RAAP 050506\05022

RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

WORK PLAN ADDENDUM NO. 16
Site Screening Process for
Solid Waste Management Units
13, 37, 38, 46, 57, 68, 69, 75, 76 and
Areas of Concern A, F, Q

FINAL
AUGUST 2003

PREPARED BY:

URS

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ARCHITECT-ENGINEER SERVICES
CONTRACT NO. DACA31-00-0011
DELIVERY ORDER NO. 0046

DEPARTMENT OF THE ARMY
U.S. ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE
5158 BLACKHAWK ROAD
ABERDEEN PROVING GROUND, MARYLAND 21010-5403

REPLY TO
ATTENTION OF

MCHB-TS-REH (40)

25 November 2003

MEMORANDUM FOR Radford Army Ammunition Plant ATTN: SOSRF-OP-EQ (Jim McKenna), PO Box 2, Radford, VA 24143-0002

SUBJECT: Final Work Plan Addendum No. 16 Site Screening Process for Solid Waste Management Units 13, 37, 38, 46, 57, 68, 69, 75, 76 and Areas of Concern A, F, Q. August, 2003

1. The US Army Center for Health Promotion and Preventive Medicine reviewed the subject document on behalf of the Office of The Surgeon General pursuant to AR 200-1 (Environmental Protection and Enhancement) without comment. Thank you for the opportunity to review this document. We concur with the conclusions and recommendations contained in this report.

2. The scientist reviewing this document and our point of contact is Mr. Keith Williams, Environmental Health Risk Assessment Program, at DSN 584-7722 or commercial (410) 436-7722.

FOR THE COMMANDER:

DAVID A. REED
Program Manager
Environmental Health Risk Assessment

CF:
HQDA(DASG-HS-PE)
USACE (CENWO-HX-H)
USAEC (SFIM-AEC-ER)
IMA, NERO (SFIM-NE-PW-ER)

Received 9-11-03

03-81 C: Jake Kibler EN file D.P. GOSEN-MN01-102 D.W. SHEAD-MN01-102-0

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

September 8, 2003

In reply
Refer to 3HS13

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

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

C.A. Jake
Environmental Manager
Alliant Techsystems, Inc.
Radford Army Ammunition Plant
P.O. Box 1
Radford, VA 24141-0100

Re: Radford Army Ammunition Plant
SWMUS 13, 37, 38, 46, 57, 68, 69, 75, & 76
Areas of Concern A, F, & Q
Document submittal and review

Dear Mr. McKenna and Ms. Jake:

The U.S. Environmental Protection Agency (EPA) has reviewed the Army's August, 2003 revised draft *Work Plan Addendum 16* for the site screening investigation of SWMUs 13, 37, 38, 46, 57, 68, 69, 75, and 76, along with Areas of Concern (AOCs) A, F, and Q, located at the Radford Army Ammunition Plant (RFAAP). Below, please find EPA's comment based upon that review:

Section 1.6 SWMU 13 The burning ground area at RFAAP is highly suspect for perchlorate contamination. The most appropriate sampling strategy for detecting perchlorates is to analyze the groundwater in the vicinity of the suspect source area. The current sampling scheme for SWMU 13, as proposed in WPA 16, does not address this data gap. However, the Army has proposed that groundwater sampling at SWMU 13 be conducted as part of a separate work plan

to address the issue of perchlorate contamination. This is acceptable to EPA as long as the sampling strategy is adequate and EPA is given the opportunity to comment on the work plan.

This concludes EPA's review of the Army's August, 2003 revised draft *Work Plan Addendum 16: SWMUs 13, 37, 38, 46, 57, 68, 69, 75, & 76, and AOCs A, F, and Q* located at the RFAAP. Given the above, the referenced revised draft *Work Plan* is conditionally approved by EPA in its current form, provided that EPA's comment is satisfactorily addressed. In accordance with Part II. (E)(5) of RFAAP's Corrective Action Permit, *Work Plan Addendum 16* is now considered final.

If you have any questions, please call me at 215-814-3357.

Sincerely,

Robert Thomson

Robert Thomson, PE
Federal Facilities Branch

cc: Russell Fish, EPA
Leslie Romanchik, VDEQ-RCRA
Mark Leeper, VDEQ-CERCLA

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

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28 August 03

Mr. James McKenna
Radford Army Ammunition Plant
SIORF-SE-EQ
P.O. Box 2
Radford, VA 24141-0099

RE: Work Plan Addendum 016 (WPA 16)

Dear Mr. McKenna:

This office has reviewed the referenced draft document and concurs with WPA 16. No revisions to the document are required. Please provide one copy of the Final WPA 16 document to this office on CD when completed.

If you have any questions, please call me at 804.698.4308.

Sincerely,

Mark S. Leeper
Remedial Project Manager

cc: Norman L. Auldridge - WCRO, DEQ
Durwood Willis - DEQ
Robert Thompson, Region III, U.S.EPA, 3HS13

Radford Army Ammunition Plant
Route 114, P.O. Box 1
Radford, VA 24141
USA

August 7, 2003

Mr. Robert Thomson
U. S. Environmental Protection Agency
Region III
1650 Arch Street
Philadelphia, PA 19103-2029

Subject: Work Plan Addendum 16 Site Screening Process for Solid Waste Management Units 13, 37, 38, 46, 57, 68, 69, 75, 76 and Areas of Concern A, F, Q, Radford Army Ammunition Plant EPA ID# VA1 210020730

Dear Mr. Thomson:

Enclosed is one certified copy of Work Plan Addendum 16 Site Screening Process for Solid Waste Management Units 13, 37, 38, 46, 57, 68, 69, 75, 76 and Areas of Concern A, F, Q, Radford Army Ammunition Plant for your review and comment or approval. Your additional five copies will be sent under separate cover as well as additional copies to the Virginia Department of Environmental Quality (VDEQ), U.S. Army Environmental Center, U.S. Army Center for Health Promotion and Preventive Medicine.

As the Work Plan Addendum has been revised to address review comments in your June 16, 2003 letter, it is being submitted as a final document. The responses are enclosed as Attachment 1.

Please coordinate with and provide any questions or comments to myself at (540) 639-8266, Jerry Redder of my staff (540) 639-7536 or Jim McKenna, ACO Staff (540) 639-8641.

Sincerely,

for E. A. Jake, Environmental Manager
Alliant Ammunition and Powder Company LLC

Enclosure

w/o enclosure

c: Russell Fish, P.E., EPA Region III

Durwood Willis
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03-815-124
JMcKenna/JJRedder

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Coordination: J. McKenna

bc: Administrative File
J. McKenna, ACO Staff
Rob Davie-ACO Staff
C. A. Jake
J. J. Redder
Env. File

03-815-124
JMcKenna/JJRedder

Concerning the following:

Work Plan Addendum 16
Site Screening Process for Solid Waste Management Units 13, 37, 38, 46, 57, 68, 69, 75, 76
and
Areas of Concern A, F, Q
Final

Radford Army Ammunition Plant

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: Anthony R. Skinner
PRINTED NAME: Anthony R. Skinner
TITLE: LTC, CM, Commanding
Radford AAP

SIGNATURE: MMiano
PRINTED NAME: Anthony Miano
TITLE: Vice President Operations
Alliant Ammunition and Powder Company LLC

03-815-124
JMcKenna/JJRedder

Attachment 1
Response to USEPA Comments Dated 16 June 2003
Received via email on 16 June 2003
for
Draft Work Plan Addendum No. 16
Site Screening Process for SWMUs 13, 37, 38, 46, 57, 68, 69, 75, 76, and Areas A, F, and Q

General Comments

EPA Comment 1
Work Plan Addendum No. 16 outlines data gaps remaining from previous investigations at the Solid Waste Management Units (SWMUs) or Areas of Concern (AOCs). The data gaps identified for each SWMU or AOC do not include analysis for cyanide. Section 3.0 of the Radford Army Ammunition Plant (RFAAP) Site Screening Process (SSP) (October 26, 2001) states, "All environmental media samples collected during the SSP will be analyzed for the full suite of Contract Laboratory Procedure (CLP) constituents and other constituents based on the findings of the Desktop Audit including additional analytes requested by EPA. The analytical target list will include Target Compound List (TCL) volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs) and dioxins (where appropriate), and Target Analyte List (TAL) inorganic chemicals, including cyanide." Since this is a site screening process investigation and previous investigations have not determined the absence of cyanide, this constituent should be analyzed for all media samples proposed at each SWMU and AOC as required by the RFAAP SSP. Please revise the Work Plan to include cyanide analysis for appropriate media samples proposed for each SWMU and AOC.

Army Response
The Work Plan Addendum will be revised to include cyanide analysis for appropriate media samples proposed for each SWMU or AOC.

EPA Comment 2
The Work Plan states that the site screening process is geared toward a screening-level evaluation of constituent concentrations in soil and that for the purposes of this site screening process, groundwater is not considered an available medium for sampling. It further states that an evaluation of the groundwater pathway is beyond the scope of the investigation detailed in the Work Plan and that the RFAAP is assessing subsurface flow characteristics and constituent concentrations in groundwater on a site-wide, holistic basis through the implementation of Area Groundwater Studies. While this approach is acceptable, please note that the facility-wide groundwater investigation must be comprehensive enough to characterize the groundwater at the individual SWMUs and AOCs. EPA recognizes the complex nature (karst) of the groundwater at the site and will consider the groundwater concerns at individual SWMUs during review of the site-wide groundwater study. However, we recommend that the groundwater pathway be evaluated for SWMU-13 as extensive quarterly monitoring data for this SWMU are available. In addition, if groundwater data also exists for SWMU 76, near the former lead furnace area, this pathway should be evaluated since 2,900 mg/kg leachable lead has been reported.

Army Response
EPA's position on the nature and objective of site-wide holistic groundwater characterization is acknowledged.

As discussed in the response to EPA Comment 5 and consistent with discussions with EPA at the IAP workshop and thereafter, the focus of SSP investigative activities at SWMU 13 will shift from the active operational area to areas outside of the active operational area. SSP investigative activities will focus on the area between the New River and the earthen berm that borders the southern portion of the active operational area. Thus, SSP investigations at SWMU 13 will evaluate soil, sediment, and surface water migration pathways at the perimeter of SWMU 13 rather than groundwater within the active operational area.

Groundwater data in the vicinity of SWMU 76 is not available; therefore, groundwater in this area will be evaluated as part of future facility-wide groundwater investigations.

EPA Comment 3

The CSM for all the SWMUs and AOCs does not consider a trespasser (adult or child/adolescent) a receptor to any potential pathway for either current or future land-use scenarios. The rationale provided states that the areas are within the installation perimeter fence and, therefore, potential receptors are limited to site workers, future construction workers, and terrestrial biota. While EPA agrees with the current scenario, please be aware that the purpose of the SSP is to establish whether a SWMU or AOC can be equivalently "clean-closed". Under RCRA, this essentially means that there are no site use restrictions and the residential scenario is the default to be used. Since this future scenario should be evaluated under the SSP, both the residential scenario, and possibly the child/adolescent trespasser should be considered a receptor at each SWMU and AOC. In addition, for completeness, groundwater and surface water pathways should be shown as potential pathways for all SWMUs and AOCs where groundwater is known to exist at shallow depths or impacted (e.g., SWMUs 13, 37, 38, 46, and 75, and AOCs F and Q) and where surface water is present in the vicinity of the SWMUs and AOC, unless data show minimum potential impacts from a SWMU or an AOC on groundwater and surface water exist. For surface water pathway evaluation, in addition to the SWMUs and AOCs where surface water was considered a potential pathway, the CSM for SWMUs 37, 38, 46 and AOCs F and Q should include surface water pathway. Please revise the figures and text to incorporate groundwater and surface water pathways in the CSM as appropriate.

Army Response

Consistent with the SSP, both industrial and residential scenarios will be considered. The risk screening will consider the industrial worker scenario. This scenario is considered more conservative than the trespasser scenario; therefore, negating the need to consider the trespasser scenario separately.

The Work Plan Addendum proposes additional sampling and analysis that will provide for future refinement of the conceptual site models. Revisions to the CSM based upon the results of the Site Screening Process investigation will consider surface water and groundwater pathways, where relevant.

EPA Comment 4

The investigations proposed for target analyte list (TAL) metals at most of the SWMUs would not provide the desired level of characterization that may be necessary in order to further characterize the extent of contamination at each area. At most of the SWMUs and AOCs, metals contamination exceeding EPA Region III Risk Based Concentrations (RBCs) and the Biological

Technical Assistance Group (BTAG) guidelines have already been realized. Therefore, most of the sites included in this Work Plan will not be screened out. Since the analyses for TAL metals will be conducted on samples collected from the same proposed sampling locations, in most cases, the results will only serve to fill data gaps. Please be aware of this.

For example, for SWMU 13 (Waste Propellant Burning Ground), seven soil borings are proposed. These sample locations will provide useful information regarding VOCs, SVOCs/PAHs, PCBs, pesticides and explosives, but most of them would not provide further characterization of metals contamination. Past investigations have shown metals contamination at the extremity of the SWMU (e.g., sample locations 13SB3, 13SB2, 13SB1 and 13SB6) and also within what is considered the SWMU boundary, with constituents exceeding RBCs and BTAG values. However, none of the sample locations proposed are located in the perimeter areas or outward from the sample locations previously located in the center of the SWMU to further characterize the limits of contamination. Conversely, the surface water and sediment samples proposed, 13SW1 and 13SE1, respectively, are not ideally located for screening the potential presence or absence of VOCs, SVOCs/PAHs, PCBs, pesticides and explosives in the Settling Lagoon (because they are not located within the lagoon), but would provide additional information for the metals contaminant migration. Please see the following comment.

Army Response
EPA's concern regarding TAL inorganics is acknowledged. There are several benefits to conducting TAL inorganic analysis at each area including:

- Filling identified data gaps;
- Identification of constituents of potential concern at each area; and
- Development of more focused RFIs for those sites not screened out with the SSP process.

Regarding EPA's concern with site characterization, the objective of the SSP is to assess the presence or absence of constituents rather than to define the nature and extent of constituents at each site. Thus, the SSP process is designed to evaluate whether the areas investigated should move to an RFI, or should be screened out. Investigations beyond the SSP at specific SWMUs or AOCs will be designed to characterize the nature and extent of constituents consistent with the RFI process.

Please see response to Comment 5 for discussion of SWMU 13.

EPA Comment 5
The purpose of the investigation at SWMU 13 is to determine the presence of contamination caused by past activities at the burning ground, as well as the potential for or existence of contamination migrating off SWMU 13. Thus, the focus of the SSP should be the investigation of the abandoned on-ground burning pads, as well as the sampling of the identified pathways leading off SWMU 13. While the current draft Work Plan Addendum 16 addresses filling data gaps at existing sampling locations, the draft Work Plan does not fulfill the requirements for a complete SSP at SWMU 13. Therefore, there are two options at this point, (1) continue with the current proposed sampling in Work Plan Addendum 16, with the inclusion of additional analytes as specified below, to fulfill the data gap needs, or (2) develop a full SSP strategy for SWMU 13. As noted in General Comment 4, at most of the SWMUs and AOCs, metals contamination

exceeding EPA Region III Risk Based Concentrations (RBCs) and the Biological Technical Assistance Group (BTAG) guidelines have already been realized. Therefore, most of the sites included in this Work Plan will not be screened out. Please be aware of this.

Army Response
Consistent with the discussions with EPA at the May 1, 2003 IAP workshop and thereafter, the focus of SSP investigative activities at SWMU 13 will shift from the active operational area to areas outside of the active operational area, specifically, the area between the New River and the earthen berm that borders the southern portion of the active operational area. Therefore, the WPA will be revised to include a focused sampling and analysis plan to fill spatial and chemical data gaps at the perimeter of SWMU 13 and to evaluate associated SWMU 13 migration pathways. This plan will include analysis for cyanide in each sample and perchlorate in proposed surface water samples.

EPA Comment 6
In the future, when submitting draft Work Plans for SWMUs and AOCs that have existing data, it would be extremely helpful to perform site screening on the existing past data, and to present the results of the "interim" risk screening in the draft Work Plan. The presentation of such would greatly facilitate the development of a more focused scope of work for the planned additional investigative work.

Army Response
Existing site data is presented within the text of the WPA for SWMUs and Areas of Concern (with the exception of groundwater at SWMU 13). This data has been screened against current risk-based criteria as specified within the RFAAP Site Screening Process. No revision of the WPA is proposed. In accordance with the SSP, a comprehensive screening of existing and new data will be included in the report of results.

Specific Comments

EPA Comment 7
Section 1.3.3.2, Relative Risk Evaluation - 1997, page 1-21: This section discusses subsurface samples collected from three locations (S46-6, S46-7, and S46-8). Figure 1-9 is referenced for the locations of the samples. However, sample locations 6, 7 and 8 (different nomenclature than used in the text) are located in an area not identified as the location of SWMU 46 on Figures 1-7 and 1-8. Sample locations 9, 10 and 11 are located in the area identified as SWMU 46, but the results from these sample locations are not discussed in this section. Please revise this section to provide data relevant to SWMU 46 and also discuss how data from sample locations 6, 7 and 8 relate to this SWMU.

Army Response
The text and figures in Section 1.3 of the Work Plan Addendum will be revised to provide a more complete discussion of data relevant to SWMU 46 and will screen the existing data against current risk-based criteria identified within the Site Screening Process.

EPA Comment 8

Section 1.3.3.2, Relative Risk Evaluation, Table 1-4, page 1-23: This table indicates that soil samples 46SS1 and 46SS2 were collected in 1991. However, the text of this section states the soil sampling was conducted in 1992. Please revise this section to resolve this discrepancy.

Army Response

Although the Verification Investigation samples at SWMU 46 were collected in October 1991, the results were reported by Dames & Moore in 1992. The text will be revised to clarify this apparent discrepancy.

EPA Comment 9

Section 1.3.5, Data Gap Analysis, page 1-25: Under "TCL SVOCs/PAHs" it is stated that "TCL SVOCs were not detected in the soil samples collected during the USACHPPM Relative Risk Investigation." However, no data relating to this site have been presented. Please remove this statement from this section or discuss how the data referenced are relevant to SWMU 46.

Army Response

The Work Plan Addendum will be revised to include a complete discussion of the suite of analyses that were performed on soil samples collected from SWMU 46 during the 1997 U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) Relative Risk Investigation.

EPA Comment 10

Section 1.3.5 SWMU 46, page 1-25: Please add perchlorates as a data gap for SWMU 46 in the final Work Plan.

Army Response

Media available for sample collection at SWMU 46 include surface soil and subsurface soil. Approved Test Methods for perchlorate are limited to aqueous media; therefore, perchlorate cannot be analyzed at SWMU 46 and is not identified as a data gap.

EPA Comment 11

Section 1.3.6.1, Soil Borings, page 1-28: This section proposes two soil borings to investigate SWMU 46. One of the stated objectives of the sampling is to assess the extent of disposal activities at the SWMU. In reality, the purpose of this sampling event is to attempt to first locate SWMU 46. Since the limits or the exact location of the SWMU is unknown, it appears two sample locations may be insufficient to assess the location of the alleged disposal site. In order to assess the limits and exact location of this SWMU, it is necessary to provide a plan for more sampling locations. A grid sampling methodology or other approach for locating source areas maybe a better plan for this SWMU.

Army Response

Previous investigations conducted at SWMU 46, 1) the Verification Investigation (Dames & Moore, 1992) and 2) the Relative Risk Evaluation (USACHPPM, 1997) examined multiple areas in the vicinity of SWMU 46 possibly containing explosive waste material and have found no evidence of propellant or explosive residue. The Installation is left to conclude that the source area of SWMU 46, if present, is in the vicinity of the sign indicating "BURIED EXPLOSIVE WASTE." As previously stated in Response 4,

characterization of the extent of COPCs, if identified, would be conducted during the subsequent RFI phase.

EPA Comment 12

Section 1.4.3.1, SWMU 75, page 1-33: It must be noted that during the removal of the SWMU 75 UST, soil samples were analyzed for total petroleum hydrocarbons (TPH) and the results indicated that concentrations of TPH were reported in samples collected from two locations of the excavation—on the south wall (1,400 mg/kg) and on the bottom of the excavation near the southern end (130 mg/kg). These elevated levels of TPH may have the potential to leach to the groundwater and may be a concern for the site-wide groundwater study. We noted site characterization report submissions by RFAAP to the VaDEQ in 1995, as included in Appendix C. However, we did not note approval of tank closure by the VDEQ. In order to close-out SWMU 75 without further investigation, EPA requires closure approval by the VDEQ. Please provide a copy of the VaDEQ tank closure approval letter as part of the final Work Plan.

Army Response

Additional available Virginia Department of Environmental Quality (VDEQ) documentation regarding tank closure at SWMU 75 will be included in the final WPA.

EPA Comment 13

Section 1.5.4, SWMU 76, page 1-37: At SWMU 76, concentrations of total lead (63,000 mg/kg) and leachable lead (2,900 mg/L) still remained present in samples collected from under the spill area after cleanup. It is stated in the Work Plan that a lead furnace operated during World War II near this area may have been the source of the lead contamination and that this Former Lead Furnace Area is currently being investigated as part of Work Plan Addendum No. 12. We noted a September 9, 1992 initial abatement measures letter from VaDEQ in Appendix C. This letter references "*...the subsurface contamination resulting from releases of lead, chromium, and halide at the Radford Army Ammunition Plant ...*". VaDEQ's letter does not reference the source of the identified releases. However, the letter also states that "*...it appears that acceptable site check measures for the suspected petroleum UST release have been achieved, and no further UST investigation is required at this time ...*". Based upon VaDEQ's letter, EPA-Region III is assuming the UST investigation at SWMU 76 is complete. However, the question remains as how to handle the remaining contamination in the subsurface at SWMU 76. Please provide a description of how the remaining contamination at SWMU 76 will be investigated in the final Work Plan. It is appropriate to reference the ongoing work under Work Plan Addendum 12, i.e. will include contamination at SWMU 76.

Army Response

The Work Plan Addendum will be revised to describe how the remaining constituents in the subsurface at SWMU 76 will be investigated. The ongoing investigation being conducted under Work Plan Addendum No. 12 will include an assessment of subsurface constituents identified at the Former Lead Furnace Area (FLFA), which is adjacent to SWMU 76. Additionally, closure procedures at SWMU 17 will deal with remaining issues potentially related to surrounding SWMUs (SWMU 76 and FLFA).

EPA Comment 14

Section 1.6.3.2, SWMU 13 RFI Program - 1992, page 1-42: The second full paragraph under this section indicates that four surface samples (13SS1 through 13SS4) were collected from the

drainage ditch (Figures 1-20 and 1-21). However, these figures do not show the location of 13SS4. It appears that 13SS4 is mislabeled as 13SB4 on Figure 1-20.

The third paragraph states, "a review of Table 1-5 indicates that sample results are below facility-wide background point estimate concentrations for RFAAP soil with the exception of thallium." It is not clear which results this statement is referring to, as Table 1-5 shows that several metals exceeded the facility-wide background for all samples (i.e., surface, subsurface and composite). Please clarify this statement.

The third paragraph further states, "Table 1-5 further indicates that concentrations of eight metals (aluminum, arsenic, chromium, iron, lead, manganese, thallium, and vanadium) exceed their respective 2002 Residential RBC criteria in at least one or more samples. However, these levels are noted to be similar to the upgradient samples collected at 13SB1 and 13SB2 during this program." It is not clear why 13SB1 and 13SB2 are considered "upgradient" and why the sample results are being compared to these sampling locations when there are established facility-wide background concentrations against which the inorganics results should be compared as required by the RFAAP SSP. Please revise the Work Plan to remove this comparison and the resulting conclusions.

On Table 1-5, page 1-48, the concentration for beryllium (0.958 mg/kg) at 13SB3 is not in bold to indicate that this concentration exceeds the background concentration for beryllium (0.69 mg/kg). Please revise the table to show this data point in bold.

The results discussed in the last paragraph on page 1-42 are for 2,4,6-trinitrobenzene (TNB) (based on data presented on table 1-5) but the RBC used is for 2,4,6-trinitrotoluene (TNT). Please correct the text and/or the table to provide the correct data for 2,4,6-TNT.

Army Response
The Work Plan Addendum will be revised to correct the figures and tables, thereby clarifying the comparisons and conclusions.

The text noting the similarity between the detected constituent concentrations and 13SB1 and 13SB2 has been removed from the Work Plan Addendum.

EPA Comment 15
Section 1.6.5, SWMU 13, page 1-65: Please include perchlorates and dioxins as data gaps in the sampling event at SWMU 13. Additionally, hundreds of scintillation vials were reported found at Site 13. Scintillation vials are used to measure radiation in samples, and sometimes contain radioactive waste. Therefore, EPA recommends that an investigation into possible radioactive contamination at this site be considered, and sampling done appropriately.

Army Response
The data gaps currently identified within the Work Plan Addendum include dioxins/furans (page 1-68, second paragraph). The Work Plan will be revised to include perchlorate as a data gap for existing and newly proposed surface water sampling locations.

The use of the term "scintillation vials" was from the 1987 RFA. Radford AAP personnel are not aware of the use of such vials past or present at RFAAP for scintillation measurements. The reference to vials in the RFA potentially could be related to sampling containers or another similar container. Text will be added to the WPA to clarify this point. Based on available information, sampling for radioactive contamination does not appear to be warranted.

EPA Comment 16

Section 1.6.6.1, Soil Borings, page 1-68: This section indicates that seven soil borings will be advanced to investigate SWMU 13. These borings are identified in both the text and Figure 1-25 as 13SB1 through 13SB7. The identifications for 13SB1 through 13SB6 are the same as the borings advanced during 1992 RFI program. Please revise the text and the figures to assign new identifiers for the proposed borings that are different from the ones used during the previous investigations.

Army Response

Text in Section 1.6.6.1, Soil Borings, will be modified to specify unique sample identifiers at SWMU 13.

EPA Comment 17

Section 1.7.5, Data Gap Analysis for SWMU 57, page 1-78: Under "TCL VOCs," it is stated that "TCL VOCs were not detected in either sediment or surface water samples collected during the 1992 VI Program." However, Section 1.7.3.1 of the Work Plan does not indicate that the two samples (one surface water and one sediment) were analyzed for TCL VOCs. It indicates that the samples were analyzed for TAL metals and discusses only the results of the TAL analyses. Please revise the Work Plan to resolve this discrepancy.

Army Response

The Work Plan Addendum will be revised to include presentation of the full suite of analyses that were performed on samples of surface water and sediment collected from SWMU 57 during the Dames & Moore Verification Investigation.

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

June 16, 2003

In reply
Refer to 3HS13

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

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

C.A. Jake
Environmental Manager
Alliant Techsystems, Inc.
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Radford, VA 24141-0100

Re: Radford Army Ammunition Plant
SWMUS 13, 37, 38, 46, 57, 68, 69, 75, & 76
Areas of Concern A, F, & Q
Document submittal and review

Dear Mr. McKenna and Ms. Jake:

The U.S. Environmental Protection Agency (EPA) has reviewed the Army's draft *Work Plan Addendum 16* for the site screening investigation of SWMUs 13, 37, 38, 46, 57, 68, 69, 75, and 76, along with Areas of Concern (AOCs) A, F, and Q, located at the Radford Army Ammunition Plant (RFAAP). Outlined below, please find EPA's comments based upon that review:

General Comments

1. Work Plan Addendum No. 16 outlines data gaps remaining from previous investigations at the Solid Waste Management Units (SWMUs) or Areas of Concern (AOCs). The data gaps identified for each SWMU or AOC do not include analysis for cyanide. Section 3.0 of the Radford Army Ammunition Plant (RFAAP) Site Screening Process (SSP) (October

26, 2001) states, "All environmental media samples collected during the SSP will be analyzed for the full suite of Contract Laboratory Procedure (CLP) constituents and other constituents based on the findings of the Desktop Audit including additional analytes requested by EPA. The analytical target list will include Target Compound List (TCL) volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs) and dioxins (where appropriate), and Target Analyte List (TAL) inorganic chemicals, including cyanide." Since this is a site screening process investigation and previous investigations have not determined the absence of cyanide, this constituent should be analyzed for all media samples proposed at each SWMU and AOC as required by the RFAAP SSP. Please revise the Work Plan to include cyanide analysis for appropriate media samples proposed for each SWMU and AOC.

2. The Work Plan states that the site screening process is geared toward a screening-level evaluation of constituent concentrations in soil and that for the purposes of this site screening process, groundwater is not considered an available medium for sampling. It further states that an evaluation of the groundwater pathway is beyond the scope of the investigation detailed in the Work Plan and that the RFAAP is assessing subsurface flow characteristics and constituent concentrations in groundwater on a site-wide, holistic basis through the implementation of Area Groundwater Studies. While this approach is acceptable, please note that the facility-wide groundwater investigation must be comprehensive enough to characterize the groundwater at the individual SWMUs and AOCs. EPA recognizes the complex nature (karst) of the groundwater at the site and will consider the groundwater concerns at individual SWMUs during review of the site-wide groundwater study. However, we recommend that the groundwater pathway be evaluated for SWMU-13 as extensive quarterly monitoring data for this SWMU are available. In addition, if groundwater data also exists for SWMU 76, near the former lead furnace area, this pathway should be evaluated since 2,900 mg/kg leachable lead has been reported.

3. The CSM for all the SWMUs and AOCs does not consider a trespasser (adult or child/adolescent) a receptor to any potential pathway for either current or future land-use scenarios. The rationale provided states that the areas are within the Installation perimeter fence and, therefore, potential receptors are limited to site workers, future construction workers, and terrestrial biota. While EPA agrees with the current scenario, please be aware that the purpose of the SSP is to establish whether a SWMU or AOC can be equivalently "clean-closed". Under RCRA, this essentially means that there are no site use restrictions and the residential scenario is the default to be used. Since this future scenario should be evaluated under the SSP, both the residential scenario, and possibly the child/adolescent trespasser should be considered a receptor at each SWMU and AOC. In addition, for completeness, groundwater and surface water pathways should be shown as potential pathways for all SWMUs and AOCs where groundwater is known to exist at shallow depths or impacted (e.g., SWMUs 13, 37, 38, 46, and 75, and AOCs F and Q) and where surface water is present in the vicinity of the SWMUs and AOC, unless data show minimum potential impacts from a SWMU or an AOC on groundwater and surface water exist. For surface water pathway evaluation, in addition to the SWMUs and AOCs where surface water was considered a potential pathway, the CSM for SWMUs 37, 38, 46 and AOCs F and Q should include surface water pathway. Please revise the figures and text to incorporate groundwater and surface water pathways in the CSM as appropriate.

4. The investigations proposed for target analyte list (TAL) metals at most of the SWMUs would not provide the desired level of characterization that may be necessary in order to further characterize the extent of contamination at each area. At most of the SWMUs and AOCs, metals contamination exceeding EPA Region III Risk Based Concentrations (RBCs) and the Biological Technical Assistance Group (BTAG) guidelines have already been realized. Therefore, most of the sites included in this Work Plan will not be screened out. Since the analyses for TAL metals will be conducted on samples collected from the same proposed sampling locations, in most cases, the results will only serve to fill data gaps. Please be aware of this.

   For example, for SWMU 13 (Waste Propellant Burning Ground), seven soil borings are proposed. These sample locations will provide useful information regarding VOCs, SVOCs/PAHs, PCBs, pesticides and explosives, but most of them would not provide further characterization of metals contamination. Past investigations have shown metals contamination at the extremity of the SWMU (e.g., sample locations 13SB3, 13SB2, 13SB1 and 13SB6) and also within what is considered the SWMU boundary, with constituents exceeding RBCs and BTAG values. However, none of the sample locations proposed are located in the perimeter areas or outward from the sample locations previously located in the center of the SWMU to further characterize the limits of contamination. Conversely, the surface water and sediment samples proposed, 13SW1 and 13SE1, respectively, are not ideally located for screening the potential presence or absence of VOCs, SVOCs/PAHs, PCBs, pesticides and explosives in the Settling Lagoon (because they are not located withing the lagoon), but would provide additional information for the metals contaminant migration. Please see the following comment.

5. The purpose of the investigation at SWMU 13 is to determine the presence of contamination caused by past activities at the burning ground, as well as the potential for or existence of contamination migratmg off SWMU 13. Thus, the focus of the SSP should be the investigation of the abandoned on-ground burning pads, as well as the sampling of the identified pathways leading off SWMU 13. While the current draft Work Plan Addendum 16 addresses filling data gaps at existing sampling locations, the draft Work Plan does not fulfill the requirements for a complete SSP at SWMU 13. Therefore, there are two options at this point, (1) continue with the current proposed sampling in Work Plan Addendum 16, with the inclusion of additional analytes as specified below, to fulfill the data gap needs, or (2) develop a full SSP strategy for SWMU 13. As noted in General Comment 4, at most of the SWMUs and AOCs, metals contamination exceeding EPA Region III Risk Based Concentrations (RBCs) and the Biological Technical Assistance Group (BTAG) guidelines have already been realized. Therefore, most of the sites included in this Work Plan will not be screened out. Please be aware of this.

6. In the future, when submitting draft Work Plans for SWMUs and AOCs that have existing data, it would be extremely helpful to perform site screening on the existing past data, and to present the results of the "interim" risk screening in the draft Work Plan. The presentation of such would greatly facilitate the development of a more focused scope of work for the planned additional investigative work.

Specific Comments

7. **Section 1.3.3.2, Relative Risk Evaluation - 1997, page 1-21:** This section discusses subsurface samples collected from three locations (S46-6, S46-7, and S46-8). Figure 1-9 is referenced for the locations of the samples. However, sample locations 6, 7 and 8 (different nomenclature than used in the text) are located in an area not identified as the location of SWMU 46 on Figures 1-7 and 1-8. Sample locations 9, 10 and 11 are located in the area identified as SWMU 46, but the results from these sample locations are not discussed in this section. Please revise this section to provide data relevant to SWMU 46 and also discuss how data from sample locations 6, 7 and 8 relate to this SWMU.

8. **Section 1.3.3.2, Relative Risk Evaluation, Table 1-4, page 1-23:** This table indicates that soil samples 46SS1 and 46SS2 were collected in 1991. However, the text of this section states the soil sampling was conducted in 1992. Please revise this section to resolve this discrepancy.

9. **Section 1.3.5, Data Gap Analysis, page 1-25:** Under "TCL SVOCs/PAHs" it is stated that "TCL SVOCs were not detected in the soil samples collected during the USACHPPM Relative Risk Investigation." However, no data relating to this site have been presented. Please remove this statement from this section or discuss how the data referenced are relevant to SWMU 46.

10. **Section 1.3.5 SWMU 46, page 1-25:** Please add perchlorates as a data gap for SWMU 46 in the final Work Plan.

11. **Section 1.3.6.1, Soil Borings, page 1-28:** This section proposes two soil borings to investigate SWMU 46. One of the stated objectives of the sampling is to assess the extent of disposal activities at the SWMU. In reality, the purpose of this sampling event is to attempt to first locate SWMU 46. Since the limits or the exact location of the SWMU is unknown, it appears two sample locations may be insufficient to assess the location of the alleged disposal site. In order to assess the limits and exact location of this SWMU, it is necessary to provide a plan for more sampling locations. A grid sampling methodology or other approach for locating source areas maybe a better plan for this SWMU.

12. **Section 1.4.3.1, SWMU 75, page 1-33:** It must be noted that during the removal of the SWMU 75 UST, soil samples were analyzed for total petroleum hydrocarbons (TPH) and the results indicated that concentrations of TPH were reported in samples collected from two locations of the excavation—on the south wall (1,400 mg/kg) and on the bottom of the excavation near the southern end (130 mg/kg). These elevated levels of TPH may have the potential to leach to the groundwater and may be a concern for the site-wide groundwater study. We noted site characterization report submissions by RFAAP to the VaDEQ in 1995, as included in Appendix C. However, we did not note approval of tank closure by the VDEQ. In order to close-out SWMU 75 without further investigation, EPA requires closure approval by the VDEQ. Please provide a copy of the VaDEQ tank closure approval letter as part of the final Work Plan.

13. **Section 1.5.4, SWMU 76, page 1-37:** At SWMU 76, concentrations of total lead (63,000 mg/kg) and leachable lead (2,900 mg/L) still remained present in samples collected from under the spill area after cleanup. It is stated in the Work Plan that a lead furnace operated during World War II near this area may have been the source of the lead contamination and that this Former Lead Furnace Area is currently being investigated as part of Work Plan Addendum No. 12. We noted a September 9, 1992 initial abatement measures letter from VaDEQ in Appendix C. This letter references "*...the subsurface contamination resulting from releases of lead, chromium, and halide at the Radford Army Ammunition Plant ...*". VaDEQ's letter does not reference the source of the identified releases. However, the letter also states that "*...it appears that acceptable site check measures for the suspected petroleum UST release have been achieved, and no further UST investigation is required at this time ...*". Based upon VaDEQ's letter, EPA-Region III is assuming the UST investigation at SWMU 76 is complete. However, the question remains as how to handle the remaining contamination in the subsurface at SWMU 76. Please provide a description of how the remaining contamination at SWMU 76 will be investigated in the final Work Plan. It is appropriate to reference the ongoing work under Work Plan Addendum 12, i.e. will include contamination at SWMU 76.

14. **Section 1.6.3.2, SWMU 13 RFI Program - 1992, page 1-42:** The second full paragraph under this section indicates that four surface samples (13SS1 through 13SS4) were collected from the drainage ditch (Figures 1-20 and 1-21). However, these figures do not show the location of 13SS4. It appears that 13SS4 is mislabeled as 13SB4 on Figure 1-20.

The third paragraph states, "a review of Table 1-5 indicates that sample results are below facility-wide background point estimate concentrations for RFAAP soil with the exception of thallium." It is not clear which results this statement is referring to, as Table 1-5 shows that several metals exceeded the facility-wide background for all samples (i.e., surface, subsurface and composite). Please clarify this statement.

The third paragraph further states, "Table 1-5 further indicates that concentrations of eight metals (aluminum, arsenic, chromium, iron, lead, manganese, thallium, and vanadium) exceed their respective 2002 Residential RBC criteria in at least one or more samples. However, these levels are noted to be similar to the upgradient samples collected at 13SB1 and 13SB2 during this program." It is not clear why 13SB1 and 13SB2 are considered "upgradient" and why the sample results are being compared to these sampling locations when there are established facility-wide background concentrations against which the inorganics results should be compared as required by the RFAAP SSP. Please revise the Work Plan to remove this comparison and the resulting conclusions.

On Table 1-5, page 1-48, the concentration for beryllium (0.958 mg/kg) at 13SB3 is not in bold to indicate that this concentration exceeds the background concentration for beryllium (0.69 mg/kg). Please revise the table to show this data point in bold.

The results discussed in the last paragraph on page 1-42 are for 2,4,6-trinitrobenzene (TNB) (based on data presented on table 1-5) but the RBC used is for 2,4,6-trinitrotoluene (TNT). Please correct the text and/or the table to provide the correct data

for 2,4,6-TNT.

15. **Section 1.6.5, SWMU 13, page 1-65:** Please include perchlorates and dioxins as data gaps in the sampling event at SWMU 13. Additionally, hundreds of scintillation vials were reported found at Site 13. Scintillation vials are used to measure radiation in samples, and sometimes contain radioactive waste. Therefore, EPA recommends that an investigation into possible radioactive contamination at this site be considered, and sampling done appropriately.

16. **Section 1.6.6.1, Soil Borings, page 1-68:** This section indicates that seven soil borings will be advanced to investigate SWMU 13. These borings are identified in both the text and Figure 1-25 as 13SB1 through 13SB7. The identifications for 13SB1 through 13SB6 are the same as the borings advanced during 1992 RFI program. Please revise the text and the figures to assign new identifiers for the proposed borings that are different from the ones used during the previous investigations.

17. **Section 1.7.5, Data Gap Analysis for SWMU 57, page 1-78:** Under "TCL VOCs," it is stated that "TCL VOCs were not detected in either sediment or surface water samples collected during the 1992 VI Program." However, Section 1.7.3.1 of the Work Plan does not indicate that the two samples (one surface water and one sediment) were analyzed for TCL VOCs. It indicates that the samples were analyzed for TAL metals and discusses only the results of the TAL analyses. Please revise the Work Plan to resolve this discrepancy.

This concludes EPA's review of the Army's draft *Work Plan Addendum 16: SWMUs 13, 37, 38, 46, 57, 68, 69, 75, & 76, and AOCs A, F, and Q* located at the RFAAP. The referenced draft *Work Plan* is disapproved by EPA in its current form, and must be revised to reflect the comments above. Per Part II, Section E.4.e. of the EPA RCRA Corrective Action Permit, the Army is required to revise the draft document and submit a revised draft copy to EPA for review within 60 days of the receipt of EPA comments on the draft document. Part II, Section E.4.f. of the Permit allows for an additional 20 days for issuing the revised draft document to EPA, provided that timely notice is given, i.e. within 10 days. Additional time extensions can be requested under Part II, Section F. of the permit.

If you have any questions, please call me at 215-814-3357.

Sincerely,

Robert Thomson, PE
Federal Facilities Branch

cc: Russell Fish, EPA
Leslie Romanchik, VDEQ-RCRA
Mark Leeper, VDEQ-CERCLA

47

McKenna, Jim

From: McKenna, Jim
Sent: Thursday, April 03, 2003 11:31 AM
To: 'rob thomson'
Cc: 'mark leeper'; Redder, Jerome; 'john e tesner';
Subject: FW: SSP QAPP Checklist
Importance: High

Rob, QAAP checklist for WPA 16. Please forward to your review team. Thanks, Jim.
-----Original Message-----
From: John.E.Tesner@nab02.usace.army.mil [mailto:John.E.Tesner@nab02.usace.army.mil]
Sent: Thursday, April 03, 2003 11:14 AM
To: Jim_McKenna@ATK.com
Subject: SSP QAPP Checklist

Jim-
SAB.
JT
<<qappprepcklist_SSP.rtf>>

Radford Army Ammunition Plant
Route 114, P.O. Box 1
Radford, VA 24141
USA

March 3, 2003

Mr. Robert Thomson
U. S. Environmental Protection Agency
Region III
1650 Arch Street
Philadelphia, PA 19103-2029

Subject: Work Plan Addendum 16 Site Screening Process for Solid Waste Management Units 13, 37, 38, 46, 57, 68, 69, 75, 76 and Areas of Concern A, F, Q, Radford Army Ammunition Plant EPA ID# VA1 210020730

Dear Mr. Thomson:

Enclosed is one certified copy of Work Plan Addendum 16 Site Screening Process for Solid Waste Management Units 13, 37, 38, 46, 57, 68, 69, 75, 76 and Areas of Concern A, F, Q, Radford Army Ammunition Plant for your review and comment or approval. Your additional five copies will be sent under separate cover as well as additional copies to the Virginia Department of Environmental Quality (VDEQ), U.S. Army Environmental Center, U.S. Army Center for Health Promotion and Preventive Medicine.

Please coordinate with and provide any questions or comments to myself at (540) 639-8266, Jerry Redder of my staff (540) 639-7536 or Jim McKenna, ACO Staff (540) 639-8641.

Sincerely,

J J Redder

for C. A. Jake, Environmental Manager
Alliant Ammunition and Powder Company, LLC

Enclosure

w/o enclosure

c: Russell Fish, P.E., EPA Region III

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Coordination: J. McKenna

bc: Administrative File
[redacted]
Rob Davie-ACO Staff
C. A. Jake
J. J. Redder
Env. File

03-815-36
JMcKenna/JJRedder

Concerning the following:

Work Plan Addendum 16
Site Screening Process for Solid Waste Management Units 13, 37, 38, 46, 57, 68, 69, 75, 76
and
Areas of Concern A, F, Q

Radford Army Ammunition Plant

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: Brian A. Butler
TITLE: LTC, CM, Commanding
Radford AAP

SIGNATURE:
PRINTED NAME: Anthony Miano
TITLE: Vice President Operations
Alliant Ammunition and Powder Company, LLC

McKenna, Jim

From: McKenna, Jim
Sent: Friday, December 20, 2002 7:26 AM
To: 'john e tesner'; Redder, Jerome
Subject: FW: NHPAP Work Plan Addenda 15 and 16

John, Jerry. FYI

-----Original Message-----
From: Jenkins, Joanne
Sent: Friday, December 20, 2002 7:22 AM
To: McKenna, Jim
Cc: Davie, Robert
Subject: RE: NHPAP Work Plan Addenda 15 and 16

With this added information I feel we can safely say that there is no potential to cause effect.

Joanne Jenkins
Industrial Specialist
Government Staff
DSN 931-7480. COM 540-639-7480

-----Original Message-----
From: McKenna, Jim
Sent: Tuesday, December 17, 2002 6:28 AM
To: Jenkins, Joanne
Cc: Davie, Robert
Subject: RE: NHPAP Work Plan Addenda 15 and 16
Importance: High

I have some more information to share which needs to be considered.

The sites under investigation are/were waste disposal units and were created from significant earth disturbances with waste materials disposed in and/or on them. So the site boundary only is the waste handling/disposal unit and does not encompass any area that may have been undisturbed by plant activities. Also the soil sampling equipment will travel over existing, active roads to get to the sites. Based on the information contained in these work plans we can make the assessment locally that the sampling effort will not disturb any cultural resources that may exist any more than current operations. With this in mind, I respectfully request that the decision for SHPO review be reconsidered.

Thanks,
Jim

-----Original Message-----
From: Jenkins, Joanne
Sent: Monday, December 16, 2002 10:24 AM
To: McKenna, Jim
Cc: Davie, Robert
Subject: RE: NHPAP Work Plan Addenda 15 and 16

I have checked the location of the sites you furnished. I don't have any concerns about SWMU 57, 68, 69, 75, 76 and Areas A & F. I do however have concerns about SWMU 8 and 36 as they are located at the bio plant. I also have concerns about SWMU 37, 38, 46 and Area Q. These are located in an area where there is potential for historical sites. These need to be reviewed by the SHPO.

Joanne Jenkins

Industrial Specialist
COM 540-639-7480 DSN 931-7480

-----Original Message-----
From: **McKenna, Jim**
Sent: Monday, December 16, 2002 8:08 AM
To: Jenkins, Joanne
Cc: Davie, Robert
Subject: NHPAP Work Plan Addenda 15 and 16
Importance: High

Joanne:

1. Work Plan Addendum 15 identifies sampling work that will occur at Solid Waste Management Units (SWMUs) 8 and 36 in the Main Manufacturing Area. The WPA has maps that show sampling locations.

2. Work Plan Addendum 16 identifies sampling work that will occur at SWMUs 37, 38, 46 75, and 76 in the Main Manufacturing Area and SWMUS 13, 57 68 and 69 in the Horseshoe Area and Areas of Concern (AOC) A, F and Q in the Main Manufacturing Area. The WPA has maps that show sampling locations.

Need you/us to review for possible interference with historical sites.

Thanks,
Jim

RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

WORK PLAN ADDENDUM NO. 16
Site Screening Process for
Solid Waste Management Units
13, 37, 38, 46, 57, 68, 69, 75, 76 and
Areas of Concern A, F, Q

FINAL
AUGUST 2003

PREPARED BY:

URS

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ARCHITECT-ENGINEER SERVICES
CONTRACT NO. DACA31-00-0011
DELIVERY ORDER NO. 0046

PREFACE

A two-stage approach has been developed to facilitate and streamline Resource Conservation Recovery Act (RCRA) site investigations at Radford Army Ammunition Plant (RFAAP) pursuant to the Permit for Corrective Action and Waste Minimization (USEPA 2000b). 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 constituents 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.

The Site Screening Process (SSP) has been developed as the central document describing how site screening will be applied to the RFAAP. Overall, the SSP is devised to fulfill a commitment made by the stakeholders during the May 16-17, 2002, Installation Action Workshop to assess the Site Screening Areas (SSAs) in an expedited manner and to assess what level of evaluation is appropriate for these identified areas. The SSP will help identify whether there have been releases of hazardous substances, pollutants, contaminants, hazardous wastes, or hazardous constituents to the environment from an SSA, and assess whether an SSA should proceed further through the RCRA Facility Investigation (RFI) process, be the subject of an interim removal action, or be proposed for no further action.

MASTER WORK PLAN ADDENDUM NO. 16
SSP WORK PLAN ADDENDUM
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Appendix C Supporting Documents

LIST OF ABBREVIATIONS AND ACRONYMS

%..... Percent
AES ..... Atomic Emission Spectroscopy
AST ..... Aboveground Storage Tank
ASTM..... American Society for Testing and Materials
ATK..... Alliant TechSystems
bgs ..... Below Ground Surface
BRA..... Baseline Risk Assessment
$CaSO_4$ ..... Calcium Sulfate
CFR ..... Code of Federal Regulations
CLP..... Contract Laboratory Program
CN ..... Cyanide
CNCl..... Cyanogen Chloride
COPC..... Constituent of Potential Concern
COR..... Contracting Officer's Representative
CSM..... Conceptual Site Model
dBA ..... Decibels on the A-Weighted Scale
DC ..... Direct Current
DQO ..... Data Quality Objective
ECD..... Electron Capture Detector
ELCD..... Electrolytic Conductivity Detector
EM..... Electromagnetic
EPIC ..... Environmental Photographic Interpretation Center
ERA..... Ecological Risk Assessment
ERIS ..... Environmental Restoration Information System
FWBC..... Facility-Wide Background Study
ft ..... Feet
GC ..... Gas Chromatography
GPS..... Global Positioning System
HAZCOM..... Hazard Communication
HBN..... Health-Based Number
HHRA..... Human Health Risk Assessment
HMX..... cyclotetramethylene-tetranitramine
HPLC..... High Performance Liquid Chromatography
HQ ..... Hazard Quotient
HRGC/HRMS High-Resolution Gas Chromatography/High-Resolution Mass Spectrometry
HSA..... Horseshoe Area
HSP..... Health and Safety Plan
HSPA..... Health and Safety Plan Addendum
HTRW ..... Hazardous, Toxic, and Radioactive Waste
Hz ..... Hertz
ICP..... Inductively Coupled Plasma
IDM ..... Investigation-Derived Material
MCL ..... Maximum Contaminant Level
MDL..... Method Detection Limit
µg/L ..... Micrograms Per Liter
mg/kg..... Milligrams Per Kilogram

mg/L ..... Milligrams Per Liter
MHSP ..... Master Health and Safety Plan
MMA ..... Main Manufacturing Area
MQAP ..... Master Quality Assurance Plan
MS ..... Mass Spectrometer
MSDS ..... Material Safety Data Sheet
msl ..... Mean Sea Level
MWP ..... Master Work Plan
nm ..... Nanometer
OSHA ..... Occupational Safety and Health Administration
PAH ..... Polynuclear Aromatic Hydrocarbon
PAO ..... Phenyl Arsine Oxide
PCB ..... Polychlorinated Biphenyl
PID ..... Photoionization Detector
PM ..... Project Manager
ppb ..... Parts Per Billion
PPE ..... Personal Protective Equipment
ppm ..... Parts Per Million
ppq ..... Parts Per Quadrillion
ppt ..... Parts Per Trillion
QA ..... Quality Assurance
QC ..... Quality Control
QA/QC ..... Quality Assurance/Quality Control
QAP ..... Quality Assurance Plan
QAPA ..... Quality Assurance Plan Addendum
RBC ..... Risk-Based Concentration
RCRA ..... Resource Conservation and Recovery Act
RDX Hexahydro-1,3,5-trinitro-1,3,5-triazine
RFA ..... RCRA Facility Assessment
RFAAP ..... Radford Army Ammunition Plant
RFI ..... RCRA Facility Investigation
RL ..... Reporting Limit
SAP ..... Sampling and Analysis Plan
SHSO ..... Site Health and Safety Officer
SOP ..... Standard Operating Procedure
SOW ..... Statement of Work
SSP ..... Site Screening Process
SVOC ..... Semivolatile Organic Compound
SWMU ..... Solid Waste Management Unit
TAL ..... Target Analyte List
TCL ..... Target Compound List
TCLP ..... Toxicity Characteristic Leaching Procedure
TEF ..... Toxicity Equivalence Factor
TEQ ..... Toxicity Equivalent Concentration
TOC ..... Total Organic Content

LIST OF ABBREVIATIONS AND ACRONYMS (CONTINUED)

TOX..... Total Organic Halogen
TPH ..... Total Petroleum Hydrocarbon
TWA..... Time Weighted Average
URS ..... URS Group, Inc.
USACE..... United States Army Corps of Engineers
USAEHA..... United States Army Environmental Hygiene Agency
USACHPPM .. United States Army Center for Health Promotion and Preventive Medicine
USATHMA .... United States Army Toxic and Hazardous Materials Agency
USEPA ..... United States Environmental Protection Agency
UST ..... Underground Storage Tank
UV ..... Ultraviolet
VDEQ..... Virginia Department of Environmental Quality
VDOT..... Virginia Department of Transportation
VI..... Verification Investigation
VOC..... Volatile Organic Compound
VPDES ..... Virginia Pollution Discharge Elimination System
VSI..... Visual Site Inspection
WPA ..... Work Plan Addendum

1.0 WORK PLAN ADDENDUM

In accordance with Contract Number DACA31-00-D-0011, Delivery Order No. 0046, URS Group, Inc. (URS) has been tasked by the United States Army Corps of Engineers (USACE), Baltimore District to perform a Site Screening Process (SSP) effort for nine Solid Waste Management Units (SWMUs) and three Areas of Concern (AOCs) at the Radford Army Ammunition Plant (RFAAP), Radford, Virginia (Figure 1-1). This Work Plan for nine SWMUs and three AOCs is presented as an addendum (Work Plan Addendum No. 16) and incorporates by reference, the elements of the RFAAP Master Work Plan (MWP; URS 2002).

