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US Army Corps of Engineers
Baltimore District

FINAL

WORK PLAN ADDENDUM 25

RCRA FACILITY INVESTIGATION WORK PLAN:

TCE Plume at Bldgs 1549, 1041, and 1034 (RAAP-047)

ARCADIS
Infrastructure, environment, facilities

Prepared for:
Radford Army Ammunition Plant

May 2008

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

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

www.atk.com

May 5, 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,
Final Work Plan Addendum 25 RCRA Facility Investigation Work Plan: TCE Plume at Bldgs 1549, 1041, and 1034 (RAAP-047) May 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 May 1, 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,

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

08-815-80
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
ATTN: CENAB-EN-HM
10 South Howard Street
Baltimore, MD 21201

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

08-815-80
JMcKenna

Concerning the following:

Radford Army Ammunition Plant

Final Work Plan Addendum 25
RCRA Facility Investigation Work Plan:
TCE Plume at Bldgs 1549, 1041, and 1034 (RAAP-047)
May 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

08-815-80
JMcKenna

Greene, Anne

From: McKenna, Jim
Sent: Thursday, May 01, 2008 2:04 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; Meyer, Tom NAB02; Parks, Jeffrey N; Timothy.Leahy@shawgrp.com; Tina_Devine@URSCorp.com
Subject: Final WPA 25 RFI Workplan TCE Plume (UNCLASSIFIED)

Importance: High

Attachments: R47RFIWP_DF_EPA_RTC.PDF

R47RFIWP_DF_EPA
_RTC.PDF (32 KB...

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. Also note that attached to this email are the response to comments.

Certification letter will follow from Radford AAP under separate cover.

Immediately below are the POCs with tracking numbers:

Jim McKenna, Radford Army Ammunition Plant, 2 copies, 1 CD: 7984 3206 8078

Rich Mendoza, Army Environmental Command-RIA, 1 copy, 1 CD: 7998 4673 9361

Jim Cutler, Virginia Dept of Environmental Quality, 1 copy: 7926 9260 9663

Durwood Willis, Virginia Dept of Environmental Quality, 1 copy: 8659 8469 2493

Elizabeth A. Lohman, Virginia Dept of Environmental Quality, 1 copy: 7993 1714 4879

Tom Meyer, USACE-Baltimore, 1 copy, 1 CD: 7900 0490 3810

William Geiger, US EPA Region III, 3 copies, 8659 8469 2508

Jutta Schneider , Virginia Dept of Environmental Quality , 1 copy: 8659 8469 2482

Thank you for your support of the Radford AAP Installation Restoration Program.

Jim McKenna

Classification: UNCLASSIFIED
Caveats: NONE

Comments and Responses on the
Draft Final RFI Work Plan for TCE PLUME AT BLDGS 1549, 1041, AND 1034 (RAAP-47)

Radford Army Ammunition Plant
April 2008

Item No.	Report Reference	COMMENT	RESPONSE
1	Section 1	ASD requirements are adequately described in workplan (p.1).	*Noted.*
2		Reporting should specify that a separate ASD report will be prepared once sufficient information has been compiled, as agreed to by all parties (p.3).	*Agreed. Paragraph 6 has been revised to include the following sentence:* In addition, a separate ASD report will be prepared once sufficient information has been compiled, as agreed to by all parties.
3		The Conceptual Site Model as presented in the workplan has inadequate detail in terms of describing the hydrogeologic system at the site. It is understood that as additional data is collected, more detailed information will be provided, to include cross-sections and water table maps and any other representations of factors (such as karst features) impacting groundwater flow, quality and contaminant transport	*Noted. Section 3 has been revised to indicate that as additional data is collected, it will be provided to the stakeholders.* Material anticipated to be presented during the decision point meetings including the following: • A summary of analytical results for samples collected to date; • Figures depicting the locations of samples collected thus far; • Conceptual Site Model. After each component of the investigation is completed, the CSM will be updated and provided to the stakeholders. The CSM will be updated to include water table data and karst features as available; • Figures depicting the locations of propose samples to be collected during the next investigation component.

Comments and Responses on the
Draft Final RFI Work Plan for TCE PLUME AT BLDGS 1549, 1041, AND 1034 (RAAP-47)

Radford Army Ammunition Plant
April 2008

Item No.	Report Reference	COMMENT	RESPONSE
4	Section 2	As part of the first decision point, under the "if no TCE sources have been identified" scenario, a statement should be added that additional investigation in support of the ASD will evaluate if any data exist between HWMU-5 and impacted monitoring wells and include the possibility of additional soil and possibly groundwater samples between HWMU-5 and impacted monitoring wells (p.6)	*Agreed. The following text has been added to Decision Point 1 paragraph:* Potential alternate sources include the area between HWMU-5 and impacted monitoring wells. If this is identified as a potential source based on data gathered during Step 1, soil and groundwater samples between HWMU-5 and impacted monitoring wells will be collected to better define the nature/extent of the contamination, if found.
5	Section 2	"Vertical aquifer profiling" (VAP) references installation of wells "around the buildings" but the VAP transects are a different set of wells, this should be clarified. (p.6)	*Agreed. This sentence has been revised as follows:* If TCE or other chemicals of interest have been detected at one or more of the three buildings, groundwater samples will be collected along one or two transects crossing the presumed groundwater flow path between the buildings and the impacted monitoring wells and vertical aquifer profiling (VAP) of the overburden may be completed.
6		As part of VAP, under the "if no groundwater impacts have been identified" scenario, a statement should be added that additional investigation in support of the ASD will evaluate if any data exist between HWMU-5 and impacted monitoring wells and include the possibility of additional soil and possibly groundwater samples between HWMU-5 and impacted monitoring wells. (p.6)	*Agreed. The last sentence of this paragraph has been revised as follows:* The investigation will also be refocused to continue support of the ASD for HWMU-5 as described under the first decision point.
7		There should be a statement in section 2 that a stand-alone ASD report will be prepared once the stakeholders agree that the data collection effort in support of the ASD is complete.	*Agreed. This statement has been added to both Sections 1 and 4.*

Comments and Responses on the
Draft Final RFI Work Plan for TCE PLUME AT BLDGS 1549, 1041, AND 1034 (RAAP-47)

Radford Army Ammunition Plant
April 2008

Item No.	Report Reference	COMMENT	RESPONSE
8	Section 4	Section 4.3 indicates that VAP will be done from borings. It should be clarified if temporary wells will be installed in case of high turbidity.	*Agreed. Section 4.3 has been revised as follows:* ARCADIS anticipates collecting two groundwater samples using screen points at each VAP location.
9		Section 4.4 discusses well installation. It should be clarified if these wells will be temporary or permanent wells.	*Agreed. The text has been clarified to indicate that permanent monitoring wells will be installed.*
10		Section 4.6 should be revised to state that plume delineation may be decoupled from the ASD	*Agreed. Section 4.6 has been revised to include the following sentence:* Note at this point, it may be appropriate to complete the ASD report if agreed to by all parties.
11	Section 7.	A statement should be added indicating that there will be a separate report presenting the data that support the ASD, including a description of the alternate source and the identified pathways. If no alternate source is found, or if a source is found but no pathway to the impacted wells could be identified, the report will include the results of the investigation up to that decision point.	*Agreed. The work plan has been revised to include the following text:* In addition, if the investigation yields sufficient information to identify a source of the TCE in groundwater proximal to HWMU 5 that data will be used to support a revised ASD for HWMU 5. The ASD will present a description of the alternate source and the identified pathways. If no alternate source is found, or if a source is found but no pathway to the impacted wells could be identified, the report will include the results of the investigation up to that decision point.
12	Figure 3	Figure 3 boring locations shown don't exactly match location descriptions on page 5 and page 9. Either the figure or the text need to be revised.	*Agreed. The text has been revised to indicate that 3 borings will be installed adjacent to Bldg 1549 and 10 borings will be installed in the vicinity of Bldgs 1041 and 1034 on page 5 and page 9. In addition, Figure 3 was revised to indicate that 4 borings will be installed in the ditch.*

Comments and Responses on the
Draft Final RFI Work Plan for TCE PLUME AT BLDGS 1549, 1041, AND 1034 (RAAP-47)

Radford Army Ammunition Plant
April 2008

Item No.	Report Reference	COMMENT	RESPONSE
13	Figure 4	Figure 4 should be revised to show a separate ASD report, as well as data evaluation and possible data collection around the impacted wells at HWMU 5.	*Agreed. Figure 4 has been revised to indicate possible data collection between HWMU-5 and the impacted wells.*
14	SOP 3	Standard Operating Procedure No. 3 (SOP 3) does not reflect site conditions. SOP 3 should be revised to reference alluvium, epikarst, and bedrock at 15 to 50 ft bgs instead of till and bedrock at 60-65 ft bgs. There should be a reference or description of a procedure for dealing with immiscible layers.	*Agreed. SOP has been revised to reference alluvium/overburden rather than till. In addition the depths to bedrock were revised to be 15 to 50 ft bgs.*
Commenter: Michael Cramer (EPA)			
1	General	Although the cover title of the document makes reference to a RCRA Facility Investigation (RFI), the Introduction characterizes the document as an RFI/CSM (sic). Since no corrective measures are proposed, this document should not be characterized as a CMS.	*This document was intended to be a work plan for collecting the data necessary to complete both the RCRA Facility Investigation and the Corrective Measures Study. However, for clarification purposes, references to the CMS have been deleted where appropriate.*
2	Page 6	Page 6 of the slide show describes drainage from Building 1041 as entering a suspected UST. Please provide further information to characterize the drainage system and/or the UST system.	*Information regarding this drainage system and UST were presented in the 2007 Draft ASD. No additional information is available at this time.*
3		SOP: Vertical Aquifer Profiling, Page 2: EPA Region III modifications to the pumping rate discussed in 4. sixth bullet item, recommend that the pumping rate be set between 100 mL/min and 400 mL/min, vice 500 mL/min shown in the SOP.	*Agreed. The pumping rate has been revised to a maximum of 400 mL/min, consistent with USEPA Region 3 Low-Flow Purging and Sampling of Groundwater Monitoring Wells, Bulletin No. QAD023 (October 1997).*

Comments and Responses on the
Draft Final RFI Work Plan for TCE PLUME AT BLDGS 1549, 1041, AND 1034 (RAAP-47)

