/17	0.517 - 12.9	1,070	N	2,346	30,660	N	BSL
	TCL VOCs (µg/kg)												
120821	1,2,4-Trichlorobenzene	9.6E-01	9.6E-01	µg/kg	13SB10A	1/17	0.451 - 0.656	9.6E-01	N	7.8E+04	1.0E+06	N	BSL
78933	2-Butanone	2.4E+01	4.0E+02	µg/kg	13SB9B	16/17	5.5 - 8	4.0E+02	N	4.7E+06	6.1E+07	N	BSL
67641	Acetone	3.1E+01	3.2E+02	µg/kg	13SB10A	17/17	5.5 - 8	3.2E+02	N	7.0E+06	9.2E+07	N	BSL
71432	Benzene	6.9E-01	1.5E+00	µg/kg	13SB11B	4/17	0.58 - 0.843	1.5E+00	C	1.2E+04	5.2E+04	N	BSL
156592	cis-1,2-Dichloroethene	1.9E+00	4.2E+00	µg/kg	13SB11C	2/17	0.781 - 1.14	4.2E+00	N	7.8E+04	1.0E+06	N	BSL
75092	Methylene chloride	4.1E+00	1.1E+01	µg/kg	13SB10A	16/17	3.09 - 4.5	1.1E+01	C	8.5E+04	3.8E+05	N	BSL
108883	Toluene	6.6E-01	3.5E+00	µg/kg	13SB10A	8/17	0.51 - 0.742	3.5E+00	N	6.3E+05	8.2E+06	N	BSL
79016	Trichloroethene	9.6E+00	5.7E+01	µg/kg	13SB11C	3/17	0.745 - 1.08	5.7E+01	C	1.6E+03	7.2E+03	N	BSL
	VOC TICs (µg/kg)												
60297	Ethyl Ether	2.8E+01	2.8E+01	µg/kg	13SB12C	1/17	0 - 0	2.8E+01	N	1.6E+06	2.0E+07	N	BSL
66251	Hexanal	4.7E+00	3.5E+02	µg/kg	13SB10A	6/17	0 - 0	3.5E+02	--	--	--	Y	NSV
	TCL SVOCs (µg/kg)												
91576	2-Methylnaphthalene	4.0E+00	2.2E+01	µg/kg	13SB8A	4/17	3.01 - 4.38	2.2E+01	N	3.1E+04	4.1E+05	N	BSL
121142	2,4-Dinitrotoluene	3.5E+01	1.1E+03	µg/kg	13SB12B - DUP AVG	7/17	3.47 - 5.04	1.1E+03	N	1.6E+04	2.0E+05	N	BSL
606202	2,6-Dinitrotoluene	3.2E+01	2.1E+02	µg/kg	13SB12A	3/17	30.5 - 44.3	2.1E+02	N	7.8E+03	1.0E+05	N	BSL
--	Dinitrotoluene Mix	3.5E+01	1.2E+03	µg/kg	13SB12B - DUP AVG	5/17	0 - 0	1.2E+03	C	9.4E+02	4.2E+03	Y	**ARES**
59507	4-Chloro-3-Methylphenol	8.0E+00	2.4E+01	µg/kg	13SB8B	11/17	5.73 - 8.34	2.4E+01	--	--	--	Y	NSV
83329	Acenaphthene	3.0E+00	1.9E+01	µg/kg	13SB8A	6/17	1.89 - 2.75	1.9E+01	N	4.7E+05	6.1E+06	N	BSL
208968	Acenaphthylene[4]	2.0E+00	6.0E+00	µg/kg	13SB10B	7/17	1.65 - 2.4	6.0E+00	N	2.3E+05	3.1E+06	N	BSL
120127	Anthracene	1.5E+01	3.7E+01	µg/kg	13SB8A	6/17	5.08 - 7.39	3.7E+01	N	2.3E+06	3.1E+07	N	BSL
56553	Benzo(a)anthracene	2.2E+01	1.7E+02	µg/kg	13SB9A	8/17	1.86 - 186	1.7E+02	C	2.2E+02	3.9E+03	N	BSL
50328	Benzo(a)pyrene	7.0E+00	1.3E+02	µg/kg	13SB9A	13/17	4.72 - 9.14	1.3E+02	C	2.2E+01	3.9E+02	Y	**ARES**
205992	Benzo(b)fluoranthene	1.3E+01	2.1E+02	µg/kg	13SB9A	14/17	10.7 - 15.6	2.1E+02	C	2.2E+02	3.9E+03	N	BSL
191242	Benzo(g,h,i)perylene[4]	1.1E+01	7.2E+01	µg/kg	13SB8A	10/17	9.59 - 14	7.2E+01	N	2.3E+05	3.1E+06	N	BSL
207089	Benzo(k)fluoranthene	2.2E+01	8.9E+01	µg/kg	13SB9A	7/17	14.7 - 21.4	8.9E+01	C	2.2E+03	3.9E+04	N	BSL
117817	Bis(2-ethylhexyl)phthalate	1.5E+01	1.0E+03	µg/kg	13SB12C	17/17	2.28 - 3.31	1.0E+03	C	4.6E+04	2.0E+05	N	BSL
85687	Butylbenzylphthalate	6.0E+00	4.0E+01	µg/kg	13SB11C	7/17	4.93 - 7.17	4.0E+01	N	1.6E+06	2.0E+07	N	BSL
86748	Carbazole	2.1E+01	2.1E+01	µg/kg	13SB9A	1/17	6.71 - 9.76	2.1E+01	C	3.2E+04	1.4E+05	N	BSL
218019	Chrysene	1.6E+01	1.9E+02	µg/kg	13SB9A	12/17	11.2 - 16.3	1.9E+02	C	2.2E+04	3.9E+05	N	BSL
53703	Dibenz(a,h)anthracene	1.3E+01	1.8E+01	µg/kg	13SB8A	4/17	6.49 - 9.44	1.8E+01	C	2.2E+01	3.9E+02	N	BSL
132649	Dibenzofuran	6.0E+00	1.3E+01	µg/kg	13SB8A	2/17	3.48 - 5.06	1.3E+01	--	--	--	Y	NSV
84662	Diethylphthalate	3.0E+00	2.3E+03	µg/kg	13SB12B - DUP AVG	17/17	2.09 - 5.32	2.3E+03	N	6.3E+06	8.2E+07	N	BSL
131113	Dimethylphthalate	1.0E+01	5.5E+02	µg/kg	13SB11B	4/17	3.64 - 5.3	5.5E+02	--	--	--	Y	NSV
84742	Di-n-butylphthalate	6.2E+01	1.6E+03	µg/kg	13SB12B - DUP AVG	17/17	4.2 - 10.7	1.6E+03	N	7.8E+05	1.0E+07	N	BSL
206440	Fluoranthene	9.0E+00	3.7E+02	µg/kg	13SB8A	14/17	2.59 - 3.76	3.7E+02	N	3.1E+05	4.1E+06	N	BSL
86737	Fluorene	4.0E+00	2.0E+01	µg/kg	13SB8A	6/17	1.85 - 2.69	2.0E+01	N	3.1E+05	4.1E+06	N	BSL

Table 4-7
HHRS COPC Selection (Total Soil) for SWMU 13
SSP Report
Radford Army Ammunition Plant, Radford, VA

CAS #	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	C/N	Adjusted RBC Residential	Adjusted RBC Industrial	COPC Flag (Y/N)	Rationale for Selection or Deletion
193395	Indeno(1,2,3-cd)pyrene	5.0E+00	7.3E+01	µg/kg	13SB8A	12/17	4.31 - 6.27	7.3E+01	C	2.2E+02	3.9E+03	N	BSL
91203	Naphthalene	4.0E+00	1.5E+01	µg/kg	13SB12C	3/17	3.03 - 4.4	1.5E+01	N	1.6E+05	2.0E+06	N	BSL
86306	N-Nitrosodiphenylamine	2.1E+01	9.5E+02	µg/kg	13SB11B	8/17	5.23 - 7.6	9.5E+02	C	1.3E+05	5.8E+05	N	BSL
85018	Phenanthrene[4]	4.0E+00	1.7E+02	µg/kg	13SB10A	14/17	2.53 - 3.68	1.7E+02	N	2.3E+05	3.1E+06	N	BSL
129000	Pyrene	3.0E+00	2.6E+02	µg/kg	13SB8A	15/17	1.63 - 2.37	2.6E+02	N	2.3E+05	3.1E+06	N	BSL
	SVOC TICs (µg/kg)												
301020	(Z)-9-Octadecenamide	8.3E+01	1.2E+02	µg/kg	13SB12A	2/17	0 - 0	1.2E+02	--	--	--	Y	NSV
15594908	1-Heneicosanol	2.2E+02	2.2E+02	µg/kg	13SB11A	1/17	0 - 0	2.2E+02	--	--	--	Y	NSV
72101190	1,1'-Biphenyl, (1,1-dimethylethoxy)-	3.6E+02	3.6E+02	µg/kg	13SB12C	1/17	0 - 0	3.6E+02	--	--	--	Y	NSV
69009901	1,1'-Biphenyl, bis(1-methylethyl)-	6.6E+01	6.6E+01	µg/kg	13SB12B - DUP AVG	1/17	0 - 0	6.6E+01	--	--	--	Y	NSV
84695	1,2-Benzenedicarboxylicacid, bis(2-methy	1.2E+02	6.7E+02	µg/kg	13SB9A	11/17	0 - 0	6.7E+02	--	--	--	Y	NSV
17851535	1,2-Benzenedicarboxylic acid, butyl 2-me	4.7E+01	5.3E+02	µg/kg	13SB10A	5/17	0 - 0	5.3E+02	--	--	--	Y	NSV
84640	1,2-Benzenedicarboxylic acid, butyl cycl	3.1E+02	3.1E+02	µg/kg	13SB11C	1/17	0 - 0	3.1E+02	--	--	--	Y	NSV
149575	2-Ethyl-hexanoic Acid	1.6E+02	1.6E+02	µg/kg	13SB12B - DUP AVG	1/17	0 - 0	1.6E+02	--	--	--	Y	NSV
101371	2,4,6-Triallyloxy-1,3,5-triazine	3.6E+01	1.5E+02	µg/kg	13SB10B	6/17	0 - 0	1.5E+02	--	--	--	Y	NSV
1000194624	4,4,6a,6b,8a,11,11,14b-Octamethyl-1,4,4a	7.1E+02	7.1E+02	µg/kg	13SB10A	1/17	0 - 0	7.1E+02	--	--	--	Y	NSV
207841	7H-Dibenzo (a,g) carbazole	2.8E+02	2.8E+02	µg/kg	13SB12B - DUP AVG	1/17	0 - 0	2.8E+02	--	--	--	Y	NSV
112798	9-Octadecenoic acid, (E)-	7.4E+01	7.4E+01	µg/kg	13SB8B	1/17	0 - 0	7.4E+01	--	--	--	Y	NSV
0118967	Benzene, 2-methyl-1,3,5-trinitro-	2.1E+02	3.5E+02	µg/kg	13SB12A	3/17	0 - 0	3.5E+02	--	--	--	Y	NSV
119755	Benzeneamine, 2-nitro-N-phenyl-	7.1E+01	7.5E+02	µg/kg	13SB12B - DUP AVG	5/17	0 - 0	7.5E+02	--	--	--	Y	NSV
142165	Bis(2-ethylhexyl)maleate	1.2E+02	1.4E+02	µg/kg	13SB11C	2/17	0 - 0	1.4E+02	--	--	--	Y	NSV
123955	Butyl Ester Octadecanioc	1.3E+02	1.3E+02	µg/kg	13SB11A	1/17	0 - 0	1.3E+02	--	--	--	Y	NSV
57885	Cholesterol	1.2E+02	4.7E+02	µg/kg	13SB10A	2/17	0 - 0	4.7E+02	--	--	--	Y	NSV
112845	Erucylamide	1.2E+02	9.0E+02	µg/kg	13SB10B	13/17	0 - 0	9.0E+02	--	--	--	Y	NSV
2136712	Ethanol, 2-(hexadecyloxy)-	3.9E+02	3.9E+02	µg/kg	13SB11A	1/17	0 - 0	3.9E+02	--	--	--	Y	NSV
24085652	Ether, bis(p-tert-butylphenyl)	8.3E+02	8.3E+02	µg/kg	13SB12C	1/17	0 - 0	8.3E+02	--	--	--	Y	NSV
83476	.Gamma.-sitosterol	7.6E+01	2.4E+03	µg/kg	13SB10A	5/17	0 - 0	2.4E+03	--	--	--	Y	NSV
630024	Octacosane	1.8E+02	1.8E+02	µg/kg	13SB12B - DUP AVG	1/17	0 - 0	1.8E+02	--	--	--	Y	NSV
1058613	Stigmast-4-en-3-one	1.4E+02	2.4E+02	µg/kg	13SB8A	2/17	0 - 0	2.4E+02	--	--	--	Y	NSV
1000214207	Stigmasterol, 22,23-dihydro-	1.6E+02	1.6E+02	µg/kg	13SB9A	1/17	0 - 0	1.6E+02	--	--	--	Y	NSV
127220	Taraxerol	2.9E+02	2.9E+02	µg/kg	13SB8A	1/17	0 - 0	2.9E+02	--	--	--	Y	NSV
638584	Tetradecanamide	6.0E+01	6.0E+01	µg/kg	13SB8B	1/17	0 - 0	6.0E+01	--	--	--	Y	NSV
102761	Triacetin	1.4E+02	1.2E+03	µg/kg	13SB12B - DUP AVG	3/17	0 - 0	1.2E+03	--	--	--	Y	NSV
115866	Triphenyl Phosphate	1.1E+02	2.0E+02	µg/kg	13SB12B - DUP AVG	2/17	0 - 0	2.0E+02	--	--	--	Y	NSV
611927	Urea, N,N'-dimethyl-N,N'-diphenyl-	4.8E+01	9.1E+02	µg/kg	13SB12A	3/17	0 - 0	9.1E+02	--	--	--	Y	NSV
10191410	Vitamin E	1.6E+02	6.0E+02	µg/kg	13SB10A	2/17	0 - 0	6.0E+02	--	--	--	Y	NSV
	PAHs (µg/kg)												
83329	Acenaphthene	1.4E+01	1.7E+01	µg/kg	13SB9A	2/17	10.3 - 15	1.7E+01	N	4.7E+05	6.1E+06	N	BSL
120127	Anthracene	1.0E+00	3.8E+01	µg/kg	13SB10A	11/17	0.77 - 1.12	3.8E+01	N	2.3E+06	3.1E+07	N	BSL
56553	Benzo(a)anthracene	1.4E+00	1.4E+02	µg/kg	13SB10A	16/17	0.88 - 1.28	1.4E+02	C	2.2E+02	3.9E+03	N	BSL
50328	Benzo(a)pyrene	4.4E+00	1.9E+02	µg/kg	13SB10A	11/17	1.1 - 1.6	1.9E+02	C	2.2E+01	3.9E+02	Y	**ARES**
205992	Benzo(b)fluoranthene	3.8E+00	1.4E+02	µg/kg	13SB10A	11/17	1.43 - 2.08	1.4E+02	C	2.2E+02	3.9E+03	N	BSL
191242	Benzo(g,h,i)perylene[4]	1.5E+01	3.9E+02	µg/kg	13SB9A	10/17	13.8 - 20	3.9E+02	N	2.3E+05	3.1E+06	N	BSL
207089	Benzo(k)fluoranthene	4.5E+00	8.0E+01	µg/kg	13SB10A	9/17	1.1 - 1.6	8.0E+01	C	2.2E+03	3.9E+04	N	BSL
218019	Chrysene	1.7E+00	1.5E+02	µg/kg	13SB10A	15/17	1.32 - 1.92	1.5E+02	C	2.2E+04	3.9E+05	N	BSL
53703	Dibenz(a,h)anthracene	2.3E+00	8.0E+00	µg/kg	13SB10B	4/17	1.54 - 2.24	8.0E+00	C	2.2E+01	3.9E+02	N	BSL
206440	Fluoranthene	3.3E+00	4.7E+02	µg/kg	13SB10A	15/17	1.87 - 2.72	4.7E+02	N	3.1E+05	4.1E+06	N	BSL
86737	Fluorene	5.9E+00	1.7E+01	µg/kg	13SB10A	3/17	1.43 - 2.08	1.7E+01	N	3.1E+05	4.1E+06	N	BSL
193395	Indeno(1,2,3-cd)pyrene	3.6E+00	1.3E+02	µg/kg	13SB10A	12/17	0.77 - 1.12	1.3E+02	C	2.2E+02	3.9E+03	N	BSL
85018	Phenanthrene[4]	1.8E+00	2.1E+02	µg/kg	13SB10A	16/17	0.66 - 0.96	2.1E+02	N	2.3E+05	3.1E+06	N	BSL
129000	Pyrene	3.0E+00	3.2E+02	µg/kg	13SB10A	16/17	0.99 - 1.44	3.2E+02	N	2.3E+05	3.1E+06	N	BSL
	Explosives (mg/kg)												
99650	1,3-Dinitrobenzene	2.0E-01	2.0E-01	mg/kg	13SB12B - DUP AVG	1/17	0.159 - 0.159	2.0E-01	N	7.8E-01	1.0E+01	N	BSL
121142	2,4-Dinitrotoluene	1.3E-01	3.9E-01	mg/kg	13SB12A	2/17	0.142 - 0.142	3.9E-01	N	1.6E+01	2.0E+02	N	BSL
--	Dinitrotoluene Mix	1.3E-01	3.9E-01	mg/kg	13SB12A	2/17	0 - 0	3.9E-01	C	9.4E-01	4.2E+00	N	BSL
118967	2,4,6-Trinitrotoluene	2.7E-01	5.6E-01	mg/kg	13SB12B - DUP AVG	4/17	0.167 - 0.167	5.6E-01	C	3.9E+01	5.1E+02	N	BSL
121824	RDX (Hexahydro-1,3,5-trinitro-1,3,5-tria	1.8E-01	1.8E-01	mg/kg	13SB12B - DUP AVG	1/17	0.131 - 0.131	1.8E-01	C	5.8E-01	2.6E+00	N	BSL

Table 4-7
HHRS COPC Selection (Total Soil) for SWMU 13
SSP Report
Radford Army Ammunition Plant, Radford, VA

CAS #	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	C/N	Adjusted RBC Residential	Adjusted RBC Industrial	COPC Flag (Y/N)	Rationale for Selection or Deletion
	Nitroglycerin/PETN (mg/kg)												
55630	Nitroglycerin	4.5E-01	3.6E+01	mg/kg	13SB12B - DUP AVG	8/17	0.195 - 0.276	3.6E+01	N	1.3E+02	1.7E+03	N	BSL
	Cyanide (mg/kg)												
57125	Cyanide	7.0E-02	3.5E-01	mg/kg	13SB11B	14/17	0.0356 - 0.0356	3.5E-01	N	1.6E+02	2.0E+03	N	BSL
	Dioxins/Furans (mg/g)												
1746016	Total 2,3,7,8-TCDD Equivalents	--	--	mg/kg	13SB9A	1/1	--	2.1E-06	C	4.6E-06	1.9E-05	N	BSL

Notes:
CAS = Chemical Abstracts Service
COPC = Chemical of Potential Concern
mg/kg = Milligram Per Kilogram
µg/kg = Microgram Per Kilogram
TAL = Target Analyte List
TCL = Target Compound List
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound
PAH = Polynuclear Aromatic Hydrocarbon
TIC = Tentatively Identified Compound
DUP AVG = results for duplicate samples averaged

[1] = Chromium VI RBC value was used
[2] = Lead criteria are Action Levels; see USEPA Region III guidance
[3] = Mercuric chloride soil RBC value used
[4] = RBC value for pyrene was used for these compounds

RBC = USEPA Region III Risk-Based Concentration
(RBC) values from the October 31, 2006,
RBC Table and October 10, 2006, Alternate RBC Table
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
C = Carcinogenic per EPA RBC Table (October 2006)
N = Noncarcinogenic per EPA RBC Table (October 2006)

ARES = Above Residential RBC
ARES/IND = Above Residential RBC/Industrial RBC
BSL = Below Residential/Industrial RBC Screening Levels
NSV = No Screening Value Available

Table 4-8
Conversion of Dioxin Detections in Soil to Equivalents of 2,3,7,8-TCDD for SWMU 13
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

Sample ID Sample Date		13SB9A-DUPS AVG 09/30/03		
Dioxin/Furans Method 8290	**TEF[1]**	**mg/kg**	**Flags**	**2,3,7,8-TCDD Equivalents mg/kg**
1,2,3,4,6,7,8,9-OCDD	0.0003	2.21E-03	J	6.63E-07
1,2,3,4,6,7,8,9-OCDF	0.0003	7.78E-06	J	2.33E-09
1,2,3,4,6,7,8-HpCDD	0.01	4.53E-05		4.53E-07
1,2,3,4,6,7,8-HpCDF	0.01	3.63E-06	J	3.63E-08
1,2,3,4,7,8,9-HpCDF	0.01	3.52E-07	J	3.52E-09
1,2,3,4,7,8-HxCDD	0.1	6.06E-07	J	6.06E-08
1,2,3,4,7,8-HxCDF	0.1	4.79E-07	J	4.79E-08
1,2,3,6,7,8-HxCDD	0.1	1.64E-06	J	1.64E-07
1,2,3,6,7,8-HxCDF	0.1	3.89E-07	J	3.89E-08
1,2,3,7,8,9-HxCDD	0.1	1.85E-06		1.85E-07
1,2,3,7,8,9-HxCDF	0.1	< 5.88E-07		--
1,2,3,7,8-PeCDD	0.03	4.21E-07	J	1.26E-08
1,2,3,7,8-PeCDF	1	2.79E-07	J	2.79E-07
2,3,4,6,7,8-HxCDF	0.1	3.73E-07	J	3.73E-08
2,3,4,7,8-PeCDF	0.3	3.70E-07	J	1.11E-07
2,3,7,8-TCDD	1	< 1.32E-07		--
2,3,7,8-TCDF	0.1	4.89E-07	A	4.89E-08
Total HpCDD	0	9.54E-05		--
Total HpCDF	0	8.94E-06		--
Total HxCDD	0	1.61E-05		--
Total HxCDF	0	5.25E-06		--
Total PeCDD	0	3.19E-06	J	--
Total PeCDF	0	2.89E-06	J	--
Total TCDD	0	6.06E-07	J	--
Total TCDF	0	4.10E-06		--
Total 2,3,7,8-TCDD Equivalents				2.14E-06

Notes:

[1] = Developed by the World Health Organization (2005). [Van den Berg, et al. Re-evaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-like compounds. ToxSci Advance Access, 7 July 2006]
mg/kg = Milligram Per Kilogram

Table 4-9
Cumulative HHRS for SWMU 13 (Surface Soil)
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

CAS #	Chemical	Units	Detection Frequency	MDC	C/N	RBC Residential	RBC Industrial	Non Carcinogenic HI (RBC_{Res})	Excess Cancer Risk (RBC_{Res})	Non Carcinogenic HI (RBC_{Ind})	Excess Cancer Risk (RBC_{Ind})
	TAL Metals										
7429905	Aluminum	mg/kg	6/6	1.98E+04	--	--	--	--	--	--	--
7440382	Arsenic	mg/kg	6/6	2.55E+00	C	4.26E-01	1.91E+00	--	6.E-06	--	1.E-06
7440382	Arsenic	mg/kg	6/6	2.55E+00	N	2.35E+01	3.07E+02	1.E-01	--	8.E-03	--
7440473	Chromium[1]	mg/kg	6/6	3.80E+01	N	2.35E+02	3.07E+03	2.E-01	--	1.E-02	--
7440484	Cobalt	mg/kg	6/6	1.30E+01	--	--	--	--	--	--	--
7439896	Iron	mg/kg	6/6	3.62E+04	N	2.35E+04	3.07E+05	2.E+00	--	1.E-01	--
7439965	Manganese	mg/kg	6/6	1.32E+03	N	1.56E+03	2.04E+04	8.E-01	--	6.E-02	--
7440280	Thallium	mg/kg	6/6	8.65E-01	N	5.48E+00	7.15E+01	2.E-01	--	1.E-02	--
7440622	Vanadium	mg/kg	6/6	3.60E+01	N	7.82E+01	1.02E+03	5.E-01	--	4.E-02	--
	VOC TICs (µg/kg)										
66251	Hexanal	µg/kg	2/6	3.50E+02	--	--	--	--	--	--	--
	TCL SVOCs (µg/kg)										
59507	4-Chloro-3-Methylphenol	µg/kg	5/6	1.90E+01	--	--	--	--	--	--	--
50328	Benzo(a)pyrene	µg/kg	5/6	1.30E+02	C	2.20E+01	3.92E+02	--	6.E-06	--	3.E-07
132649	Dibenzofuran	µg/kg	2/6	1.30E+01	--	--	--	--	--	--	--
131113	Dimethylphthalate	µg/kg	2/6	1.40E+02	--	--	--	--	--	--	--
121142	2,4-Dinitrotoluene	µg/kg	3/6	7.10E+02	N	1.56E+05	2.04E+06	5.E-03	--	3.E-04	--
--	Dinitrotoluene Mix	µg/kg	2/6	9.20E+02	C	9.40E+02	4.20E+03	--	1.E-06	--	2.E-07
	SVOC TICs (µg/kg)										
301020	(Z)-9-Octadecenamide	µg/kg	1/6	1.20E+02	--	--	--	--	--	--	--
15594908	1-Heneicosanol	µg/kg	1/6	2.20E+02	--	--	--	--	--	--	--
84695	1,2-Benzenedicarboxylicacid, bis(2-methy	µg/kg	4/6	6.70E+02	--	--	--	--	--	--	--
17851535	1,2-Benzenedicarboxylic acid, butyl 2-me	µg/kg	2/6	5.30E+02	--	--	--	--	--	--	--
101371	2,4,6-Triallyloxy-1,3,5-triazine	µg/kg	2/6	6.00E+01	--	--	--	--	--	--	--
1000194624	4,4,6a,6b,8a,11,11,14b-Octamethyl-1,4,4a	µg/kg	1/6	7.10E+02	--	--	--	--	--	--	--
119755	Benzeneamine, 2-nitro-N-phenyl-	µg/kg	1/6	2.80E+02	--	--	--	--	--	--	--
123955	Butyl Ester Octadecanioc	µg/kg	1/6	1.30E+02	--	--	--	--	--	--	--
57885	Cholesterol	µg/kg	2/6	4.70E+02	--	--	--	--	--	--	--
112845	Erucylamide	µg/kg	6/6	5.70E+02	--	--	--	--	--	--	--
2136712	Ethanol, 2-(hexadecyloxy)-	µg/kg	1/6	3.90E+02	--	--	--	--	--	--	--
83476	.Gamma.-sitosterol	µg/kg	4/6	2.40E+03	--	--	--	--	--	--	--
1058613	Stigmast-4-en-3-one	µg/kg	2/6	2.40E+02	--	--	--	--	--	--	--
1000214207	Stigmasterol, 22,23-dihydro-	µg/kg	1/6	1.60E+02	--	--	--	--	--	--	--
127220	Taraxerol	µg/kg	1/6	2.90E+02	--	--	--	--	--	--	--
102761	Triacetin	µg/kg	1/6	1.40E+02	--	--	--	--	--	--	--
611927	Urea, N,N'-dimethyl-N,N'-diphenyl-	µg/kg	2/6	9.10E+02	--	--	--	--	--	--	--
10191410	Vitamin E	µg/kg	2/6	6.00E+02	--	--	--	--	--	--	--
							Cumulative Risk	3.E+00	1.E-05	3.E-01	2.E-06

Notes:

mg/kg = Milligram Per Kilogram
µg/kg = Microgram Per Kilogram
CAS = Chemical Abstracts Service
TAL = Target Analyte List
TCL = Target Compound List
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound
TIC = Tentatively Identified Compound
[1] = Chromium VI RBC value was used

MDC = Maximum Detected Concentration
HI = Hazard Index
RBC = USEPA Region III Risk-Based Concentration (RBC) values from the October 31, 2006, RBC Table and October 10, 2006, Alternate RBC Table
C = Carcinogenic per EPA RBC Table (October 2006)
N = Noncarcinogenic per EPA RBC Table (October 2006)

Table 4-10
Exposure Point Concentration Summary for SWMU 13
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

Scenario Timeframe:	Future
Medium:	Total Soil
Exposure Medium:	Total Soil

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic (1)	Rationale (2)
Total Soil	Aluminum	mg/kg	1.38E+04	1.60E+04	2.1E+04	1.60E+04	mg/kg	95% UCL (Student's t)	85% < FOD, Normal
	Antimony	mg/kg	9.25E-01	1.21E+00	4.7E+00	1.21E+00	mg/kg	95% UCL (Land's)	50% < FOD<85%, Lognormal
	Arsenic	mg/kg	2.35E+00	2.85E+00	4.7E+00	2.85E+00	mg/kg	95% UCL (Student's t)	85% < FOD, Normal
	Chromium	mg/kg	2.94E+01	3.27E+01	3.9E+01	3.27E+01	mg/kg	95%UCL (Chebyshev)	85% < FOD, Normal
	Cobalt	mg/kg	--	--	1.6E+01	1.60E+01	mg/kg	--	--
	Iron	mg/kg	2.29E+03	3.37E+04	4.9E+04	3.37E+04	mg/kg	95% UCL (Student's t)	85% < FOD, Normal
	Manganese	mg/kg	9.13E+02	1.13E+03	1.7E+03	1.13E+03	mg/kg	95% UCL (Student's t)	85% < FOD, Normal
	Thallium	mg/kg	--	--	8.7E-01	8.70E-01	mg/kg	--	--
	Vanadium	mg/kg	2.46E+01	2.80E+01	3.6E+01	2.80E+01	mg/kg	95% UCL (Student's t)	85% < FOD, Normal
	Benzo(a)pyrene	µg/kg	4.05E+01	1.78E+02	1.9E+02	1.78E+02	ug/kg	Pro UCL-99% UCL (Chebyshev)	50% < FOD<85%, Normal
	Dinitrotoluene Mix	µg/kg	1.74E+02	2.46E+02	1.2E+03	2.46E+02	ug/kg	95% UCL (Bounding)	FOD < 50%

Notes:
mg/kg = Milligram Per Kilogram
µg/kg = Microgram Per Kilogram
UCL = Upper Confidence Limit

(1) See Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites (OSWER Directive 9285.6-10, December 2002) for details on the following methods for calculating the 95% UCL:
95% UCL (Bounding) = The frequency of detection is less than 50%; therefore, the 95% UCL is calculated by the bounding method.
95% UCL (Student's t, adj) = The frequency of detection is between 50% and 85%, and the underlying distribution (detects only) is normal; therefore, Aitchison's Method is used to adjust the detects-only mean and standard deviaiton, and the 95% UCL is calculated using the Student's t method.
95% UCL (Land, adj) = The frequency of detection is between 50% and 85%, and the underlying distribution (detects only) is lognormal; therefore, Aitchison's Method is used to adjust the detects-only mean and standard deviation, and the 95% UCL is calculated using Land's method.
95% UCL (Student's t) = The frequency of detection is greater than 85%, and the distribution is normal.; therefore, the 95% UCL is calculated using the Student's t method.
95% UCL (Chebyshev) = The frequency of detection is between 50% and 85% and the underlying distribution (detects only) is neither normal nor lognormal, OR the frequency of detection is greater than 85% and the distribution (with non-detects represented by half of the detection limit) is neither normal nor lognormal; therefore, the 95% UCL is calculated using Hall's bootstrap method.
Maximum: The 95% UCL exceeds the maximum detected concentration; therefore, the maximum detected concentration is used to represent the 95% UCL.