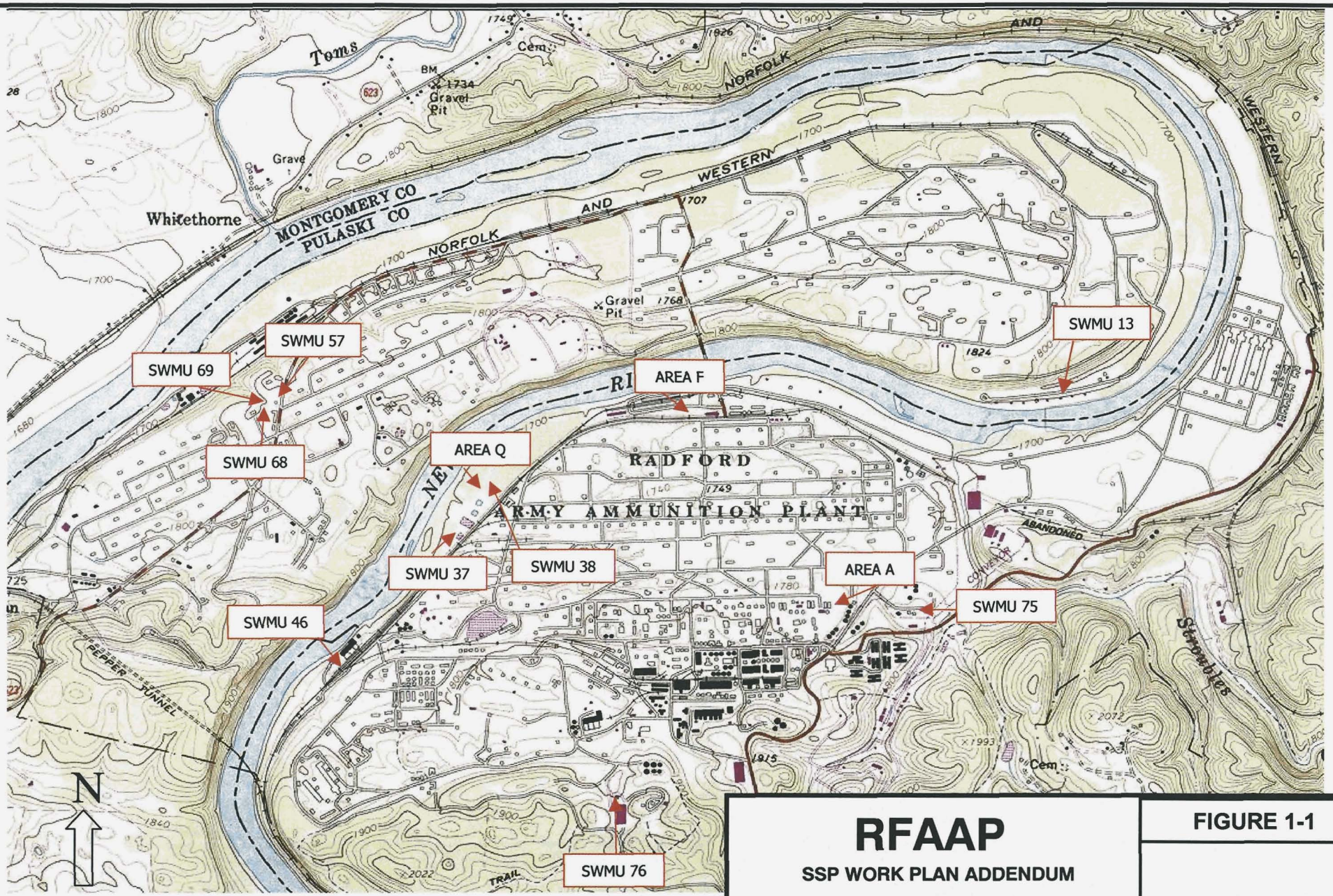
1.1 INTRODUCTION

The project objectives of this effort are to:

- Assess whether there have been releases of hazardous substances, pollutants, contaminants, hazardous wastes, or hazardous constituents to the environment from the nine SWMUs and three AOCs;
- Fulfill a commitment made by the stakeholders during the May 16-17, 2002, RFAAP Installation Action Plan Workshop to look at the sites in an expedited manner; It was agreed during this Workshop to apply the SSP as the means to accomplish this objective; and
- Reach a decision regarding future action at each area.

The following are the sites included in this WPA:

- SWMU 37 — $CaSO_4$ Drying Bed
- SWMU 38 — $CaSO_4$ Drying Bed
- Area Q — $CaSO_4$ Treatment Disposal Area
- SWMU 46 — Propellant Burial Area
- SWMU 75 — Used Oil Storage Tank (Inert Gas Plant)
- SWMU 76 — Oil Tanks
- SWMU 13 — Waste Propellant Burning Ground
- SWMU 57 — Pond by Buildings 4931 & 4932
- SWMU 68 — Chromic Acid Treatment Tanks
- SWMU 69 — Pond by Chromic Acid Treatment Tanks
- Area A — Nitrocellulose Rainwater Ditch
- Area F — Former Drum Storage Area



RFAAP

SSP WORK PLAN ADDENDUM

FIGURE 1-1

SITE LOCATION MAP

Date: *October 2002*	**Prepared by:** *KDC/DR*
Scale: *1" = 2000'*	**File Name:** *09604-317-155-Figure 1-1.ppt*

Consistent with the MWP, this addendum is composed of the following sections:

- Section 1, Work Plan Addendum (WPA);
- Section 2, Quality Assurance Plan (QAP) Addendum (QAPA); and
- Section 3, Health and Safety Plan (HSP) Addendum (HSPA).

This WPA specifically addresses sections and Standard Operating Procedures (SOPs) contained in the MWP for the site screening at nine SWMUs and three AOCs. Relevant SOPs are included in Appendix A of this WPA. The MWP will be maintained on site and referenced during field activities.

Investigative activities that will be performed as specified in the MWP are listed in Table 1-1. The investigative activities performed as part of this WPA will be conducted in accordance with the MWP and the SOPs. WPA-specific SOPs are included in Appendix A.

Changes to the approved WPA will be documented using the Work Plan Revision Form (Form 1-1). 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 1-2). The Site Health and Safety Officer (SHSO) will retain this form on site during investigative activities. Appropriate health and safety precautions must be taken due to the potential handling of hazardous materials, energetics, and/or their degradation compounds.

1.1.1 Investigation Overview

The investigation program focuses on obtaining the data needed to attain the project objectives. The program articulates project objectives, assumptions, and data use specifications. Program elements include performance of a desktop audit and site visit, a description of site conditions and previous investigations, and a presentation of the planned field activities and the technical approach.

The SSP is geared toward a screening-level evaluation of constituent concentrations in soil; for the purposes of the SSP, groundwater is not considered an available medium for sampling. An evaluation of the groundwater pathway is beyond the scope of the investigations detailed herein. The RFAAP is assessing subsurface flow characteristics and constituent concentrations in groundwater on a site-wide, holistic basis through the implementation of Area Groundwater Studies. These Studies will be conducted within the framework of the Master Work Plan as Work Plan Addenda.

1.1.1.1 Desktop Audit and Site Visit

A desktop audit was performed for each of the nine SWMUs and three AOCs included in this SSP WPA. The purpose of this audit was to evaluate and document site use and operational history and to evaluate the likelihood that these operations have resulted in the release of hazardous substances/wastes to the environment. The audit consisted of an evaluation of existing information and analytical data to identify historical uses and potential environmental factors, a visual inspection of each SWMU, and development of a site-specific Conceptual Site Model (CSM). The findings of the desktop audit and site inspection were evaluated to identify potential contaminant sources, migration pathways, potential human and ecological receptors, and receptor exposure pathways at each SWMU.

Table 1-1
Applicable MWP Activities and Related SOPs
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

Subject	MWP Section	Standard Operating Procedures (SOPs) MWP Appendix A and Appendix A to WPA No. 16
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
Air Monitoring		90.1 Photoionization Detector (HNu Model PI-101 and HW-101)
Subsurface Investigation	5.2 5.8	20.11 Drilling Methods and Procedures 30.1 Soil Sampling 30.6 Containerized Material 30.7 Sampling Strategies 30.9 Collection of Soil Samples by USEPA SW-846

Form 1-1
Work Plan Revision Form
Work Plan – Quality Assurance Plan – Health and Safety Plan – Addendum No. 16
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

SITE DESIGNATION / LOCATION:

Radford Army Ammunition Plant

Radford, VA

Section: _____

Addendum: _____

Version: _____

Effective Date: _____

SUBJECT:

Approved by:

Field Operations Leader

_____

Date: _____

Concurrence:

Project Manager

_____

Date _____

Sheet _____ of _____

Form 1-2
Worker Acknowledgement Form
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

Document: Master Work Plan/QAP/HSP and Work Plan Addendum No. 16

Version: Draft

Project: Radford Army Ammunition Plant

Location: Main Manufacturing Area and Horseshoe Area

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 CFR 1910.120 concerning training and medical monitoring requirements.

Site Personnel:

Name (please print)	**Signature**	**Date**

1.1.1.2 Description of Site Conditions and Previous Investigations

Each site-specific section of this WPA begins with a brief description of the site and a summary of the current conditions at the site. This section includes descriptions of the physical and natural features that may affect the migration and exposure pathways. Subsequent to the site description, a summary of previous investigations is provided. These sections are intended to be a review of the previous site investigations (e.g., Dames and Moore Verification Investigation (VI) and Environmental Photographic Interpretation Center (EPIC) Photo Assessment) emphasizing the usability of the collected data and screening of historical data with respect to current criteria (i.e., current USEPA Region III Risk-based Concentrations (RBCs), USEPA National Primary Drinking Water Standards Maximum Contaminant Levels (MCLs), and USEPA Region III Draft Biological Technical Assistance Group Screening Levels (BTAGs) to identify constituents of potential concern (COPCs).

Three key previous investigations were used during the development of this work plan as follows:

- **Verification Investigation (VI) Report:** The objective of the VI report was to "evaluate whether toxic or hazardous contaminants are present and are, or have the potential of, migrating beyond the boundaries of the identified SWMUs" (Dames and Moore 1992). Dames and Moore obtained data to be used in conjunction with existing data to evaluate the nature and extent of hazardous constituents in surface water, groundwater, soil, and sediment and to assess the need for further VI efforts. Several of the SWMUs associated with this SSP Work Plan were evaluated under the VI and the results are included herein.

- **Environmental Photographic Interpretation Center (EPIC) Installation Assessment Report:** EPIC under direction of the USEPA performed an assessment of multiple SWMUs at RFAAP using selected aerial photographs from 1937 to 1986. The objective was to "concentrate upon tracking 42 known SWMUs located at the RFAAP and to identify other features which may represent potential groundwater or surface water contamination sources (USEPA 1992)." Several of the SWMUs associated with this SSP Work Plan were included as part of this photo assessment and the results are provided as part of the previous investigations.

- **Facility-wide Background Study Report:** A Facility-wide Background Study (FWBS) was conducted at the Main Manufacturing Area of RFAAP to characterize naturally occurring background soil inorganic concentrations. Point estimate concentration values were subsequently developed to represent background for future site comparisons. These values are included in the FWBS as a point of reference for point-by-point comparisons for site screening.

1.1.2 Investigation-Derived Material Handling and Disposal

Activities conducted during this investigation will comply with the relevant Occupational Safety and Health Administration (OSHA) 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 MWP SOP 70.1. Table 1-2 gives the suspected nature (hazardous vs. non-hazardous) of the resultant materials expected during investigative activities.

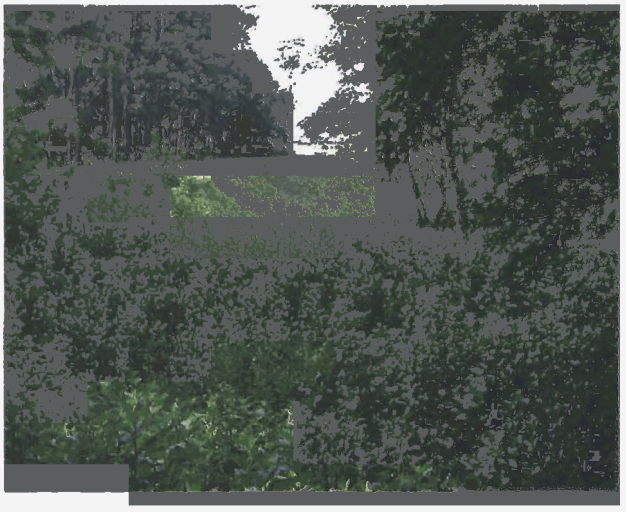
Table 1-2
Handling, Characterization, and Disposal of Investigation-Derived Material (IDM)
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

Phase	Matrix	Material	Description	Quantity	Concern	Action	Expected Nature of Material
Soil Investigation	Solid	Soil Cuttings	From Geoprobe Borings	Approx. three 55-gal drums	COPCs	Collect IDM Sample for TCLP Full, Ignitability, Corrosivity, Reactivity and Paint Filter Liquids	Non-hazardous. Concentrations in soil cuttings are not expected to exceed regulatory limits.
	Aqueous	Decontamination Water	From Soil Drilling Program	Approx. two 55-gal drums	COPCs	Collect IDM Samples for TCLP Full, Corrosivity, Reactivity, and COD	Non-hazardous. Concentrations are not expected to exceed regulatory limits.
	Solid	PPE, Plastic Sheeting, Disposable Sampling Equipment	From Drilling and Sampling Activities	Approx. three 55-gal drums	IDM	Confirm Results of Associated Tests for Soil and Liquid IDM	Same as associated soil and decontamination water.

Notes:
COPC = Constituent of Potential Concern
IDM = Investigation-Derived Material
TCLP = Toxicity Characteristic Leaching Procedure
COD = Chemical Oxygen Demand
PPE = Personal Protective Equipment
Approx. = Approximately
gal = gallon

1.2 SWMU 37, SWMU 38, AND AREA Q – $CaSO_4$ DRYING BEDS AND TREATMENT AND DISPOSAL AREA

1.2.1 Site Background – Environmental Setting



Physiography – SWMU 37, SWMU 38 ($CaSO_4$ Drying Beds), and Area Q ($CaSO_4$ Treatment and Disposal Area) are located along the New River in the northwest section of the RFAAP Main Manufacturing Area (MMA). The elevation at these SWMUs is approximately 1,710 ft msl (Figure 1-2). A gravel road is located to the east of these SWMUs and a densely wooded area surrounds the area to the north, south, and west where the topography slopes down to the New River. SWMU 37, SWMU 38, and Area Q are excavated into the natural grade and are unlined. SWMU 37 is densely vegetated, is approximately 80 feet wide by 100 feet long, and is located immediately southwest of and adjacent to SWMU 9, $CaSO_4$ Settling Lagoons. SWMU 38 (see photograph inset) is also densely vegetated, is approximately 40 feet wide by 225 feet long, and is located immediately north-northeast of and adjacent to SWMU 9. Area Q is a densely wooded depression located immediately to the west and adjacent to the northwest corner of SWMU 38. Each unit is surrounded by an earthen berm with an observed depth of 4 to 8 feet.

Surface Water – Based on topography, SWMU 37, SWMU 38, and Area Q have internal drainage (i.e., surface runoff does not flow out of the immediate SWMU areas). A well-defined drainage ditch is located approximately 100 feet down gradient of SWMU 9 and another is located approximately 50 feet to the west of SWMU 37. Other surface water bodies, drainage ditches, manholes, catch basins, or other flow paths do not appear to be present in the immediate SWMU 37, SWMU 38, and Area Q area. The New River flows northeast approximately 300 to 400 feet northwest of these sites.

Geology and Soil – SWMU 37, SWMU 38, and Area Q are underlain by the Unison-Urban land complex soil (IT 2002b). This soil has moderate permeability and medium-to-strong acidity. Site-specific data regarding subsurface conditions at SWMU 37, SWMU 38, and Area Q have not been collected. Data have been collected from SWMU 9 that is situated adjacent to SWMU 37 and SWMU 38. Boring data from SWMU 9 indicate the presence of two units: an upper stratum consisting of yellowish brown sand with clay lenses in the upper portion and with increasing gravel and cobble content with depth and a lower bedrock unit consisting of the gray limestone/dolostone of the Elbrook Formation. The bedrock is highly argillaceous and moderately weathered and fractured. Depth to bedrock in the immediate area of these SWMUs ranges from 20 to 35 ft bgs (Dames and Moore 1992a).

Groundwater – Five groundwater monitoring wells have been constructed near SWMU 9, located adjacent to SWMU 37 and SWMU 38. Groundwater monitoring well data from SWMU 9 (Dames and Moore 1992a) indicates that the water is present from approximately 26 to 29 ft bgs. Well data indicate that the hydraulic gradient is relatively gentle and slopes northwest toward the New River.

Tanks and Structures – In addition to SWMU 9, other tanks and structures near SWMU 37, SWMU 38, and Area Q include a control house for the settling lagoons and other associated piping and appurtenances. No other tanks or structures are located in or near SWMU 37, SWMU 38, or Area Q.



VICINITY MAP
N.T.S.

(SOURCE: MODIFIED FROM HERCULES, INC., 1992)

0 200
1 inch = 200 feet

RFAAP

SSP WORK PLAN ADDENDUM: SWMU 37, SWMU 38, & AREA Q

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FIGURE 1-2

SITE TOPOGRAPHY LAYOUT

1.2.2 Site Background – History

SWMU 37 and SWMU 38 are inactive units previously used for the drying of sludge that was removed from SWMU 9 (USEPA 1987). SWMU 9 consists of two below-grade unlined earthen lagoons listed in the RFAAP Virginia Pollution Discharge Elimination System (VPDES) permit. These lagoons formerly received neutralized wastewater from the Acidic Wastewater Treatment Plant and now receive stormwater. The wastewater containing the calcium sulfate was gravity-fed into SWMU 9 via an underground process sewer pipe (Dames and Moore 1992a). The calcium sulfate precipitated and settled in the lagoons then was removed and placed in SWMU 37, SWMU 38, and Area Q. Area Q is reportedly an abandoned lagoon that was used as a sludge drying bed when SWMU 38 was full. Sludge was pumped from SWMU 38 to SWMU Q via pipes that ran through a depression in the berm surrounding the drying bed (Dames and Moore 1992a).

1.2.3 Previous Investigations

The following section reviews previous site investigations emphasizing the usability of collected data and the screening of historical data with respect to current criteria (i.e., current RBCs and BTAGs).

1.2.3.1 Verification Investigation – 1992

In 1992, as part of a Verification Investigation (VI), Dames and Moore collected and analyzed wastes from SWMU 37, SWMU 38, and Area Q to "evaluate whether hazardous constituent concentrations exceed[ed] the [then current] health based numbers (HBNs) in the [Facility] permit (Dames and Moore 1992a)." One sample was collected from the top one foot of sludge present in SWMU 38. Because the calcium sulfate drying beds at SWMU 37 and SWMU Q were dry at the time of sampling, a five-foot hand-auger composite hole was advanced in the central part of each bed (Figure 1-3). One sample was composited from the five-foot hole to ensure a representative sample of numerous sludge-drying episodes (Dames and Moore 1992a). Waste characterization samples were analyzed for Volatile Organic Compounds (VOCs), Semivolatile Organic Compounds (SVOCs) and Toxicity Characteristic Leaching Procedure (TCLP) Metals.

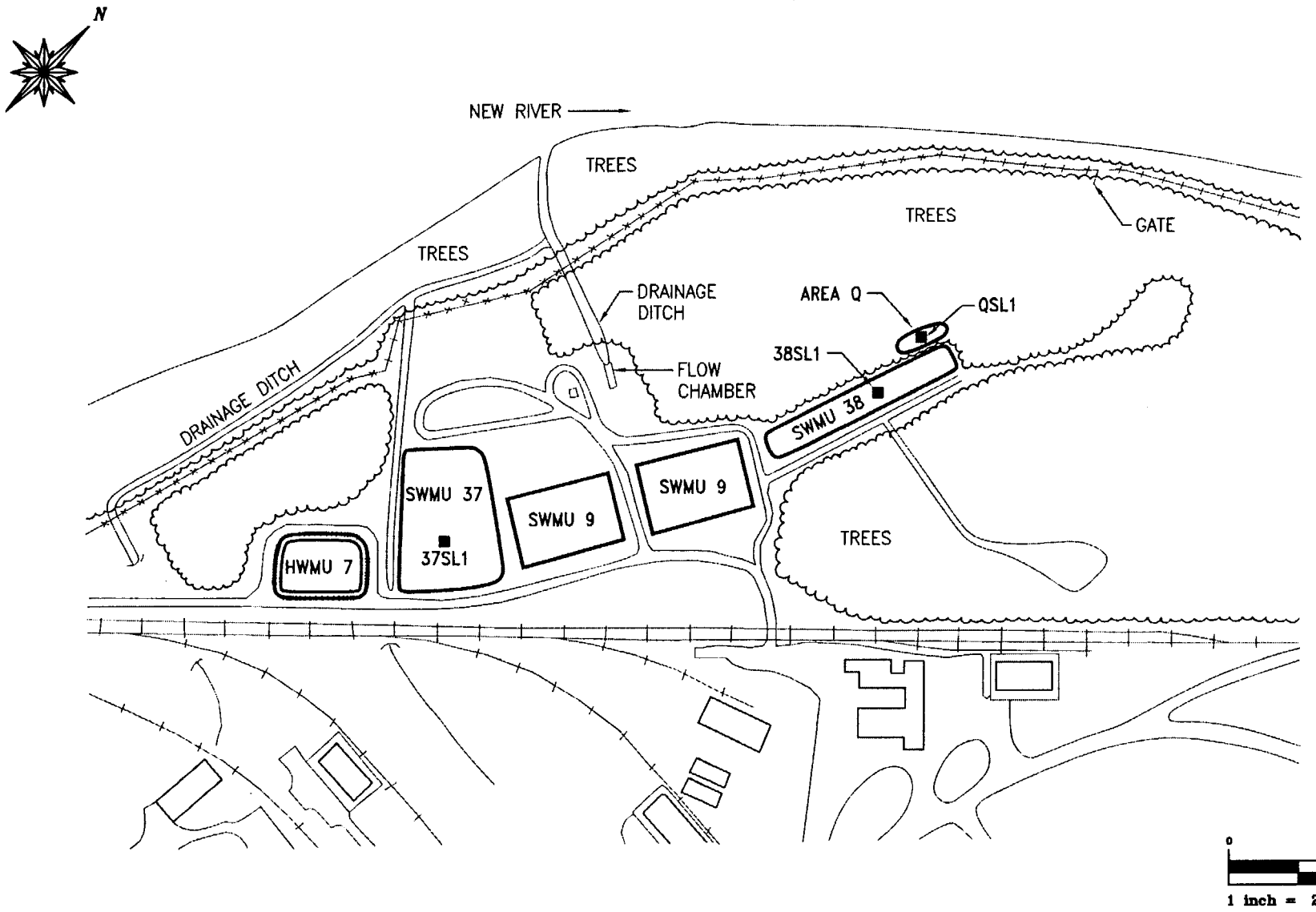
Table 1-3 presents a summary of the detected constituents as part of the waste characterization investigation for SWMU 37, SWMU 38, and Area Q. A review of the data indicates that detected concentrations of constituents did not exceed the current April 2003 Soil RBCs.

1.2.3.2 Review of the EPIC Aerial Photo Assessment Report – 1992

Activity within SWMU 37, SWMU 38, and Area Q was first noted on a 1962 photograph. SWMU 37 and 38 reportedly consisted of one "lagoon" each, although the lagoons did not appear to contain liquid (USEPA 1992). USEPA noted that both lagoons were present on the 1986 photograph, SWMU 37 is noted to contain "a small amount of reddish liquid" and SWMU 38 appeared empty. The 1962 photograph reportedly depicts a lagoon containing "possible liquid" at Area Q. The 1971 photograph reportedly depicts Area Q as re-vegetating.

1.2.4 Conceptual Site Model

A CSM for SWMU 37, SWMU 38, and Area Q is presented in Figure 1-4. The SWMUs are represented as being located in a relatively flat area adjacent to the steep banks of the New River. Subsurface geology is indicated as a generally sandy stratum with increasing gravel and cobbles with depth. Silty clay lenses as reported from SWMU 9 (Dames and Moore 1992a) are also represented. The water table surface is represented as within the sand and gravel; however, site-specific conditions may differ and groundwater may be present solely in bedrock at the site.



LEGEND

■ Waste Sample

(SOURCE: MODIFIED FROM DAMES & MOORE, 1992a)

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FIGURE 1-3

SWMU LAYOUT MAP

Table 1-3
Summary of Analytical Data For Sediment/Sludge Samples
Collected At SWMU 37, SWMU 38, and Area Q
Modified from Dames and Moore Verification Investigation Report
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

SITE ID FIELD ID SAMPLE DATE DEPTH (ft bgs) MATRIX UNITS	PQLs mg/kg	37SL1 RVFS*34 15-Jan-92 5.0 CSE mg/kg	38SL1 RVFS*35 15-Jan-92 5.0 CSE mg/kg	QSL1 RVFS*87 15-Jan-92 5.0 CSE mg/kg	Adjusted Soil Industrial RBC mg/kg	Adjusted Soil Residential RBC mg/kg	Draft BTAG Screening Level mg/kg
Volatiles							
1,1,1- Trichloroethane	0.005	< 0.004	< 0.004	< 0.004	28,616	2,190	0.3
Acetone	0.1	< 0.017	< 0.017	< 0.017	10,000	780	--
Chloroform	0.005	< 0.001	< 0.001	<0.001	1,022	78	0.3
Semivolatiles							
2-Methylnaphalene	0.3	< 0.245	< 0.049	< 0.049	2,044	156	--
Di-N-Butyl-Phthalate	0.3	41.5	1.48	3.01	10,220	782	--
N-Nitrosodiphenylamine	0.3	5.71	0.702	<0.19	584	130	--
Naphthalene	0.3	< 0.185	< 0.037	<0.037	2,044	156	0.1
Phenanthrene(1)	0.5	< 0.165	< 0.033	<0.033	3,066	235	0.1

Notes:

BTAG = USEPA Region III Draft, Biological Technical Assistance Group Screening Level

CSE = Chemical Sediment

ft bgs = Feet below ground surface

mg/kg = Milligrams per kilogram

PQL = Practical quantitation limit; the lowest concentration that can be reliably detected at a defined level of precision for a given analytical method

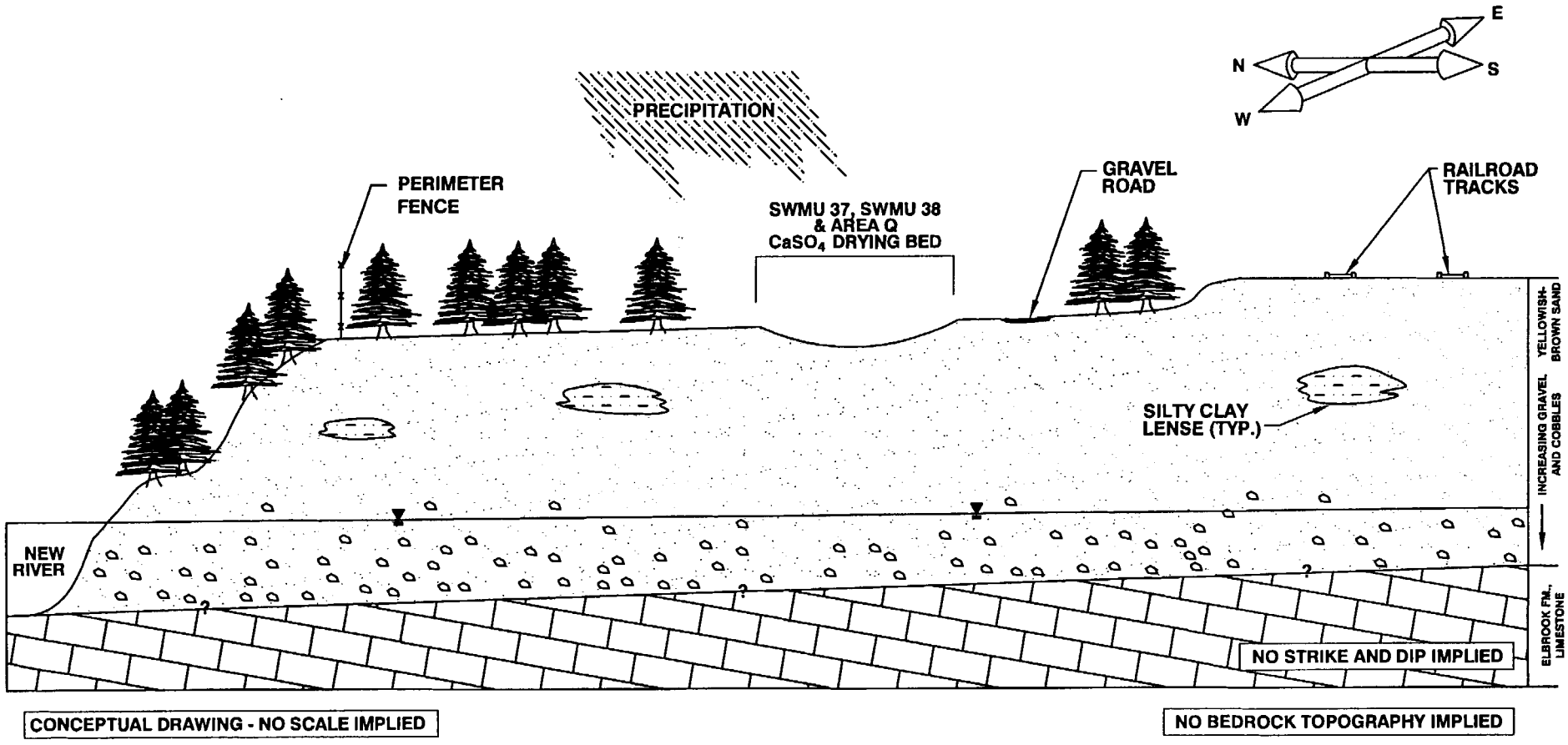
RBC = Risk-Based Concentration

USEPA = United State Environmental Protection Agency

USEPA Region III Risk-Based Concentration (RBC) values from the April 25, 2003 RBC Table

Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens

(1) = RBC value for pyrene used for phenanthrene



RFAAP

SSP WORK PLAN ADDENDUM: SWMU 37, SWMU 38, & AREA Q

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FIGURE 1-4

CONCEPTUAL SITE MODEL FIGURE

Potentially affected media include surface and subsurface soil. Surface water and sediment are not present in or near the drying beds. The three SWMU areas are depressed, therefore not allowing surface water to migrate overland from the SWMUs. Surface water would likely infiltrate into the ground. The $CaSO_4$ sludge may have potentially impacted surface soil through direct deposition and subsurface soil through leaching of constituents into site soil.

Current and future land-use scenarios are limited to industrial operations and SWMU 37, SWMU 38, and Area Q are enclosed by the Installation perimeter fence; therefore, potential receptors are limited to site workers, future construction workers, and terrestrial biota. Figure 1-5 presents the potential exposure pathways for each receptor. Direct deposition via surface deposition of sludge is considered a potential release mechanism to surface soil at these sites. Site workers, construction workers, and terrestrial biota could contact surface soil. Leaching of constituents through site soil is considered a potential release mechanism to subsurface soil and subsurface soil may be received by construction workers.

1.2.5 Data Gap Analysis

TCL VOCs – A review of the data indicates that TCL VOCs are not identified as COPCs; however, in order to meet the objectives of the SSP, TCL VOCs will be analyzed in surface and subsurface soil.

TCL SVOCs – TCL SVOC analysis was performed on sludge during the VI with SVOC detections reported. Subsurface samples were not collected and PAH analysis was not conducted during the previous investigations. Therefore, in order to meet the objectives of the SSP effort, TCL SVOCs and PAHs will be analyzed in surface and subsurface soil.

TCL PCBs – TCL PCBs analysis has not been performed on previous samples. Therefore, TCL PCBs represent a data gap and will be analyzed in surface soil.

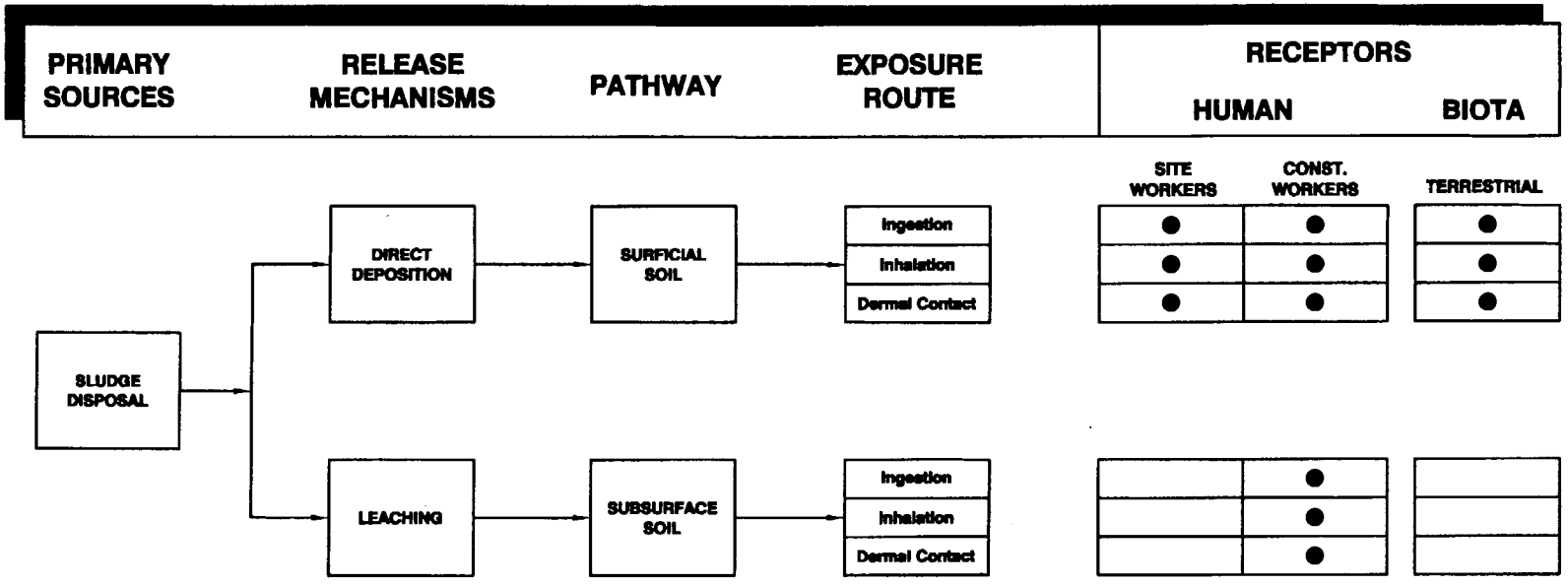
TCL Pesticides – These sites were not characterized for TCL Pesticides during previous investigations. Therefore, TCL Pesticides represent a data gap and will be analyzed in surface soil.

Explosives – Samples were not analyzed for explosive constituents during the previous investigations. Therefore, explosives represent a data gap and will be analyzed in surface and subsurface soil.

TAL Inorganics – Sludge samples were analyzed for TCLP Metals during the VI. Soil has not been tested for TAL Inorganics. Therefore, TAL Inorganics are considered a data gap and will be analyzed in surface and subsurface soil.

Dioxins/furans – Dioxins/furans are not considered a data gap because SWMU 37, SWMU 38, and Area Q were not used for burning or storage/disposal of burned waste.

Other – An analysis of the physical properties of subsurface soil to aid in assessing the nature of possible constituent mobility has not been performed during the previous investigations. Therefore, soil samples from each site will be analyzed for total organic content (TOC), grain size, specific gravity, percent moisture, and bulk density to assess the mobility of constituents in soil.



RFAAP

SSP WORK PLAN ADDENDUM: SWMU 37, SWMU 38, & AREA Q

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FIGURE 1-5

CONCEPTUAL SITE MODEL DIAGRAM

1.2.6 Planned Field Activities

Based on the results of the data gap analysis, additional sampling and analysis is proposed to meet the objectives of the SSP at these sites. Sampling locations were selected based on previous sample analytical data, site observations, and the CSM. Proposed analyses for various media types were identified by the results of the data gap analysis.

1.2.6.1 Soil Borings

The following sections discuss proposed soil investigations to be conducted at SWMU 37, SWMU 38, Area Q using the direct push method of boring advancement, as described in SOP 20.11 in Appendix A. A four-foot, Geoprobe Macro-Core® sampling device will be used to collect soil samples continuously from each of the borings, as described in SOP 20.11 in Appendix A. The location of each soil boring will be established to the nearest meter using GPS equipment.

Three soil borings will be advanced at each SWMU (37SB1, 37SB2, 37SB3; 38SB1, 38SB2, 38SB3; and QSB1, QSB2, QSB3). Proposed sampling locations are presented on Figure 1-6. Soil borings will be advanced to the groundwater table or top of bedrock, whichever is encountered first. During boring advancement, subsurface soil samples will be screened for the presence of VOCs a PID consistent with SOP 90.1 included in Appendix A. Soil borings will be completed at the following locations:

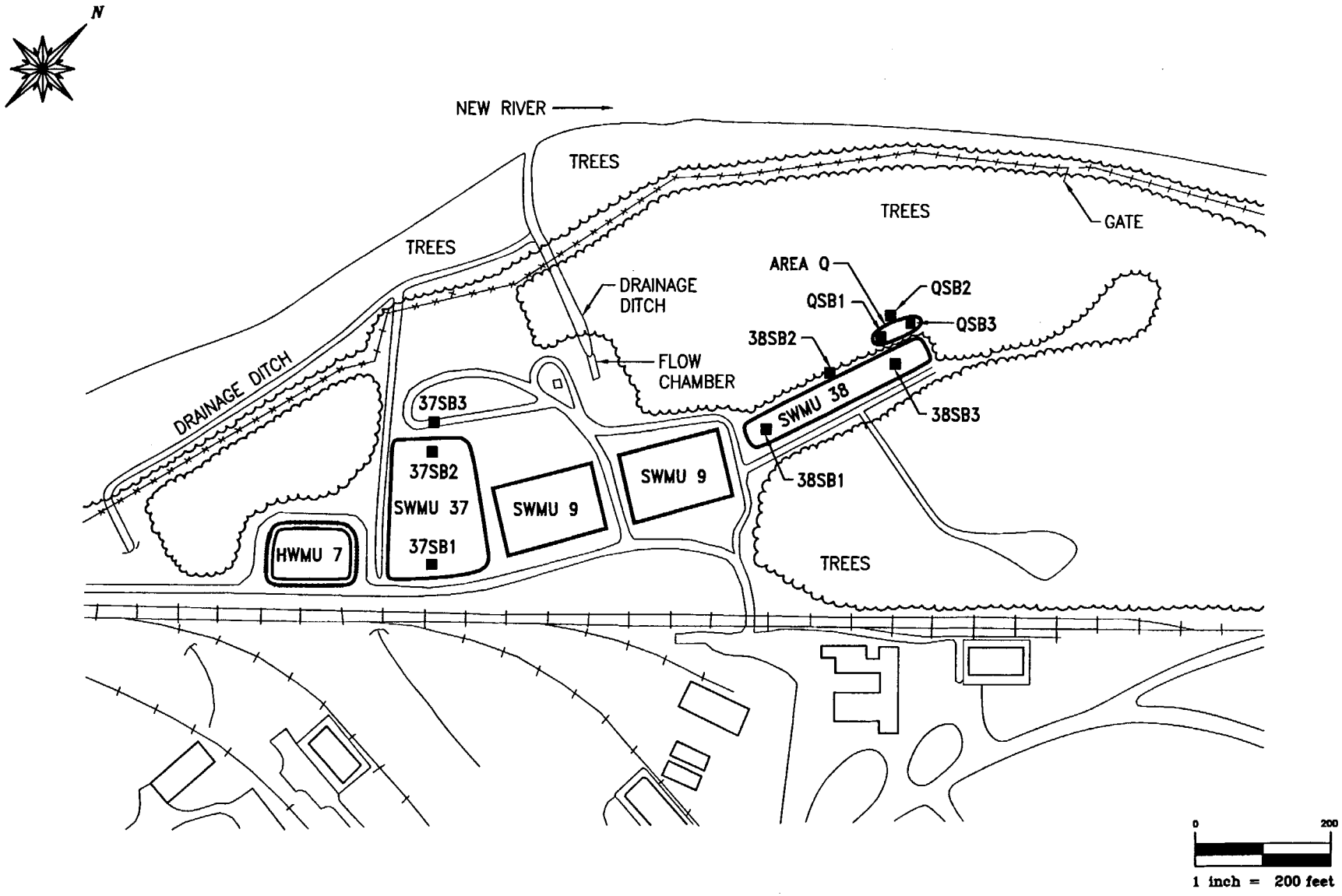
- Two borings are proposed within the limits of each SWMU (i.e., within the areas identified as having sludge present during operation of these units); and
- A third soil boring will be located outside the bermed area and down gradient of each SWMU to identify potential releases from each SWMU.

To meet the objectives of the soil screening at SWMU 37, SWMU 38, and Area Q, outlined above, and to fill the data gaps identified in Section 1.2.11:

- One surface sample will be collected from each boring (i.e., 0 to 6 inches bgs below gravel, vegetative, or organic layers and 6 to 12 inches bgs for VOCs) to characterize surface soil;
- Two subsurface soil samples will be collected from each boring, with samples collected from an intermediate zone (approximately 14 to 16 ft bgs) and from the terminational zone (above the groundwater table or top of bedrock); and
- Each of the soil samples will be analyzed for TCL VOCs, TCL SVOCs/ PAHs, explosives (including nitroglycerin), and TAL Inorganics. Three of the surface soil samples (one from each site) will be analyzed for TCL Pesticides and TCL PCBs consistent with the requirements of the MWP QAP and Section 2.0 of this WPA.

Stratigraphic logs will be prepared for each boring location in accordance with the procedures outlined in SOP 10.3 in Appendix A.

Two samples (from each site) will be collected from selected boreholes and analyzed for the physical properties total organic content (TOC), grain size, specific gravity, percent moisture, and bulk density in accordance with the QAPA in Section 2.0 of this document.



LEGEND

■ Proposed Sampling Location

(SOURCE: MODIFIED FROM DAMES AND MOORE, 1992a)

RFAAP

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FIGURE 1-6

PROPOSED SAMPLING LOCATIONS

1.3 SWMU 46 – PROPELLANT BURIAL AREA

1.3.1 Site Background – Environmental Setting



Physiography – SWMU 46 is a maintained grass area located in the northwest section of the MMA approximately 240 feet southeast of the New River (Dames and Moore 1992a). The area elevation is approximately 1,720 ft msl (Figure 1-7).

The precise location of this SWMU has historically been disputed (USACHPPM 1997), however, the area is assumed to be near the location of a sign indicating "BURIED EXPLOSIVE WASTE." RFAAP personnel verified that the sign was originally placed in the area where the propellant waste was reportedly found (Dames and Moore 1992a). The area surrounding the SWMU is relatively flat with a moderate slope to the northwest towards the New River. The immediate SWMU 46 area is a localized depression between the railroad tracks to the southeast and the asphalt roadway and parking area to the northwest.

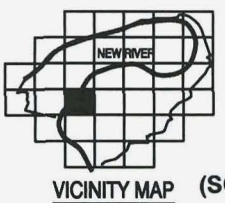
Surface Water – The New River is the nearest naturally occurring perennial surface water body and is located 240 feet northwest of SWMU 46. Precipitation and run-on likely percolate into the subsurface at the SWMU. Overland flow originating on the SWMU not percolating into the subsurface would likely migrate across maintained grass approximately 300 feet to the northeast and then 200 feet to the northwest to the New River. The actual size of this SWMU is unknown; however, based on the waste quantity reportedly disposed, it is likely limited to the observed depressed area with limited outward drainage. Manholes, catch basins, storm drains, or other well-defined drainage pathways have not been associated with the SWMU 46 area.

Geology and Soil – SWMU 46 is underlain by the Unison-Urban Land complex soil (IT 2002b). This soil has moderate permeability and medium-to-strong acidity (IT 2002b). Site-specific data regarding subsurface conditions at SWMU 46 have been collected (Dames and Moore 1992a); however, the investigation was limited to site soil and depth to bedrock. Data collected by Dames and Moore indicate that soil consists of fine-grained sandy silt. Investigations at other SWMUs in similar settings at RFAAP (i.e., adjacent to the New River on a point bar deposit) indicate the presence of 5 to 20 feet of soil and unconsolidated alluvial deposits overlying carbonate bedrock.

Groundwater – Site-specific data regarding hydrogeologic conditions at SWMU 46 have not been collected. Based on similar geomorphic setting to other SWMUs at RFAAP, groundwater is likely present from 10 to 30 ft bgs in unconsolidated alluvium and as diffuse and/or conduit flow in bedrock.

Tanks and Structures – A non-related building is located immediately to the northwest across an asphalt road and parking area. In addition to the railroad tracks located approximately 20 feet southwest of the SMWU area, a boundary fence exists to the east and west of SWMU 46. No other tanks or structures are located in or near SWMU 46.





VICINITY MAP
N.T.S.

(SOURCE: MODIFIED FROM HERCULES 1992)

0 200

1 inch = 200 feet

RFAAP

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FIGURE 1-7

SITE TOPOGRAPHY LAYOUT

1.3.2 Site Background – History

Approximately one ton of propellants and propellant-contaminated soil was reportedly deposited at this location. No other activities have been associated with the SWMU 46 area.

1.3.3 Previous Investigations

The following section is intended to be a review of previous site investigations with emphasis placed on the usability of collected data and screening of historical data with respect to current criteria (i.e., current RBCs and BTAGs).

1.3.3.1 Verification Investigation – 1992

Soil – In 1992, Dames and Moore reported the results of soil sampling conducted in October of 1991 at SWMU 46 to "evaluate whether soil contamination exists from the one-time release of waste propellants." Four, 3 feet by 3 feet by 5 feet test pits were excavated in the area identified as the buried explosives waste area; visual evidence of contamination or disturbed soil were not reported (Dames and Moore 1992a). Two soil samples (46SS1 and 46SS2) were collected at a depth of approximately 1 foot from separate pits and analyzed for TAL Metals and explosives (Figure 1-8). Please note that SWMU 46 sampling took place in October 1991 and the results were reported in 1992. A summary of the detected constituents is presented on Table 1-4.

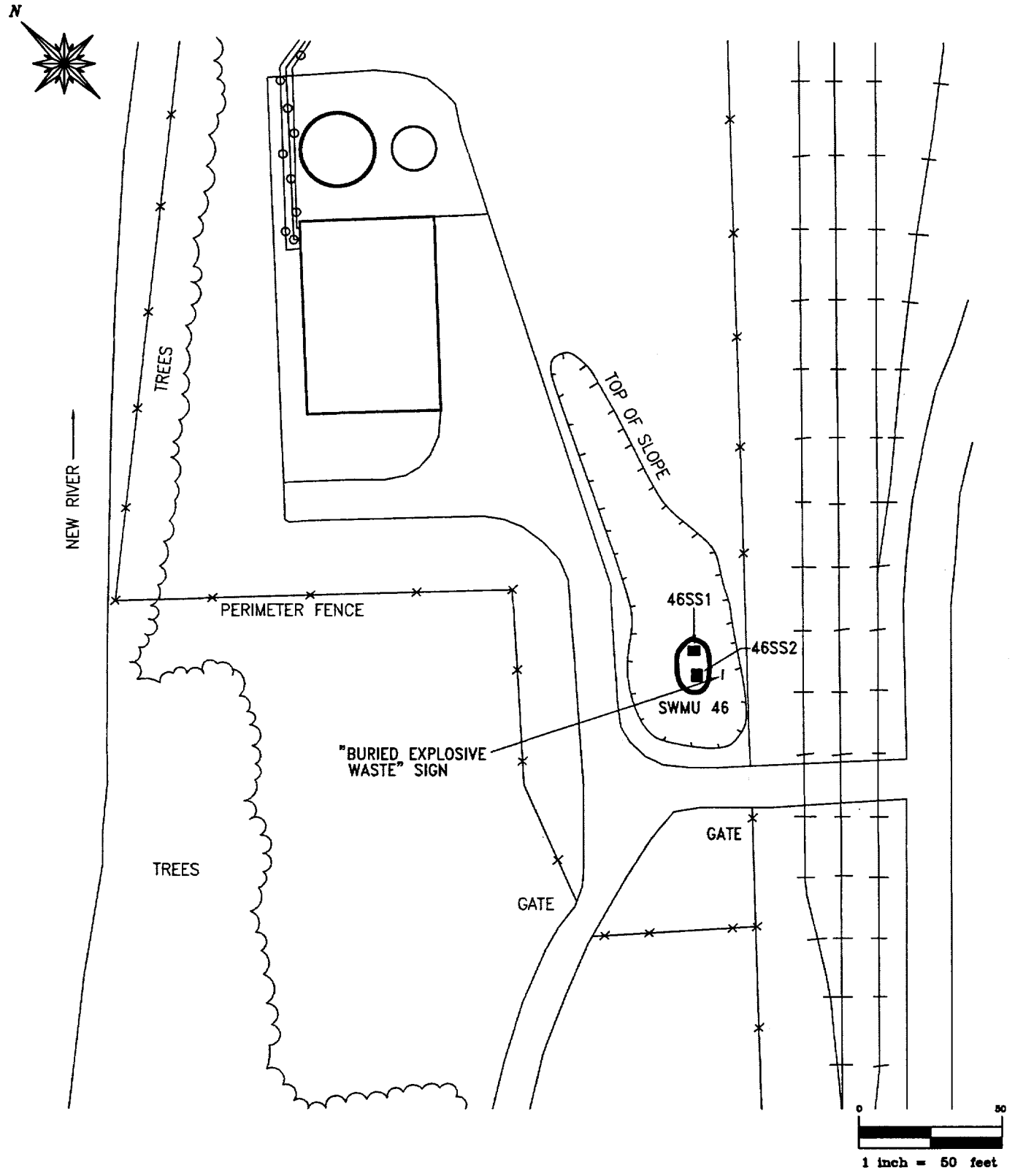
Results of the chemical analyses of 46SS1 and 46SS2 indicated that exceedance of the facility-wide background point estimates is limited to thallium. Seven metals (aluminum, arsenic, chromium, iron, manganese, thallium, and vanadium) were reported above their respective April 2003 Residential Soil RBCs. Three metals (arsenic, iron, and thallium) were reported above their respective, 2003 Industrial RBCs. Eleven metals were present above their respective Draft BTAG screening levels in samples 46SS1 and 46SS2. Explosives were not detected in either sample.

1.3.3.2 Relative Risk Site Evaluation – 1997

In 1997, the United States Army Center for Health Promotion and Preventive Medicine (USACHPPM) conducted a Relative Risk Site Evaluation in the SWMU 46 area. A Geoprobe® was used to advance eleven borings to a depth of 5 to 9 ft bgs at three areas thought to represent the burial site (USACHPPM 1997). Evidence of propellant was not reported in the borings and the soil was reported to appear undisturbed (USACHPPM 1997). Five subsurface soil samples were collected from three borings in one of the areas (S46-6, S46-7, and S46-8; Figure 1-9). A sample was collected from S46-6 at 5 to 9 ft bgs and samples from S46-7 and S46-8 were collected from both 1 to 5 ft bgs and 5 to 9 ft bgs. These samples were analyzed for SVOCs (USEPA SW-846 Test Method 8270B), explosives (USEPA SW-846 Test Method 8330), Total Metals (EPA SW-846 Test Method 6010A/7471A), and nitrite/nitrate analysis (USEPA Method 353.2). A summary of the detected constituents is presented on Table 1-5. Additional samples for chemical analysis were not collected from other soil boring locations in the SWMU 46 area during the Relative Risk Site Evaluation.

A review of the data indicates that chromium was detected in one sample at 24.7 mg/kg, a concentration that exceeds the April 2003 Residential RBC of 23 mg/kg. Four metals (cadmium, chromium, nickel, and zinc) were reported present above their respective Draft BTAG Screening Levels. Note that laboratory reporting limits were inadequate to properly screen data versus current screening criteria.

SVOCs and explosives were not detected in the soil samples collected as part of this investigation.