Radford Army Ammunition Plant
April 2008

Item No.	Report Reference	COMMENT	RESPONSE
4		Please expand the Conceptual Site Model to describe site hydrogeology. Since this is a Triad based investigation, the CSM should evolve over the course of the field/lab work. Please include the appropriate cross-sections, subsurface features, ground water characterization, and plume characterization in three dimensions.	*Agreed. Please see Response To VDEQ Comment No. 3.*
5		Existing data should be evaluated to further define the source of ground water pollutants, if this investigation can not reveal the source.	*Agreed. Please see Response to VDEQ Comment No. 11.*
6		Prepare a final, post Triad report which combines an analysis of current field conditions with existing data. The report should outline the path forward in light of field conditions.	*Agreed. Data gathered during this investigation will be presented along with any existing data in the RFI Report.*

From: Geiger.William@epamail.epa.gov
Sent: Wednesday, April 23, 2008 1:09 PM
To: McKenna, Jim J Mr CIV USA AMC
Cc: Llewellyn, Tim; Wisbeck, Diane; jeremy.flint@atk.com; jerome.redder@atk.com; jlcutler@deq.virginia.gov
Subject: WP Add 25
Attachments: Final GW Memo - HWMU 5 ASD RFI Workplan.doc; mem27_WPA_25_RAAP047_TCE_Plume_RFI_WP_Draft_Mem_rev_0.wpd

Here are EPA/VDEQ comments on the Draft WP Addendum 25 that we discussed yesterday. I didn't have time to sort through and combine them, so I apologize if there are any repeats. Thanks

William A. Geiger
USEPA Region III
1650 Arch Street
Philadelphia, PA 19103
(215)814-3413

----- Forwarded by William Geiger/R3/USEPA/US on 04/23/2008 01:03 PM -----

"Cutler,Jim" <jlcutler@deq.virginia.gov>
04/21/2008 05:04 PM

To: William Geiger/R3/USEPA/US@EPA
cc: "Schneider,Jutta" <jschneider@deq.virginia.gov>, "Stepien,Matthew" <mmstepien@deq.virginia.gov>
Subject: WP Add 25

Will,

I’m forwarding attached comments from Jutta.

My main comment is to ensure that GW delineation will happen regardless of the early findings. At the first decision point additional ground water investigation would be expected if no TCE sources are detected. Unless the GW cluster contamination is clearly associated with HWMU-5, the RAAP 047 RFI would need to include a delineation of any plume that encompasses the contaminated well cluster. I would also suggest that more investigation be performed at the well cluster, including a review of all well log data, insitu flow analysis, VAP, etc.

Thanks,

Jim

James L. Cutler Jr.
Federal Facilities Project Manager
Office of Remediation Programs

Virginia Dept. of Environmental Quality
804-698-4498
(See attached file: Final GW Memo - HWMU 5 ASD RFI Workplan.doc)

(See attached file:
mem27_WPA_25_RAAP047_TCE_Plume_RFI_WP_Draft_Mem_rev_0.wpd)

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

SUBJECT: RAAP Technical Review of the WPA 25 RFI Draft Work Plan, dated March 2008, for the TCE Plume at Buildings 1549, 1041, 1034 (RAAP-047)

DATE: 04/08/08

FROM: Michael P. Cramer
WCMD Technical Support Branch (3WC11)

TO: Wil Geiger, RPM
RCRA General Operations Branch (3WC32)

1. The work will be performed under the Master Work Plan Addendum 25. Comments on this work plan addendum are provided below.

2. RAAP, and Its contractor, presented an outline of the work plan using a slide show during a telephone conference call on 04/08/08.

Comments

1. Although the cover title of the document makes reference to a RCRA Facility Investigation(RFI), the Introduction characterizes the document as an RFI/CSM(sic). Since no corrective measures are proposed, this document should not be characterized as a CMS.

2. Page 6 of the slide show describes drainage from Building 1041 as entering a suspected UST. Please provide further information to characterize the drainage system and/or the UST system.

3. SOP: Vertical Aquifer Profiling, Page 2: EPA Region III modifications to the pumping rate discussed in 4. sixth bullet item, recommend that the pumping rate be set between 100 mL/min and 400 mL/min, vice 500 mL/min shown in the SOP.

4. Please expand the Conceptual Site Model to describe site hydrogeology. Since this is a Triad based investigation, the CSM should evolve over the course of the field/lab work. Please include the appropriate cross-sections, subsurface features, ground water characterization, and plume characterization in three dimensions.

5. Existing data should be evaluated to further define the source of ground water pollutants, if this investigation can not reveal the source.

6. Prepare a final, post Triad report which combines an analysis of current field conditions with existing data. The report should outline the path forward in light of field conditions.

VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY
WASTE DIVISION
OFFICE OF HAZARDOUS WASTE

Memorandum

TO: Jim Cutler
Office of Remediation Programs

FROM: Jutta Schneider
Office of Hazardous Waste/Groundwater

COPIES: Fuxing Zhou, OHW
Matt Stepien, OHW

DATE: April 21, 2008

SUBJECT: Review of Work Plan Addendum 25, RFI/CMS Work Plan RAAP 047, "TCE Plume at Buildings 1549, 1041 and 1034", March 2008, pertaining to the proposed Alternate Source Demonstration for HWMU-5, Radford Army Ammunition Plant, Radford, VA
EPA ID# VA1210020730

As discussed during a conference call with EPA, the facility and their consultants on April 8, 2008, the OHW groundwater staff has reviewed the Work Plan Addendum 25 with respect to its use in support of the facility's proposed Alternate Source Demonstration (ASD) for TCE in monitoring wells downgradient of the facility's HWMU-5. The groundwater staff's comments are provided to you for consolidation with your and EPA's comments pertaining to the RFI/CMS aspects of the proposed work. Please provide a copy of these comments to the facility as an attachment to the combined agency response.

Section 1.

1. ASD requirements are adequately described in workplan (p.1).
2. Reporting should specify that a separate ASD report will be prepared once sufficient information has been compiled, as agreed to by all parties (p.3).
3. The Conceptual Site Model as presented in the workplan has inadequate detail in terms of describing the hydrogeologic system at the site. It is understood that as additional data is collected, more detailed information will be provided, to include cross-sections and water table maps and any other representations of factors (such as karst features) impacting groundwater flow, quality and contaminant transport.

Section 2.

1. As part of the first decision point, under the "if no TCE sources have been

identified" scenario, a statement should be added that additional investigation in support of the ASD will evaluate if any data exist between HWMU-5 and impacted monitoring wells and include the possibility of additional soil and possibly groundwater samples between HWMU-5 and impacted monitoring wells (p.6)
2. "Vertical aquifer profiling" (VAP) references installation of wells "around the buildings" but the VAP transects are a different set of wells, this should be clarified. (p.6)
3. As part of VAP, under the "if no groundwater impacts have been identified" scenario, a statement should be added that additional investigation in support of the ASD will evaluate if any data exist between HWMU-5 and impacted monitoring wells and include the possibility of additional soil and possibly groundwater samples between HWMU-5 and impacted monitoring wells. (p.6)
4. There should be a statement in section 2 that a stand-alone ASD report will be prepared once the stakeholders agree that the data collection effort in support of the ASD is complete.

Section 4.

1. Section 4.3 indicates that VAP will be done from borings. It should be clarified if temporary wells will be installed in case of high turbidity.
2. Section 4.4 discusses well installation. It should be clarified if these wells will be temporary or permanent wells.
3. Section 4.6 should be revised to state that plume delineation may be decoupled from the ASD.

Section 7.

1. A statement should be added indicating that there will be a separate report presenting the data that support the ASD, including a description of the alternate source and the identified pathways. If no alternate source is found, or if a source is found but no pathway to the impacted wells could be identified, the report will include the results of the investigation up to that decision point.

Figures, Tables and Attachments

1. Figure 3 Boring locations shown don't exactly match location descriptions on page 5 and page 9. Either the figure or the text need to be revised.
2. Figure 4 should be revised to show a separate ASD report, as well as data evaluation and possible data collection around the impacted wells at HWMU 5.
3. Standard Operating Procedure No. 3 (SOP 3) does not reflect site conditions. SOP 3 should be revised to reference alluvium, epikarst, and bedrock at 15 to 50 ft bgs instead of till and bedrock at 60-65 ft bgs. There should be a reference or description of a procedure for dealing with immiscible layers.

Please feel free to contact me at 698-4099 if you have any questions about the above.

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

www.atk.com
April 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,
Draft Work Plan Addendum 25 RCRA Facility Investigation Work Plan: TCE Plume at Buildings 1549, 1041, and 1034 (RAAP-047) March 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 March 31, 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,

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

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

08-815-63
JMcKenna

Tom Meyer
Corps of Engineers, Baltimore District
ATTN: CENAB-EN-HM
10 South Howard Street
Baltimore, MD 21201

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

08-815-63
JMcKenna

Concerning the following:

Radford Army Ammunition Plant

Draft Work Plan Addendum 25
RCRA Facility Investigation Work Plan:
TCE Plume at Bldgs 1549, 1041, and 1034 (RAAP-047)
March 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 Division

08-815-63
JMcKenna

Greene, Anne

From: McKenna, Jim
Sent: Monday, March 31, 2008 2:35 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: Draft Work Plan Addendum 25 RFI at RAAP-047 Tracking 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.

Richard Mendoza (USAEC)	7998 2826 4072 (1 copy and 1 cd)
Tom Meyer (USACE)	7926 7421 9528 (1 copy and 1 cd)
Dennis Druck (CHPPM)	7904 8140 3219 (1 copy)
William Geiger (USEPA Region 3)	7909 7288 2816 (3 copies)
James Cutler (VDEQ)	7992 9868 3826 (1 copy)
Durwood Willis (VDEQ)	7989 0843 4610 (1 copy)
E. Lohman (VDEQ)	7920 3111 7784 (1 copy)

Thank you for your support of the Radford AAP Installation Restoration Program.