(2) FOD = Frequency of detection
FOD < 50%: Frequency of detection is less than 50%
50% < FOD < 85%, Normal: Frequency of detection is between 50% and 85%, and the underlying distribution (detects only) is normal.
50% < FOD < 85%, Lognormal: Frequency of detection is between 50% and 85%, and the underlying distribution (detects only) is lognormal.
50% < FOD < 85%, Unknown: Frequency of detection is between 50% and 85%, and the underlying distribution (detects only) is neither normal nor lognormal.
85% < FOD, Normal: Frequency of detection is greater than 85%, and the distribution is normal.
85% < FOD, Lognormal: Frequency of detection is greater than 85%, and the distribution is lognormal.
85% < FOD, Unknown: Frequency of detection is greater than 85%, and the distribution is neither normal nor lognormal.

Table 4-11
Cumulative HHRS for SWMU 13 (Total Soil)
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

CAS #	Chemical	Units	Detection Frequency	Maximum EPC	C/N	RBC Residential	RBC Industrial	Non Carcinogenic HI (RBC_{Res})	Excess Cancer Risk (RBC_{Res})	Non Carcinogenic HI (RBC_{Ind})	Excess Cancer Risk (RBC_{Ind})
	TAL Metals										
7429905	Aluminum	mg/kg	17/17	1.60E+04	--	--	--	--	--	--	--
7440360	Antimony	mg/kg	13/17	1.21E+00	N	3.13E+01	4.09E+02	4.E-02	--	3.E-03	--
7440382	Arsenic	mg/kg	17/17	2.85E+00	C	4.26E-01	1.91E+00	--	7.E-06	--	1.E-06
7440382	Arsenic	mg/kg	17/17	2.85E+00	N	2.35E+01	3.07E+02	1.E-01	--	9.E-03	--
7440473	Chromium[1]	mg/kg	17/17	3.27E+01	N	2.35E+02	3.07E+03	1.E-01	--	1.E-02	--
7440484	Cobalt	mg/kg	17/17	3.37E+01	--	--	--	--	--	--	--
7439896	Iron	mg/kg	17/17	3.37E+04	N	2.35E+04	3.07E+05	1.E+00	--	1.E-01	--
7439965	Manganese	mg/kg	17/17	1.13E+03	N	1.56E+03	2.04E+04	7.E-01	--	6.E-02	--
7440280	Thallium	mg/kg	17/17	8.70E-01	N	5.48E+00	7.15E+01	2.E-01	--	1.E-02	--
7440622	Vanadium	mg/kg	17/17	2.80E+01	N	7.82E+01	1.02E+03	4.E-01	--	3.E-02	--
	VOC TICs (µg/kg)										
66251	Hexanal	ug/kg	6/17	3.50E+02	--	--	--	--	--	--	--
	TCL SVOCs (µg/kg)										
59507	4-Chloro-3-Methylphenol	ug/kg	11/17	2.40E+01	--	--	--	--	--	--	--
50328	Benzo(a)pyrene	ug/kg	13/17	1.78E+02	C	2.20E+01	3.92E+02	--	8.E-06	--	5.E-07
132649	Dibenzofuran	ug/kg	2/17	1.30E+01	--	--	--	--	--	--	--
131113	Dimethylphthalate	ug/kg	4/17	5.50E+02	--	--	--	--	--	--	--
121142	2,4-Dinitrotoluene	ug/kg	7/17	1.10E+03	N	1.56E+05	2.04E+06	7.E-03	--	5.E-04	--
606202	2,6-Dinitrotoluene	ug/kg	3/17	2.10E+02	N	7.82E+04	1.02E+06	3.E-03	--	2.E-04	--
--	Dinitrotoluene Mix	ug/kg	5/17	2.46E+02	C	9.40E+02	4.20E+03	--	3.E-07	--	6.E-08
	SVOC TICs (µg/kg)										
301020	(Z)-9-Octadecenamide	ug/kg	2/17	1.20E+02	--	--	--	--	--	--	--
15594908	1-Heneicosanol	ug/kg	1/17	2.20E+02	--	--	--	--	--	--	--
72101190	1,1'-Biphenyl, (1,1-dimethylethoxy)-	ug/kg	1/17	3.60E+02	--	--	--	--	--	--	--
69009901	1,1'-Biphenyl, bis(1-methylethyl)-	ug/kg	1/17	6.60E+01	--	--	--	--	--	--	--
84695	1,2-Benzenedicarboxylicacid, bis(2-methy	ug/kg	11/17	6.70E+02	--	--	--	--	--	--	--
17851535	1,2-Benzenedicarboxylic acid, butyl 2-me	ug/kg	5/17	5.30E+02	--	--	--	--	--	--	--
84640	1,2-Benzenedicarboxylic acid, butyl cycl	ug/kg	1/17	3.10E+02	--	--	--	--	--	--	--
149575	2-Ethyl-hexanoic Acid	ug/kg	1/17	1.60E+02	--	--	--	--	--	--	--
101371	2,4,6-Triallyloxy-1,3,5-triazine	ug/kg	6/17	1.50E+02	--	--	--	--	--	--	--
1000194624	4,4,6a,6b,8a,11,11,14b-Octamethyl-1,4,4a	ug/kg	1/17	7.10E+02	--	--	--	--	--	--	--
207841	7H-Dibenzo (a,g) carbazole	ug/kg	1/17	2.80E+02	--	--	--	--	--	--	--
112798	9-Octadecenoic acid, (E)-	ug/kg	1/17	7.40E+01	--	--	--	--	--	--	--
119755	Benzeneamine, 2-nitro-N-phenyl-	ug/kg	5/17	7.50E+02	--	--	--	--	--	--	--
142165	Bis(2-ethylhexyl)maleate	ug/kg	2/17	1.40E+02	--	--	--	--	--	--	--
123955	Butyl Ester Octadecanioc	ug/kg	1/17	1.30E+02	--	--	--	--	--	--	--
57885	Cholesterol	ug/kg	2/17	4.70E+02	--	--	--	--	--	--	--
112845	Erucylamide	ug/kg	13/17	9.00E+02	--	--	--	--	--	--	--
2136712	Ethanol, 2-(hexadecyloxy)-	ug/kg	1/17	3.90E+02	--	--	--	--	--	--	--
24085652	Ether, bis(p-tert-butylphenyl)	ug/kg	1/17	8.30E+02	--	--	--	--	--	--	--
83476	.Gamma.-sitosterol	ug/kg	5/17	2.40E+03	--	--	--	--	--	--	--
630024	Octacosane	ug/kg	1/17	1.80E+02	--	--	--	--	--	--	--
1058613	Stigmast-4-en-3-one	ug/kg	2/17	2.40E+02	--	--	--	--	--	--	--
1000214207	Stigmasterol, 22,23-dihydro-	ug/kg	1/17	1.60E+02	--	--	--	--	--	--	--
127220	Taraxerol	ug/kg	1/17	2.90E+02	--	--	--	--	--	--	--
638584	Tetradecanamide	ug/kg	1/17	6.00E+01	--	--	--	--	--	--	--
102761	Triacetin	ug/kg	3/17	1.15E+03	--	--	--	--	--	--	--
115866	Triphenyl Phosphate	ug/kg	2/17	2.00E+02	--	--	--	--	--	--	--
611927	Urea, N,N'-dimethyl-N,N'-diphenyl-	ug/kg	3/17	9.10E+02	--	--	--	--	--	--	--
10191410	Vitamin E	ug/kg	2/17	6.00E+02	--	--	--	--	--	--	--
							Cumulative Risk	3.E+00	2.E-05	2.E-01	2.E-06

Notes:

CAS = Chemical Abstracts Service
TAL = Target Analyte List
TCL = Target Compound List
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound
TIC = Tentatively Identified Compound

mg/kg = Milligram Per Kilogram
µg/kg = Microgram Per Kilogram
[1] = Chromium VI RBC value was used
HI = Hazard Index
EPC = Exposure Point Concentration

RBC = USEPA Region III Risk-Based Concentration
(RBC) values from the October 31, 2006,
RBC Table and October 10, 2006, Alternate RBC Table
C = Carcinogenic per EPA RBC Table (October 2006)
N = Noncarcinogenic per EPA RBC Table (October 2006)

Table 4-12
HHRS SSL Comparison for SWMU 13 (Soil)
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

CAS #	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Soil to Groundwater SSL (DAF 20)	COPC Flag (Y/N)	Rationale for Selection or Deletion
	TAL Metals (mg/kg)										
7429905	Aluminum	4,250	21,400	mg/kg	13SB7C	11/11	1.83 - 1.83	21,400	--	Y	NSV
7440360	Antimony	0.09	4.7	mg/kg	13SB11B	8/11	0.0518 - 0.0518	4.7	13.2	N	BSL
7440382	Arsenic	0.12	4.7	mg/kg	13SB11C	11/11	0.0232 - 0.0232	4.7	0.026	N	BSL
7440393	Barium	29	211	mg/kg	13SB11C	11/11	0.106 - 0.106	211	6,015.2	N	BSL
7440417	Beryllium	0.65	1.3	mg/kg	13SB7C	6/11	0.0333 - 0.167	1.3	1,153.7	N	BSL
7440439	Cadmium	0.72	2.7	mg/kg	13SB11C	11/11	0.182 - 0.182	2.7	27.4	N	BSL
7440702	Calcium	1,300	4,730	mg/kg	13SB12B - DUP AVG	11/11	16.6 - 16.6	4,730	Nutrient	N	Nutrient
7440473	Chromium[1]	11	39	mg/kg	13SB11C	11/11	0.912 - 0.912	39	42	N	BSL
7440484	Cobalt	3.90	16	mg/kg	13SB11C	11/11	0.208 - 0.208	16	--	Y	NSV
7440508	Copper	2.50	98	mg/kg	13SB11B	11/11	0.368 - 1.84	98	10,517.8	N	BSL
7439896	Iron	5,330	48,600	mg/kg	13SB11C	11/11	4.24 - 42.4	48,600	--	Y	NSV
7439921	Lead [2]	12.00	26,500	mg/kg	13SB11B	11/11	0.0218 - 109	26,500	--	Y	NSV
7439954	Magnesium	1,210	3,980	mg/kg	13SB12C	11/11	3.21 - 3.21	3,980	Nutrient	N	Nutrient
7439965	Manganese	59	1,700	mg/kg	13SB11C	11/11	0.264 - 6.6	1,700	951.9	N	BSL
7439976	Mercury [3]	0.01	0.13	mg/kg	13SB12C	10/11	0.0077 - 0.0077	0.13	--	Y	NSV
7440020	Nickel	3.80	21.00	mg/kg	13SB11C	11/11	0.0356 - 0.0356	21	--	Y	NSV
7440097	Potassium	548	2,150	mg/kg	13SB12C	11/11	5 - 5	2,150	Nutrient	N	Nutrient
7782492	Selenium	0.23	1.50	mg/kg	13SB11C	11/11	0.0502 - 0.0502	1.50	19	N	BSL
7440224	Silver	0.02	0.45	mg/kg	13SB8B	11/11	0.0044 - 0.0044	0.45	31	N	BSL
7440235	Sodium	46	170	mg/kg	13SB12B - DUP AVG	11/11	18.1 - 18.1	170	Nutrient	N	Nutrient
7440280	Thallium	0.05	0.86	mg/kg	13SB7C	11/11	0.027 - 0.027	0.86	3.6	N	BSL
7440622	Vanadium	11	36	mg/kg	13SB7C	11/11	0.207 - 0.207	36	730	N	BSL
7440666	Zinc	46	1,070	mg/kg	13SB11C	11/11	0.517 - 12.9	1,070	13,622	N	BSL
	TCL VOCs (µg/kg)										
78933	2-Butanone	2.4E+01	4.0E+02	µg/kg	13SB9B	10/11	5.5 - 8	4.0E+02	2.9E+04	N	BSL
67641	Acetone	3.1E+01	2.0E+02	µg/kg	13SB11C	11/11	5.5 - 8	2.0E+02	2.2E+04	N	BSL
71432	Benzene	6.9E-01	1.5E+00	µg/kg	13SB11B	3/11	0.58 - 0.843	1.5E+00	1.9E+00	N	BSL
156592	cis-1,2-Dichloroethene	1.9E+00	4.2E+00	µg/kg	13SB11C	2/11	0.781 - 1.14	4.2E+00	--	Y	NSV
75092	Methylene chloride	5.0E+00	7.4E+00	µg/kg	13SB10C	10/11	3.09 - 4.5	7.4E+00	1.9E+01	N	BSL
108883	Toluene	1.0E+00	1.4E+00	µg/kg	13SB11B	3/11	0.51 - 0.742	1.4E+00	2.7E+04	N	BSL
79016	Trichloroethene	3.1E+01	5.7E+01	µg/kg	13SB11C	2/11	0.745 - 1.08	5.7E+01	2.6E-01	Y	**ASSL**
	VOC TICs (µg/kg)										
60297	Ethyl Ether	2.8E+01	2.8E+01	µg/kg	13SB12C	1/11	0 - 0	2.8E+01	8.5E+03	N	BSL
66251	Hexanal	4.7E+00	9.0E+00	µg/kg	13SB10B	4/11	0 - 0	9.0E+00	--	Y	NSV
	TCL SVOCs (µg/kg)										
91576	2-Methylnaphthalene	4.0E+00	4.0E+00	µg/kg	13SB10B	1/11	3.01 - 4.38	4.0E+00	4.4E+03	N	BSL
121142	2,4-Dinitrotoluene	5.1E+01	1.1E+03	µg/kg	13SB12B - DUP AVG	4/11	3.47 - 5.04	1.1E+03	5.7E+02	N	BSL
606202	2,6-Dinitrotoluene	3.2E+01	5.9E+01	µg/kg	13SB12B - DUP AVG	2/11	30.5 - 44.3	5.9E+01	2.5E+02	N	BSL
--	Dinitrotoluene Mix	6.5E+01	1.2E+03	µg/kg	13SB12B - DUP AVG	3/11	0 - 0	1.2E+03	--	Y	NSV
59507	4-Chloro-3-Methylphenol	8.0E+00	2.4E+01	µg/kg	13SB8B	6/11	5.73 - 8.34	2.4E+01	--	Y	NSV
83329	Acenaphthene	3.0E+00	4.0E+00	µg/kg	13SB10B	2/11	1.89 - 2.75	4.0E+00	1.0E+05	N	BSL
208968	Acenaphthylene [4]	2.0E+00	6.0E+00	µg/kg	13SB10B	3/11	1.65 - 2.4	6.0E+00	--	Y	NSV
120127	Anthracene	1.6E+01	2.2E+01	µg/kg	13SB10C	2/11	5.08 - 7.39	2.2E+01	4.7E+05	N	BSL
56553	Benzo(a)anthracene	2.2E+01	7.3E+01	µg/kg	13SB10B	4/11	1.86 - 21.3	7.3E+01	4.8E+02	N	BSL
50328	Benzo(a)pyrene	7.0E+00	9.5E+01	µg/kg	13SB10B	8/11	4.72 - 9.14	9.5E+01	1.2E+02	N	BSL
205992	Benzo(b)fluoranthene	1.3E+01	1.5E+02	µg/kg	13SB10B	8/11	10.7 - 15.6	1.5E+02	1.5E+03	N	BSL
191242	Benzo(g,h,i)perylene [4]	1.4E+01	6.0E+01	µg/kg	13SB10B	5/11	9.59 - 14	6.0E+01	--	Y	NSV
207089	Benzo(k)fluoranthene	2.2E+01	6.4E+01	µg/kg	13SB10B	3/11	14.7 - 21.4	6.4E+01	1.5E+04	N	BSL
117817	Bis(2-ethylhexyl)phthalate	1.5E+01	1.0E+03	µg/kg	13SB12C	11/11	2.28 - 3.31	1.0E+03	2.9E+06	N	BSL
85687	Butylbenzylphthalate	6.0E+00	4.0E+01	µg/kg	13SB11C	4/11	4.93 - 7.17	4.0E+01	1.7E+07	N	BSL
218019	Chrysene	1.6E+01	1.0E+02	µg/kg	13SB10B	7/11	11.2 - 16.3	1.0E+02	4.8E+04	N	BSL
53703	Dibenz(a,h)anthracene	1.3E+01	1.6E+01	µg/kg	13SB10B	2/11	6.49 - 9.44	1.6E+01	4.6E+02	N	BSL

Table 4-12
HHRS SSL Comparison for SWMU 13 (Soil)
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

CAS #	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Soil to Groundwater SSL (DAF 20)	COPC Flag (Y/N)	Rationale for Selection or Deletion
84662	Diethylphthalate	3.0E+00	2.3E+03	µg/kg	13SB12B - DUP AVG	11/11	2.09 - 5.32	2.3E+03	4.5E+05	N	BSL
131113	Dimethylphthalate	1.7E+01	5.5E+02	µg/kg	13SB11B	2/11	3.64 - 5.3	5.5E+02	--	Y	NSV
84742	Di-n-butylphthalate	8.5E+01	1.6E+03	µg/kg	13SB12B - DUP AVG	11/11	4.2 - 10.7	1.6E+03	5.0E+06	N	BSL
206440	Fluoranthene	1.1E+01	9.0E+01	µg/kg	13SB10B	8/11	2.59 - 3.76	9.0E+01	6.3E+06	N	BSL
86737	Fluorene	4.0E+00	4.0E+00	µg/kg	13SB10B	2/11	1.85 - 2.69	4.0E+00	1.4E+05	N	BSL
193395	Indeno(1,2,3-cd)pyrene	5.0E+00	5.4E+01	µg/kg	13SB10B	7/11	4.31 - 6.27	5.4E+01	4.2E+03	N	BSL
91203	Naphthalene	1.5E+01	1.5E+01	µg/kg	13SB12C	1/11	3.03 - 4.4	1.5E+01	1.5E+02	N	BSL
86306	N-Nitrosodiphenylamine	1.2E+02	9.5E+02	µg/kg	13SB11B	4/11	5.23 - 7.6	9.5E+02	7.6E+02	N	BSL
85018	Phenanthrene [4]	5.3E+00	5.2E+01	µg/kg	13SB12C	8/11	2.53 - 3.68	5.2E+01	--	Y	NSV
129000	Pyrene	3.0E+00	8.3E+01	µg/kg	13SB10B	9/11	1.63 - 2.37	8.3E+01	6.8E+05	N	BSL
	SVOC TICs (µg/kg)										
301020	(Z)-9-Octadecenamide	8.3E+01	8.3E+01	µg/kg	13SB9B	1/11	0 - 0	8.3E+01	--	Y	NSV
72101190	1,1'-Biphenyl, (1,1-dimethylethoxy)-	3.6E+02	3.6E+02	µg/kg	13SB12C	1/11	0 - 0	3.6E+02	--	Y	NSV
69009901	1,1'-Biphenyl, bis(1-methylethyl)-	6.6E+01	6.6E+01	µg/kg	13SB12B - DUP AVG	1/11	0 - 0	6.6E+01	--	Y	NSV
84695	1,2-Benzenedicarboxylicacid, bis(2-methy	1.4E+02	5.3E+02	µg/kg	13SB10C	7/11	0 - 0	5.3E+02	--	Y	NSV
17851535	1,2-Benzenedicarboxylic acid, butyl 2-me	4.7E+01	3.5E+02	µg/kg	13SB9C	3/11	0 - 0	3.5E+02	--	Y	NSV
84640	1,2-Benzenedicarboxylic acid, butyl cycl	3.1E+02	3.1E+02	µg/kg	13SB11C	1/11	0 - 0	3.1E+02	--	Y	NSV
149575	2-Ethyl-hexanoic Acid	1.6E+02	1.6E+02	µg/kg	13SB12B - DUP AVG	1/11	0 - 0	1.6E+02	--	Y	NSV
101371	2,4,6-Triallyloxy-1,3,5-triazine	3.6E+01	1.5E+02	µg/kg	13SB10B	4/11	0 - 0	1.5E+02	--	Y	NSV
207841	7H-Dibenzo (a,g) carbazole	2.8E+02	2.8E+02	µg/kg	13SB12B - DUP AVG	1/11	0 - 0	2.8E+02	--	Y	NSV
112798	9-Octadecenoic acid, (E)-	7.4E+01	7.4E+01	µg/kg	13SB8B	1/11	0 - 0	7.4E+01	--	Y	NSV
0118967	Benzene, 2-methyl-1,3,5-trinitro-	2.1E+02	2.1E+02	µg/kg	13SB12B - DUP AVG	1/11	0 - 0	2.1E+02	--	Y	NSV
119755	Benzeneamine, 2-nitro-N-phenyl-	7.1E+01	7.5E+02	µg/kg	13SB12B - DUP AVG	4/11	0 - 0	7.5E+02	--	Y	NSV
142165	Bis(2-ethylhexyl)maleate	1.2E+02	1.4E+02	µg/kg	13SB11C	2/11	0 - 0	1.4E+02	--	Y	NSV
112845	Erucylamide	1.2E+02	9.0E+02	µg/kg	13SB10B	7/11	0 - 0	9.0E+02	--	Y	NSV
24085652	Ether, bis(p-tert-butylphenyl)	8.3E+02	8.3E+02	µg/kg	13SB12C	1/11	0 - 0	8.3E+02	--	Y	NSV
83476	.Gamma.-sitosterol	7.6E+01	7.6E+01	µg/kg	13SB8B	1/11	0 - 0	7.6E+01	--	Y	NSV
630024	Octacosane	1.8E+02	1.8E+02	µg/kg	13SB12B - DUP AVG	1/11	0 - 0	1.8E+02	--	Y	NSV
638584	Tetradecanamide	6.0E+01	6.0E+01	µg/kg	13SB8B	1/11	0 - 0	6.0E+01	--	Y	NSV
102761	Triacetin	2.4E+02	1.2E+03	µg/kg	13SB12B - DUP AVG	2/11	0 - 0	1.2E+03	--	Y	NSV
115866	Triphenyl Phosphate	1.1E+02	2.0E+02	µg/kg	13SB12B - DUP AVG	2/11	0 - 0	2.0E+02	--	Y	NSV
611927	Urea, N,N'-dimethyl-N,N'-diphenyl-	1.0E+02	1.0E+02	µg/kg	13SB12B	1/11	0 - 0	1.0E+02	--	Y	NSV
	PAHs (µg/kg)										
120127	Anthracene	1.0E+00	1.4E+01	µg/kg	13SB10B	7/11	0.77 - 1.12	1.4E+01	4.7E+05	N	BSL
56553	Benzo(a)anthracene	1.4E+00	5.6E+01	µg/kg	13SB10B	10/11	0.88 - 1.28	5.6E+01	4.8E+02	N	BSL
50328	Benzo(a)pyrene	4.4E+00	1.3E+02	µg/kg	13SB10B	6/11	1.1 - 1.6	1.3E+02	1.2E+02	N	BSL
205992	Benzo(b)fluoranthene	3.8E+00	9.1E+01	µg/kg	13SB10B	6/11	1.43 - 2.08	9.1E+01	1.5E+03	N	BSL
191242	Benzo(g,h,i)perylene [4]	1.5E+01	2.9E+02	µg/kg	13SB10B	6/11	13.8 - 20	2.9E+02	--	Y	NSV
207089	Benzo(k)fluoranthene	4.5E+00	5.2E+01	µg/kg	13SB10B	5/11	1.1 - 1.6	5.2E+01	1.5E+04	N	BSL
218019	Chrysene	1.7E+00	8.0E+01	µg/kg	13SB10B	9/11	1.32 - 1.92	8.0E+01	4.8E+04	N	BSL
53703	Dibenz(a,h)anthracene	5.3E+00	8.0E+00	µg/kg	13SB10B	2/11	1.54 - 2.24	8.0E+00	4.6E+02	N	BSL
206440	Fluoranthene	3.3E+00	1.3E+02	µg/kg	13SB12C	9/11	1.87 - 2.72	1.3E+02	6.3E+06	N	BSL
86737	Fluorene	1.2E+01	1.2E+01	µg/kg	13SB11B	1/11	1.43 - 2.08	1.2E+01	1.4E+05	N	BSL
193395	Indeno(1,2,3-cd)pyrene	3.6E+00	1.1E+02	µg/kg	13SB10B	7/11	0.77 - 1.12	1.1E+02	4.2E+03	N	BSL
85018	Phenanthrene [4]	1.8E+00	1.1E+02	µg/kg	13SB11B	10/11	0.66 - 0.96	1.1E+02	--	Y	NSV
129000	Pyrene	3.0E+00	9.9E+01	µg/kg	13SB12C	10/11	0.99 - 1.44	9.9E+01	6.8E+05	N	BSL
	Explosives (mg/kg)										
99650	1,3-Dinitrobenzene	2.0E-01	2.0E-01	mg/kg	13SB12B - DUP AVG	1/11	0.159 - 0.159	2.0E-01	3.7E-02	Y	**ASSL**
121142	2,4-Dinitrotoluene	1.3E-01	1.3E-01	mg/kg	13SB12B - DUP AVG	1/11	0.142 - 0.142	1.3E-01	5.7E-01	N	BSL
--	Dinitrotoluene Mix	1.3E-01	1.3E-01	mg/kg	13SB12B - DUP AVG	1/11	0 - 0	1.3E-01	--	Y	NSV
118967	2,4,6-Trinitrotoluene	5.4E-01	5.6E-01	mg/kg	13SB12B - DUP AVG	2/11	0.167 - 0.167	5.6E-01	--	Y	NSV
121824	RDX (Hexahydro-1,3,5-trinitro-1,3,5-tria	1.8E-01	1.8E-01	mg/kg	13SB12B - DUP AVG	1/11	0.131 - 0.131	1.8E-01	--	Y	NSV

Table 4-12
HHRS SSL Comparison for SWMU 13 (Soil)
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