LEGEND

■ Soil Sample

(SOURCE: MODIFIED FROM DAMES & MOORE, 1992a)

RFAAP

SSP WORK PLAN ADDENDUM: SWMU 46

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Scale:	**File Name:**
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FIGURE 1-8

SWMU LAYOUT MAP

Table 1-4
Summary of Analytical Data for Soil Samples Collected at SWMU 46
Modified from Dames and Moore Verification Investigation Report
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

SITE ID FIELD ID SAMPLE DATE DEPTH (ft bgs) MATRIX UNITS	PQLs mg/kg	46SS1 RVFS*47 29-Oct-91 1.0 CSO mg/kg	46SS2 RVFS*48 29-Oct-91 1.0 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	**17,100**	**21,100**	102,200	7,821	1	40,041
Arsenic	30	2.13B	**3.57**	1.91	0.43	328	15.8
Barium	1	108	119	7,154	548	440	209
Beryllium	0.2	**0.842**	**0.832**	204	16	0.02	1.02
Calcium	100	2,700B	1,170B	--	--	--	--
Chromium[1]	4	31.7B	**38.3**	307	23	0.0075	65.3
Cobalt	3	15.6	19	2,044	156	100	72.3
Copper	7	12.6	**16.5**	4,088	313	15	53.5
Iron	1,000	**28,400**	**34,000**	30,660	2,346	12	50,962
Magnesium	50	6,360B	5,180B	--	--	4,400	--
Manganese[2]	0.275	**653**	**671**	2,044	156	330	2,543
Nickel	3	**16**	**20.7**	2,044	156	2	62.8
Potassium	37.5	1,520B	2,170	--	--	--	--
Silver	4	<0.589	**0.788**	511	39	0.0000098	--
Sodium	150	215B	233B	--	--	--	--
Thallium	20	<6.62	**12.6**	7.15	0.547	0.001	2.11
Vanadium	0.775	**57.4**	**70.5**	715	54.8	0.5	108
Zinc	30.2	**67.3**	**82.8**	30,660	2,346	10	202

Notes:

B = Analyte was detected in corresponding method blank; values are flagged if the sample concentration is less than ten (10) times the method blank concentration for common laboratory constituents and five (5) times for all other constituents

BTAG = USEPA Region III, Biological Technical Assistance Group Screening Level

CSO = Chemical soil

ft bgs = Feet below ground surface

mg/kg = Micrograms per kilogram

PQL = Practical quantitation limit; the lowest concentration that can be reliably detected at a defined level of precision for a given analytical method

TAL = Target Analyte List

RBC = Risk-Based Concentration

USEPA = United States Environmental Protection Agency

USEPA Region III Risk-Based Concentration (RBC) values from the April 25, 2003 RBC Table

Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens

[1] = Chromium VI RBC value used

[2] = Manganese-nonfood RBC value used

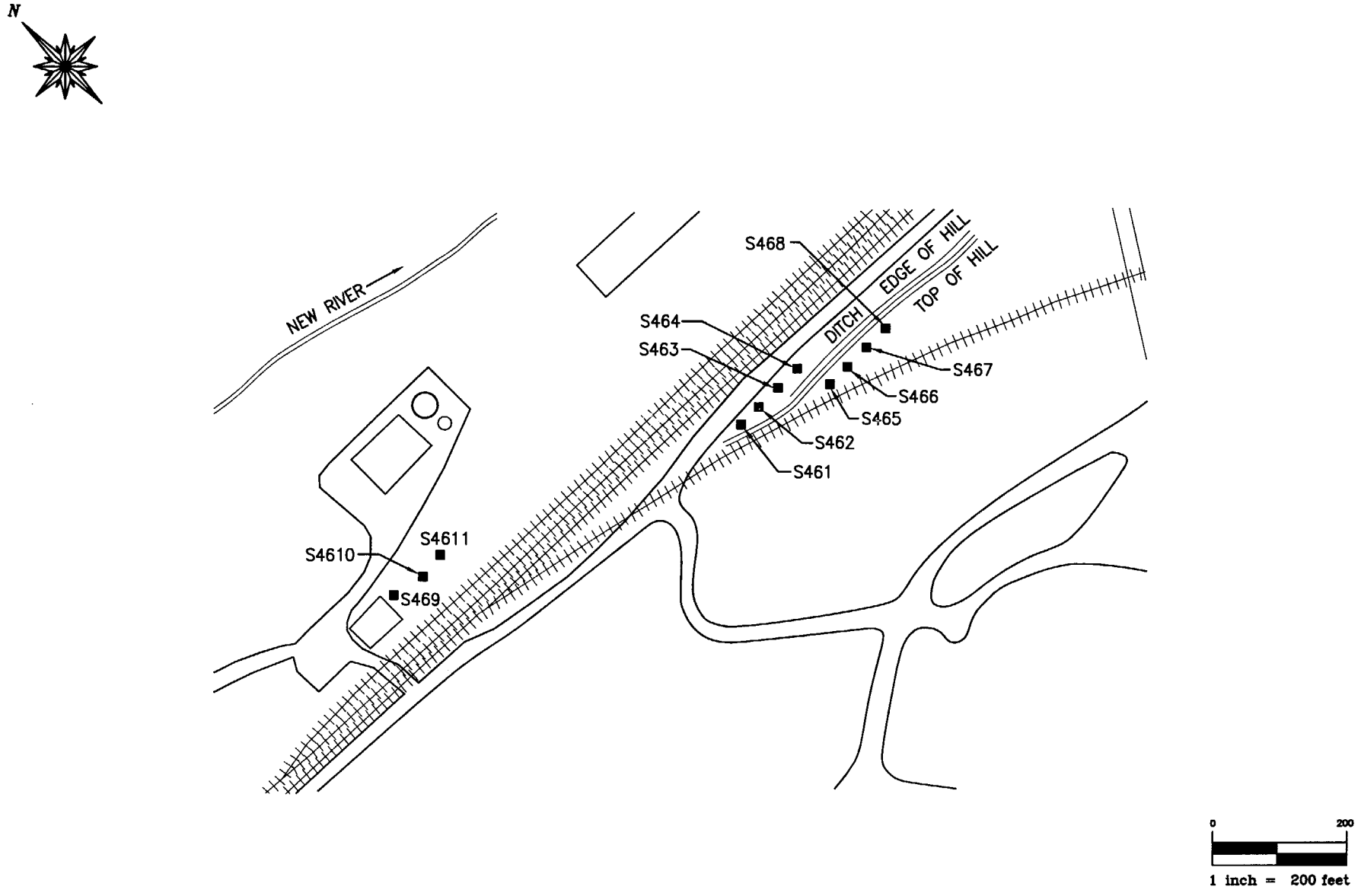
[A] = Facility-Wide Background Point Estimate as Reported in the Facility-Wide Background Study Report (IT 2002b)

bold = Concentration exceeds Industrial RBC

= Concentration exceeds Residential RBC

= Concentration exceeds BTAG Screening Level

underline = Concentration exceeds Facility-wide Background Point Estimate



LEGEND

■ Soil Sample

(SOURCE: MODIFIED FROM USACHPPM, 1997)

RFAAP

SSP WORK PLAN ADDENDUM: SWMU 46

Date:	Prepared By:
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Scale:	**File Name:**
AS SHOWN	09604-317-155

FIGURE 1-9

USACHPPM SAMPLING LOCATIONS

Table 1-5
Summary of Detected Analytes for Soil Samples Collected at SWMU 46
Modified from USACHPPM Relative Risk Site Evaluation
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

FIELD ID	S46-6-5	S46-7-1	S46-7-5	S46-8-1	S46-8-5	Adjusted Soil Industrial RBC	Adjusted Soil Residential RBC	Draft BTAG Screening Level	Facility-Wide Background Point Estimates[A]
SAMPLE DATE	12-May-97	12-May-97	12-May-97	12-May-97	12-May-97				
DEPTH (ft bgs)	5-9	1-5	5-9	1-5	5-9				
MATRIX	CSO	CSO	CSO	CSO	CSO				
UNITS	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Metals (EPA Method 6010A)									
Barium	77.2	95.6	88.7	83.4	85.4	7,154	548	440	209
Cadmium	2.61	2.60	3.23	2.20	3.00	102	7.82	2.5	0.69
Calcium	781	785	812	806	757	–	–	–	–
Chromium[1]	16.0	24.7	22.3	19.0	18.9	307	23	0.0075	65.3
Cobalt	<11.4	13	<12	<11	13	2,044	156	100	72.3
Magnesium	2,160	1,692	2,557	1,574	2,486	–	–	4,400	–
Nickel	14.2	12.2	17.1	11.1	21.2	2,044	156	2	62.8
Zinc	40.7	43.3	47.5	42.5	45.4	30,660	2,346	10	202

Notes:

BTAG = USEPA Region III Draft, Biological Technical Assistance Group Screening Level

CSO = Chemical soil

ft bgs = Feet below ground surface

mg/kg = Milligrams per kilogram

RBC = Risk-Based Concentration

USEPA = United States Environmental Protection Agency

USEPA Region III Risk-Based Concentration (RBC) values from the April 25, 2003 RBC Table

Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens

bold = Concentration exceeds Industrial RBC

= Concentration exceeds Residential RBC

= Concentration exceeds Draft BTAG Screening Level

underline = Concentration exceeds Facility-Wide Background Point Estimate

[A] = Facility-Wide Background Point Estimate as Reported in the Facility-Wide Background Study Report (IT 2002b)

[1] = Chromium VI RBC value used

1.3.4 Conceptual Site Model

A CSM for SWMU 46 is presented in Figure 1-10. The site is shown as a depressed area surrounded by relatively flat land with a gentle slope towards the steep banks of the New River. Subsurface geology is indicated as a generally silty stratum with increasing gravel and cobbles with depth. Silty clay lenses as reported from SWMU 9 (Dames and Moore 1992a) are also represented. The water table surface is represented as within the sand and gravel; however, site-specific conditions may differ and groundwater may be present solely in bedrock at the site. Potentially affected media include surface and subsurface soil. The one time release of propellants may have potentially impacted surface soil through direct deposition and subsurface soil through leaching of constituents into site soil. SWMU 46 is composed of a depressed area and precipitation and overland flow would likely percolate into the subsurface. Therefore, surface water and sediment have not been associated with this SWMU.

Current and future land-use scenarios are limited to industrial operations and SWMU 46 is located within the Installation perimeter fence; therefore, limiting potential receptors to site workers, future construction workers, and terrestrial biota. Figure 1-11 presents the potential exposure pathways for each receptor. Direct deposition via the disposal of waste is considered a potential release mechanism to surface soil at this site. Site workers, construction workers, and terrestrial biota could contact. Leaching of constituents through site soil is considered a potential release mechanism to subsurface soil and subsurface soil may be received by construction workers.

1.3.5 Data Gap Analysis

TCL VOCs - Samples were not collected for TCL VOC analysis during the previous investigations. Therefore, TCL VOCs represent a data gap and will be analyzed in surface and subsurface soil.

TCL SVOCs/PAHs - TCL SVOCs were not detected in the soil samples collected during the USACHPPM Relative Risk Investigation. However, samples were not collected for PAH analysis during previous investigations. Therefore, in order to meet the objectives of the SSP effort, TCL SVOCs/PAHs will be analyzed in surface and subsurface soil samples.

TCL PCBs - TCL PCBs analysis has not been performed on previous samples. Therefore, TCL PCBs represent a data gap and will be analyzed in surface soil.

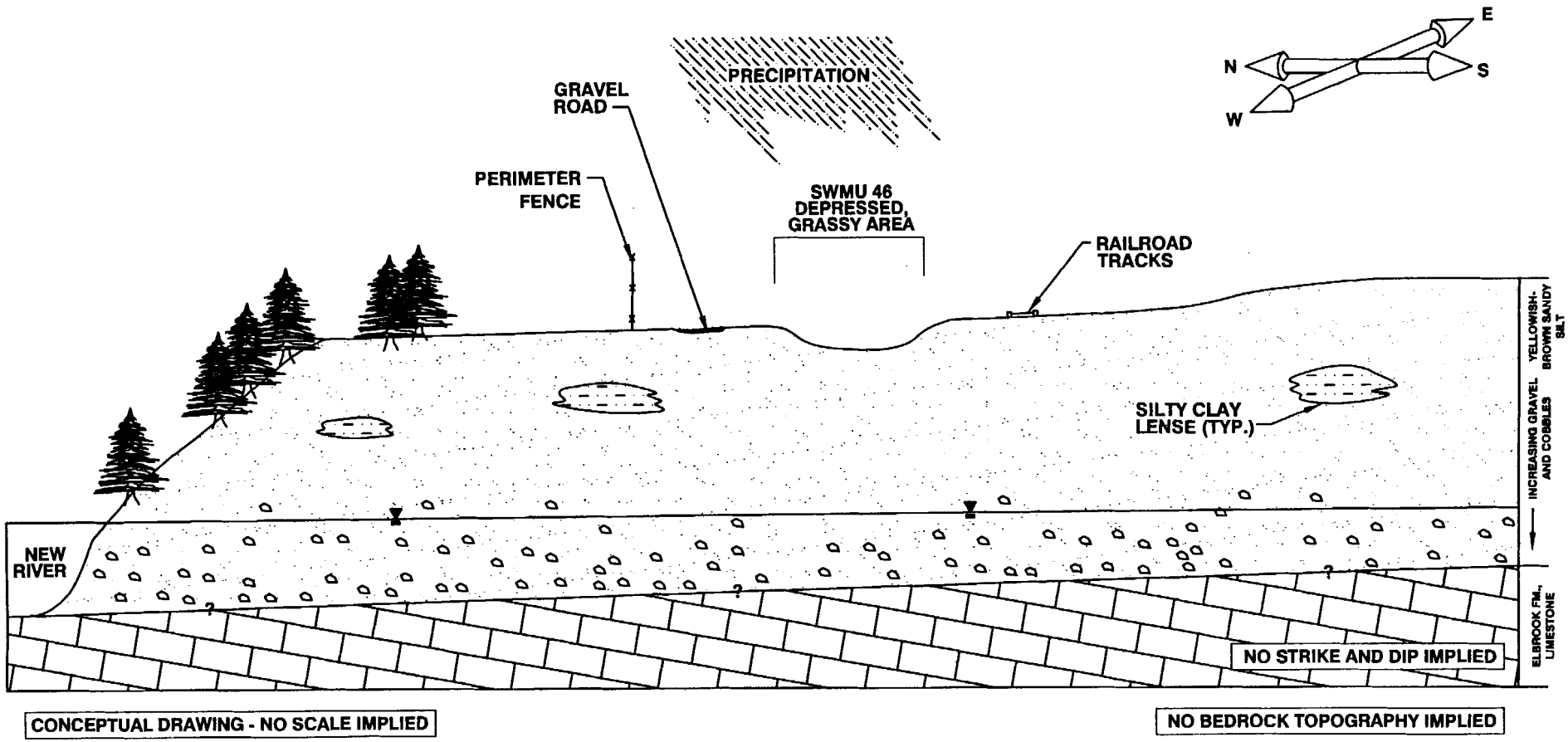
TCL Pesticides - TCL Pesticide analysis has not been performed on previous samples. Therefore, TCL pesticides represent a data gap and will be analyzed in surface soil.

Explosives – Explosive constituents were not detected during the previous investigations. Therefore, in order to meet the objectives of the SSP, explosives will be analyzed in surface and subsurface soil samples.

TAL Inorganics - Metals analysis was performed on two subsurface soil samples during the VI. A review of the results indicates that select TAL Inorganics area identified as COPCs at SWMU 46. Additional samples will be collected from the surface and subsurface soil to appropriately screen the site for SSP purposes.

Dioxins/furans - Dioxins/furans are not considered a data gap because SWMU 46 was not used for burning or storage/disposal of burned waste.

Other - An analysis of the physical properties of subsurface soil to aid in assessing the nature of possible constituent mobility has not been performed during the previous investigations. Therefore, soil samples will be analyzed for TOC, grain size, specific gravity, percent moisture, and bulk density to assess the mobility of constituents in soil.



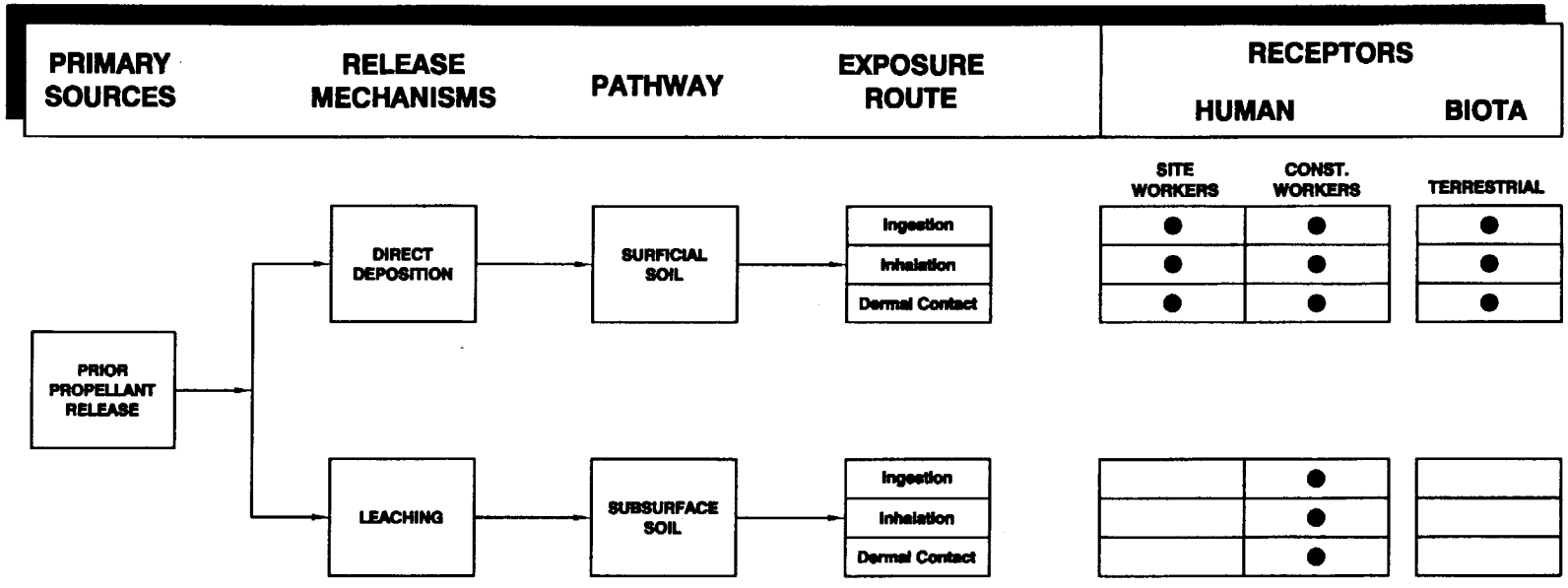
RFAAP

SSP WORK PLAN ADDENDUM: SWMU 46

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NO SCALE	*09604-317-155*

FIGURE 1-10

CONCEPTUAL SITE MODEL FIGURE



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Scale:	**File Name:**
NO SCALE	*09604-317-155*

FIGURE 1-11

CONCEPTUAL SITE MODEL DIAGRAM

1.3.6 Planned Field Activities

Based on the results of the data gap analysis, additional sampling and analysis is proposed to perform the SSP at this site. Sampling locations were selected based on previous sample analytical results, site observations, and the CSM. Proposed analyses for various media types were identified by the results of the data gap analysis.

1.3.6.1 Soil Borings

The following sections discuss proposed soil investigations to be conducted at SWMU 46 using the direct push method of boring advancement, as described in SOP 20.11 in Appendix A. A four-foot, Geoprobe Macro-Core® sampling device will be used to collect soil samples continuously from each of the borings, as described in SOP 20.11 in Appendix A. The location of each soil boring will be established to the nearest meter using (GPS) equipment.

Two soil borings will be advanced at SWMU 46 (46SB1 and 46SB2). Proposed sampling locations are presented on Figure 1-12. Soil borings will be advanced to the groundwater table or top of bedrock, whichever is encountered first, using direct push technology. During boring advancement, subsurface soil samples will be screened for the presence of volatile organic compounds using a PID consistent with SOP 90.1 included in Appendix A. Soil borings will be completed at the following locations:

- Boring, 46SB1 will be advanced within the area identified as having propellants disposed (i.e., near the sign) to further screen this area for hazardous constituents; and

- Boring 46SB2 will be located immediately down gradient from the disposal area to further assess the potential vertical and horizontal migration.

To meet the objectives of the soil screening at SWMU 46 outlined above and to fill the data gaps identified in Section 1.3.5:

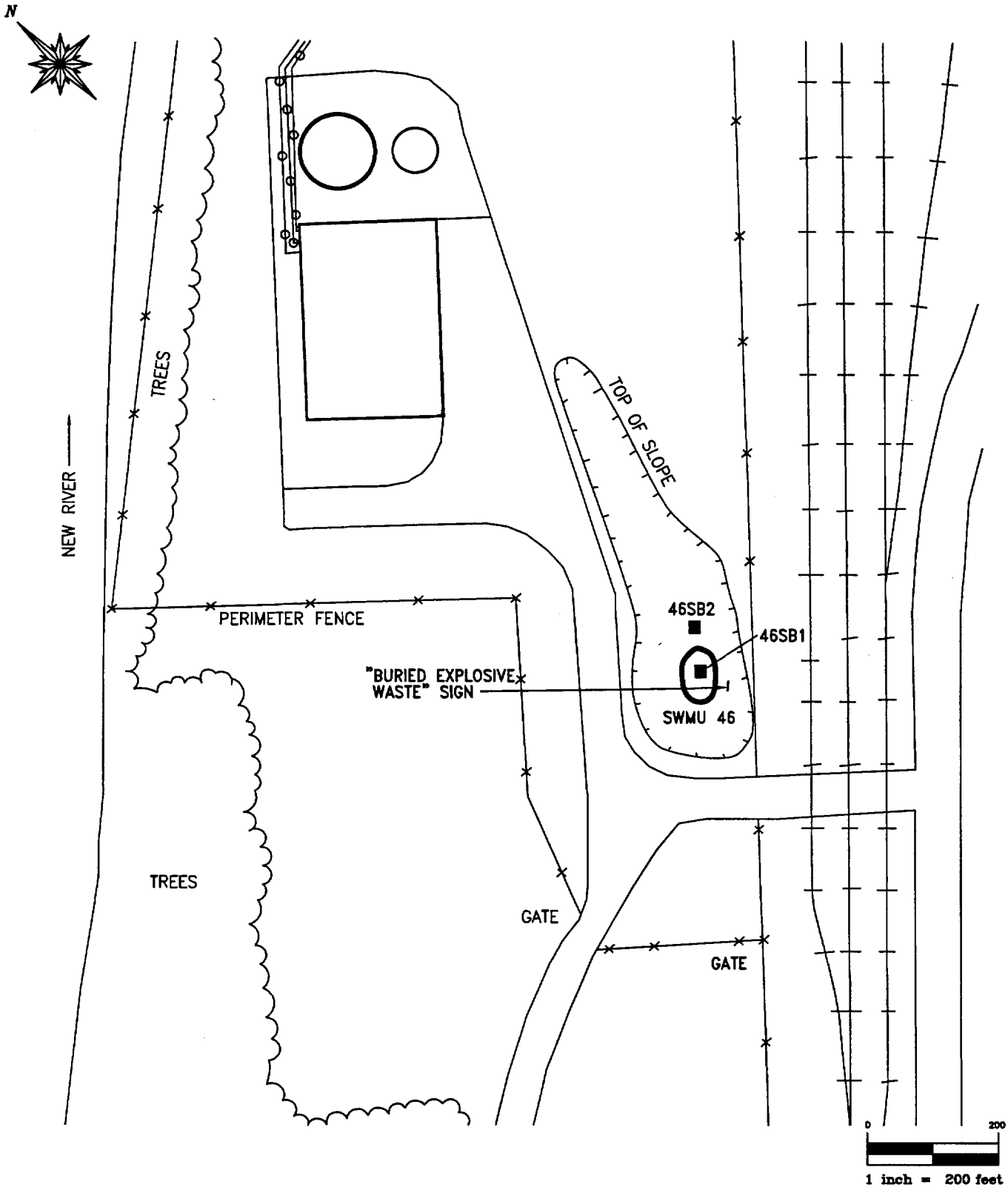
- One surface soil sample will be collected from each boring (i.e., 0 to 6 inches bgs below gravel, vegetative, or organic layers and 6 to 12 inches bgs for VOCs) to assess the extent of disposal activities;

- Two subsurface soil samples will be collected from each boring, with one from an intermediate zone (approximately 10 to 12 ft bgs) and one from the terminational zone (above the groundwater table or top of bedrock); and

- Each of the soil samples will be analyzed for TCL VOCs, TCL SVOCs/ PAHs, explosives (including nitroglycerin), and TAL Inorganics. One surface soil sample will be analyzed for TCL Pesticides and TCL PCBs consistent with the requirements of the MQAP and Section 2.0 of this WPA.

Stratigraphic logs will be prepared for each boring location in accordance with the procedures outlined in SOP 10.3 in Appendix A.

Two samples will be collected from different strata from one boring and analyzed for the physical properties TOC, grain size, specific gravity, percent moisture, and bulk density in accordance with the QAPA in Section 2.0 of this document.



LEGEND

■ Proposed Sampling Location

(SOURCE: MODIFIED FROM DAMES & MOORE, 1992a)

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SSP WORK PLAN ADDENDUM: SWMU 46

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FIGURE 1-12

PROPOSED SAMPLING LOCATIONS

1.4 SWMU 75 – USED OIL STORAGE TANK (INERT GAS PLANT)

1.4.1 Site Background – Environmental Setting



Physiography – SWMU 75 is located on a relatively level section of the MMA below a prominent slope to the south and a gentle slope to the north (Figure 1-13). The SWMU is located 20 feet west of a non-related building (Figure 1-14). SWMU 75 is the area of a previously removed 750-gallon underground storage tank (UST) utilized for the storage of used oil from RFAAP. An active compressor building operates 50 feet to the west. The tank area consists of gravel with overhead steam piping and an upward sloping grassed area across the asphalt road adjacent to the south.

Surface Water – Based on site topography, surface water in the immediate area of SWMU 75 would infiltrate into the ground, however, based on topography surrounding SWMU 75, surface water appears to flow northward. Manholes, catch basins, storm drains, or other well-defined drainage pathways have not been associated with SWMU 75.

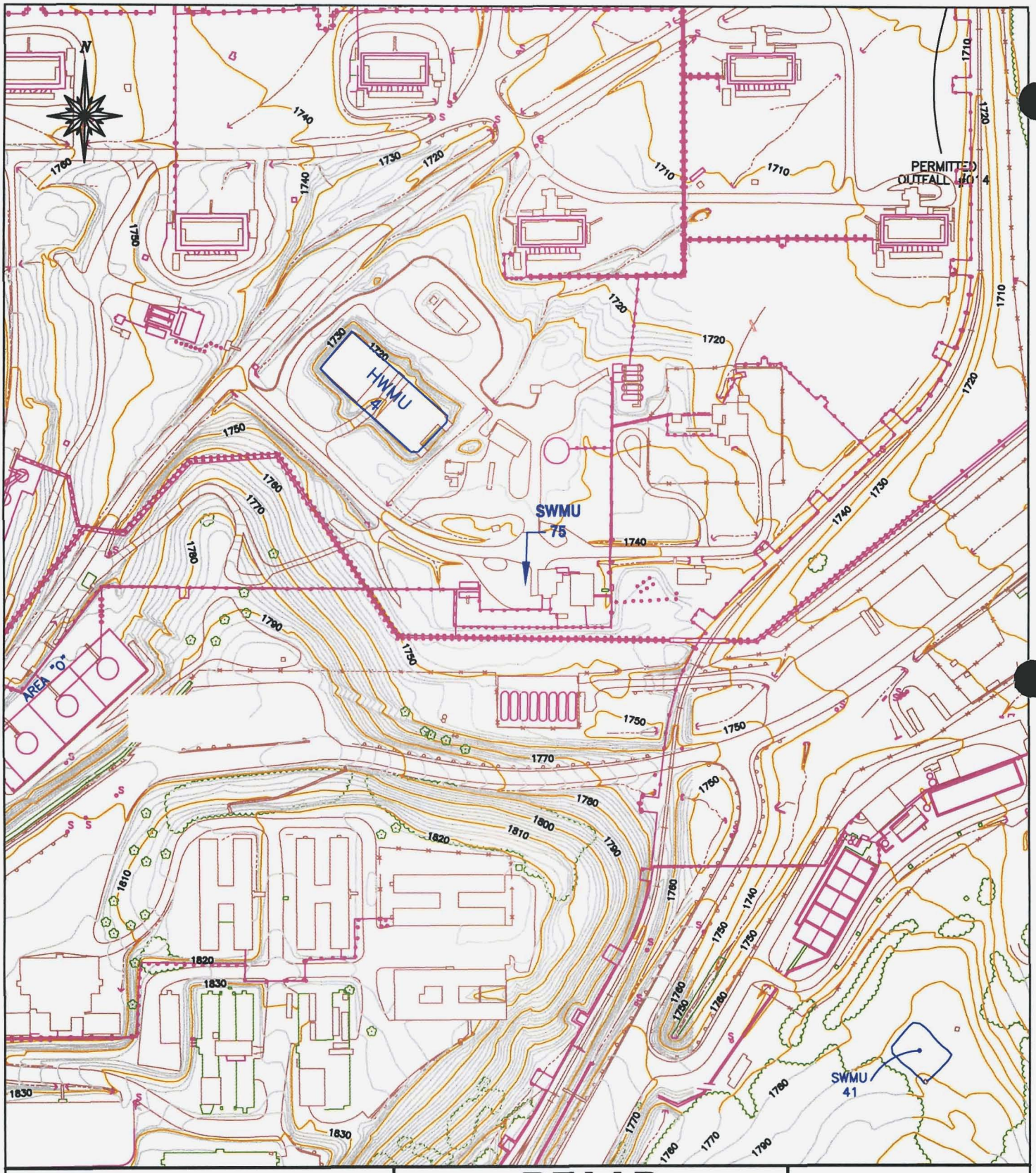
Geology and Soil – SWMU 75 is underlain by the Unison-Urban Land complex soil. This soil has moderate permeability and medium-to-strong acidity (IT 2002b). Site-specific data regarding subsurface conditions at SWMU 75 have not been collected. Data have been collected from Area O located approximately 700 ft to the west of SWMU 75. RCRA Facility Investigation (RFI) boring data from Area O indicate the presence of unconsolidated alluvial deposits that are divided into two strata. The shallowest stratum consists of fine, brown to yellow-brown plastic silt and clay. The second stratum is yellowish-brown silty clay or yellowish-brown clay with gravel and silt seams and is present below the first stratum and overlying the bedrock (Dames and Moore 1994). These gravels are discontinuous near Area O. Underlying the two strata is the gray limestone/dolostone of the Elbrook Formation. The bedrock is argillaceous with frequent brecciated, conglomeratic, and vuggy zones. The bedrock is highly weathered and fractured with small quartz and calcite veins (Dames and Moore 1994).

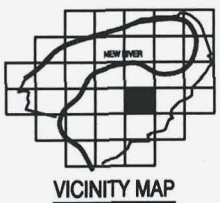
Groundwater – Site-specific data regarding groundwater conditions at SWMU 75 have not been collected. Hydrogeologic conditions of Area O were investigated through field investigation and data collected from slug tests performed on three wells during the RFI. Groundwater monitoring data from Area O (Dames and Moore 1994) indicate that a relatively shallow water table exists from 2 to 24 ft bgs; the shallow groundwater table (i.e., 2 ft bgs) is restricted to areas on the hill to the south of SWMU 75 where bedrock is present within 5 ft of the surface. Based on groundwater measurements obtained during the RFI, the water table slopes toward the northeast (Dames and Moore 1994).

Tanks and Structures – A sump exists between the former UST location and a new building. No other tanks or structures are located in or near SWMU 75.

1.4.2 Site Background – History

The UST was reportedly a single-walled tank installed in 1973 with a capacity of 750 gallons (ATK 2002). The UST stored used oil and hydraulic fluids that were generated in a nearby compressor building. The contents of the UST were reportedly pumped into 55-gallon drums for use as fuel at the Hazardous Waste Incinerator (USEPA 1987). During the RFA, discolored soil was observed around the tank access port (USEPA 1987). Tank use ceased in June 1991 and the Installation completed removal in June 1995.





VICINITY MAP
N.T.S.

0 200

1 inch = 200 feet

(SOURCE: MODIFIED FROM HERCULES, INC., 1992)

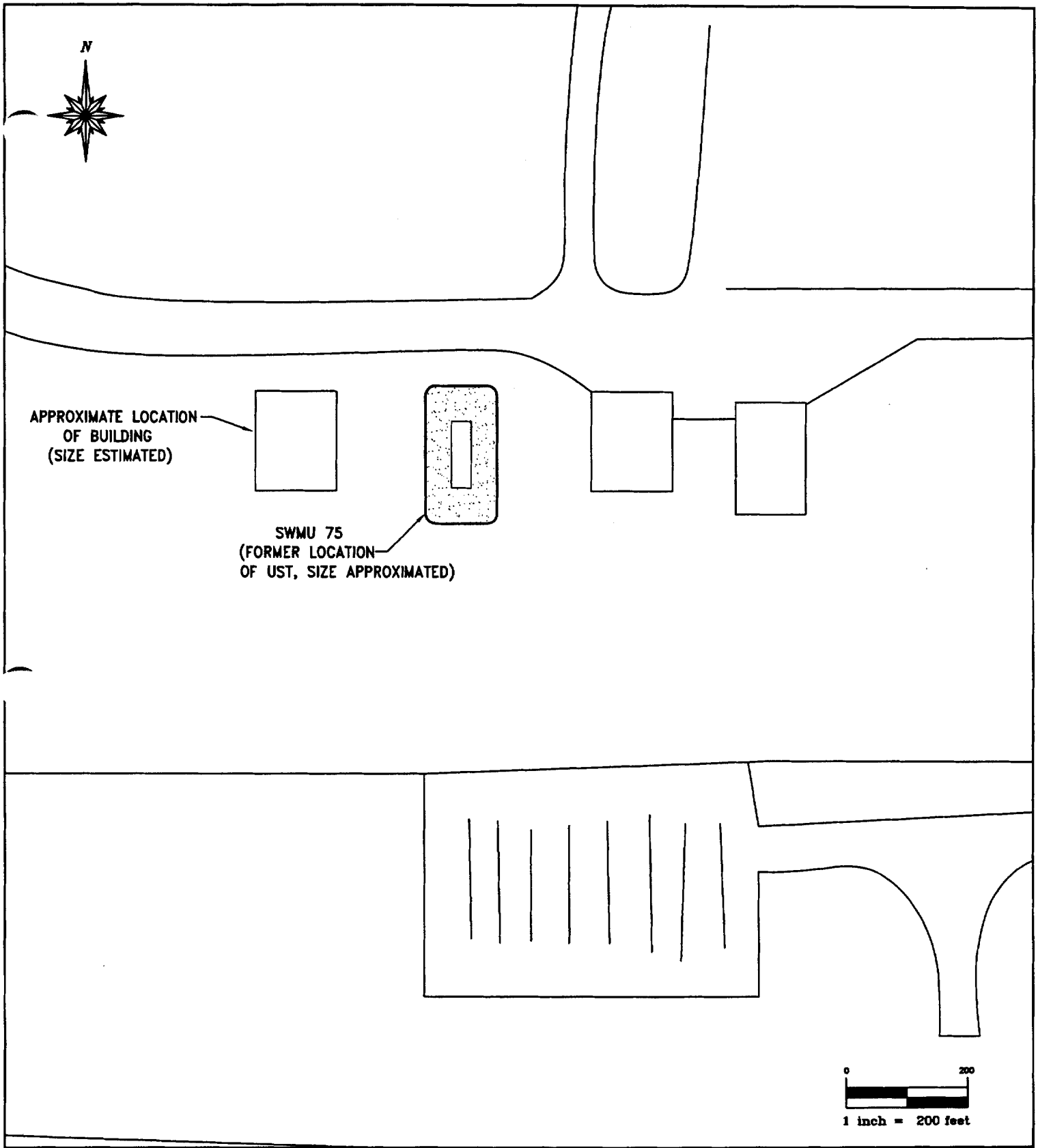
RFAAP

SSP WORK PLAN ADDENDUM: SWMU 75

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OCTOBER 2002	KDC/DR
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FIGURE 1-13

SITE TOPOGRAPHY LAYOUT



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FIGURE 1-14

SWMU LAYOUT MAP

1.4.3 Previous Investigations

The following section is intended to be a review of previous site investigations with emphasis placed on the usability of collected data and screening of historical data with respect to current criteria (i.e., current RBCs and BTAGs).

1.4.3.1 Tank Closure – 1995

In 1995, ATK conducted a tank removal and closure at SWMU 75. Five soil samples were collected from the excavation of the former UST, one sample from each of the sidewalls and one from the bottom of the excavation. Soil samples were analyzed for Total Petroleum Hydrocarbons (TPH). Results indicate that concentrations of TPH were reported in samples collected from two locations of the excavation, on the south wall (1,400 mg/kg), and on the bottom of the excavation near the southern end (130 mg/kg).

A site characterization report was prepared and submitted to the Virginia Department of Environmental Quality (VDEQ) including an amended USEPA Form 7530-1 (Notification of Underground Storage Tanks) indicating tank closure (ATK 1995). According to VDEQ database records, the SWMU 75 tank closure was assigned file number PC-95-1099 and records indicate, "No initial abatement report needed." Records further indicate that the PC-95-1099 file was "closed October 1995." Closure correspondence from the VDEQ Water Regional Office (Appendix C) stated that, "Based on the information provided [in the site characterization report], it appears that acceptable site characterization and abatement measures have been achieved (VDEQ 1995)." The correspondence also stated that, "There does not appear to be a current or potential risk to human health or the environment (VDEQ 1995)."

1.4.4 Planned Field Activities

The tanks associated with this SWMU have been removed, impacted soils were removed, closure notification was filed, and closure was approved by the VDEQ. Therefore, no additional field activities are proposed for the investigation of this former UST site.

1.5 SWMU 76 – OIL TANKS

1.5.1 Site Background – Environmental Setting

Physiography – SWMU 76 is located in the south central section of the MMA in a region of gently to steeply sloping ridges (Figure 1-15). This region of the MMA is characterized by the presence of sinkholes and bedrock fracture traces (IT 2001a). SWMU 76 formerly consisted of two underground waste oil collection tanks situated adjacent to the southeast perimeter of SWMU 17. The location of the former waste oil tanks lies along the southeastern embankment (Figure 1-16) of SWMU 17 at an elevation of approximately 1,895 ft msl. Non-related buildings are located to the south and gravel roads and wooded areas surround SWMU 17 and SWMU 76.



Surface Water – Based on topography, surface water in the area of the SWMU 76 would flow from the surrounding hillsides and collect in the areas of lower elevations of SWMU 17. This water runoff would likely percolate into the site soil. According to RFAAP utility maps, there are no manholes, catch basins, or storm drains near SWMU 76.

Geology and Soil – SWMU 76 is underlain by the Unison-Urban land complex soil. This soil has moderate permeability and medium-to-strong acidity (IT 2002b). Abundant data have been collected from SWMU 17, which is situated adjacent to SWMU 76. Boring data from SWMU 17 indicate a stratum of gray-brown clayey silt overlying the Elbrook Formation consisting of predominantly a highly argillaceous, weathered dolomite interbedded with limestone and siltstone (Parsons 1996). Boring advancement in the vicinity to SWMU 17 indicates the presence of subsurface voids typical of an area exhibiting development of karst features.

Groundwater – Five groundwater monitoring wells and one piezometer have been constructed near SWMU 76. Ground water monitoring data from these wells (Parsons 1996) indicate the groundwater table is deep (i.e., greater than 100 ft bgs) and is contained within bedrock. Groundwater level measurements collected at SWMU 17 between 1992 and 1995 (Parsons 1996) have shown groundwater elevations in this area fluctuate over a wide range and flow toward the west-northwest. The observed groundwater fluctuations are considered typical of groundwater flow through fractures, bedding planes, and karst solution features (Parsons 1996).

Tanks and Structures – No other tanks or structures exist in the area of SWMU 76.

1.5.2 Site Background – History

The capacity of one tank was 5,500 gallons and the capacity of the second tank was 2,650 gallons (Hercules 1991b). Used oil from machinery and vehicle engines throughout RFAAP was collected in the Mobile Waste Oil Tanks (SWMU 61) and stored in the SWMU 76 tanks prior to being sold to an off-post firm for reclamation (RFA 1987). The two USTs at SWMU 76 were removed and closed in June 1991. During the tank removal, a spill of oily wastewater and sludge occurred from the 5,500-gallon UST. Approximately 250 gallons of the oily wastewater sludge, which was not evacuated from the UST before removal, drained into a trench alongside the tank as the tank was being removed (Hercules 1991b).



VICINITY MAP
N.T.S.

0 200

1 inch = 200 feet

(SOURCE: MODIFIED FROM HERCULES, INC., 1992)

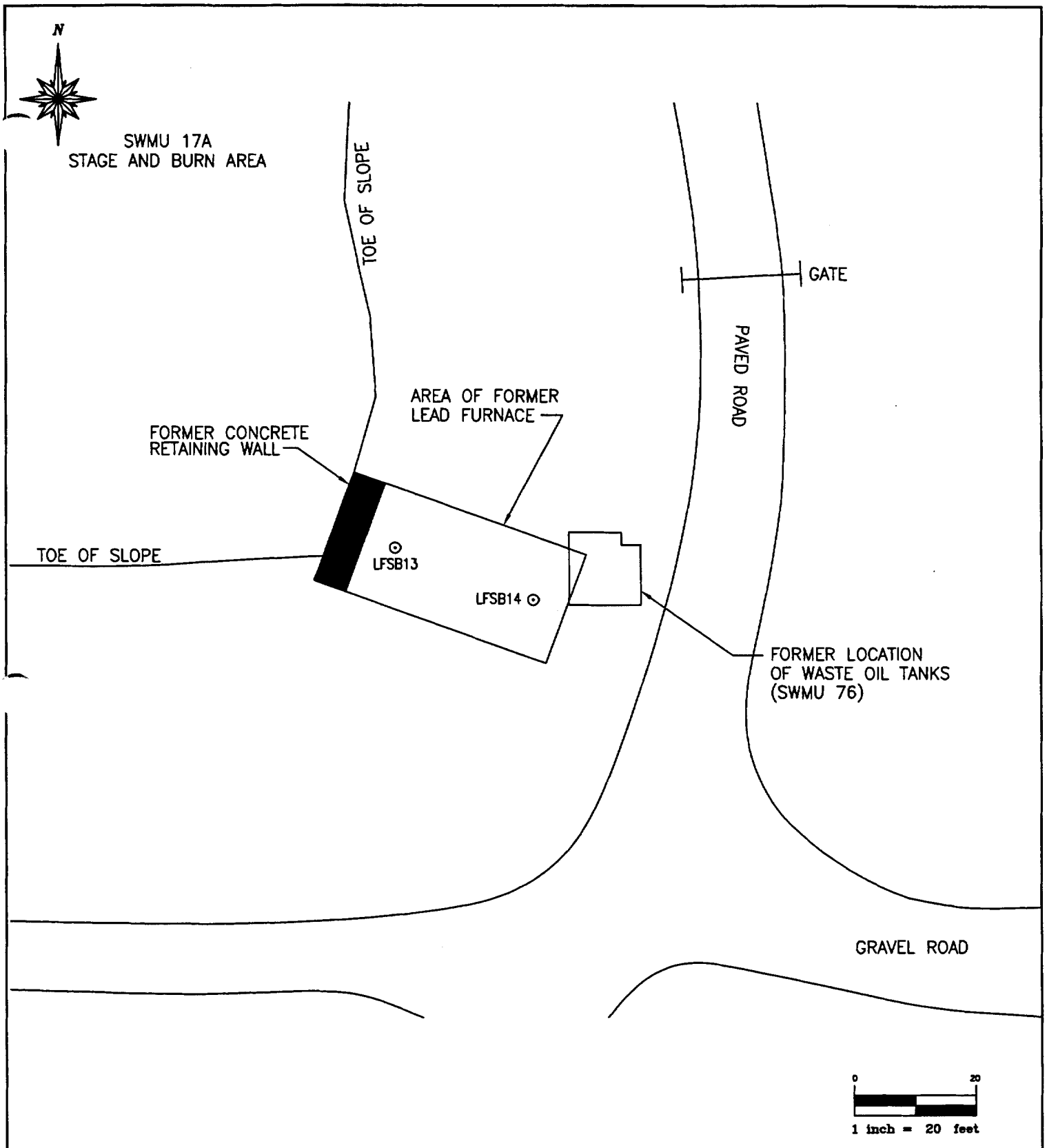
RFAAP

SSP WORK PLAN ADDENDUM: SWMU 76

Date:	Prepared By:
OCTOBER 2002	KDC/DR
	File Name: 09604-317-155

FIGURE 1-15

SITE TOPOGRAPHY LAYOUT



LEGEND

LFSB13 ⊙ Soil Boring Location (Work Plan Addendum 12)

(SOURCE: MODIFIED FROM IT CORPORATION, 2002a)

RFAAP

SSP WORK PLAN ADDENDUM: SWMU 76

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Scale:	**File Name:**
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FIGURE 1-16

SWMU LAYOUT MAP

Samples of the oily wastewater sludge spill were collected and sent for laboratory analysis. The tests indicated the spilled material exhibited hazardous waste characteristics for lead. The oily wastewater sludge was removed from the containment area using a suction pump and placed in a waste oil storage tank for off-site treatment and disposal. The remaining material within the trench was absorbed with an absorbent compound (Hercules 1991b). Approximately 13 cubic yards of soil/absorbed material were removed from the area and disposed of off site.

1.5.3 Previous Investigations

The following section is intended to be a review of previous site investigations with emphasis placed on the usability of collected data and screening of historical data with respect to current criteria (i.e., current RBCs and BTAGs).

1.5.3.1 Oily Waste Water Spill Investigation – 1991

As part of the clean-up activities from the spill, Hercules collected soil samples from one foot below the tank level and analyzed for TPH by USEPA test method 418.1. Since lead was detected in the oily wastewater sludge sample, analysis for total lead in addition to the TPH analysis was conducted on the soil samples collected from under the spill area.

Analytical results indicate that the TPH concentration in one soil was 1,590 mg/kg before the spill cleanup and less than 60 mg/kg TPH after the spill cleanup was completed (Hercules 1991). Concentrations of total lead (63,000 mg/kg) and leachable lead (2,900 mg/L) still remained present in samples collected from under the spill area after clean-up. A lead furnace operated during World War II near this area and may have been a contributing source of lead (Figure 1-16). This Former Lead Furnace Area (FLFA) is currently being investigated as part of Work Plan Addendum No. 12 to complete the characterization of this area. Soil borings have been advanced adjacent to SWMU 76 and samples were collected as part of the FLFA investigation and are indicated on Figure 1-16.

An oily wastewater spill Site Check Report was prepared and submitted to the Virginia State Water Control Board (now part of the VDEQ) including an amended USEPA Form 7530-1 indicating tank closure (VDEQ 1992). According to VDEQ database records, the SWMU 76 tank closure was assigned file number PC-91-1777 and a VDEQ correspondence indicates, "it appears that acceptable site check measures for the suspected petroleum UST release have been achieved, and no further UST investigation is required at this time (VDEQ 1992)." VDEQ records further indicate tank closure was completed and the file closed in September 1992 (VDEQ 1992).

1.5.3.2 Review of EPIC Aerial Photo Assessment Report – 1992

Activity at SWMU 76 was first noted on a 1986 aerial photograph. The 1962 photograph indicated the presence of "two stains" in the area (USEPA 1992).

1.5.4 Planned Field Activities

The tanks associated with this SWMU have been removed, impacted soils were removed, and closure notification was filed with the VDEQ. The ongoing investigation being conducted under Work Plan Addendum No. 12 will include an assessment of subsurface constituents identified at the FLFA, which is adjacent to SWMU 76. Additionally, future closure procedures at SWMU 17 will address remaining issues potentially related to the coincident SWMUs (SWMU 76 and FLFA); therefore, no additional field activities are proposed for the investigation of this former UST site.

1.6 SWMU 13 – WASTE PROPELLANT BURNING GROUND

1.6.1 Site Background – Environmental Setting



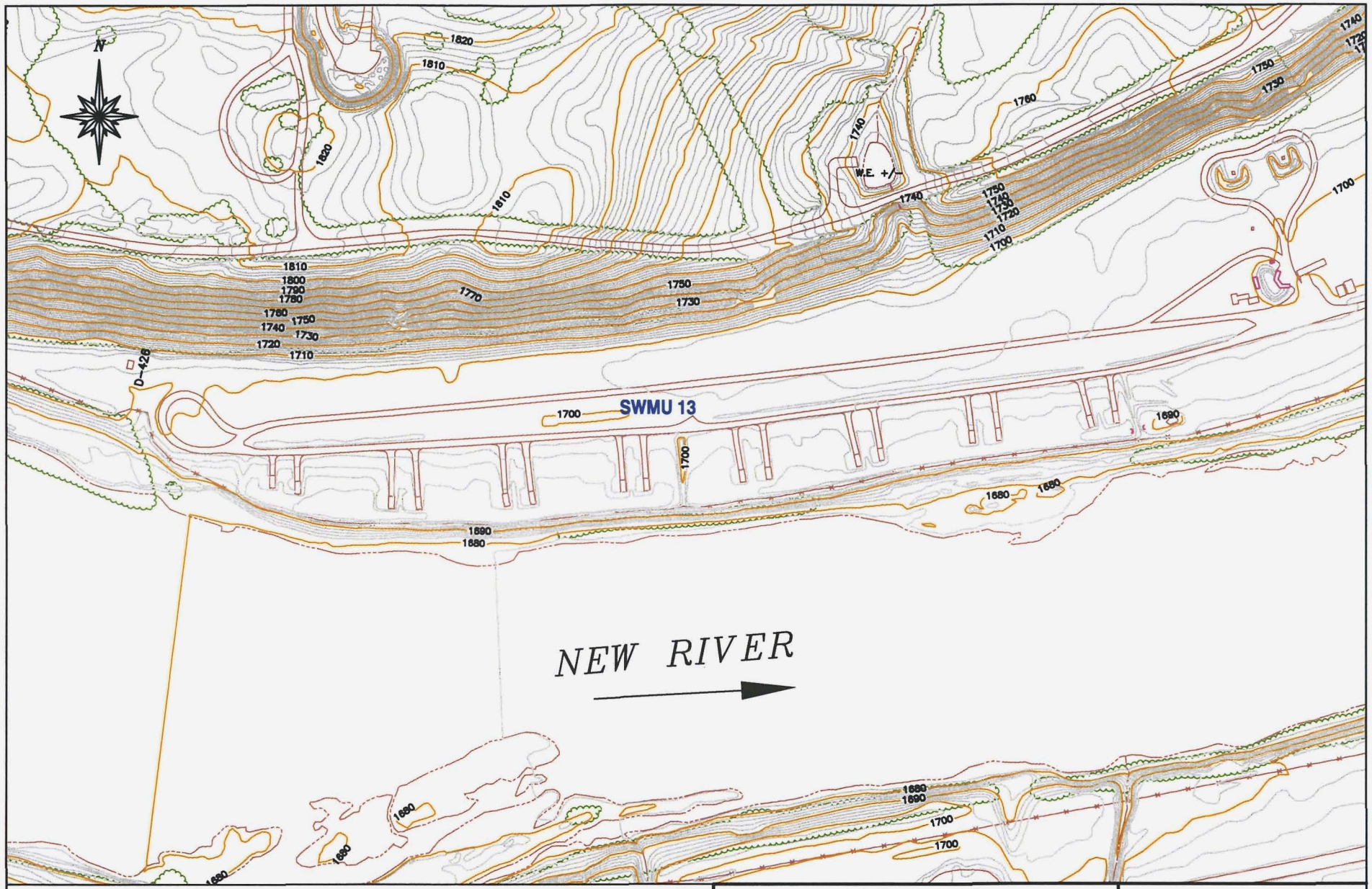
Physiography – SWMU 13 is an active 20-acre unit located in the southeastern portion of the Horseshoe Area (HSA) of RFAAP. SWMU 13 is situated on the north bank of the New River within the 100-year flood plain. Topography at SWMU 13 is sloping to the south; with an elevation of approximately 1,700 feet above mean sea level (ft msl) in the northern SWMU area and approximately 1,695 ft msl in the southern SWMU area (Figure 1-17). The RFAAP Installation perimeter fence separates SWMU 13 from the New River, and prevents access by trespassers attempting to enter RFAAP from the New River. To the north, two parallel asphalt access roads border SWMU 13. To the north of the access roads and to the west of SWMU 13 the flood plain area is terminated by steep, densely wooded topography.

Currently, SWMU 13 consists of eight pairs of burning pads (Figure 1-18). A metal burning pan and a mobile temporary storage unit (wheeled covers to prevent rainwater accumulation in the pans) overlie each burning pad. The burning pans are approximately 18 feet long by 6 feet wide by 1 foot deep. A maximum of 1,000 pounds of waste is burned in one pan at one time.

Surface Water – The SWMU 13 area is surrounded on the western, southern, and eastern sides by a berm. Surface water on the burning ground flows southward and then eastward along the southern berm before emptying into a settling lagoon, located at the eastern perimeter of SWMU 13. The settling lagoon is approximately 35 feet long by 20 feet wide, has been excavated below grade, is not bermed, and is not lined. Surface water runoff entering the settling lagoon from SWMU 13 discharges directly to the New River via VPDES Outfall 017.

Topography south of SWMU 13 is moderately to steeply sloping towards the New River, which is located approximately 50 feet south of the burning ground. The New River at this point flows east prior to turning north around the Horseshoe Area.

Geology and Soil – SWMU 13 is underlain by the Wheeling sandy loam soil. This soil has moderate permeability and medium-to-strong acidity (IT 2002b). The geology of SWMU 13 was previously explored during an RFI, conducted by Dames and Moore in 1992, through the drilling of 22 exploratory soil borings and seven monitoring well borings (Figure 1-18). The borings ranged from 10 to 38 feet below ground surface (ft bgs) in depth.



VICINITY MAP
N.T.S.