Jim McKenna

Classification: UNCLASSIFIED
Caveats: NONE

FINAL

Work Plan Addendum 25
RFI Work Plan RAAP-047
Radford Army Ammunition Plant

TCE Plume at Buildings 1549, 1041 and 1034

May 2008

Joe Quinnan
Project Hydrogeologist

Christopher Sharpe
Site Manager

Tim Llewellyn
Project Manager

Final

Radford Army Ammunition Plant RAAP-047 RFI Work Plan

TCE Plume at Buildings 1549, 1041, and 1034

Prepared for:
Radford Army Ammunition Plant

Prepared by:
ARCADIS
1114 Benfield Blvd
Suite A
Millersville
Maryland 21108
Tel 410-987.0032
Fax 410.987.4392

Our Ref.:
GP08RAAP.0047

Date:
May 2008

Table of Contents

RFI Work Plan for TCE Plume at Buildings 1034,1041, and 1549 (RAAP-047)

Figures

Appendices

List of Acronyms and Abbreviations

AEC	Army Environmental Command
AMSL	above mean seal level
ARCADIS	ARCADIS U.S., Inc.
ASD	Alternate Source Demonstration
bgs	below ground surface
COCs	constituents of concern
CSM	Conceptual Site Model
ES	Engineering Science, Inc
GFPR	Firm Fixed-Price Remediation
HSP	Health and Safety Plan
HWMU	Hazard Waste Management Unit
IRP	Installation Restoration Program
MMA	Main Manufacturing Area
MWP	Master Work Plan
NRU	Net River Unit
PCE	tetrachloroethene
QA/QC	Quality control/quality assurance
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RFAAP	Radford Army Ammunition Plant
RFI	RCRA Facility Investigation
RFI/CMS	RCRA Facility Investigation/ Corrective Measures Study
SBA	South Bank Area
SOPs	standard operating procedures
SWMU	Solid Waste Management Unit
SVOCs	semivolatile organic compounds

List of Acronyms and Abbreviations Continued

TAL	Target Analyte List
TCE	trichloroethylene
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
VAP	Vertical aquifer profiling
VOC	volatile organic compound
VDEQ	Virginia Department of Environmental Quality

1.0 Introduction

ARCADIS U.S, Inc. (ARCADIS) has been retained by the United States Army Environmental Command (AEC) to perform Installation Restoration Program (IRP) activities at Radford Army Ammunition Plant (RFAAP), located in Radford Virginia. This work is being conducted under a Performance Based Contract (PBC) that encompasses the New River Unit (NRU), two Solid Waste Management Units (SWMUs), and one Hazard Waste Management Unit (HWMU) currently under RCRA Recovery Act (RCRA) Part II Permit.

This site-specific RCRA Facility Investigation (RFI) Work Plan addresses the trichloroethene (TCE) plume identified as RAAP-047 in wells 5W5B, 5W21, 5W22 and 5W23, and the suspected source areas identified as Buildings 1034, 1041, and 1549 in the Main manufacturing Area (MMA). This plan incorporates by reference applicable sections of the Master Work Plan (MWP) (URS, 2003) and Standard Operating Procedures (SOPs). The health and safety requirements for all fieldwork at RAAP-047 are included in the Health and Safety Plan (HSP) addendum, which will be provided under separate cover as will the ARCADIS Quality Assurance Project Plan (QAPP) addendum to the Master Work Plan. This Work Plan is being submitted as Addendum 25 to the Master Work Plan.

1.1 Purpose

The purpose of this Work Plan is to facilitate the collection of the data necessary to complete a RFI for the three buildings suspected of being a source of TCE in groundwater (RAAP-047). Each building in RAAP-047 has a documented history of solvent use, but no confirmed releases. Additionally, the data collected under this investigation will be used to support an Alternative Source Demonstration (ASD) for HWMU-5 (RAAP-042). The ASD requires identification of the alternative source of TCE in groundwater east of HWMU-5, and demonstration of a valid contaminant migration pathway from that source, in order to be approved by the Virginia Department of Environmental Quality (VDEQ). This work plan describes the phased approach of a targeted investigation designed to meet these objectives. As described in Section 2.0, USEPA's interactive triad approach (USEPA, 2004) will be used to guide the work utilizing various field techniques that build on each other to define the site conditions. This approach will allow a focused investigation that adapts to the site conditions, in real time, as they are defined. As discussed under Section 2.0, adaptive decisions will be made with input from all Stakeholders at specific decision points as the work proceeds.

The first phase will be used to characterize the subsurface conditions, including the distribution of any contamination, around the three buildings, and along the trace of a surface drainage swale. Additional phases of the investigation that target transport mechanisms and pathways may be required as the site conditions are defined by the initial phase will be refined during decision point meetings. Data will be evaluated both for the successful completion of the RAAP-047 RFI and an approved ASD required at HWMU 5 (RAAP-042) by:

- Delineating any environmental impacts around the three buildings for an approved analyte list (Section 4.0) and around well cluster 5W5B, 5W21, 5W22 and 5W23 for TCE;

- Evaluating whether past releases (if any) at the three specified buildings are the source of the persistent, low-level TCE observed in groundwater at monitoring wells adjacent to HWMU-5 by evaluating contaminant migration pathways; and,.

- Using the RFI data to complete the ASD at HWMU 5 demonstrating an alternative source and valid migration pathway.

This work plan has been prepared in accordance with the requirements of Virginia Department of Environmental Quality (VDEQ) and United States Environmental protection Agency (USEPA). The scope of this investigation will be dynamic and adaptive, following the model of USEPA's Triad approach (2004) to expedite investigation and potential corrective action selection during the Corrective Measures Study (CMS).

The intent of this work plan is to define the objectives and methods of the investigation, rather than provide a prescriptive scope of work. As the investigation proceeds, new data will provide direction for additional work. The goal is to adapt the scope based on these findings in real-time, using streamlined communications and data evaluation methods. Project Stakeholders (i.e., USEPA, VDEQ, AEC, USACE, and RFAAP) will be kept informed of progress so that interim decisions can be made swiftly to keep the investigation moving forward.

This work plan describes a generalized scope of work with anticipated decision-making points identified throughout the process. The ultimate course of the investigation will be determined by intermediate decisions made by the Stakeholders based upon data obtained as the investigation proceeds. This approach will focus investigation efforts

on the project objectives, reduce decision-making uncertainty, and ultimately optimize both the speed and effectiveness of the investigation.

Upon completion of this investigation, ARCADIS will prepare and submit a RFI report including a human health risk assessment (HHRA) and if necessary Ecological Risk Assessment. In addition, a separate ASD report will be prepared once sufficient information has been compiled, as agreed to by all parties.

1.2 Objectives of the Investigation

This investigation has four major objectives as follows.

- Complete an RFI for RAAP-047 including a Human Health and Ecological Risk Assessment;
- Determine whether or not Buildings 1034, 1041 and 1549 are potential sources of the TCE observed in groundwater samples collected from wells 5W21, 5W22, 5W23 and 5W5B located near HWMU-5;
- Evaluate the path by which the TCE is reaching wells 5W21, 5W22, 5W23 and 5W5B: and,
- Collect adequate data to complete an ASD at HWMU-5 (RAAP-042).

1.3 Conceptual Site Model

RAAP-047 is located in the South Bank Area (SBA) of the Radford Army Ammunition Plant's MMA. The SBA is on north sloping ground, spanning the one mile distance between the New River, to the north, and the foot of a ridge to the south (Figure 1). Based on borings completed near HWMU-5, the shallow geology consists of alluvial deposits overlying karst-affected dolomite bedrock. The generalized stratigraphic column for this area is summarized in the table below.

Unit	Likely depth to upper surface	Characteristics
Floodplain and alluvial terrace deposits.	0 feet bgs	Fining upward alluvial sequence or sequences. Basal deposits may locally include several feet of rounded cobbles, often in a finer grained matrix (i.e., "riverjack").

Unit	Likely depth to upper surface	Characteristics
Epikarst	10 to 30 feet bgs	Zone of partially weathered dolomite rock and residuum of irregularly varying competency. Bedrock surface interpreted to be pinnacled. Solution pockets between rock pinnacles may be open or thinly-filled void space.
Elbrook Formation dolomite bedrock	15 to 50 feet bgs	Highly deformed, fractured and karst weathered dolomite. Solution cavities may form integrated conduit networks.

The water table beneath RAAP-047 is expected to occur within the alluvium, approximately 10 feet below ground surface (bgs), and likely 1,770 to 1,790 feet above mean seal level (AMSL). The New River water surface is about 1,690 ft AMSL nearest RAAP-047, and is expected to be the ultimate point of discharge for groundwater flowing beneath RAAP-047. Groundwater flow may occur within the alluvium, epikarst and in bedrock. Flow occurring in the epikarst or in bedrock may be rapid and focused within discrete conduits that are discharging at springs into the New River. A tracer study completed at SWMU-17, approximately 3,000 feet southeast of RAAP-047, has demonstrated the potential for rapid conduit-dominated groundwater flow (ES, 1994).

Wells 5W21, 5W22, 5W23 and 5W5B located near HWMU-5 (where TCE has been detected) are screened within the epikarst. The source of the TCE observed at these wells is currently unknown. The three buildings included in RAAP-047 have been identified as potential sources of TCE based on historical solvent use. As reported in the Draft ASD, each building is a potential, but unconfirmed source. The following are brief descriptions of the buildings and their historical solvent use:

- **Building 1034.** A 10,000 ft^2 former nitrocellulose laboratory, now an electrical and refrigeration shop. Records indicate that DuPont Cleaning Solvent # 49 (which contains tetrachloroethene [PCE]) was used in electric motor cleaning.

- **Building 1041.** A 1,200 ft^2 former degreasing shop, now scale maintenance and cleaning shop. The building formerly contained a solvent dip tank, and may have drained via a terracotta pipe to an underground storage tank.

- **Building 1549.** A 2,400 ft^2 area maintenance shop. Employee interviews suggested that in the past, spent solvents had been disposed of in floor drains.

2.0 General Approach to Investigation

Using USEPA's Triad Approach (2004), a three-phase approach has been developed for the site characterization which encompasses source identification; evaluation of transport pathways; and delineation of contamination. The dynamic investigation approach presented herein streamlines the site characterization process by providing multiple points at which the Conceptual Site Model (CSM) can be updated as each phase of the investigation is completed. This provides the opportunity to obtain regulatory acceptance of the CSM as it develops rather than waiting for submission of the RFI.

This investigation is structured with a sequence of major components divided by decision points. At each decision point, data collected to that point will be used to update the CSM and refocus any additional work on meeting the project objectives in conjunction with the project Stakeholders. The major components of the anticipated work and their expected order of implementation are discussed below and presented in Figure 4. Details of the investigations are provided as Section 4.0.