CAS #	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Soil to Groundwater SSL (DAF 20)	COPC Flag (Y/N)	Rationale for Selection or Deletion
	Nitroglycerin/PETN (mg/kg)										
55630	Nitroglycerin	9.5E-01	3.6E+01	mg/kg	13SB12B - DUP AVG	5/11	0.2 - 0.265	3.6E+01	--	Y	NSV
	Cyanide (mg/kg)										
57125	Cyanide	1.1E-01	3.5E-01	mg/kg	13SB11B	8/11	0.0356 - 0.0356	3.5E-01	1.5E+02	N	BSL

Notes:
CAS = Chemical Abstracts Service
mg/kg = Milligram Per Kilogram
µg/kg = Microgram Per Kilogram
TAL = Target Analyte List
TCL = Target Compound List
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound
PAH = Polynuclear Aromatic Compound
TIC = Tentatively Identified Compound
[1] = Chromium VI SSL DAF20 value was used
[2] = Lead criteria are Action Levels; see USEPA Region III guidance
[3] = Mercuric chloride soil RBC value used
[4] = RBC value for pyrene was used for these compounds

DUP AVG = results for duplicate samples averaged
SSL DAF20 = Soil Screening Levels at a Dilution Attenuation Factor of 20
Per (SSL) values from the October 31, 2006, RBC Table

ASSL = Above Soil Screening Level
BSL = Below Soil Screening Levels
NSV = No Screening Value Available
* = Surface Soil Detections used for SSL Screening due to testing of
one surface soil sample for PCB/Pesticides/Herbicides

Table 4-13
COPC/Background Comparison for SWMU 13
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

Surface Soil COPC/Background Comparison

CAS #	Chemical	Minimum Concentration Surface Soil	Maximum Concentration Surface Soil	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Point Estimate[A]	Background Comparison
	TAL Metals (mg/kg)								
7429905	Aluminum	6,630	19,800	13SB11A	6/6	1.83 - 1.83	19,800	40,041	N
7440360	Antimony	0.069	1.1	13SB12A	5/6	0.0518 - 0.0518	1.1	--	NBE
7440382	Arsenic	1.6	2.55	13SB9A	6/6	0.0232 - 0.0232	2.55	16	N
7440473	Chromium	18	38	13SB11A	6/6	0.912 - 0.912	38	65	N
7440484	Cobalt	5.10	13	13SB11A	6/6	0.208 - 0.208	13	72	N
7439896	Iron	14,800	36,200	13SB9A	6/6	21.2 - 42.4	36,200	50,962	N
7439921	Lead	111.00	8,620	13SB8A	6/6	0.545 - 21.8	8,620	27	**Y**
7439965	Manganese	301	1,315	13SB9A	6/6	0.264 - 1.32	1,315	2,543	N
7440280	Thallium	0.13	0.865	13SB9A	6/6	0.027 - 0.027	0.865	2.11	N
7440622	Vanadium	14	36	13SB9A	6/6	0.207 - 0.207	36	108	N

Total Soil COPC/Background Comparison

CAS #	Chemical	Minimum Concentration Total Soil	Maximum Concentration Total Soil	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Point Estimate[A]	Background Comparison
	TAL Metals (mg/kg)								
7429905	Aluminum	4,250	21,400	13SB7C	17/17	1.83	21,400	40,041	N
7440360	Antimony	0.069	4.7	13SB11B	13/17	0.0518	4.7	--	NBE
7440382	Arsenic	0.12	4.7	13SB11C	17/17	0.0232	4.7	16	N
7440473	Chromium	11	39	13SB11C	17/17	0.912	39	65	N
7440484	Cobalt	3.90	16	13SB11C	17/17	0.208	16	72	N
7439896	Iron	5,330	48,600	13SB11C	17/17	4.24	48,600	50,962	N
7439921	Lead	12.00	26,500	13SB11B	17/17	0.0218	26,500	27	**Y**
7439965	Manganese	59	1,700	13SB11C	17/17	0.264	1,700	2,543	N
7440280	Thallium	0.047	0.865	13SB9A	17/17	0.027	0.865	2.11	N
7440622	Vanadium	11	36	13SB7C	17/17	0.207	36	108	N

Notes:
CAS = Chemical Abstracts Service
TAL = Target Analyte List
mg/kg = Milligram Per Kilogram
[A] = Facility-Wide Background Point Estimate as
Reported in the Facility-Wide Background Study Report (IT 2001a)
NBE = No Background Estimate Available

Table 4-14
HHRS COPC Selection (Sediment) for SWMU 13
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

CAS #	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	C/N	Adjusted RBC Residential	Adjusted RBC Industrial	COPC Flag (Y/N)	Rationale for Selection or Deletion
	TAL Metals (mg/kg)												
7429905	Aluminum	9,870	21,500	mg/kg	13SD3-DUP AVG	2/2	1.83 - 5.1	21,500	--	--	--	Y	**NSV**
7440360	Antimony	0.18	2.7	mg/kg	13SD3-DUP AVG	2/2	0.0518 - 0.0518	2.7	N	3.13	40.9	N	BSL
7440382	Arsenic	3.30	3.55	mg/kg	13SD3-DUP AVG	2/2	0.0232 - 0.0232	3.55	C	0.43	1.91	Y	***ARES/IND***
7440393	Barium	101	150	mg/kg	13SD3-DUP AVG	2/2	0.106 - 0.106	150	N	1,564	20,440	N	BSL
7440417	Beryllium	0.83	1.3	mg/kg	13SD3-DUP AVG	2/2	0.167 - 0.167	1.3	N	16	204	N	BSL
7440439	Cadmium	0.57	0.97	mg/kg	13SD3-DUP AVG	2/2	0.182 - 0.182	0.97	N	3.91	51	N	BSL
7440702	Calcium	1,270	1,850	mg/kg	13SD3-DUP AVG	2/2	16.6 - 16.6	1,850	--	Nutrient	Nutrient	N	Nutrient
7440473	Chromium[1]	27	36	mg/kg	13SD3-DUP AVG	2/2	0.912 - 0.912	36	N	23.5	306.60	Y	**ARES**
7440484	Cobalt	9.90	13	mg/kg	13SD3-DUP AVG	2/2	0.208 - 0.208	12.5	--	--	--	Y	NSV
7440508	Copper	14.00	34	mg/kg	13SD3-DUP AVG	2/2	0.368 - 0.368	34	N	313	4,088	N	BSL
7439896	Iron	34,550	34,600	mg/kg	13SD2	2/2	71.6 - 71.6	34,600	N	2,346	30,660	Y	***ARES/IND***
7439921	Lead[2]	132.00	259	mg/kg	13SD3-DUP AVG	2/2	0.545 - 1.09	259	--	400	750	N	BSL
7439954	Magnesium	2,130	3,450	mg/kg	13SD3-DUP AVG	2/2	3.21 - 3.21	3,450	--	Nutrient	Nutrient	N	Nutrient
7439965	Manganese	594	720	mg/kg	13SD2	2/2	0.264 - 0.264	720	N	156	2,044	Y	**ARES**
7439976	Mercury[3]	0.03	0.12	mg/kg	13SD3-DUP AVG	2/2	0.0077 - 0.0077	0.12	--	0.8	10	N	BSL
7440020	Nickel	12.00	18.50	mg/kg	13SD3-DUP AVG	2/2	0.0356 - 0.0356	18.5	N	156	2,044	N	BSL
7440097	Potassium	1,020	1,735	mg/kg	13SD3-DUP AVG	2/2	5 - 5	1,735	--	Nutrient	Nutrient	N	Nutrient
7782492	Selenium	0.85	1.20	mg/kg	13SD3-DUP AVG	2/2	0.0502 - 0.0502	1.20	N	39.1	511	N	BSL
7440224	Silver	0.12	0.13	mg/kg	13SD3-DUP AVG	2/2	0.0044 - 0.0044	0.13	N	39.1	511	N	BSL
7440235	Sodium	45	53	mg/kg	13SD2	2/2	8.92 - 8.92	53	--	Nutrient	Nutrient	N	Nutrient
7440280	Thallium	0.46	0.51	mg/kg	13SD3-DUP AVG	2/2	0.027 - 0.027	0.51	N	0.55	7.15	N	BSL
7440622	Vanadium	19	38	mg/kg	13SD3-DUP AVG	2/2	0.207 - 0.207	38	N	7.8	102	Y	**ARES**
7440666	Zinc	442	541	mg/kg	13SD3-DUP AVG	2/2	3.35 - 3.35	541	N	2,346	30,660	N	BSL
	TCL VOCs (µg/kg)												
78933	2-Butanone	3.1E+01	4.2E+01	µg/kg	13SD2	2/2	7.5 - 7.5	42	N	4.7E+06	6.1E+07	N	BSL
67641	Acetone	7.0E+01	1.8E+02	µg/kg	13SD2	2/2	7.5 - 7.5	180	N	7.0E+06	9.2E+07	N	BSL
156592	cis-1,2-Dichloroethene	9.5E+00	9.5E+00	µg/kg	13SD3-DUP AVG	1/2	1.07 - 1.07	9.5	N	7.8E+04	1.0E+06	N	BSL
75092	Methylene chloride	4.4E+00	4.4E+00	µg/kg	13SD3-DUP AVG	1/2	4.22 - 4.22	4.36	C	8.5E+04	3.8E+05	N	BSL
127184	Tetrachloroethene	3.6E+00	3.6E+00	µg/kg	13SD3-DUP AVG	1/2	0.92 - 0.92	3.55	C	1.2E+03	5.3E+03	N	BSL
108883	Toluene	1.1E+00	1.4E+00	µg/kg	13SD3-DUP AVG	2/2	0.696 - 0.696	1.4	N	6.3E+05	8.2E+06	N	BSL
79016	Trichloroethene	5.1E+01	5.1E+01	µg/kg	13SD3-DUP AVG	1/2	1.02 - 1.02	51	C	1.6E+03	7.2E+03	N	BSL
	TCL SVOCs (µg/kg)												
91576	2-Methylnaphthalene	7.0E+00	1.2E+01	µg/kg	13SD2	2/2	4.11 - 4.11	12	N	3.1E+04	4.1E+05	N	BSL
83329	Acenaphthene	5.0E+00	5.0E+00	µg/kg	13SD2	1/2	2.58 - 2.58	5	N	4.7E+05	6.1E+06	N	BSL
208968	Acenaphthylene[4]	6.0E+00	6.0E+00	µg/kg	13SD3-DUP AVG	1/2	2.25 - 2.25	6	N	2.3E+05	3.1E+06	N	BSL
120127	Anthracene	2.8E+01	2.8E+01	µg/kg	13SD3-DUP AVG	1/2	6.93 - 6.93	28	N	2.3E+06	3.1E+07	N	BSL
56553	Benzo(a)anthracene	3.3E+01	5.8E+01	µg/kg	13SD3-DUP AVG	2/2	20 - 20	58	C	2.2E+02	3.9E+03	N	BSL
50328	Benzo(a)pyrene	4.2E+01	9.7E+01	µg/kg	13SD3-DUP AVG	2/2	8.57 - 8.57	96.5	C	2.2E+01	3.9E+02	Y	**ARES**
205992	Benzo(b)fluoranthene	6.4E+01	1.4E+02	µg/kg	13SD3-DUP AVG	2/2	14.6 - 14.6	138	C	2.2E+02	3.9E+03	N	BSL
191242	Benzo(g,h,i)perylene[4]	3.5E+01	6.9E+01	µg/kg	13SD3-DUP AVG	2/2	13.1 - 13.1	68.5	N	2.3E+05	3.1E+06	N	BSL
207089	Benzo(k)fluoranthene	2.7E+01	6.4E+01	µg/kg	13SD3-DUP AVG	2/2	20.1 - 20.1	64	C	2.2E+03	3.9E+04	N	BSL
117817	Bis(2-ethylhexyl)phthalate	2.8E+01	3.8E+01	µg/kg	13SD3-DUP AVG	2/2	3.11 - 3.11	38	C	4.6E+04	2.0E+05	N	BSL
218019	Chrysene	3.7E+01	1.4E+02	µg/kg	13SD3-DUP AVG	2/2	15.3 - 15.3	142	C	2.2E+04	3.9E+05	N	BSL
53703	Dibenz(a,h)anthracene	1.5E+01	2.3E+01	µg/kg	13SD3-DUP AVG	2/2	8.85 - 8.85	23.4	C	2.2E+01	3.9E+02	Y	**ARES**
84662	Diethylphthalate	1.4E+01	2.0E+01	µg/kg	13SD3-DUP AVG	2/2	2.85 - 2.85	20	N	6.3E+06	8.2E+07	N	BSL
131113	Dimethylphthalate	7.0E+02	7.0E+02	µg/kg	13SD3-DUP AVG	1/2	4.97 - 4.97	701	--	--	--	Y	NSV
84742	Di-n-butylphthalate	6.9E+01	1.2E+02	µg/kg	13SD3-DUP AVG	2/2	5.73 - 5.73	120	N	7.8E+05	1.0E+07	N	BSL
206440	Fluoranthene	3.0E+01	5.6E+01	µg/kg	13SD2	2/2	3.53 - 3.53	56	N	3.1E+05	4.1E+06	N	BSL
86737	Fluorene	2.7E+00	5.0E+00	µg/kg	13SD2	2/2	2.52 - 2.52	5	N	3.1E+05	4.1E+06	N	BSL
193395	Indeno(1,2,3-cd)pyrene	3.1E+01	6.5E+01	µg/kg	13SD3-DUP AVG	2/2	5.88 - 5.88	65	C	2.2E+02	3.9E+03	N	BSL
91203	Naphthalene	3.6E+00	3.6E+00	µg/kg	13SD3-DUP AVG	1/2	4.13 - 4.13	3.6	N	1.6E+05	2.0E+06	N	BSL
85018	Phenanthrene[4]	2.2E+01	3.4E+01	µg/kg	13SD2	2/2	3.45 - 3.45	34	N	2.3E+05	3.1E+06	N	BSL
129000	Pyrene	3.0E+01	5.1E+01	µg/kg	13SD2	2/2	2.22 - 2.22	51	N	2.3E+05	3.1E+06	N	BSL
	SVOC TICs (µg/kg)												
301020	(Z)-9-Octadecenamide	6.6E+01	6.6E+01	µg/kg	13SD2	1/2	0 - 0	66	--	--	--	Y	NSV
84695	1,2-Benzenedicarboxylicacid, bis(2-methy	2.4E+02	2.4E+02	µg/kg	13SD3-DUP AVG	1/2	0 - 0	235	--	--	--	Y	NSV
17851535	1,2-Benzenedicarboxylic acid, butyl 2-me	9.1E+01	9.1E+01	µg/kg	13SD2	1/2	0 - 0	91	--	--	--	Y	NSV
119755	Benzeneamine, 2-nitro-N-phenyl-	2.1E+02	2.1E+02	µg/kg	13SD3-DUP AVG	1/2	0 - 0	205	--	--	--	Y	NSV
112845	Erucylamide	4.0E+02	4.0E+02	µg/kg	13SD3-DUP AVG	1/2	0 - 0	400	--	--	--	Y	NSV
198550	Perylene	1.1E+02	1.1E+02	µg/kg	13SD3-DUP AVG	1/2	0 - 0	113.5	--	--	--	Y	NSV

Table 4-14
HHRS COPC Selection (Sediment) for SWMU 13
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

CAS #	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	C/N	Adjusted RBC Residential	Adjusted RBC Industrial	COPC Flag (Y/N)	Rationale for Selection or Deletion
	PAHs (µg/kg)												
120127	Anthracene	3.8E+00	9.4E+00	µg/kg	13SD3-DUP AVG	2/2	1.05 - 1.05	9.4	N	2.3E+06	3.1E+07	N	BSL
56553	Benzo(a)anthracene	2.1E+01	3.0E+01	µg/kg	13SD3-DUP AVG	2/2	1.2 - 1.2	30	C	2.2E+02	3.9E+03	N	BSL
50328	Benzo(a)pyrene	2.6E+01	4.9E+01	µg/kg	13SD3-DUP AVG	2/2	1.5 - 1.5	49	C	2.2E+01	3.9E+02	Y	**ARES**
205992	Benzo(b)fluoranthene	2.3E+01	3.6E+01	µg/kg	13SD3-DUP AVG	2/2	1.95 - 1.95	36	C	2.2E+02	3.9E+03	N	BSL
191242	Benzo(g,h,i)perylene[4]	4.0E+01	8.8E+01	µg/kg	13SD3-DUP AVG	2/2	18.8 - 18.8	88	N	2.3E+05	3.1E+06	N	BSL
207089	Benzo(k)fluoranthene	1.2E+01	2.4E+01	µg/kg	13SD3-DUP AVG	2/2	1.5 - 1.5	24	C	2.2E+03	3.9E+04	N	BSL
218019	Chrysene	1.9E+01	4.3E+01	µg/kg	13SD3-DUP AVG	2/2	1.8 - 1.8	43.3	C	2.2E+04	3.9E+05	N	BSL
53703	Dibenz(a,h)anthracene	6.2E+00	6.2E+00	µg/kg	13SD3-DUP AVG	1/2	2.1 - 2.1	6.2	C	2.2E+01	3.9E+02	N	BSL
206440	Fluoranthene	1.9E+01	4.8E+01	µg/kg	13SD2	2/2	2.55 - 2.55	48	N	3.1E+05	4.1E+06	N	BSL
193395	Indeno(1,2,3-cd)pyrene	1.8E+01	4.5E+01	µg/kg	13SD3-DUP AVG	2/2	1.05 - 1.05	45	C	2.2E+02	3.9E+03	N	BSL
85018	Phenanthrene[4]	5.2E+00	1.6E+01	µg/kg	13SD2	2/2	0.9 - 0.9	16	N	2.3E+05	3.1E+06	N	BSL
129000	Pyrene	1.4E+01	4.5E+01	µg/kg	13SD2	2/2	1.35 - 1.35	45	N	2.3E+05	3.1E+06	N	BSL
	Cyanide (mg/kg)												
57125	Cyanide	7.0E-02	3.0E-01	µg/kg	13SD3-DUP AVG	2/2	0.0356 - 0.0356	0.295	N	1.6E+02	2.0E+03	N	BSL

Notes:
CAS = Chemical Abstracts Service
mg/kg = Milligram Per Kilogram
µg/kg = Microgram Per Kilogram
COPC = Chemical of Potential Concern
TAL = Target Analyte List
TCL = Target Compound List
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound
PAH = Polynuclear Aromatic Hydrocarbon
TIC = Tentatively Identified Compound
[1] = Chromium VI RBC value was used
[2] = Lead criteria are Action Levels; see USEPA Region III guidance
[3] = Mercuric chloride soil RBC value used
[4] = RBC value for pyrene was used for these compounds

DUP AVG = results for duplicate samples averaged
RBC = USEPA Region III Risk-Based Concentration (RBC) values from the October 31, 2006, RBC Table and October 10, 2006, Alternate RBC Table
C = Carcinogenic per EPA RBC Table (October 2006)
N = Noncarcinogenic per EPA RBC Table (October 2006)

ARES = Above Residential RBC
ARES/IND = Above Residential RBC/Industrial RBC
BSL = Below Residential/Industrial RBC Screening Levels
NSV = No Screening Value Available

Table 4-15
Cumulative HHRS for SWMU 13 (Sediment)
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

CAS #	Chemical	Units	Detection Frequency	MDC	C/N	RBC Residential	RBC Industrial	Non Carcinogenic HI (RBC_{Res})	Excess Cancer Risk (RBC_{Res})	Non Carcinogenic HI (RBC_{Ind})	Excess Cancer Risk (RBC_{Ind})
	TAL Metals										
7429905	Aluminum	mg/kg	2/2	2.15E+04	--	--	--	--	--	--	--
7440382	Arsenic	mg/kg	2/2	3.55E+00	C	4.26E-01	1.91E+00	--	8.E-06	--	2.E-06
7440382	Arsenic	mg/kg	2/2	3.55E+00	N	2.35E+01	3.07E+02	2.E-01	--	1.E-02	--
7440473	Chromium[1]	mg/kg	2/2	3.55E+01	N	2.35E+02	3.07E+03	2.E-01	--	1.E-02	--
7440484	Cobalt	mg/kg	2/2	1.25E+01	--	--	--	--	--	--	--
7439896	Iron	mg/kg	2/2	3.46E+04	N	2.35E+04	3.07E+05	1.E+00	--	1.E-01	--
7439965	Manganese	mg/kg	2/2	7.20E+02	N	1.56E+03	2.04E+04	5.E-01	--	4.E-02	--
7440622	Vanadium	mg/kg	2/2	3.80E+01	N	7.82E+01	1.02E+03	5.E-01	--	4.E-02	--
	TCL SVOCs										
50328	Benzo(a)pyrene	µg/kg	2/2	9.65E+01	C	2.20E+01	3.92E+02	--	4.E-06	--	2.E-07
53703	Dibenz(a,h)anthracene	µg/kg	2/2	2.34E+01	C	2.20E+01	3.92E+02	--	1.E-06	--	6.E-08
131113	Dimethylphthalate	µg/kg	1/2	7.01E+02	--	--	--	--		--	
	SVOC TICs										
301020	(Z)-9-Octadecenamide	µg/kg	1/2	6.60E+01	--	--	--	--	--	--	--
84695	1,2-Benzenedicarboxylicacid, bis(2-methy	µg/kg	1/2	2.35E+02	--	--	--	--	--	--	--
17851535	1,2-Benzenedicarboxylic acid, butyl 2-me	µg/kg	1/2	9.10E+01	--	--	--	--	--	--	--
119755	Benzeneamine, 2-nitro-N-phenyl-	µg/kg	1/2	2.05E+02	--	--	--	--	--	--	--
112845	Erucylamide	µg/kg	1/2	4.00E+02	--	--	--	--	--	--	--
198550	Perylene	µg/kg	1/2	1.14E+02	--	--	--	--	--	--	--
							Cumulative Risk	3.E+00	1.E-05	2.E-01	2.E-06

Notes:

CAS = Chemical Abstracts Service
mg/kg = Milligram Per Kilogram
µg/kg = Microgram Per Kilogram
TAL = Target Analyte List
TCL = Target Compound List
SVOC = Semivolatile Organic Compound
TIC = Tentatively Identified Compound
[1] = Chromium VI RBC value was used

HI = Hazard Index
MDC = Maximum Detected Concentration
RBC = USEPA Region III Risk-Based Concentration (RBC) values from the October 31, 2006, RBC Table and October 14, 2006, Alternate RBC Table
C = Carcinogenic per EPA RBC Table (April 2006)
N = Noncarcinogenic per EPA RBC Table (April 2006)

Table 4-16
HHRS SSL Comparison for SWMU 13 (Sediment)
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

CAS #	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Soil to Groundwater SSL (DAF 20)	COPC Flag (Y/N)	Rationale for Selection or Deletion
	TAL Metals (mg/kg)										
7429905	Aluminum	9,870	21,500	mg/kg	13SD3-DUP AVG	2/2	1.83 - 5.1	21,500	--	Y	NSV
7440360	Antimony	0.18	2.7	mg/kg	13SD3-DUP AVG	2/2	0.0518 - 0.0518	2.7	13.2	N	BSL
7440382	Arsenic	3.3	3.55	mg/kg	13SD3-DUP AVG	2/2	0.0232 - 0.0232	3.55	0.026	N	BSL
7440393	Barium	101	150	mg/kg	13SD3-DUP AVG	2/2	0.106 - 0.106	150	6,015.2	N	BSL
7440417	Beryllium	0.83	1.3	mg/kg	13SD3-DUP AVG	2/2	0.167 - 0.167	1.3	1,153.7	N	BSL
7440439	Cadmium	0.57	0.97	mg/kg	13SD3-DUP AVG	2/2	0.182 - 0.182	0.97	27.4	N	BSL
7440702	Calcium	1,270	1,850	mg/kg	13SD3-DUP AVG	2/2	16.6 - 16.6	1,850	Nutrient	N	Nutrient
7440473	Chromium	27	36	mg/kg	13SD3-DUP AVG	2/2	0.912 - 0.912	36	42.05	N	BSL
7440484	Cobalt	9.90	12.5	mg/kg	13SD3-DUP AVG	2/2	0.208 - 0.208	12.5	--	Y	NSV
7440508	Copper	14.00	34	mg/kg	13SD3-DUP AVG	2/2	0.368 - 0.368	34	10,518	N	BSL
7439896	Iron	34,550	34,600	mg/kg	13SD2	2/2	71.6 - 71.6	34,600	--	Y	NSV
7439921	Lead	132.00	259	mg/kg	13SD3-DUP AVG	2/2	0.545 - 1.09	259	--	Y	NSV
7439954	Magnesium	2,130	3,450	mg/kg	13SD3-DUP AVG	2/2	3.21 - 3.21	3,450	Nutrient	N	Nutrient
7439965	Manganese	594	720	mg/kg	13SD2	2/2	0.264 - 0.264	720	951.9	N	BSL
7439976	Mercury	0.03	0.12	mg/kg	13SD3-DUP AVG	2/2	0.0077 - 0.0077	0.12	--	Y	NSV
7440020	Nickel	12.00	18.5	mg/kg	13SD3-DUP AVG	2/2	0.0356 - 0.0356	18.5	--	Y	NSV
7440097	Potassium	1,020	1,735	mg/kg	13SD3-DUP AVG	2/2	5 - 5	1,735	Nutrient	N	Nutrient
7782492	Selenium	0.85	1.2	mg/kg	13SD3-DUP AVG	2/2	0.0502 - 0.0502	1.2	18.98	N	BSL
7440224	Silver	0.12	0.13	mg/kg	13SD3-DUP AVG	2/2	0.0044 - 0.0044	0.13	31.03	N	BSL
7440235	Sodium	45	53	mg/kg	13SD2	2/2	8.92 - 8.92	53	Nutrient	N	Nutrient
7440280	Thallium	0.46	0.51	mg/kg	13SD3-DUP AVG	2/2	0.027 - 0.027	0.51	3.6	N	BSL
7440622	Vanadium	19	38	mg/kg	13SD3-DUP AVG	2/2	0.207 - 0.207	38	730	N	BSL
7440666	Zinc	442	541	mg/kg	13SD3-DUP AVG	2/2	3.35 - 3.35	541	13,622	N	BSL
	TCL VOCs (µg/kg)										
78933	2-Butanone	3.1E+01	4.2E+01	µg/kg	13SD2	2/2	7.5 - 7.5	4.2E+01	2.9E+04	N	BSL
67641	Acetone	7.0E+01	1.8E+02	µg/kg	13SD2	2/2	7.5 - 7.5	1.8E+02	2.2E+04	N	BSL
156592	cis-1,2-Dichloroethene	9.5E+00	9.5E+00	µg/kg	13SD3-DUP AVG	1/2	1.07 - 1.07	9.5E+00	--	Y	NSV
75092	Methylene chloride	4.4E+00	4.4E+00	µg/kg	13SD3-DUP AVG	1/2	4.22 - 4.22	4.4E+00	1.9E+01	N	BSL
127184	Tetrachloroethene	3.6E+00	3.6E+00	µg/kg	13SD3-DUP AVG	1/2	0.92 - 0.92	3.6E+00	4.7E+00	N	BSL
108883	Toluene	1.1E+00	1.4E+00	µg/kg	13SD3-DUP AVG	2/2	0.696 - 0.696	1.4E+00	2.7E+04	N	BSL
79016	Trichloroethene	5.1E+01	5.1E+01	µg/kg	13SD3-DUP AVG	1/2	1.02 - 1.02	5.1E+01	2.6E-01	Y	**ASSL**
	TCL SVOCs (µg/kg)										
91576	2-Methylnaphthalene	7.0E+00	1.2E+01	µg/kg	13SD2	2/2	4.11 - 4.11	1.2E+01	4.4E+03	N	BSL
83329	Acenaphthene	5.0E+00	5.0E+00	µg/kg	13SD2	1/2	2.58 - 2.58	5.0E+00	1.0E+05	N	BSL
208968	Acenaphthylene	6.0E+00	6.0E+00	µg/kg	13SD3-DUP AVG	1/2	2.25 - 2.25	6.0E+00	--	Y	NSV
120127	Anthracene	2.8E+01	2.8E+01	µg/kg	13SD3-DUP AVG	1/2	6.93 - 6.93	2.8E+01	4.7E+05	N	BSL
56553	Benzo(a)anthracene	3.3E+01	5.8E+01	µg/kg	13SD3-DUP AVG	2/2	20 - 20	5.8E+01	4.8E+02	N	BSL
50328	Benzo(a)pyrene	4.2E+01	9.7E+01	µg/kg	13SD3-DUP AVG	2/2	8.57 - 8.57	9.7E+01	1.2E+02	N	BSL
205992	Benzo(b)fluoranthene	6.4E+01	1.4E+02	µg/kg	13SD3-DUP AVG	2/2	14.6 - 14.6	1.4E+02	1.5E+03	N	BSL
191242	Benzo(g,h,i)perylene	3.5E+01	6.9E+01	µg/kg	13SD3-DUP AVG	2/2	13.1 - 13.1	6.9E+01	--	Y	NSV
207089	Benzo(k)fluoranthene	2.7E+01	6.4E+01	µg/kg	13SD3-DUP AVG	2/2	20.1 - 20.1	6.4E+01	1.5E+04	N	BSL
117817	Bis(2-ethylhexyl)phthalate	2.8E+01	3.8E+01	µg/kg	13SD3-DUP AVG	2/2	3.11 - 3.11	3.8E+01	2.9E+06	N	BSL
218019	Chrysene	3.7E+01	1.4E+02	µg/kg	13SD3-DUP AVG	2/2	15.3 - 15.3	1.4E+02	4.8E+04	N	BSL
53703	Dibenz(a,h)anthracene	1.5E+01	2.3E+01	µg/kg	13SD3-DUP AVG	2/2	8.85 - 8.85	2.3E+01	4.6E+02	N	BSL
84662	Diethylphthalate	1.4E+01	2.0E+01	µg/kg	13SD3-DUP AVG	2/2	2.85 - 2.85	2.0E+01	4.5E+05	N	BSL
131113	Dimethylphthalate	7.0E+02	7.0E+02	µg/kg	13SD3-DUP AVG	1/2	4.97 - 4.97	7.0E+02	--	Y	NSV
84742	Di-n-butylphthalate	6.9E+01	1.2E+02	µg/kg	13SD3-DUP AVG	2/2	5.73 - 5.73	1.2E+02	5.0E+06	N	BSL
206440	Fluoranthene	3.0E+01	5.6E+01	µg/kg	13SD2	2/2	3.53 - 3.53	5.6E+01	6.3E+06	N	BSL
86737	Fluorene	2.7E+00	5.0E+00	µg/kg	13SD2	2/2	2.52 - 2.52	5.0E+00	1.4E+05	N	BSL
193395	Indeno(1,2,3-cd)pyrene	3.1E+01	6.5E+01	µg/kg	13SD3-DUP AVG	2/2	5.88 - 5.88	6.5E+01	4.2E+03	N	BSL
91203	Naphthalene	3.6E+00	3.6E+00	µg/kg	13SD3-DUP AVG	1/2	4.13 - 4.13	3.6E+00	1.5E+02	N	BSL
85018	Phenanthrene	2.2E+01	3.4E+01	µg/kg	13SD2	2/2	3.45 - 3.45	3.4E+01	--	Y	NSV
129000	Pyrene	3.0E+01	5.1E+01	µg/kg	13SD2	2/2	2.22 - 2.22	5.1E+01	6.8E+05	N	BSL