(SOURCE: MODIFIED FROM HERCULES, INC., 1992)

0 200
1 inch = 200 feet

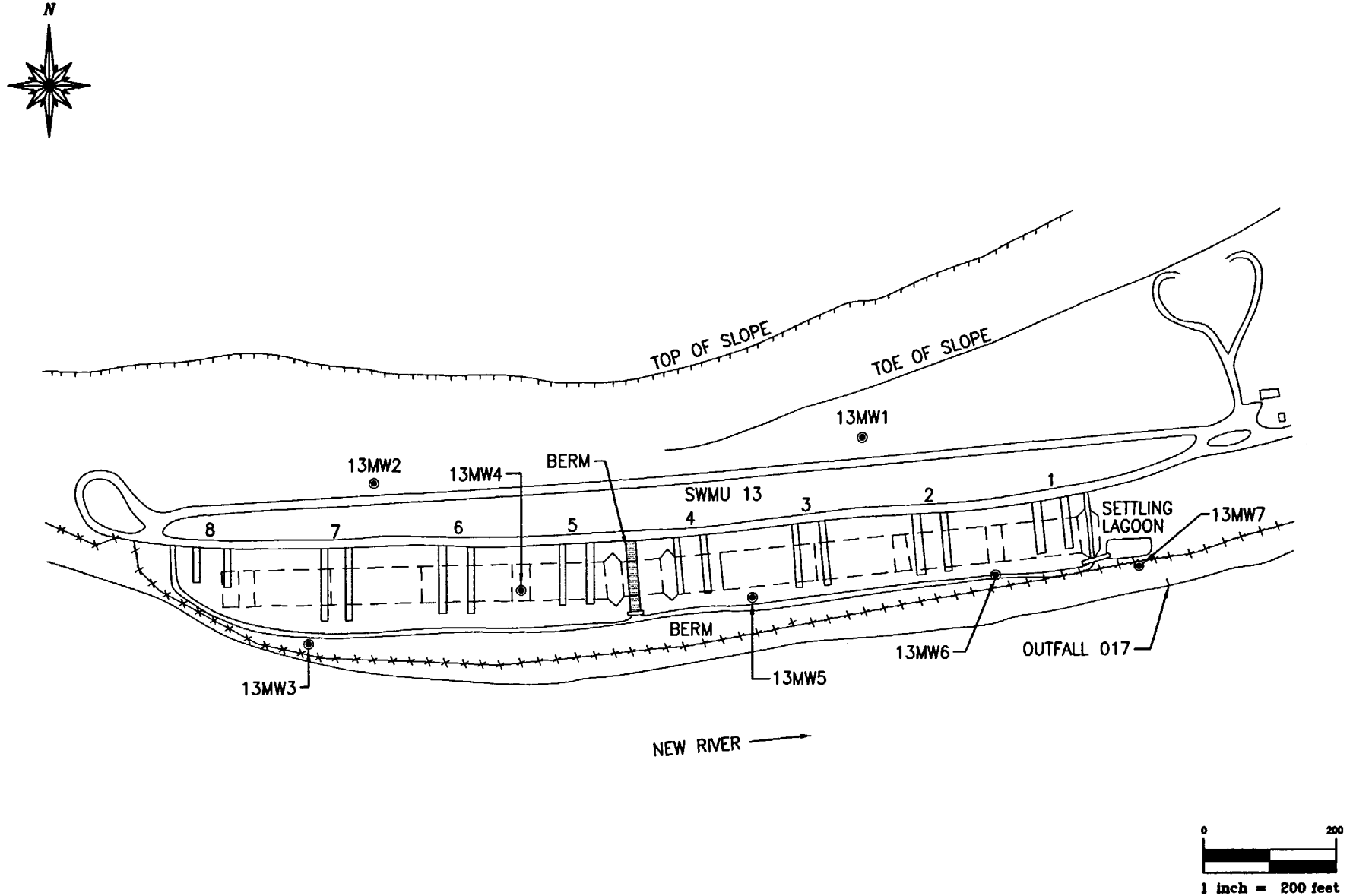
RFAAP

SSP WORK PLAN ADDENDUM: SWMU 13

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OCTOBER 2002	KDC/DR
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FIGURE 1-17

SITE TOPOGRAPHY LAYOUT



LEGEND

◉ Monitoring Well

(SOURCE: MODIFIED FROM DAMES & MOORE, 1992a)

RFAAP

SSP WORK PLAN ADDENDUM: SWMU 13

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Scale:	File Name:
AS SHOWN	09604-317-155

FIGURE 1-18

SWMU LAYOUT MAP

Unconsolidated soil and alluvial deposits thicken away from the river and can be divided into two strata based on information gathered during the RFI boring program. Stratum 1 consists of fine to coarse grained, micaceous, reddish-brown, sandy silt and silty sand. Stratum 2 is a micaceous, yellowish-brown, silty sand or a yellowish-brown sand and gravel and is present below Stratum 1and overlying bedrock (Dames and Moore 1992b). Brown-gray limestone/dolostone of the Elbrook Formation underlie Strata 1 and 2 at the site. At SWMU 13, the limestone/dolostone has been described as argillaceous and frequently interbedded with shale (Dames and Moore 1992b). Bedrock is reportedly highly weathered and fractured; occasional clay seams and brecciated zones are present near the river. Bedrock is reportedly less weathered and more competent in an up gradient direction to the north. Calcite commonly fills fractures and veins (Dames and Moore 1992b).

Groundwater – Hydrogeologic conditions within the unconsolidated soil and alluvial deposits as well as bedrock were investigated during the RFI (Dames and Moore 1992b). A relatively shallow groundwater table is present from 14 to 20 ft bgs at SWMU 13 (IT 2002a). This unconfined water table is generally present just below the soil/bedrock contact to the north of SWMU 13 (13MW1 and 13MW2), but is one to three feet above the bedrock surface (within the sand and gravel layer) within SWMU 13 (Dames and Moore 1992b). Based on groundwater measurements obtained during the recent Current Conditions Study, the unconfined water table slopes toward the New River (IT 2002a).

Tanks/Structures – In addition to the burning pads and the RFAAP perimeter fence, an office trailer is present to the east of SWMU 13. No other tanks or structures are located in or near SWMU 13.

1.6.2 Site Background – History

SWMU 13 has been in continuous use for open burning of waste and off-specification energetic products since manufacturing operations began at RFAAP in 1941. Open detonation is not conducted at SWMU 13. SWMU 13 is an interim status RCRA Subpart X treatment unit. A Part B application was submitted in 1988 as required by regulation. An updated Part B application was submitted to VDEQ in the summer of 2000. SWMU 13 is used for open burning of D003 waste material. The material consists of waste explosives (i.e. TNT, RDX, HMX), propellants (i.e. nitroglycerin and nitrocellulose), and laboratory wastes (propellant and explosives residue samples and analytical residues). According to the RFA (USEPA 1987), three types of propellant waste have been burned at SWMU 13: single base (nitrocellulose), double base (nitrocellulose and nitroglycerin), and triple base (nitrocellulose, nitroglycerin, and nitroguanidine). The RFA did not mention the other energetic materials or the burning rate modifiers such as lead, DNT, and other organics and inorganics.

The eight pairs of burning pads and their appurtenances were brought into use in 1985 (Dames and Moore 1992a). Prior to that time, wastes were burned in earthen pits (i.e., burn pits) at the same location currently occupied by the burning pans. After burning, burn residue is removed from the pans and areas around the pans are inspected for burn residue. Burn residue is moved to the designated accumulation area at the burning ground. Energetic material found in the residue is returned to the pans to be re-treated. A composite sample of burn residue is analyzed approximately every two months for disposal characterization (ATK 2002). During the USEPA RFA site visit in 1987, various signs of release from the burning pans were evident. Remnants of incompletely combusted propellant were observed throughout the area and several hundred charred scintillation vials were accumulated at the mouth of the culvert pipe to the settling lagoon (USEPA 1987). These vials may have been sampling containers. Incompletely combusted propellant and scintillation vials were not observed in the area during the URS site visit in August 2002. The use of the term "scintillation vials" was from the 1987 RFA. RFAAP personnel are not aware of the use of such vials past or present at RFAAP. There neither was nor is a known usage for scintillation vials for scintillation measurements at RFAAP. Sampling for radioactive contamination does not appear to be warranted.

1.6.3 Previous Investigations

The following section reviews previous site investigations emphasizing the usability of collected data and screening of historical data with respect to current criteria (i.e., RBCs and Draft BTAG screening levels).

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

In 1987, the United States Army Environmental Hygiene Agency (USAEHA) conducted a Soil Sampling Study at SWMU 13. During this investigation, the burning ground was divided into 28 sections and 28 soil samples were collected (Figure 1-19). The samples were analyzed for explosives and leachable metals. USAEHA reported that the western half of the SWMU appeared to be relatively free of soil contamination. Elevated levels, ranging from 5.7 to 10,900 mg/kg, of TNT were detected in the eastern half of the burning ground (Sections 17 through 22 and Section 24). Sampling section 19 also reportedly contained elevated levels of 2,6-DNT and 2,4-DNT.

1.6.3.2 SWMU 13 RFI Program – 1992

In 1992, Dames and Moore reported the results of an RFI Program at SWMU 13 conducted to evaluate potential contamination in soil, sediment, surface water, and groundwater.

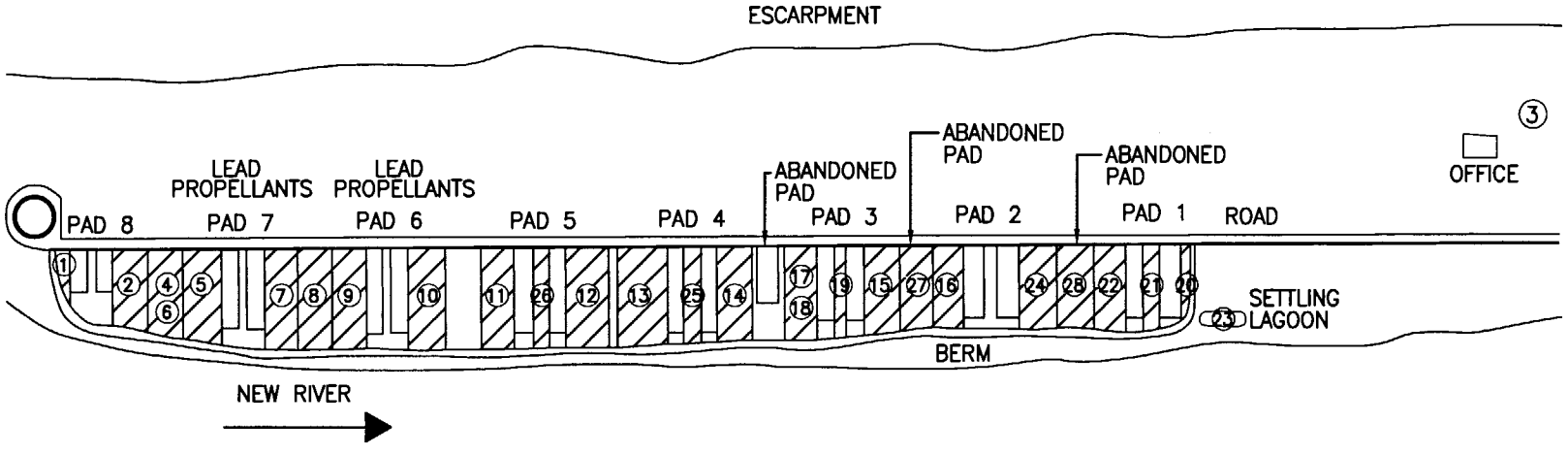
Soil – Six soil borings (13SB1 through 13SB6) were advanced in areas outside the vicinity of the former burn pits (Figures 1-20 and 1-21) to evaluate the extent of potential soil contamination. Two of these soil borings (13SB1 and 13SB2) were advanced north of the access road. The easternmost and westernmost soil borings (13SB3 and 13SB6) were advanced in areas outside of the perimeter berms. Two down gradient soil borings (13SB4 and 13SB5) were advanced inside of the southern berm. Samples were collected from each boring at three depths (0.5, 5, and 10 ft bgs).

In addition to the six soil borings discussed above, twenty-four composite soil samples (13SC1 through 13SC8) were collected from borings adjacent to the burn pits (Figure 1-20 and 1-21). Soil samples were collected from each boring at 0.5, 5, and 10 ft bgs. Samples from the same depth for each boring were composited and submitted for chemical analysis. Note that samples submitted for VOC analyses were not composited. Four surface soil samples (13SS1 through 13SS4) were also collected from the drainage ditch (Figures 1-20 and 1-21).

The composite and surface soil samples were analyzed for metals, explosives, VOCs, and SVOCs. The 24 composite soil samples were also analyzed for TCLP Metals to evaluate potential remediation and disposal options. Please note that VI soil sampling was conducted in August 1991, and results were reported in 1992. Results are presented on Table 1-6.

A review of Table 1-6 indicates that eight metals (barium, beryllium, cadmium, copper, lead, mercury, thallium, and zinc) were reported above their respective facility-wide background point estimate concentrations in one or more samples for RFAAP soil. Table 1-6 further indicates that concentrations of eight metals (aluminum, arsenic, chromium, iron, lead, manganese, thallium, and vanadium) exceeded their respective April 2003 Residential RBCs in one or more samples. Concentrations of arsenic, iron, lead, and thallium exceeded the Industrial RBC value in at least one or more samples.

The explosive, 2,4-dinitrotoluene, was reported at one location, 13SS4 (37.5 mg/kg) above the April 2003 Residential RBC of 16 mg/kg for 2,4-dinitrotoluene.



LEGEND

③ Sampled Area and Sample Number

(SOURCE: MODIFIED FROM USAEHA, 1987)

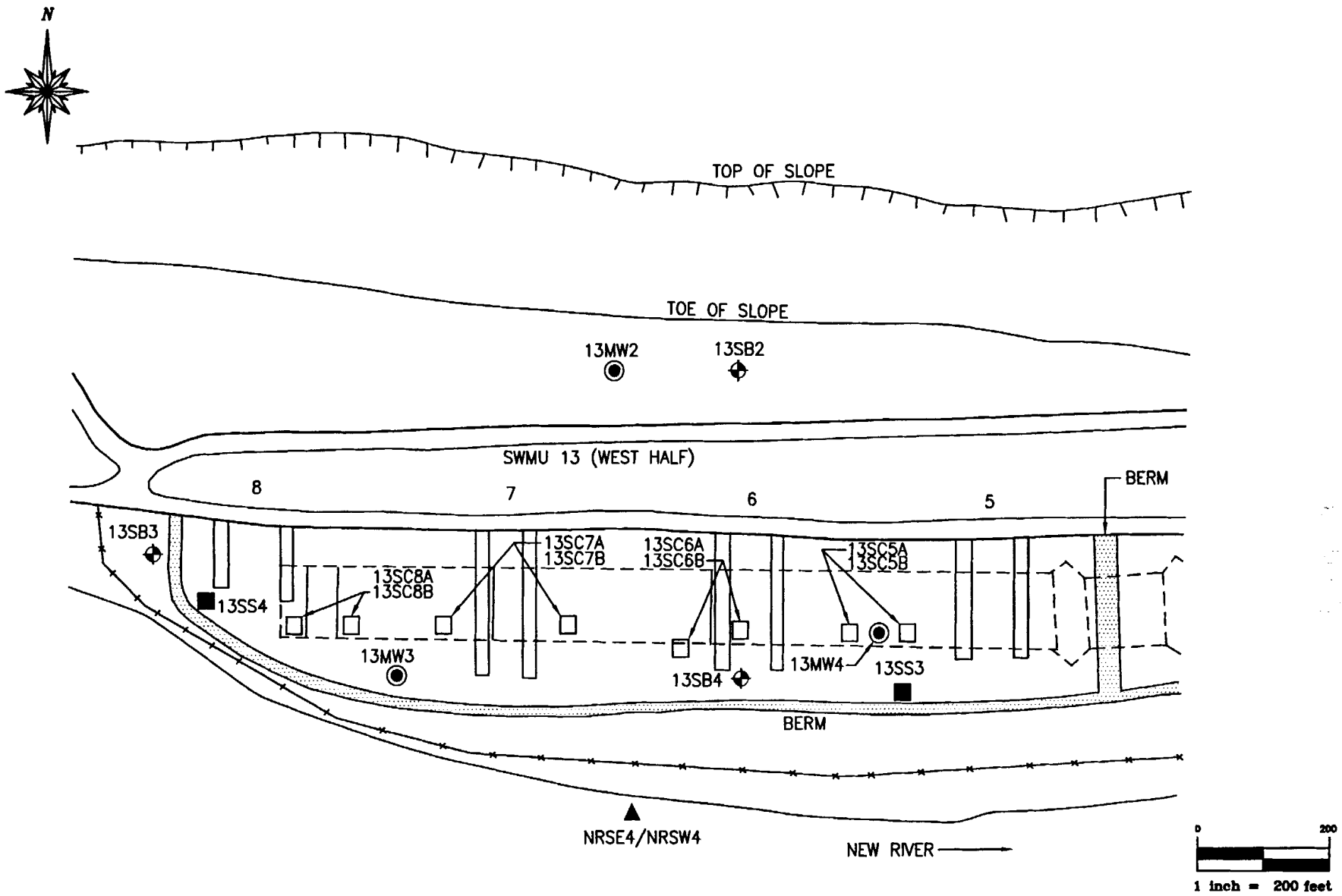
RFAAP

SSP WORK PLAN ADDENDUM: SWMU 13

Date:	Prepared By:
OCTOBER 2002	*KDC/DR*
Scale:	**File Name:**
AS SHOWN	*09604-317-155*

FIGURE 1-19

HISTORICAL SAMPLE LOCATIONS



LEGEND

- Soil Sampling Location
- Monitoring Well
- Soil Composite Sample
- Soil Boring
- ---- Original Burning Pads Outline
- ▲ Surface Water/Sediment Sample

(SOURCE: FROM DAMES & MOORE, 1992b)

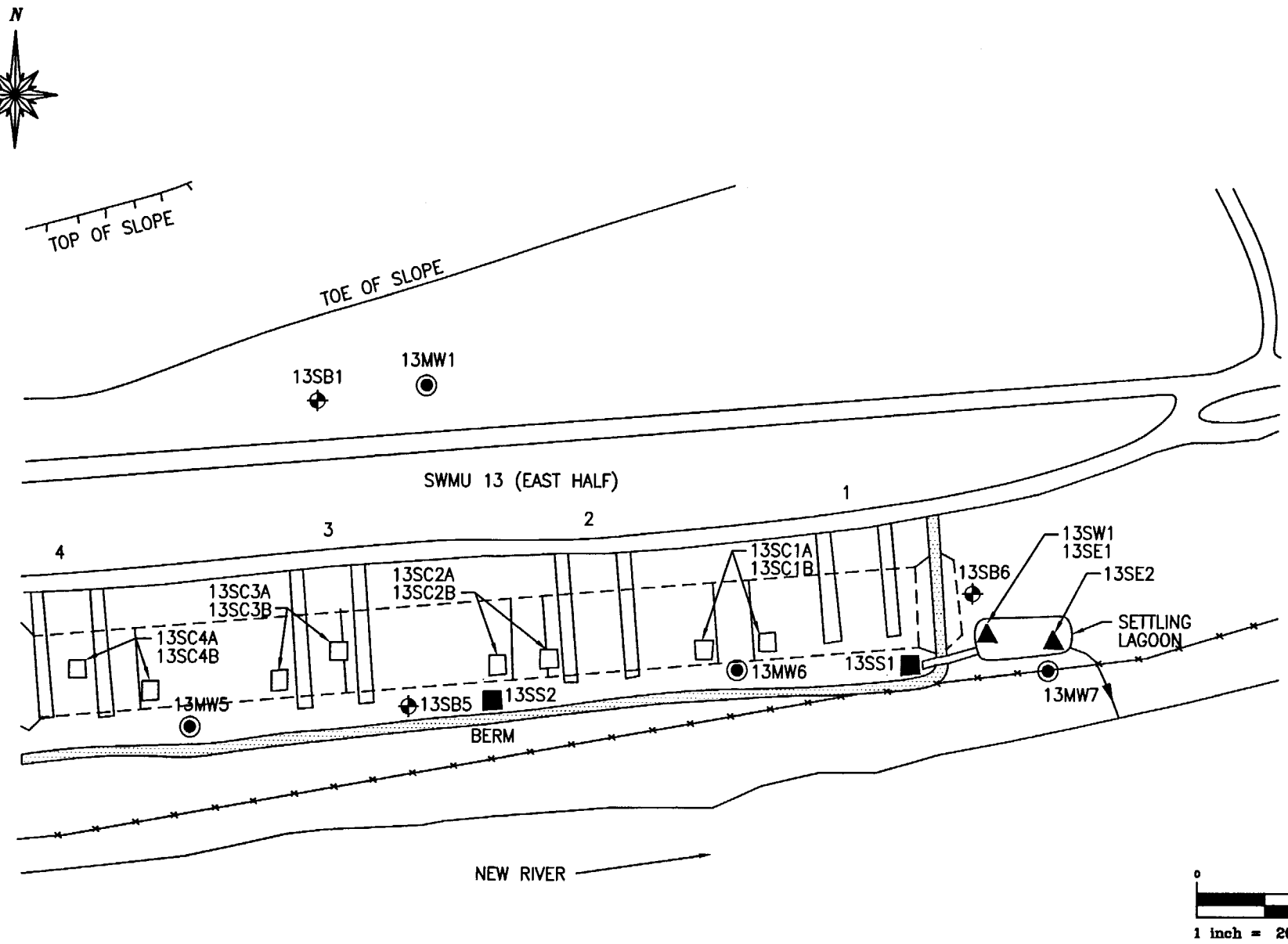
RFAAP

SSP WORK PLAN ADDENDUM: SWMU 13

Date:	Prepared By:
OCTOBER 2002	KDC/DR
Scale:	File Name:
AS SHOWN	09604-317-155

FIGURE 1-20

MONITORING WELLS, BORINGS, AND SAMPLE LOCATIONS-WESTERN HALF



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 WORK PLAN ADDENDUM: SWMU 13

Date:	Prepared By:
OCTOBER 2002	*KDC/DR*
Scale:	**File Name:**
AS SHOWN	*09604-317-155*

FIGURE 1-21

MONITORING WELLS, BORINGS, AND SAMPLE LOCATIONS-EASTERN HALF

Table 1-6

Summary of Analytical Data for Soil Samples Collected at SWMU 13

Modified from Dames and Moore SWMU 13 RFI Investigation Report

SSP WPA for Nine SWMUs and Three AOCs

Radford Army Ammunition Plant, Radford, Virginia

SITE ID		13SB1	13SB1	13SB1	13SB2D	13SB2	13SB2	13SB2	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
FIELD ID		RFIS*1	RFIS*2	RFIS*3	RFIS*19	RFIS*4	RFIS*5	RFIS*6				
SAMPLE DATE		20-Aug-91	20-Aug-91	20-Aug-91	26-Aug-91	26-Aug-91	26-Aug-91	26-Aug-91				
DEPTH (ft bgs)		0.5	5.0	10.0	0.5	0.5	5.0	10.0				
MATRIX	PQLs	CSO	CSO	CSO	CSO	CSO	CSO	CSO				
UNITS	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	1,000	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	715	54.8	0.5	108
Zinc	30.2	129	95.8	108	297	223	70.1	86.9	30,660	2,346	10	202
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	51.1	3.9	--	--
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	10,000	780	--	--
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	--	--

Table 1-6 (Continued)
Summary of Analytical Data for Soil Samples Collected at SWMU 13
Modified from Dames and Moore SWMU 13 RFI Investigation Report
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

SITE ID		13SB1	13SB1	13SB1	13SB2D	13SB2	13SB2	13SB2				
FIELD ID		RFIS*1	RFIS*2	RFIS*3	RFIS*19	RFIS*4	RFIS*5	RFIS*6	Adjusted	Adjusted	Draft	Facility-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
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	584	130	--	--

Table 1-6 (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	Adjusted	Adjusted	Draft	Facility-Wide
FIELD ID		RFIS*7	RFIS*8	RFIS*9	RFIS*10	RFIS*11	RFIS*12	RFIS*13	Soil	Soil	BTAG	Background
SAMPLE DATE		26-Aug-91	26-Aug-91	26-Aug-91	28-Aug-91	28-Aug-91	28-Aug-91	22-Aug-91	Industrial	Residential	Screening	Point
DEPTH (ft bgs)		0.5	5.0	10.0	0.5	5.0	10.0	0.5	RBC	RBC	Level	Estimates[A]
MATRIX	PQLs	CSO	CSO	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
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	2.42	1.57	1.11	<0.5	1.31	2.11	1.54	204	15.6	0.02	1.02
Cadmium	2	0.958	<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	99.5	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	258	<10.5	<10.5	367	13.7	17.9	110	1,000	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	715	54.8	0.5	108
Zinc	30.2	821	59.2	46.2	72.5	59.5	91.3	93.5	30,660	2,346	10	202
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	51.1	3.9	--	--
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	10,000	780	--	--
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	--	--

Table 1-6 (Continued)
Summary of Analytical Data For Soil Samples Collected At SWMU 13
Modified from Dames and Moore SWMU 13 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	Adjusted	Adjusted	Draft	Facility-wide
FIELD ID		RFIS*7	RFIS*8	RFIS*9	RFIS*10	RFIS*11	RFIS*12	RFIS*13	Soil	Soil	BTAG	Background
SAMPLE DATE		26-Aug-91	26-Aug-91	26-Aug-91	28-Aug-91	28-Aug-91	28-Aug-91	22-Aug-91	Industrial	Residential	Screening	Point
DEPTH (ft bgs)		0.5	5.0	10.0	0.5	5.0	10.0	0.5	RBC	RBC	Level	Estimates[A]
MATRIX	PQLs	CSO	CSO	CSO	CSO	CSO	CSO	CSO	mg/kg	mg/kg	mg/kg	mg/kg
UNITS	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg				
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	584	130	--	--

Table 1-6 (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		13SB5	13SB5	13SB6	13SB6	13SB6	13SC1	13SC1	Adjusted	Adjusted	Draft	Facility-Wide
FIELD ID		RFIS*14	RFIS*15	RFIS*16	RFIS*17	RFIS*18	RFIS*21	RFIS*22	Soil	Soil	BTAG	Background
SAMPLE DATE		22-Aug-91	22-Aug-91	21-Aug-91	21-Aug-91	21-Aug-91	20-Aug-91	20-Aug-91	Industrial	Residential	Screening	Point
DEPTH (ft bgs)		5.0	10.0	0.5	5.0	10.0	0.5	5.0	RBC	RBC	Level	Estimates[A]
MATRIX	PQLs	CSO	CSO	CSO	CSO	CSO	CSO	CSO	mg/kg	mg/kg	mg/kg	mg/kg
UNITS	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	1,000	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	715	54.8	0.5	108
Zinc	30.2	60.2	97.8	213	62.8	72	67.6	72.4	30,660	2,346	10	202
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	51.1	3.9	--	--
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	10,000	780	--	--
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	--	--

Table 1-6 (Continued)
Summary of Analytical Data For Soil Samples Collected At SWMU 13
Modified from Dames and Moore SWMU 13 RFI Investigation Report
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

SITE ID		13SB5	13SB5	13SB6	13SB6	13SB6	13SC1	13SC1	Adjusted	Adjusted	Draft	Facility-wide
FIELD ID		RFIS*14	RFIS*15	RFIS*16	RFIS*17	RFIS*18	RFIS*21	RFIS*22	Soil	Soil	BTAG	Background
SAMPLE DATE		22-Aug-91	22-Aug-91	21-Aug-91	21-Aug-91	21-Aug-91	20-Aug-91	20-Aug-91	Industrial	Residential	Screening	Point
DEPTH (ft bgs)		5.0	10.0	0.5	5.0	10.0	0.5	5.0	RBC	RBC	Level	Estimates[A]
MATRIX	PQLs	CSO	CSO	CSO	CSO	CSO	CSO	CSO	mg/kg	mg/kg	mg/kg	mg/kg
UNITS	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg				
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	584	130	--	--

Table 1-6 (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		13SC1	13SC2	13SC2	13SC2	13SC3	13SC3	13SC3	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
FIELD ID		RFIS*23	RFIS*24	RFIS*25	RFIS*26	RFIS*27	RFIS*28	RFIS*29				
SAMPLE DATE		20-Aug-91	21-Aug-91	21-Aug-91	21-Aug-91	21-Aug-91	21-Aug-91	21-Aug-91				
DEPTH (ft bgs)		10.0	0.5	5.0	10.0	0.5	5.0	10.0				
MATRIX		CSO	CSO	CSO	CSO	CSO	CSO	CSO				
UNITS	PQLs mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	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	1.61	1.49	1.34	1.88	0.945	1.37	1.28	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	55.6	<10.5	<10.5	320	<10.5	<10.5	1,000	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	9.82	<6.62	12	<6.62	7.15	0.548	0.001	2.11
Vanadium	0.775	27	24.7	27.2	32.5	14	26	26.5	715	54.8	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
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	51.1	3.9	--	--
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	10,000	780	--	--
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	--	--

Table 1-6 (Continued)
Summary of Analytical Data For Soil Samples Collected At SWMU 13
Modified from Dames and Moore SWMU 13 RFI Investigation Report
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

SITE ID		13SC1	13SC2	13SC2	13SC2	13SC3	13SC3	13SC3	Adjusted	Adjusted	Draft	Facility-wide
FIELD ID		RFIS*23	RFIS*24	RFIS*25	RFIS*26	RFIS*27	RFIS*28	RFIS*29	Soil	Soil	BTAG	Background
SAMPLE DATE		20-Aug-91	21-Aug-91	21-Aug-91	21-Aug-91	21-Aug-91	21-Aug-91	21-Aug-91	Industrial	Residential	Screening	Point
DEPTH (ft bgs)		10.0	0.5	5.0	10.0	0.5	5.0	10.0	RBC	RBC	Level	Estimates[1,4]
MATRIX	PQLs	CSO	CSO	CSO	CSO	CSO	CSO	CSO	mg/kg	mg/kg	mg/kg	mg/kg
UNITS	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg				
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	584	130	--	--

Table 1-o (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		13SC4	13SC4	13SC4	13SC5	13SC5	13SC5	13SC6	Adjusted	Adjusted	Draft	Facility-Wide
FIELD ID		RFIS*30	RFIS*31	RFIS*32	RFIS*33	RFIS*34	RFIS*35	RFIS*36	Soil	Soil	BTAG	Background
SAMPLE DATE		22-Aug-91	22-Aug-91	22-Aug-91	26-Aug-91	26-Aug-91	26-Aug-91	27-Aug-91	Industrial	Residential	Screening	Point
DEPTH (ft bgs)		0.5	5.0	10.0	0.5	5.0	10.0	0.5	RBC	RBC	Level	Estimates[A]
MATRIX	PQLs	CSO	CSO	CSO	CSO	CSO	CSO	CSO	mg/kg	mg/kg	mg/kg	mg/kg
UNITS	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	1,000	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	715	54.8	0.5	108
Zinc	30.2	153	63.2	61	167	93.1	82.3	61.9	30,660	2,346	10	202
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	51.1	3.9	--	--
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	10,000	780	--	--
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	--	--

Table 1-6 (Continued)
Summary of Analytical Data For Soil Samples Collected At SWMU 13
Modified from Dames and Moore SWMU 13 RFI Investigation Report
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

SITE ID		13SC4	13SC4	13SC4	13SC5	13SC5	13SC5	13SC6	Adjusted	Adjusted	Draft	Facility-wide
FIELD ID		RFIS*30	RFIS*31	RFIS*32	RFIS*33	RFIS*34	RFIS*35	RFIS*36	Soil	Soil	BTAG	Background
SAMPLE DATE		22-Aug-91	22-Aug-91	22-Aug-91	26-Aug-91	26-Aug-91	26-Aug-91	27-Aug-91	Industrial	Residential	Screening	Point
DEPTH (ft bgs)		0.5	5.0	10.0	0.5	5.0	10.0	0.5	RBC	RBC	Level	Estimates[a]
MATRIX	PQLs	CSO	CSO	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
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	584	130	--	--

Table 1-6 (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		13SC6	13SC6	13SC7	13SC7	13SC7	13SC8	13SC8				
FIELD ID		RFIS*37	RFIS*38	RFIS*39	RFIS*40	RFIS*41	RFIS*42	RFIS*43	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
SAMPLE DATE		27-Aug-91	27-Aug-91	28-Aug-91	28-Aug-91	28-Aug-91	29-Aug-91	29-Aug-91				
DEPTH (ft bgs)		5.0	10.0	0.5	5.0	10.0	0.5	5.0				
MATRIX	PQLs	CSO	CSO	CSO	CSO	CSO	CSO	CSO				
UNITS	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	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	1,000	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	715	54.8	0.5	108
Zinc	30.2	62.5	59	88.4	52.8	48.5	723	43.1	30,660	2,346	10	202
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	51.1	3.9	--	--
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	10,000	780	--	--
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	--	--

Table 1-6 (Continued)
Summary of Analytical Data For Soil Samples Collected At SWMU 13
Modified from Dames and Moore SWMU 13 RFI Investigation Report
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

SITE ID		13SC6	13SC6	13SC7	13SC7	13SC7	13SC8	13SC8	Adjusted	Adjusted	Draft	Facility-wide
FIELD ID		RFIS*37	RFIS*38	RFIS*39	RFIS*40	RFIS*41	RFIS*42	RFIS*43	Soil	Soil	BTAG	Background
SAMPLE DATE		27-Aug-91	27-Aug-91	28-Aug-91	28-Aug-91	28-Aug-91	29-Aug-91	29-Aug-91	Industrial	Residential	Screening	Point
DEPTH (ft bgs)		5.0	10.0	0.5	5.0	10.0	0.5	5.0	RBC	RBC	Level	Estimates[a]
MATRIX	PQLs	CSO	CSO	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
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	584	130	--	--

Table 1-6 (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		13SC8	13SE1	13SE2	13SS1	13SS1D	13SS2	13SS3	13SS4	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
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
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	1,000	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	715	54.8	0.5/--	108
Zinc	30.2	50.4	390	646	525	507	196	264	375	30,660	2,346	10/150	202
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	51.1	3.9	--	--
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	10,000	780	--	--
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	--	--

Table 1-6 (Continued)
Summary of Analytical Data For Soil Samples Collected At SWMU 13
Modified from Dames and Moore SWMU 13 RFI Investigation Report
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

SITE ID		13SC8	13SE1	13SE2	13SS1	13SS1D	13SS2	13SS3	13SS4	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
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
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	584	130	--/0.028	--

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 25, 2003 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 2002b)

(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

= Concentration exceeds Residential RBC

= Concentration exceeds Draft BTAG Screening Level

underline = Concentration exceeds Facility-Wide Background Point Estimate

Sediment – Two sediment samples (13SE1 and 13SE2) were collected from the settling basin. One sample was collected adjacent to the influent pipe (13SE1) and the second (13SE2) was collected near the eastern end of the basin. Samples were collected from the top 12 inches of sediment. The sediment samples were analyzed for metals, explosives, VOCs, and SVOCs. Sediment sample results are included on Table 1-6. A review of Table 1-6 indicates that seven metals (aluminum, arsenic, chromium, iron, lead, manganese, thallium, and vanadium) were detected above their respective April 2003 Residential RBCs in one or both samples.

The data also indicates that of those eight metals, arsenic (4.2 mg/kg) and thallium (14.1 mg/kg) were reported present in 13SE2 at concentrations above their respective 2003 Industrial RBC levels. Four TAL Metals, beryllium, copper, lead, and thallium exceeded their respective facility-wide background point estimate concentrations. In addition, 14 metals exceeded their respective BTAG screening levels.

The explosive 2,4,6-TNT was reported in sample 13SE3 at a concentration (3.94C mg/kg) above the April 2003 Residential RBC level of 3.9 mg/kg.

Surface Water – One surface water sample (13SW1) was collected from the settling basin. A review of the data in Table 1-7 indicates that seven metals (aluminum, arsenic, barium, chromium, iron, manganese, and vanadium) were detected above their respective 2003 April Tap Water RBCs in sample 13SW1. Results also indicate that lead (500 µg/L) exceeded its action level of 15 µg/L. In addition, six metals (aluminum, chromium, copper, iron, lead, and zinc) were reported present at concentrations exceeding their respective Draft BTAG screening levels. A review of the data indicates that three explosives (2,4,6-TNT, 2,4-DNT, and 2,6-DNT) exceeded their respective 2003 Tap Water RBCs in sample 13SW1. SVOC constituent 2,4-DNT also exceeded its April 2003 Tap Water RBC in sample 13SW1.

Table 1-7
Summary of Analytical Surface Water Data Collected at SWMU 13
Modified from Dames and Moore SWMU 13 RFI Investigation Report
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

SITE ID FIELD ID SAMPLE DATE DEPTH (ft bgs) MATRIX UNITS	PQLs µg/L	13SW1 RDWA*11 15-Jan-92 0.0 CSW µg/L	Adjusted Tap Water RBC µg/L	MCL µg/L	Draft BTAG Screening Level 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	25.6	--	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 25, 2003 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

= Concentration exceeds Tap Water RBC

= Concentration exceeds lead action level

= Concentration exceeds Draft BTAG Screening Level

1.6.3.3 Review of EPIC Aerial Photo Report – 1992

Activity within the SWMU 13 area was first noted on a 1949 photograph. The 1949 photograph reportedly indicated that the western portion of SWMU 13 "has been cleared, and seven burning pits (not annotated) divided by earthen berms are visible (USEPA 1992)." The report also indicated that the burning pits "do not appear dark-toned at this time." USEPA could not conclude from the photograph if actual burning activities were ongoing at this time.

The 1962 photograph reportedly indicates, "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 is reported to be present in the center of this SWMU. USEPA reported that burning might have occurred within this bermed area. The photograph also reportedly depicts that an area of "probable light-toned liquid" is present west of the aforementioned berm (USEPA 1992).

The 1971 photograph reportedly depicts the burning pits as being divided by berms into eight burning areas. The photo also shows that the three-sided berm area seen in the center of SWMU 13 in the 1962 photo had one side intact. A "light-toned" liquid/material is seen near the remaining berm and "probable liquid" is present along the southern boundary in the 1971 photo (USEPA 1992).

The 1986 photograph was interpreted to indicate that the "pit burning" method had changed to "pan burning" with eight cells present. Light-colored liquids and staining are reportedly visible. The settling basin is apparently visible as a "lagoon" at the eastern edge of SWMU 13 (USEPA 1992).

The 1986 photograph reportedly depicts eight cells consisting of two burning areas each as being present and two areas of "light-toned" material are seen near the northern edge of the site (USEPA 1992). The photograph also reportedly shows several areas of "staining" visible along the site's northwestern and southern boundaries. This is the first year that the settling pond was reported at the eastern edge of the burning ground.

1.6.3.4 New River and Tributaries Study – 1997

The objective of the New River and Tributaries Study was to provide data for migration pathways along the New River and its tributaries at RFAAP to assess adverse impacts to human health and the environment (Parsons 1997). One sediment sample (NRSE4) was collected from the New River near SWMU 13 to assess potential impacts from this SWMU. The sample was analyzed for VOCs, SVOCs, Pesticides, PCBs, and TAL Metals. Sample results indicate that constituents were reported present below their respective April 2003 RBCs. Results indicate two TAL Metals (lead and chromium) exceeded their respective Draft BTAG screening level concentrations in sediment sample NRSE4.

One surface water sample (NRSW4) was collected from the New River near SWMU 13 to assess potential impacts to surface water from this SWMU. The sample was analyzed for VOCs, SVOCs, Pesticides, PCBs, and TAL Metals. Sample results indicate that constituents were reported present below their respective April 2003 RBCs and current USEPA MCLs.

1.6.3.5 Current Conditions Report – 2002

The purpose of the Current Conditions Report was to develop a conceptualized picture of the geology and hydrogeology of the Horseshoe area of the RFAAP. This conceptualization supports the development of future investigation activities and includes: 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 chemistry data.

As reported in the Current Conditions Report, seven monitoring wells (13MW1 through 13MW7) are sampled quarterly at SWMU 13. Analytical parameters that were reported in the Current Conditions Report as exceeding the RBCs and the MCLs for quarterly sampling are presented on Figure 1-22 (IT 2002a). Bis(2-ethylhexyl)phthalate concentrations (11 to 790 µg/L) were reported as detected above the RBC (5 µg/L) in monitoring wells 13MW1 through 13MW5 and 13MW7. Ammonia was reported as detected in all seven monitoring wells above the RBC (209 µg/L) at concentrations ranging from 250 to 2,000 µg/L (IT 2002a).

Metals that were reported as exceeding the RBCs and/or the MCLs included aluminum, antimony, arsenic, iron, and manganese. These metals were reported as detected above the RBC and/or MCL in all seven monitoring wells. Concentrations were reported ranging from 60 to 6,090 µg/L for aluminum, 7 to 12 µg/L for antimony, 1 to 4 µg/L for arsenic, 310 to 22,600 µg/L for iron, and 51 to 646 µg/L for manganese (IT 2002a).

1.6.4 Conceptual Site Model

A CSM for SWMU 13 is presented in Figure 1-23. This CSM is limited to addressing releases to surface and subsurface soil at SWMU 13 prior to the installation of the burning pads in 1985. Potentially affected media include surface and subsurface soil, surface water, and groundwater. The area north of SWMU 13 is shown as sloping steeply to the south with bedrock exposures present. The SWMU 13 area is shown as sloping gently to the south. The settling lagoon is indicated immediately beyond the enclosing berm and prior to a steep slope down to the New River. Site geology is based on subsurface data and interpretations by Dames and Moore (Dames and Moore 1992b) and is indicated by soil/alluvial strata overlying bedrock. The groundwater table is indicated present within bedrock to the north and within soil/alluvial deposits to the south.

Past burning operations may have affected surface and subsurface soil. In addition, the area associated with the settling lagoon may have been affected by storm water runoff received from SWMU 13.

Current and future land-use scenarios are limited to industrial operations and the Installation perimeter fence encloses SWMU 13; therefore, potential receptors are limited to site workers, future construction workers, and terrestrial and aquatic biota. Figure 1-24 presents the potential exposure pathways for each receptor. Storm water transport of surficial materials to the settling lagoon is shown as resulting in a surface soil exposure pathway.

1.6.5 Data Gap Analysis

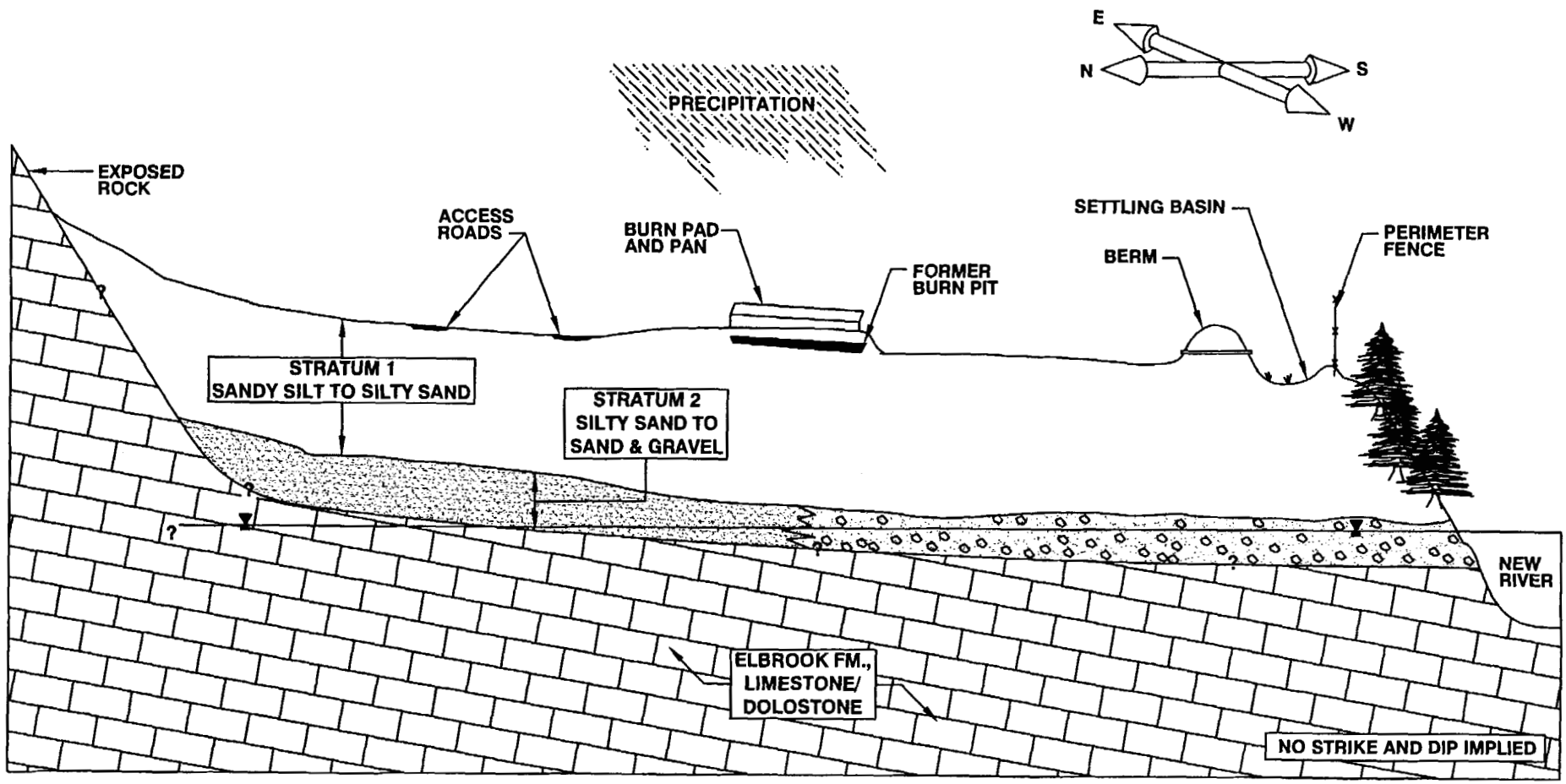
TCL VOCs – TCL VOCs have been analyzed in soil and groundwater samples collected from the site. TCL VOC COPCs have not been identified in soil; however, detections of VOCs in groundwater samples have been reported. As such, TCL VOCs will be analyzed in surface soil, subsurface soil, sediment, and surface water in order to meet the objectives of the SSP.

TCL SVOCs/PAHs – A review of the data indicates that samples were not collected for PAH analysis during the previous investigation and that select SVOCs have been detected at the site. Therefore, in order to meet the objectives of the SSP, TCL SVOCs and PAHs will be analyzed in surface soil, subsurface soil, sediment, and surface water.

TCL PCBs – Samples were not collected for TCL PCB analysis during the previous investigations. Therefore, TCL PCBs represent a data gap and will be analyzed in surface soil.

TCL Pesticides – Samples were not collected for TCL Pesticide analysis during the previous investigations. Therefore, TCL Pesticides represent a data gap and will be analyzed in surface soil.

Explosives – A review of the data indicates that explosive constituents are identified as COPCs at the site. As such, explosives will be analyzed in surface soil, subsurface soil, sediment, and surface water to meet the objectives of the SSP.



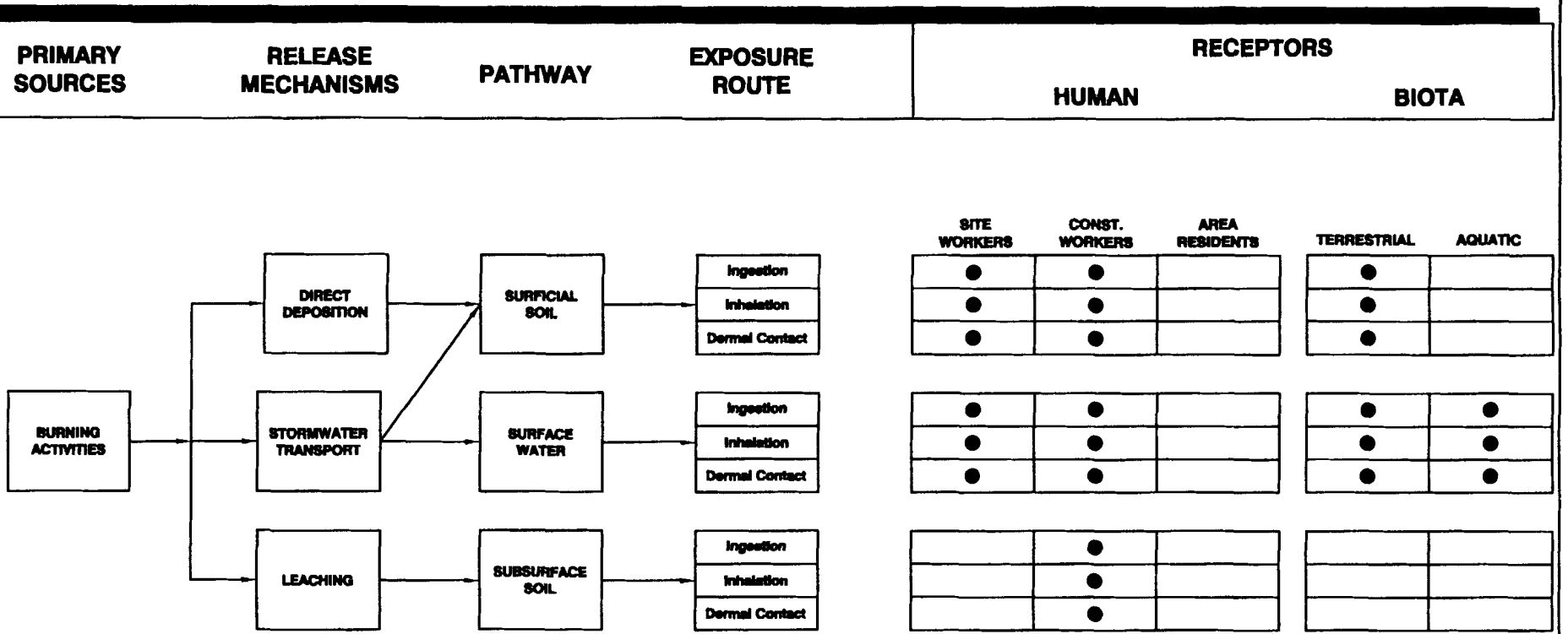
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FIGURE 1-23

CONCEPTUAL SITE MODEL FIGURE



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FIGURE 1-24

CONCEPTUAL SITE MODEL DIAGRAM

TAL Inorganics – A review of the data indicates that select TAL Inorganics are identified as COPCs at the site. As such, TAL Inorganics will be analyzed in surface soil, subsurface soil, sediment, and surface water to meet the objectives of the SSP.

Dioxins/furans – Dioxins/furans are potential chemicals of concern since this site is used for burning operations. Samples were not collected during previous investigations for dioxins/furans. Therefore, dioxins/furans represent a data gap and will be analyzed in surface soil, subsurface soil, sediment, and surface water.

Perchlorate – Samples were not collected for perchlorate analysis during the previous investigations. Therefore, perchlorate represents a data gap and will be analyzed in surface water.

Other – Analysis of selected physical properties of subsurface soil to aid in assessing the nature of possible constituent mobility has been performed during previous investigations (hydraulic conductivity and grain size analysis). Soil samples will be collected for analysis of TOC, grain size, specific gravity, percent moisture, and bulk density to aid in assessing the mobility of constituents in soil.

1.6.6 Planned Field Activities

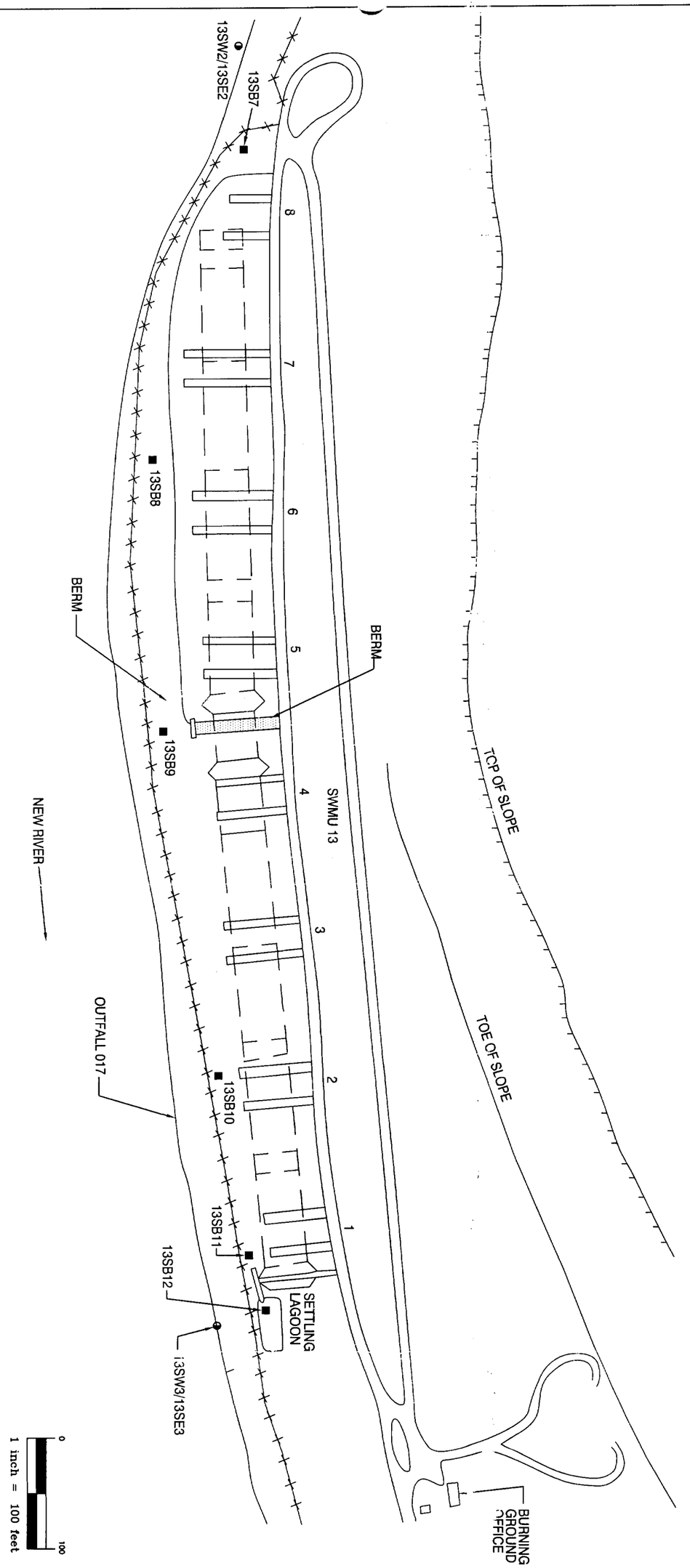
Based on the results of the data gap analysis, additional sampling and analysis is proposed to perform the SSP at this site. Soil, surface water, and sediment sampling locations were selected based on site background, previous sample results, site visit observations, and the CSM. Proposed analyses for various media types were identified by the results of the data gap analysis. The proposed sampling program includes the following soil borings, media samples, and analyses.