1. **Direct Push Boring Investigation**. Anticipated sampling zones are designated on **Figure 3**.

a. **Soil Gas Study**. Soil gas data will be used to conduct a preliminary screening to identify and locate volatile organic compound (VOC) source material, if present. A minimum of 20 soil gas samples will be collected inside and outside of the RAAP-47 buildings and along the trace of underground utilities (if considered a possible migration pathway).

b. **Soil Borings**. Direct Push soil sampling will be completed in conjunction with the soil gas study to investigate potential release points and/or at locations identified. Three borings will be installed at Bldg 1549; a total of 10 borings will be installed in the area of Bldgs 1041 and 1034. Soil samples will be collected to assess the surface and subsurface soils as part of the RFI. Up to two depth discrete samples will be collected from each of the borings. The deeper sample will be held pending the analytical results of the shallower sample. Soil samples will be collected above the water table. An additional four borings will be located in a drainage ditch located between Building 1549 and the TCE impacted monitoring wells located near HWMU-5.

c. **Shallow Source Area Groundwater Sampling**. Groundwater samples will be collected from inferred source areas to assess potential groundwater impacts around the buildings. The decision on the location and number of the shallow source-area groundwater samples will be made in the field after review of the soil data collected under Step 1b. If turbidity is high then temporary groundwater wells may be installed and/or filtered and unfiltered samples collected.

Decision Point. Field data and analytical results from Direct Push Sampling will be summarized and presented to the Stakeholders as a data transmittal/brief technical memorandum. If TCE or other chemicals of interest are detected then the investigation will proceed to Step 2 described below. If no TCE sources or other chemicals of interest associated with the three buildings have been identified then a reassessment of the potential sources may need to occur and the next phase of the investigation will need to be redefined. Potential alternate sources include the area between HWMU-5 and impacted monitoring wells. If this is identified as a potential source based on data gathered during Step 1, soil and groundwater samples between HWMU-5 and impacted monitoring wells may be collected.

2. **Vertical Aquifer Profiling**. If TCE or other chemicals of interest have been detected at one or more of the three buildings, groundwater samples will be collected along one or two transects crossing the presumed groundwater flow path between the buildings and the impacted monitoring wells and vertical aquifer profiling (VAP) of the overburden may be completed. If no groundwater impacts are identified based on the VAP sampling, the focus of the investigation will be to complete the RFI for the buildings (RAAP 047). The investigation will also be refocused to continue support of the ASD for HWMU-5 as described under the first decision point.

Decision Point. Field data and analytical results from Step 2 will be summarized and presented to the Stakeholders as a data transmittal/brief technical memorandum. If profile borings and groundwater data do not indicate a clear groundwater transport pathway (but chemicals of interest in groundwater have been detected upgradient of well cluster 5W5B, 5W21, 5W22 and 5W23), additional investigation (tracer studies and additional VAP) may be performed.

3. **Tracer Study**. A tracer study may be conducted to evaluate surface or groundwater flow-paths and transport velocities if investigations to this point suggest that surface flow or karst processes are significant potential transport mechanisms. A tracer study will be considered if conduits in bedrock or

preferential pathways at the bedrock surface (i.e., epikarst) are suspected of providing migration pathways for TCE from the buildings to the impacted wells. The study results will be used to identify potential groundwater discharge points (e.g., springs), where monitoring would be appropriate. The results will be used to focus the groundwater investigation for the plume delineation and evaluate if a connection exists between the suspect source(s) and TCE-impacted monitoring wells near HWMU-5.

Decision Point. The results of the tracer study will be summarized and presented to the Stakeholders as a data transmittal/brief technical memorandum. If the tracer study demonstrates karst-controlled flow (e.g., rapid, conduit dominated, non-diffuse flow), ARCADIS will evaluate those pathways in a manner appropriate for karst groundwater flow.

4. **Contaminant Delineation**. If site characterization data indicate that one of the investigated areas identified as part of RAAP-047 is a source of COCs to the subsurface, ARCADIS will evaluate the extent of those impacts in a manner appropriate to the impacted media. If the investigation suggests that groundwater in bedrock conduits is impacted, ARCADIS will not attempt to delineate those impacts using monitoring wells. Monitoring wells may however be required to delineate impacts in the overburden, but are technically inappropriate to investigate the distribution of solutes in a karst aquifer. The preferred approach for karst systems is tracer studies and spring sampling as described in Step 3.

3.0 Project Communication and Decision Making

Open and frequent communication is an essential component of the proposed dynamic approach to this investigation. Rapid regulatory concurrence will be necessary at several decision points structured into the investigation. ARCADIS anticipates that a communication plan will include the following.

- Preliminary agreement on the project objectives, the investigation approach, and in-principal agreement on a decision making tree.

- Prior acceptance of informal submission types (e.g., technical memoranda) as grounds for decision making.

- Development of a record-keeping system to document Stakeholder decisions, and register comments and concerns.

Dynamic and adaptive investigations are founded upon a solid relationship between the various Stakeholders involved in the process. Open communication, and decision making based on data and focused on the project objectives are essential. Face-to-face meetings, conference calls, technical memoranda, and "live-meeting" software will all be used as tools to facilitate the decision making process. Material anticipated to be presented during the decision point meetings including the following:

- A summary of analytical results for samples collected to date;
- Figures depicting the locations of samples collected thus far;
- Conceptual Site Model. After each component of the investigation is completed, the CSM will be updated and provided to the stakeholders. The CSM will be updated to include water table data and karst features as these data become available;

4.0 Figures depicting the locations of propose samples to be collected during the next investigation component.Sampling and Investigation Procedures

The section describes the tasks that are expected to comprise this investigation. Both the scope of investigations, and the procedures and methodologies described herein are considered dynamic and adaptive, and therefore, subject to change as new data improve the CSM. The project Stakeholders will be consulted for all substantial deviations.

General procedures for the investigations, as they are currently envisioned, are provided in Appendix A of this document, or in the Final Master Work Plan (URS, 2003), as referenced. Quality assurance/quality control procedures are described in the Master Quality Assurance Plan (Volume II of the Final Master Work Plan). Health and safety procedures will be described in a forthcoming site-specific health and safety plan.

4.1 Preliminary Site Inspection and Utility Mark-Out

Prior to any subsurface investigation, ARCADIS will complete a preliminary site inspection and utility mark-out. Field personnel will perform the following activities.

- Consult with installation personnel about the location of above and below ground utilities, tanks, foundations or process lines that may form drilling hazards or represent potential TCE release points.

- Obtain, if feasible, installation utility maps.

- Evaluate potential subsurface investigation locations with respect to access and potential hazards.

- If appropriate, supervise a professional utility locator for the mark-out of the anticipated investigation locations.

- Obtain any necessary site-specific work permits.

4.2 Direct Push Boring Investigation

ARCADIS will collect samples of soil, soil gas and groundwater via direct push. Two sub-slab soil gas samples will be collected from targeted points within the basement of the addition to Building 1034. Boring locations will be biased based upon field observations of potentially suspect areas. Anticipated boring locations are shown on Figure 3.

The borings are expected to be distributed as follows.

- Ten borings adjacent to Buildings 1041 and 1034;

- Three borings adjacent to Building 1549;

- Four borings within or adjacent to the drainage ditch north of Building 1549.

Borings will be completed as close to the buildings as feasible, at locations chosen in the field to optimize proximity to potential release points. Additional borings may be completed for preliminary delineation of impacts if screening results (e.g., elevated photoionization detector [PID] readings), indicate that an area may be impacted.

An initial boring outside each building will be advanced to refusal in order to determine the shallow lithology and the feasible depth of direct-push borings. If borings can be advanced to the water table without repeated attempts, the direct push sampling program will proceed at follows.

- Two sub-slab soil gas samples will be collected from beneath Building 1034.

- A minimum of 20 soil gas samples will be collected from a depth judged to be deeper than the building footings (estimated 5 to 10 feet). Soil gas samples will be analyzed for VOCs by method TO-15.

- Soil borings will be advanced in a minimum of 12 locations (4 per building; one per side and 4 locations in the drainage ditch). A minimum one sample will be collected from each boring and analyzed for VOCs, semivolatile organic compounds (SVOCs), metals, polychlorinated biphenyls (PCBs), and explosives compounds.

- If groundwater is encountered, one grab groundwater sample will be collected from each boring and analyzed for VOCs, SVOCs, metals, PCBs, and explosives compounds. Depending upon turbidity, grab groundwater samples may be collected from temporary wells, or from filtered and unfiltered samples for PCBs and metals.

If sample collection from direct-push borings is infeasible because of subsurface conditions, then deep (or sample volume intensive) sampling will be deferred until the next phase of work utilizing a sonic rig or other methodology. In this case, the use of direct push borings will be focused upon collecting soil gas samples.

Sub-slab soil gas samples and exterior soil gas samples will be collected following the procedures defined in ARCADIS SOP-1 and SOP-2, respectively, provided in Appendix A. Soil and groundwater samples will be collected via direct push consistent with procedures outlined in SOP 20.11 and 20.12. Stratigraphic logs will be prepared for each boring location in accordance with SOP 10.3.

4.3 Vertical Aquifer Profiling

VAP groundwater sampling may be completed down gradient of observed impacts to evaluate potential flow paths in the overburden if appropriate based on data collection to that point.

Figure 3 depicts two potential VAP groundwater sampling transects. The southern transect will be completed if COCs are observed at either Buildings 1041 or 1034. The northern transect will be completed if impacts are observed at any of the buildings.

VAP borings will be advanced by a sonic drilling rig to the top of competent bedrock. The drilling method will permit collection of detailed lithologic data and allow groundwater sample collection from selected intervals.

ARCADIS anticipates collecting two groundwater samples using screen points from each VAP location. Samples will be collected on a protocol biased toward distinct stratigraphic intervals but at least at ten-foot intervals, starting at the water table. Each transect is anticipated to include five VAP groundwater sampling locations, spaced no greater than 60 feet apart. If preliminary data clearly identify a source area, additional VAP borings may be installed to define the lateral and vertical extents of impacts. The southern transect will be completed if VOCs are observed at either Buildings 1041 or 1034 and believed to be migrating north and the northern transect will be completed if VOC impacts are observed at any of the buildings and thought to be migrating north towards the river. VAP will be performed following ARCADIS SOP-3 provided in Appendix A.

4.4 Source Area Monitoring Wells

If data collected up to this point in the investigation indicate that a source area relating to one of the areas identified as RAAP-47 exists, then ARCADIS anticipates installing one to three permanent monitoring wells in the vicinity of the inferred source. The wells will be used to characterize groundwater quality and provide hydraulic information.