Table 4-16
HHRS SSL Comparison for SWMU 13 (Sediment)
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

CAS #	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Soil to Groundwater SSL (DAF 20)	COPC Flag (Y/N)	Rationale for Selection or Deletion
	SVOC TICs (µg/kg)										
301020	(Z)-9-Octadecenamide	6.6E+01	6.6E+01	µg/kg	13SD2	1/2	0 - 0	6.6E+01	--	Y	NSV
84695	1,2-Benzenedicarboxylicacid, bis(2-methy	2.4E+02	2.4E+02	µg/kg	13SD3-DUP AVG	1/2	0 - 0	2.4E+02	--	Y	NSV
17851535	1,2-Benzenedicarboxylic acid, butyl 2-me	9.1E+01	9.1E+01	µg/kg	13SD2	1/2	0 - 0	9.1E+01	--	Y	NSV
119755	Benzeneamine, 2-nitro-N-phenyl-	2.1E+02	2.1E+02	µg/kg	13SD3-DUP AVG	1/2	0 - 0	2.1E+02	--	Y	NSV
112845	Erucylamide	4.0E+02	4.0E+02	µg/kg	13SD3-DUP AVG	1/2	0 - 0	4.0E+02	--	Y	NSV
198550	Perylene	1.1E+02	1.1E+02	µg/kg	13SD3-DUP AVG	1/2	0 - 0	1.1E+02	--	Y	NSV
	PAHs (µg/kg)										
120127	Anthracene	3.8E+00	9.4E+00	µg/kg	13SD3-DUP AVG	2/2	1.05 - 1.05	9.4E+00	4.7E+05	N	BSL
56553	Benzo(a)anthracene	2.1E+01	3.0E+01	µg/kg	13SD3-DUP AVG	2/2	1.2 - 1.2	3.0E+01	4.8E+02	N	BSL
50328	Benzo(a)pyrene	2.6E+01	4.9E+01	µg/kg	13SD3-DUP AVG	2/2	1.5 - 1.5	4.9E+01	1.2E+02	N	BSL
205992	Benzo(b)fluoranthene	2.3E+01	3.6E+01	µg/kg	13SD3-DUP AVG	2/2	1.95 - 1.95	3.6E+01	1.5E+03	N	BSL
191242	Benzo(g,h,i)perylene	4.0E+01	8.8E+01	µg/kg	13SD3-DUP AVG	2/2	18.8 - 18.8	8.8E+01			
207089	Benzo(k)fluoranthene	1.2E+01	2.4E+01	µg/kg	13SD3-DUP AVG	2/2	1.5 - 1.5	2.4E+01	1.5E+04	N	BSL
218019	Chrysene	1.9E+01	4.3E+01	µg/kg	13SD3-DUP AVG	2/2	1.8 - 1.8	4.3E+01	4.8E+04	N	BSL
53703	Dibenz(a,h)anthracene	6.2E+00	6.2E+00	µg/kg	13SD3-DUP AVG	1/2	2.1 - 2.1	6.2E+00	4.6E+02	N	BSL
206440	Fluoranthene	1.9E+01	4.8E+01	µg/kg	13SD2	2/2	2.55 - 2.55	4.8E+01	6.3E+06	N	BSL
193395	Indeno(1,2,3-cd)pyrene	1.8E+01	4.5E+01	µg/kg	13SD3-DUP AVG	2/2	1.05 - 1.05	4.5E+01	4.2E+03	N	BSL
85018	Phenanthrene	5.2E+00	1.6E+01	µg/kg	13SD2	2/2	0.9 - 0.9	1.6E+01	--	Y	NSV
129000	Pyrene	1.4E+01	4.5E+01	µg/kg	13SD2	2/2	1.35 - 1.35	4.5E+01	6.8E+05	N	BSL
	Cyanide (mg/kg)										
57125	Cyanide	7.0E-02	3.0E-01	µg/kg	13SD3-DUP AVG	2/2	0.0356 - 0.0356	3.0E-01	1.5E+02	N	BSL

Notes:

CAS = Chemical Abstracts Service
mg/kg = Milligram Per Kilogram
µg/kg = Microgram Per Kilogram
TAL = Target Analyte List
TCL = Target Compound List
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound
PAH = Polynuclear Aromatic Compound
TIC = Tentatively Identified Compound
[1] = Chromium VI RBC value was used
[2] = Lead criteria are Action Levels; see USEPA Region III guidance
[3] = Mercuric chloride soil RBC value used
[4] = RBC value for pyrene was used for these compounds

DUP AVG = results for duplicate samples averaged
SSL DAF20 = Soil Screening Levels at a Dilution Attenuation Factor of 20
Per (SSL) values from the October 31, 2006, RBC Table

ASSL = Above Soil Screening Level
BSL = Below Soil Screening Levels
NSV = No Screening Value Available
* = Surface Soil Detections used for SSL Screening due to testing of one surface soil sample for PCB/Pesticides/Herbicides

Table 4-17
HHRS COPC Selection (Surface Water) for SWMU 13
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

CAS #	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	C/N	Adjusted Tap Water RBC	MCL	Virginia Water Quality Criteria[A]	COPC Flag (Y/N)	Rationale for Selection or Deletion
	TAL Metals (mg/kg)													
7429905	Aluminum	59.5	74	ug/L	13SW2	2/2	18.7 - 18.7	74	N	--	--	--	Y	NSV
7440360	Antimony	0.7	0.7	ug/L	13SW3-DUP AVG	1/2	0.552 - 0.552	0.7	N	1.5	6	--	N	BSL
7440360	Antimony, Dissolved	0.8	0.8	ug/L	13SW3-DUP AVG	1/2	0.552 - 0.552	0.8	N	1.5	6	--	N	BSL
7440393	Barium	21	22	ug/L	13SW2	2/2	1.82 - 1.82	22	N	730	2,000	2,000	N	BSL
7440393	Barium, Dissolved	17.5	18	ug/L	13SW2	2/2	1.82 - 1.82	18	N	256	2,000	2,000	N	BSL
7440702	Calcium	13,000	13,000	ug/L	13SW2	2/2	170 - 170	13,000	--	--	--	--	N	Nutrient
7440702	Calcium, Dissolved	13,000	13,000	ug/L	13SW2	2/2	170 - 170	13,000		--	--	--	N	Nutrient
7440473	Chromium	0.7	0.8	ug/L	13SW2	2/2	0.554 - 0.554	0.8	N	11	100	--	N	BSL
7440473	Chromium, Dissolved	0.7	0.7	ug/L	13SW3-DUP AVG	1/2	0.554 - 0.554	0.7	N	11	100	--	N	BSL
7439896	Iron	175	190	ug/L	13SW2	2/2	2.95 - 2.95	190	N	1,095	--	300	N	BSL
7439896	Iron, Dissolved	37	37	ug/L	13SW2	2/2	2.95 - 2.95	37	N	1,095	--	300	N	BSL
7439921	Lead	0.6	0.9	ug/L	13SW3-DUP AVG	2/2	0.281 - 0.281	0.9	--	--	15	15	N	BSL
7439954	Magnesium	5,350	5,700	ug/L	13SW2	2/2	57.4 - 57.4	5,700	--	--	--	--	N	Nutrient
7439954	Magnesium, Dissolved	5,450	5,600	ug/L	13SW2	2/2	57.4 - 57.4	5,600	--	--	--	--	N	Nutrient
7439965	Manganese	27	27	ug/L	13SW2	2/2	3.16 - 3.16	27	N	73	--	50	N	BSL
7439965	Manganese, Dissolved	6.1	10	ug/L	13SW2	2/2	3.16 - 3.16	10	N	73	--	50	N	BSL
7440020	Nickel	0.8	1	ug/L	13SW2	2/2	0.41 - 0.41	1	N	73	--	610	N	BSL
7440020	Nickel, Dissolved	0.9	1.1	ug/L	13SW2	2/2	0.41 - 0.41	1.1	N	73	--	610	N	BSL
7440097	Potassium	1,800	1,850	ug/L	13SW3-DUP AVG	2/2	59.7 - 59.7	1,850	--	--	--	--	N	Nutrient
7440097	Potassium, Dissolved	1,600	1,650	ug/L	13SW3-DUP AVG	2/2	59.7 - 59.7	1,650	--	--	--	--	N	Nutrient
7440235	Sodium	5,050	5,100	ug/L	13SW2	2/2	76.9 - 76.9	5,100	--	--	--	--	N	Nutrient
7440235	Sodium, Dissolved	5,050	5,100	ug/L	13SW2	2/2	76.9 - 76.9	5,100	--	--	--	--	N	Nutrient
7440280	Thallium	0.27	0.27	ug/L	13SW3-DUP AVG	1/2	0.208 - 0.208	0.3	N	0.26	2	--	Y	**ARBC**
7440666	Zinc	5.5	5.5	ug/L	13SW2	1/2	4.55 - 4.55	5.5	N	1,095	--	5,000	N	BSL
	TCL SVOCs (µg/L)													
117817	Bis(2-ethylhexyl)phthalate	0.3	0.3	ug/L	13SW2	2/2	0.149 - 0.149	0.3	C	5	--	--	N	BSL
85687	Butylbenzylphthalate	0.1	0.1	ug/L	13SW2	2/2	0.015 - 0.015	0.1	N	730	--	3,000	N	BSL
84662	Diethylphthalate	0.1	0.1	ug/L	13SW2	1/2	0.074 - 0.074	0.1	N	2,920	--	23,000	N	BSL
	SVOC TICs (µg/L)													
629969	(M) 1-Eicosanol	0.8	0.9	ug/L	13SW2	2/2	0 - 0	0.9	--	--	--	--	Y	NSV
301020	(Z)-9-Octadecenamide	10.4	10.4	ug/L	13SW3-DUP AVG	1/2	0 - 0	10.4	--	--	--	--	Y	NSV
36653824	1-Hexadecanol	0.5	0.5	ug/L	13SW2	1/2	0 - 0	0.5	--	--	--	--	Y	NSV
84695	1,2-Benzenedicarboxylicacid, bis(2-methy	0.5	0.8	ug/L	13SW2	2/2	0 - 0	0.8	--	--	--	--	Y	NSV
17851535	1,2-Benzenedicarboxylic acid, butyl 2-me	0.5	0.5	ug/L	13SW3-DUP AVG	1/2	0 - 0	0.5	--	--	--	--	Y	NSV
101371	2,4,6-Triallyloxy-1,3,5-triazine	1.2	1.6	ug/L	13SW2	2/2	0 - 0	1.6	--	--	--	--	Y	NSV
629970	Docosane, 11-butyl-	0.5	0.5	ug/L	13SW3-DUP AVG	1/2	0 - 0	0.5	--	--	--	--	Y	NSV
112958	Eicosane	0.5	0.5	ug/L	13SW2	1/2	0 - 0	0.5	--	--	--	--	Y	NSV
112845	Erucylamide	9.6	20.8	ug/L	13SW2	2/2	0 - 0	20.8	--	--	--	--	Y	NSV

Notes:

CAS = Chemical Abstracts Service
µg/L = Microgram Per Liter
TAL = Target Analyte List
TCL = Target Compound List
SVOC = Semivolatile Organic Compound
TIC = Tentatively Identified Compound
COPC = Chemical of Potential Concern
DUP AVG = results for duplicate samples averaged

MCL = Maximum Contaminant Level
RBC = USEPA Region III Risk-Based Concentration (RBC) values from the October 31, 2006, RBC Table and October 10, 2006, Alternate RBC Table
C = Carcinogenic per EPA RBC Table (October 2006)
N = Noncarcinogenic per EPA RBC Table (October 2006)
[A] = Virginia Water Quality Criteria Values Taken from 9 VAC 25-260-140 Human Health - Public Water Supplies Values Used

ARBC = Above Tap Water RBC
BSL = Below Tap Water RBC/MCL
NSV = No Screening Value Available

Table 4-18
Cumulative HHRS for SWMU 13 (Surface Water)
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

CAS #	Chemical	Units	Detection Frequency	MDC	C/N	Non Carcinogenic HI ($RBC_{Tap\ Water}$)	Excess Cancer Risk ($RBC_{Tap\ Water}$)
	TAL Metals						
7429905	Aluminum	µg/L	2/2	7.40E+01	N	--	--
7440280	Thallium	µg/L	1/2	2.70E-01	N	1.E-01	--
	SVOC TICs (µg/l)						
629969	(M) 1-Eicosanol	µg/L	2/2	9.10E-01	--	--	--
301020	(Z)-9-Octadecenamide	µg/L	1/2	1.04E+01	--	--	--
36653824	1-Hexadecanol	µg/L	1/2	5.10E-01	--	--	--
84695	1,2-Benzenedicarboxylicacid, bis(2-methy	µg/L	2/2	8.40E-01	--	--	--
17851535	1,2-Benzenedicarboxylic acid, butyl 2-me	µg/L	1/2	5.10E-01	--	--	--
101371	2,4,6-Triallyloxy-1,3,5-triazine	µg/L	2/2	1.63E+00	--	--	--
629970	Docosane, 11-butyl-	µg/L	1/2	4.90E-01	--	--	--
112958	Eicosane	µg/L	1/2	5.40E-01	--	--	--
112845	Erucylamide	µg/L	2/2	2.08E+01	--	--	--
						1.E-01	--

Notes:
CAS = Chemical Abstracts Service
µg/L = Microgram Per Liter
TAL = Target Analyte List
SVOC = Semivolatile Organic Compound
TIC = Tentatively Identified Compound
MDC = Maximum Detected Concentration
HI = Hazard Index

RBC = USEPA Region III Risk-Based Concentration (RBC) values from the October 31, 2006, RBC Table and October 10, 2006, Alternate RBC Table
C = Carcinogenic per EPA RBC Table (October 2006)
N = Noncarcinogenic per EPA RBC Table (October 2006)

Table 4-19
Detected Chemical Occurrence for SWMU 13 - Soil
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

CAS #	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening
	TAL Metals (mg/kg)							
7429905	Aluminum	6,630	20,400	mg/kg	13SB9A	6/6	1.83 - 1.83	20,400
7440360	Antimony	0.07	1.1	mg/kg	13SB12A	5/6	0.0518 - 0.0518	1.1
7440382	Arsenic	1.6	2.7	mg/kg	13SB9A	6/6	0.0232 - 0.0232	3
7440393	Barium	78	175	mg/kg	13SB9A	6/6	0.106 - 0.106	175
7440417	Beryllium	0.66	1.2	mg/kg	13SB9A	5/6	0.0333 - 0.167	1.20
7440439	Cadmium	0.9	2.2	mg/kg	13SB9A	6/6	0.182 - 0.182	2.20
7440702	Calcium	1,890	12,400	mg/kg	13SB12A	6/6	16.6 - 16.6	12,400
18540299	Chromium	18	38	mg/kg	13SB11A	6/6	0.912 - 0.912	38
7440484	Cobalt	5.1	13	mg/kg	13SB11A	6/6	0.208 - 0.208	13
7440508	Copper	13	45	mg/kg	13SB12A	6/6	0.368 - 0.368	45
7439896	Iron	14,800	36,500	mg/kg	13SB9A	6/6	21.2 - 42.4	36,500
7439921	Lead	111	8,620	mg/kg	13SB8A	6/6	0.545 - 21.8	8,620
7439954	Magnesium	3,240	5,330	mg/kg	13SB12A	6/6	3.21 - 3.21	5,330
7439965	Manganese	301	1,240	mg/kg	13SB9A	6/6	0.264 - 1.32	1,240
7439976	Mercury	0.016	0.052	mg/kg	13SB11A	6/6	0.0077 - 0.0077	0.05
7440020	Nickel	8.3	19	mg/kg	13SB9A	6/6	0.0356 - 0.0356	19
7440097	Potassium	1,050	2,680	mg/kg	13SB11A	6/6	5 - 5	2,680
7782492	Selenium	0.32	0.9	mg/kg	13SB9A	6/6	0.0502 - 0.0502	0.93
7440224	Silver	0.06	0.14	mg/kg	13SB8A	6/6	0.0044 - 0.0044	0.14
7440235	Sodium	36	102	mg/kg	13SB12A	6/6	18.1 - 18.1	102
7440280	Thallium	0.13	0.78	mg/kg	13SB9A	6/6	0.027 - 0.027	0.78
7440622	Vanadium	14	37	mg/kg	13SB9A	6/6	0.207 - 0.207	37
7440666	Zinc	214	1,010	mg/kg	13SB9A	6/6	2.59 - 12.9	1,010
	TCL VOCs (µg/kg)							
120821	1,2,4-Trichlorobenzene	9.6E-01	9.6E-01	µg/kg	13SB10A	1/6	0.492 - 0.574	9.6E-01
78933	2-Butanone	2.6E+01	4.5E+01	µg/kg	13SB11A	6/6	6 - 7	4.5E+01
67641	Acetone	4.9E+01	3.2E+02	µg/kg	13SB10A	6/6	6 - 7	3.2E+02
71432	Benzene	9.1E-01	9.1E-01	µg/kg	13SB11A	1/6	0.632 - 0.738	9.1E-01
75092	Methylene chloride	4.1E+00	1.1E+01	µg/kg	13SB10A	6/6	3.37 - 3.93	1.1E+01
108883	Toluene	6.6E-01	3.5E+00	µg/kg	13SB10A	5/6	0.557 - 0.65	3.5E+00
79016	Trichloroethene	9.6E+00	9.6E+00	µg/kg	13SB11A	1/6	0.812 - 0.948	9.6E+00

Table 4-19
Detected Chemical Occurrence for SWMU 13 - Soil
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

CAS #	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening
	TCL SVOCs[1] (µg/kg)							
91576	2-Methylnaphthalene	4.0E+00	2.2E+01	µg/kg	13SB8A	3/6	3.29 - 3.84	2.2E+01
606202	2,6-Dinitrotoluene	2.1E+02	2.1E+02	µg/kg	13SB12A	1/6	33.2 - 38.8	2.1E+02
59507	4-Chloro-3-Methylphenol	9.0E+00	2.5E+01	µg/kg	13SB9A	5/6	6.25 - 7.29	2.5E+01
208968	Acenaphthylene	2.0E+00	7.0E+00	µg/kg	13SB9A	4/6	1.8 - 2.1	7.0E+00
117817	Bis(2-ethylhexyl)phthalate	1.9E+01	4.5E+02	µg/kg	13SB10A	6/6	2.48 - 2.9	4.5E+02
85687	Butylbenzylphthalate	6.0E+00	3.8E+01	µg/kg	13SB10A	3/6	5.38 - 6.27	3.8E+01
132649	Dibenzofuran	6.0E+00	1.3E+01	µg/kg	13SB8A	2/6	3.79 - 4.42	1.3E+01
84662	Diethylphthalate	9.0E+00	9.5E+02	µg/kg	13SB12A	6/6	2.28 - 2.66	9.5E+02
131113	Dimethylphthalate	1.8E+01	1.4E+02	µg/kg	13SB10A	2/6	3.97 - 4.63	1.4E+02
84742	Di-n-butylphthalate	6.2E+01	6.8E+02	µg/kg	13SB12A	6/6	4.58 - 5.35	6.8E+02
91203	Naphthalene	4.0E+00	1.0E+01	µg/kg	13SB8A	2/6	3.3 - 3.85	1.0E+01
86306	N-Nitrosodiphenylamine	2.1E+01	6.3E+02	µg/kg	13SB12A	4/6	5.7 - 6.65	6.3E+02
	PAHs[2] (µg/kg)							
83329	Acenaphthene	1.4E+01	1.7E+01	µg/kg	13SB9A	2/6	11.3 - 13.2	1.7E+01
120127	Anthracene	6.6E+00	3.8E+01	µg/kg	13SB9A	4/6	0.84 - 0.98	3.8E+01
56553	Benzo(a)anthracene	2.1E+00	1.4E+02	µg/kg	13SB10A	6/6	0.96 - 1.12	1.4E+02
50328	Benzo(a)pyrene	6.5E+00	1.9E+02	µg/kg	13SB10A	5/6	1.2 - 1.4	1.9E+02
205992	Benzo(b)fluoranthene	4.9E+00	1.4E+02	µg/kg	13SB10A	5/6	1.56 - 1.82	1.4E+02
191242	Benzo(g,h,i)perylene	8.2E+01	5.4E+02	µg/kg	13SB9A	4/6	15 - 17.5	5.4E+02
207089	Benzo(k)fluoranthene	2.0E+01	8.0E+01	µg/kg	13SB10A	4/6	1.2 - 1.4	8.0E+01
218019	Chrysene	2.4E+00	1.5E+02	µg/kg	13SB9A	6/6	1.44 - 1.68	1.5E+02
53703	Dibenz(a,h)anthracene	2.3E+00	5.2E+00	µg/kg	13SB10A	2/6	1.68 - 1.96	5.2E+00
206440	Fluoranthene	5.0E+00	4.7E+02	µg/kg	13SB10A	6/6	2.04 - 2.38	4.7E+02
86737	Fluorene	1.1E+01	1.7E+01	µg/kg	13SB10A	2/6	1.56 - 1.82	1.7E+01
193395	Indeno(1,2,3-cd)pyrene	5.9E+00	1.3E+02	µg/kg	13SB10A	5/6	0.84 - 0.98	1.3E+02
85018	Phenanthrene	2.1E+00	2.1E+02	µg/kg	13SB10A	6/6	0.72 - 0.84	2.1E+02
129000	Pyrene	3.6E+00	3.2E+02	µg/kg	13SB10A	6/6	1.08 - 1.26	3.2E+02
	Explosives[3] (mg/kg)							
121142	2,4-Dinitrotoluene	3.9E-01	3.9E-01	mg/kg	13SB12A	1/6	0.142 - 0.142	3.9E-01
118967	2,4,6-Trinitrotoluene	2.7E-01	4.3E-01	mg/kg	13SB11A	2/6	0.167 - 0.167	4.3E-01

Table 4-19
Detected Chemical Occurrence for SWMU 13 - Soil
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

CAS #	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening
	Nitroglycerin/PETN (mg/kg)							
55630	Nitroglycerin	2.1E+00	8.5E+00	mg/kg	13SB12A	2/6	0.195 - 0.276	8.5E+00
	Cyanide (mg/kg)							
57125	Cyanide	7.0E-02	3.5E-01	mg/kg	13SB9A	6/6	0.0356 - 0.0356	3.5E-01
	Dioxins/Furans (mg/kg)*							
	Total 2,3,7,8-TCDD Equivalents							

Notes:
CAS = Chemical Abstracts Sevice
TAL = Target Analyte List
TCL = Target Compound List
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound
PAH = Polynuclear Aromatic Hydrocarbon
mg/kg = Milligram Per Kilogram
µg/kg = Microgram Per Kilogram
[1] = SVOCs analyzed by USEPA SW-846 8270 Method 8270C
[2] = PAHs analyzed by USEPA SW-846 Method8310
[3] = Explosives analyzed by USEPA SW-846 Method 8330
* = See Table 4-20 for dioxin/furans

Table 4-20
Conversion of Dioxin Detections in Soil to Equivalents of 2,3,7,8-TCDD for SWMU 13
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

Sample ID Sample Date		13SB9A 09/30/03		
Dioxin/Furans Method 8290	**TEF(1)**	**pg/g**	**Flags**	**2,3,7,8-TCDD Equivalents pg/g**
1,2,3,4,6,7,8,9-OCDD	0.0001	1520	J	1.52E-01
1,2,3,4,6,7,8,9-OCDF	0.0001	11.2	J	1.12E-03
1,2,3,4,6,7,8-HpCDD	0.01	50		5.00E-01
1,2,3,4,6,7,8-HpCDF	0.01	5.11	J	5.11E-02
1,2,3,4,7,8,9-HpCDF	0.01	0.46	J	4.60E-03
1,2,3,4,7,8-HxCDD	0.1	0.735	J	7.35E-02
1,2,3,4,7,8-HxCDF	0.01	0.681	J	6.81E-03
1,2,3,6,7,8-HxCDD	0.1	2.24	J	2.24E-01
1,2,3,6,7,8-HxCDF	0.1	0.534	J	5.34E-02
1,2,3,7,8,9-HxCDD	0.1	2.33		2.33E-01
1,2,3,7,8-PeCDD	1	0.656	J	6.56E-01
1,2,3,7,8-PeCDF	0.05	0.45	J	2.25E-02
2,3,4,6,7,8-HxCDF	0.1	0.494	J	4.94E-02
2,3,4,7,8-PeCDF	0.5	0.574	J	2.87E-01
2,3,7,8-TCDF	0.1	0.784	A	7.84E-02
Total HpCDD		96.8		--
Total HpCDF		13		--
Total HxCDD		21.6		--
Total HxCDF		8.31		--
Total PeCDD		3.82	J	--
Total PeCDF		4.85	J	--
Total TCDD		1.08	J	--
Total TCDF		7.11		--
Total 2,3,7,8-TCDD Equivalents				2.39E+00

NOTES:
(1) = Developed by the World Health Organization [Van den Berg, et al. (1998). Toxic Equivalency Factors (TEFs) for PCBs, PCDDs, PCDFs for Humans and for Wildlife.
µg/kg = Microgram Per Kilogram

Table 4-21
Non-detected Chemicals for SWMU 13 (Soil)
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