1.6.6.1 Soil Borings

The following sections discuss proposed soil investigations to be conducted at SWMU 13 using the direct push method of boring advancement, as described in SOP 20.11 in Appendix A. A four-foot, Geoprobe Macro-Core® sampling device will be used to collect soil samples continuously from each of the borings, as described in SOP 20.11 in Appendix A. The location of each soil boring will be established to the nearest meter using Global Positioning System (GPS) equipment.

Due to the past operational history and previous sampling performed at SWMU 13, six soil borings are proposed (13SB7 through 13SB12). Proposed sampling locations are presented on Figure 1-25. Soil borings will be advanced to the groundwater table or top of bedrock, whichever is encountered first (approx. 20 ft bgs). During boring advancement, subsurface soil samples will be screened for the presence of VOCs using a PID consistent with SOP 90.1 included in Appendix A. Soil borings will be completed at the following locations:

- Boring 13SB7 will be advanced west of burning pad 8 adjacent to and outside of the active western portion of SWMU 13. This soil boring is designed to provide additional information regarding site conditions outside the limits of the active western portion of the burning ground;
- Borings 13SB8, 13SB9, 13SB10, and 13SB11 will be advanced south of the limits of the active portion of the burning ground. These soil borings are designed to provide information regarding site conditions outside of the active burning ground and adjacent to the New River; and
- Boring 13SB12 will be advanced within the limits of the settling pond to assess possible constituents within the settling lagoon.



LEGEND

- Soil Sampling Location
- Surface Water/Sediment Sampling Location
- — — Original Burning Pads Outline

(SOURCE: MODIFIED FROM DAMES & MOORE, 1992b)

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FIGURE 1-25

PROPOSED SAMPLING LOCATIONS

To meet the objectives of the soil screening at SWMU 13 and to fill the data gaps identified in Section 1.2.5:

- One surface sample will be collected from each boring (i.e., 0 to 6 inches bgs below gravel, vegetative, or organic layers) to screen surface soil (samples for VOC analysis will be collected from 6 to 12 inches bgs);

- Two subsurface soil samples will be collected from each boring, with one from an intermediate zone (approximately 8 to 10 ft bgs) and one from the terminational zone (above the groundwater table or the top of bedrock); and

- Each of the soil samples will be analyzed for TCL VOCs, TCL SVOCs, PAHs, explosives (including nitroglycerin), and TAL Inorganics. One surface soil sample will be analyzed for TCL Pesticides, TCL PCBs, and dioxins/furans consistent with the requirements of the MQAP and Section 2.0 of this WPA.

Stratigraphic logs will be prepared for each boring location in accordance with the procedures outlined in SOP 10.3 in Appendix A.

Two soil samples will be collected and analyzed for the physical properties TOC, grain size, specific gravity, percent moisture, and bulk density in accordance with the QAPA in Section 2.0 of this document.

1.6.6.2 Surface Water and Sediment Samples

The following section discusses the proposed surface water and sediment investigation to be conducted at SWMU 13 using methods for grab sampling that are suitable for sampling surface water and sediment, as described in SOPs 30.3 and 30.4 in Appendix A. The surface water samples will be collected by submerging and direct filling sample containers. The sediment samples will be collected by the scoop and trowel method to sample exposed sediment or sediment in surface water less than 6-inches deep, with nominal flow. The surface water and sediment samples will be analyzed for TCL VOCs, TCL SVOCs, PAHs, explosives (including nitroglycerin), perchlorate (surface water), and TAL Inorganics.

Due to the past operational history and previous sampling performed at SWMU 13, two surface water and two sediment samples will be collected. Surface water and sediment samples will be collected from the New River at the point of site runoff discharge. One sample will be collected from the probable point of entry for surface water runoff from the settling lagoon at SWMU 13 and an additional sample will be collected from a location immediately upstream of the burning ground. The proposed sampling locations are presented on Figure 1-25. During surface water and sediment collection, samples will be screened for the presence of VOCs using a PID consistent with SOP 90.1 included in Appendix A.

Logs will be prepared for each sample location in accordance with the procedures outlined in SOP 10.2 in Appendix A. The location of the surface water and sediment samples will be established to the nearest meter using GPS equipment.

1.7 SWMU 57 – POND BY BUILDINGS 4931 & 4932

1.7.1 Site Background – Environmental Setting

Physiography – SWMU 57 consists of a man-made "pond" in the western section of the HSA located on a localized plateau above a hillside sloping down to the northwest toward the New River (Figure 1-26). The elevation at SWMU 57 is approximately 1805 ft msl. There is an asphalt-paved road to the east and several overhead pipes with associated appurtenances near SWMU 57. A 4-foot perimeter chain link fence with a locked gate encloses the pond. Surrounding both the pond and within the fence is a four-foot soil berm overlain with a 1-inch gravel/tar cover. At the time of the SSP site visit, the pond was observed to be dry and heavily vegetated.



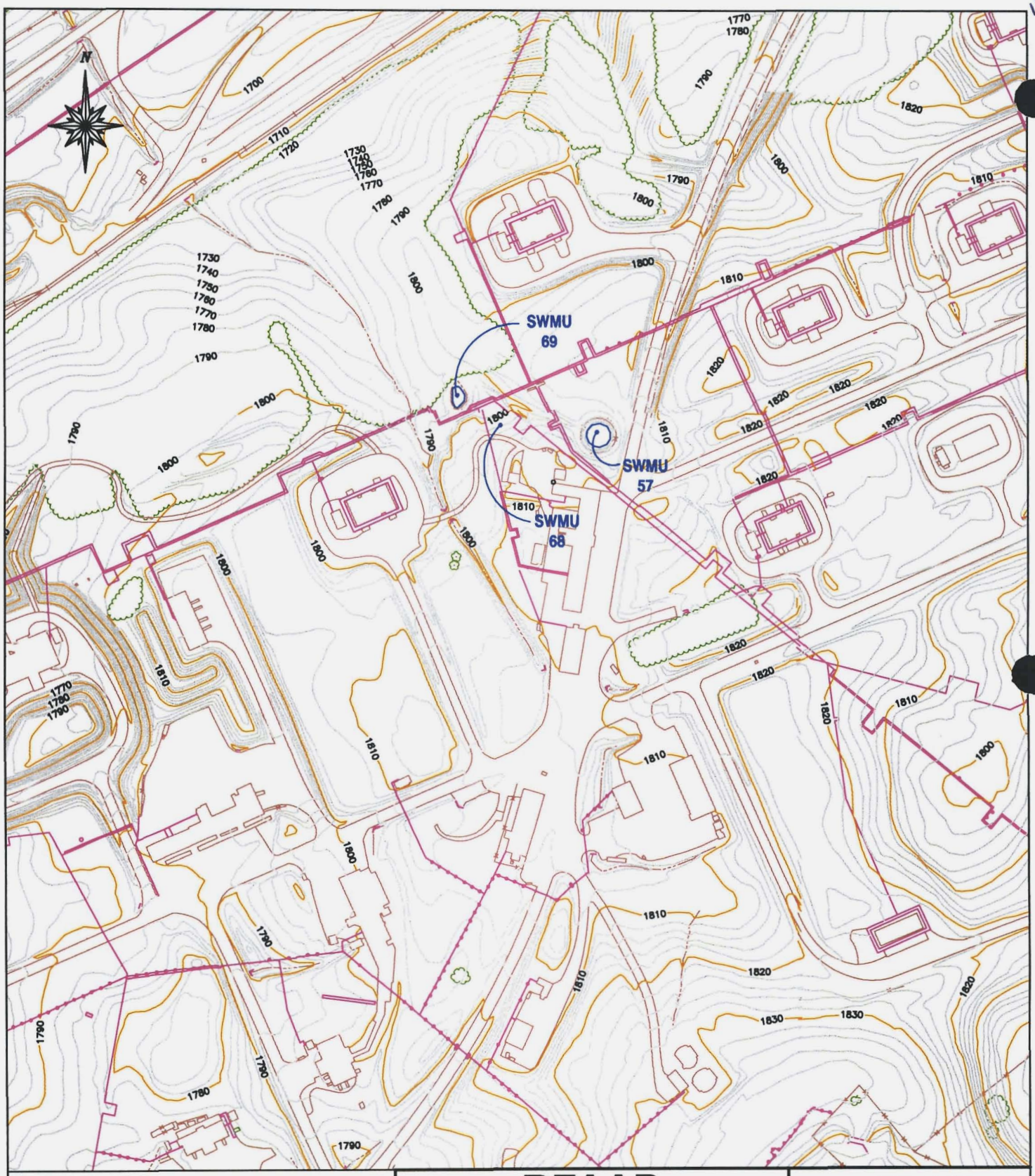
Surface Water – Based on site topography, surface water near SWMU 57 appears to flow southwestward or northeastward along well-defined drainage pathways to perennial streams flowing to the New River. These drainage pathways flow northeast and northwest and then discharge into the New River approximately 1,500 ft from SWMU 57. A shallow, well-defined, surface water drainage ditch surrounds the pond. The berm surrounding the pond prevents run-on and runoff to or from the pond. Manholes, catch basins, storm drains, or other drainage pathways have not been associated with SWMU 57.

Geology and Soil – SWMU 57 is underlain by the Braddock loam soil. This soil has moderate permeability and is acidic-to-strongly acidic (IT 2002a). Site-specific data regarding subsurface conditions at SWMU 57 have not been collected. Investigations at nearby SWMU 68 and SWMU 69 (ICF Kaiser 1998) and other SWMUs in similar settings at RFAAP (i.e., upland areas in the HSA) indicate the presence of unconsolidated alluvium consisting of sand, silt, and clay with silty gravel layers (Dames and Moore 1992a). This soil overlies the fractured interbedded siltstone, limestone, and dolostone of the Elbrook Formation (IT 2002a).

Based on Figure 4-1 of the Current Conditions Report (IT 2002b) several overlapping photolineaments have been identified near SWMU 57.

Groundwater – Site-specific data regarding hydrogeologic conditions at SWMU 57 are not known. Based on similar geomorphic setting to other SWMUs at RFAAP groundwater is likely present near the overburden-bedrock interface, follows the topography, and flows northwestward.

Tanks and Structures – In addition to the pond, several overhead pipes with associated appurtenances, the SWMU perimeter fence, and historically related buildings exist to the south of the pond (Figure 1-27). No other tanks or structures are located near SWMU 57.



VICINITY MAP
N.T.S.

0 200
1 inch = 200 feet

(SOURCE: MODIFIED FROM HERCULES, INC., 1992)

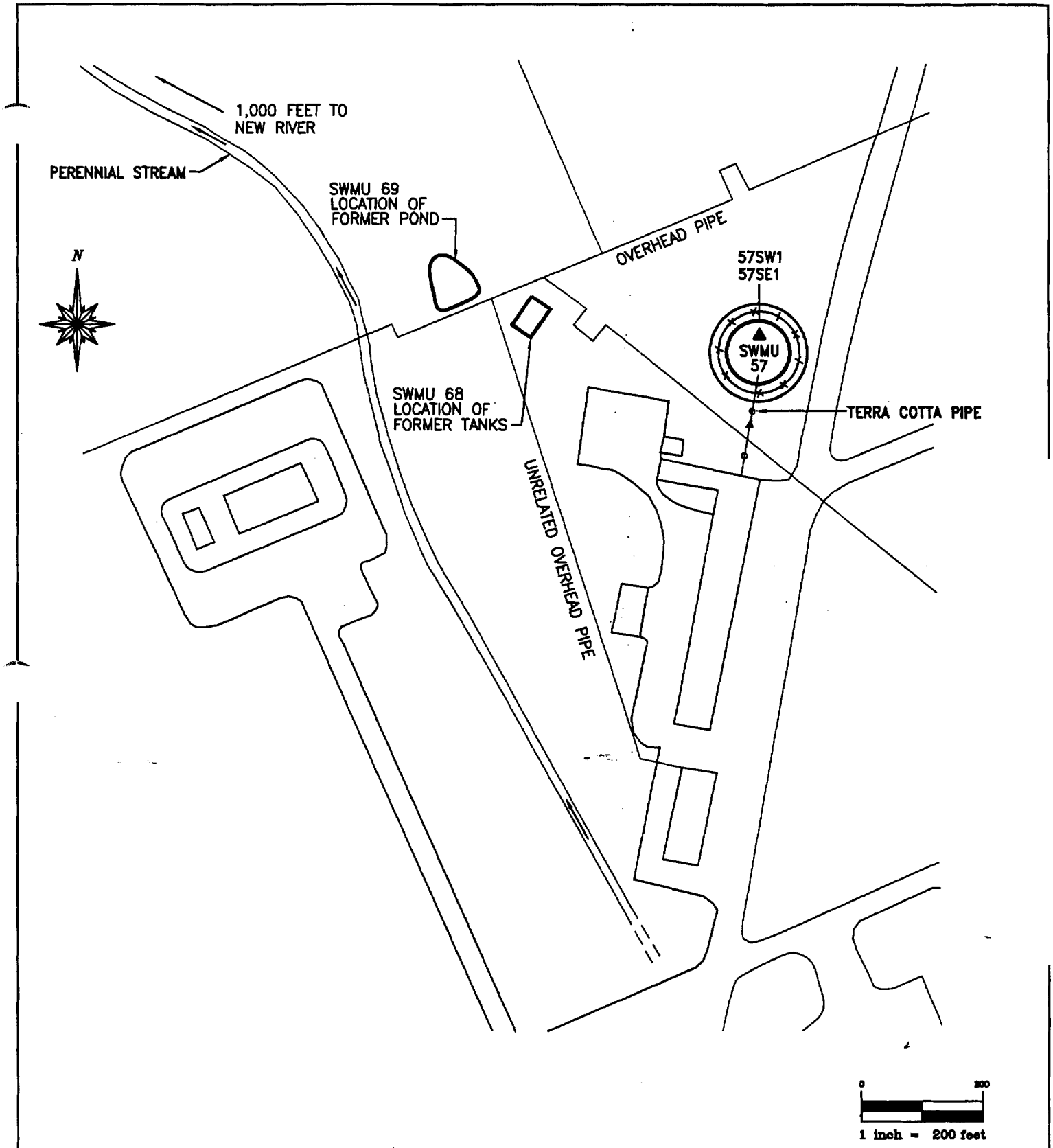
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FIGURE 1-26

SITE TOPOGRAPHY LAYOUT



LEGEND

▲ Surface Water/Sediment Sample

(SOURCE: MODIFIED FROM DAMES & MOORE, 1992a)

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FIGURE 1-27

SWMU LAYOUT MAP

1.7.2 Site Background – History

SWMU 57 is an inactive unit historically used as an acid-settling pond. Available construction plans were reviewed to assess the process history associated with the pond. As-built drawings from 1954 and 1967 identify this pond as the "Acid Settling Pool." This "pool" was constructed having a diameter of approximately 50 feet and a capacity of 30,000 gallons. RFAAP as-built drawings (1954) show a six-inch diameter terra-cotta drainpipe connecting a 4-inch Duriron® floor drain, located near the Chromic Acid and Oakite 33 wash stations in a building related to the pond. Reportedly, this pipe discharged chromic acid, hydraulic oil, Oakite-33, and zinc phosphate to SWMU 57 (ATK, 2002). Oakite-33 was used after 1974 as an acidic rust stripper instead of chromic acid to clean rocket encasements and was comprised of a phosphoric acid and butyl Cellosolve® mixture (Dames and Moore 1992a). At the time of the SSP site visit, the terra-cotta pipe was observed partially broken and no liquid was flowing through the pipe.

1.7.3 Previous Investigations

The following section reviews previous site investigations emphasizing the usability of collected data and the screening of historical data with respect to current criteria (i.e., current RBCs and BTAGs).

1.7.3.1 Verification Investigation – 1992

In 1992, Dames and Moore collected and analyzed one sediment and one surface water sample from SWMU 57. Both samples were collected from the north side of the pond (Figure 1-27). The sediment sample was collected to evaluate the characteristics of the sediment in the pond and was analyzed for TAL Metals, VOCs, and SVOCs. The surface water sample was collected to evaluate the characteristics of the liquid in the pond and was analyzed for TAL Metals, VOCs, SVOCs, TOC, Total Organic Halogens, and pH.

Sediment – A review of the data indicates that the TAL Metals aluminum, arsenic, chromium, iron, and vanadium were reported above their respective 2003 Residential RBCs. In addition, arsenic (4.66 mg/kg) was reported above its respective April 2003 Industrial RBC (1.91 mg/kg). Two metals (arsenic and chromium) were reported above the Draft BTAG sediment screening level criteria in sample 57SE1. VOCs and SVOCs were not detected in this sample. A summary of the detected analytes for sample 57SE1 can be found on Table 1-8.

Surface water – A review of the data indicates TAL Metals arsenic, chromium, iron, and manganese were reported at concentrations exceeding their respective April 2003 Tap Water RBCs. In addition, six metals (aluminum, chromium, copper, iron, lead, and zinc) were reported at concentrations exceeding their respective Draft BTAG surface water screening level criteria. A summary of the detected analytes for sample 57SW1 can be found on Table 1-9.

1.7.3.2 Review of EPIC Aerial Photo Assessment Report – 1992

Activity at SWMU 57 was first noted on a 1962 aerial photograph. The interpretation of the 1971 photograph indicated the presence of a pond containing liquid. This area remained unchanged through the 1986 photograph, although a drainage channel extending from the pond to the New River was noted (USEPA 1992).

1.7.4 Conceptual Site Model

A CSM for SWMU 57 is presented in Figure 1-28. The SWMU is depicted as occupying a bermed area atop a broad upland at RFAAP. Subsurface geology is shown as an upper layer of mixed silt, sand, and clay with increasing gravel content with depth. These sediments are depicted as overlying the Elbrook Formation. Potentially affected media include surface soil and subsurface soil. Surface soil may be potentially affected by liquids from past operations. The liquids may have potentially impacted surface soil through direct deposition and subsurface soil through infiltration of constituents into site soil.

Table 1-8
Summary of Analytical Data for Sediment Sample Collected at SWMU 57
Modified from Dames and Moore Verification Investigation Report
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

SITE ID FIELD ID SAMPLE DATE DEPTH (ft bgs) MATRIX UNITS	PQLs mg/kg	57SE1 RVFS*92 10-Feb-92 0.5 CSE 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	30,000	102,200	7,821	–	40,041
Arsenic	30	**4.66**	1.91	0.426	0.057	15.8
Barium	1	65.5	7,154	548	–	209
Calcium	100	30,800	–	–	–	–
Chromium[1]	4	**42.5**	307	23.5	0.005	65.3
Cobalt	3	4.71	2,044	156	–	72.3
Copper	7	12.9	4,088	313	34	53.5
Iron	1,000	24,400	30,660	2,346	–	50,962
Magnesium	50	18,500	–	–	–	–
Manganese[2]	0.275	126	2,044	156	–	2,543
Mercury[3]	0.1	0.142	30.7	2.35	0.15	0.13
Nickel	3	10.3	2,044	156	20.9	62.8
Potassium	37.5	785	–	–	–	–
Sodium	150	532B	–	–	–	–
Vanadium	0.775	85	715	55	–	108
Zinc	30.2	61.6	30,660	2,346	150	202

Notes:
BTAG = USEPA Region III Draft, Biological Technical Assistance Group Screening Level
CSE = Chemical sediment
ft bgs = Feet below ground surface
mg/kg = Milligrams per kilogram
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 25, 2003 RBC Table
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
TAL = Target Analyte List
[A] = Facility-Wide Background Point Estimate as Reported in the Facility-Wide Background Study Report (IT 2002b)
[1] = Chromium VI RBC value was used
[2] = Manganese-nonfood RBC value was used
[3] = Mercuric chloride RBC value was used

bold = Concentration exceeds Industrial RBC

= Concentration exceeds Residential RBC

= Concentration exceeds BTAG Screening Level

underline = Concentration exceeds Facility-Wide Background Point Estimate

Table 1-9
Summary of Analytical Data for Surface Water Sample Collected at SWMU 57
Modified from Dames and Moore Verification Investigation Report
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

SITE ID FIELD ID SAMPLE DATE DEPTH (ft bgs) MATRIX UNITS	PQLs µg/L	57SW1 RVFS*92 10-Feb-92 0.0 CSW µg/L	Adjusted Tap Water RBC µg/L	MCL µg/L	Draft BTAG Screening Level µg/L
TAL Metals					
Aluminum	141	871	3,650	--	25
Arsenic	10	6.29	0.045	10	48
Barium	20	23.1	256	2,000	10,000
Calcium	500	16,700	--	--	--
Chromium[1]	10	15.9	11.0	100	2
Copper	60	11.8	146	1,300 (AL)	6.5
Iron	38.1	2,750	1,100	--	320
Lead	10	14	--	15 (AL)	3.2
Magnesium	500	6,670	--	--	--
Manganese[2]	2.75	380	73	--	14,500
Potassium	375	8,850	--	--	--
Sodium	500	14,000	--	--	--
Zinc	50	155	1,095	--	30

Notes:

BTAG = USEPA Region III Draft, Biological Technical Assistance Group Screening Level

CSW = Chemical Soil

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 25, 2003 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

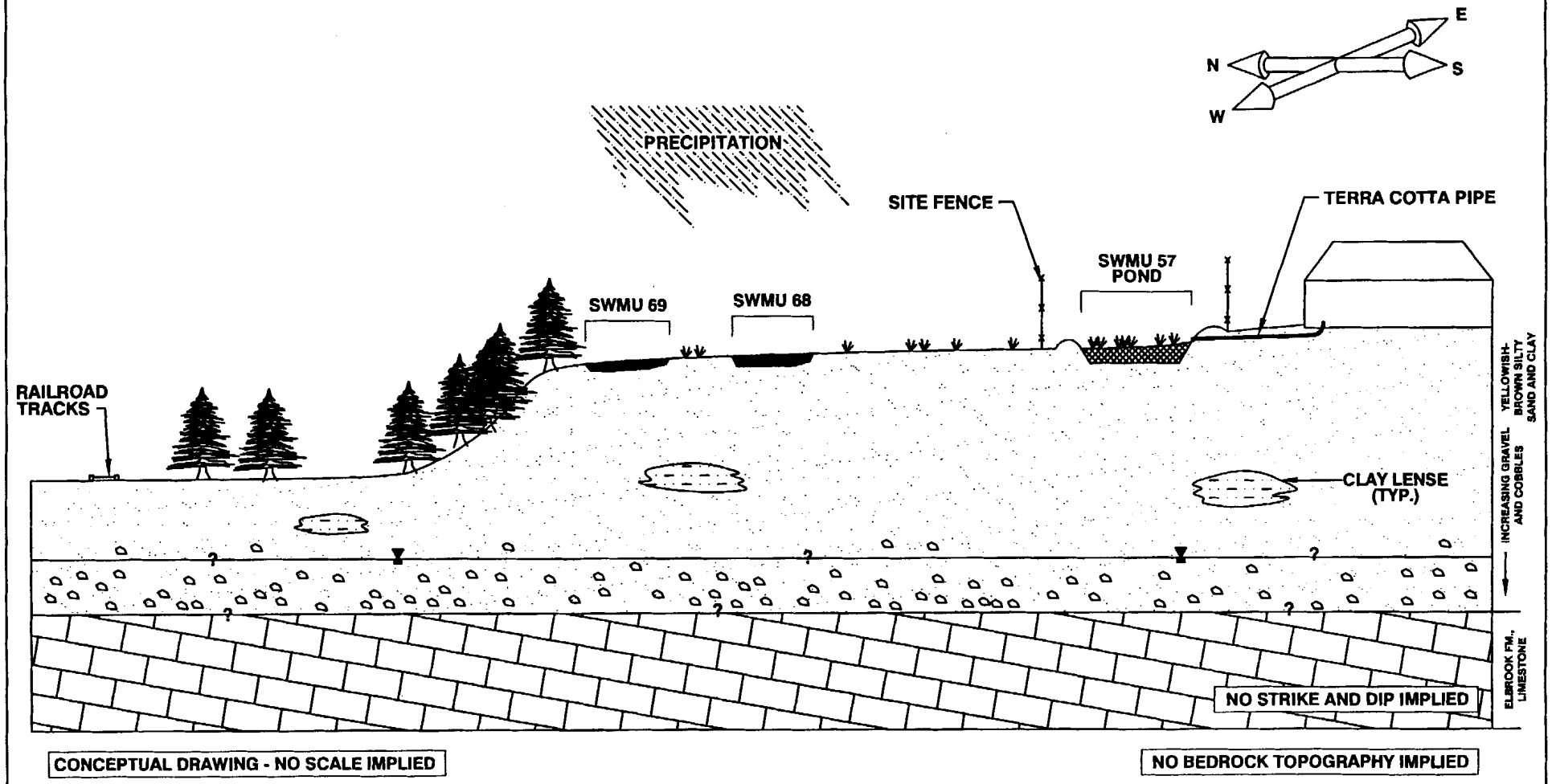
(1) = Chromium VI RBC value used

(2) = Manganese-nonfood RBC value used

= Concentration exceeds Tap Water RBC

= Concentration exceeds MCL

= Concentration exceeds Draft BTAG Screening Level



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FIGURE 1-28

CONCEPTUAL SITE MODEL FIGURE

Current and future land-use scenarios are limited to industrial operations and SWMU 57 is located within a SWMU perimeter fence and within the Installation perimeter fence; therefore, potential receptors are limited to site workers, future construction workers and terrestrial biota. Figure 1-29 presents the potential exposure pathways for each receptor. Direct deposition via the wastewater releases to the pond is considered a potential release mechanism to surface soil within the pond. Site workers, construction workers, and terrestrial biota could contact surface soil. Leaching of constituents through site soil is considered a potential release mechanism to subsurface soil and subsurface soil may be received by construction workers.

1.7.5 Data Gap Analysis

TCL VOCs – TCL VOCs were not detected in either the sediment or surface water samples collected during the 1992 VI Program. However, a data gap exists for surface and subsurface soil, since TCL VOCs samples were not previous collected from these media. Therefore, TCL VOCs will be sampled and analyzed in surface and subsurface soil.

TCL SVOCs/PAHs – SVOCs were not detected in either the sediment or surface water samples collected and samples were not collected for PAH analysis during previous investigations. Therefore, SVOCs/PAHs represent a data gap and will be analyzed in surface and subsurface soil.

TCL PCBs – TCL PCBs analysis has not been performed on previous samples. Therefore, TCL PCBs represent a data gap and will be analyzed in surface soil.

TCL Pesticides – TCL Pesticides analysis has not been performed on previous samples. Therefore, TCL Pesticides represent a data gap and will be analyzed in surface soil.

Explosives – Explosive constituents were not analyzed during the previous investigations. Therefore, explosives represent a data gap and will be analyzed in surface and subsurface soil.

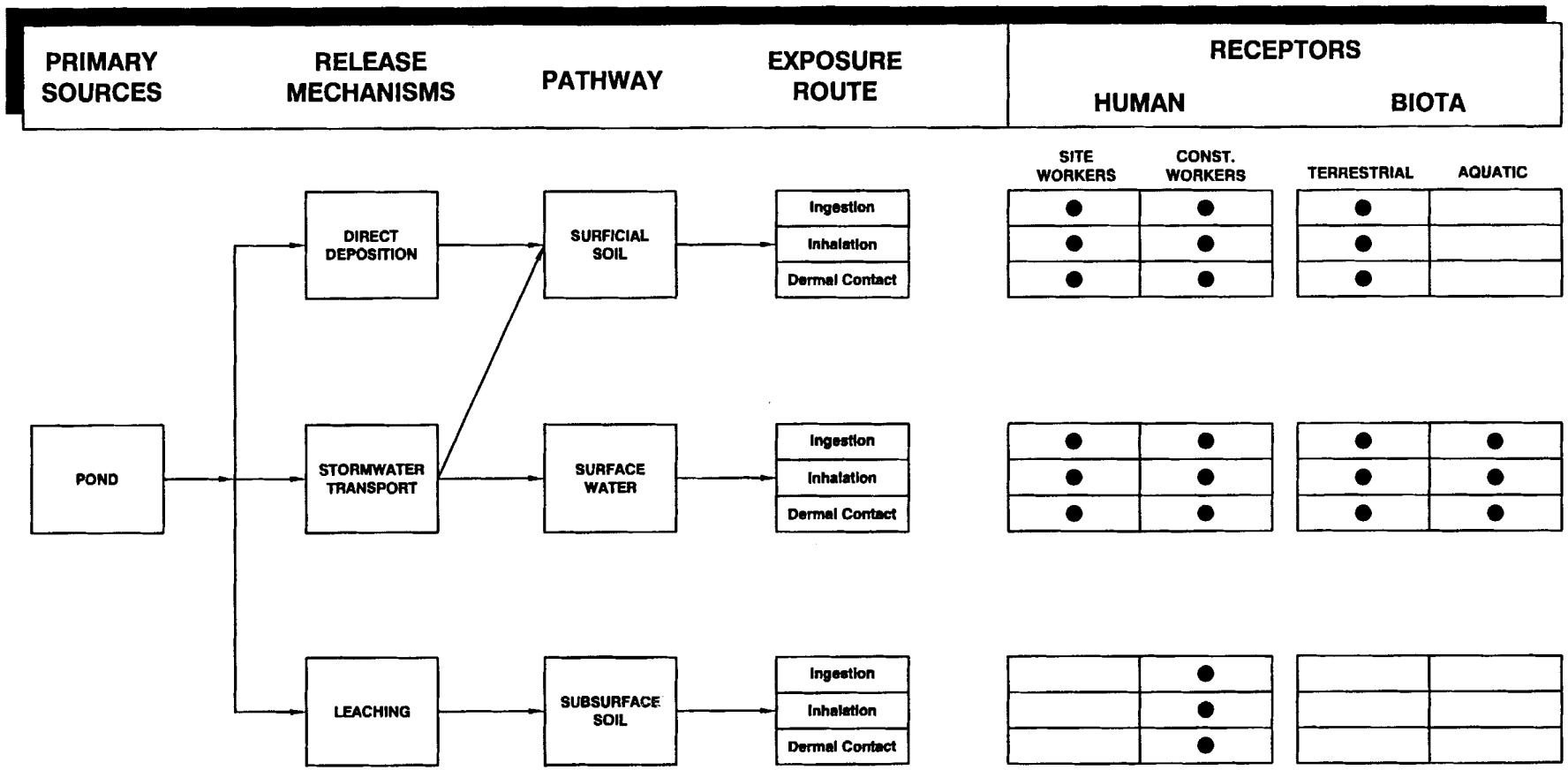
TAL Inorganics – TAL Inorganics were detected in the sediment and surface water samples during the VI Program. However, samples have not been collected and analyzed for TAL Inorganics from the surface and subsurface soil; therefore, these media represent a data gap and will be analyzed in surface and subsurface soil for site screening purposes.

Dioxins/furans – Dioxins/furans are not considered a data gap because SWMU 57 was not used for burning or storage/disposal of burned waste.

Other – An analysis of the physical properties of subsurface soil to aid in assessing the nature of possible constituent mobility has not been performed during the previous investigations. Therefore, soil samples will be sampled and analyzed for TOC, grain size, specific gravity, percent moisture, and bulk density to assess the mobility of constituents in soil.

1.7.6 Planned Field Activities

Based on the results of the data gap analysis, additional sampling and analysis is proposed to perform the SSP effort at this site. Sampling locations were selected based on previous sample analytical results, site observations, and the CSM. Proposed analyses for various media types were identified by the results of the data gap analysis.



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FIGURE 1-29

CONCEPTUAL SITE MODEL DIAGRAM

1.7.6.1 Soil Borings

The following sections discuss proposed soil investigations to be conducted at SWMU 57 using the direct push method of boring advancement, as described in SOP 20.11 in Appendix A. A four-foot Geoprobe Macro-Core® or hand-augering sampling device will be used to collect soil samples continuously from each of the borings, as described in SOP 20.11 in Appendix A. The location of each soil boring will be established to the nearest meter using GPS equipment.

Four soil borings will be advanced at SWMU 57 (57SB1, 57SB2, 57SB3, and 57SB4). Proposed sampling locations are presented on Figure 1-30. Soil borings 57SB1, 57SB2, 57SB3, and 57SB4 will be advanced to the groundwater table or top of bedrock, whichever is encountered first, using direct push technology consistent with the procedures outlined in SOP 20.11. During boring advancement subsurface soil samples will be screened for the presence of VOCs using a PID consistent with SOP 90.1 included in Appendix A. Soil borings will be completed at the following locations:

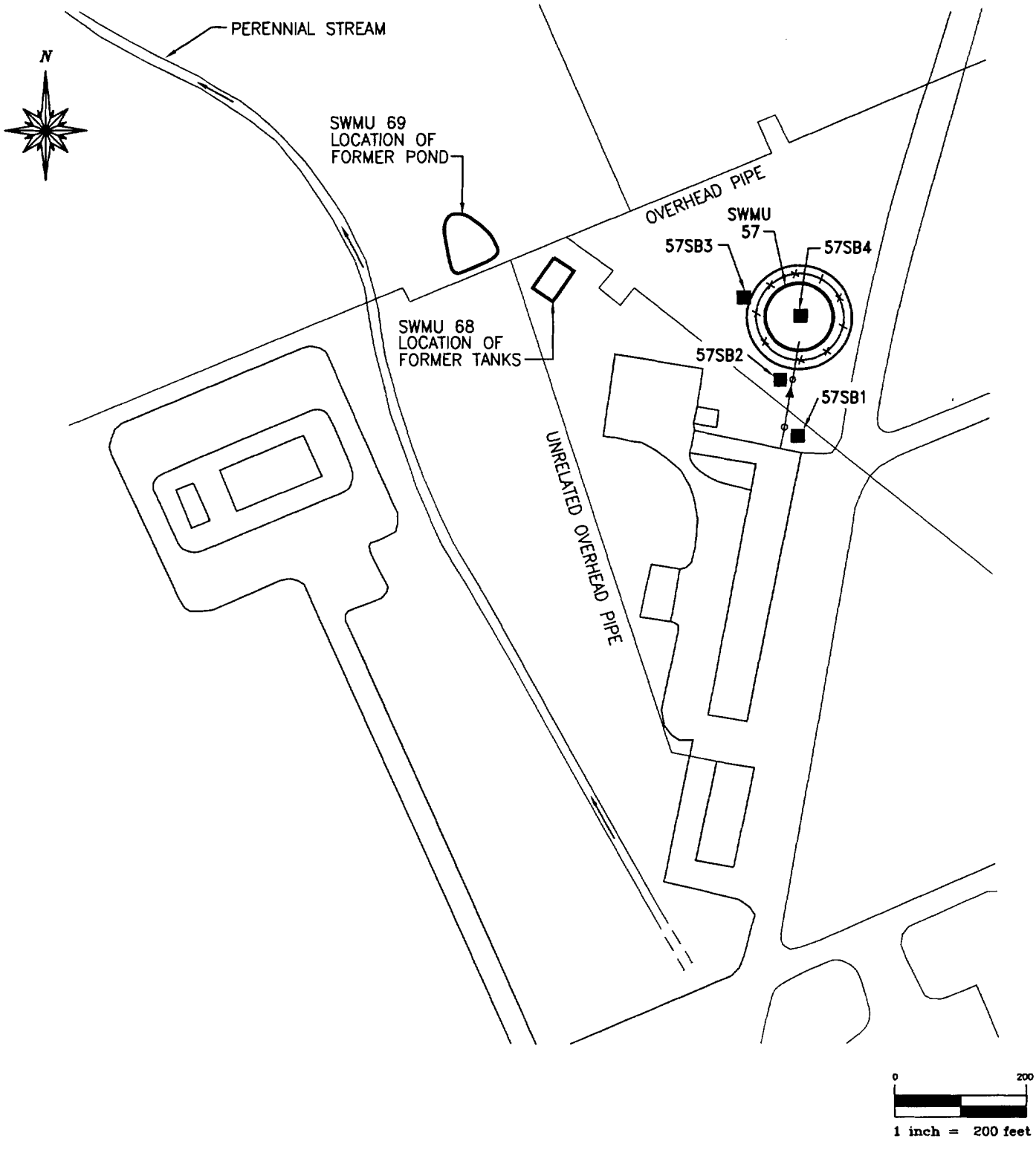
- Soil Boring 57SB1 is proposed in the proximity of the first node of the piping leading to the pond from the process building relating to the pond;
- Soil boring 57SB2 is proposed immediately up gradient of the limits of the pond, near the terra cotta pipe that formerly discharged into SWMU 57;
- Soil boring 57SB3 will be located within the surface water drainage ditch located down gradient of the pond to assess whether elevated concentrations of hazardous constituents exist beyond the settling pond; and
- Soil boring 57SB4 is proposed within the limits of the pond to screen materials within the bermed area.

To meet the objectives of the soil screening at SWMU 57 outlined above and to fill data gaps identified in Section 1.7.5:

- One surface sample will be collected from each boring (i.e., 0 to 6 inches bgs below gravel, vegetative, or organic layers and 6 to 12 inches bgs for VOCs) to assess the nature of releases;
- Two subsurface soil samples will be collected from each boring, with one from an intermediate zone (approximately 10 to 12 ft bgs) and one from the terminational zone (above the groundwater table or top of bedrock); and
- Each of the soil samples will be analyzed for TCL VOCs, TCL SVOCs, PAHs, explosives (including nitroglycerin), and TAL Inorganics. One surface soil sample will be analyzed for TCL Pesticides and TCL PCBs consistent with the requirements of the MWP QAP and Section 2.0 of this WPA.

Stratigraphic logs will be prepared for each boring location in accordance with the procedures outlined in SOP 10.3 in Appendix A.

Two samples will be collected from different strata from one boring and analyzed for the physical properties TOC, grain size, specific gravity, percent moisture, and bulk density in accordance with the QAPA in Section 2.0 of this document.



LEGEND

■ Proposed Sampling Location

(SOURCE: MODIFIED FROM DAMES & MOORE, 1992a)

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FIGURE 1-30

PROPOSED SAMPLING LOCATIONS

DAMES & MOORE, 1992a)

1.8 SWMU 68 – CHROMIC ACID TREATMENT TANKS

1.8.1 Site Background – Environmental Setting



Physiography – SWMU 68 is located in the western section of the HSA northwest of historically related buildings. Topography at SWMU 68 is moderately sloping towards the northwest at an elevation of approximately 1,800 ft msl (Figure 1-31). SWMU 68 is comprised of an area of dense vegetation that includes the area of the former chromic acid tanks. Related piping components and an eye wash station remain. There are asphalt-paved roads to the east, a densely wooded area to the north and west, and several unrelated overhead pipes and associated appurtenances near SWMU 68.

Surface Water – Drainage from this area was engineered to flow into a former settling pond (SWMU 69). Surface water in the area of SWMU 68 was observed during the SSP site visit flowing westward in a well-defined drainage pathway and then to a perennial stream flowing to the New River. The stream flows approximately 1,400 ft northwestward and discharges into the New River. Manholes, catch basins, storm drains, or other drainage pathways have not been associated with SWMU 68.

Geology and Soil – SWMU 68 is underlain by the Braddock loam soil. This soil has moderate permeability and is acidic-to-strongly acidic (IT 2002a). Site-specific data regarding subsurface conditions at SWMU 68 have been collected by ICF Kaiser (1998). These investigations were limited to site soil. Data collected by ICF Kaiser indicate surface soil consists of a yellow-orange to light brown mixture of sand, silt, and clay with a trace of gravel. Investigations at other SWMUs in similar settings at RFAAP (i.e., upland areas in the HSA) indicate the presence of unconsolidated alluvium consisting of sand and silt with some silt and gravel. The soil overlies the fractured interbedded siltstone, limestone, and dolostone of the Elbrook Formation.

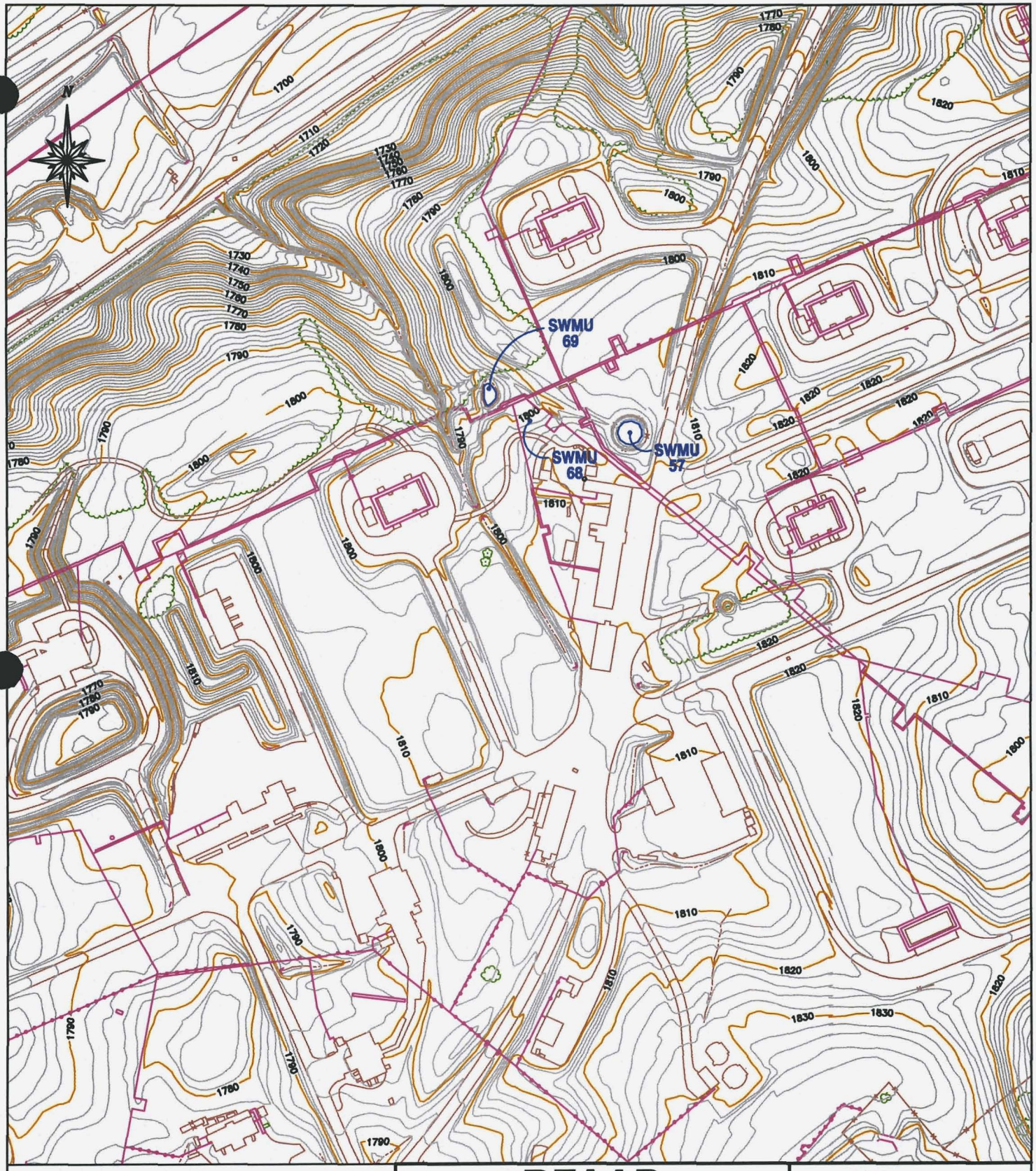
Based on Figure 4-1 of the Current Conditions Report (IT 2002a), several overlapping photolineaments are present near SWMU 68.

Groundwater – Site-specific data regarding hydrogeologic conditions at SWMU 68 have not been collected. Based on similar geomorphic setting to other SWMUs at RFAAP groundwater is likely present near the overburden bedrock interface, follows topography, and flows northwestward toward the New River.

Tanks and Structures – No other tanks or structures are located on or near SWMU 68.

1.8.2 Site Background – History

Beginning in 1958, RFAAP reconditioned "Nike" and "Honest John" rocket motors utilizing a chromic acid rinse with rust inhibitors (Hercules 1958). RFAAP operated a Virginia State Water Control Board





VICINITY MAP
N.T.S.

0 200
1 inch = 200 feet

(SOURCE: MODIFIED FROM HERCULES, INC., 1992)

RFAAP

SSP WORK PLAN ADDENDUM: SWMU 68

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OCTOBER 2002	KDC/DR
Scale:	**File Name:**
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FIGURE 1-31

SITE TOPOGRAPHY LAYOUT

approved chromic acid waste treatment plant (SWMU 68) in the Cast Propellant Area to treat wastewater before discharge to the New River (Hercules 1958, SWCB 1958).

A review of as-built specifications and drawings indicates that SWMU 68 consisted of two 4,000-gallon above ground, open top tanks with associated pumps, piping, and appurtenances. Each tank was reportedly 9 ft tall with an 8.5 ft diameter. The former tanks were connected to chemical feed tanks (sodium metabisulfate, sulfuric acid, and lime) located in a nearby building via an existing 4-inch diameter stainless steel line. The drawings also depict a 4-inch diameter terra cotta line from a 1,500-gallon Chromic Acid Treatment Tank in nearby building 4931 connected to the former tanks.

The tanks in the nearby building were used prior to 1974 to treat spent chromic acid generated from the cleaning of rocket encasements (USEPA 1987). Hexavalent chromic acid was batch treated using hydroxide precipitation. Spent hexavalent chromic acid (Cr^{+6}) was first adjusted to a pH of approximately 1.5 using sulfuric acid, and then reduced to the trivalent state (Cr^{+3}) using sodium metabisulfate. High calcium lime was added to the solution to adjust the pH to approximately 8.6. The treated wastewater was discharged to a 12,000-gal settling pond (SWMU 69) where chromium hydroxide sludge precipitated (Hercules 1958a). Additionally, spent Oakite 33® was pH adjusted to 5.0 with soda ash and high-pH rust stripper was neutralized with sulfuric acid prior to discharge to SWMU 69 (Hercules 1958a).

In July 1997, SWMU 68 underwent closure including removal of the two AST treatment tanks, appurtenances, and impacted soil. A draft SWMU 68 Closure Report was prepared by ICF Kaiser and submitted by RFAAP to the USEPA Region III and VDEQ in October 1997 (ATK 1997b). USEPA Region III responded in March 1998 with a completeness review and requested revisions to the draft SWMU 68 Closure Plan (USEPA 1998). RFAAP revised the Plan to comply with the USEPA revision request and resubmitted the Final Closure Plan to USEPA Region III and VDEQ in April 1998 (ATK 1998a; Appendix C). Based on the results of the investigation, no further action was recommended for this site (ICF Kaiser 1998).

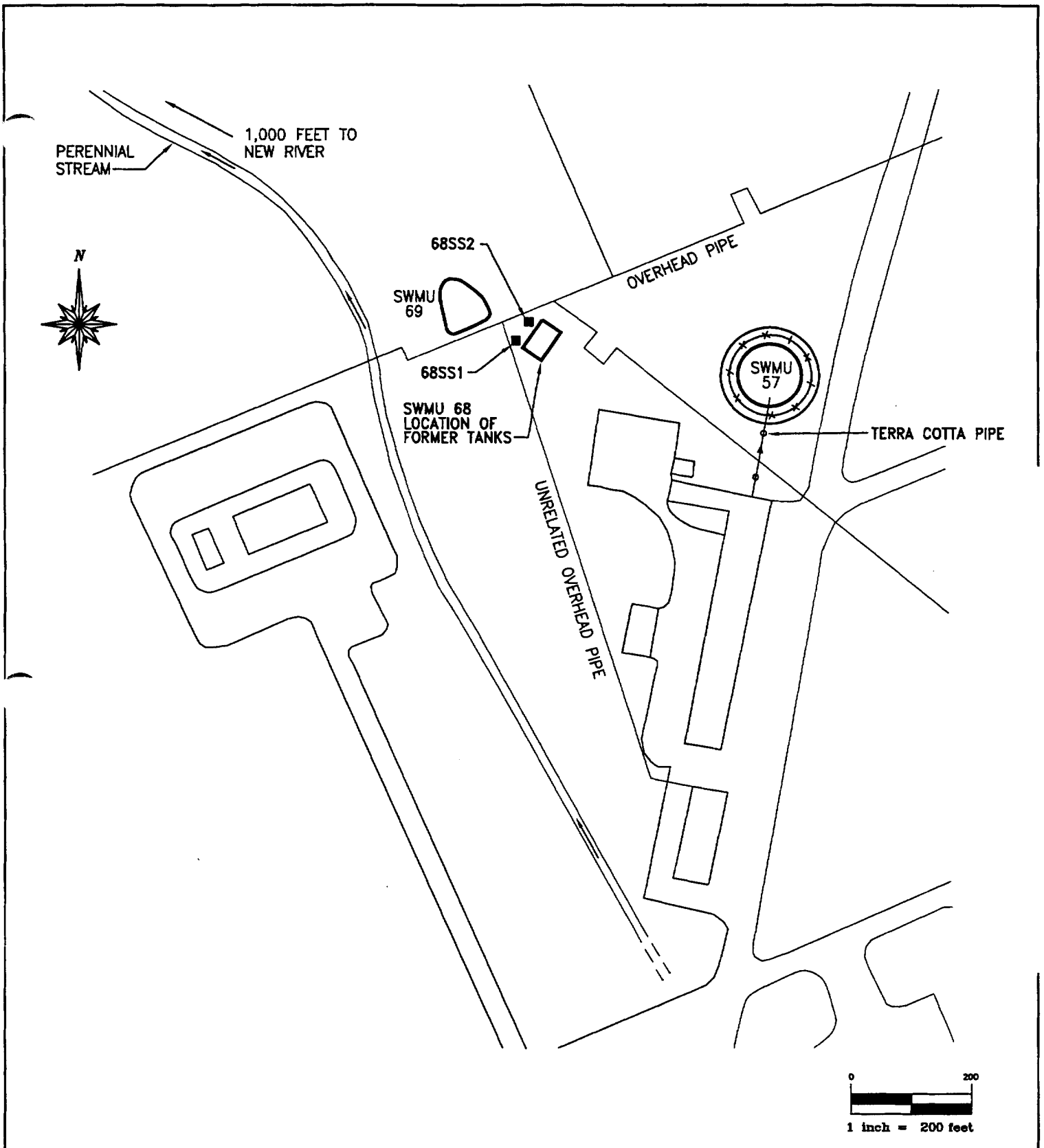
1.8.3 Previous Investigations

The following section is intended to review previous site investigations emphasizing the usability of collected data and the screening of historical data with respect to current criteria (i.e., current RBCs and BTAGs).

1.8.3.1 Verification Investigation – 1992

During the VI, Dames and Moore collected two surface soil samples (Figure 1-32) to "evaluate whether surface soil in the vicinity of the treatment tanks were impacted as a results of past spills, leaks, or overflows of waste chromic acid (Dames and Moore 1992a)." The two samples were collected from a depth of 0 to 6 inches bgs and were analyzed for pH and TAL Metals.

The results for the two surface soil samples (68SS1 and 68SS2) collected at SWMU 68 are presented in Table 1-10. A review of the data indicates concentrations of TAL Metals beryllium, cadmium, lead, mercury, and thallium exceeded their respective facility-wide background point estimate concentrations in one or both samples. Fourteen metals were present above their respective Draft BTAG screening levels. Aluminum, antimony, arsenic, chromium, iron, manganese, thallium, and vanadium exceeded their respective 2003 Residential Soil RBCs in one or both of the surface soil samples. Arsenic, iron, and thallium concentrations exceeded their respective April 2003 Industrial Soil RBCs in one or both samples.