Monitoring well construction will be determined in consultation with the Stakeholders, and will be dependent on the understanding of the CSM at that point. Construction methods and materials will be based on procedures given in the Final Master Work Plan.

ARCADIS anticipates installing the source area monitoring wells in the overburden. If contamination is found in bedrock water bearing zone, a tracer study will be performed.

4.5 Tracer Test

A tracer study may be completed if:

- A potential source area relating to one of the RAAP-047 buildings has been identified, and

- The data suggest that transport of chemicals of interest in groundwater may be affected by high-permeability preferential pathways, either in the epikarst or via karst conduits in bedrock.

The goal of a tracer study would be to identify transport flow paths and assess the nature of transport processes. The results of a tracer study would provide an understanding of the groundwater system to enable development of delineation and monitoring network (Section 4.6).

ARCADIS anticipates that a tracer study would generally conform with the procedures outlined in the Final Master Work Plan (URS, 2003). However, if a tracer study is ultimately included in this investigation; final design of the study would be done following the refined understanding of the CSM in consultation with the Stakeholders. .

4.6 Plume Delineation

If a source is found at one or more of the RAAP-047 potential source areas, the final stage of this investigation will be plume delineation. Note at this point, it may be appropriate to complete the ASD report if agreed to by all parties. Delineation sampling will collect a sufficient number of samples to complete the RFI. The ultimate scope of the investigation will depend on the location of the source or sources and the transport paths that it is inferred to take. ARCADIS anticipates that full delineation may require a combination of:

- Additional monitoring wells, if existing wells are not sufficient,
- Additional tracer testing, and
- Spring monitoring.

ARCADIS will delineate the extent of groundwater impacts relating to RAAP-047 to the degree necessary to complete the RFI. The scope of investigations needed to meet this requirement will be decided by Stakeholders in due consideration of the CSM. If this investigation shows that a principal transport pathway of COCs is via groundwater in karst solution conduits, ARCADIS will focus delineation efforts on mapping points of discharge (e.g., springs), and evaluating groundwater quality at those points of discharge. The intent of monitoring wells, if installed, will be delineation of potential TCE and other chemicals of interest in the overburden.

4.7 Surveying

Horizontal coordinates and ground surface elevations for soil borings will be obtained using a GPS unit. Horizontal coordinates and vertical elevations of each monitoring well will be surveyed by Virginia licensed surveyor experienced working at RFAAP. Horizontal coordinates (northing and easting) will be surveyed using the North American Datum of 1983. At each monitoring well location, the ground surface elevation and elevation of the top of the inner well casing used for measuring water levels will be surveyed to the nearest 0.01 ft.

5.0 Quality Control

Quality control/quality assurance (QA/QC) for this investigation will be handled in accordance with the Master QAPP (URS, 2003) as amended by the ARCADIS Project QAPP, submitted under a separate cover. The ARCADIS Project QAPP describes sample management, analytical procedures (including reporting limits and laboratory control limits), quality control checks, and data validation. This site-specific QAPP presented below summarizes the analyses to be performed, and QA and quality control (QC) samples for the RAAP-047 RFI.

5.1 Data Quality Objectives for Measurement Data

Data Quality Objectives (DQOs) for RAAP-047 have been designed to characterize the nature and extent of contamination at the Site. Additional analyses have been included that will provide for data of particular use to the RAAP-042 ASD.

In addition to the qualitative DQOs discussed above, the analyses conducted will also conform to the project DQOs pertaining to field sampling methodology and laboratory-specific DQOs referenced in the Project QAPP.

5.2 Measurement/Data Acquisition

Field, laboratory, and data handling procedures relating to activities performed at RAAP-047 will conform to the specific requirements detailed in the Master Work Plan or in the ARCADIS Project QAPP as identified below.

Subject	MWP Section	SOP(s)
Sample management	5.1	50.1, 50.2, 50.3
Documentation	4.3	10.1, 10.2, 10.3, 10.4

Direct Push Methods	5.2.3.3	20.12
Well Drilling/Installation	5.2	20.1, 20.2, 20.11
Boring Logs / Stratigraphic Characterization	5.2.5	10.3
Soil Sampling	5.2.8	30.1, 30.7, 30.9
Groundwater Sampling	5.2.10.3	20.12, 30.2
Soil Gas Sampling	NA	ARCADIS SOP 1 and 2
Vertical Aquifer Profiling	NA	ARCADIS SOP 3
Decontamination Requirements	5.12	80.1
Investigation-Derived Material	5.14	70.1

Because of the dynamic and adaptive nature of this work plan, the exact numbers of environmental samples has not been determined. Therefore, the number of quality control (QC) samples to be collected at RAAP-047 can not be specified. However, in accordance with the project requirements, duplicate samples, will be collected at a rate of one sample per 20 for each sample matrix, equipment blanks will be collected at a rate of 1 per 20 per medium where dedicated equipment is not used, trip blanks will accompany every cooler containing aqueous VOC samples; and temperature blanks will be provided in every shipping container requiring controlled temperatures.

5.3 Assessment/Oversight

Assessment and oversight activities for this site will be conducted in accordance with the Project QAPP.

5.4 Data Validation and Usability

Data validation for samples collected and analyzed from RAAP-047 will be conducted in accordance with Section 9.5 of the Master QAPP (URS, 2003) and the ARCADIS Project QAPP.

6.0 Investigation Derived Materials

Investigation derived materials (IDM) will be managed in accordance with SOP 70.1 in the Master Work Plan (URS, 2003). Investigation derived materials include soil

cuttings, purge water, decontamination water, and disposable supplies that have contacted impacted media.

7.0 Reporting

The results of the field investigations will be used to develop a site-specific HHRA and SLERA. The field investigation results, HHRA, and SLERA will be presented in a RFI Report that will serve as the basis for corrective action decisions at this site. The RFI Report will present the results and conclusions based upon this investigation and will detail and select the remaining steps necessary to achieve closure at this site under the RCRA process. In addition, if the investigation yields sufficient information to identify a source of the TCE in groundwater proximal to HWMU 5 that data will be used to support a revised ASD for HWMU 5. The ASD will present a description of the alternate source and the identified pathways. If no alternate source is found, or if a source is found but no pathway to the impacted wells could be identified, the report will include the results of the investigation up to that decision point.

8.0 References

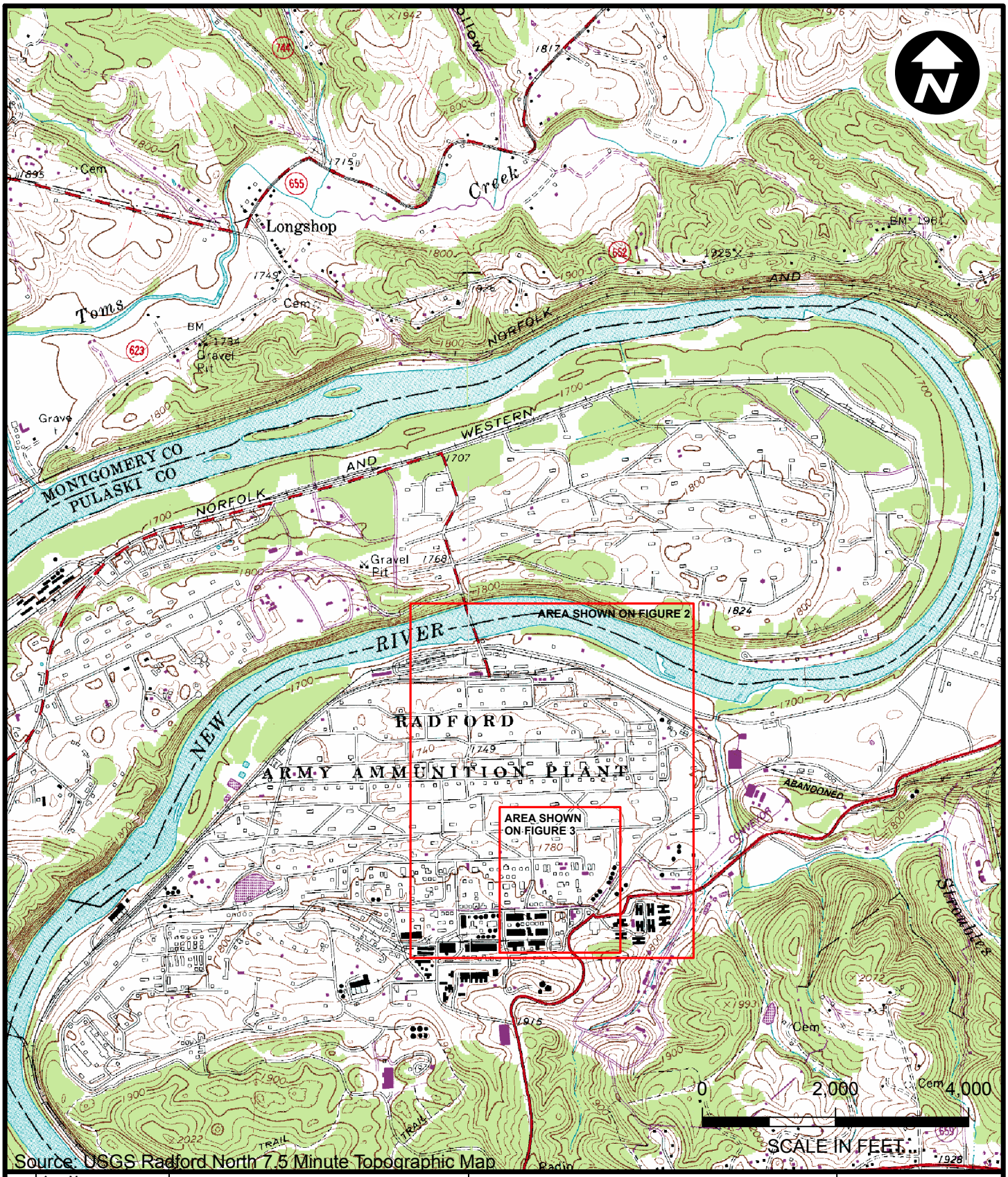
Draper Aden Associates. 2007. Alternative Source Demonstration for Trichloroethene, Hazardous Waste Management Unit 5, Radford Army Ammunition Plant. April

Engineering Science, Inc (ES), 1994, Dye Tracing Study Report for the Radford Army Ammunition Plant.

U.S. Environmental Protection Agency (USEPA.). 2004. Summary of the Triad Approach. Office of Superfund Remediation Technology Innovation. March 25.