CAS #	Parameter Name	Units	Number of Samples	Minimum MDL	Maximum MDL	TSV	Maximum Detection Limit Exceeds TSV
TAL Metals							
7440417	Beryllium	mg/kg	1	0.0391	0.0391	10	N
7440360	Antimony	mg/kg	1	0.0518	0.0518	5	**Y**
Pesticides/Herbicides							
72548	4,4'-DDD	ug/kg	1	0.309	0.309	--	NS
72559	4,4'-DDE	ug/kg	1	0.228	0.228	100	**Y**
50293	4,4'-DDT	ug/kg	1	0.234	0.234	100	N
309002	Aldrin	ug/kg	1	0.395	0.395	100	N
319846	alpha-BHC	ug/kg	1	0.394	0.394	100	N
5103719	alpha-Chlordane	ug/kg	1	0.564	0.564	100	N
319857	beta-BHC	ug/kg	1	1.47	1.47	100	N
319868	delta-BHC	ug/kg	1	1.06	1.06	100	N
60571	Dieldrin	ug/kg	1	0.402	0.402	100	N
959988	Endosulfan I	ug/kg	1	1.18	1.18	--	NS
33213659	Endosulfan II	ug/kg	1	0.278	0.278	--	NS
1031078	Endosulfan Sulfate	ug/kg	1	0.654	0.654	--	NS
72208	Endrin	ug/kg	1	0.387	0.387	100	N
7421934	Endrin aldehyde	ug/kg	1	1.44	1.44	--	NS
53494705	Endrin ketone	ug/kg	1	0.358	0.358	--	NS
58899	gamma-BHC (Lindane)	ug/kg	1	0.252	0.252	100	N
5103742	gamma-Chlordane	ug/kg	1	0.914	0.914	100	N
76448	Heptachlor	ug/kg	1	0.917	0.917	--	NS
1024573	Heptachlor epoxide	ug/kg	1	0.592	0.592	100	N
72435	Methoxychlor	ug/kg	1	0.364	0.364	100	N
8001352	Toxaphene	ug/kg	1	30.3	30.3	--	NS
93765	2,4,5-T	ug/kg	1	2.6	2.6	--	NS
93721	2,4,5-TP (Silvex)	ug/kg	1	5.2	5.2	--	NS
94757	2,4-D	ug/kg	1	20.8	20.8	--	NS
94826	2,4-DB	ug/kg	1	80.6	80.6	--	NS
75990	Dalapon	ug/kg	1	74.1	74.1	--	NS
1918009	Dicamba	ug/kg	1	2.6	2.6	--	NS
120365	Dichlorprop	ug/kg	1	22.1	22.1	--	NS
88857	Dinoseb	ug/kg	1	27.3	27.3	--	NS
94746	MCPA	ug/kg	1	1810	1810	--	NS
93652	MCPP	ug/kg	1	6570	6570	--	NS
PCBs							
12674112	Aroclor 1016	ug/kg	1	20.8	20.8	--	NS
11104282	Aroclor 1221	ug/kg	1	2.6	2.6	--	NS
11141165	Aroclor 1232	ug/kg	1	6.5	6.5	--	NS
53469219	Aroclor 1242	ug/kg	1	3.9	3.9	--	NS
12672296	Aroclor 1248	ug/kg	1	6.5	6.5	--	NS
11097691	Aroclor 1254	ug/kg	1	3.9	3.9	371	N
11096825	Aroclor 1260	ug/kg	1	9.1	9.1	371	N
VOCs							
71556	1,1,1-Trichloroethane	ug/kg	6	0.511	0.596	300	N
79345	1,1,2,2-Tetrachloroethane	ug/kg	6	0.784	0.914	300	N
76131	1,1,2-Trichloro-1,2,2-trifluoroethane	ug/kg	6	0.911	1.06	--	NS
79005	1,1,2-Trichloroethane	ug/kg	6	0.712	0.83	300	N
75343	1,1-Dichloroethane	ug/kg	6	0.869	1.01	300	N
75354	1,1-Dichloroethene	ug/kg	6	0.88	1.03	--	NS
87616	1,2,3-Trichlorobenzene	ug/kg	6	0.653	0.762	--	NS
120821	1,2,4-Trichlorobenzene	ug/kg	5	0.492	0.533	100	N
96128	1,2-Dibromo-3-chloropropane	ug/kg	6	2.5	2.91	--	NS
106934	1,2-Dibromoethane	ug/kg	6	0.822	0.959	--	NS
95501	1,2-Dichlorobenzene	ug/kg	6	0.581	0.678	100	N
107062	1,2-Dichloroethane	ug/kg	6	0.517	0.603	870,000	N

Table 4-21
Non-detected Chemicals for SWMU 13 (Soil)
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CAS #	Parameter Name	Units	Number of Samples	Minimum MDL	Maximum MDL	TSV	Maximum Detection Limit Exceeds TSV
78875	1,2-Dichloropropane	ug/kg	6	0.703	0.82	700,000	N
541731	1,3-Dichlorobenzene	ug/kg	6	0.322	0.375	--	NS
106467	1,4-Dichlorobenzene	ug/kg	6	0.852	0.994	100	N
591786	2-Hexanone	ug/kg	6	2.71	3.16	--	NS
108101	4-Methyl-2-pentanone	ug/kg	6	1.75	2.04	--	NS
71432	Benzene	ug/kg	5	0.632	0.738	100	N
74975	Bromochloromethane	ug/kg	6	0.913	1.07	--	NS
75274	Bromodichloromethane	ug/kg	6	0.601	0.701	450,000	N
75252	Bromoform	ug/kg	6	0.694	0.809	--	NS
74839	Bromomethane	ug/kg	6	1.8	2.1	--	NS
75150	Carbon disulfide	ug/kg	6	1.74	2.03	--	NS
56235	Carbon tetrachloride	ug/kg	6	0.559	0.652	300	N
108907	Chlorobenzene	ug/kg	6	0.793	0.925	100	N
75003	Chloroethane	ug/kg	6	1.62	1.89	--	NS
67663	Chloroform	ug/kg	6	0.535	0.624	300	N
74873	Chloromethane	ug/kg	6	1	1.17	--	NS
156592	cis-1,2-Dichloroethene	ug/kg	6	0.852	0.994	300	N
10061015	cis-1,3-Dichloropropene	ug/kg	6	0.589	0.687	--	NS
110827	Cyclohexane	ug/kg	6	0.379	0.442	--	NS
124481	Dibromochloromethane	ug/kg	6	0.62	0.724	--	NS
75718	Dichlorodifluoromethane	ug/kg	6	0.802	0.935	--	NS
100414	Ethylbenzene	ug/kg	6	0.508	0.592	100	N
98828	Isopropylbenzene	ug/kg	6	0.655	0.764	--	NS
79209	Methyl acetate	ug/kg	6	4.16	4.86	--	NS
1634044	methyl tert-Butyl ether	ug/kg	6	0.769	0.897	--	NS
108872	Methylcyclohexane	ug/kg	6	1.01	1.18	--	NS
100425	Styrene	ug/kg	6	0.53	0.619	100	N
127184	Tetrachloroethene	ug/kg	6	0.736	0.858	300	N
108883	Toluene	ug/kg	1	0.557	0.557	100	N
156605	trans-1,2-Dichloroethene	ug/kg	6	0.844	0.984	300	N
10061026	trans-1,3-Dichloropropene	ug/kg	6	0.625	0.729	--	NS
79016	Trichloroethene	ug/kg	5	0.812	0.948	300	N
75694	Trichlorofluoromethane	ug/kg	6	0.892	1.04	--	NS
75014	Vinyl Chloride	ug/kg	6	0.444	0.518	300	N
1330207	Xylenes	ug/kg	6	0.505	0.589	100	N
SVOCs							
92524	1,1'-Biphenyl	ug/kg	6	2.95	3.44	--	NS
95943	1,2,4,5-Tetrachlorobenzene	ug/kg	6	34.4	40.2	--	NS
108601	2,2'-oxybis(1-Chloropropane)	ug/kg	6	1.58	1.85	--	NS
95954	2,4,5-Trichlorophenol	ug/kg	6	4.01	4.68	100	N
88062	2,4,6-Trichlorophenol	ug/kg	6	3.14	3.67	100	N
120832	2,4-Dichlorophenol	ug/kg	6	4.22	4.93	100	N
105679	2,4-Dimethylphenol	ug/kg	6	9.53	11.1	100	N
51285	2,4-Dinitrophenol	ug/kg	6	3.84	4.48	20,000	N
121142	2,4-Dinitrotoluene	ug/kg	3	3.78	4.41	--	NS
606202	2,6-Dinitrotoluene	ug/kg	5	33.2	38.8	--	NS
91587	2-Chloronaphthalene	ug/kg	6	2.76	3.22	--	NS
95578	2-Chlorophenol	ug/kg	6	2.41	2.81	100	N
91576	2-Methylnaphthalene	ug/kg	3	3.29	3.56	--	NS
95487	2-Methylphenol	ug/kg	6	5.81	6.78	100	N
88744	2-Nitroaniline	ug/kg	6	5.52	6.44	--	NS
88755	2-Nitrophenol	ug/kg	6	2.04	2.38	--	NS
91941	3,3'-Dichlorobenzidine	ug/kg	6	66.5	77.6	--	NS
99092	3-Nitroaniline	ug/kg	6	22	25.6	--	NS
534521	4,6-Dinitro-2-methylphenol	ug/kg	6	5.41	6.31	--	NS
101553	4-Bromophenyl-phenylether	ug/kg	6	4.06	4.73	--	NS

Table 4-21
Non-detected Chemicals for SWMU 13 (Soil)
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CAS #	Parameter Name	Units	Number of Samples	Minimum MDL	Maximum MDL	TSV	Maximum Detection Limit Exceeds TSV
59507	4-Chloro-3-Methylphenol	ug/kg	1	6.77	6.77	--	NS
106478	4-Chloroaniline	ug/kg	6	1.51	1.76	--	NS
7005723	4-Chlorophenyl-phenylether	ug/kg	6	3.92	4.58	--	NS
106445	4-Methylphenol	ug/kg	6	7.64	8.92	100	N
100016	4-Nitroaniline	ug/kg	6	8.7	10.2	--	NS
100027	4-Nitrophenol	ug/kg	6	3.4	3.96	100	N
83329	Acenaphthene	ug/kg	2	2.06	2.24	100	N
208968	Acenaphthylene	ug/kg	2	1.8	1.95	100	N
98862	Acetophenone	ug/kg	6	2.28	2.66	--	NS
120127	Anthracene	ug/kg	2	5.54	6.01	100	N
1912249	Atrazine	ug/kg	6	8.26	9.63	--	NS
100527	Benzaldehyde	ug/kg	6	4.86	5.67	--	NS
56553	Benzo(a)anthracene	ug/kg	2	16	17.3	100	N
50328	Benzo(a)pyrene	ug/kg	1	7.42	7.42	100	N
191242	Benzo(g,h,i)perylene	ug/kg	1	11.3	11.3	100	N
207089	Benzo(k)fluoranthene	ug/kg	2	16.1	17.4	100	N
111911	Bis(2-chloroethoxy)methane	ug/kg	6	3.77	4.4	--	NS
111444	Bis(2-chloroethyl)ether	ug/kg	6	2.08	2.42	--	NS
85687	Butylbenzylphthalate	ug/kg	3	5.82	5.82	--	NS
105602	Caprolactam	ug/kg	6	7.66	8.93	--	NS
86748	Carbazole	ug/kg	6	7.32	8.54	--	NS
218019	Chrysene	ug/kg	1	13.3	13.3	100	N
53703	Dibenz(a,h)anthracene	ug/kg	4	7.08	8.26	100	N
132649	Dibenzofuran	ug/kg	4	3.79	4.11	--	NS
131113	Dimethylphthalate	ug/kg	4	3.97	4.3	200,000	N
117840	Di-n-octylphthalate	ug/kg	6	3.72	4.34	--	NS
86737	Fluorene	ug/kg	2	2.02	2.18	100	N
118741	Hexachlorobenzene	ug/kg	6	3.01	3.51	1,000,000	N
87683	Hexachlorobutadiene	ug/kg	6	4.64	5.42	--	NS
77474	Hexachlorocyclopentadiene	ug/kg	6	2.38	2.77	10,000	N
67721	Hexachloroethane	ug/kg	6	2.8	3.27	--	NS
193395	Indeno(1,2,3-cd)pyrene	ug/kg	1	5.1	5.1	100	N
78591	Isophorone	ug/kg	6	2.08	2.42	--	NS
91203	Naphthalene	ug/kg	4	3.3	3.85	100	N
98953	Nitrobenzene	ug/kg	6	3.84	4.48	40,000	N
621647	N-Nitrosodi-n-propylamine	ug/kg	6	3.95	4.61	--	NS
86306	N-Nitrosodiphenylamine	ug/kg	2	5.7	6.65	20,000	N
87865	Pentachlorophenol	ug/kg	6	5.27	6.15	100	N
108952	Phenol	ug/kg	6	4.75	5.54	100	N
Dioxin/Furans							
72918219	1,2,3,7,8,9-HxCDF	pg/g	1	0.554	0.554	--	NS
1746016	2,3,7,8-TCDD	pg/g	1	0.117	0.117	--	NS
PAHs							
83329	Acenaphthene	ug/kg	4	11.3	12.2	100	N
208968	Acenaphthylene	ug/kg	6	13.9	16.2	100	N
120127	Anthracene	ug/kg	2	0.84	0.91	100	N
50328	Benzo(a)pyrene	ug/kg	1	1.2	1.2	100	N
205992	Benzo(b)fluoranthene	ug/kg	1	1.56	1.56	100	N
191242	Benzo(g,h,i)perylene	ug/kg	2	15	16.3	100	N
207089	Benzo(k)fluoranthene	ug/kg	2	1.2	1.3	100	N
53703	Dibenz(a,h)anthracene	ug/kg	4	1.68	1.82	100	N
86737	Fluorene	ug/kg	4	1.56	1.69	100	N
193395	Indeno(1,2,3-cd)pyrene	ug/kg	1	0.84	0.84	100	N
91203	Naphthalene	ug/kg	6	9.48	11.1	100	N

Table 4-21
Non-detected Chemicals for SWMU 13 (Soil)
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CAS #	Parameter Name	Units	Number of Samples	Minimum MDL	Maximum MDL	TSV	Maximum Detection Limit Exceeds TSV
Explosives							
99354	1,3,5-Trinitrobenzene	mg/kg	6	0.14	0.14	--	NS
99650	1,3-Dinitrobenzene	mg/kg	6	0.159	0.159	--	NS
118967	2,4,6-Trinitrotoluene	mg/kg	4	0.167	0.167	--	NS
121142	2,4-Dinitrotoluene	mg/kg	5	0.142	0.142	--	NS
606202	2,6-Dinitrotoluene	mg/kg	6	0.25	0.25	--	NS
35572782	2-Amino-4,6-dinitrotoluene	mg/kg	6	0.151	0.151	--	NS
88722	2-Nitrotoluene	mg/kg	6	0.266	0.266	--	NS
99081	3-Nitrotoluene	mg/kg	6	0.184	0.184	--	NS
1946510	4-Amino-2,6-dinitrotoluene	mg/kg	6	0.162	0.162	--	NS
99990	4-Nitrotoluene	mg/kg	6	0.251	0.251	--	NS
2691410	HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,	mg/kg	6	0.229	0.229	--	NS
98953	Nitrobenzene	mg/kg	6	0.102	0.102	40,000	N
121824	RDX (Hexahydro-1,3,5-trinitro-1,3,5-tria	mg/kg	6	0.131	0.131	--	NS
Nitroglycerin/PETN							
628966	Nitroglycerin	mg/kg	4	0.195	0.276	--	NS
78115	PETN	mg/kg	6	0.269	0.381	--	NS

Notes:
CAS = Chemical Abstracts Service
TAL = Target Analyte List
TCL = Target Compound List
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound
PAH = Polynuclear Aromatic Hydrocarbon
mg/kg = Milligram Per Kilogram
µg/kg = Microgram Per Kilogram
NS = No screening value
TSV = Toxicity Screening Value
MDL = Method Detection Limit

Table 4-22
Detected Chemicals Occurrence for SWMU 13 - Sediment
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

CAS #	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening
	TAL Metals (mg/kg)							
7429905	Aluminum	9,870	23,400	mg/kg	13SD3	2/2	1.83 - 5.1	23,400
7440360	Antimony	0.18	3.5	mg/kg	13SD3	2/2	0.0518 - 0.0518	3.50
7440382	Arsenic	3.3	3.4	mg/kg	13SD3	2/2	0.0232 - 0.0232	3.4
7440393	Barium	101	169	mg/kg	13SD3	2/2	0.106 - 0.106	169
7440417	Beryllium	0.83	1.3	mg/kg	13SD3	2/2	0.167 - 0.167	1.30
7440439	Cadmium	0.57	1	mg/kg	13SD3	2/2	0.182 - 0.182	1.00
7440702	Calcium	1,270	2,080	mg/kg	13SD3	2/2	16.6 - 16.6	2,080
18540299	Chromium	27	40	mg/kg	13SD3	2/2	0.912 - 0.912	40
7440484	Cobalt	9.9	13	mg/kg	13SD3	2/2	0.208 - 0.208	13
7440508	Copper	14	36	mg/kg	13SD3	2/2	0.368 - 0.368	36
7439896	Iron	34,600	37,100	mg/kg	13SD3	2/2	71.6 - 71.6	37,100
7439921	Lead	132	247	mg/kg	13SD3	2/2	0.545 - 1.09	247
7439954	Magnesium	2,130	3,870	mg/kg	13SD3	2/2	3.21 - 3.21	3,870
7439965	Manganese	544	720	mg/kg	13SD2	2/2	0.264 - 0.264	720
7439976	Mercury	0.03	0.13	mg/kg	13SD3	2/2	0.0077 - 0.0077	0.13
7440020	Nickel	12	19	mg/kg	13SD3	2/2	0.0356 - 0.0356	19
7440097	Potassium	1,020	1,950	mg/kg	13SD3	2/2	5 - 5	1,950
7782492	Selenium	0.9	1.2	mg/kg	13SD3	2/2	0.0502 - 0.0502	1.20
7440224	Silver	0.12	0.12	mg/kg	13SD2	2/2	0.0044 - 0.0044	0.12
7440235	Sodium	52	53	mg/kg	13SD2	2/2	8.92 - 8.92	53
7440280	Thallium	0.46	0.52	mg/kg	13SD3	2/2	0.027 - 0.027	0.52
7440622	Vanadium	19	44	mg/kg	13SD3	2/2	0.207 - 0.207	44
7440666	Zinc	442	541	mg/kg	13SD3	2/2	3.35 - 3.35	541
	TCL VOCs (µg/kg)							
78933	2-Butanone	31	42	µg/kg	13SD2	2/2	7.5 - 7.5	42
67641	Acetone	80	180	µg/kg	13SD2	2/2	7.5 - 7.5	180
156592	cis-1,2-Dichloroethene	11	11	µg/kg	13SD3	1/2	1.07 - 1.07	11.0
127184	Tetrachloroethene	5	5	µg/kg	13SD3	1/2	0.92 - 0.92	5.0
108883	Toluene	1	2	µg/kg	13SD3	2/2	0.696 - 0.696	1.8
79016	Trichloroethene	64	64	µg/kg	13SD3	1/2	1.02 - 1.02	64
	TCL SVOCs[1] (µg/kg)							
91576	2-Methylnaphthalene	7	12	µg/kg	13SD2	2/2	4.11 - 4.11	12
83329	Acenaphthene	5	5	µg/kg	13SD2	1/2	2.58 - 2.58	5
208968	Acenaphthylene	9	9	µg/kg	13SD3	1/2	2.25 - 2.25	9
117817	Bis(2-ethylhexyl)phthalate	28	41	µg/kg	13SD3	2/2	3.11 - 3.11	41
84662	Diethylphthalate	14	18	µg/kg	13SD3	2/2	2.85 - 2.85	18
131113	Dimethylphthalate	1400	1400	µg/kg	13SD3	1/2	4.97 - 4.97	1,400
84742	Di-n-butylphthalate	69	130	µg/kg	13SD3	2/2	5.73 - 5.73	130
86737	Fluorene	4	5	µg/kg	13SD2	2/2	2.52 - 2.52	5
91203	Naphthalene	5	5	µg/kg	13SD3	1/2	4.13 - 4.13	5.0
	PAHs[2] (µg/kg)							
120127	Anthracene	3.8	9.4	µg/kg	13SD3	2/2	1.05 - 1.05	9.4
56553	Benzo(a)anthracene	21	30	µg/kg	13SD3	2/2	1.2 - 1.2	30
50328	Benzo(a)pyrene	26	49	µg/kg	13SD3	2/2	1.5 - 1.5	49
205992	Benzo(b)fluoranthene	23	36	µg/kg	13SD3	2/2	1.95 - 1.95	36
191242	Benzo(g,h,i)perylene	40	88	µg/kg	13SD3	2/2	18.8 - 18.8	88
207089	Benzo(k)fluoranthene	12	24	µg/kg	13SD3	2/2	1.5 - 1.5	24
218019	Chrysene	19	84	µg/kg	13SD3	2/2	1.8 - 1.8	84

Table 4-22
Detected Chemicals Occurrence for SWMU 13 - Sediment
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

CAS #	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening
53703	Dibenz(a,h)anthracene	6.2	6.2	µg/kg	13SD3	1/2	2.1 - 2.1	6.2
206440	Fluoranthene	19	48	µg/kg	13SD2	2/2	2.55 - 2.55	48
193395	Indeno(1,2,3-cd)pyrene	18	45	µg/kg	13SD3	2/2	1.05 - 1.05	45
85018	Phenanthrene	5.2	16	µg/kg	13SD2	2/2	0.9 - 0.9	16
129000	Pyrene	14	45	µg/kg	13SD2	2/2	1.35 - 1.35	45
	Cyanide (mg/kg)							
57125	Cyanide	0.1	0.2	mg/kg	13SD3	2/2	0.0356 - 0.0356	0.20

Notes:
CAS = Chemical Abstracts Sevice
TAL = Target Analyte List
TCL = Target Compound List
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound
PAH = Polynuclear Aromatic Hydrocarbon
mg/kg = Milligram Per Kilogram
µg/kg = Microgram Per Kilogram
[1] = SVOCs analyzed by USEPA SW-846 8270 Method 8270C
[2] = PAHs analyzed by USEPA SW-846 Method8310

Table 4-23
Non-detected Chemicals for SWMU 13 - Sediment
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

CAS #	Parameter Name	Units	Number of Samples	Minimum MDL	Maximum MDL	TSV	Maximum Detection Limit Exceeds TSV
VOCs							
71556	1,1,1-Trichloroethane	ug/kg	2	0.639	0.639	--	N
79345	1,1,2,2-Tetrachloroethane	ug/kg	2	0.98	0.98	--	N
76131	1,1,2-Trichloro-1,2,2-trifluoroethane	ug/kg	2	1.14	1.14	--	N
79005	1,1,2-Trichloroethane	ug/kg	2	0.89	0.89	--	N
75343	1,1-Dichloroethane	ug/kg	2	1.09	1.09	--	N
75354	1,1-Dichloroethene	ug/kg	2	1.1	1.1	--	N
87616	1,2,3-Trichlorobenzene	ug/kg	2	0.816	0.816	--	N
120821	1,2,4-Trichlorobenzene	ug/kg	2	0.615	0.615	--	N
96128	1,2-Dibromo-3-chloropropane	ug/kg	2	3.12	3.12	--	N
106934	1,2-Dibromoethane	ug/kg	2	1.03	1.03	--	N
95501	1,2-Dichlorobenzene	ug/kg	2	0.726	0.726	35	N
107062	1,2-Dichloroethane	ug/kg	2	0.647	0.647	--	N
78875	1,2-Dichloropropane	ug/kg	2	0.879	0.879	--	N
541731	1,3-Dichlorobenzene	ug/kg	2	0.402	0.402	--	N
106467	1,4-Dichlorobenzene	ug/kg	2	1.07	1.07	110	N
591786	2-Hexanone	ug/kg	2	3.39	3.39	--	N
108101	4-Methyl-2-pentanone	ug/kg	2	2.19	2.19	--	N
71432	Benzene	ug/kg	2	0.791	0.791	--	N
74975	Bromochloromethane	ug/kg	2	1.14	1.14	--	N
75274	Bromodichloromethane	ug/kg	2	0.752	0.752	--	N
75252	Bromoform	ug/kg	2	0.867	0.867	--	N
74839	Bromomethane	ug/kg	2	2.25	2.25	--	N
75150	Carbon disulfide	ug/kg	2	2.18	2.18	--	N
56235	Carbon tetrachloride	ug/kg	2	0.699	0.699	--	N
108907	Chlorobenzene	ug/kg	2	0.992	0.992	--	N
75003	Chloroethane	ug/kg	2	2.03	2.03	--	N
67663	Chloroform	ug/kg	2	0.669	0.669	--	N
74873	Chloromethane	ug/kg	2	1.25	1.25	--	N
156592	cis-1,2-Dichloroethene	ug/kg	1	1.07	1.07	--	N
10061015	cis-1,3-Dichloropropene	ug/kg	2	0.737	0.737	--	N
110827	Cyclohexane	ug/kg	2	0.474	0.474	--	N
124481	Dibromochloromethane	ug/kg	2	0.776	0.776	--	N
75718	Dichlorodifluoromethane	ug/kg	2	1	1	--	N
100414	Ethylbenzene	ug/kg	2	0.635	0.635	10	N
98828	Isopropylbenzene	ug/kg	2	0.819	0.819	--	N
79209	Methyl acetate	ug/kg	2	5.21	5.21	--	N
1634044	methyl tert-Butyl ether	ug/kg	2	0.962	0.962	--	N
108872	Methylcyclohexane	ug/kg	2	1.27	1.27	--	N
75092	Methylene chloride	ug/kg	2	4.22	4.22	--	N
100425	Styrene	ug/kg	2	0.663	0.663	--	N
127184	Tetrachloroethene	ug/kg	1	0.92	0.92	57	N
156605	trans-1,2-Dichloroethene	ug/kg	2	1.05	1.05	--	N
10061026	trans-1,3-Dichloropropene	ug/kg	2	0.782	0.782	--	N
79016	Trichloroethene	ug/kg	1	1.02	1.02	--	N
75694	Trichlorofluoromethane	ug/kg	2	1.11	1.11	--	N
75014	Vinyl Chloride	ug/kg	2	0.555	0.555	--	N
1330207	Xylenes	ug/kg	2	0.632	0.632	40	N
SVOCs							
92524	1,1'-Biphenyl	ug/kg	2	3.69	3.69	--	N
95943	1,2,4,5-Tetrachlorobenzene	ug/kg	2	43.1	43.1	--	N
108601	2,2'-oxybis(1-Chloropropane)	ug/kg	2	1.98	1.98	--	N
95954	2,4,5-Trichlorophenol	ug/kg	2	5.01	5.01	--	N
88062	2,4,6-Trichlorophenol	ug/kg	2	3.93	3.93	--	N
120832	2,4-Dichlorophenol	ug/kg	2	5.28	5.28	--	N

Table 4-23
Non-detected Chemicals for SWMU 13 - Sediment
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

CAS #	Parameter Name	Units	Number of Samples	Minimum MDL	Maximum MDL	TSV	Maximum Detection Limit Exceeds TSV
105679	2,4-Dimethylphenol	ug/kg	2	11.9	11.9	29	N
51285	2,4-Dinitrophenol	ug/kg	2	4.8	4.8	--	N
121142	2,4-Dinitrotoluene	ug/kg	2	4.73	4.73	--	N
606202	2,6-Dinitrotoluene	ug/kg	2	41.6	41.6	--	N
91587	2-Chloronaphthalene	ug/kg	2	3.45	3.45	--	N
95578	2-Chlorophenol	ug/kg	2	3.02	3.02	--	N
95487	2-Methylphenol	ug/kg	2	7.26	7.26	63	N
88744	2-Nitroaniline	ug/kg	2	6.9	6.9	--	N
88755	2-Nitrophenol	ug/kg	2	2.55	2.55	--	N
91941	3,3'-Dichlorobenzidine	ug/kg	2	83.1	83.1	--	N
99092	3-Nitroaniline	ug/kg	2	27.5	27.5	--	N
534521	4,6-Dinitro-2-methylphenol	ug/kg	2	6.77	6.77	--	N
101553	4-Bromophenyl-phenylether	ug/kg	2	5.07	5.07	--	N
59507	4-Chloro-3-Methylphenol	ug/kg	2	7.82	7.82	--	N
106478	4-Chloroaniline	ug/kg	2	1.89	1.89	--	N
7005723	4-Chlorophenyl-phenylether	ug/kg	2	4.91	4.91	--	N
106445	4-Methylphenol	ug/kg	2	9.56	9.56	670	N
100016	4-Nitroaniline	ug/kg	2	10.9	10.9	--	N
100027	4-Nitrophenol	ug/kg	2	4.25	4.25	--	N
83329	Acenaphthene	ug/kg	1	2.58	2.58	16	N
208968	Acenaphthylene	ug/kg	1	2.25	2.25	44	N
98862	Acetophenone	ug/kg	2	2.85	2.85	--	N
120127	Anthracene	ug/kg	1	6.93	6.93	85.3	N
1912249	Atrazine	ug/kg	2	10.3	10.3	--	N
100527	Benzaldehyde	ug/kg	2	6.08	6.08	--	N
111911	Bis(2-chloroethoxy)methane	ug/kg	2	4.71	4.71	--	N
111444	Bis(2-chloroethyl)ether	ug/kg	2	2.6	2.6	--	N
85687	Butylbenzylphthalate	ug/kg	2	6.72	6.72	63	N
105602	Caprolactam	ug/kg	2	9.57	9.57	--	N
86748	Carbazole	ug/kg	2	9.15	9.15	--	N
132649	Dibenzofuran	ug/kg	2	4.74	4.74	540	N
131113	Dimethylphthalate	ug/kg	1	4.97	4.97	71	N
117840	Di-n-octylphthalate	ug/kg	2	4.65	4.65	6,200	N
118741	Hexachlorobenzene	ug/kg	2	3.77	3.77	22	N
87683	Hexachlorobutadiene	ug/kg	2	5.81	5.81	11	N
77474	Hexachlorocyclopentadiene	ug/kg	2	2.97	2.97	--	N
67721	Hexachloroethane	ug/kg	2	3.5	3.5	--	N
78591	Isophorone	ug/kg	2	2.6	2.6	--	N
91203	Naphthalene	ug/kg	1	4.13	4.13	160	N
98953	Nitrobenzene	ug/kg	2	4.8	4.8	--	N
621647	N-Nitrosodi-n-propylamine	ug/kg	2	4.94	4.94	--	N
86306	N-Nitrosodiphenylamine	ug/kg	2	7.13	7.13	28	N
87865	Pentachlorophenol	ug/kg	2	6.59	6.59	360	N
108952	Phenol	ug/kg	2	5.94	5.94	--	N
PAHs							
83329	Acenaphthene	ug/kg	2	14.1	14.1	16	N
208968	Acenaphthylene	ug/kg	2	17.4	17.4	44	N
53703	Dibenz(a,h)anthracene	ug/kg	1	2.1	2.1	--	N
86737	Fluorene	ug/kg	2	1.95	1.95	19	N
91203	Naphthalene	ug/kg	2	11.9	11.9	160	N
Explosives							
99354	1,3,5-Trinitrobenzene	mg/kg	2	0.14	0.14	--	N
99650	1,3-Dinitrobenzene	mg/kg	2	0.159	0.159	--	N
118967	2,4,6-Trinitrotoluene	mg/kg	2	0.167	0.167	--	N
121142	2,4-Dinitrotoluene	mg/kg	2	0.142	0.142	--	N