LEGEND

■ Soil Sample

(SOURCE: MODIFIED FROM DAMES & MOORE, 1992a)

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FIGURE 1-32

SWMU LAYOUT MAP

Table 1-10
Summary of Detected Analytes for Soil Samples Collected at SWMU 68
Modified from Dames and Moore Verification Investigation Report
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

SITE ID FIELD ID SAMPLE DATE DEPTH (ft bgs) MATRIX UNITS	PQLs mg/kg	68SS1 RVFS*59 4-Feb-92 0.5 CSO mg/kg	68SS2 RVFS*60 4-Feb-92 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
TAL Metals							
Aluminum	14.1	**9,450**	**18,500**	102,200	7,821	1	40,041
Antimony	20	<7.14	**26.3**	40.9	3.13	0.48	--
Arsenic	30	**2.40**	**7.3**	1.91	0.43	328	15.8
Barium	1	118	61.3	7,154	548	440	209
Beryllium	0.2	1.13	1.87	204	16	0.02	1.02
Cadmium	2	1.59	<0.7	102	7.82	2.5	0.69
Calcium	100	624B	2270B	--	--	--	--
Chromium[1]	4	**26.9**	**49.2**	307	23.0	0.0075	65.3
Cobalt	3	11.5	14.6	2,044	156	100	72.3
Copper	7	9.96	**20.1**	4,088	313	15	53.5
Iron	1000	**12,600**	**33,900**	30,660	2,346	12	50,962
Lead[2]	2	**16.5**	**28.7**	1,000	400	0.01	26.8
Magnesium	50	642B	1,610	--	--	4,400	--
Manganese[3]	0.275	**1,250**	**885**	2,044	156	330	2,543
Mercury[4]	0.1	<0.05	**0.362**	30.7	2.35	0.058	0.13
Nickel	3	**8.77**	**10.7**	2,044	156	2	62.8
Potassium	37.5	538	1010	--	--	--	--
Silver	4	**0.779**	**1.1**	511	39	0.0000098	--
Sodium	150	650B	188B	--	--	--	--
Thallium	20	**9.62**	**21.1**	7.15	0.547	0.001	2.11
Vanadium	0.775	**30.5**	**75.8**	715	54.8	0.5	108
Zinc	30.2	**54.1**	**87.4**	30,660	2,346	10	202

Notes:
B = Analyte was detected in corresponding method blank; values are flagged if the sample concentration is less than ten (10) times the method blank concentration for common laboratory constituents and five (5) times for all other constituents
BTAG = USEPA Region III Draft, Biological Technical Assistance Group Screening Level
CSO = Chemical soil
ft bgs = Feet below ground surface
mg/kg = Micrograms per kilogram
PQL = Practical quantitation limit; the lowest concentration that can be reliably detected at a defined level of precision for a given analytical method
TAL = Target Analyte List
RBC = Risk-Based Concentration
USEPA = United States Environmental Protection Agency
USEPA Region III Risk-Based Concentration (RBC) values from the April 25, 2003 RBC Table
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
[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 was used
[A] = Facility-Wide Background Point Estimate as Reported in the Facility-Wide Background Study Report (IT 2002b)

bold = Concentration exceeds Industrial RBC

= Concentration exceeds Residential RBC

= Concentration exceeds Draft BTAG Screening Level

underline = Concentration exceeds Facility-Wide Background Point Estimate

1.8.3.2 SWMU 68 Closure Report – 1997/1998

In 1998, ICF Kaiser conducted SWMU closure activities at SWMU 68 in accordance with Draft Final Master WPA No. 001. The investigation was performed as, "a follow up to the SWMU 69 removal", and the approach sought to "characterize and remove any contaminated material in one relatively quick step (ATK 1997a)." The investigation objectives included background soil characterization, removal action, and subsurface soil characterization (ICF Kaiser 1998). In order to facilitate that characterization, two tanks and appurtenant piping were removed. Soil below the tanks was characterized by test pitting to a depth of 4 ft bgs. Removed soil was disposed as IDM and the excavation backfilled. The subsurface investigation included the sampling and analysis of 24 confirmatory samples and two contingency samples.

The location of the twelve test pits is shown in Figure 1-33. One sample and one duplicate soil sample were collected within each assumed-homogeneous 8 ft by 8 ft by 4 ft sample grid as shown in Figure 1-33. Each sample was collected from approximately 4 to 5 ft bgs and was analyzed for TAL Metals. Two contingency samples were also collected from 8.0 to 8.5 feet bgs in the northwest and southwest quadrants. Analytical results are presented in Table 1-11.

A review of the data indicates that TAL Metals, aluminum, beryllium, cadmium, iron, and mercury were reported above their respective facility-wide background point estimate concentrations in at least one of the samples (ICF Kaiser 1998). TAL Metals aluminum, arsenic, chromium, iron, manganese, and vanadium were reported above their respective 2003 Residential Soil RBCs in at least one or more of the samples. Arsenic and iron were present above their respective 2003 Industrial Soil RBCs at one or more locations. Arsenic was reported present (4.6 mg/kg) in contingency sample 68SB01 above its 2003 Industrial Soil RBC (1.91 mg/kg); however, sample 68SB01 was not reported exceeding its facility-wide background point estimate (15.8 mg/kg) concentration for arsenic.

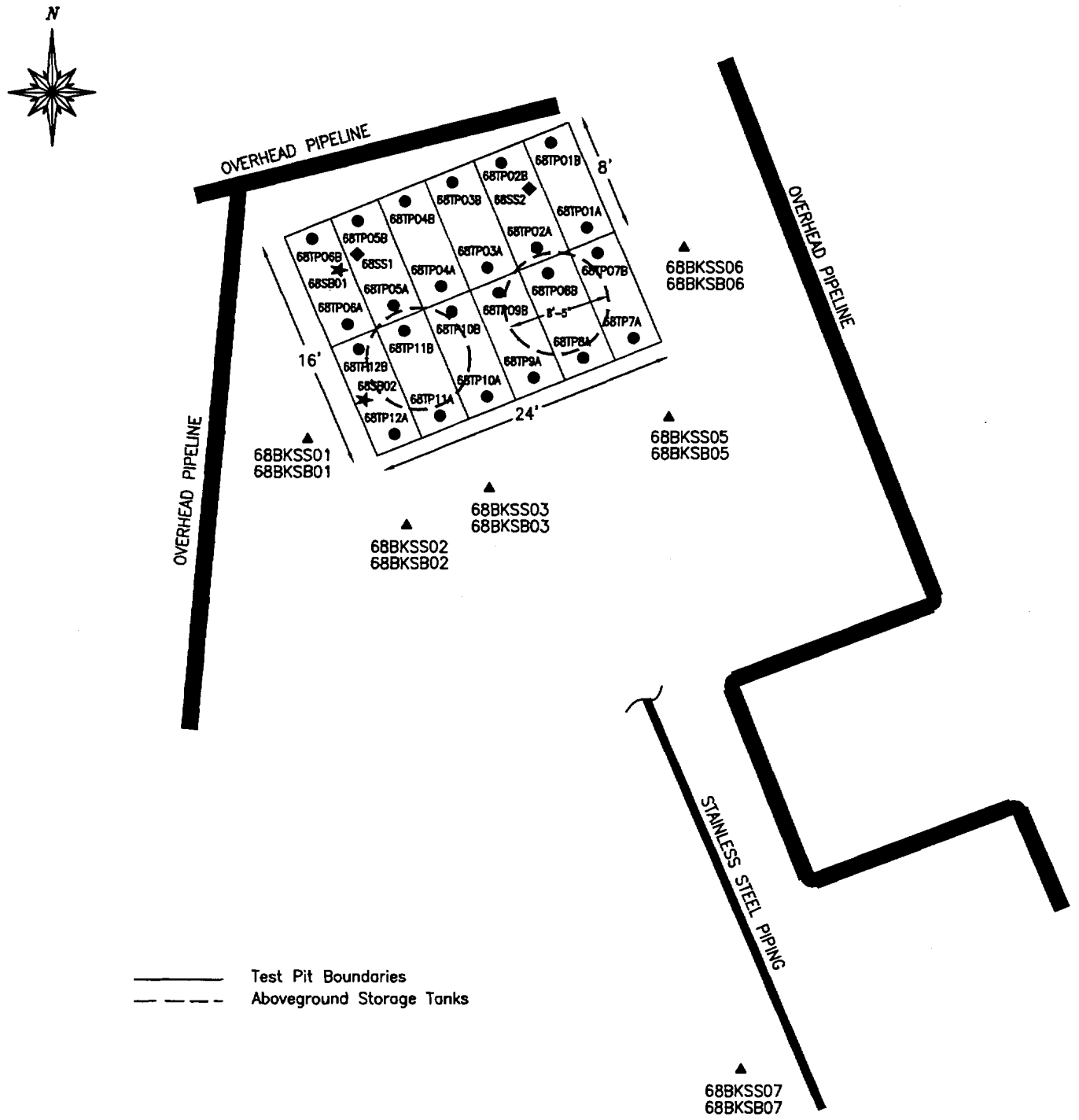
1.8.3.3 Review of EPIC Aerial Photo Assessment Report – 1992

Activity at SWMU 68 was first noted on a 1962 aerial photograph as "two visible tanks." This area remained unchanged through the 1986 photograph (USEPA 1992).

1.8.4 Conceptual Site Model

A CSM for SWMU 68 is presented in Figure 1-34. Subsurface geology is shown as an upper layer of sands, silts, and clays with gravels increasing with depth overlying the Elbrook Formation. Potentially affected media include surface and subsurface soil. The area surrounding the former tanks is maintained grass with surface water runoff flowing to a well-defined drainage ditch that leads northwest toward a perennial stream flowing to the New River. Tank activities may have impacted surface soil through direct deposition and subsurface soil through leaching of constituents into site soil.

Current and future land-use scenarios are limited to industrial operations and SWMU 68 is located within the Installation perimeter fence; therefore, potential receptors are limited to site workers, future construction workers, and terrestrial biota. Figure 1-35 presents the potential exposure pathways for each receptor. Direct deposition via potential spills is considered a potential release mechanism to surface soil and surface water (nearby drainage ditch). Site workers, construction workers, and terrestrial biota could contact surface soil. Leaching of constituents through site soil is considered a potential release mechanism to subsurface soil and subsurface soil may be received by construction workers.



LEGEND

- ■ VI Samples 0–6" bgs
- ▲ Preliminary Background Samples 0–6", 4–5' bgs
- ● Confirmatory Samples 4–5' bgs
- ✱ Contingency Samples 7–9' bgs

(SOURCE: MODIFIED FROM ICF KAISER ENGINEERS, 1998)

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FIGURE 1-33

TEST PIT AND CLOSURE SAMPLING LOCATIONS

Table 1-11
Summary of Detected Analytes for Soil Samples Collected at SWMU 68
Modified from ICF Kaiser Engineers, Inc. SWMU 68 Closure Report
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

SITE ID		68TP01A	68TP01B	68TP02A	68TP02B	68TP03A	68TP03B	Adjusted Soil Industrial RBC	Adjusted Soil Residential RBC	Draft BTAG Screening Level	Facility-Wide Background Point Estimates[A]
SAMPLE DATE		23-Jul-97	23-Jul-97	23-Jul-97	23-Jul-97	23-Jul-97	23-Jul-97				
DEPTH (ft bgs)		4-4.5	4-4.5	4-4.5	4-4.5	4-4.5	4-4.5				
MATRIX	PQLs	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL				
UNITS	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	10	32,100	28,600	19,900	18,300	18,900	11,800	102,200	7,821	1	40,041
Antimony	20	1.0L	1.6L	0.66L	0.77L	0.71L	0.60L	40.9	3.13	0.48	--
Arsenic	30	5.10	5.1	5.3	5.8	4.1	6.1	1.91	0.43	328	15.8
Barium	1	63.8	64.3	50.7	45.0	39.1	34.6	7,154	548	440	209
Beryllium	0.2	0.60	0.59	0.52	0.48	0.58	0.39	204	16	0.02	1.02
Cadmium	2	0.94	<0.61	1.3	0.86	0.84	<0.60	102	7.82	2.5	0.69
Calcium	50	1,330L	4,080L	1,360L	<605L	1,060L	<597L	--	--	--	--
Chromium[1]	4	30K	34.8K	37.3K	43.1K	26.3K	53.8K	307	23.0	0.0075	65.3
Cobalt	0.8	8.8	10.6	10.3	12.8	6.3	12.8	2,044	156	100	72.3
Copper	2	20.9	17.5	16.4	17.9	22.1	11.3	4,088	313	15	53.5
Iron	10	34,700	32,200	31,600	25,700	23,500	25,100	30,660	2,346	12	50,962
Lead[2]	2	<13	13.1	12.5	13.7	<12.1	19.3	1,000	400	0.01	26.8
Magnesium	50	1,370	2,610	984	836	977	<597	--	--	4,400	--
Manganese[3]	1	316	458	391	631	227	990	2,044	156	330	2,543
Mercury[4]	0.1	0.150	<0.12	<0.12	<0.12	<0.12	<0.12	30.7	2.35	0.058	0.13
Nickel	3	15.4	14	36.7	9	9.3	5.8	2,044	156	2	62.8
Potassium	500	1,290	1,240	1,100	1,020	1,560	644	--	--	--	--
Selenium	40	<32.6	<30.5	<30.2	<30.2	<30.3	<29.8	511	39.1	1.8	--
Silver	4	<1.3	<1.2	<1.2	<1.2	<1.2	<1.2	511	39	0.0000098	--
Sodium	500	<652	<609	<603	<605	<605	<597	--	--	--	--
Vanadium	1	63.5	54.6	54.4	52.8	38.7	49.8	715	54.8	0.5	108
Zinc	2	60.5	58.9	57.2	44.1	36.2	25.8	30,660	2,346	10	202

Table 1-11 (Continued)
Summary of Detected Analytes for Soil Samples Collected at SWMU 68
Modified from ICF Kaiser Engineers, Inc. SWMU 68 Closure Report
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

SITE ID		68TP04A	68TP04B	68TP05A	68TP05B	68TP06A	68TP06B	Adjusted Soil Industrial RBC	Adjusted Soil Residential RBC	Draft BTAG Screening Level	Facility-Wide Background Point Estimates[A]
SAMPLE DATE		23-Jul-97	23-Jul-97	23-Jul-97	23-Jul-97	23-Jul-97	23-Jul-97				
DEPTH (ft bgs)		4-4.5	4-4.5	4-4.5	4-4.5	4-4.5	4-4.5				
MATRIX	PQLs	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL				
UNITS	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	10	23,200	25,700	29,800	30,100	29,300	30,000	102,200	7,821	1	40,041
Antimony	20	0.76L	1.1L	1.3L	<0.67L	0.96L	<0.66L	40.9	3.13	0.48	--
Arsenic	30	4.0	4.8	4.4	2.4	3.5	4.2	1.91	0.43	328	15.8
Barium	1	47.2	44.6	81.6	28.6	28.8	27.3	7,154	548	440	209
Beryllium	0.2	1.10	0.98	1.10	0.96	0.98	1.40	204	16	0.02	1.02
Cadmium	2	0.96	1.0	0.8	0.68	0.77	0.74	102	7.82	2.5	0.69
Calcium	50	2,600L	1,540L	2,190L	<668L	1,170L	697L	--	--	--	--
Chromium[1]	4	13.6K	18.9K	21.4K	15.7K	25K	22.9K	307	23.0	0.0075	65.3
Cobalt	0.8	11.2	7.0	29.9	3.8	4.4	4.8	2,044	156	100	72.3
Copper	2	16.20	21.5	19.5	14.1	39.6	14.5	4,088	313	15	53.5
Iron	10	35,200	33,800	41,600	38,800	43,600	38,100	30,660	2,346	12	50,962
Lead[2]	2	<13.4	<14	16.3	<13.4	<13.7	<13.3	*1,000*	*400*	*0.01*	*26.8*
Magnesium	50	1,110	1,130	1,660	1,170	1,390	2,030	--	--	4,400	--
Manganese[3]	1	694	216	1,420	111	86	57	2,044	156	330	2,543
Mercury[4]	0.1	<0.13	<0.14	<0.13	<0.13	<0.14	<0.13	30.7	2.35	0.058	0.13
Nickel	3	11.2	11.4	31.3	12.8	11.8	11.4	2,044	156	2	62.8
Potassium	500	1,850	1,990	3,460	2,080	1,670	4,060	--	--	--	--
Selenium	40	<33.6	<35	<33.4	<33.4	<34.2	<33.2	511	39.1	1.8	--
Silver	4	<1.3	<1.4	<1.3	<1.3	<1.4	<1.3	511	39	0.0000098	--
Sodium	500	<671	<699	<668	<668	1170	<664	--	--	--	--
Vanadium	1	28.5	35.9	36.1	29.1	48.4	28.7	715	54.8	0.5	108
Zinc	2	31.6	37.7	31.8	22.4	26	20.3	30,660	2,346	10	202

Table 1-11 (Continued)
Summary of Detected Analytes for Soil Samples Collected at SWMU 68
Modified from ICF Kaiser Engineers, Inc. SWMU 68 Closure Report
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

SITE ID		68TP07A	68TP07B	68TP08A	68TP08B	68TP09A	68TP09B	Adjusted Soil Industrial RBC	Adjusted Soil Residential RBC	Draft BTAG Screening Level	Facility-Wide Background Point Estimates[A]
SAMPLE DATE		23-Jul-97	23-Jul-97	23-Jul-97	23-Jul-97	23-Jul-97	23-Jul-97				
DEPTH (ft bgs)		4-4.5	4-4.5	4-4.5	4-4.5	4-4.5	4-4.5				
MATRIX	PQLs	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL				
UNITS	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	10	39,300	25,000	34,800	32,900	26,800	23,200	102,200	7,821	1	40,041
Antimony	20	<0.64L	0.81L	<0.65L	<0.64L	<0.63L	<0.66L	40.9	3.13	0.48	--
Arsenic	30	2.6	2.8	2.8	3.5	2.4	2.7	1.91	0.43	328	15.8
Barium	1	76.1	40.4	64.0	51.1	44.9	28.2	7,154	548	440	209
Beryllium	0.2	0.56	0.38	0.48	0.55	0.56	0.95	204	16	0.02	1.02
Cadmium	2	<0.64	<0.63	<0.65	0.81	<0.63	<0.66	102	7.82	2.5	0.69
Calcium	50	1,210L	816L	1,240L	1,180L	798L	1,270L	--	--	--	--
Chromium[1]	4	25.7K	22.1K	26.6K	29K	20.4K	26K	307	23.0	0.0075	65.3
Cobalt	0.8	7.6	3.8	4.5	12.5	5.0	9.3	2,044	156	100	72.3
Copper	2	17.5	13.4	15.4	15.6	13.8	8.2	4,088	313	15	53.5
Iron	10	29,700	21,500	30,100	24,700	30,700	40,900	30,660	2,346	12	50,962
Lead[2]	2	<12.7	<12.6	<13	<12.8	<12.6	<13.2	1,000	400	0.01	26.8
Magnesium	50	1,930	857	1,360	1,110	1,100	1,080	--	--	4,400	--
Manganese[3]	1	242	78	79.7	398	103	339	2,044	156	330	2,543
Mercury[4]	0.1	<0.13	<0.13	<0.13	<0.13	<0.13	<0.13	30.7	2.35	0.058	0.13
Nickel	3	18	11.4	14.4	13.6	12.3	10.5	2,044	156	2	62.8
Potassium	500	2,080	948	1,470	1,110	1,200	1,910	--	--	--	--
Selenium	40	<31.8	<31.4	<32.6	<31.9	<31.6	<33	511	39.1	1.8	--
Silver	4	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	511	39	0.0000098	--
Sodium	500	<637	<629	<651	<639	<631	<660	--	--	--	--
Vanadium	1	74.9	44.3	74.1	49.2	72.8	29	715	54.8	0.5	108
Zinc	2	55.6	38.2	49.1	37.7	39.6	21.7	30,660	2,346	10	202

Table 1-11 (Continued)
Summary of Detected Analytes for Soil Samples Collected at SWMU 68
Modified from ICF Kaiser Engineers, Inc. SWMU 68 Closure Report
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

SITE ID		68TP10A	68TP10B	68TP11A	68TP11B	68TP12A	68TP12B	68SB01	Adjusted Soil Industrial RBC	Adjusted Soil Residential RBC	Draft BTAG Screening Level	Facility-Wide Background Point Estimates[A]
SAMPLE DATE		24-Jul-97	24-Jul-97	24-Jul-97	24-Jul-97	24-Jul-97	24-Jul-97	23-Jul-97				
DEPTH (ft bgs)		4-4.5	4-4.5	4-4.5	4-4.5	4-4.5	4-4.5	8.0-8.5				
MATRIX		SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL				
UNITS	PQLs 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	10	**39,000**	**29,500**	**28,000**	**40,300**	**24,100**	**28,600**	**14,900**	102,200	7,821	1	40,041
Antimony	20	<0.69L	**0.94L**	<0.61L	**0.80L**	<0.61L	<0.66L	<0.63	40.9	3.13	0.48	--
Arsenic	30	**8.90**	**4.0**	**3.6**	**10.4**	**2.2**	**3.3**	**4.6**	1.91	0.43	328	15.8
Barium	1	45.4	28.1	51.7	52.9	44.4	<26.2	17.1	7,154	548	440	209
Beryllium	0.2	**1.10**	**1.10**	**0.49**	**0.98**	**0.45**	**1.10**	**0.80**	204	16	0.02	1.02
Cadmium	2	1.90	1.2	<0.61	1.2	<0.61	0.74	<0.63	102	7.82	2.5	0.69
Calcium	50	1350	1,510L	<606	<775L	<608	<655L	200	--	--	--	--
Chromium[1]	4	**52.9K**	**31.4K**	**35.4K**	**34.6K**	**21.5K**	**19.7K**	**12.1**	307	23.0	0.0075	65.3
Cobalt	0.8	8.5	5.5	13.9	9.9	6.1	8.6	14.0	2,044	156	100	72.3
Copper	2	**37.3**	14.2	**17.5**	**37.9**	10.7	**34.3**	14.0	4,088	313	15	53.5
Iron	10	**53,300**	**43,900**	**26,400**	**55,100**	**22,700**	**37,300**	**25,000**	30,660	2,346	12	50,962
Lead[2]	2	**14**	<13.8	**13.9**	**15.6**	<12.2	<13.1	<6.3	1,000	400	0.01	26.8
Magnesium	50	2,740	1,540	909	6,900	816	1,690	942	--	--	4,400	--
Manganese[3]	1	**160**	**80**	**349**	**170**	**181**	**359**	**165**	2,044	156	330	2,543
Mercury[4]	0.1	<0.14	<0.14	<0.12	<0.16	<0.12	<0.13	<0.13	30.7	2.35	0.058	0.13
Nickel	3	**25.3**	**15.6**	**13.4**	**32.8**	**13**	**8.7**	**12.8**	2,044	156	2	62.8
Potassium	500	2,060	2,510	859	3,980	1,040	3,590	1,270	--	--	--	--
Selenium	40	<34.6	<34.4	<30.3	<38.8	<30.4	<32.8	<25.1	511	39.1	1.8	--
Silver	4	<1.4	<1.4	<1.2	<1.6	<1.2	<1.3	<1.3	511	39	0.0000098	--
Sodium	500	<692	<689	726	<775	<608	1510	877	--	--	--	--
Vanadium	1	**77**	**42.5**	**40.7**	**78.7**	**50.6**	**24.3**	**17.8**	715	54.8	0.5	108
Zinc	2	**82.9**	**46.1**	**29.9**	**42.6**	**31.6**	**17.4**	**12**	30,660	2,346	10	202

Notes:

ft bgs = Feet below ground surface

K = Data is biased high

L = Data is biased low

mg/kg = Milligrams per kilogram

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 25, 2003 RBC Table

Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens

BTAG = USEPA Region III Draft, Biological Technical Assistance Group Screening Level

TAL = Target Analyte List

[A] = Facility-Wide Background Point Estimate as Reported in the Facility-Wide Background Study Report (IT 2002b)

[1] = Chromium VI RBC value used

[2] = Lead criteria are Action Levels; see USEPA Region III guidance

[3] = Manganese-nonfood RBC value used

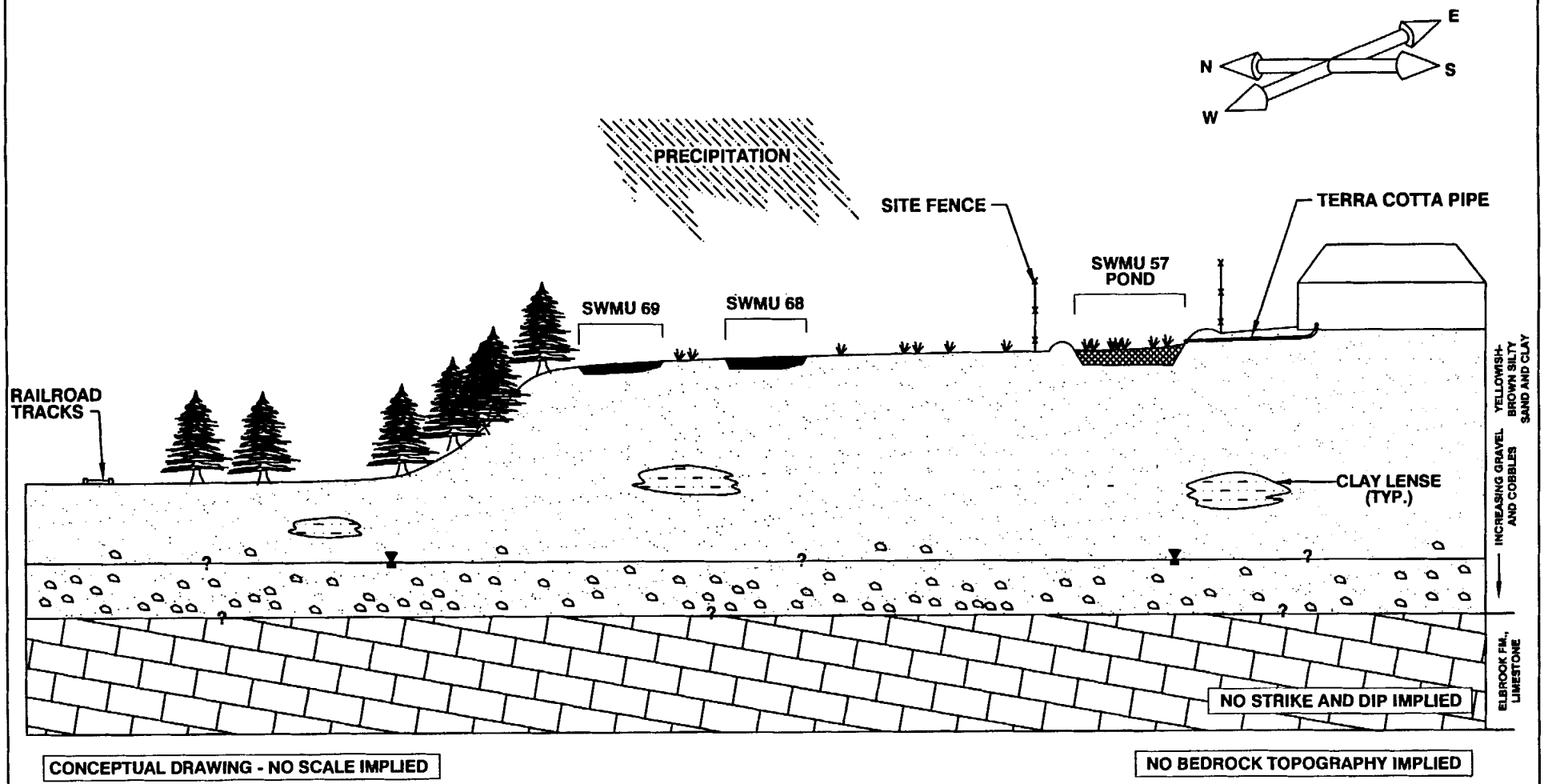
[4] = Mercuric chloride RBC value used

bold = Concentration exceeds Industrial RBC

= Concentration exceeds Residential RBC

= Concentration exceeds Draft BTAG Screening Level

underline = Concentration exceeds Facility-Wide Background Point Estimate



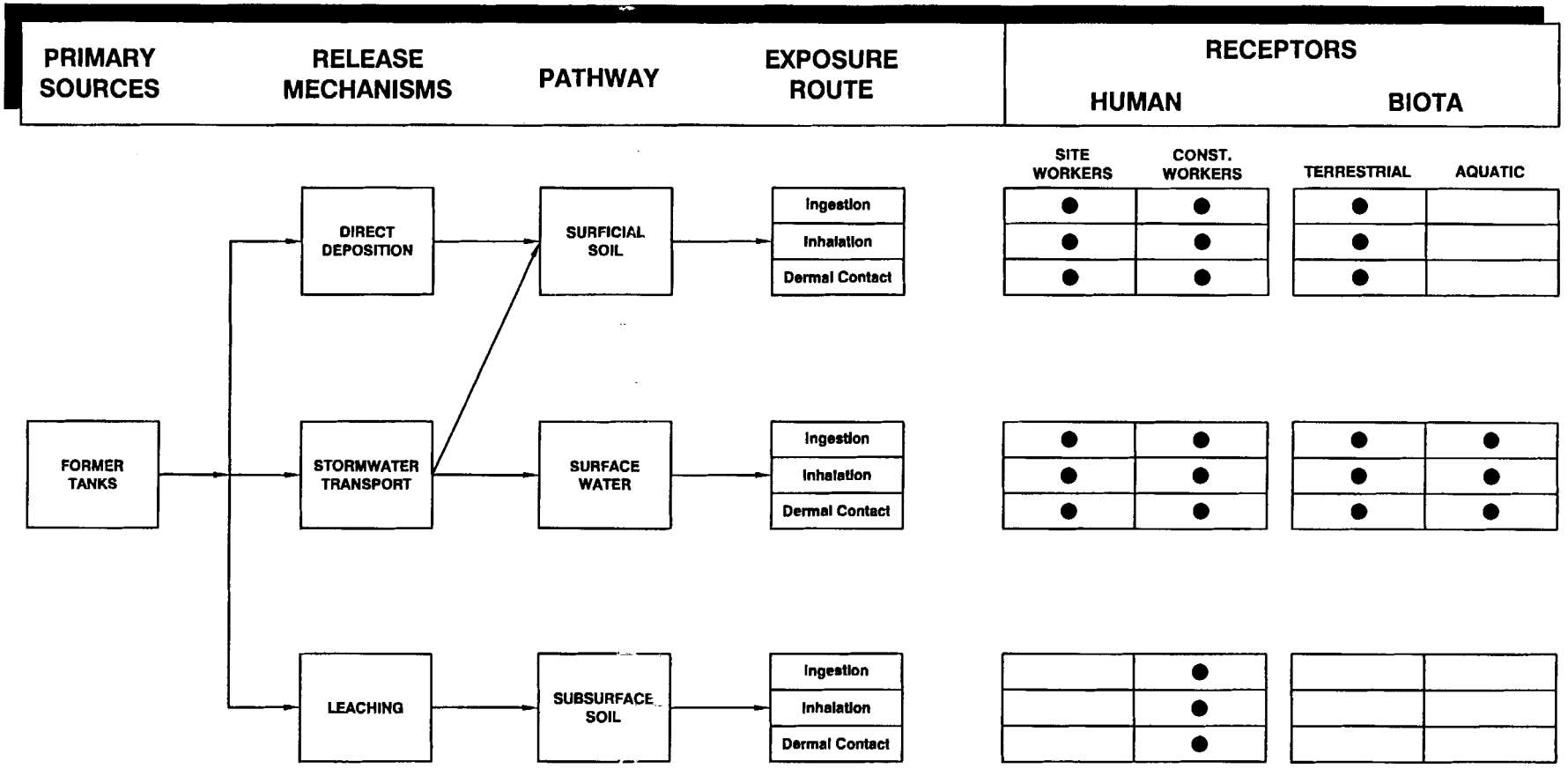
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NO SCALE	09604-317-155

FIGURE 1-34

CONCEPTUAL SITE MODEL FIGURE



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Scale:	**File Name:**
NO SCALE	*09604-317-155*

FIGURE 1-35

CONCEPTUAL SITE MODEL DIAGRAM

1.8.5 Data Gap Analysis

TCL VOCs – TCL VOCs analysis has not been performed on previous samples. Therefore, TCL VOCs represent a data gap and will be analyzed in surface and subsurface soil.

TCL SVOCs/PAHs – TCL SVOC/PAH analysis has not been performed on previous samples. Therefore, TCL SVOC/PAH represents a data gap and will be analyzed in surface and subsurface soil.

TCL PCBs – TCL PCBs analysis has not been performed on previous samples. Therefore, TCL PCBs represent a data gap and will be analyzed in surface and subsurface soil.

TCL Pesticides – TCL Pesticide analysis has not been performed on previous samples. Therefore, TCL Pesticides represent a data gap and will be analyzed in surface soil.

Explosives – Explosive analysis has not been performed on previous samples. Therefore, explosives represent a data gap and will be analyzed in surface and subsurface soil.

TAL Inorganics – Surface and subsurface soil samples were collected during previous investigations. Results indicate that TAL Inorganics are identified as COPCs at the site. Additional samples will be collected and analyzed in the surface and subsurface to appropriately screen the site for SSP purposes.

Dioxins/furans – Dioxins/furans are not considered a data gap because SWMU 68 was not used for burning or storage/disposal of burned waste.

Other – An analysis of the physical properties of subsurface soil to aid in assessing the nature of possible constituent mobility has not been performed during the previous investigations. Therefore, soil samples will be analyzed for TOC, grain size, specific gravity, percent moisture, and bulk density to assess the mobility of constituents in soil.

1.8.6 Planned Field Activities

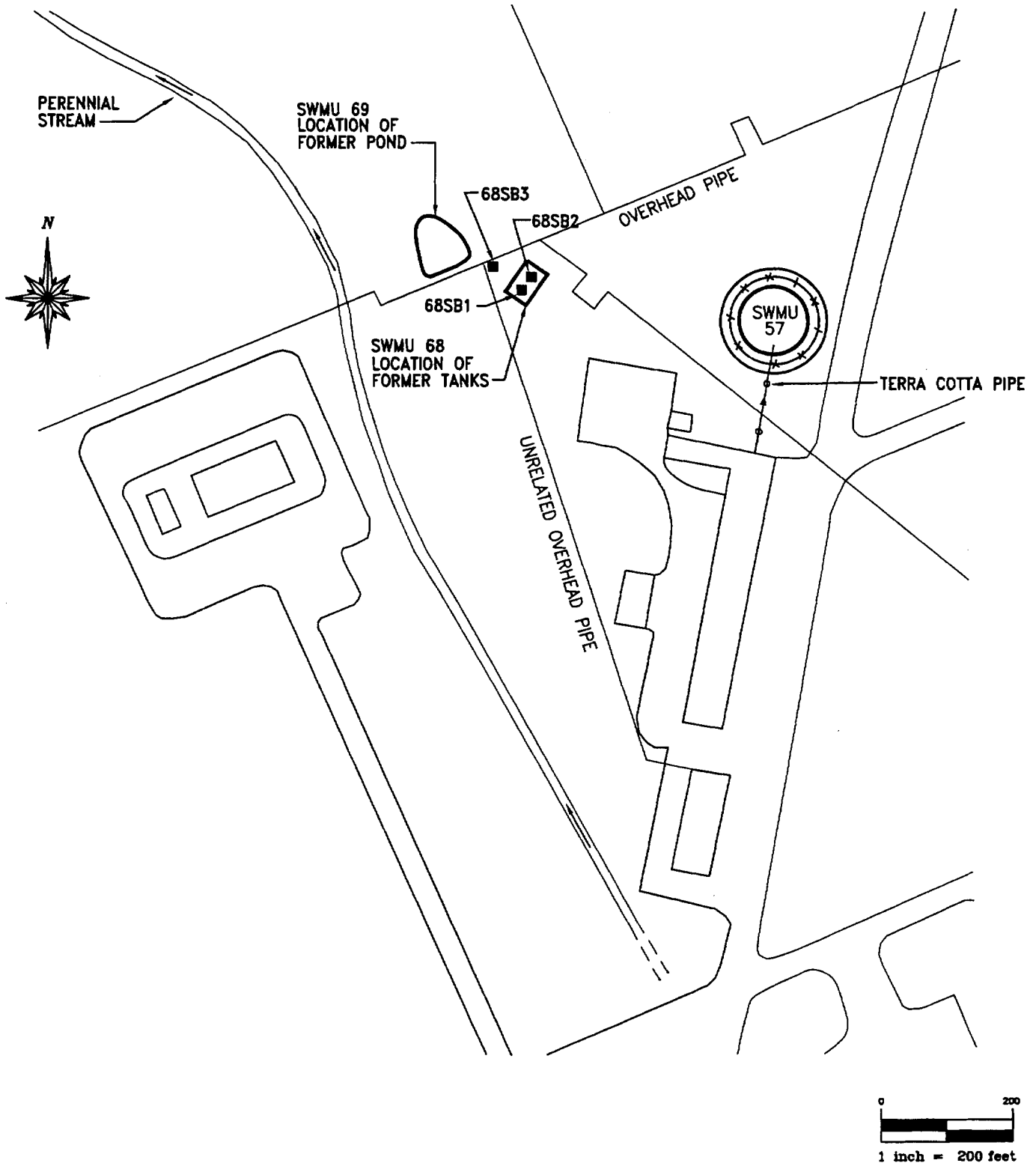
Based on the results of the data gap analysis, additional sampling and analysis is proposed to perform the SSP effort at this site. Sampling locations were selected based on previous sample analytical results, site observations, and the CSM. Proposed analyses for various media types were identified by the results of the data gap analysis.

1.8.6.1 Soil Borings

The following sections discuss proposed soil investigations to be conducted at SWMU 68 using the direct push method of boring advancement, as described in SOP 20.11 in Appendix A. A four-foot, Geoprobe Macro-Core® sampling device will be used to collect soil samples continuously from each of the borings, as described in SOP 20.11 in Appendix A. The location of each soil boring will be established to the nearest meter using GPS equipment.

Three soil borings will be advanced at SWMU 68 (68SB1, 68SB2, and 68SB3). Proposed sampling locations are presented on Figure 1-36. Soil borings will be advanced to the groundwater table or top of bedrock, whichever is encountered first, using direct push technology consistent with the procedures outlined in SOP 20.11. During boring advancement, subsurface soil samples will be screened for volatile organic compounds using a PID consistent with SOP 90.1 included in Appendix A. Soil borings will be completed at the following locations:

- Soil boring 68SB1 and 68SB2 will be located near the centers of the former tank locations. These borings are proposed to verify previous investigation activities; and



LEGEND

■ Proposed Sampling Location

(SOURCE: MODIFIED FROM DAMES & MOORE, 1992a)

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FIGURE 1-36

PROPOSED SAMPLING LOCATIONS

- Boring 68SB3 will be located down gradient of the former tank locations to assess potential constituent migration.

To meet the objectives of the soil screening at SWMU 68 outlined above and to fill data gaps identified in Section 1.5.5:

- One surface sample will be collected from each boring (i.e., 0 to 6 inches bgs below gravel, vegetative, or organic layers and 6 to 12 inches bgs for VOCs) to assess the fill placed above the native soil;

- Two subsurface soil samples will be collected from each boring, with one from the fill/native interface (approximately 4 to 5 ft bgs) and one from the terminational zone (above the groundwater table or top of bedrock); and

- Each soil sample will be analyzed for TCL VOCs, TCL SVOCs, PAHs, explosives (including nitroglycerin), and TAL Inorganics. One surface soil sample will be analyzed for TCL Pesticides and TCL PCBs, consistent with the requirements of the MWP QAP and Section 2.0 of this WPA.

Stratigraphic logs will be prepared for each boring location in accordance with the procedures outlined in SOP 10.3 in Appendix A.

Two samples will be collected and analyzed for the physical properties TOC, grain size, specific gravity, percent moisture, and bulk density in accordance with the QAPA in Section 2.0 of this document.

1.9 SWMU 69 – POND BY CHROMIC ACID TREATMENT TANKS

1.9.1 Site Background – Environmental Setting



Physiography – SWMU 69 is located in the western section of the HSA approximately 20 feet down gradient and west from SWMU 68. SWMU 69 is a slightly depressed grassy area with moderately sloping topography at an elevation of approximately 1,790 ft msl sloping towards a wooded area to the west (Figure 1-37). Historically related buildings are located to the southeast and several unrelated overhead pipes and associated appurtenances lie between SWMU 68 and SWMU 69.

Surface Water – Surface water in the area of SWMU 69 was observed during the SSP site visit to flow west-southwest toward a perennial stream of the New River. The stream flows north-northwest and discharges into the New River approximately 1,400 feet from SWMU 69 (Dames and Moore 1992a). Manholes, catch basins, storm drains, or other drainage pathways have not been associated with SWMU 69.

Geology and Soil – SWMU 69 is underlain by the Braddock loam soil. This soil has moderate permeability and is acidic-to-strongly acidic (IT 2002a). Site-specific data regarding subsurface conditions at SWMU 69 have not been collected. Data collected by ICF Kaiser (ICF Kaiser 1998) indicate surface soil consists of a yellow-orange to light brown mixture of sand, silt, and clay with a trace of gravel. Investigations at other SWMUs in similar settings at RFAAP indicate the presence of unconsolidated alluvium consisting of sand and silt with some silt and gravel. The soil overlies the fractured interbedded siltstone, limestone, and dolostone of the Elbrook Formation.

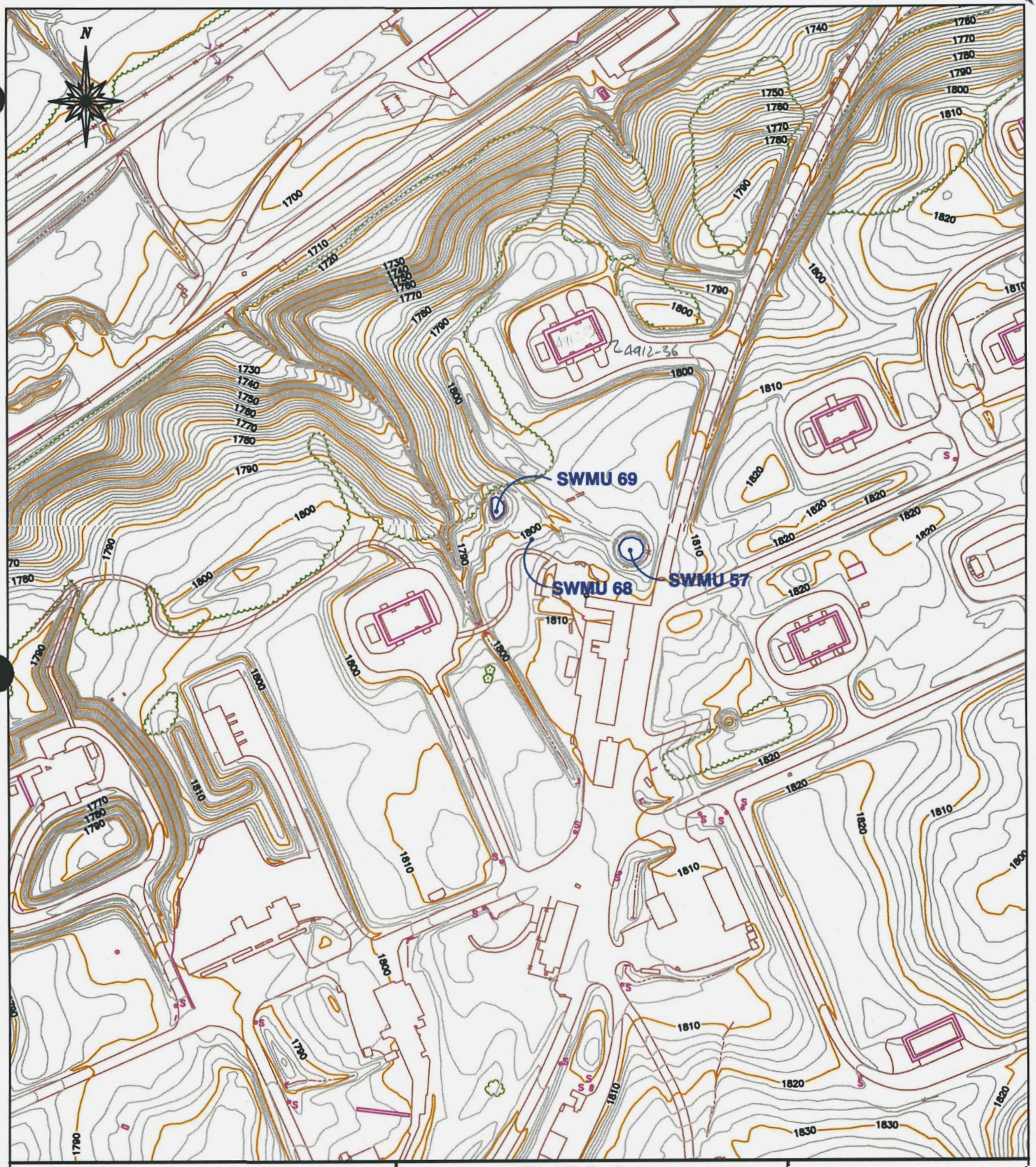
Based on Figure 4-1 of the Current Conditions Report (IT 2002a) several overlapping photolineaments are present near SWMU 69.

Groundwater – Site-specific data regarding hydrogeologic conditions at SWMU 69 have not been collected. Based on a similar geomorphic setting to other SWMUs at RFAAP, groundwater is likely present near the overburden-bedrock interface, follows topography, flows northwestward, and may discharge into the New River.

Tanks and Structures – No other related tanks or structures are located on or near SWMU 69.

1.9.2 Site Background – History

This area was once a shallow settling pond that collected treated wastewater containing chromium hydroxide sludge from SWMU 68, the Chromic Acid Treatment Tanks (Hercules 1958). The pond was bermed and approximately 1 to 2 feet deep. The supernatant from SWMU 69 discharged to a perennial stream flowing to the New River (Hercules 1958).





VICINITY MAP
N.T.S.

0 200

1 inch = 200 feet

(SOURCE: MODIFIED FROM HERCULES, INC., 1992)

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FIGURE 1-37

SITE TOPOGRAPHY LAYOUT

In accordance with the recommendations included in the VI Report for SWMU 69, interim measures were undertaken and SWMU 69 underwent closure including removal of impacted soil (Dames & Moore 1994; Appendix C). A SWMU 69 Closure Report was prepared by Dames & Moore and submitted by RFAAP to the USEPA Region III and the VDEQ. This closure and characterization resulted in approximately 700 cubic yards of material being excavated and disposed at Fly Ash Landfill #2 located at RFAAP. After confirmatory sampling was completed, the site was restored with clean fill supplied by RFAAP and graded to reestablish the preexisting drainage course.

1.9.3 Previous Investigations

The following section reviews previous site investigations emphasizing the usability of collected data and the screening of historical data with respect to current criteria (i.e., current RBCs and BTAGs).

1.9.3.1 Verification Investigation – 1992

In 1992, Dames and Moore collected one sediment sample (69SE1) and one surface water sample (69SW1) from the pond to "evaluate whether the pond (SWMU 69) received hazardous constituents from past discharges from the chromium tanks at SWMU 68 (Dames and Moore 1992a)." Two surface soil samples (69SS1 and 69SS2; Figure 1-38) also were collected from an area down gradient, which "potentially may have been impacted by overflows from the pond (Dames and Moore 1992a)." Samples were analyzed for pH and TAL Metals.

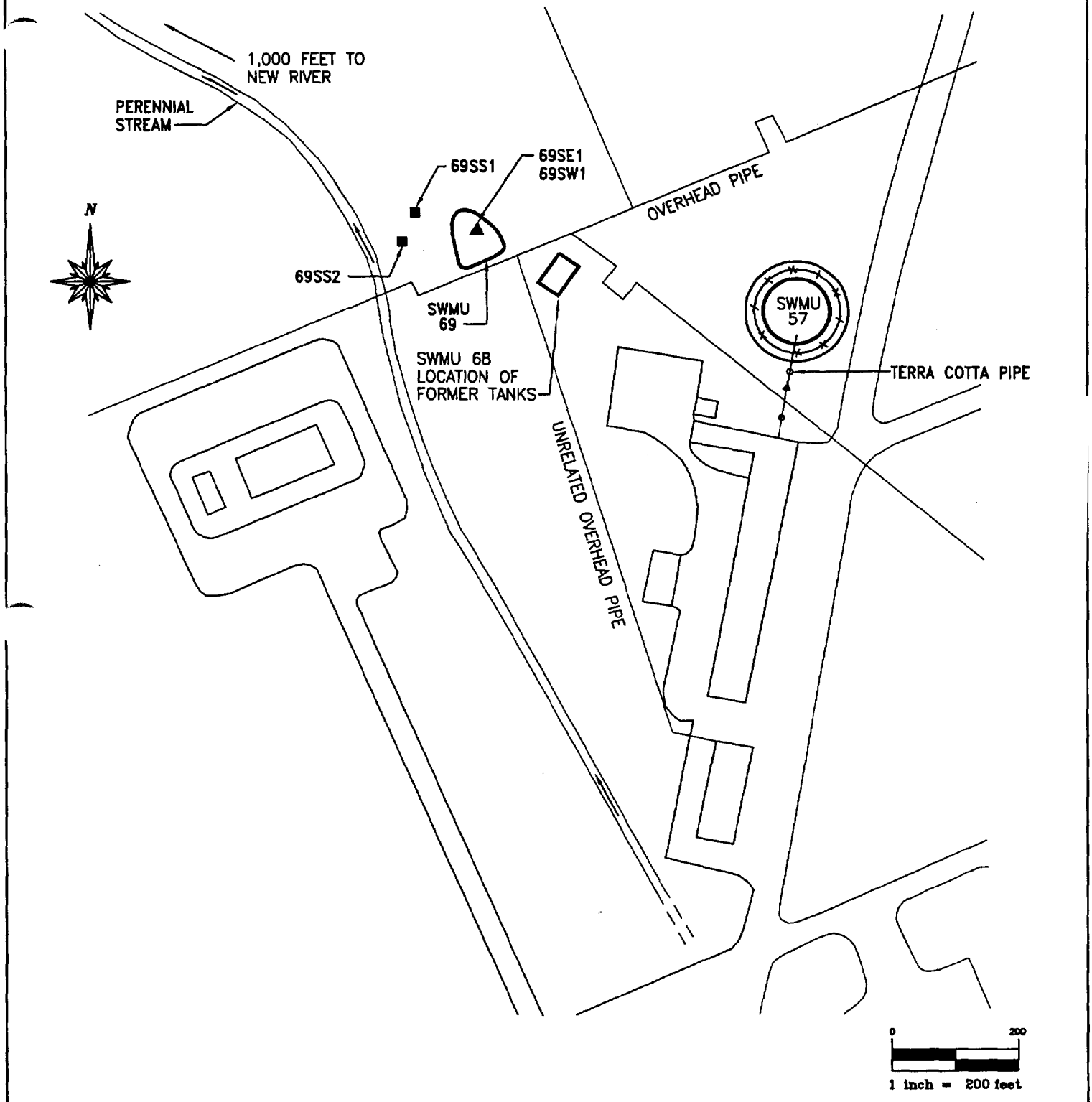
Soil – A review of the data indicates that reported concentrations of five TAL Metals, cadmium, chromium, lead, thallium, and zinc exceeded their respective facility-wide background point estimate concentrations for RFAAP soil. TAL Metals aluminum, antimony, arsenic, cadmium, chromium, iron, manganese, thallium, and zinc exceeded their respective April 2003 Residential Soil RBCs in at least one of the soil samples. Antimony, arsenic, and thallium exceeded their respective 2003 Industrial Soil RBCs in one or both samples. Sixteen metals were reported as exceeding their respective Draft BTAG screening level concentrations in one or both surface soil samples at SWMU 69 (Table 1-12).

Sediment – A review of the data indicates that seven TAL Metals, cadmium, chromium, copper, lead, nickel, thallium, and zinc exceeded their respective facility-wide background point estimate concentrations for RFAAP soil. Eleven TAL Metals exceeded (Table 1-13) their respective April 2003 Residential RBCs in sample 69SE1. TAL Metals antimony, arsenic, cadmium, chromium, iron, lead, and thallium exceeded their respective April 2003 Industrial Soil RBC concentrations. In addition, nine TAL Metals were reported exceeding their BTAG screening criteria at sample 69SE1.

Surface Water – Results indicate that 12 metals exceeded their respective 2003 Tap Water RBCs and five metals (antimony, cadmium, chromium, copper, and lead) exceeded their MCLs in sample 69SW1 (Table 1-14). Results also indicate that eleven metals exceeded their respective BTAG screening level concentrations.

1.9.3.2 Review of EPIC Aerial Photo Assessment Report – 1992

Activity at SWMU 69 was first noted on a 1962 aerial photograph. The 1962 photograph indicated the presence of a "probable lagoon containing liquid (USEPA 1992)." This area remained unchanged through the 1986 photograph (USEPA 1992).