URS, 2003, Final Master Work Plan, Radford Army Ammunition Plant, Radford, Virginia.

Figures



Source: USGS Radford North 7.5 Minute Topographic Map

Area Manager	
Project Director	
Task Manager	
Technical Review	

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RADFORD ARMY AMMUNITION PLANT

SITE LOCATION
MAIN MANUFACTURING AREA

RADFORD, VIRGINIA

Project Number	GP08RAAP.0047
Date	12-MAR-2008
Figure Number	1

Area Manager	
Project Director	
Task Manager	
Technical Review	

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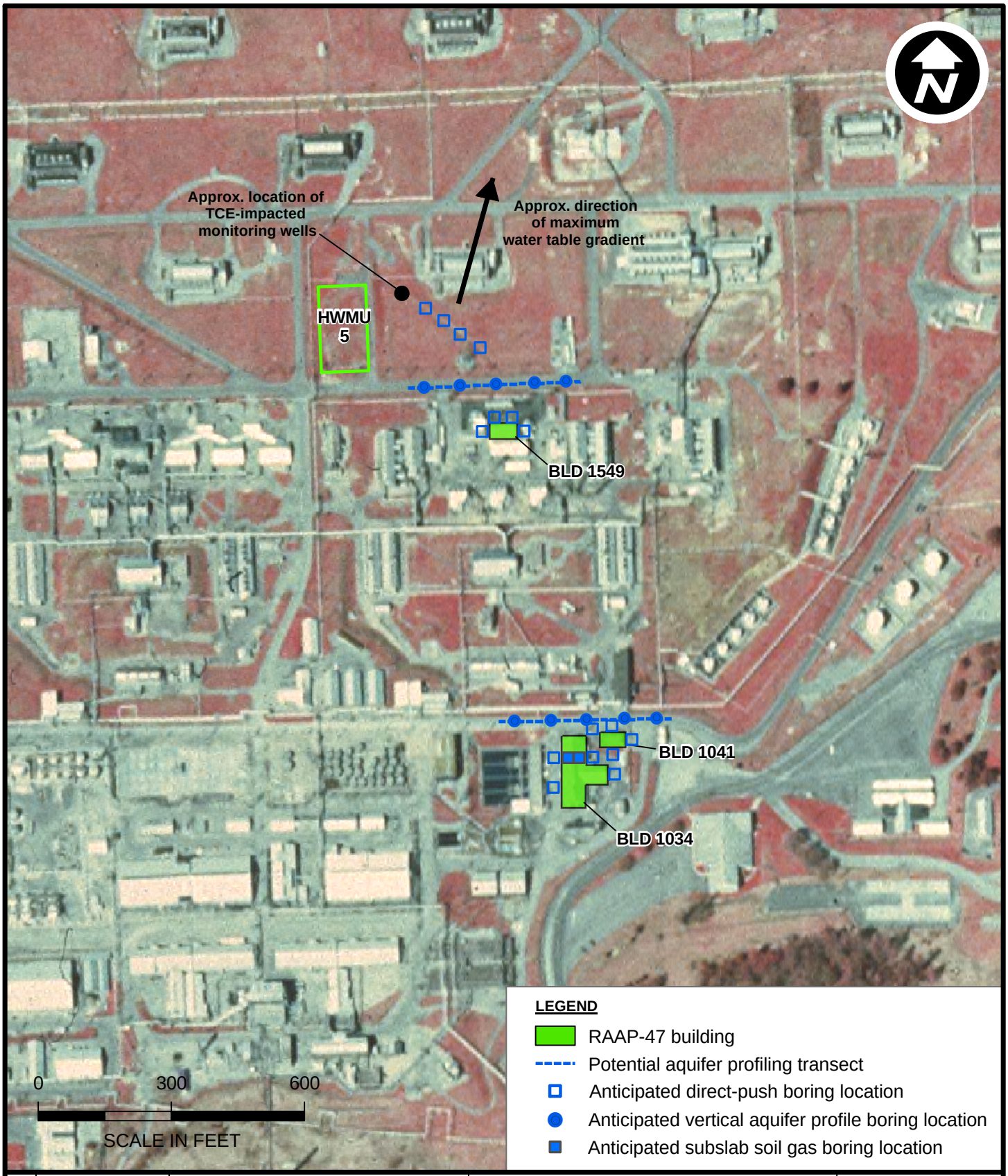
RADFORD ARMY AMMUNITION PLANT

RAAP-47
BUILDING LOCATIONS

RADFORD, VIRGINIA

Project Number	GP08RAAP.0047
Date	12-MAR-2008
Figure Number	2



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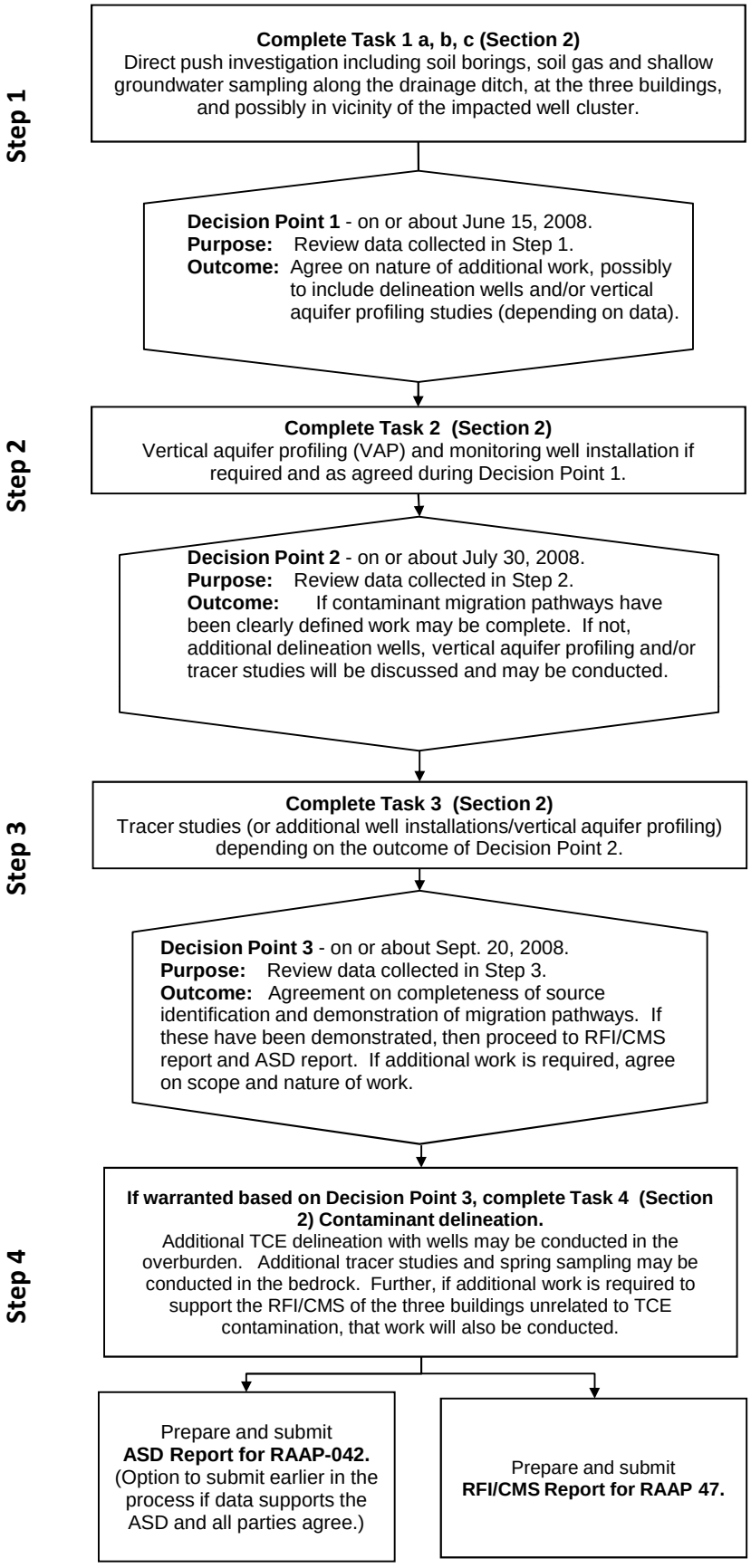
RADFORD ARMY AMMUNITION PLANT

RAAP-47 PRELIMINARY INVESTIGATION LOCATIONS

RADFORD, VIRGINIA

Project Number	GP08RAAP.0047
Date	25-APRIL-2008
Figure Number	3

Figure 4
Flow Chart
RAAP-047, Radford Army Ammunition Plan



Appendix A

Standard Operating Procedures

STANDARD OPERATING PROCEDURE NO. 1

Sub-slab Soil Vapor Sampling

Rev. #: Internal Draft

Rev Date: March 14, 2008

1. Scope and Application

This document describes the procedures to collect sub-slab soil vapor samples for the analysis of volatile organic compounds (VOCs) by U.S. Environmental Protection Agency (USEPA) Method TO-15 (TO-15). The TO-15 method uses a 6-liter SUMMA® passivated stainless-steel canister. An evacuated 6-liter SUMMA® canister (< 28 inches of mercury [Hg]) will provide a recoverable whole-gas sample of approximately 5.5 liters when allowed to fill to a vacuum of 2 inches of Hg. The whole-air sample will be analyzed for VOCs using gas chromatograph/mass spectrometer (GC/MS) system to provide compound detection limits of 0.5 parts per billion volume (ppbv).

The following sections list the necessary equipment and provide detailed instructions for the installation of temporary and permanent soil gas probes (using direct-push technology and steel probe rods), checking the integrity of sampling vapor points with helium tracer gas, and the collection of soil gas samples for VOC analysis.

2. Personnel Qualifications

ARCADIS field sampling personnel will be in full accordance with the Site Health and Safety Plan (HASP). ARCADIS personnel responsible for leading subsurface soil gas sample collection activities will have previous subsurface soil gas sampling experience.

Equipment: Hammer Drill; 3/8 in. bit; tedlar bags; peristaltic pump; ¼ inch ID Masterflex tubing; concrete sealant; 6-L Summa™ canister; regulator; barometer

3. Equipment List

3.1 Installing a Soil Gas Point

The general equipment required to install a sub-slab soil vapor point for collection of samples is presented below. If a permanent vapor point is to be installed, the additional equipment listed in 3.1.1 is required. If a temporary vapor point is to be installed refer to 3.1.2 for additional equipment.