Table 4-23
Non-detected Chemicals for SWMU 13 - Sediment
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

CAS #	Parameter Name	Units	Number of Samples	Minimum MDL	Maximum MDL	TSV	Maximum Detection Limit Exceeds TSV
606202	2,6-Dinitrotoluene	mg/kg	2	0.25	0.25	--	N
35572782	2-Amino-4,6-dinitrotoluene	mg/kg	2	0.151	0.151	--	N
88722	2-Nitrotoluene	mg/kg	2	0.266	0.266	--	N
99081	3-Nitrotoluene	mg/kg	2	0.184	0.184	--	N
1946510	4-Amino-2,6-dinitrotoluene	mg/kg	2	0.162	0.162	--	N
99990	4-Nitrotoluene	mg/kg	2	0.251	0.251	--	N
2691410	HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,	mg/kg	2	0.229	0.229	--	N
98953	Nitrobenzene	mg/kg	2	0.102	0.102	--	N
121824	RDX (Hexahydro-1,3,5-trinitro-1,3,5-tria	mg/kg	2	0.131	0.131	--	N
Nitroglycerin/PETN							
628966	Nitroglycerin	mg/kg	2	0.239	0.245	--	N
78115	PETN	mg/kg	2	0.328	0.337	--	N

Notes:
CAS = Chemical Abstracts Service
TAL = Target Analyte List
TCL = Target Compound List
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound
PAH = Polynuclear Aromatic Hydrocarbon
mg/kg = Milligram Per Kilogram
µg/kg = Microgram Per Kilogram
NS = No screening value
TSV = Toxicity Screening Value
MDL = Method Detection Limit

Table 4-24
Detected Chemicals Occurrence for SWMU 13 - Surface Water
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

CAS #	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening
	TAL Metals (ug/L)							
7429905	Aluminum	66	74	ug/l	13SW2	2/2	18.7 - 18.7	74
7440360	Antimony	0.7	0.7	ug/l	13SW3	1/2	0.552 - 0.552	0.7
7440360	Antimony, Dissolved	0.8	0.8	ug/l	13SW3	1/2	0.552 - 0.552	0.8
7440393	Barium	21	22	ug/l	13SW2	2/2	1.82 - 1.82	22
7440393	Barium, Dissolved	18	18	ug/l	13SW2	2/2	1.82 - 1.82	18
7440702	Calcium	13,000	13,000	ug/l	13SW2	2/2	170 - 170	13,000
7440702	Calcium, Dissolved	13,000	13,000	ug/l	13SW2	2/2	170 - 170	13,000
18540299	Chromium	0.8	0.8	ug/l	13SW2	2/2	0.554 - 0.554	0.8
18540299	Chromium, Dissolved	0.6	0.6	ug/l	13SW3	1/2	0.554 - 0.554	0.6
7439896	Iron	180	190	ug/l	13SW2	2/2	2.95 - 2.95	190
7439896	Iron, Dissolved	37	38	ug/l	13SW3	2/2	2.95 - 2.95	38
7439921	Lead	0.6	0.9	ug/l	13SW3	2/2	0.281 - 0.281	0.9
7439954	Magnesium	5,400	5,700	ug/l	13SW2	2/2	57.4 - 57.4	5,700
7439954	Magnesium, Dissolved	5,500	5,600	ug/l	13SW2	2/2	57.4 - 57.4	5,600
7439965	Manganese	27	30	ug/l	13SW3	2/2	3.16 - 3.16	30
7439965	Manganese, Dissolved	7.9	10	ug/l	13SW2	2/2	3.16 - 3.16	10
7440020	Nickel	0.8	0.96	ug/l	13SW2	2/2	0.41 - 0.41	1
7440020	Nickel, Dissolved	1.0	1.1	ug/l	13SW2	2/2	0.41 - 0.41	1.1
7440097	Potassium	1,800	1,900	ug/l	13SW3	2/2	59.7 - 59.7	1,900
7440097	Potassium, Dissolved	1,600	1,600	ug/l	13SW2	2/2	59.7 - 59.7	1,600
7440235	Sodium	5,100	5,100	ug/l	13SW2	2/2	76.9 - 76.9	5,100
7440235	Sodium, Dissolved	5,100	5,100	ug/l	13SW2	2/2	76.9 - 76.9	5,100
7440280	Thallium	0.30	0.30	ug/l	13SW3	1/2	0.208 - 0.208	0.3
7440666	Zinc	5.5	5.5	ug/l	13SW2	1/2	4.55 - 4.55	5.5
	TCL SVOCs (µg/L)							
117817	Bis(2-ethylhexyl)phthalate	0.3	0.3	ug/l	13SW2	2/2	0.149 - 0.149	0.3
85687	Butylbenzylphthalate	0.1	0.1	ug/l	13SW2	2/2	0.015 - 0.015	0.1
84662	Diethylphthalate	0.1	0.1	ug/l	13SW2	1/2	0.074 - 0.074	0.1

Notes:
CAS = Chemical Abstracts Sevice
TAL = Target Analyte List
TCL = Target Compound List
SVOC = Semivolatile Organic Compound
µg/L = Microgram Per Liter

Table 4-25
Non-detected Chemicals for SWMU 13 - Surface Water
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

Parameter Name	Units	Number of Samples	Minimum MDL	Maximum MDL	BTAG Screening Value	Maximum MDL exceeds Screening Value
Inorganics						
Aluminum, Dissolved	ug/l	2	18.7	18.7	25	N
Antimony	ug/l	1	0.552	0.552	30	N
Antimony, Dissolved	ug/l	1	0.552	0.552	30	N
Arsenic	ug/l	2	0.429	0.429	874	N
Arsenic, Dissolved	ug/l	2	0.429	0.429	874	N
Beryllium	ug/l	2	0.295	0.295	5.3	N
Beryllium, Dissolved	ug/l	2	0.295	0.295	5.3	N
Cadmium	ug/l	2	0.135	0.135	0.53	N
Cadmium, Dissolved	ug/l	2	0.135	0.135	0.53	N
Chromium, Dissolved	ug/l	1	0.554	0.554	2	N
Cobalt	ug/l	2	3.91	3.91	35,000	N
Cobalt, Dissolved	ug/l	2	3.91	3.91	35,000	N
Copper	ug/l	2	5.36	5.36	6.5	N
Copper, Dissolved	ug/l	2	5.36	5.36	6.5	N
Cyanide	ug/l	2	3.4	3.4	5.2	N
Lead, Dissolved	ug/l	2	0.281	0.281	3.2	N
Mercury	ug/l	2	0.0584	0.0584	0.012	**Y**
Mercury, Dissolved	ug/l	2	0.0584	0.0584	0.012	**Y**
Selenium	ug/l	2	0.933	0.933	5	N
Selenium, Dissolved	ug/l	2	0.933	0.933	5	N
Silver	ug/l	2	0.0765	0.0765	0.0001	**Y**
Silver, Dissolved	ug/l	2	0.0765	0.0765	0.0001	**Y**
Thallium	ug/l	1	0.208	0.208	40	N
Thallium, Dissolved	ug/l	2	0.208	0.208	40	N
Vanadium	ug/l	2	2.89	2.89	10,000	N
Vanadium, Dissolved	ug/l	2	2.89	2.89	10,000	N
Zinc	ug/l	1	4.55	4.55	30	N
Zinc, Dissolved	ug/l	2	4.55	4.55	30	N
VOCs						
1,1,1-Trichloroethane	ug/l	2	0.142	0.142	--	N
1,1,2,2-Tetrachloroethane	ug/l	2	0.148	0.148	--	N
1,1,2-Trichloro-1,2,2-trifluoroethane	ug/l	2	0.179	0.179	--	N
1,1,2-Trichloroethane	ug/l	2	0.142	0.142	--	N
1,1-Dichloroethane	ug/l	2	0.057	0.057	160,000	N
1,1-Dichloroethene	ug/l	2	0.133	0.133	11,600	N
1,2,3-Trichlorobenzene	ug/l	2	0.228	0.228	--	N
1,2,4-Trichlorobenzene	ug/l	2	0.189	0.189	--	N
1,2-Dibromo-3-chloropropane	ug/l	2	0.27	0.27	--	N
1,2-Dibromoethane	ug/l	2	0.171	0.171	18,000	N
1,2-Dichlorobenzene	ug/l	2	0.164	0.164	763	N
1,2-Dichloroethane	ug/l	2	0.111	0.111	20,000	N
1,2-Dichloropropane	ug/l	2	0.255	0.255	--	N
1,3-Dichlorobenzene	ug/l	2	0.16	0.16	763	N
1,4-Dichlorobenzene	ug/l	2	0.124	0.124	763	N
2-Butanone	ug/l	2	0.417	0.417	--	N
2-Hexanone	ug/l	2	0.455	0.455	428,000	N
4-Methyl-2-pentanone	ug/l	2	0.364	0.364	--	N
Acetone	ug/l	2	1.07	1.07	9,000,000	N
Benzene	ug/l	2	0.022	0.022	5,300	N
Bromochloromethane	ug/l	2	0.076	0.076	11,000	N
Bromodichloromethane	ug/l	2	0.431	0.431	11,000	N
Bromoform	ug/l	2	0.11	0.11	--	N
Bromomethane	ug/l	2	0.267	0.267	--	N
Carbon disulfide	ug/l	2	0.059	0.059	2	N
Carbon tetrachloride	ug/l	2	0.115	0.115	35,200	N
Chlorobenzene	ug/l	2	0.157	0.157	50	N
Chloroethane	ug/l	2	0.18	0.18	--	N
Chloroform	ug/l	2	0.101	0.101	1,240	N
Chloromethane	ug/l	2	0.103	0.103	--	N
cis-1,2-Dichloroethene	ug/l	2	0.139	0.139	11,600	N
cis-1,3-Dichloropropene	ug/l	2	0.189	0.189	--	N

Table 4-25
Non-detected Chemicals for SWMU 13 - Surface Water
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

Parameter Name	Units	Number of Samples	Minimum MDL	Maximum MDL	BTAG Screening Value	Maximum MDL exceeds Screening Value
Cyclohexane	ug/l	2	0.215	0.215	--	N
Dibromochloromethane	ug/l	2	0.108	0.108	11,000	N
Dichlorodifluoromethane	ug/l	2	0.12	0.12	11,000	N
Ethylbenzene	ug/l	2	0.195	0.195	32,000	N
Isopropylbenzene	ug/l	2	0.09	0.09	--	N
Methyl acetate	ug/l	2	0.231	0.231	--	N
methyl tert-Butyl ether	ug/l	2	0.077	0.077	--	N
Methylcyclohexane	ug/l	2	0.168	0.168	--	N
Methylene chloride	ug/l	2	0.117	0.117	11,000	N
Styrene	ug/l	2	0.137	0.137	--	N
Tetrachloroethene	ug/l	2	0.193	0.193	840	N
Toluene	ug/l	2	0.214	0.214	17,000	N
trans-1,2-Dichloroethene	ug/l	2	0.143	0.143	11,600	N
trans-1,3-Dichloropropene	ug/l	2	0.117	0.117	--	N
Trichloroethene	ug/l	2	0.211	0.211	21,900	N
Trichlorofluoromethane	ug/l	2	0.051	0.051	11,000	N
Vinyl Chloride	ug/l	2	0.119	0.119	11,600	N
Xylenes	ug/l	2	0.16	0.16	6,000	N
SVOCs						
1,1'-Biphenyl	ug/l	2	0.013	0.013	--	N
1,2,4,5-Tetrachlorobenzene	ug/l	2	0.775	0.775	--	N
2,2'-oxybis(1-Chloropropane)	ug/l	2	0.014	0.014	--	N
2,4,5-Trichlorophenol	ug/l	2	0.014	0.014	63	N
2,4,6-Trichlorophenol	ug/l	2	0.015	0.015	970	N
2,4-Dichlorophenol	ug/l	2	0.018	0.018	365	N
2,4-Dimethylphenol	ug/l	2	0.198	0.198	2,120	N
2,4-Dinitrophenol	ug/l	2	1.24	1.24	--	N
2-Chloronaphthalene	ug/l	2	0.005	0.005	--	N
2-Chlorophenol	ug/l	2	0.011	0.011	970	N
2-Methylnaphthalene	ug/l	2	0.084	0.084	--	N
2-Methylphenol	ug/l	2	0.007	0.007	--	N
2-Nitroaniline	ug/l	2	0.01	0.01	--	N
2-Nitrophenol	ug/l	2	0.011	0.011	--	N
3,3'-Dichlorobenzidine	ug/l	2	0.058	0.058	--	N
3-Nitroaniline	ug/l	2	0.032	0.032	--	N
4,6-Dinitro-2-methylphenol	ug/l	2	0.054	0.054	--	N
4-Bromophenyl-phenylether	ug/l	2	0.019	0.019	--	N
4-Chloro-3-Methylphenol	ug/l	2	0.018	0.018	--	N
4-Chloroaniline	ug/l	2	0.011	0.011	--	N
4-Chlorophenyl-phenylether	ug/l	2	0.015	0.015	--	N
4-Methylphenol	ug/l	2	0.014	0.014	--	N
4-Nitroaniline	ug/l	2	0.07	0.07	--	N
4-Nitrophenol	ug/l	2	0.134	0.134	150	N
Acetophenone	ug/l	2	0.011	0.011	--	N
Atrazine	ug/l	2	0.018	0.018	--	N
Benzaldehyde	ug/l	2	0.616	0.616	--	N
Bis(2-chloroethoxy)methane	ug/l	2	0.013	0.013	--	N
Bis(2-chloroethyl)ether	ug/l	2	0.012	0.012	--	N
Caprolactam	ug/l	2	0.024	0.024	--	N
Carbazole	ug/l	2	0.015	0.015	--	N
Dibenzofuran	ug/l	2	0.014	0.014	--	N
Diethylphthalate	ug/l	1	0.074	0.074	3	N
Dimethylphthalate	ug/l	2	0.013	0.013	3	N
Di-n-butylphthalate	ug/l	2	1.6	1.6	0.3	N
Di-n-octylphthalate	ug/l	2	0.162	0.162	0.3	N
Hexachlorobenzene	ug/l	2	0.011	0.011	3.68	N
Hexachlorobutadiene	ug/l	2	0.019	0.019	9.3	N
Hexachlorocyclopentadiene	ug/l	2	0.016	0.016	5.2	N
Hexachloroethane	ug/l	2	0.023	0.023	540	N
Isophorone	ug/l	2	0.017	0.017	117,000	N
N-Nitrosodi-n-propylamine	ug/l	2	0.017	0.017	--	N
N-Nitrosodiphenylamine	ug/l	2	0.019	0.019	5,850	N

Table 4-25
Non-detected Chemicals for SWMU 13 - Surface Water
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

Parameter Name	Units	Number of Samples	Minimum MDL	Maximum MDL	BTAG Screening Value	Maximum MDL exceeds Screening Value
Pentachlorophenol	ug/l	2	0.075	0.075	13	N
Phenol	ug/l	2	0.006	0.006	79	N
PAHs						
Acenaphthene	ug/l	2	0.0279	0.0307	520	N
Acenaphthylene	ug/l	2	0.0525	0.0578	--	N
Anthracene	ug/l	2	0.0024	0.00264	0.1	N
Benzo(a)anthracene	ug/l	2	0.0026	0.00286	6.3	N
Benzo(a)pyrene	ug/l	2	0.0069	0.00759	--	N
Benzo(b)fluoranthene	ug/l	2	0.0138	0.0152	--	N
Benzo(g,h,i)perylene	ug/l	2	0.0539	0.0593	--	N
Benzo(k)fluoranthene	ug/l	2	0.0043	0.00473	--	N
Chrysene	ug/l	2	0.0034	0.00374	--	N
Dibenz(a,h)anthracene	ug/l	2	0.0416	0.0458	--	N
Fluoranthene	ug/l	2	0.0074	0.00814	--	N
Fluorene	ug/l	2	0.0096	0.0106	430	N
Indeno(1,2,3-cd)pyrene	ug/l	2	0.005	0.0055	--	N
Naphthalene	ug/l	2	0.0422	0.0464	100	N
Phenanthrene	ug/l	2	0.0032	0.00352	6.3	N
Pyrene	ug/l	2	0.0194	0.0213	--	N
Explosives						
1,3,5-Trinitrobenzene	ug/l	2	0.15	0.15	--	N
1,3-Dinitrobenzene	ug/l	2	0.121	0.121	--	N
2,4,6-Trinitrotoluene	ug/l	2	0.102	0.102	--	N
2,4-Dinitrotoluene	ug/l	2	0.114	0.114	230	N
2,6-Dinitrotoluene	ug/l	2	0.217	0.217	--	N
2-Amino-4,6-dinitrotoluene	ug/l	2	0.245	0.245	--	N
2-Nitrotoluene	ug/l	2	0.175	0.175	--	N
3-Nitrotoluene	ug/l	2	0.413	0.413	--	N
4-Amino-2,6-dinitrotoluene	ug/l	2	0.239	0.239	--	N
4-Nitrotoluene	ug/l	2	0.488	0.488	--	N
HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,	ug/l	2	0.277	0.277	--	N
Nitrobenzene	ug/l	2	0.0825	0.0825	27,000	N
RDX (Hexahydro-1,3,5-trinitro-1,3,5-tria	ug/l	2	0.109	0.109	--	N
Tetryl (Methyl-2,4,6-trinitrophenylnitra	ug/l	2	0.0931	0.0931	--	N
Nitroglycerin/PETN						
Nitroglycerin	ug/l	2	0.213	0.213	--	N
PETN	ug/l	2	0.311	0.311	--	N
Perchlorate						
Perchlorate	ug/l	2	1	1	--	N

Notes:
CAS = Chemical Abstracts Service
TAL = Target Analyte List
TCL = Target Compound List
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound
PAH = Polynuclear Aromatic Hydrocarbon
mg/kg = Milligram Per Kilogram
µg/kg = Microgram Per Kilogram
NS = No screening value
TSV = Toxicity Screening Value
MDL = Method Detection Limit

Table 4-26
Preliminary Invertebrate Risk Characterization for SWMU 13 - Soil
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

Measured Analytes	CAS #	MDC for Surface Soil	Screening Level	Screening Level Source	HQ
TAL Metals (mg/kg)					
Aluminum	7429-90-5	19,800	1	BTAG 1995	**19,800**
Antimony	7440-36-0	1.1	78.0	ECO SSL 2005	<1
Arsenic	7440-38-2	2.55	328	BTAG 1995	<1
Barium	7440-39-3	177	330	ECO SSL 2005	<1
Beryllium	7440-41-7	1.15	40.00	ECO SSL 2005	<1
Cadmium	7440-43-9	2.3	140.00	ECO SSL 2005	<1
Chromium	7440-47-3	38	0.0075	BTAG 1995	**5,067**
Cobalt	7440-48-4	13	200	BTAG 1995	<1
Copper	7440-50-8	45	50	ORNL 1997a	<1
Iron	7439-89-6	36,200	12	BTAG 1995	**3,017**
Lead	7439-92-1	8,620	1,700	ECO SSL 2005	**5**
Manganese	7439-96-5	1,315	330	BTAG 1995	**4**
Mercury	7439-97-6	0.052	0.06	BTAG 1995	<1
Nickel	7440-02-0	18	100	ORNL 1997a	<1
Selenium	7782-49-2	0.89	1.80	BTAG 1995	<1
Silver	7440-22-4	0.14	20.00	CCME 2004	<1
Thallium	7440-28-0	0.87	1.00	CCME 2004	<1
Vanadium	7440-62-2	36	58	BTAG 1995	<1
Zinc	7440-66-6	990	100	ORNL 1997a	**10**
TCL VOCs (µg/kg)					
1,2,4-Trichlorobenzene	120-82-1	9.6E-01	1.0E+02	BTAG 1995	<1
2-Butanone	78-93-3	4.5E+01	NV	--	NC
Acetone	67-64-1	3.2E+02	NV	--	NC
Benzene	71-43-2	9.1E-01	1.0E+02	BTAG 1995	<1
Methylene chloride	75-09-2	1.1E+01	3.0E+02	BTAG 1995	<1
Toluene	108-88-3	3.5E+00	1.0E+02	BTAG 1995	<1
Trichloroethene	79-01-6	9.6E+00	3.0E+02	BTAG 1995	<1
TCL SVOCs (µg/kg)					
2-Methylnaphthalene	91-57-6	2.2E+01	NV	--	NC
2,6-Dinitrotoluene	606-20-2	2.1E+02	NV	--	NC
4-Chloro-3-Methylphenol	59-50-7	1.9E+01	NV	--	NC
Acenaphthylene	208-96-8	5.0E+00	1.0E+02	BTAG 1995	<1
Bis(2-ethylhexyl)phthalate	117-81-7	4.5E+02	NV	--	NC
Butylbenzylphthalate	85-68-7	3.8E+01	NV	--	NC
Dibenzofuran	132-64-9	1.3E+01	NV	--	NC
Diethylphthalate	84-66-2	9.5E+02	NV	--	NC
Dimethylphthalate	131-11-3	1.4E+02	NV	--	NC
Di-n-butylphthalate	84-74-2	6.8E+02	NV	--	NC
Naphthalene	91-20-3	1.0E+01	1.0E+02	BTAG 1995	<1
N-Nitrosodiphenylamine	86-30-6	6.3E+02	NV	--	NC
PAHs (µg/kg)					
Acenaphthene	83-32-9	1.9E+01	1.0E+02	BTAG 1995	<1
Anthracene	120-12-7	3.7E+01	1.0E+02	BTAG 1995	<1
Benzo(a)anthracene	56-55-3	1.7E+02	1.0E+02	BTAG 1995	**2**
Benzo(a)pyrene	50-32-8	1.3E+02	1.0E+02	BTAG 1995	**1.3**
Benzo(b)fluoranthene	205-99-2	2.1E+02	1.0E+02	BTAG 1995	**2**
Benzo(g,h,i)perylene	191-24-2	7.2E+01	1.0E+02	BTAG 1995	<1
Benzo(k)fluoranthene	207-08-9	8.9E+01	1.0E+02	BTAG 1995	<1
Chrysene	218-01-9	1.9E+02	1.0E+02	BTAG 1995	**2**
Dibenz(a,h)anthracene	53-70-3	1.8E+01	1.0E+02	BTAG 1995	<1
Fluoranthene	206-44-0	3.7E+02	1.0E+02	BTAG 1995	**4**
Fluorene	86-73-7	2.0E+01	1.0E+02	BTAG 1995	<1
Indeno(1,2,3-cd)pyrene	193-39-5	7.3E+01	1.0E+02	BTAG 1995	<1
Phenanthrene	85-01-8	1.7E+02	1.0E+02	BTAG 1995	**2**
Pyrene	129-00-0	2.6E+02	1.0E+02	BTAG 1995	**3**

Table 4-26
Preliminary Invertebrate Risk Characterization for SWMU 13 - Soil
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

Measured Analytes	CAS #	MDC for Surface Soil	Screening Level	Screening Level Source	HQ
Explosives (mg/kg)					
2,4-Dinitrotoluene	121-14-2	7.1E+02	NV	--	NC
2,4,6-Trinitrotoluene	118-96-7	3.5E+02	NV	--	NC
Nitroglycerin/PETN (mg/kg)					
Nitroglycerin	55-63-0	8.5E+00	NV	--	NC
Cyanide (mg/kg)					
Cyanide	57-12-5	3.1E-01	5.0E-03	BTAG 1995	**61**
Dioxins/Furans (mg/kg)*					
Total 2,3,7,8-TCDD Equivalents					

Notes:
CAS = Chemical Abstracts Service
TAL = Target Analyte List
TCL = Target Compound List
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound
mg/kg = Milligram Per Kilogram
µg/kg = Microgram Per Kilogram
MDC = Maximum Detected Concentration
TRV = Toxicity Reference Value
* = See Table 4-20 for dioxin/furans

NV = No Value
HQ = Hazard Quotient
NC = Not Calculated no TRV available
BTAG = Biological Technical Assistance Group Screening Level, Draft 1995

Screening Level Source:
Region III BTAG (USEPA 1995)
Oak Ridge National Laboratory (Efroymson et al. 1997a)
USEPA Ecological SSL (ECO-SSL 2005)
Canadian Environmental Quality Guidelines (CCME 2004)

Table 4-27
Inorganic COPEC/Background Comparison for SWMU 13
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

Measured Analytes	CAS-Number	MDC for Surface Soil	Background Point Estimate [A]	Maximum Concentration Exceeds Background Point Estimate
TAL METALS (mg/kg)				
ALUMINUM	7429-90-5	19,800	40,041	N
CHROMIUM	7440-47-3	38	65	N
IRON	7439-89-6	36,200	50,962	N
LEAD	7439-92-1	8,620	27	**Y**
MANGANESE	7439-96-5	1,315	2,543	N
ZINC	7440-66-6	990	202	**Y**

Notes:
CAS = Chemical Abstracts Service
mg/kg = Milligram Per Kilogram
MDC = Maximum Detected Concentration
[A] = Facility-Wide Background Point Estimate as
Reported in the Facility-Wide Background Study Report (IT 2001a)

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Table 4-28
Preliminary Wildlife Risk Characterization - Soil
Screening Level Ecological Risk Assessment
SSP Report - SWMU 13
Radford Army Ammunition Plant, Radford, Virginia