LEGEND

■ Soil Sample

Surface Water/Sediment Sample

(SOURCE: MODIFIED FROM DAMES & MOORE, 1992a)

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SSP WORK PLAN ADDENDUM: SWMU 69

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FIGURE 1-38

SWMU LAYOUT MAP

Table 1-12
Summary of Analytical Data for Soil Samples Collected at SWMU 69
Modified from Dames and Moore Verification Investigation Report
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

SITE ID FIELD ID SAMPLE DATE DEPTH (ft bgs) MATRIX UNITS	PQLs mg/kg	69SS1 RVFS*62 10-Feb-92 0.5 CSO mg/kg	69SS2 RVFS*63 10-Feb-92 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
TAL Inorganics							
Aluminum	14.1	**10,500**	**9,340**	102,200	7,821	1	40,041
Antimony	20	**859**	**25.3**	40.9	3.13	0.48	--
Arsenic	30	**3.27**	**6.03**	1.91	0.43	328	15.8
Barium	1	138	92.7	7,154	548	440	209
Beryllium	0.2	**0.981**	<0.5	204	16	0.02	1.02
Cadmium	2	**31**	**3.73**	102	7.82	2.5	0.69
Calcium	100	4,930B	1,620B	--	--	--	--
Chromium[1]	4	**159**	**145**	307	23.0	0.0075	65.3
Cobalt	3	9.98	6.49	2,044	156	100	72.3
Copper	7	**26.6**	14.7	4,088	313	15	53.5
Iron	1000	**20,600**	**19,100**	30,660	2,346	12	50,962
Lead[2]	2	**307**	**162**	1,000	400	0.01	26.8
Magnesium	50	6,430	972	--	--	4,400	--
Manganese[3]	0.275	**765**	**766**	2,044	156	330	2,543
Mercury[4]	0.1	**0.117**	<0.05	30.7	2.35	0.058	0.13
Nickel	3	**46.6**	**11.7**	2,044	156	2	62.8
Potassium	37.5	868	710	--	--	--	--
Silver	4	**0.919**	<0.589	511	39	0.0000098	--
Sodium	150	334B	208B	--	--	--	--
Thallium	20	**10.6**	<6.62	7.15	0.547	0.001	2.11
Vanadium	0.775	**36.3**	**36.6**	715	54.8	0.5	108
Zinc	30.2	**2,500**	**261**	30,660	2,346	10	202

Notes:

B = Analyte was detected in corresponding method blank; values are flagged if the sample concentration is less than ten (10) times the method blank concentration for common laboratory constituents and five (5) times for all other constituents

BTAG = USEPA Region III Draft, Biological Technical Assistance Group Screening Level

CSO = Chemical soil

ft bgs = Feet below ground surface

mg/kg = Milligrams per kilogram

PQL = Practical quantitation limit; the lowest concentration that can be reliably detected at a defined level of precision for a given analytical method

TAL = Target Analyte List

RBC = Risk-Based Concentration

USEPA = United States Environmental Protection Agency

USEPA Region III Risk-Based Concentration (RBC) values from the April 25, 2003 RBC Table

Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens

[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 was used

[A] = Facility-Wide Background Point Estimate as Reported in the Facility-Wide Background Study Report (IT 2002b)

bold = Concentration exceeds Industrial RBC

= Concentration exceeds Residential RBC

= Concentration exceeds Draft BTAG Screening Level

underline = Concentration exceeds Facility-Wide Background Point Estimate

Table 1-13
Summary of Analytical Data for Sediment Sample Collected at SWMU 69
Modified from Dames and Moore Verification Investigation Report
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

SITE ID FIELD ID SAMPLE DATE DEPTH (ft bgs) MATRIX UNITS	PQLs mg/kg	69SE1 RVFS*61 10-Feb-92 0.5 CSE 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 Inorganics						
Aluminum	14.1	10,900	102,200	7,821	--	40,041
Antimony	20	**178**	40.9	3.13	150	--
Arsenic	30	**2.13**	1.91	0.43	0.057	15.8
Barium	1	165	7,154	548	--	209
Cadmium	2	**610**	102	7.82	1.2	0.69
Calcium	100	50,200	--	--	--	--
Chromium[1]	4	**2,040**	307	23.0	0.005	65.3
Cobalt	3	20.7	2,044	156	--	72.3
Copper	7	**818**	4,088	313	34	53.5
Iron	1000	**34,500**	30,660	2,346	--	50,962
Lead[2]	2	**1,330**	1,000	400	46.7	26.8
Magnesium	50	2,200	--	--	--	--
Manganese[3]	0.275	621	2,044	156	--	2,543
Nickel	3	**77**	2,044	156	20.9	62.8
Potassium	37.5	522	--	--	--	--
Silver	4	**3.03**	511	39	1	--
Sodium	150	7,990	--	--	--	--
Thallium	20	**18.5**	7.15	0.547	--	2.11
Vanadium	0.775	25.1	715	54.8	--	108
Zinc	30.2	**10,000**	30,660	2,346	150	202

Notes:

BTAG = USEPA Region III Draft, Biological Technical Assistance Group Screening Level

CSE = Chemical sediment

ft bgs = Feet below ground surface

mg/kg = Milligrams per kilogram

PQL = Practical quantitation limit; the lowest concentration that can be reliably detected at a defined level of precision for a given analytical method

TAL = Target Analyte List

RBC = Risk-Based Concentration

USEPA = United States Environmental Protection Agency

USEPA Region III Risk-Based Concentration (RBC) values from the April 25, 2003 RBC Table

Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens

[1] = Chromium VI RBC value used

[2] = Lead criteria are Action Levels; see USEPA Region III guidance

[3] = Manganese-nonfood RBC value used

[A] = Facility-Wide Background Point Estimate as Reported in the Facility-Wide Background Study Report (IT 2002b)

bold = Concentration exceeds Industrial RBC

= Concentration exceeds Residential RBC

= Concentration exceeds Draft BTAG Screening Level

underline = Concentration exceeds Facility-Wide Background Point Estimate

Table 1-14
Summary of Analytical Data for Surface Water Samples at SWMU 69
Modified from Dames and Moore Verification Investigation Report
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

SITE ID FIELD ID SAMPLE DATE DEPTH (ft bgs) MATRIX UNITS	PQLs µg/L	69SW1 RDWD*2 10-Feb-92 0.0 CSW µg/L	Adjusted Tap Water RBC µg/L	MCL µg/L	Draft BTAG Screening Level µg/L
TAL Metals					
Aluminum	141	**9,800**	3,650	--	25
Antimony	30	**269**	1.5	6	30
Arsenic	10	3.62	0.045	10	48
Barium	20	159	256	2,000	10,000
Cadmium	1	**2,540**	2	5.0	0.53
Calcium	500	268,000	--	--	--
Chromium[1]	10	**25,000**	11.0	100	2
Cobalt	70	1,640	73.0	--	35,000
Copper	60	**1,450**	146	1,300 [AL]	6.5
Iron	38.1	**650,000**	1,100	--	320
Lead	10	**7,900**	--	15 [AL]	3.2
Magnesium	500	29,300	--	--	--
Manganese[2]	2.75	**25,300**	73	--	14,500
Nickel	50	**120,000**	73	--	160
Potassium	375	3,210	--	--	--
Silver	2	**5.83**	18.3	--	0.0001
Sodium	500	950,000	--	--	--
Vandium	40	161	25.6	--	10,000
Zinc	50	**61,000**	1,095	--	30

Notes:
BTAG = USEPA Region III Draft, Biological Technical Assistance Group Screening Level
CSW = Chemical surface water
ft bgs = Feet below ground surface
MCL = Maximum Contaminant Level
PQL = Practical quantitation limit; the lowest concentration that can be reliably detected at a defined level of precision for a given analytical method
TAL = Target Analyte List
RBC = Risk-Based Concentration
USEPA = United States Environmental Protection Agency
USEPA Region III Risk-Based Concentration (RBC) values from the April 25, 2003 RBC Table
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
µg/L = Microgram Per Liter
[AL] = Action Level
[1] = Chromium VI RBC value used
[2] = Manganese-nonfood RBC value used

= Concentration exceeds Tap Water RBC

= Concentration exceeds MCL

= Concentration exceeds Draft BTAG Screening Level

bold = Concentration exceeds both the Tap Water RBC and MCL

1.9.3.3 Closure Report, SWMU 69, Pond by Chromic Acid Treatment Tanks – 1994

Additional investigation was conducted to further delineate soil. X-ray florescence (XRF) was selected to delineate the limits of the area to be investigated. Lead was selected as the indicator for field screening of soil due to concentrations present in the pond sediment (Dames and Moore 1994). The delineation activities consisted of test pitting, on-site sampling and analysis, confirmatory sampling and analysis, and backfilling and grading operations.

Eight soil samples were collected from the test pit after the soil was removed. One sample (69SO1) was collected from the center of the south wall of the test pit and seven samples (69SO2 through 69SO8) were collected from the floor of the test pit (Figure 1-39). These samples were analyzed for TAL Metals and full TCLP analyses to confirm the XRF screening data. Results reported indicate that the lead impacted soil had been identified and removed.

As shown on Table 1-15, eight soil samples were analyzed for TAL Metals. A review of the data indicates lead values do not exceed the 2003 Action Level. Seven TAL metals (beryllium, cadmium, chromium, iron, lead, thallium, and zinc) exceeded facility-wide background point estimates. TAL Metals, aluminum, antimony, arsenic, cadmium, chromium, iron, manganese, thallium, and vanadium were present above their respective April 2003 Residential Soil RBCs. Concentrations of antimony, arsenic, chromium, iron, and thallium were present above their respective April 2003 Industrial Soil RBCs. Results indicate that fifteen TAL Metals were above their respective Draft BTAG screening level concentrations in one or more of the soil samples at SWMU 69. A review of the TCLP data indicated detections did not exceed TCLP criteria.

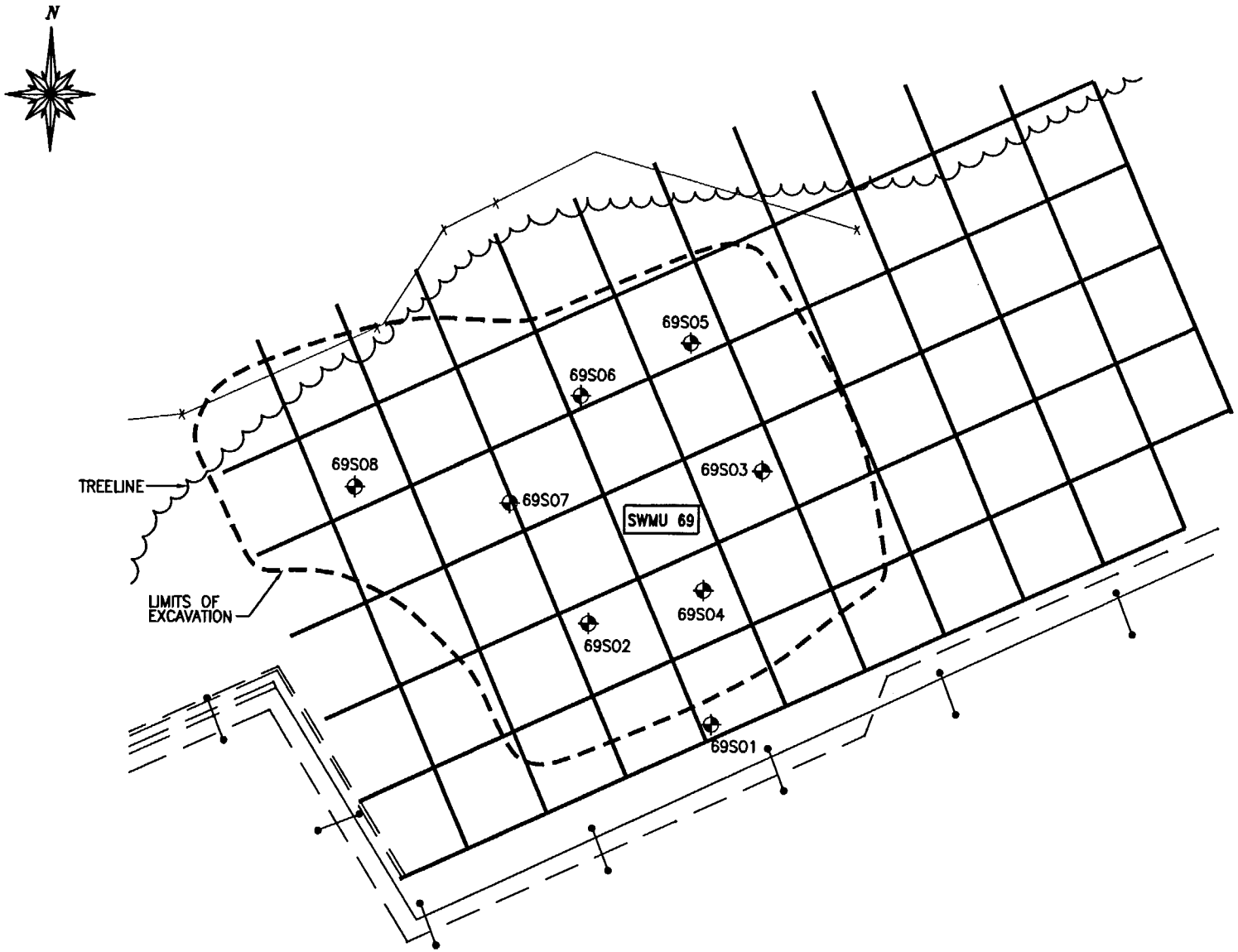
At the completion of sampling, the test pit was backfilled with clean fill as supplied by RFAAP (Dames and Moore 1994).

1.9.3.4 New River and Tributaries Study – 1997

The objective of the New River and Tributaries Study was to provide data for migration pathways along the river and tributaries to assess adverse impacts to human health and the environment (Parsons 1997). One sediment sample (NRSE16) was collected from the "unnamed tributary" downstream of SWMUs 57, 68, and 69 to assess potential impacts from these SWMUs. The sample was analyzed for VOCs, SVOCs, Pesticides, PCBs, and TAL Metals. Sample results indicate that four metals (aluminum, chromium, iron, and manganese) were reported present above their respective 2002 Residential RBCs. Arsenic exceeded (5.1 mg/kg) its 2002 Industrial RBC (3.8 mg/kg). Results indicate ten TAL Metals exceeded their respective BTAG screening level concentrations in sediment sample NRSE16.

1.9.4 Conceptual Site Model

A CSM for SWMU 69 is presented in Figure 1-40. Subsurface geology is shown as an upper layer of sands, silts, and clays with increasing gravels present with depth overlying the Elbrook Formation. Potentially affected media include surface water, groundwater, and surface and subsurface soil. Overflows of the pond may have potentially resulted in constituent migration to surface water drainage ditches down gradient of the pond area. The area surrounding the former pond is maintained grass with surface water runoff flowing first southwest in a well-defined drainage ditch and then north-northwest in an unnamed tributary to the New River. Pond wastewater and sludge may have potentially impacted the remaining subsurface soil through leaching of constituents into site soil.



LEGEND

Sample Location

Limits of Excavation

XRF Sampling Grid

(SOURCE: MODIFIED FROM DAMES & MOORE, 1'

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SSP WORK PLAN ADDENDUM: SWMU 69

Date:	Prepared By:
OCTOBER 2002	KDC/DR
Scale:	File Name:
AS SHOWN	09604-317-155

FIGURE 1-39

SOIL SAMPLE LOCATIONS

Table 1-15

Summary of Analytical Data for Sediment and Confirmatory Soil Samples Collected at SWMU 69
Modified from Dames and Moore Closure Report SWMU 69 - Pond by Chromic Acid Treatment Tanks
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

SITE ID		69SE2	69SL1	69SO1	69SO2	69SO3	Adjusted Soil Industrial RBC	Adjusted Soil Residential RBC	Draft BTAG Screening Level (Soil/Sediment)	Facility-Wide Background Point Estimates[A]
FIELD ID		RDSW*27	RDSW*28	RDSX*17	RDSX*18	RDSX*19				
SAMPLE DATE		28-Apr-94	29-Apr-94	2-May-94	3-May-94	3-May-94				
DEPTH (ft bgs)		3.0	3.0	5.0	0.5	0.5				
MATRIX	PQLs	CSE	CSE	CSO	CSO	CSO				
UNITS	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	9,500	11,200	30,500	25,300	31,300	102,200	7,821	1/--	40,041
Antimony	20	60.5	83.4	64.2	<7.14	<7.14	40.9	3.13	0.48/150	--
Arsenic	30	1.21	1.77	3.01	3.94	4.79	1.91	0.43	328/0.057	15.8
Barium	1	62.3	90.9	40.6	43.1	45.4	7,154	548	440/--	209
Beryllium	0.2	0.694	1.05	1.49	2.34	2.60	204	15.6	0.02/--	1.02
Cadmium	2	<0.7	65.1	8.79	<0.7	<0.7	102	7.8	2.5/1.2	0.69
Calcium	500	4,480	12,800	3,350	577	1,120	--	--	--	--
Chromium[1]	4	75.9	443	50.9	29.9	51.7	307	23.5	0.0075/0.005	65.3
Cobalt	3	3.14	8.7	5.84	7.41	19.7	2,044	156	100/--	72.3
Copper	7	7.04	43.7	21.6	21.3	28.7	4,088	313	15/34	53.5
Iron	1000	16,200	22,600	38,700	44,600	46,500	30,660	2,346	12/--	50,962
Lead[2]	2	<10.5	169	<10.5	<10.5	<10.5	1,000	400	0.01/46.7	26.8
Magnesium	50	966	997	1,320	4,720	2,350	--	--	4,400/--	--
Manganese[3]	0.275	345	647	328	81.8	132	2,044	156	330/--	2,543
Mercury[4]	0.1	<0.05	0.0703	0.122	<0.05	<0.05	31	2.3	0.058/0.15	0.13
Nickel	3	13.2	27.5	25.6	29.9	32.7	2,044	156	2/20.9	62.8
Potassium	37.5	919	769	1,410	2,620	1,720	--	--	--	--
Selenium	40	<0.5	1.1	<0.5	<0.5	<0.5	511	39	2/--	--
Silver	4	<0.589	<0.589	<0.589	<0.589	<0.589	511	39.1	0.000098/1	--
Sodium	150	1,430	4,020	4,860	3,990	4,500	--	--	--	--
Thallium	4	<6.62	33.2	39.1	44.9	49.5	7.15	0.548	0.001/--	2.11
Vanadium	0.775	31.9	43.4	64.8	84.9	68.9	715	54.8	0.5/--	108
Zinc	30.2	160	1,110	119	28.2	32.7	30,660	2,346	10/150	202

Table 1-15 (Continued)
Summary of Analytical Data for Sediment and Confirmatory Soil Samples Collected at SWMU 69
Modified from Dames and Moore Closure Report SWMU 69 - Pond by Chromic Acid Treatment Tanks
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

SITE ID		69SO4	69SO5	69SO6	69SO7	69SO8	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
FIELD ID		RDSX*20	RDSX*21	RDSX*22	RDSX*23	RDSX*24				
SAMPLE DATE		3-May-94	3-May-94	3-May-94	3-May-94	3-May-94				
DEPTH (ft bgs)		0.5	0.5	0.5	0.5	0.5				
MATRIX	PQLs	CSO	CSO	CSO	CSO	CSO				
UNITS	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg				
TAL Metals										
Aluminum	14.1	31,700	27,500	23,600	11,400	12,700	102,200	7,821	1	40,041
Antimony	20	24	21.2	<7.14	<7.14	9.91	40.9	3.13	0.48	--
Arsenic	30	3.16	7.98	2.78	2.44	2.7	1.91	0.43	328	15.8
Barium	1	58.3	47.2	53.5	33.4	38	7,154	548	440	209
Beryllium	0.2	2.51	2.89	2.89	1.05	1.06	204	15.6	0.02	1.02
Cadmium	2	<0.7	6.9	<0.7	<0.7	<0.7	102	7.8	3	0.69
Calcium	500	1,530	604	1,110	214	556	--	--	--	--
Chromium[1]	4	56.7	75.2	41.6	38.2	29.5	307	23.5	0.0075	65.3
Cobalt	3	6.94	9.25	9.69	5.76	10.4	2,044	156	100	72.3
Copper	7	32.4	27.3	25.6	9.12	9.84	4,088	313	15	53.5
Iron	1000	49,500	51,500	43,000	23,600	21,900	30,660	2,346	12	50,962
Lead[2]	2	<10.5	24.5	<10.5	<10.5	18.3	1,000	400	0.01	26.8
Magnesium	50	2,240	5,540	6,620	654	940	--	--	4,400	--
Manganese[3]	0.275	184	168	243	580	758	2,044	156	330	2,543
Mercury[4]	0.1	0.124	0.0801	<0.05	0.0701	0.0674	31	2.3	0.058	0.13
Nickel	3	29.4	29.9	25.9	6.86	5.87	2,044	156	2	62.8
Potassium	37.5	1,850	3,400	3,260	767	781	--	--	--	--
Selenium	40	<0.5	1	<0.5	<0.5	<0.5	511	39	2	--
Silver	4	<0.589	<0.589	<0.589	<0.589	<0.589	511	39.1	0.000098	--
Sodium	150	4,770	4,720	3,730	2,540	1,400	--	--	--	--
Thallium	4	53.1	54.6	62.6	27.5	22.3	7.15	0.548	0.001	2.11
Vanadium	0.775	89.8	74.7	83	49.5	47.5	715	54.8	0.5	108
Zinc	30.2	69.1	140	46.8	22.4	33	30,660	2,346	10	202

Notes:

BTAG = USEPA Region III Draft, Biological Technical Assistance Group Screening Level

CSE = Chemical sediment

CSO = Chemical soil

ft bgs = Feet below ground surface

mg/kg = Milligrams per kilogram

PQL = Practical quantitation limit; the lowest concentration that can be reliably detected at a defined level of precision for a given analytical method

TAL = Target Analyte List

RBC = Risk-Based Concentration

USEPA = United States Environmental Protection Agency

USEPA Region III Risk-Based Concentration (RBC) values from the April 25, 2003 RBC Table

Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens

(A) = Facility-Wide Background Point Estimate as Reported in the Facility-Wide Background Study Report (IT 2002b)

(1) = Chromium VI RBC value used

(2) = Lead criteria are Action Levels; see USEPA Region III guidance

(3) = Manganese-nonfood RBC value used

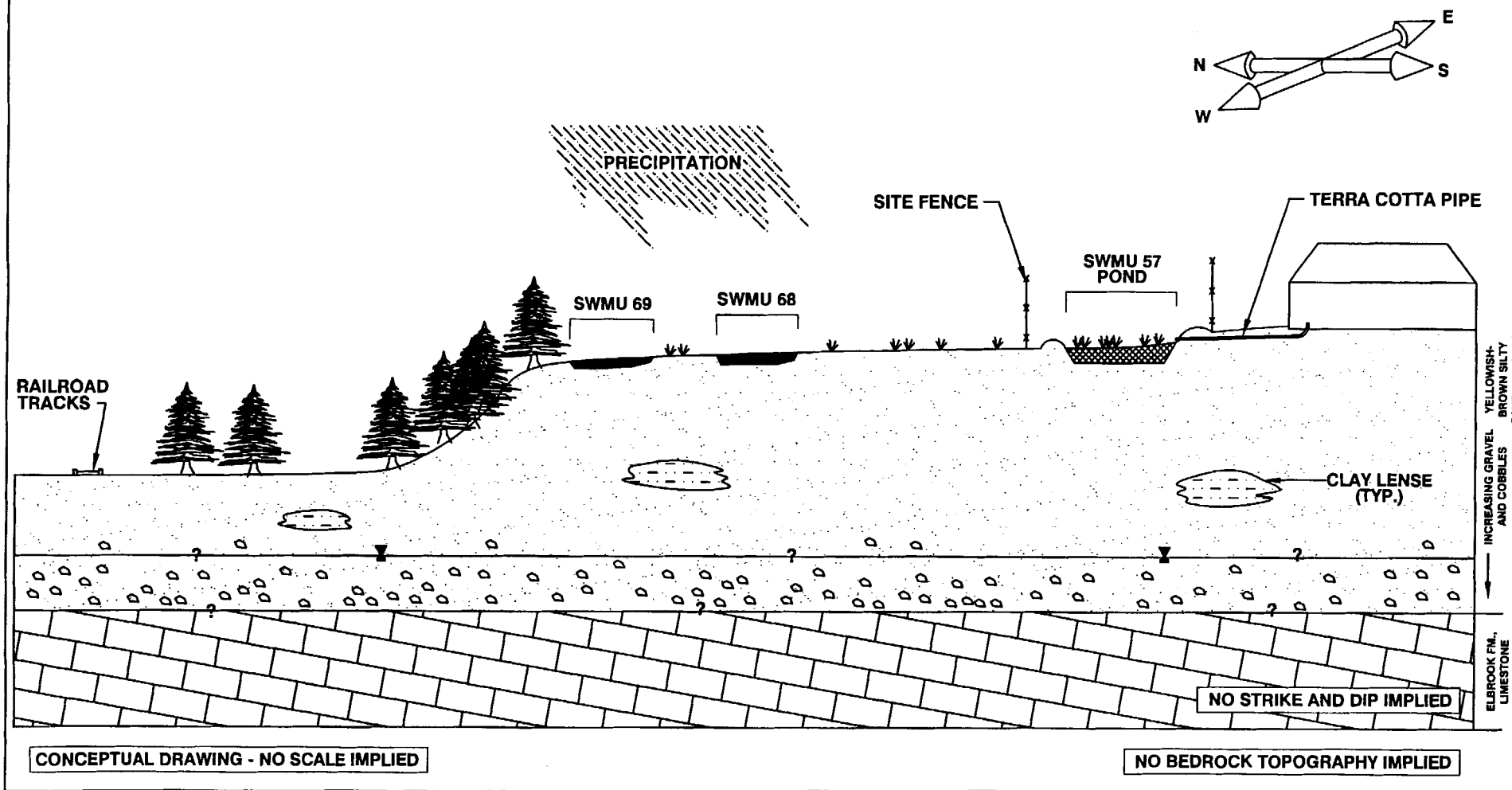
(4) = Mercuric chloride RBC value used

bold = Concentration exceeds Industrial RBC

= Concentration exceeds Residential RBC

= Concentration exceeds Draft BTAG Screening Level

underline = Concentration exceeds Facility-Wide Background Point Estimate



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SSP WORK PLAN ADDENDUM: SWMU 69

Date: *OCTOBER 2002*	**Prepared By:** *KDC/DR*
Scale: *NO SCALE*	**File Name:** *09604-317-155*

FIGURE 1-40

CONCEPTUAL SITE MODEL FIGURE

Current and future land-use scenarios are limited to industrial operations. SWMU 69 is located within the Installation perimeter fence; therefore, potential receptors are limited to site workers, future construction workers, and terrestrial biota. Figure 1-41 presents the potential exposure pathways for each receptor. Direct deposition of wastewater is considered a release mechanism to surface soil. Site workers, construction workers, and terrestrial biota could contact surface soil. Leaching of constituents through site soil is considered a potential release mechanism to subsurface soil and subsurface soil may be received by construction workers.

1.9.5 Data Gap Analysis

TCL VOCs – TCL VOCs analysis has not been performed on previous samples. Therefore, TCL VOCs represent a data gap and will be analyzed in surface and subsurface soil.

TCL SVOCs/PAHs – TCL SVOC/PAH analysis has not been performed on previous samples. Therefore, TCL SVOC/PAH represents a data gap and will be analyzed in surface and subsurface soil.

TCL PCBs – TCL PCBs analysis has not been performed on previous samples. Therefore, TCL PCBs represent a data gap and will be analyzed in surface soil.

TCL Pesticides – TCL Pesticide analysis has not been performed on previous samples. Therefore, TCL Pesticides represent a data gap and will be analyzed in surface soil.

Explosives – Explosive analysis has not been performed on previous samples. Therefore, explosives represent a data gap and will be analyzed in surface and subsurface soil.

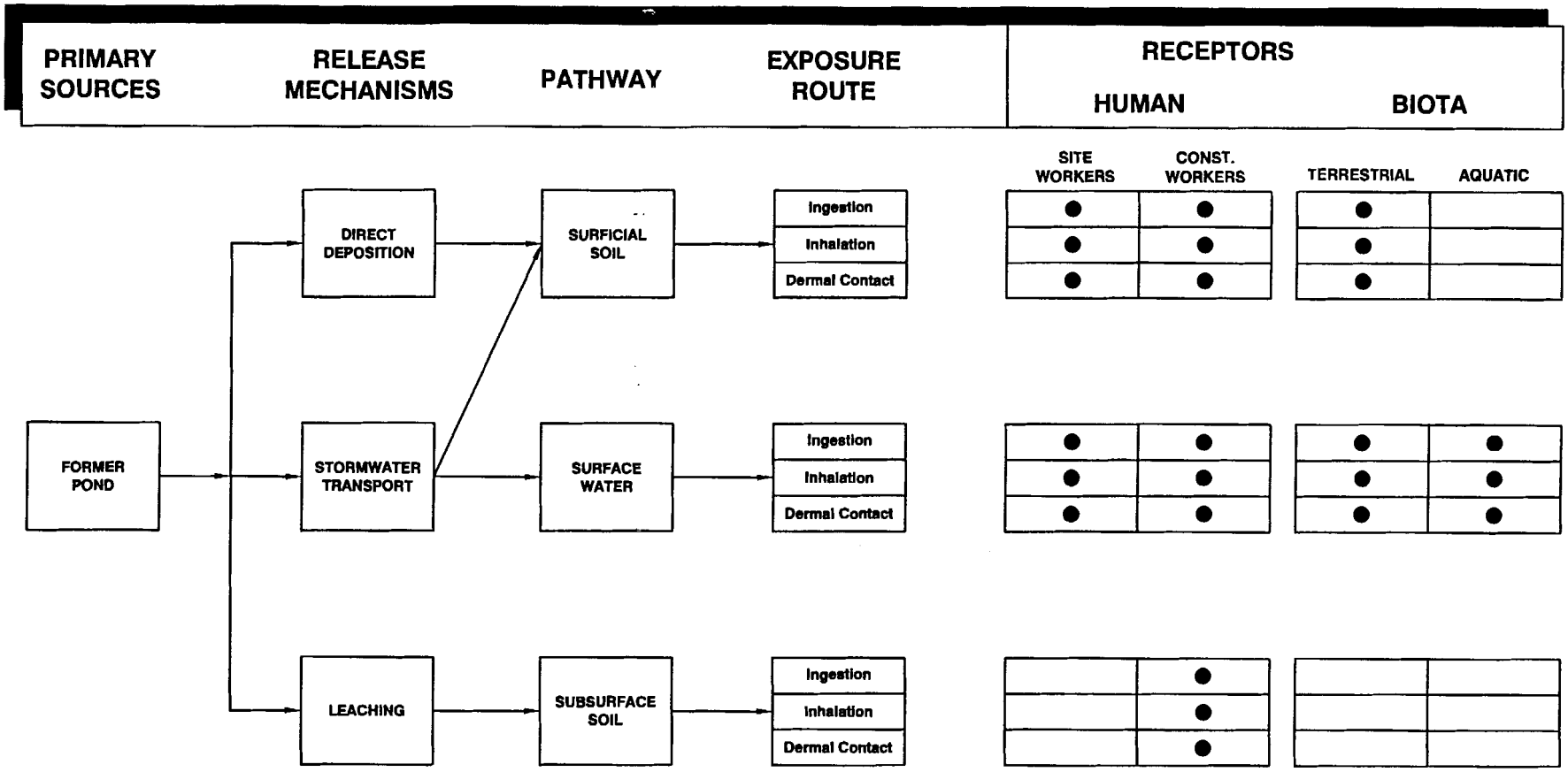
TAL Inorganics – Sediment, surface water, and surface soil samples collected from SWMU 69 during previous investigations were analyzed for TAL Metals and TCLP Metals. A review of the results indicates that TAL Inorganics are identified as COPCs at the site. Therefore, additional samples will be collected from the surface and subsurface soil to appropriately screen the site for SSP purposes.

Dioxins/furans – Dioxins/furans are not considered a data gap because SWMU 69 was not used for burning or storage/disposal of burned waste.

Other – An analysis of the physical properties of subsurface soil to aid in assessing the nature of possible constituent mobility has not been performed during the previous investigations. Therefore, soil samples will be analyzed for TOC, grain size, specific gravity, percent moisture, and bulk density to assess the mobility of constituents in soil.

1.9.6 Planned Field Activities

Based on the results of the data gap analysis, additional sampling and analysis is proposed to characterize this site for SSP purposes. Sampling locations were selected based on previous sample analytical results, site observations, and the CSM. Proposed analyses for various media types were identified by the results of the data gap analysis.



RFAAP

SSP WORK PLAN ADDENDUM: SWMU 69

Date: *OCTOBER 2002*	Prepared By: *KDC/DR*
Scale: *NO SCALE*	File Name: *09604-317-155*

FIGURE 1-41

CONCEPTUAL SITE MODEL DIAGRAM

1.9.6.1 Soil Borings

The following sections discuss proposed soil investigations to be conducted at SWMU 69 using the direct push method of boring advancement, as described in SOP 20.11 in Appendix A. A four-foot, Geoprobe Macro-Core® sampling device will be used to collect soil samples continuously from each of the borings, as described in SOP 20.11 in Appendix A. The location of each soil boring will be established to the nearest meter using GPS equipment.

Three soil borings will be advanced at SWMU 69 (69SB1, 69SB2, and 69SB3). Proposed sampling locations are presented on Figure 1-42. Soil borings will be advanced to the water table or bedrock, whichever is encountered first, using direct push technology consistent with the procedures outlined in SOP 20.11. During boring advancement, subsurface soil samples will be screened for the presence of volatile organic compounds using a PID consistent with SOP 90.1 included in Appendix A. Soil borings will be completed at the following locations:

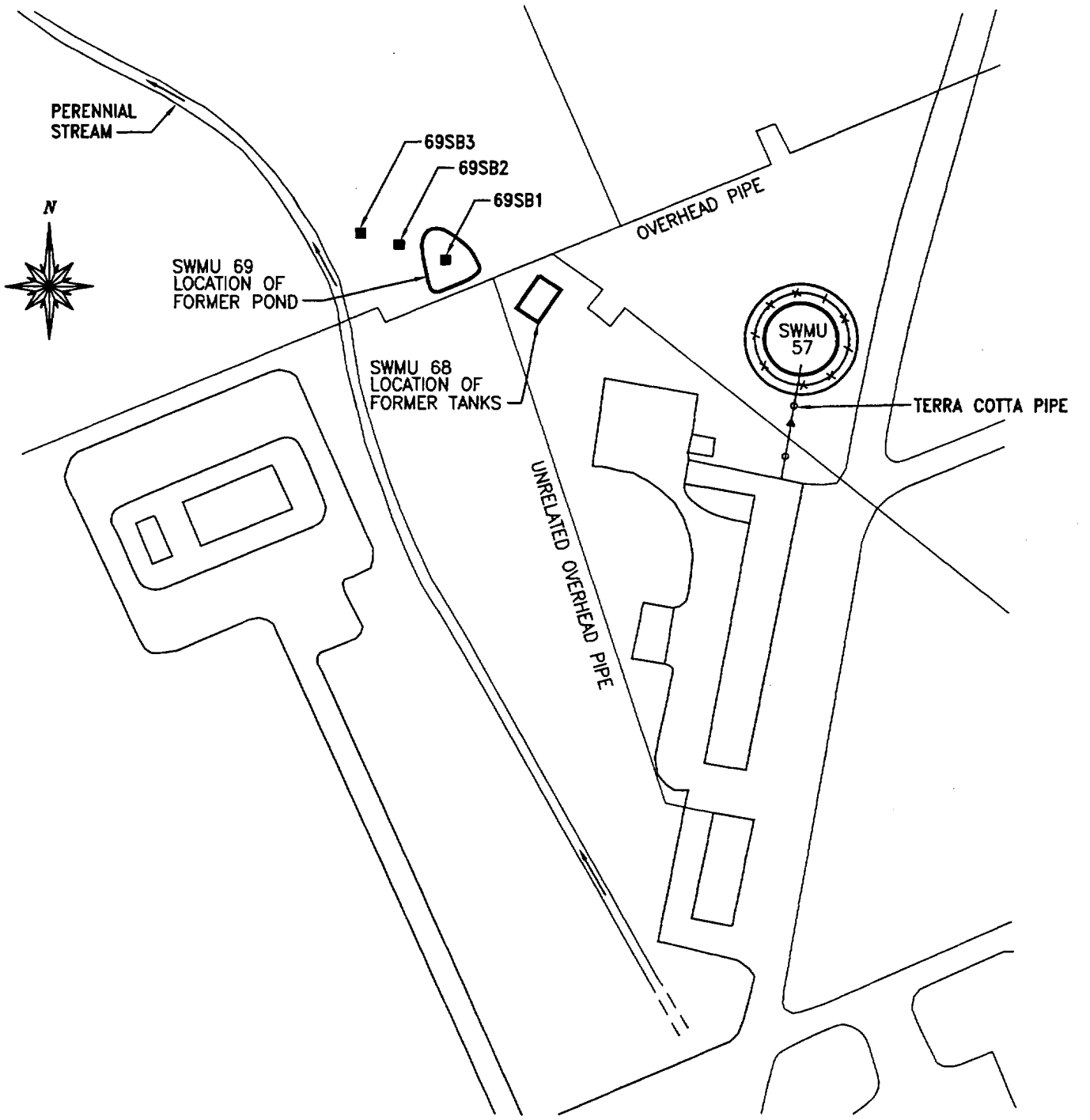
- Boring 69SB1 will be located within the limits of the former pond. This boring will assess previous pond investigation activities;
- Boring 69SB2 will be located down gradient of 69SB1 to evaluate if the down gradient area was impacted by overflow from the pond; and
- Boring 69SB3 will be located approximately 30 feet down gradient of the former pond. This boring will evaluate if this down gradient area was impacted by overflow from the pond and will provide data to evaluate potential constituent migration.

To meet the objectives of the soil screening at SWMU 69 outlined above and to fill data gaps identified in Section 1.6.5:

- One surface sample will be collected from each boring (i.e., 0 to 6 inches bgs below gravel, vegetative or organic layers and 6 to 12 inches bgs for VOCs) to assess the fill placed above the native soil (69SB1) and surface soil conditions at 69SB2 and 69SB3;
- Two subsurface soil samples will be collected from 69SB1, with one from the fill/native soil interface (depth unknown, will be field assessed) and one from the terminational zone (above the groundwater table or top of bedrock);
- Two subsurface soil samples will be collected from 69SB2 and 69SB3, with one from an intermediate zone (approximately 10 to 12 ft bgs) and one from the terminational zone (above the groundwater table or top of bedrock); and
- Each of the soil samples will be analyzed for TCL VOCs, TCL SVOCs, PAHs, explosives (including nitroglycerin), and TAL Inorganics. One surface soil sample will be analyzed for TCL Pesticides and TCL PCBs consistent with the requirements of the MQAP and Section 2.0 of this WPA.

Stratigraphic logs will be prepared for each boring location in accordance with the procedures outlined in SOP 10.3 in Appendix A.

Two soil samples will be collected and analyzed for the physical properties TOC, grain size, specific gravity, percent moisture, and bulk density in accordance with the QAPA in Section 2.0 of this document.



LEGEND

- ■ Proposed Sampling Location
- ▲ Surface Water/Sediment Sample

(SOURCE: MODIFIED FROM DAMES & MOORE, 1992a)

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SSP WORK PLAN ADDENDUM: SWMU 69

Date:	Prepared By:
OCTOBER 2002	*KDC/DR*
Scale:	**File Name:**
AS SHOWN	*09604-317-155*

FIGURE 1-42

PROPOSED SAMPLING LOCATIONS

1.10 AREA A – NITROCELLULOSE RAINWATER DITCH

1.10.1 Site Background – Environmental Setting



Physiography – Area A is located in the industrialized eastern portion of the MMA near several buildings. Area A lies in a relatively flat area of the MMA at an elevation of approximately 1800 ft msl (Figure 1-43). Area A was identified during the April 1987 Visual Site Inspection (VSI) as a one-foot deep soil depression that received runoff from the Nitrocellulose A-Line (USEPA 1987; Figure 1-44). The area was devoid of vegetation and discolored soil was observed during the 1987 VSI (USEPA 1987). During the August 2002 SSP site visit, the area was heavily vegetated and discolored soil was not observed. Several buildings, paved roads, and overhead lines are located near Area A.

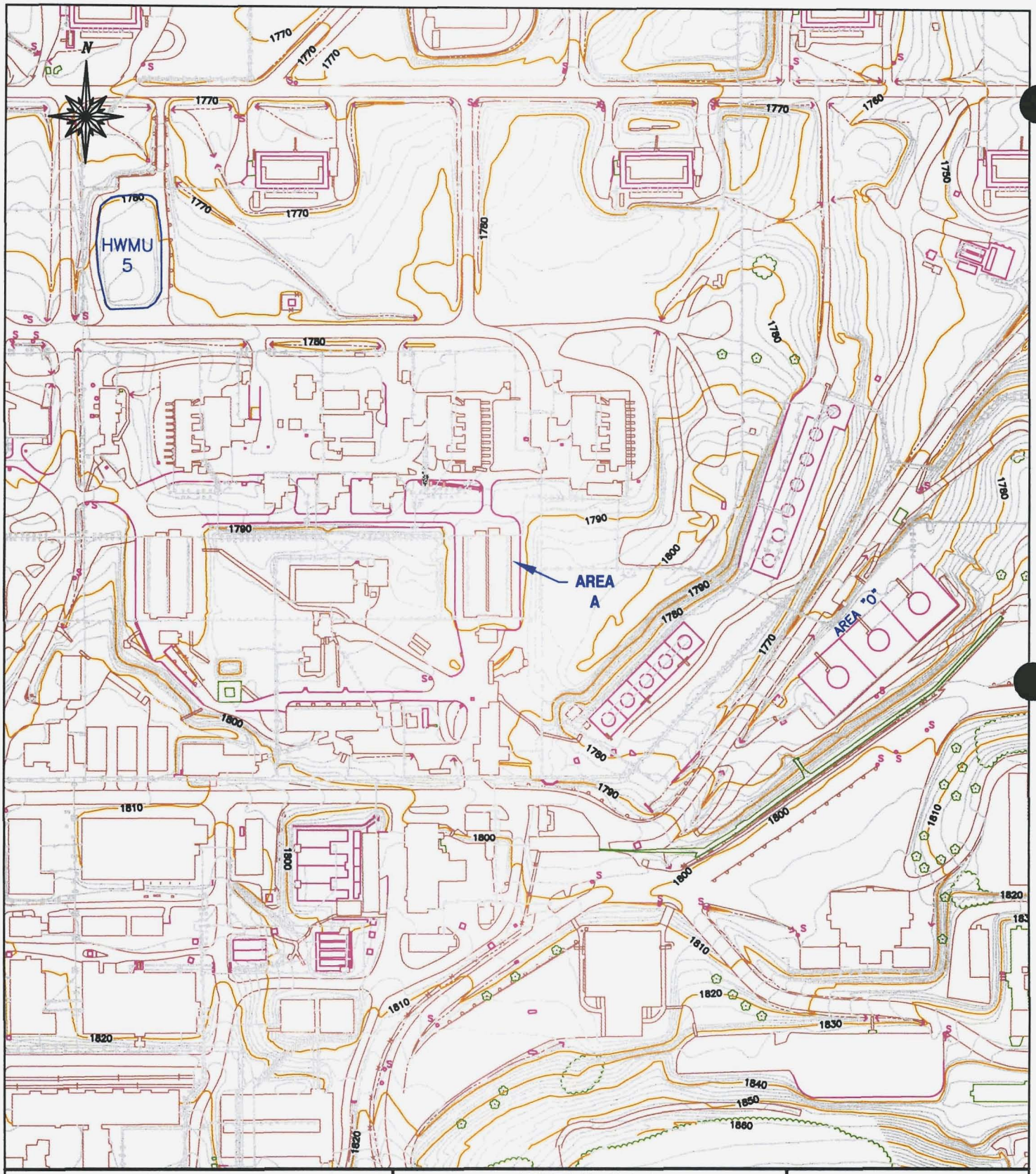
Surface Water – Based on topography, precipitation and run-on at Area A would flow from the area of surrounding buildings (A-line) and drain to the slightly depressed area (Area A). Water runoff appears to flow north along the depressed grassy area and percolate into the surface soil. Manholes are present north and south of Area A. No other surface water bodies, drainage ditches, manholes, catch basins, or other flow paths have been associated with Area A.

Geology and Soil – Area A is underlain by the Unison-Urban land complex soil. This soil has moderate permeability and is medium-to-strongly acidic (IT 2002b). Site-specific data regarding subsurface conditions at Area A have not been collected. Data have been collected from Area O located approximately 800 ft to the southeast of Area A. RFI boring data from Area O indicate the presence of unconsolidated alluvial deposits that are divided into two strata. The shallowest stratum consists of fine, brown to yellow-brown, plastic silt and clay. The second stratum is yellowish-brown silty clay or yellowish-brown clay with gravel and silt seams and is present below the first stratum and overlying the bedrock. These gravel are discontinuous in the area of Area O.

Underlying the two strata is the gray limestone/dolostone of the Elbrook Formation. The bedrock is argillaceous with frequent brecciated, conglomeratic, and vuggy zones. The bedrock is highly weathered and fractured with small quartz and calcite veins (Dames and Moore 1994). Based on Figure 4-1 of the Current Conditions Report (IT 2002a), several overlapping photolineaments are located near Area A.

Groundwater – Hydrogeologic conditions of Area O were investigated through field investigation and data collected from slug tests performed on three wells during the RFI. Groundwater monitoring data from Area O (Dames and Moore 1994) indicate that a relatively shallow water table exists from 2 to 24 ft bgs. Based on groundwater measurements obtained during the RFI, the water table slopes toward the northeast (Dames and Moore 1994b).

Tanks and Structures – Numerous un-related buildings, overhead lines, and tanks exist near Area A.



VICINITY MAP
N.T.S.

0 200
1 inch = 200 feet

(SOURCE: MODIFIED FROM HERCULES, INC., 1992)

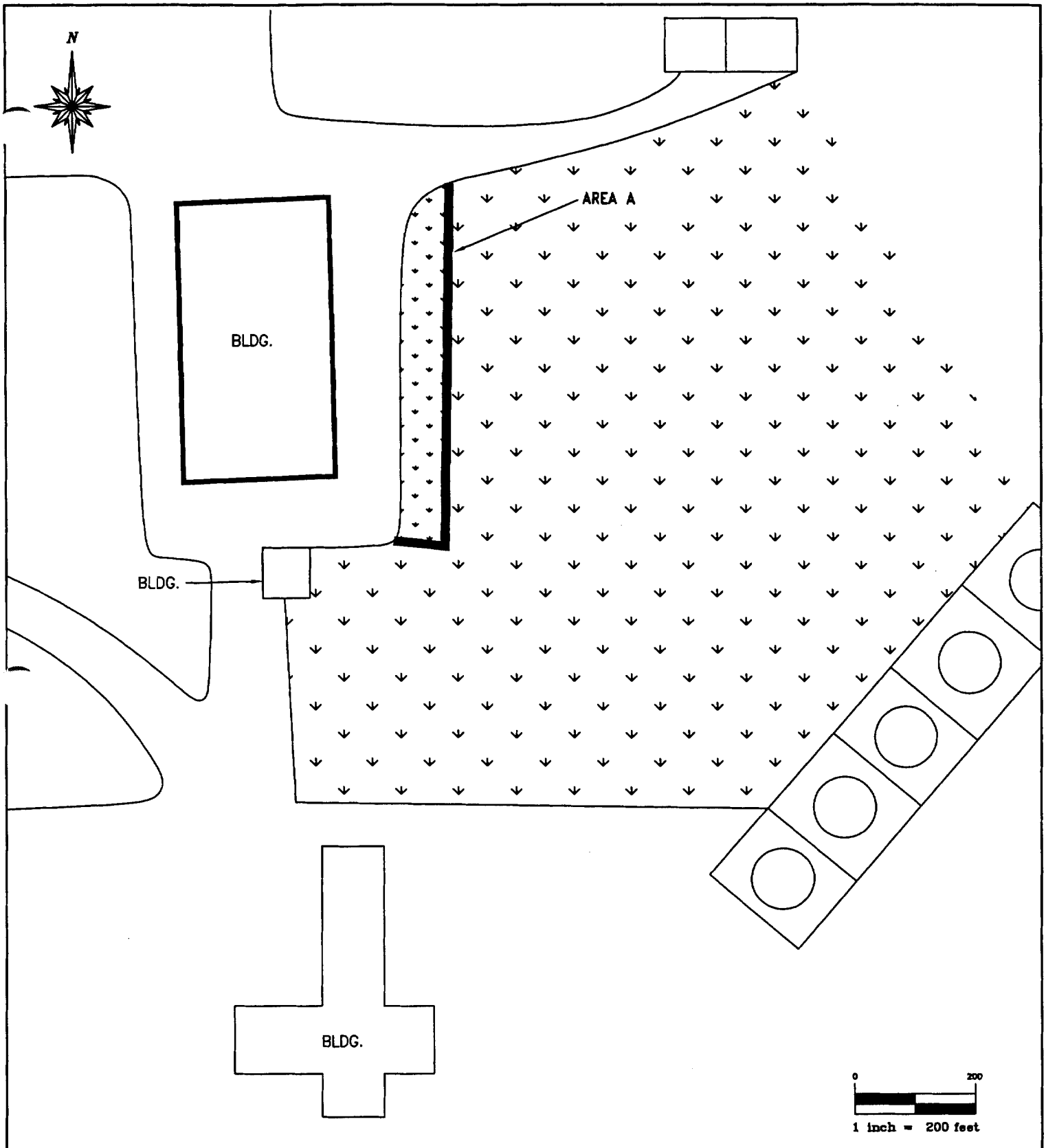
RFAAP

SSP WORK PLAN ADDENDUM: AREA A

Date:	Prepared By:
OCTOBER 2002	KDC/DR
Scale:	**File Name:**
AS SHOWN	09604-317-155

FIGURE 1-43

SITE TOPOGRAPHY LAYOUT



RFAAP

SSP WORK PLAN ADDENDUM: AREA A

Date:	Prepared By:
OCTOBER 2002	KDC/DR
Scale:	**File Name:**
AS SHOWN	09604-317-155

FIGURE 1-44

SWMU LAYOUT MAP

1.10.2 Site Background – History

This unit is located near the Nitrocellulose A-Line production area (USEPA 1987). A low depression, approximately one foot deep, "which appears to be an unlined rainwater ditch" was identified during the April 1987 Visual Site Inspection. No other information was found for preparation of this work plan.

1.10.3 Previous Investigations

Previous investigations associated with this AOC were not found during preparation of this work plan.

1.10.4 Conceptual Site Model

A CSM for Area A is presented in Figure 1-45. Subsurface geology is shown as an upper layer of clayey silts underlain by silty gravels overlying the Elbrook Formation. Potentially affected media include surface and subsurface soil. The area surrounding Area A is comprised of structures, maintained grass, and asphalt-paved roadways. Storm water runoff from the Nitrocellulose A-Line may have potentially impacted surface and subsurface soil through direct deposition and leaching of constituents into site soil.

Current and future land-use scenarios are limited to industrial operations and Area A is enclosed by the Installation perimeter fence; therefore, potential receptors are limited to site workers, future construction workers, and terrestrial biota. Figure 1-46 presents the potential exposure pathways for each receptor. Direct deposition is considered a potential release mechanism to surface soil at these sites. Site workers, construction workers, and terrestrial biota could contact surface soil. Leaching of constituents through site soil is considered a potential release mechanism to subsurface soil at the site and subsurface soil may be received by construction workers.

1.10.5 Data Gap Analysis

TCL VOCs – TCL VOCs analysis has not been performed. Therefore, TCL VOCs represent a data gap and will be analyzed in surface and subsurface soil.

TCL SVOCs/PAHs – TCL SVOC/PAH analysis has not been performed. Therefore, TCL SVOC/PAH represents a data gap and will be analyzed in surface and subsurface soil.

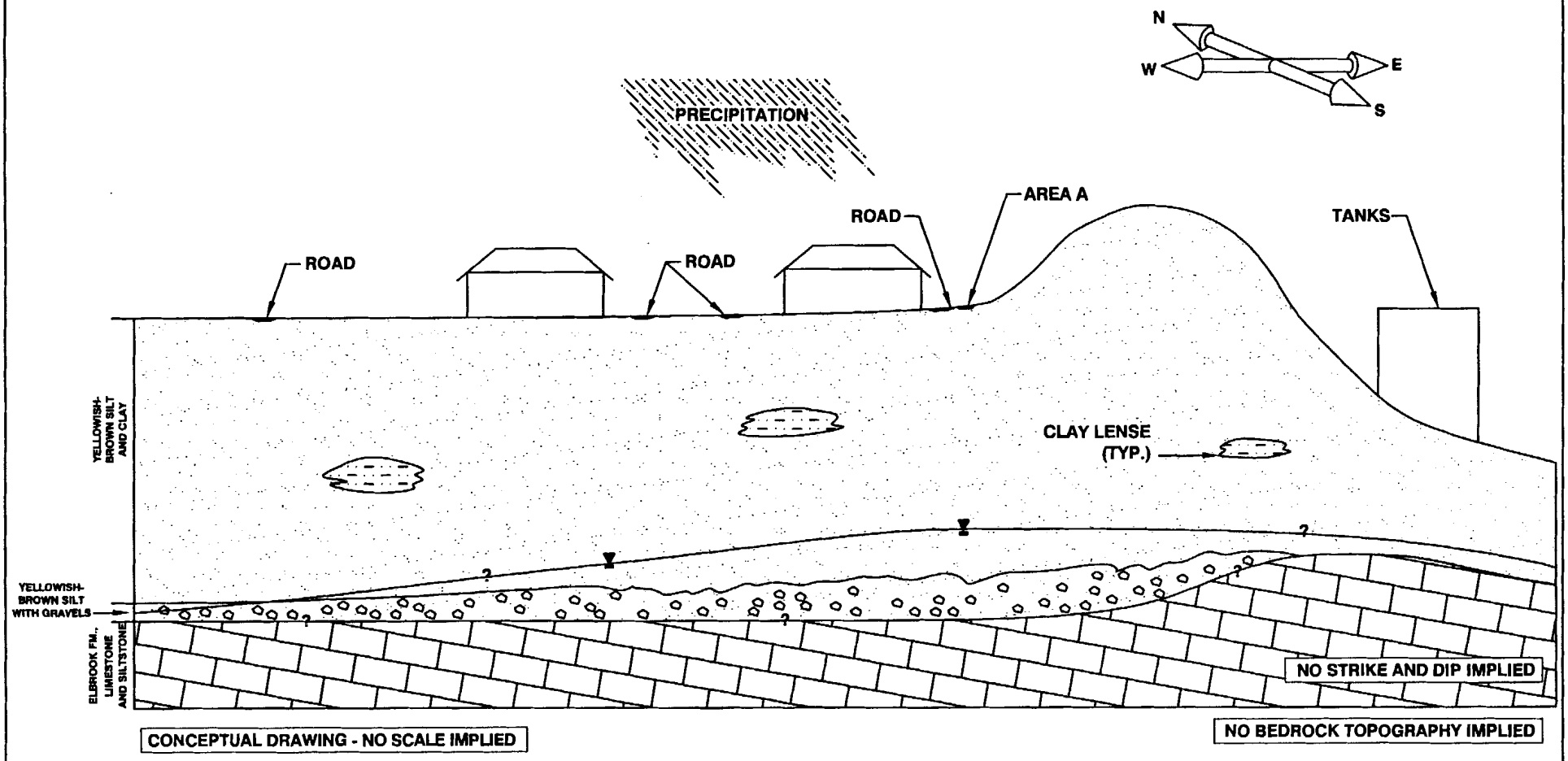
TCL PCBs – TCL PCBs analysis has not been performed. Therefore, TCL PCBs represent a data gap and will be analyzed in surface soil.