- Appropriate personal protective equipment (PPE) (as required by the site specific ARCADIS Health and Safety Plan)
- Hammer Drill (and identified power source)
- Spare concrete bits (one per sample location)

3.1.1 Specifics for temporary vapor point installation:

- 1-2 ft stainless steel tubing (1 per sample location of sufficient length to penetrate slab);
- Tygon tubing, fittings, and all required supplies;
- Commercially available model clay (for sealing around probe); and,
- Tubing of sufficient diameter to slip over stainless steel probe and ¼ inch ID tubing (listed below, note that tubing connections should provide a snug connection).

3.2 Sample Collection

- The equipment required for soil gas sample collection is presented below: Stainless steel 6 L SUMMA® canisters
    - Cans should be batch certified as clean
    - Order one spare canister if possible
- Flow controllers with in-line particulate filters and vacuum gauges; flow controllers are pre-calibrated to specified sample duration (e.g., 30 minutes, 8 hours, 24 hours) or flow rate (e.g., 200 milliliters per minute [mL/min]); confirm with the laboratory that the flow controller comes with an in-line particulate filter and pressure gauge (order at least one extra, if possible)
- ¼-inch I.D. tubing (Teflon® or Teflon® lined)
    - Available from McMaster-Carr (#5466K14)
    - Store tubing away from sources of contamination (fuels, solvents, etc.)
- Stainless Steel Swagelok fittings and ferrules (supplied by lab providing Summa® canisters)
- Stainless steel “T” fitting (if collecting duplicate [i.e., split] samples, also certified clean and supplied by laboratory supplying canisters)
- Portable vacuum pump capable of producing very low flow rates (e.g., 100 to 200 mL/min)

  - Pump should be equivalent to SKC 222 series, with additional flow restrictor and effluent port if necessary

- If vacuum pump does not have a flow gauge; calibrate with Rotameter or an electric flow sensor
  - Test final vacuum pump flow rate by discharging into a Tedlar bag
- 2 small adjustable wrenches
- Chain-of-custody form (COC)
- Sampling summary logs
- Field notebook
- Nitrile gloves

4. Cautions

The sample locations should be checked for the presence of utilities prior to sample point installation.

All sampling equipment and supplies should be inspected by field personnel upon receipt prior to mobilization.

Sampling personnel should not handle hazardous substances (such as gasoline), permanent marking pens, or smoke cigarettes before and/or during the sampling event. Sampling crew should also wear nitrile gloves when handling tubing, connectors or SUMMA® canisters to avoid contamination.

Care should also be taken to ensure that the flow controller is pre-calibrated by the supplying laboratory to the proper sample collection time (confirm with laboratory). Sample integrity is maintained if the sampling event is shorter than the target duration, sample integrity can be compromised if the event is extended to the point that the canister reaches atmospheric pressure. Sampling personnel should record vacuum pre and post sampling, post sampling vacuum should not reach zero vacuum (2 inches of Hg is target).

Care must be taken to maintain integrity of tubing. Tubing can easily pick up contamination and yield faulty results upon laboratory analysis. Do not store tubing near sources of possible contamination including fuels, solvents, exhaust, cigarette

smoke, etc. Use a new piece of tubing for each sample, if there is any question on the quality or cleanliness of tubing, then it will be replaced. Equipment used for tracer gas testing should also be kept clean. The bucket used should be clean and in good condition.

If samples from multiple depths are to be collected at a given location, the shallowest sample should be taken first. Also, multiple depth samples cannot be taken from the same vapor point push. If multiple depth samples are required, separate vapor points should be installed at the location with at least a few feet separating vapor points.

5. Procedure

5.1 Point installation/ preparation

- Prior to subslab vapor probe installation, identify and mark utilities coming into the building from the outside (e.g., gas, water, sewer, refrigerant, and electrical lines) and utilities beneath (inside) the building.
- Core/drill hole through cement slab.
- Drill an approximately 3/8 inch boring approximately 3 inches into subslab soil.
- Remove the drill and cover the hole with inert material until the probe is ready to be inserted.
- Install sampling apparatus (i.e., commercially available soil vapor point and tubing) so that it “floats” in the slab avoiding obstruction with subslab material.
- Seal boring by creating an air-tight seal around sample tubing at ground surface using an inert material (clay).
- Check sampling apparatus connections. Note that barbed union fittings should be used for tubing connections. If there is a problem with obtaining appropriate fittings, the connections may be sealed using an inert material.

5.2 Soil Vapor Collection

- Record the following for each location on Soil Vapor Sample Log:
  - Date;
  - Time;
  - Weather;
    - Atmospheric pressure:
    - Wind conditions; and,
- Approximate depth of probe intake.
- Connect Tygon sample tubing to ¼ inch ID tubing and a peristaltic pump and 1-L Tedlar bag. Use of a peristaltic pump will ensure that sampled air does not circulate through a pump causing potential cross contamination and leakage.
- Purge vapor probe by filling two Tedlar bags or routing purge air to the exterior of the building with tubing. A purge volume of 2 L was calculated based on the assumptions of a 2-inch sampling interval and an affected sample diameter of 0.61 m (2 ft). Purge rate should be approximately 200 cubic centimeters per minute (i.e., 5 minutes per Tedlar bag).
- Record purge date and time (length or start and stop) on Soil Vapor Sample Log
- Collect subslab vapor samples in evacuated 6-L Summa™ polished canisters equipped with regulators to control intake rate. Note that the canister should be certified to the appropriate level for the anticipated results of the samples. Sampling rate should be approximately 200 cubic centimeters per minute. Check vacuum in canisters prior to sampling. At least 4-L of air will be collected in the canister for analysis (i.e. 20 minute collection time at 200 cubic centimeters per minute).

5.3 Termination of Sample Collection:

- Arrive at the SUMMA® canister location at least 10 to 15 minutes prior to the end of the required sampling interval (e.g., 30 to 60 minutes).

- Record the final vacuum measurement. Close the valve on the SUMMA® canister to cease sample collection. The canister should have a minimum amount of vacuum (approximately 2 inches of Hg or slightly greater).

- Record the date and local time (24-hour basis) of valve closing in the field notebook, sampling summary form, and COC.

- Remove the particulate filter (may be part of flow restrictor) and flow controller from the SUMMA® canister, re-install the brass plug on the canister fitting, and tighten with the appropriate wrench.

- Package the canister and flow controller in the shipping container supplied by the laboratory for return shipment to the laboratory. The SUMMA® canister does not require preservation with ice or refrigeration during shipment. Apply custody seals if required by field sampling plan.

5.4 Vapor Point Abandonment

Remove sampling apparatus and seal the borehole annulus with an appropriate sealant to the original surface grade (note duplicate sample collection method below).

5.5 Duplicate Soil Vapor Sample Collection

- Note duplicate sample location on Soil Vapor Sample Log.

- Duplicate samples will be collected using duplicate tees and flow restrictors per laboratory guidance Check vacuum in canisters prior to sampling. At least 4-L of air will be collected in the canister for analysis (i.e. 20 minute collection time at 200 cubic centimeters per minute). Following sample collection, check and record final vacuum in canister. Record Duplicate Sample ID, Date, Time and analysis requested on the Sample Label.

- Submit canisters to a commercial laboratory for analysis.

6. Waste Management

Field personnel will collect and remove all investigation-derived materials (including disposable equipment) for proper disposal following Master Plan SOP 70.1.

7. Data Recording and Management

Measurements will be recorded in the field notebook at the time of measurement following Master Plan 10.1. In addition, the log book will contain the notations of the project name, sample date, sample start and finish time, sample location (e.g., GPS coordinates, distance from permanent structure, canister serial number, flow controller serial number, initial vacuum reading, and final pressure reading. Field sampling logs and COC records will be transmitted to the Project Manager.

Standard Operating Procedure
NO. 2

Soil Vapor Sampling

Rev. #: Internal Draft

Rev Date: March 14, 2008

1. Scope and Application

This document describes the procedures to collect subsurface soil vapor samples for the analysis of volatile organic compounds (VOCs) by U.S. Environmental Protection Agency (USEPA) Method TO-15 (TO-15). The TO-15 method uses a 6-liter SUMMA® passivated stainless-steel canister. An evacuated 6-liter SUMMA® canister (< 28 inches of mercury [Hg]) will provide a recoverable whole-gas sample of approximately 5.5 liters when allowed to fill to a vacuum of 2 inches of Hg. The whole-air sample will be analyzed for VOCs using gas chromatograph/mass spectrometer (GC/MS) system to provide compound detection limits of 0.5 parts per billion volume (ppbv).

The following sections list the necessary equipment and provide detailed instructions for the installation of temporary and permanent soil vapor probes (using direct-push technology and steel probe rods), checking the integrity of sampling vapor points with helium tracer gas, and the collection of soil vapor samples for VOC analysis.

2. Personnel Qualifications

ARCADIS field sampling personnel will be in full accordance with Health and Safety Plan (HASP) developed for sampling site. ARCADIS personnel responsible for leading subsurface soil vapor sample collection activities will have previous subsurface soil vapor sampling experience.

3. Equipment List

3.1 Installing a Soil Vapor Point

The general equipment required to install a soil vapor point for collection of samples is presented below. If a permanent vapor point is to be installed, the additional equipment listed in 3.1.1 is required. If a temporary vapor point is to be installed refer to 3.1.2 for additional equipment.