Parameter	Maximum Soil Concentration (mg/kg)	Wildlife TRV-Based Soil Concentrations																			
		American Robin				Red-tailed Hawk				Meadow Vole				Red Fox				Short-tailed Shrew			
		NOAEL	HQ	LOAEL	HQ	NOAEL	HQ	LOAEL	HQ	NOAEL	HQ	LOAEL	HQ	NOAEL	HQ	LOAEL	HQ	NOAEL	HQ	LOAEL	HQ
Metals																					
ARSENIC	3	1.39E+01	<1	3.46E+01	<1	3.89E+02	<1	9.71E+02	<1	8.99E+00	<1	8.99E+01	<1	1.34E+00	2.2	1.34E+01	<1	3.02E-01	9.9	3.02E+00	<1
CADMIUM	2.2	6.75E-01	3.3	9.31E+00	<1	3.91E+02	<1	5.40E+03	<1	1.50E+01	<1	1.50E+02	<1	1.48E+01	<1	1.48E+02	<1	1.16E+00	1.9	1.16E+01	<1
CHROMIUM	38	5.27E+00	7.2	2.64E+01	1.4	2.70E+01	1.4	1.35E+02	<1	8.65E+05	<1	8.65E+06	<1	2.38E+04	<1	2.38E+05	<1	1.78E+04	<1	1.78E+05	<1
COPPER	45	1.38E+02	<1	1.82E+02	<1	7.11E+02	<1	9.33E+02	<1	8.34E+02	<1	1.10E+03	<1	7.43E+01	<1	9.78E+01	<1	9.57E+01	<1	1.26E+02	<1
LEAD	8,620	5.18E+00	1662.9	5.18E+01	166.3	5.69E+02	15.1	5.69E+03	1.5	1.05E+03	8.2	1.05E+04	<1	4.97E+02	17.3	4.97E+03	1.7	5.45E+01	158.3	5.45E+02	15.8
MERCURY	0.05	6.08E-01	<1	1.22E+00	<1	2.62E-01	<1	5.23E-01	<1	4.27E-01	<1	1.74E+00	<1	3.93E-03	12.7	1.60E-02	3.1	8.31E-02	<1	3.39E-01	<1
NICKEL	19	3.86E+02	<1	5.33E+02	<1	1.95E+03	<1	2.70E+03	<1	5.54E+03	<1	1.11E+04	<1	3.23E+02	<1	6.46E+02	<1	2.86E+02	<1	5.71E+02	<1
SELENIUM	0.93	3.13E-01	3.0	6.27E-01	1.5	4.03E+00	<1	8.06E+00	<1	2.73E+00	<1	4.50E+00	<1	6.09E-01	1.5	1.00E+00	<1	5.27E-01	1.8	8.70E-01	1.1
SILVER	0.14	2.31E+01	<1	1.73E+02	<1	8.34E+02	<1	6.26E+03	<1	1.72E+03	<1	1.72E+04	<1	2.89E+02	<1	2.89E+03	<1	5.85E+01	<1	5.85E+02	<1
ZINC	1,010	1.40E+01	72.2	1.26E+02	8.0	2.19E+01	46.1	1.98E+02	5.1	3.38E+03	<1	6.75E+03	<1	8.28E+01	12.2	1.66E+02	6.1	4.22E+02	2.4	8.44E+02	1.2
SVOCs/PAHs																					
ACENAPHTHYLENE	0.007	NC		NC		NC		NC		1.38E+04	<1	6.90E+04	<1	9.71E+03	<1	4.85E+04	<1	9.32E+02	<1	4.66E+03	<1
ACENAPHTHENE	0.017	5.84E+00	<1	2.92E+01	<1	3.05E+03	<1	1.52E+04	<1	1.16E+03	<1	5.78E+03	<1	8.83E+02	<1	4.41E+03	<1	7.82E+01	<1	3.91E+02	<1
ANTHRACENE	0.038	NC		NC		NC		NC		5.23E+04	<1	5.23E+05	<1	2.14E+04	<1	2.14E+05	<1	2.20E+03	<1	2.20E+04	<1
BENZO(A)ANTHRACENE	0.14	NC		NC		NC		NC		4.78E+01	<1	4.78E+02	<1	2.55E+00	<1	2.55E+01	<1	1.43E+00	<1	1.43E+01	<1
BENZO(A)PYRENE	0.19	3.56E+00	<1	1.78E+01	<1	9.73E+00	<1	4.87E+01	<1	1.66E+02	<1	1.66E+03	<1	3.48E+00	<1	3.48E+01	<1	4.23E+00	<1	4.23E+01	<1
BENZO(B)FLUORANTHENE	0.14	NC		NC		NC		NC		1.68E+02	<1	1.68E+03	<1	2.87E+00	<1	2.87E+01	<1	5.12E+00	<1	5.12E+01	<1
BENZO(G,H,I)PERYLENE	0.54	NC		NC		NC		NC		8.86E+01	<1	4.43E+02	<1	1.87E-01	2.9	9.34E-01	<1	2.84E+00	<1	1.42E+01	<1
BENZO(K)FLUORANTHENE	0.08	NC		NC		NC		NC		1.85E+03	<1	1.85E+04	<1	3.16E+01	<1	3.16E+02	<1	5.65E+01	<1	5.65E+02	<1
CHRYSENE	0.15	NC		NC		NC		NC		2.37E+03	<1	2.37E+04	<1	1.24E+02	<1	1.24E+03	<1	5.65E+01	<1	5.65E+02	<1
DIBENZO(A,H)ANTHRACENE	0.0052	NC		NC		NC		NC		3.55E+02	<1	3.55E+03	<1	1.94E+00	<1	1.94E+01	<1	7.18E+00	<1	7.18E+01	<1
FLUORANTHENE	0.47	NC		NC		NC		NC		4.11E+03	<1	2.05E+04	<1	7.02E+02	<1	3.51E+03	<1	1.24E+02	<1	6.22E+02	<1
FLUORENE	0.017	6.55E+00	<1	3.28E+01	<1	1.56E+03	<1	7.81E+03	<1	4.15E+01	<1	2.07E+02	<1	2.48E+01	<1	1.24E+02	<1	2.27E+00	<1	1.13E+01	<1
INDENO(1,2,3-CD)PYRENE	0.13	NC		NC		NC		NC		1.92E+03	<1	1.92E+04	<1	1.15E+01	<1	1.15E+02	<1	4.26E+01	<1	4.26E+02	<1
PHENANTHRENE	0.21	8.17E+00	<1	4.08E+01	<1	7.63E+02	<1	3.81E+03	<1	7.32E+02	<1	3.66E+03	<1	2.98E+02	<1	1.49E+03	<1	3.22E+01	<1	1.61E+02	<1
PYRENE	0.32	NC		NC		NC		NC		1.07E+03	<1	5.35E+03	<1	1.85E+02	<1	9.25E+02	<1	3.17E+01	<1	1.58E+02	<1

Notes:
NC = Not Calculated no TRV available
TRV = Toxicity Reference Value
HQ = Hazard Quotient
LOAEL = Lowest observable adverse effects level
NOAEL = No observable adverse effects level
mg/kg = Milligram Per Kilogram
µg/kg = Microgram Per Kilogram
PCB = Polychlorinated Biphenyls
SVOC = Semi-Volatile Organic Compound
PAH = Poly-Aromatic Hydrocarbon

= Indicate HQs greater than 1.0

Refer to Appendix I for detailed description of model parameters and results

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Table 4-29
$TEQ_{2,3,7,8\text{-}TCDD}$ Preliminary Risk Characterization for SWMU 13 - Soil
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

SWMU 13					
Receptor	**$TEQ_{2,3,7,8\text{-}TCDD}$ (pg/kg bw-day)**	**NOAEL (pg/kg bw-day)**	**HQ**	**LOAEL (pg/kg bw-day)**	**HQ**
American robin	24.82	14	1.8	140	<1
Red-tailed hawk	2.25	14	<1	140	<1
Meadow vole	0.01	22.72	<1	227.17	<1
Red fox	1.28	7.14	<1	71.44	<1
Short-tailed shrew	8.62	15.19	<1	151.92	<1

Notes:
$TEQ_{2,3,7,8\ TCDD}$ = Toxicity Equivalents of 2,3,7,8 TCDD
pg/kg = Picogram per Kilogram-Body Weight-Day
HQ = Hazard Quotient
LOAEL = Low observable adverse effects level
NOAEL = No observable adverse effects level

(shaded) = HQs greater than 1.0

Table 4-30
Preliminary Invertebrate Risk Characterization for SWMU 13 - Sediment
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

Chemicals	CAS-Number	Maximum Concentration	Sediment Screening Values[1]	HQ
TAL Metals (mg/kg)				
Aluminum	7429905	23,400	NV	NC
Antimony	7440360	3.5	2	**2**
Arsenic	7440382	3.4	10	<1
Barium	7440393	169	NV	NC
Beryllium	7440417	1.3	NV	NC
Cadmium	7440439	1	1	**1.0**
Calcium	7440702	2,080	NV	NC
Chromium	7440484	40	50	<1
Cobalt	7440484	13	50	<1
Copper	7440508	36	32	**1.1**
Iron	7439896	37,100	20,000	**2**
Lead	7439921	247	36	**7**
Magnesium	7439954	3,870	NV	NC
Manganese	7439965	720	460	**2**
Mercury	7439976	0.13	0.18	<1
Nickel	7440020	19	23	<1
Potassium	7440097	1,950	NV	NC
Selenium	7782492	1.2	2	<1
Silver	7440224	0.12	1	<1
Sodium	7440235	53	NV	NC
Thallium	7440280	0.52	NV	NC
Vanadium	7440622	44	NV	NC
Zinc	7440666	541	121	**4**
TCL VOCs (µg/kg)				
2-Butanone	78933	42	NV	NC
Acetone	67641	180	NV	NC
cis-1,2-Dichloroethene	156592	11	NV	NC
Tetrachloroethene	127184	5	468	<1
Toluene	108883	2	NV	NC
Trichloroethene	79016	64	96.9	<1
TCL SVOCs (µg/kg)				
2-Methylnaphthalene	91576	12	20	<1
Acenaphthene	83329	5	7	<1
Acenaphthylene	208968	9	6	**2**
Bis(2-ethylhexyl)phthalate	117817	41	180	<1
Diethylphthalate	84662	18	603	<1
Dimethylphthalate	131113	1,400	NV	NC
Di-n-butylphthalate	84742	130	6,470	<1
Fluorene	86737	5	77	<1
Naphthalene	91203	5	176	<1

Table 4-30
Preliminary Invertebrate Risk Characterization for SWMU 13 - Sediment
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

Chemicals	CAS-Number	Maximum Concentration	Sediment Screening Values[1]	HQ
PAHs (µg/kg)				
Anthracene	120127	9.4	57	<1
Benzo(a)anthracene	56553	30	108	<1
Benzo(a)pyrene	50328	49	150	<1
Benzo(b)fluoranthene	205992	36	NV	NC
Benzo(g,h,i)perylene	191242	88	170	<1
Benzo(k)fluoranthene	207089	24	240	<1
Chrysene	218019	84	166	<1
Dibenz(a,h)anthracene	53703	6.2	33	<1
Fluoranthene	206440	48	423	<1
Indeno(1,2,3-cd)pyrene	193395	45	17	**3**
Phenanthrene	85018	16	204	<1
Pyrene	129000	45	195	<1
Cyanide (mg/kg)				
Cyanide	57125	0.2	0.1	**2**

Notes:
CAS = Chemical Abstracts Service
TAL = Target Analyte List
TCL = Target Compound List
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound
mg/kg = Milligram Per Kilogram
µg/kg = Microgram Per Kilogram
MDC = Maximum Detected Concentration
NV = No Value
HQ = Hazard Quotient
NC = Not Calculated No Screening Value Available
[1] Sediment Screening Values taken from Region III Biological Technical Assistance Group Sediment Screening Levels, 2004

Table 4-31
Preliminary Invertebrate Risk Characterization for SWMU 13 - Surface Water
SSP Report
Radford Army Ammunition Plant, Radford, Virginia

Chemicals	CAS #	Maximum Detected Concentration	Freshwater Screening Values[1]	HQ
TAL Metals (ug/L)				
Aluminum	7429905	74	87	<1
Antimony	7440360	0.7	30	<1
Antimony, Dissolved	7440360	0.8	30	<1
Barium	7440393	22	4	**6**
Barium, Dissolved	7440393	18	4	**5**
Chromium	18540299	0.8	11	<1
Chromium, Dissolved	18540299	0.6	11	<1
Iron	7439896	190	300	<1
Iron, Dissolved	7439896	38	300	<1
Lead	7439921	0.9	2.5	<1
Manganese	7439965	30	120	<1
Manganese, Dissolved	7439965	10	120	<1
Nickel	7440020	1	52	<1
Nickel, Dissolved	7440020	1.1	52	<1
Thallium	7,440,280	0.3	0.8	<1
Zinc	7,440,666	5.5	120	<1
TCL SVOCs (µg/L)				
Bis(2-ethylhexyl)phthalate	117817	0.3	16	<1
Butylbenzylphthalate	85687	0.1	19	<1
Diethylphthalate	84662	0.1	210	<1

Notes:
CAS = Chemical Abstracts Sevice
TAL = Target Analyte List
TCL = Target Compound List
SVOC = Semivolatile Organic Compound
µg/L = Microgram Per Liter
[1] Freshwater Screening Values taken from Region III Biological Technical Assistance Group Freshwater Screening Levels, 2004

Table 4-32
Preliminary Wildlife Risk Characterization - Sediment
Screening Level Ecological Risk Assessment
SSP Report - SWMU 13
Radford Army Ammunition Plant, Radford, Virginia

Parameter	Maximum Sediment Concentration (mg/kg)	Wildlife TRV-Based Soil Concentrations											
		Mallard				Kingfisher				Raccoon			
		NOAEL	HQ	LOAEL	HQ	NOAEL	HQ	LOAEL	HQ	NOAEL	HQ	LOAEL	HQ
Metals													
ARSENIC	3.4	8.56E+02	<1	2.14E+03	<1	6.68E+01	<1	1.67E+02	<1	2.73E+00	1.2	2.73E+01	<1
CADMIUM	1	5.94E+01	<1	8.19E+02	<1	7.84E+01	<1	1.08E+03	<1	2.33E+01	<1	2.33E+02	<1
CHROMIUM	40	1.89E+02	<1	9.46E+02	<1	2.22E+02	<1	1.11E+03	<1	1.13E+05	<1	1.13E+06	<1
COPPER	36	7.40E+02	<1	9.72E+02	<1	1.88E+03	<1	2.47E+03	<1	1.88E+02	<1	2.48E+02	<1
LEAD	247	3.06E+02	<1	3.06E+03	<1	9.52E+00	26.0	9.52E+01	2.6	3.52E+02	<1	3.52E+03	<1
MERCURY	0.13	1.07E+01	<1	2.14E+01	<1	8.33E-01	<1	1.67E+00	<1	3.25E-01	<1	1.33E+00	<1
NICKEL	19	2.41E+03	<1	3.33E+03	<1	9.68E+03	<1	1.34E+04	<1	7.94E+02	<1	1.59E+03	<1
SELENIUM	1.2	4.48E+00	<1	8.95E+00	<1	3.78E-01	3.2	7.56E-01	1.6	1.89E+00	<1	3.12E+00	<1
SILVER	0.12	5.15E+02	<1	3.86E+03	<1	4.21E+01	<1	3.15E+02	<1	4.41E+02	<1	4.41E+03	<1
ZINC	541	1.62E+02	3.3	1.47E+03	<1	1.34E+02	4.0	1.21E+03	<1	1.51E+03	<1	3.02E+03	<1
SVOCs/PAHs													
ACENAPHTHYLENE	0.009	NC		NC		NC		NC		4.06E+03	<1	2.03E+04	<1
ACENAPHTHENE	0.005	1.80E+02	<1	8.98E+02	<1	1.10E+01	<1	5.48E+01	<1	3.85E+02	<1	1.92E+03	<1
ANTHRACENE	0.0094	NC		NC		NC		NC		1.11E+04	<1	1.11E+05	<1
BENZO(A)ANTHRACENE	0.03	NC		NC		NC		NC		6.74E+00	<1	6.74E+01	<1
BENZO(A)PYRENE	0.049	8.89E+01	<1	4.45E+02	<1	5.43E+00	<1	2.71E+01	<1	2.20E+01	<1	2.20E+02	<1
BENZO(B)FLUORANTHENE	0.036	NC		NC		NC		NC		2.20E+01	<1	2.20E+02	<1
BENZO(G,H,I)PERYLENE	0.088	NC		NC		NC		NC		1.10E+01	<1	5.50E+01	<1
BENZO(K)FLUORANTHENE	0.024	NC		NC		NC		NC		2.42E+02	<1	2.42E+03	<1
CHRYSENE	0.084	NC		NC		NC		NC		3.33E+02	<1	3.33E+03	<1
DIBENZO(A,H)ANTHRACENE	0.0062	NC		NC		NC		NC		4.49E+01	<1	4.49E+02	<1
FLUORANTHENE	0.048	NC		NC		NC		NC		6.74E+02	<1	3.37E+03	<1
FLUORENE	0.005	1.80E+02	<1	8.98E+02	<1	1.10E+01	<1	5.48E+01	<1	1.10E+01	<1	5.50E+01	<1
INDENO(1,2,3-CD)PYRENE	0.045	NC		NC		NC		NC		2.42E+02	<1	2.42E+03	<1
PHENANTHRENE	0.016	2.01E+02	<1	1.00E+03	<1	1.23E+01	<1	6.14E+01	<1	1.54E+02	<1	7.70E+02	<1
PYRENE	0.045	NC		NC		NC		NC		NC		NC	

Notes:
NC = Not Calculated no TRV available
TRV = Toxicity Reference Value
HQ = Hazard Quotient
LOAEL = Lowest observable adverse effects level
NOAEL = No observable adverse effects level
mg/kg = Milligram Per Kilogram
µg/kg = Microgram Per Kilogram
PCB = Polychlorinated Biphenyls
SVOC = Semi-Volatile Organic Compound
PAH = Poly-Aromatic Hydrocarbon

= Indicate HQs greater than 1.0

Refer to Appendix I for detailed description of model parameters and results

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APPENDIX D.1.2

SWMU 13 SSP SCREENING TABLES EXCLUDING OBG OPERATIONAL AREA

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Table D.1.2-1
HHRS COPC Selection (Surface Soil) for SWMU 13
SSP Report
Radford Army Ammunition Plant, Radford, VA

CAS #	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	C/N	Adjusted RBC Residential	Adjusted RBC Industrial	COPC Flag (Y/N)	Rationale for Selection or Deletion
	TAL Metals (mg/kg)												
7429905	Aluminum	10,900	19,800	mg/kg	13SB11A	5/5	1.83 - 1.83	19,800	--	7,821	102,200.0	Y	**ARES**
7440360	Antimony	0.07	0.3	mg/kg	13SB11A	4/5	0.0518 - 0.0518	0.3	N	3.13	40.9	N	BSL
7440382	Arsenic	2.2	2.6	mg/kg	13SB9A	5/5	0.0232 - 0.0232	3	C	0.43	1.91	Y	***ARES/IND***
7440393	Barium	111	177	mg/kg	13SB9A	5/5	0.106 - 0.106	177	N	1,564	20,440	N	BSL
7440417	Beryllium	0.66	1.15	mg/kg	13SB9A	5/5	0.0333 - 0.167	1.15	N	16	204	N	BSL
7440439	Cadmium	0.91	2.3	mg/kg	13SB9A	5/5	0.182 - 0.182	2.3	N	3.91	51	N	BSL
7440702	Calcium	1,980	4,570	mg/kg	13SB10A	5/5	16.6 - 16.6	4,570	--	Nutrient	Nutrient	N	Nutrient
7440473	Chromium[1]	27	38	mg/kg	13SB11A	5/5	0.912 - 0.912	38	N	23.5	307	Y	**ARES**
7440484	Cobalt	9.0	13	mg/kg	13SB11A	5/5	0.208 - 0.208	13	--	--	--	Y	NSV
7440508	Copper	13	26	mg/kg	13SB11A	5/5	0.368 - 0.368	26	N	313	4,088	N	BSL
7439896	Iron	25,700	36,200	mg/kg	13SB9A	5/5	42.4 - 42.4	36,200	N	5,475	71,540	Y	**ARES**
7439921	Lead[2]	111	8,620	mg/kg	13SB8A	5/5	0.545 - 21.8	8,620	--	400	750	Y	***ARES/IND***
7439954	Magnesium	3,240	4,650	mg/kg	13SB11A	5/5	3.21 - 3.21	4,650	--	Nutrient	Nutrient	N	Nutrient
7439965	Manganese	853	1,315	mg/kg	13SB9A	5/5	0.264 - 1.32	1,315	N	156	2,044	Y	**ARES**
7439976	Mercury[3]	0.03	0.05	mg/kg	13SB11A	5/5	0.0077 - 0.0077	0.05	--	0.8	10	N	BSL
7440020	Nickel	14.0	18.00	mg/kg	13SB9A	5/5	0.0356 - 0.0356	18	N	156.43	2,044	N	BSL
7440097	Potassium	1,480	2,680	mg/kg	13SB11A	5/5	5 - 5	2,680	--	Nutrient	Nutrient	N	Nutrient
7782492	Selenium	0.57	0.89	mg/kg	13SB9A	5/5	0.0502 - 0.0502	0.89	N	39	511	N	BSL
7440224	Silver	0.08	0.14	mg/kg	13SB8A	5/5	0.0044 - 0.0044	0.14	N	39	511	N	BSL
7440235	Sodium	36	58	mg/kg	13SB7A	5/5	18.1 - 18.1	58	--	Nutrient	Nutrient	N	Nutrient
7440280	Thallium	0.32	0.87	mg/kg	13SB9A	5/5	0.027 - 0.027	0.87	N	0.55	7.15	Y	**ARES**
7440622	Vanadium	22	36	mg/kg	13SB9A	5/5	0.207 - 0.207	36	N	7.82	102	Y	**ARES**
7440666	Zinc	287	990	mg/kg	13SB9A	5/5	2.59 - 12.9	990	N	2,346	30,660	N	BSL
	TCL VOCs (µg/kg)												
120821	1,2,4-Trichlorobenzene	9.6E-01	9.6E-01	µg/kg	13SB10A	1/5	0.492 - 0.574	9.6E-01	N	7.8E+04	1.0E+06	N	BSL
78933	2-Butanone	3.0E+01	4.5E+01	µg/kg	13SB11A	5/5	6 - 7	4.5E+01	N	4.7E+06	6.1E+07	N	BSL
67641	Acetone	1.2E+02	3.2E+02	µg/kg	13SB10A	5/5	6 - 7	3.2E+02	N	7.0E+06	9.2E+07	N	BSL
71432	Benzene	9.1E-01	9.1E-01	µg/kg	13SB11A	1/5	0.632 - 0.738	9.1E-01	C	1.2E+04	5.2E+04	N	BSL
108883	Toluene	6.6E-01	3.5E+00	µg/kg	13SB10A	4/5	0.557 - 0.65	3.5E+00	N	6.3E+05	8.2E+06	N	BSL
79016	Trichloroethene	9.6E+00	9.6E+00	µg/kg	13SB11A	1/5	0.812 - 0.948	9.6E+00	C	1.6E+03	7.2E+03	N	BSL
	VOC TICs (µg/kg)												
66251	Hexanal	1.3E+01	3.5E+02	µg/kg	13SB10A	2/5	0 - 0	3.5E+02	--	--	--	Y	NSV
	TCL SVOCs (µg/kg)												
91576	2-Methylnaphthalene	4.0E+00	2.2E+01	µg/kg	13SB8A	3/5	3.29 - 3.84	2.2E+01	N	3.1E+04	4.1E+05	N	BSL
121142	2,4-Dinitrotoluene	3.5E+01	1.2E+02	µg/kg	13SB9A	2/5	3.78 - 4.41	1.2E+02	N	1.6E+04	2.0E+05	N	BSL
--	Dinitrotoluene Mix	3.5E+01	3.5E+01	µg/kg	13SB11A	1/5	0 - 0	3.5E+01	C	9.4E+02	4.2E+03	N	BSL
59507	4-Chloro-3-Methylphenol	9.0E+00	1.9E+01	µg/kg	13SB7A	4/5	6.25 - 7.29	1.9E+01	--	--	--	Y	NSV
83329	Acenaphthene	8.0E+00	1.9E+01	µg/kg	13SB8A	4/5	2.06 - 2.41	1.9E+01	N	4.7E+05	6.1E+06	N	BSL
208968	Acenaphthylene[4]	2.0E+00	5.0E+00	µg/kg	13SB9A	4/5	1.8 - 2.1	5.0E+00	N	2.3E+05	3.1E+06	N	BSL
120127	Anthracene	1.5E+01	3.7E+01	µg/kg	13SB8A	4/5	5.54 - 6.47	3.7E+01	N	2.3E+06	3.1E+07	N	BSL
56553	Benzo(a)anthracene	5.1E+01	1.7E+02	µg/kg	13SB9A	4/5	16 - 186	1.7E+02	C	2.2E+02	3.9E+03	N	BSL
50328	Benzo(a)pyrene	1.8E+01	1.3E+02	µg/kg	13SB9A	5/5	6.85 - 7.99	1.3E+02	C	2.2E+01	3.9E+02	Y	**ARES**
205992	Benzo(b)fluoranthene	2.5E+01	2.1E+02	µg/kg	13SB9A	5/5	11.7 - 13.7	2.1E+02	C	2.2E+02	3.9E+03	N	BSL
191242	Benzo(g,h,i)perylene[4]	1.1E+01	7.2E+01	µg/kg	13SB8A	5/5	10.5 - 12.2	7.2E+01	N	2.3E+05	3.1E+06	N	BSL
207089	Benzo(k)fluoranthene	2.8E+01	8.9E+01	µg/kg	13SB9A	4/5	16.1 - 18.8	8.9E+01	C	2.2E+03	3.9E+04	N	BSL
117817	Bis(2-ethylhexyl)phthalate	1.9E+01	4.5E+02	µg/kg	13SB10A	5/5	2.48 - 2.9	4.5E+02	C	4.6E+04	2.0E+05	N	BSL
85687	Butylbenzylphthalate	6.0E+00	3.8E+01	µg/kg	13SB10A	3/5	5.38 - 6.27	3.8E+01	N	1.6E+06	2.0E+07	N	BSL
86748	Carbazole	2.1E+01	2.1E+01	µg/kg	13SB9A	1/5	7.32 - 8.54	2.1E+01	C	3.2E+04	1.4E+05	N	BSL
218019	Chrysene	2.4E+01	1.9E+02	µg/kg	13SB9A	5/5	12.2 - 14.3	1.9E+02	C	2.2E+04	3.9E+05	N	BSL
53703	Dibenz(a,h)anthracene	1.6E+01	1.8E+01	µg/kg	13SB8A	2/5	7.08 - 8.26	1.8E+01	C	2.2E+01	3.9E+02	N	BSL
132649	Dibenzofuran	6.0E+00	1.3E+01	µg/kg	13SB8A	2/5	3.79 - 4.42	1.3E+01	--	7.8E+03	1.0E+05	N	BSL
84662	Diethylphthalate	9.0E+00	1.4E+02	µg/kg	13SB9A	5/5	2.28 - 2.66	1.4E+02	N	6.3E+06	8.2E+07	N	BSL
131113	Dimethylphthalate	1.0E+01	1.4E+02	µg/kg	13SB10A	2/5	3.97 - 4.63	1.4E+02	--	--	--	Y	NSV
84742	Di-n-butylphthalate	6.2E+01	5.1E+02	µg/kg	13SB9A	5/5	4.58 - 5.35	5.1E+02	N	7.8E+05	1.0E+07	N	BSL
206440	Fluoranthene	9.0E+00	3.7E+02	µg/kg	13SB8A	5/5	2.82 - 3.29	3.7E+02	N	3.1E+05	4.1E+06	N	BSL
91203	Naphthalene	4.0E+00	1.0E+01	µg/kg	13SB8A	2/5	3.3 - 3.85	1.0E+01	N	1.6E+05	2.0E+06	N	BSL
85018	Phenanthrene[4]	4.0E+00	1.7E+02	µg/kg	13SB10A	5/5	2.76 - 3.22	1.7E+02	N	2.3E+05	3.1E+06	N	BSL
129000	Pyrene	6.0E+00	2.6E+02	µg/kg	13SB8A	5/5	1.78 - 2.07	2.6E+02	N	2.3E+05	3.1E+06	N	BSL

Table D.1.2-1
HHRS COPC Selection (Surface Soil) for SWMU 13
SSP Report
Radford Army Ammunition Plant, Radford, VA

CAS #	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	C/N	Adjusted RBC Residential	Adjusted RBC Industrial	COPC Flag (Y/N)	Rationale for Selection or Deletion
	SVOC TICs (µg/kg)												
15594908	1-Heneicosanol	2.2E+02	2.2E+02	µg/kg	13SB11A	1/5	0 - 0	2.2E+02	--	--	--	Y	NSV
101371	2,4,6-Triallyloxy-1,3,5-triazine	5.0E+01	6.0E+01	µg/kg	13SB9A	2/5	0 - 0	6.0E+01	--	--	--	Y	NSV
1000194624	4,4,6a,6b,8a,11,11,14b-Octamethyl-1,4,4a	7.1E+02	7.1E+02	µg/kg	13SB10A	1/5	0 - 0	7.1E+02	--	--	--	Y	NSV
0118967	Benzene, 2-methyl-1,3,5-trinitro-	2.8E+02	2.8E+02	µg/kg	13SB11A	1/5	0 - 0	2.8E+02	--	--	--	Y	NSV
123955	Butyl Ester Octadecanioc	1.3E+02	1.3E+02	µg/kg	13SB11A	1/5	0 - 0	1.3E+02	--	--	--	Y	NSV
57885	Cholesterol	1.2E+02	4.7E+02	µg/kg	13SB10A	2/5	0 - 0	4.7E+02	--	--	--	Y	NSV
112845	Erucylamide	1.4E+02	5.7E+02	µg/kg	13SB9A	5/5	0 - 0	5.7E+02	--	--	--	Y	NSV
2136712	Ethanol, 2-(hexadecyloxy)-	3.9E+02	3.9E+02	µg/kg	13SB11A	1/5	0 - 0	3.9E+02	--	--	--	Y	NSV
83476	.Gamma.-sitosterol	1.6E+02	2.4E+03	µg/kg	13SB10A	4/5	0 - 0	2.4E+03	--	--	--	Y	NSV
1058613	Stigmast-4-en-3-one	1.4E+02	2.4E+02	µg/kg	13SB8A	2/5	0 - 0	2.4E+02	--	--	--	Y	NSV
1000214207	Stigmasterol, 22,23-dihydro-	1.6E+02	1.6E+02	µg/kg	13SB9A	1/5	0 - 0	1.6E+02	--	--	--	Y	NSV
127220	Taraxerol	2.9E+02	2.9E+02	µg/kg	13SB8A	1/5	0 - 0	2.9E+02	--	--	--	Y	NSV
611927	Urea, N,N'-dimethyl-N,N'-diphenyl-	4.8E+01	4.8E+01	µg/kg	13SB9A	1/5	0 - 0	4.8E+01	--	--	--	Y	NSV
10191410	Vitamin E	1.6E+02	6.0E+02	µg/kg	13SB10A	2/5	0 - 0	6.0E+02	--	--	--	Y	NSV
	PAHs (µg/kg)												
83329	Acenaphthene	1.4E+01	1.7E+01	µg/kg	13SB9A	2/5	11.3 - 13.2	1.7E+01	N	4.7E+05	6.1E+06	N	BSL
120127	Anthracene	6.6E+00	3.8E+01	µg/kg	13SB10A	4/5	0.84 - 0.98	3.8E+01	N	2.3E+06	3.1E+07	N	BSL
56553	Benzo(a)anthracene	2.1E+00	1.4E+02	µg/kg	13SB10A	5/5	0.96 - 1.12	1.4E+02	C	2.2E+02	3.9E+03	N	BSL
50328	Benzo(a)pyrene	4.5E+01	1.9E+02	µg/kg	13SB10A	4/5	1.2 - 1.4	1.9E+02	C	2.2E+01	3.9E+02	Y	**ARES**
205992	Benzo(b)fluoranthene	3.2E+01	1.4E+02	µg/kg	13SB10A	4/5	1.56 - 1.82	1.4E+02	C	2.2E+02	3.9E+03	N	BSL
191242	Benzo(g,h,i)perylene[4]	8.2E+01	3.9E+02	µg/kg	13SB9A	4/5	15 - 17.5	3.9E+02	N	2.3E+05	3.1E+06	N	BSL
207089	Benzo(k)fluoranthene	2.0E+01	8.0E+01	µg/kg	13SB10A	4/5	1.2 - 1.4	8.0E+01	C	2.2E+03	3.9E+04	N	BSL
218019	Chrysene	2.6E+00	1.5E+02	µg/kg	13SB10A	5/5	1.44 - 1.68	1.5E+02	C	2.2E+04	3.9E+05	N	BSL
53703	Dibenz(a,h)anthracene	2.3E+00	5.2E+00	µg/kg	13SB10A	2/5	1.68 - 1.96	5.2E+00	C	2.2E+01	3.9E+02	N	BSL
206440	Fluoranthene	5.0E+00	4.7E+02	µg/kg	13SB10A	5/5	2.04 - 2.38	4.7E+02	N	3.1E+05	4.1E+06	N	BSL
86737	Fluorene	5.9E+00	1.7E+01	µg/kg	13SB10A	2/5	1.56 - 1.82	1.7E+01	N	3.1E+05	4.1E+06	N	BSL
193395	Indeno(1,2,3-cd)pyrene	3.7E+01	1.3E+02	µg/kg	13SB10A	4/5	0.84 - 0.98	1.3E+02	C	2.2E+02	3.9E+03	N	BSL
85018	Phenanthrene[4]	2.1E+00	2.1E+02	µg/kg	13SB10A	5/5	0.72 - 0.84	2.1E+02	N	2.3E+05	3.1E+06	N	BSL
129000	Pyrene	3.6E+00	3.2E+02	µg/kg	13SB10A	5/5	1.08 - 1.26	3.2E+02	N	2.3E+05	3.1E+06	N	BSL
	Explosives (mg/kg)												
118967	2,4,6-Trinitrotoluene	4.3E-01	4.3E-01	mg/kg	13SB11A	1/5	0.167 - 0.167	4.3E-01	C	3.9E+00	5.1E+01	N	BSL
	Nitroglycerin/PETN (mg/kg)												
55630	Nitroglycerin	4.5E-01	2.1E+00	mg/kg	13SB11A	2/5	0.195 - 0.276	2.1E+00	N	7.8E-01	1.0E+01	Y	**ARES**
	Cyanide (mg/kg)												
57125	Cyanide	7.0E-02	3.1E-01	mg/kg	13SB9A	5/5	0.0356 - 0.0356	3.1E-01	N	1.6E+02	2.0E+03	N	BSL
	Dioxins/Furans (mg/g)												
1746016	Total 2,3,7,8-TCDD Equivalents	--	--	mg/kg	13SB9A	1/1	--	2.1E-06	C	4.6E-06	1.9E-05	N	BSL

Notes:
CAS = Chemical Abstracts Service
COPC = Chemical of Potential Concern
mg/kg = Milligram Per Kilogram
µg/kg = Microgram Per Kilogram
TAL = Target Analyte List
TCL = Target Compound List
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound
PAH = Polynuclear Aromatic Hydrocarbon
TIC = Tentatively Identified Compound

[1] = Chromium VI RBC value was used
[2] = Lead criteria are Action Levels; see USEPA Region III guidance
[3] = Mercuric chloride soil RBC value used
[4] = RBC value for pyrene was used for these compounds

RBC = USEPA Region III Risk-Based Concentration (RBC) values from the October 11, 2007, RBC Table and Alternate RBC Table
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
C = Carcinogenic per EPA RBC Table (October 2007)
N = Noncarcinogenic per EPA RBC Table (October 2007)

ARES = Above Residential RBC
ARES/IND = Above Residential RBC/Industrial RBC
BSL = Below Residential/Industrial RBC Screening Levels
NSV = No Screening Value Available

Table D.1.2-2
HHRS COPC Selection (Total Soil) for SWMU 13
SSP Report
Radford Army Ammunition Plant, Radford, VA

CAS #	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	C/N	Adjusted RBC Residential	Adjusted RBC Industrial	COPC Flag (Y/N)	Rationale for Selection or Deletion
	TAL Metals (mg/kg)												
7429905	Aluminum	4,250	21,400	mg/kg	13SB7C	14/17	1.83 - 1.83	21,400	--	7,821	102,200	Y	ARES
7440360	Antimony	0.07	4.7	mg/kg	13SB11B	10/17	0.0518 - 0.0518	4.7	N	3.13	40.9	Y	**ARES**
7440382	Arsenic	0.12	4.7	mg/kg	13SB11C	14/17	0.0232 - 0.0232	5	C	0.43	1.91	Y	***ARES/IND***
7440393	Barium	29	211	mg/kg	13SB11C	14/17	0.106 - 0.106	211	N	1,564	20,440	N	BSL
7440417	Beryllium	0.65	1.30	mg/kg	13SB7C	11/17	0.0333 - 0.167	1.30	N	16	204	N	BSL
7440439	Cadmium	0.72	2.7	mg/kg	13SB11C	14/17	0.182 - 0.182	2.7	N	3.91	51	N	BSL
7440702	Calcium	1,300	4,570	mg/kg	13SB10A	14/17	16.6 - 16.6	4,570	--	Nutrient	Nutrient	N	Nutrient
7440473	Chromium[1]	11	39	mg/kg	13SB11C	14/17	0.912 - 0.912	39	N	23.5	307	Y	**ARES**
7440484	Cobalt	3.90	16	mg/kg	13SB11C	14/17	0.208 - 0.208	16	--	--	--	Y	NSV
7440508	Copper	2.50	98	mg/kg	13SB11B	14/17	0.368 - 1.84	98	N	313	4,088	N	BSL
7439896	Iron	5,330	48,600	mg/kg	13SB11C	14/17	4.24 - 42.4	48,600	N	5,475	71,540	Y	***ARES***
7439921	Lead[2]	12.00	26,500	mg/kg	13SB11B	14/17	0.0218 - 109	26,500	--	400	750	Y	***ARES/IND***
7439954	Magnesium	1,210	4,650	mg/kg	13SB11A	14/17	3.21 - 3.21	4,650	--	Nutrient	Nutrient	N	Nutrient
7439965	Manganese	59	1,700	mg/kg	13SB11C	14/17	0.264 - 6.6	1,700	N	156	2,044	Y	**ARES**
7439976	Mercury[3]	0.01	0.09	mg/kg	13SB10B	13/17	0.0077 - 0.0077	0.09	--	0.8	10	N	BSL
7440020	Nickel	3.80	21.00	mg/kg	13SB11C	14/17	0.0356 - 0.0356	21	N	156	2,044	N	BSL
7440097	Potassium	548	2,680	mg/kg	13SB11A	14/17	5 - 5	2,680	--	Nutrient	Nutrient	N	Nutrient
7782492	Selenium	0.23	1.5	mg/kg	13SB11C	14/17	0.0502 - 0.0502	1.5	N	39.11	511	N	BSL
7440224	Silver	0.02	0.45	mg/kg	13SB8B	14/17	0.0044 - 0.0044	0.45	N	39.11	511	N	BSL
7440235	Sodium	36	69	mg/kg	13SB9C	14/17	18.1 - 18.1	69	--	Nutrient	Nutrient	N	Nutrient
7440280	Thallium	0.05	0.87	mg/kg	13SB9A	14/17	0.027 - 0.027	0.87	N	0.55	7.15	Y	**ARES**
7440622	Vanadium	11	36	mg/kg	13SB7C	14/17	0.207 - 0.207	36	N	7.82	102	Y	**ARES**
7440666	Zinc	46	1,070	mg/kg	13SB11C	14/17	0.517 - 12.9	1,070	N	2,346	30,660	N	BSL
	TCL VOCs (µg/kg)												
120821	1,2,4-Trichlorobenzene	9.6E-01	9.6E-01	µg/kg	13SB10A	1/17	0.451 - 0.574	9.6E-01	N	7.8E+04	1.0E+06	N	BSL
78933	2-Butanone	2.4E+01	4.0E+02	µg/kg	13SB9B	14/17	5.5 - 7	4.0E+02	N	4.7E+06	6.1E+07	N	BSL
67641	Acetone	3.1E+01	3.2E+02	µg/kg	13SB10A	14/17	5.5 - 7	3.2E+02	N	7.0E+06	9.2E+07	N	BSL
71432	Benzene	9.1E-01	1.5E+00	µg/kg	13SB11B	3/17	0.58 - 0.738	1.5E+00	C	1.2E+04	5.2E+04	N	BSL
156592	cis-1,2-Dichloroethene	1.9E+00	4.2E+00	µg/kg	13SB11C	2/17	0.781 - 0.994	4.2E+00	N	7.8E+04	1.0E+06	N	BSL
75092	Methylene chloride	4.1E+00	1.1E+01	µg/kg	13SB10A	14/17	3.09 - 3.93	1.1E+01	C	8.5E+04	3.8E+05	N	BSL
108883	Toluene	6.6E-01	3.5E+00	µg/kg	13SB10A	7/17	0.51 - 0.65	3.5E+00	N	6.3E+05	8.2E+06	N	BSL
79016	Trichloroethene	9.6E+00	5.7E+01	µg/kg	13SB11C	3/17	0.745 - 0.948	5.7E+01	C	1.6E+03	7.2E+03	N	BSL
	VOC TICs (µg/kg)												
66251	Hexanal	4.7E+00	3.5E+02	µg/kg	13SB10A	6/17	0 - 0	3.5E+02	--	--	--	Y	NSV
	TCL SVOCs (µg/kg)												
91576	2-Methylnaphthalene	4.0E+00	2.2E+01	µg/kg	13SB8A	4/17	3.01 - 3.84	2.2E+01	N	3.1E+04	4.1E+05	N	BSL
121142	2,4-Dinitrotoluene	3.5E+01	1.2E+02	µg/kg	13SB9A	4/17	3.47 - 4.41	1.2E+02	N	1.6E+04	2.0E+05	N	BSL
606202	2,6-Dinitrotoluene	3.2E+01	3.2E+01	µg/kg	13SB11B	1/17	30.5 - 38.8	3.2E+01	N	7.8E+03	1.0E+05	N	BSL
--	Dinitrotoluene Mix	3.5E+01	1.2E+02	µg/kg	13SB11B	2/17	0 - 0	1.2E+02	C	9.4E+02	4.2E+03	N	BSL
59507	4-Chloro-3-Methylphenol	8.0E+00	2.4E+01	µg/kg	13SB8B	8/17	5.73 - 7.29	2.4E+01	--	--	--	Y	NSV
83329	Acenaphthene	4.0E+00	1.9E+01	µg/kg	13SB8A	5/17	1.89 - 2.41	1.9E+01	N	4.7E+05	6.1E+06	N	BSL
208968	Acenaphthylene[4]	2.0E+00	6.0E+00	µg/kg	13SB10B	7/17	1.65 - 2.1	6.0E+00	N	2.3E+05	3.1E+06	N	BSL
120127	Anthracene	1.5E+01	3.7E+01	µg/kg	13SB8A	6/17	5.08 - 6.47	3.7E+01	N	2.3E+06	3.1E+07	N	BSL
56553	Benzo(a)anthracene	2.2E+01	1.7E+02	µg/kg	13SB9A	7/17	1.86 - 186	1.7E+02	C	2.2E+02	3.9E+03	N	BSL
50328	Benzo(a)pyrene	7.0E+00	1.3E+02	µg/kg	13SB9A	12/17	4.72 - 7.99	1.3E+02	C	2.2E+01	3.9E+02	Y	**ARES**
205992	Benzo(b)fluoranthene	1.3E+01	2.1E+02	µg/kg	13SB9A	12/17	10.7 - 13.7	2.1E+02	C	2.2E+02	3.9E+03	N	BSL
191242	Benzo(g,h,i)perylene[4]	1.1E+01	7.2E+01	µg/kg	13SB8A	10/17	9.59 - 12.2	7.2E+01	N	2.3E+05	3.1E+06	N	BSL
207089	Benzo(k)fluoranthene	2.8E+01	8.9E+01	µg/kg	13SB9A	6/17	14.7 - 18.8	8.9E+01	C	2.2E+03	3.9E+04	N	BSL
117817	Bis(2-ethylhexyl)phthalate	1.5E+01	5.4E+02	µg/kg	13SB11C	14/17	2.28 - 2.9	5.4E+02	C	4.6E+04	2.0E+05	N	BSL
85687	Butylbenzylphthalate	6.0E+00	4.0E+01	µg/kg	13SB11C	7/17	4.93 - 6.27	4.0E+01	N	1.6E+06	2.0E+07	N	BSL
86748	Carbazole	2.1E+01	2.1E+01	µg/kg	13SB9A	1/17	6.71 - 8.54	2.1E+01	C	3.2E+04	1.4E+05	N	BSL
218019	Chrysene	1.6E+01	1.9E+02	µg/kg	13SB9A	11/17	11.2 - 14.3	1.9E+02	C	2.2E+04	3.9E+05	N	BSL
53703	Dibenz(a,h)anthracene	1.3E+01	1.8E+01	µg/kg	13SB8A	4/17	6.49 - 8.26	1.8E+01	C	2.2E+01	3.9E+02	N	BSL
132649	Dibenzofuran	6.0E+00	1.3E+01	µg/kg	13SB8A	2/17	3.48 - 4.42	1.3E+01	--	7.8E+03	1.0E+05	N	BSL
84662	Diethylphthalate	3.0E+00	2.4E+02	µg/kg	13SB10B	14/17	2.09 - 2.66	2.4E+02	N	6.3E+06	8.2E+07	N	BSL
131113	Dimethylphthalate	1.0E+01	5.5E+02	µg/kg	13SB11B	3/17	3.64 - 4.63	5.5E+02	--	--	--	Y	NSV
84742	Di-n-butylphthalate	6.2E+01	6.0E+02	µg/kg	13SB11B	14/17	4.2 - 5.35	6.0E+02	N	7.8E+05	1.0E+07	N	BSL
206440	Fluoranthene	9.0E+00	3.7E+02	µg/kg	13SB8A	11/17	2.59 - 3.29	3.7E+02	N	3.1E+05	4.1E+06	N	BSL
86737	Fluorene	4.0E+00	2.0E+01	µg/kg	13SB8A	5/17	1.85 - 2.35	2.0E+01	N	3.1E+05	4.1E+06	N	BSL
193395	Indeno(1,2,3-cd)pyrene	5.0E+00	7.3E+01	µg/kg	13SB8A	11/17	4.31 - 5.49	7.3E+01	C	2.2E+02	3.9E+03	N	BSL
91203	Naphthalene	4.0E+00	1.0E+01	µg/kg	13SB8A	2/17	3.03 - 3.85	1.0E+01	N	1.6E+05	2.0E+06	N	BSL
86306	N-Nitrosodiphenylamine	2.1E+01	9.5E+02	µg/kg	13SB11B	5/17	5.23 - 6.65	9.5E+02	C	1.3E+05	5.8E+05	N	BSL

Table D.1.2-2
HHRS COPC Selection (Total Soil) for SWMU 13
SSP Report
Radford Army Ammunition Plant, Radford, VA

CAS #	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	C/N	Adjusted RBC Residential	Adjusted RBC Industrial	COPC Flag (Y/N)	Rationale for Selection or Deletion
85018	Phenanthrene[4]	4.0E+00	1.7E+02	µg/kg	13SB10A	11/17	2.53 - 3.22	1.7E+02	N	2.3E+05	3.1E+06	N	BSL
129000	Pyrene	3.0E+00	2.6E+02	µg/kg	13SB8A	12/17	1.63 - 2.07	2.6E+02	N	2.3E+05	3.1E+06	N	BSL
	SVOC TICs (µg/kg)												
301020	(Z)-9-Octadecenamide	8.3E+01	8.3E+01	µg/kg	13SB9B	1/17	0 - 0	8.3E+01	--	--	--	Y	NSV
15594908	1-Heneicosanol	2.2E+02	2.2E+02	µg/kg	13SB11A	1/17	0 - 0	2.2E+02	--	--	--	Y	NSV
84695	1,2-Benzenedicarboxylicacid, bis(2-methy	1.2E+02	6.7E+02	µg/kg	13SB9A	8/17	0 - 0	6.7E+02	--	--	--	Y	NSV
17851535	1,2-Benzenedicarboxylic acid, butyl 2-me	4.7E+01	5.3E+02	µg/kg	13SB10A	5/17	0 - 0	5.3E+02	--	--	--	Y	NSV
84640	1,2-Benzenedicarboxylic acid, butyl cycl	3.1E+02	3.1E+02	µg/kg	13SB11C	1/17	0 - 0	3.1E+02	--	--	--	Y	NSV
101371	2,4,6-Triallyloxy-1,3,5-triazine	3.6E+01	1.5E+02	µg/kg	13SB10B	6/17	0 - 0	1.5E+02	--	--	--	Y	NSV
1000194624	4,4,6a,6b,8a,11,11,14b-Octamethyl-1,4,4a	7.1E+02	7.1E+02	µg/kg	13SB10A	1/17	0 - 0	7.1E+02	--	--	--	Y	NSV
112798	9-Octadecenoic acid, (E)-	7.4E+01	7.4E+01	µg/kg	13SB8B	1/17	0 - 0	7.4E+01	--	--	--	Y	NSV
0118967	Benzene, 2-methyl-1,3,5-trinitro-	2.8E+02	2.8E+02	µg/kg	13SB11A	1/17	0 - 0	2.8E+02	--	--	--	Y	NSV
119755	Benzeneamine, 2-nitro-N-phenyl-	7.1E+01	1.5E+02	µg/kg	13SB11B	2/17	0 - 0	1.5E+02	--	--	--	Y	NSV
142165	Bis(2-ethylhexyl)maleate	1.2E+02	1.4E+02	µg/kg	13SB11C	2/17	0 - 0	1.4E+02	--	--	--	Y	NSV
123955	Butyl Ester Octadecanioc	1.3E+02	1.3E+02	µg/kg	13SB11A	1/17	0 - 0	1.3E+02	--	--	--	Y	NSV
57885	Cholesterol	1.2E+02	4.7E+02	µg/kg	13SB10A	2/17	0 - 0	4.7E+02	--	--	--	Y	NSV
112845	Erucylamide	1.2E+02	9.0E+02	µg/kg	13SB10B	11/17	0 - 0	9.0E+02	--	--	--	Y	NSV
2136712	Ethanol, 2-(hexadecyloxy)-	3.9E+02	3.9E+02	µg/kg	13SB11A	1/17	0 - 0	3.9E+02	--	--	--	Y	NSV
83476	.Gamma.-sitosterol	7.6E+01	2.4E+03	µg/kg	13SB10A	5/17	0 - 0	2.4E+03	--	--	--	Y	NSV
1058613	Stigmast-4-en-3-one	1.4E+02	2.4E+02	µg/kg	13SB8A	2/17	0 - 0	2.4E+02	--	--	--	Y	NSV
1000214207	Stigmasterol, 22,23-dihydro-	1.6E+02	1.6E+02	µg/kg	13SB9A	1/17	0 - 0	1.6E+02	--	--	--	Y	NSV
127220	Taraxerol	2.9E+02	2.9E+02	µg/kg	13SB8A	1/17	0 - 0	2.9E+02	--	--	--	Y	NSV
638584	Tetradecanamide	6.0E+01	6.0E+01	µg/kg	13SB8B	1/17	0 - 0	6.0E+01	--	--	--	Y	NSV
115866	Triphenyl Phosphate	1.1E+02	1.1E+02	µg/kg	13SB11B	1/17	0 - 0	1.1E+02	--	--	--	Y	NSV
611927	Urea, N,N'-dimethyl-N,N'-diphenyl-	4.8E+01	4.8E+01	µg/kg	13SB9A	1/17	0 - 0	4.8E+01	--	--	--	Y	NSV
10191410	Vitamin E	1.6E+02	6.0E+02	µg/kg	13SB10A	2/17	0 - 0	6.0E+02	--	--	--	Y	NSV
	PAHs (µg/kg)												
83329	Acenaphthene	1.4E+01	1.7E+01	µg/kg	13SB9A	2/17	10.3 - 13.2	1.7E+01	N	4.7E+05	6.1E+06	N	BSL
120127	Anthracene	1.0E+00	3.8E+01	µg/kg	13SB10A	10/17	0.77 - 0.98	3.8E+01	N	2.3E+06	3.1E+07	N	BSL
56553	Benzo(a)anthracene	1.4E+00	1.4E+02	µg/kg	13SB10A	13/17	0.88 - 1.12	1.4E+02	C	2.2E+02	3.9E+03	N	BSL
50328	Benzo(a)pyrene	1.3E+01	1.9E+02	µg/kg	13SB10A	9/17	1.1 - 1.4	1.9E+02	C	2.2E+01	3.9E+02	Y	**ARES**
205992	Benzo(b)fluoranthene	8.8E+00	1.4E+02	µg/kg	13SB10A	9/17	1.43 - 1.82	1.4E+02	C	2.2E+02	3.9E+03	N	BSL
191242	Benzo(g,h,i)perylene[4]	4.6E+01	3.9E+02	µg/kg	13SB9A	8/17	13.8 - 17.5	3.9E+02	N	2.3E+05	3.1E+06	N	BSL
207089	Benzo(k)fluoranthene	4.5E+00	8.0E+01	µg/kg	13SB10A	9/17	1.1 - 1.4	8.0E+01	C	2.2E+03	3.9E+04	N	BSL
218019	Chrysene	1.7E+00	1.5E+02	µg/kg	13SB10A	13/17	1.32 - 1.68	1.5E+02	C	2.2E+04	3.9E+05	N	BSL
53703	Dibenz(a,h)anthracene	2.3E+00	8.0E+00	µg/kg	13SB10B	4/17	1.54 - 1.96	8.0E+00	C	2.2E+01	3.9E+02	N	BSL
206440	Fluoranthene	3.3E+00	4.7E+02	µg/kg	13SB10A	12/17	1.87 - 2.38	4.7E+02	N	3.1E+05	4.1E+06	N	BSL
86737	Fluorene	5.9E+00	1.7E+01	µg/kg	13SB10A	3/17	1.43 - 1.82	1.7E+01	N	3.1E+05	4.1E+06	N	BSL
193395	Indeno(1,2,3-cd)pyrene	9.4E+00	1.3E+02	µg/kg	13SB10A	9/17	0.77 - 0.98	1.3E+02	C	2.2E+02	3.9E+03	N	BSL
85018	Phenanthrene[4]	1.8E+00	2.1E+02	µg/kg	13SB10A	13/17	0.66 - 0.84	2.1E+02	N	2.3E+05	3.1E+06	N	BSL
129000	Pyrene	3.0E+00	3.2E+02	µg/kg	13SB10A	13/17	0.99 - 1.26	3.2E+02	N	2.3E+05	3.1E+06	N	BSL
	Explosives (mg/kg)												
118967	2,4,6-Trinitrotoluene	4.3E-01	4.3E-01	mg/kg	13SB11A	1/17	0.167 - 0.167	4.3E-01	C	3.9E+01	5.1E+02	N	BSL
	Nitroglycerin/PETN (mg/kg)												
55630	Nitroglycerin	4.5E-01	2.6E+00	mg/kg	13SB11B	5/17	0.195 - 0.276	2.6E+00	N	7.8E-01	1.0E+01	Y	ARES
	Cyanide (mg/kg)												
57125	Cyanide	7.0E-02	3.5E-01	mg/kg	13SB11B	11/17	0.0356 - 0.0356	3.5E-01	N	1.6E+02	2.0E+03	N	BSL
	Dioxins/Furans (mg/g)												
1746016	Total 2,3,7,8-TCDD Equivalents	--	--	mg/kg	13SB9A	1/1	--	2.1E-06	C	4.6E-06	1.9E-05	N	BSL

Notes:

CAS = Chemical Abstracts Service
COPC = Chemical of Potential Concern
mg/kg = Milligram Per Kilogram
µg/kg = Microgram Per Kilogram
TAL = Target Analyte List
TCL = Target Compound List
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound
PAH = Polynuclear Aromatic Hydrocarbon
TIC = Tentatively Identified Compound
DUP AVG = results for duplicate samples averaged

[1] = Chromium VI RBC value was used
[2] = Lead criteria are Action Levels; see USEPA Region III guidance
[3] = Mercuric chloride soil RBC value used
[4] = RBC value for pyrene was used for these compounds

RBC = USEPA Region III Risk-Based Concentration (RBC) values from the October 11, 2007, RBC Table and Alternate RBC Table
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
C = Carcinogenic per EPA RBC Table (October 2007)
N = Noncarcinogenic per EPA RBC Table (October 2007)

ARES = Above Residential RBC
ARES/IND = Above Residential RBC/Industrial RBC
BSL = Below Residential/Industrial RBC Screening Levels
NSV = No Screening Value Available

APPENDIX E

FORMS

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Form E-1
Work Plan Revision Form
Work Plan – Quality Assurance Plan – Health and Safety Plan – Addendum 023
RCRA Facility Investigation at SWMU 13
Radford Army Ammunition Plant, Radford, Virginia

SITE DESIGNATION / LOCATION:	Section: ____________________
Radford Army Ammunition Plant	Addendum: ____________________
Radford, VA	Version: ____________________
	Effective Date: ____________________
SUBJECT:	Approved by:
	Field Operations Leader
	____________________
	Date: ____________________
	Concurrence:
	Project Manager
	____________________
	Date ____________________
	Sheet ______ of ______

Form E-2
Worker Acknowledgement Form
RCRA Facility Investigation at SWMU 13
Radford Army Ammunition Plant, Radford, Virginia

Document: Master Work Plan/QAP/HSP and Work Plan Addendum 023

Version: Final

Project: Radford Army Ammunition Plant

Location: Waste Propellant Burning Ground, SWMU 13

Prior to the initiation of field activities, I have been given an opportunity to read and question the contents of this Master Work Plan/QAP/HSP, this Site-Specific Addendum, and approved revisions through the number listed above. With my signature, I certify that I have read, understood, and agree to comply with the information and directions set forth in these plans. I further certify that I am in full compliance with 20 Code of Federal Regulations (CFR) 1910.120 concerning training and medical monitoring requirements.

Site Personnel:

Name (please print)	**Signature**	**Date**

WORK PLAN ADDENDUM 023

RCRA FACILITY INVESTIGATION AT SOLID WASTE MANAGEMENT UNIT 13

RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

FINAL
JULY 2008

CONTRACT NO.
W9128F-04-D-0001
DELIVERY ORDER NO. DA02

WORK PLAN ADDENDUM 023

RCRA FACILITY INVESTIGATION AT SOLID WASTE MANAGEMENT UNIT 13

RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

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