- Appropriate personal protective equipment (PPE) (as required by the site specific ARCADIS Health and Safety Plan)
- Direct-push drilling rig (e.g., Geoprobe®) equipped with interconnecting lengths of 1.25-inch diameter steel probe rods and Post Run Tubing (PRT) system
- Expendable points (one per sample)

3.1.1 Specifics for temporary vapor point installation:

- PRT compatible expendable point holder and appropriate point popper
- PRT tubing, fittings, and all required supplies
- Commercially available clean sand or play sand

3.2 Sample Collection

The equipment required for soil vapor sample collection is presented below:

- Stainless steel 6 L SUMMA® canisters
    - Cans should be batch certified as clean
    - Order one spare canister if possible
- Flow controllers with in-line particulate filters and vacuum gauges; flow controllers are pre-calibrated to specified sample duration (e.g., 30 minutes, 8 hours, 24 hours) or flow rate (e.g., 200 milliliters per minute [mL/min]); confirm with the laboratory that the flow controller comes with an in-line particulate filter and pressure gauge (order at least one extra, if possible)
- ¼-inch I.D. tubing (Teflon® or Teflon® lined)
    - Available from McMaster-Carr (#5466K14)
    - Store tubing away from sources of contamination (fuels, solvents, etc.)
- Stainless Steel Swagelok fittings and ferrules (supplied by lab providing Summa® canisters)
- Stainless steel “T” fitting (if collecting duplicate [i.e., split] samples, also certified clean and supplied by laboratory supplying canisters)
- Portable vacuum pump capable of producing very low flow rates (e.g., 100 to 200 mL/min)
    - Pump should be equivalent to SKC 222 series, with additional flow restrictor and effluent port if necessary

- If vacuum pump does not have a flow gauge; calibrate with Rotameter or an electric flow sensor
    - Test final vacuum pump flow rate by discharging into a Tedlar bag
- 2 small adjustable wrenches
- Chain-of-custody form (COC)
- Sampling summary logs
- Field notebook
- Nitrile gloves

4. Cautions

All sampling equipment and supplies should be inspected by field personnel upon receipt prior to mobilization.

Sampling personnel should not handle hazardous substances (such as gasoline), permanent marking pens, or smoke cigarettes before and/or during the sampling event. Sampling crew should also wear nitrile gloves when handling tubing, connectors or SUMMA® canisters to avoid contamination.

Care should also be taken to ensure that the flow controller is pre-calibrated by the supplying laboratory to the proper sample collection time (confirm with laboratory). Sample integrity is maintained if the sampling event is shorter than the target duration, sample integrity can be compromised if the event is extended to the point that the canister reaches atmospheric pressure. Sampling personnel should record vacuum pre and post sampling, post sampling vacuum should not reach zero vacuum (2 inches of Hg is target).

Care must be taken to maintain integrity of tubing. Tubing can easily pick up contamination and yield faulty results upon laboratory analysis. Do not store tubing near sources of possible contamination including fuels, solvents, exhaust, cigarette smoke, etc. Use a new piece of tubing for each sample, if there is any question on the quality or cleanliness of tubing, then it will be replaced. Equipment used for tracer gas testing should also be kept clean. The bucket used should be clean and in good condition.

If samples from multiple depths are to be collected at a given location, the shallowest sample should be taken first. Also, multiple depth samples cannot be taken from the same vapor point push. If multiple depth samples are required, separate vapor points should be installed at the location with at least a few feet separating vapor points.

5. Procedure

5.1 Soil Vapor Point Installation

5.1.1 Temporary Vapor Point PRT System Installation

If a temporary soil vapor point with PRT system is to be installed the following steps should be followed:

- Advance an assembly consisting of interconnected lengths of decontaminated 1.25-inch-diameter steel drive rods, affixed with an expendable PRT system point holder and expendable PRT system point at the downhole end, to the bottom of the desired sampling interval.

- When the desired sample depth is reached, retract the sampling assembly approximately 6 inches (or greater if necessary), allowing the expendable point to fall off, and creating a void in the subsurface for soil gas sample collection. Remove pull cap of probe rod and position direct-push rig to allow collection of sample.

- Fit PRT tubing with PRT adaptor, secure connection with Parafilm (film does not contact sample) and fit PRT adaptor with O-ring.

- Insert PRT tubing into steel drive rod. Work tubing to bottom of drive rod until contact with expendable point holder is made. Cut PRT tubing, leaving two feet of extra tubing outside of probe rod.

- Grasp PRT tubing and apply downward pressure while rotating counterclockwise to engage threads with point holder. When threads are fully seated, pull up gently on tubing to test proper thread engagement.

- Proceed to soil gas sample collection (With PRT system no bentonite sealing material is required; the system is airtight).

5.2 Soil vapor Sample Collection

5.2.1 Preparation of SUMMA®-Type Canister and Collection of Sample:

- Record the following information from the sire in the field notebook; if necessary (contact the local airport or other suitable information source to obtain the information):
    - Wind speed and direction;
    - Ambient temperature;
    - Barometric pressure; and
    - Relative humidity.
- Connect a short piece of tubing to the sampling port using a Swagelok fitting.
- Connect a portable vacuum pump to the sample tubing. Purge 1 to 2 (target 1.5) volumes of air from the vapor point and sampling line using a portable pump [purge volume = 1.5 r2h] at a rate of approximately 100 mL/min.
- If seal around sampling port appears adequate, remove the brass plug from the SUMMA® canister and connect the flow controller with in-line particulate filter and vacuum gauge to the SUMMA® canister. Do not open the valve on the SUMMA® canister yet. Record in the field notebook and the COC the flow controller number with the appropriate SUMMA® canister number.
    - If seal is not adequate, troubleshoot for leaks.
- Connect the clean Teflon® sample collection tubing to the flow controller and the SUMMA® canister valve. Record in the field notebook the time sampling began and the canister vacuum.
- If required collect duplicate sample by attaching second SUMMA® canister with stainless steel “T” fitting.
- Connect the unoccupied end of the Teflon® tubing to the tubing protruding from subsurface sampling port.
- Open the SUMMA® canister valve and collect sample.

- Photograph the SUMMA® canister, capturing the sample ID if possible. Also photograph canister and surrounding area, capture any available landmarks for future use in photo logs (e.g. buildings, roads, etc).

5.2.2 Termination of Sample Collection:

- Arrive at the SUMMA® canister location at least 10 to 15 minutes prior to the end of the required sampling interval (e.g., 30 to 60 minutes).

- Record the final vacuum measurement. Close the valve on the SUMMA® canister to cease sample collection. The canister should have a minimum amount of vacuum (approximately 2 inches of Hg or slightly greater).

- Record the date and local time (24-hour basis) of valve closing in the field notebook, sampling summary form, and COC.

- Remove the particulate filter and flow controller from the SUMMA® canister, re-install the brass plug on the canister fitting, and tighten with the appropriate wrench.

- Package the canister and flow controller in the shipping container supplied by the laboratory for return shipment to the laboratory. The SUMMA® canister does not require preservation with ice or refrigeration during shipment. Apply custody seals if required by field sampling plan.

- Complete the appropriate forms and sample labels as directed by the laboratory.

- Ship the container to the laboratory (via overnight carrier [e.g., Federal Express]) for analysis.

5.3 Vapor Point Abandonment

Once the soil vapor sample has been collected, the temporary vapor points will be abandoned by removing the drive rods, and filling the resulting hole with clean sand. If sampling permanent monitoring vapor points, affix PVC valve on Teflon® tubing, replace flush mount cap, and mark location of vapor point with flag or spray paint.

6. Waste Management

Field personnel will collect and remove all investigation-derived materials (including disposable equipment) for proper disposal following Master Plan SOP 70.1.

7. Data Recording and Management

Measurements will be recorded in the field logbook at the time of measurement following Master Plan SOP 10.1 In addition, the field log will including the following notations of the project name, sample date, sample start and finish time, sample location (e.g., GPS coordinates, distance from permanent structure, canister serial number, flow controller serial number, initial vacuum reading, and final pressure reading. Field logs and COC records will be transmitted to the Project Manager.

STANDARD OPERATING PROCEDURE NO. 3

Vertical Aquifer Profiling

Rev. #: Internal Draft

Rev Date: April 28, 2008

1. Scope and Application

To evaluate groundwater quality at various depths. Vertical groundwater profiling will be generally performed at 10-foot intervals throughout the alluvium/overburden to assess potential chlorinated VOC impacts and may be used later to assist in the selection of well-screen placement for future monitoring wells.

2. Equipment List

Sonic drilling, packers; retractable casing/screen; sample pump and tubing.

3. Procedure

- Drill to selected interval (10 feet) and remove and inspect core.
- Determine sample interval as follows:
    - Check for zones of saturation
        - No – drill to next 10 foot interval
        - Yes – determine sample interval as follows:
        - Visual/odor impacts
        - Higher permeable soil
        - Fractures
        - Previous analytical data/depths
        - 10 foot interval
- Continue procedure to depth
    - Maximum depth is top of bedrock at 15 to 50 feet below ground surface
- Submit samples for laboratory analysis for VOCs 8260 or equivalent
- Determine horizontal and vertical placement of wells as follows:
    - Based on analytical results to monitor impacts

- Based on previous results for delineation
- Based on depth of saturated zones

4. Vertical Aquifer Profiling

Vertical aquifer profiling will be conducted while drilling the deep borings to allow groundwater sampling and characterization. Groundwater samples (vertical profiling) will be conducted while advancing the soil borings to evaluate groundwater quality at various depths. Groundwater samples will be collected at or near the water table for new boring locations. Groundwater samples will be collected in the following manner:

- Prior to groundwater sampling, all reusable equipment will be decontaminated in accordance with the procedures outline in Master Plan SOP 80.1. To minimize the potential for cross-contamination, dedicated polyethylene tubing will be utilized for each sample collected.
- A retractable, stainless-steel drive point, consisting of a 2-foot long stainless-steel 0.010-foot slot-size screen, will be placed through the 6-inch casing to the depth of the former core barrel.
- The temporary drive point will be advanced 2 feet into the saturated section.
- An inflatable packer will be installed less than 1 foot above the top of the screen and pressurized to prevent water within the casing from entering the well screen.
- Water will be withdrawn from the screen using a submersible bladder pump using low-flow (minimal drawdown) methods.
- The discharge from the pump will be connected to a flow-through cell with instrumentation that will allow a series of field measurements, including temperature, pH, specific conductance, dissolved oxygen, oxidation/reduction potential, and turbidity to be recorded from the water stream. The pumping rate will be set between 100 and 400 milliliters per minute (mL/min) to minimize drawdown within the formation. These pumping rates are consistent with USEPA Region 3 *Low-flow Purging and Sampling of Groundwater Monitoring Wells, bulletin No. QAD023, October, 1997.*
- These parameters will be recorded every five minutes until three consecutive readings within 10 percent of the previous reading are observed. If parameter stabilization has not occurred after one half hour, a sample will be collected.

- After the field parameters stabilize, the sample tubing will be removed from the flow-through cell, and samples will be collected for on-site laboratory analysis for VOCs and biogeochemical parameters.

- The soil boring will be advanced 10 feet, and the process will be repeated until the borehole is terminated.

If an isolated saturated zone is identified within a soil core, the on-site geologist may direct the driller to retract the 6-inch casing to an elevation that would facilitate collection of a groundwater sample from such a zone by employing the drive point, packer and bladder pump method described above.