TCL Pesticides – TCL Pesticides analysis has not been performed. Therefore, TCL Pesticides represent a data gap and will be analyzed in surface soil.

Explosives – Explosives analysis has not been performed. Therefore, explosives represent a data gap and will be analyzed in surface and subsurface soil.

TAL Inorganics – TAL Inorganics analysis has not been performed. Therefore, TAL Inorganics represent a data gap and will be analyzed in surface and subsurface soil.

Dioxins/furans – Dioxins/furans are not considered a data gap because Area A was not used for burning or storage/disposal of burned waste.



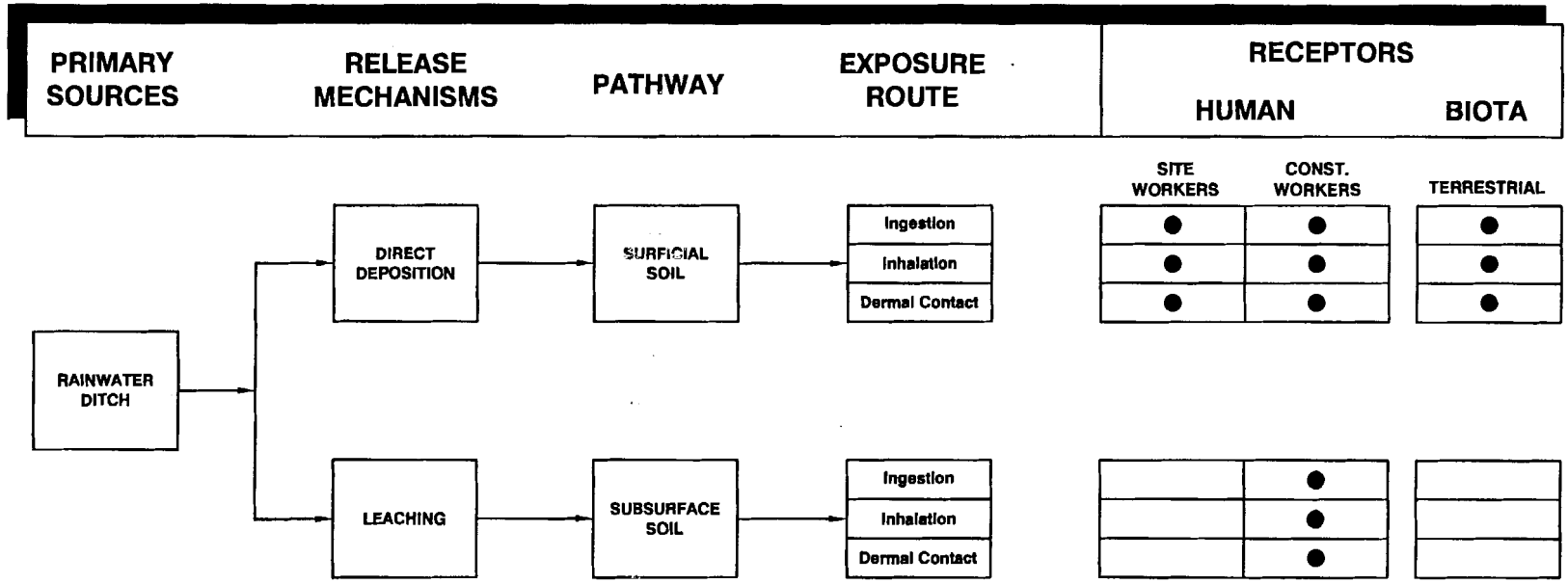
RFAAP

SSP WORK PLAN ADDENDUM: AREA A

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FIGURE 1-45

CONCEPTUAL SITE MODEL FIGURE



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SSP WORK PLAN ADDENDUM: AREA A

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FIGURE 1-46

CONCEPTUAL SITE MODEL DIAGRAM

Other – An analysis of the physical properties of subsurface soil to aid in assessing the nature of possible constituent mobility has not been performed during the previous investigations. Therefore, soil samples will be analyzed for TOC, grain size, specific gravity, percent moisture, and bulk density to assess the mobility of constituents in soil.

1.10.6 Planned Field Activities

Based on the results of the data gap analysis, additional sampling and analysis is proposed to characterize this site for SSP purposes. Sampling locations were selected based on site observations and the CSM. Proposed analyses for various media types were identified by the results of the data gap analysis.

1.10.6.1 Soil Borings

The following sections discuss proposed soil investigations to be conducted at Area A using the direct push method of boring advancement, as described in SOP 20.11 in Appendix A. A four-foot, Geoprobe Macro-Core® sampling device will be used to collect soil samples continuously from each of the borings, as described in SOP 20.11 in Appendix A. The location of each soil boring will be established to the nearest meter using GPS equipment.

Three soil borings will be advanced at Area A (ASB1, ASB2, and ASB3). Proposed sampling locations are presented on Figure 1-47. Soil borings will be advanced to the groundwater table or to the top of bedrock using direct push technology, consistent with the procedures outlined in SOP 20.11. During boring advancement subsurface soil samples will be screened for the presence of volatile organic compounds using a PID consistent with SOP 90.1 included in Appendix A. Soil borings will be completed at the following locations:

- Borings ASB1, ASB2, and ASB3 will be located along the depressed area (i.e., drainage channel). These borings will assess whether environmental media have been impacted from A-Line runoff.

To meet the objectives of the soil screening at Area A outlined above to fill the data gaps identified in Section 1.9.5:

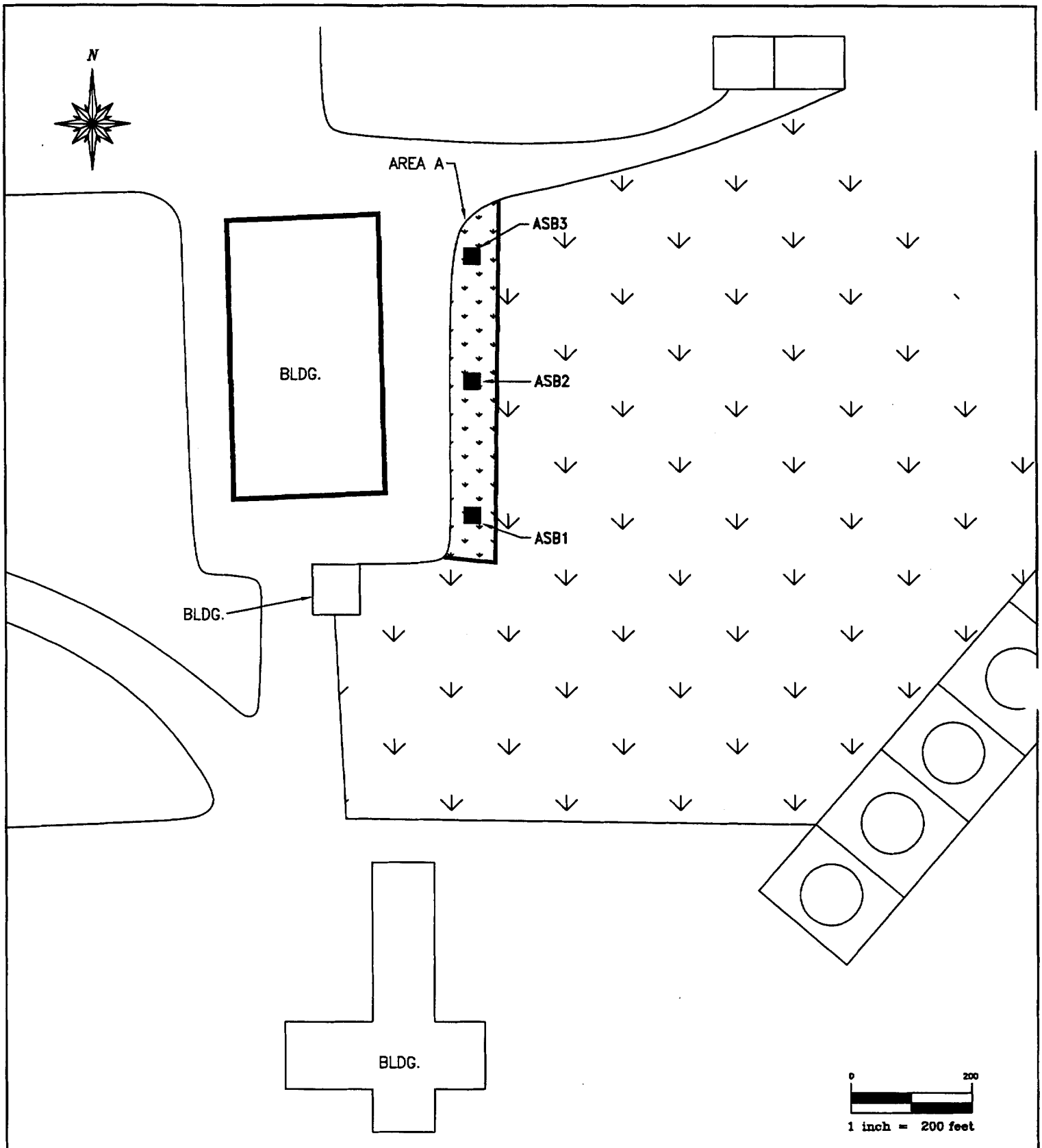
- One surface sample will be collected from each boring (i.e., 0 to 6 inches bgs gravel, vegetative organic layers and 6 to 12 inches bgs for VOCs) to screen surface soil since data does not exist for this area;

- Two subsurface soil samples will be collected from each boring, with one from an intermediate zone (approximately 10 to 12 ft bgs) and one from the terminational zone (above the groundwater table or top of bedrock); and

- Each of the soil samples will be analyzed for TCL VOCs, TCL SVOCs, PAHs, explosives (including nitroglycerin) and TAL Inorganics. One surface soil sample will be analyzed for TCL Pesticides and TCL PCBs consistent with the requirements of the MWP QAP and Section 2.0 of this WPA.

Stratigraphic logs will be prepared for each boring location in accordance with the procedures outlined in SOP 10.3 in Appendix A.

Two samples will be collected and analyzed for the physical properties TOC, grain size, specific gravity, percent moisture, and bulk density in accordance with the QAPA in Section 2.0 of this document.



LEGEND

■ Proposed Sampling Location

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FIGURE 1-47

PROPOSED SAMPLING LOCATIONS

1.11 AREA F – FORMER DRUM STORAGE AREA

1.11.1 Site Background – Environmental Setting



Physiography – Area F is located 80 feet southeast of an unrelated building, approximately 300 feet from the New River in the northern section of the MMA. The topography near Area F is gently-to-steeply sloping upward to the south at an elevation of approximately 1,700 ft msl (Figure 1-48). The area was constructed as a 50 ft by 50 ft gravel lot. The area is surrounded on three sides by maintained grass and an asphalt-paved road lies to the north. Overhead lines traverse along the site to the west.

Surface Water – Based on the topography, the surface water runoff at Area F appears to flow through well-defined drainage pathways generally to the north with discharge into the New River approximately 300 feet from the site. Runoff within the site area flows northward toward the road then flows eastward into a well-defined pathway draining northward.

Geology and Soil – Area F is underlain by the Urban-Unison land soil. This soil has a medium permeability and is medium-to-strongly acidic (IT 2002a). Site-specific data regarding subsurface conditions at Area F have not been collected. Investigations at other SWMUs in similar settings at RFAAP indicate the presence of two strata. The upper stratum consists of brown silty-to-clayey sand. The second stratum consists of reddish brown micaceous sandy silt containing large cobbles (river jack) increasing in number with depth.

Underlying the two strata is the gray limestone/dolostone of the Elbrook Formation.

Groundwater – Site-specific data regarding hydrogeologic conditions at Area F have not been collected. Based on similar geomorphic setting to other SWMUs at RFAAP, groundwater is likely present from approximately 20 to 30 ft bgs with the water table sloping north toward the New River.

Tanks and Structures – Besides previously identified nearby buildings and overhead lines, no other tanks or structures exist at Area F.

1.11.2 Site Background – History

Reportedly, empty drums from throughout RFAAP (Nitroglycerin Area, Rocket Area, and Green Line; ATK 2002) were stacked on their sides at Area F before being sold for recycling. The drums were reportedly rinsed before being stored. The drums may have contained diethyl phthalate, sodium hydrosulfide, ethyl lactate/butyl acetate solvent mix, dinitro-propylamine, waste oil or oily water, and 2-nitro-diphenylamine (ATK 2002).

1.11.3 Previous Investigations

The following section reviews previous site investigations emphasizing the usability of collected data and the screening of historical data with respect to current criteria (i.e., current RBCs and BTAG screening levels).



VICINITY MAP
N.T.S.

(SOURCE: MODIFIED FROM HERCULES, INC., 1992)

0 200
1 inch = 200 feet

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FIGURE 1-48

SITE TOPOGRAPHY LAYOUT

1.11.3.1 Verification Investigation – 1992

In 1992, Dames and Moore collected (Figure 1-49) and analyzed four surface soil samples from within the limits of the gravel storage area. Samples were analyzed for VOCs and SVOCs. Analytical results indicate trace concentrations of VOCs were detected several orders of magnitude less than the April 2003 RBC soil-screening criteria. Reported results are presented in Table 1-16.

1.11.3.2 Installation Assessment (Air Photo Interpretation) – 1992

Activity at Area F was first noted on a 1986 aerial photograph. The 1986 photograph and report indicated approximately 200 drums were stored at this location. The report also notes "a probable stain is visible in the vicinity of the drums (USEPA 1992)."

1.11.4 Conceptual Site Model

A CSM for Area F is presented in Figure 1-50. Subsurface geology is shown as an upper layer of sands and silts underlain by increasing gravel and then the Elbrook Formation. Potentially affected media include surface and subsurface soil. The area surrounding Area F is maintained grass and asphalt-paved roadways. The former drum storage area may have potentially impacted surface soil through spills and subsurface soil through leaching of constituents into site soil.

Current and future land-use scenarios are limited to industrial operations and Area F is enclosed by the Installation perimeter fence; therefore, potential receptors are limited to site workers, future construction workers, and terrestrial biota. Figure 1-51 presents the potential exposure pathways for each receptor. Direct deposition via spills of residual material in drums stored at Area F is considered a potential release mechanism to surface soil. Site workers, construction workers, and terrestrial biota could contact surface soil. Leaching of constituents through site soil is considered a potential release mechanism to subsurface soil and subsurface soil may be received by construction workers.

1.11.5 Data Gap Analysis

TCL VOCs – A review of the surface soil data indicates that TCL VOCs are not identified as COPCs; however, in order to meet the objectives of the SSP, TCL VOCs will be analyzed in both surface and subsurface soil samples.

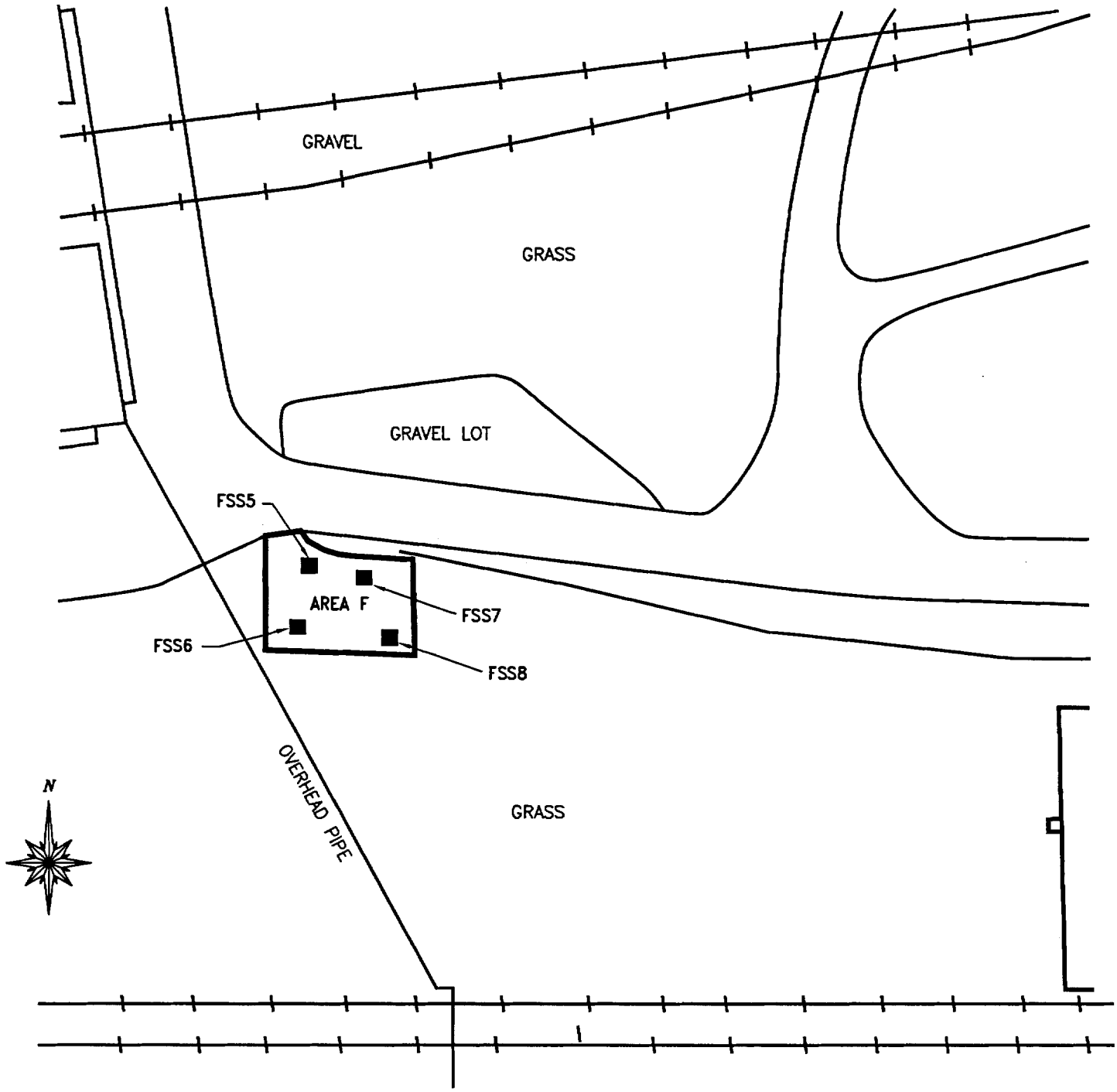
TCL SVOCs/PAHs – TCL SVOC/PAH analysis was performed during the 1992 VI. SVOCs were not detected during this investigation. However, samples were not collected for PAH analysis during previous investigations. Therefore, in order to meet the objectives of the SSP, TCL SVOCs, and PAHs will be analyzed in surface and subsurface soil samples.

TCL PCBs – TCL PCBs analysis has not been performed. Therefore, TCL PCBs represent a data gap and will be analyzed in surface soil.

TCL Pesticides – TCL Pesticides analysis has not been performed. Therefore, TCL Pesticides represent a data gap and will be analyzed in surface soil.

Explosives – Explosives analysis has not been performed. Therefore, explosives represent a data gap and will be analyzed in surface and subsurface soil.

TAL Inorganics – TAL Inorganics analysis has not been performed. Therefore, TAL Inorganics represent a data gap and will be analyzed in surface soil and subsurface soil.



LEGEND

■ Soil Sample

(SOURCE: MODIFIED FROM DAMES & MOORE, 1992a)

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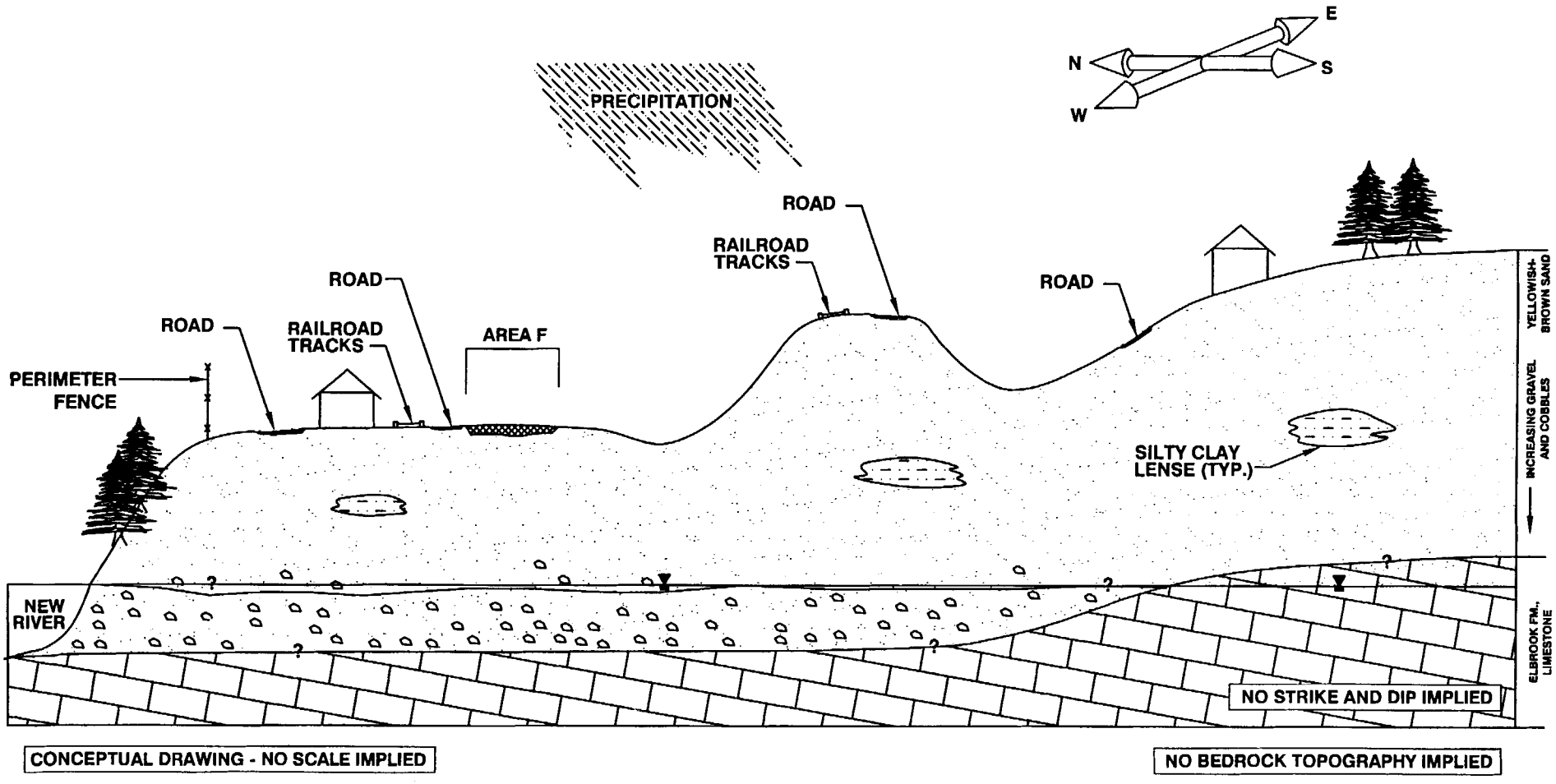
FIGURE 1-49

SWMU LAYOUT MAP

Table 1-16
Summary of Analytical Data for Soil Samples Collected at Area F
Modified from Dames and Moore Verification Investigation Report
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

SITE ID FIELD ID SAMPLE DATE DEPTH (ft bgs) MATRIX UNITS	PQLs mg/kg	FSS5 RVFS*94 18-Feb-92 0.5 CSO mg/kg	FSS6 RVFS*95 18-Feb-92 0.5 CSO mg/kg	FSS8 RVFS*97 18-Feb-92 0.5 CSO mg/kg	Adjusted Soil Industrial RBC mg/kg	Adjusted Soil Residential RBC mg/kg	Draft BTAG Screening Level mg/kg
Volatiles							
Acetone	0.1	<0.017	<0.017	<0.017	10,000	780	–
Tetrachloroethylene	0.005	<0.001	<0.001	<0.001	143	31.9	0.3
Trichlorofluoromethane	0.005	0.012	0.012	0.009	30,660	2,346	--

Notes:
BTAG = USEPA Region III Draft, Biological Technical Assistance Group Screening Level
CSO = Chemical soil
ft bgs = Feet below ground surface
mg/kg = Milligrams per kilogram
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 State Environmental Protection Agency
USEPA Region III Risk-Based Concentration (RBC) values from the April 25, 2003 RBC Table
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens



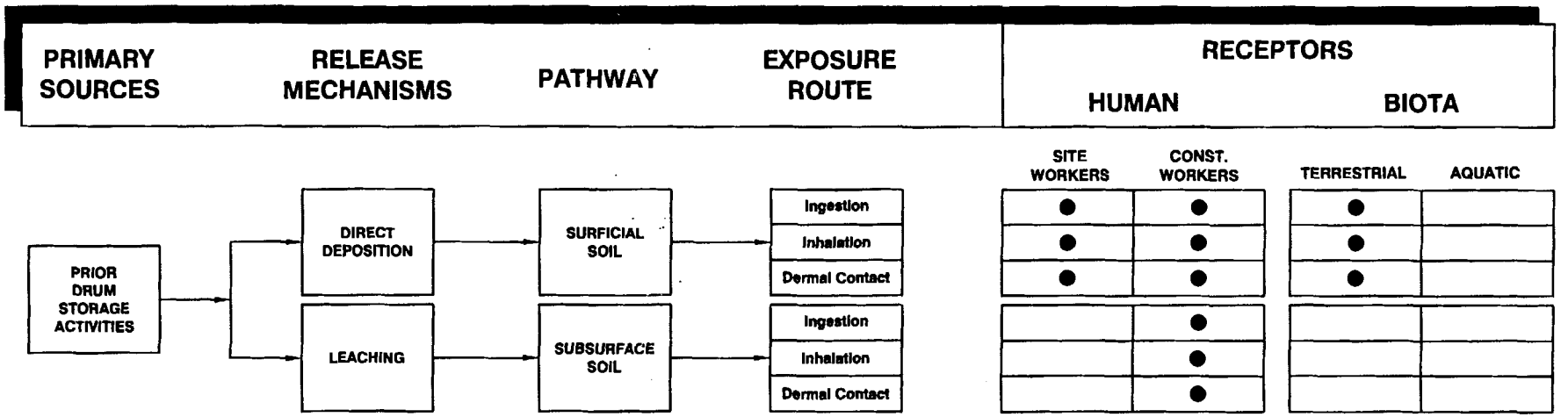
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FIGURE 1-50

CONCEPTUAL SITE MODEL FIGURE



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SSP WORK PLAN ADDENDUM: AREA F

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Scale:	File Name:
NO SCALE	09604-317-155

FIGURE 1-51

CONCEPTUAL SITE MODEL DIAGRAM

Dioxins/furans – Dioxins/furans are not considered a data gap because Area F was not used for burning or storage/disposal of burned waste.

Other – An analysis of the physical properties of subsurface soil to aid in assessing the nature of possible constituent mobility has not been performed during the previous investigations. Therefore, soil samples will be analyzed for TOC, grain size, specific gravity, percent moisture, and bulk density to assess the mobility of constituents in soil.

1.11.6 Planned Field Activities

COPCs were not identified as a result of analytical data review from previous investigations. Additional sampling and analysis is still proposed to assess this site for SSP purposes and to confirm the absence of COPCs. Sampling locations were selected based on site observations and the CSM. Proposed analyses for various media types were identified by the results of the data gap analysis.

1.11.6.1 Soil Borings

The following sections discuss proposed soil investigations to be conducted at Area F using the direct push method of boring advancement, as described in SOP 20.11 in Appendix A. A four-foot, Geoprobe Macro-Core® sampling device will be used to collect soil samples continuously from each of the borings, as described in SOP 20.11 in Appendix A. The location of each soil boring will be established to the nearest meter using GPS equipment.

Three soil borings will be advanced at SWMU Area F (FSB1, FSB2, and FSB3). Proposed sampling locations are presented on Figure 1-52. Soil borings will be advanced to the groundwater table or top of bedrock using direct push technology consistent with the procedures outlined in SOP 20.11. During boring advancement, subsurface soil samples will be screened for the presence of volatile organic compounds using a PID consistent with SOP 90.1 included in Appendix A. Soil borings will be completed at the following locations:

- Borings FSB1, FSB2, and FSB3 will be located within the gravel area of Area F. These borings will assess the nature of contamination that may have occurred from historical drum staging activities.

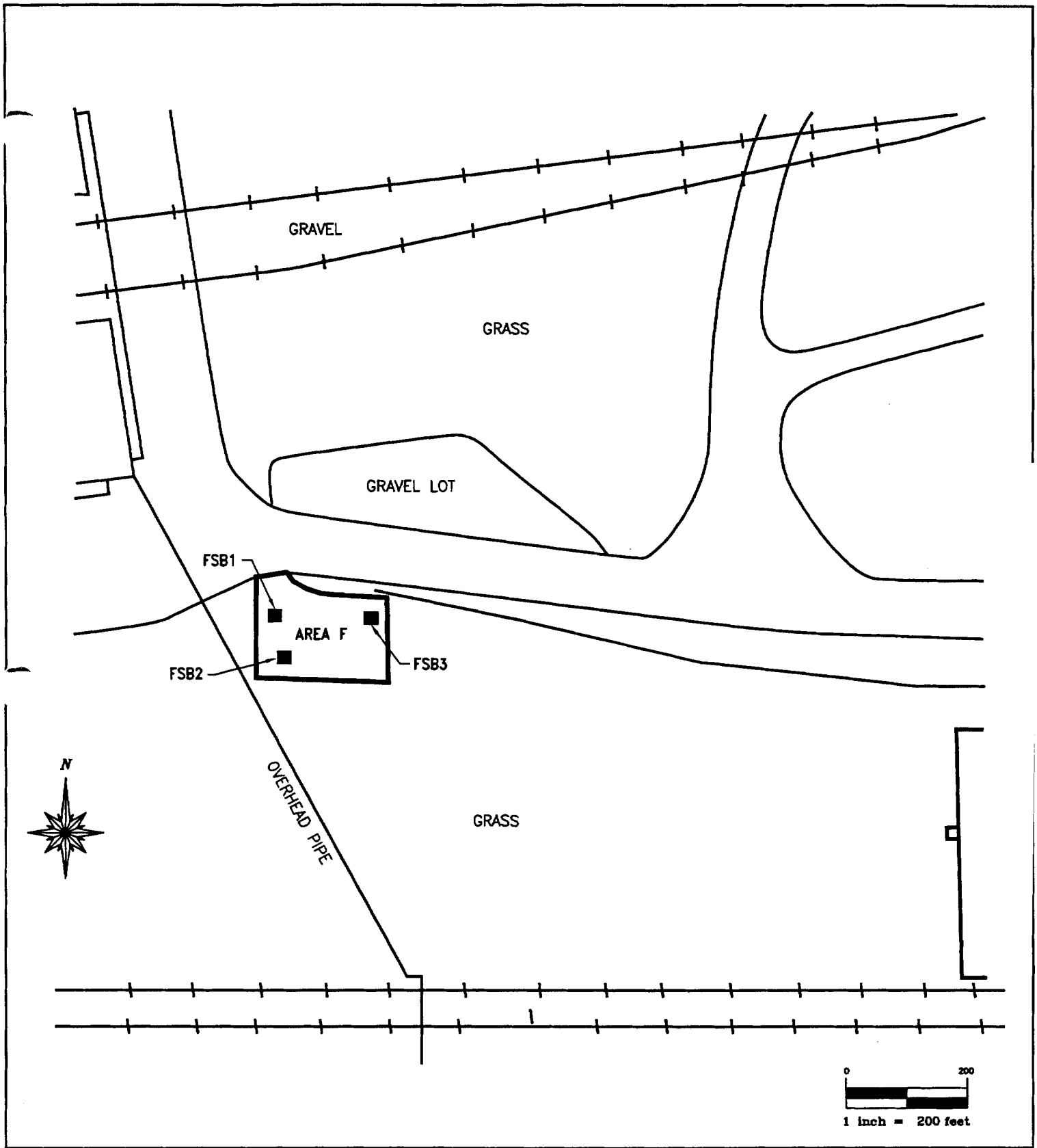
Soil samples from each boring include:

- One surface sample will be collected from each boring (i.e., 0 to 6 inches bgs below gravel, vegetative, or organic layers and 6 to 12 inches bgs for VOCs) to fully screen surface soil;

- Two subsurface soil samples will be collected from each boring, with one from an intermediate zone (approximately 10 to 12 ft bgs) and one from the terminational zone (above the groundwater table or top of bedrock); and

- Each sample will be analyzed for TCL VOCs, TCL SVOCs, PAHs, explosives (including nitroglycerin), and TAL Inorganics; one surface soil sample will be analyzed for TCL Pesticides and TCL PCBs consistent with the requirements of the MWP QAP and Section 2.0 of this WPA.

Stratigraphic logs will be prepared for each boring location in accordance with the procedures outlined in SOP 10.3 in Appendix A. Two soil samples will be collected and analyzed for the physical properties TOC, grain size, specific gravity, percent moisture, and bulk density in accordance with the QAPA in Section 2.0 of this document.



LEGEND

■ Soil Sampling Location

(SOURCE: MODIFIED FROM DAMES & MOORE, 1992a)

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FIGURE 1-52

PROPOSED SAMPLING LOCATIONS

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 QC requirements include development of 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 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
SSP WPA for Nine SWMUS and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

Quality Assurance Measure	Section in MQAP	SOP No. (MWP Appendix A and Appendix A of WPA No. 16)
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	20.11, 30.1, 30.6, 30.7, 30.9, 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 the Soil Sampling Investigation is defined in the Facility Permit (USEPA, 2000b). At least six copies of draft documents and three copies of the final plans, reports, notifications, or other documents submitted as part of the Site Screening Process Investigation 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 (3HS13)
1650 Arch Street
Philadelphia, Pennsylvania 19103

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

Commonwealth of Virginia (electronic)
Department of Environmental Quality
Waste Division
629 East Main Street
P.O. Box 10009
Richmond, Virginia 23240

Commonwealth of Virginia (electronic)
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:

John E. Tesner, P.E.
USACE, Baltimore District
ATTN: CENAB-EN-HM
10 South Howard Street
Baltimore, Maryland 21201

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

James McKenna
Radford Army Ammunition Plant
Route 114, Peppers Ferry Road
Building 220
Radford, Virginia 24143-0002

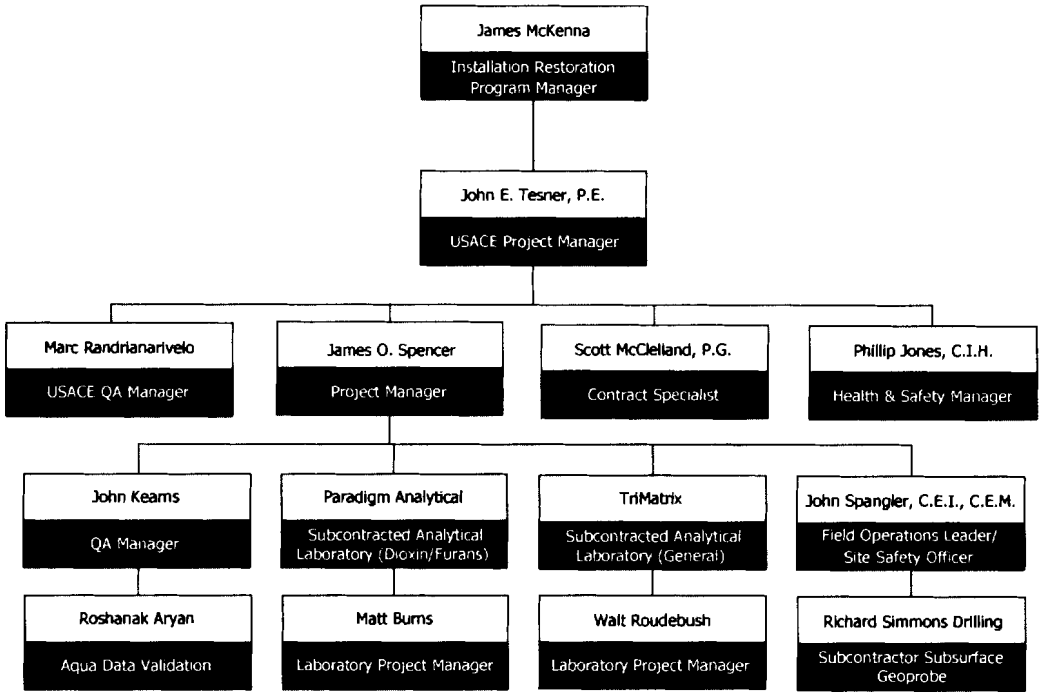
Tony Perry
US Army Environmental Center
5179 Hoadley Road, ATTN: SFIM-AEC-ERP
Aberdeen Proving Ground, MD 21010-5403

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
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia



2.2.2 Key Points of Contact

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

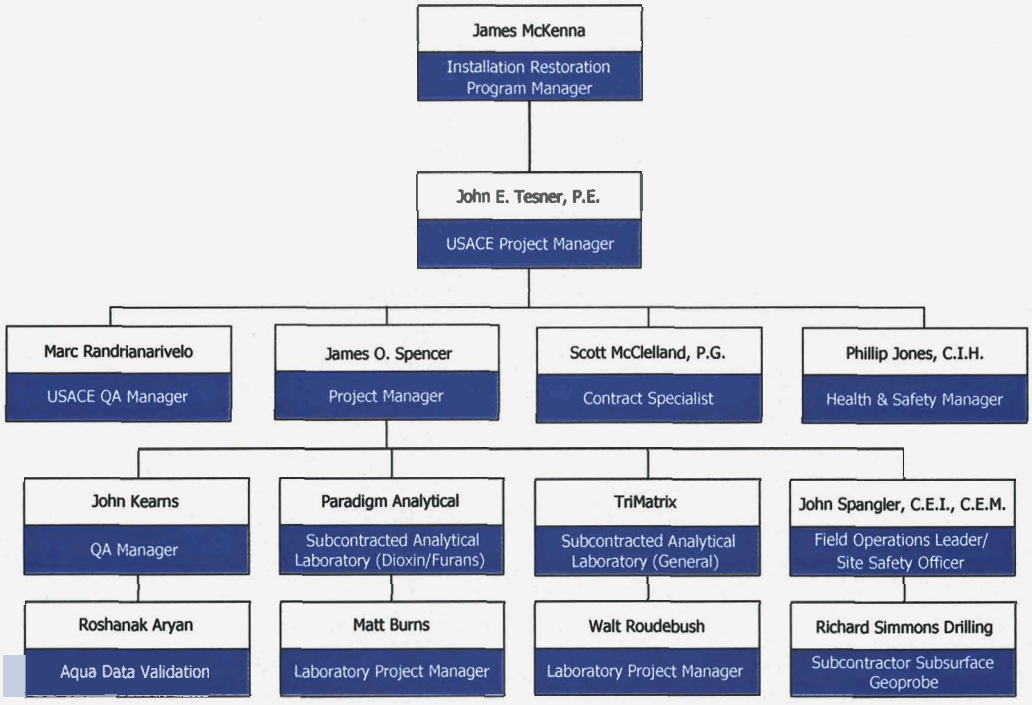
The Project Manager (PM) is responsible for ensuring that activities are conducted in accordance with contractual specifications, the Statement of Work (SOW), and approved work plans. The PM will also provide technical coordination with the Installation's designated counterpart. The PM is responsible 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.

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.

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SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia



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
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

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
Health and Safety Manager, Phillip Jones Email: Phillip_L_Jones@URSCorp.com	URS Group, Inc. 1400 Union Meeting Road, Suite 202 Blue Bell, Pennsylvania 19422-1972 Tel: 215.619.4160; Fax: 215.542.3888
Quality Assurance Manager, John Kearns Email: John_Kearns@URSCorp.com	URS Group, Inc. 849 International Drive, Suite 320 Linthicum, Maryland 21090 Tel: 410.859.5049; Fax: 410.859.5049
Data Validator, Roshanak Aryan Email: Roshanak_Aryan@URSCorp.com	URS Group, Inc.-Measurement Systems Group 849 International Drive, Suite 320 Linthicum, Maryland 21090 Tel: 410.859.5049; Fax: 410.859.5049
Field Operations Leader and Site Health and Safety Officer, John Spangler Email: John_Spangler@URSCorp.com	URS Group, Inc. 5540 Falmouth Street, Suite 201 Richmond, Virginia 23230 Tel: 804.474.5419; Fax: 804.965.9764
Subcontractor	**Key Point of Contact**
Analytical Laboratory Services, General 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
Analytical Laboratory Services, Dioxins / Furans Paradigm Analytical Laboratories, Inc. Email: RMB@ParadigmLabs.com	Matthew Burns 5500 Business Drive Wilmington, North Carolina 28405 Tel: 910.350.1903; Fax 919.552.0066
Subsurface Drilling (Geoprobe®) Richard Simmons Drilling Email: RSDrilling@AOL.com	Richard Simmons Drilling 60 Drill Rig Drive Buchanan, Virginia 24066 Tel: 540.254-2289; Fax: 540.254-1268

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 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 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, which 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 oversight 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 established in the WPA. The reviewer will establish a dialogue with the data users prior to and after review to answer questions, assist with data interpretation, and to provide the data 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;
- Preparation of project manpower estimates; and

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 Quality Assurance Objectives of this project. Conformance with 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 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 verification, validation, and documentation.

The Data Quality Objective (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. *Data Quality Objective Process for Hazardous Waste Sites* (USEPA 2000a) and *Guidance for the Data Quality Objectives Process* (USEPA 2000c) formed the basis for the DQO process and development of RFAAP data quality criteria and performance specifications.

Table 2-3
Summary of Project Data Quality Objectives
SSP WPA for Nine SWMUS and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

DQO Element	Project DQO Summary
Problem Statement	• The extent of potential contamination of the nine SWMUs and three AOCs is currently unknown • Possible risks to human health and the environment are currently unknown
Identify Decision/Study Question	• Collect and analyze samples representative of each SWMU • Collect subsurface soil samples for analysis of physical properties to aid in assessing risk and the nature of possible constituent migration
Decision Inputs	• Field investigation data: soil borings and samples • Chemical analyses: submit media samples to USACE-approved and validated off-site laboratory for analyses
Study Boundaries	• Physical horizontal boundary of each SWMU will be defined within the scope of the SSP in combination with previous site information
Decision Rule	• Comparison to USEPA Region III RBCs (USEPA April 2003 or most recent) as modified for risk screening • Comparison to USEPA Region III Draft BTAG Screening Levels • Comparison to Facility-Wide Background Concentrations
Tolerable Limits on Decision Errors	• Current SW-846 Test Methods, reporting limits, USEPA Contract Laboratory Program (CLP)-like raw data package (Level IV) suitable for validation
Optimize the Design for Obtaining Data	• Soil borings and soil sampling locations have been selected to provide crucial information

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, (2) identification of the primary decision-maker, and (3) statement of the problem.

   1) The planning team consists of the RFAAP, USACE, USEPA, Virginia Department of Environmental Quality (VDEQ), the RFAAP operating contractor, and URS;

   2) Relative to the implementation of this Work Plan Addendum, the primary decision-maker is RFAAP, in consultation with USACE, USEPA, VDEQ, and URS; and

   3) RFAAP seeks to assess whether concentrations of hazardous constituents remain at the nine SWMUs or three areas of concern exceeding USEPA Region III RBCs and/or Draft BTAG screening levels; The Site Screening Process Investigation 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.

1) Principal study questions include:

- Do concentrations of hazardous constituents at the nine SWMUs or three areas of concern exceed relevant screening criteria identified in the USEPA Site Screening Process and do the site conditions pose an unacceptable risk to human health or the environment?
- Where do the contaminant concentrations exceed applicable screening concentrations?
- Are additional investigations needed (i.e., RFI process)?

2) The resultant alternative actions include:

- If concentrations of hazardous constituents at one or more of the nine SWMUs or three areas of concern do not exceed relevant screening criteria, then these sites will be proposed for no further action; or
- If concentrations of hazardous constituents at one or more of the nine SWMUs or three areas of concern exceed relevant screening criteria, the team plans additional risk assessment activities and possibly additional investigation of the site(s).

3. **Identify Inputs to the Decision**: Identify information inputs required for resolving the decision statement and determining which inputs require environmental measures. This step of the process includes identification of the data that will be required to make the decision, determination of the information source, identification of data required for study action levels, and confirmation of appropriate field sampling and analytical methods.

1) Results of a Desktop audit to examine site use, operational history, groundwater and surface water use and characteristics, soil exposure characteristics, and air exposure pathways;

2) Findings of a site visit and visual inspection of each SWMU or AOC for aiding in site characterization; and

3) RBCs in the most recent version of the USEPA Region III Risk-based Concentration Table for soil ingestion using the residential and industrial scenarios;

4) RBCs in the most recent version of the USEPA Region III Concentration Table for tap water and federal and Virginia Ambient Water Quality Criteria;

5) USEPA RCRA Hazardous Waste Characteristics threshold concentrations;

6) Method Detection Limits and Reporting Limits for the full suite of Contract Laboratory Procedure (CLP) constituents and other constituents based on the findings of the desktop audit;

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

8) Details of a visual inspection of each SWMU or AOC; and

9) Validated results of chemical and physical analyses performed on soil and waste samples.

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

1) Physical horizontal boundary of each SWMU will be defined through historic records and within the field event (i.e., soil boring information).

2) Media COPCs have been identified from previous investigations and sample points are placed to collect samples representative of each SWMU.

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

1) Population parameters of interest include:

- TAL Inorganics, TCL SVOCs/PAHs, TCL VOCs, TCL Pesticides, TCL PCBs, explosives (including nitroglycerin), perchlorate, COD, and dioxin/furans (maximum detected concentrations or a 95% Upper Concentration Limit, if appropriate); and

- Bulk density, grain size, specific gravity, percent moisture, and total organic content (reported values).

2) Action levels include:

- Action levels for risk screening include USEPA Region III RBCs, USEPA Region III Draft BTAG screening levels, USEPA MCLs, Virginia State Water Control Board Water Quality Criteria, as well as the background soil inorganic constituent concentrations as reported in the Facility-Wide Background Study Report; and

- Method Detection Limits (MDLs) and Reporting Limits (RLs), as defined herein, will ensure that data quality is sufficient for intended data use. Selected laboratories are USACE validated and therefore it is assumed that sources of analytical errors are small and known.

3) Decision rules include:

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

- Results of site activities will be used to refine the site conceptual model and will be used in remedial alternative decisions;

- Analytical laboratory decision rules are presented in the laboratory QAP. These include specific action levels and decision rules based on accuracy and precision; and

- If boring refusal is encountered at less than the expected depth for each SWMU or AOC, the boring will be offset five feet and advanced to the depth of previous refusal prior to collection of additional samples.

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, (3) potential parameter values and probability tolerance for decision errors.

   1) Method Detection Limits (MDLs) and Reporting Limits (RLs) are established for each analyte within the suite of parameters sought. MDLs and RLs below the screening criteria will ensure the data meets the DQOs. The contract laboratory will provide a CLP-like raw data package (Level IV). Data validation will be conducted based on the MQAP, the USACE *Requirements for the Preparation of Sampling and Analysis Plans, EM 200-1-3, Appendix I, Shell for Analytical Chemistry Requirements* (USACE 2001), and relevant USEPA Region III guidance.

   2) The null hypothesis (H_0) for this investigation is that human health or environmental impacts exist and the alternative hypothesis (H_a) is that human health or environmental impacts do not exist. The consequences of deciding that human health or environmental impacts exist when they do not will result in un-necessary remedial actions. The consequences of deciding that human health or environmental impacts do not exist when the do will result in liabilities associated with future damages and environmental clean-up costs.

      The main baseline condition decision error is to decide that the true concentration of a site-related contaminant does not exceed the action level for further study when the true concentration exceeds the action level and further action is needed (Type I false rejection, α). Conversely, the alternative decision error is to decide that the true concentration of a site-related contaminant is above the action level when in fact the concentration is below the action level (Type II false acceptance, β). The acceptable project-specific probabilities for Type I and Type II decision errors are 0.05 (α) and 0.2 (β), respectively.

   3) Information from previous studies and physical features of the areas surrounding each SWMU were used to develop a sampling plan design and measurements that allow 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.

   1) DQO outputs will be reviewed based on the data collection activities and the DQOs will be refined throughout the project lifecycle; the validity of the DQOs could be verified, if necessary, based on the review.

   2) Non-statistical sampling design is proposed with biased and judgmental sampling performed to complete the site screening.

3) 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 2-5 identifies analytical parameters, container and preservation requirements, and holding times.

2.4.2 Sample Identification

The sample identification number will conform to past nomenclature at RFAAP. 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 boring, SS for surface soil, SD for sediment, and SW for surface water.

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

- **Sample Depth:** The sample collected from zero to six inches bgs will be designated with an "A" after the boring number. The sample collected from intermediate depths of the boring, or from below fill materials, will be designated with a "B" following the boring number. Samples representative of fill materials will be designated with an "F." Samples collected from above bedrock, at the base of the boring will be designated with a "C."

- **Duplicate:** Duplicate samples will be identified with a "D" designation followed by a numeric designation corresponding to the sequence of duplicates collected (e.g., D-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) A subsurface soil sample collected above the termination depth of boring location four at SWMU 13 would be identified as sample 13SB4C (for SWMU 13, soil boring four, and "C" which stands for the soil above bedrock at that location).

2) Quality Control 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 (MS), Matrix Spike Duplicate (MSD), Rinse Blank ®, and Trip Blank (T).

Table 2-4
Summary of Sample Container, Preservation Method, and Holding Time Requirements
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

PARAMETER	SAMPLE CONTAINER		PRESERVATION METHODS	HOLDING TIMES
	Quantity	Type		
SOLID SAMPLES				
TCL Volatile Organic Compounds	3	5-gram Encore samplers, zero headspace	Cool to 4 ± 2 °C; sodium bisulfate (low level), methanol (high level)	must be analyzed within 48 hours or transferred to soil purge vial with preservative within 48 hours for analysis within 14 days
TCL Semivolatile Organic Compounds	1	500-mL wide-mouth glass container, Teflon®-lined cap	Cool to 4 ± 2 °C	Extraction: 14 days Analysis: 40 days
TCL Pesticides/Aroclors	2	250-mL wide-mouth glass container, Teflon®-lined cap	Cool to 4 ± 2 °C	Extraction: 14 days Analysis: 40 days
Polyaromatic Hydrocarbons	1	250-mL wide-mouth glass container, Teflon®-lined cap	Cool to 4 ± 2 °C	Extraction: 14 days Analysis: 40 days
Explosives/Nitroglycerin	1	250-mL wide-mouth glass container, Teflon®-lined cap	Cool to 4 ± 2 °C	Extraction: 14 days Analysis: 40 days
TAL Metals	1	250-ml wide mouth polyethylene container, Teflon®-lined cap	Cool to 4 ± 2 °C	Metals: 6 months Mercury: 28 days
Dioxin/Furans	1	250-mL wide-mouth glass container, Teflon®-lined cap	Cool to 4 ± 2 °C, Dark	Extraction: 30 days Analysis: 45 days
SOLID WASTE CHARACTERIZATION				
TCLP Volatile Organic Ccompounds	1	125-mL wide-mouth glass vial, Teflon®-lined cap	Cool to 4 6 2°C	Leaching: 14 days Analysis: 14 days
TCLP Semivolatile 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: --
AQUEOUS SAMPLES				
TCL Volatile Organic Compounds	3	40-mL, glass vials, Teflon®-lined septum cap, zero headspace	HCl to pH < 2, Cool to 4 ± 2°C	14 days
TCL Semivolatile Organic Compounds	2	1-liter, narrow-mouth amber glass, Teflon®-lined cap	Cool to 4 ± 2 °C	Extraction: 7 days Analysis: 40 days
Polynuclear Aromatic Hydrocarbons	2	1-liter, narrow-mouth amber glass, Teflon®-lined cap	Cool to 4 ± 2 °C	Extraction: 7 days Analysis: 40 days
Explosives/Nitroglycerin	2	1-liter, narrow-mouth amber glass, Teflon®-lined cap	Cool to 4 ± 2 °C	Extraction: 7 days Analysis: 40 days
Unfiltered TAL Metals	1	500-ml, polyethylene container	HNO_3 to pH<2, Cool to 4 ± 2 °C	ICP: 6 months Mercury: 28 days
Field Filtered TAL Metals	1	500-ml, polyethylene container	HNO_3 to pH<2, Cool to 4 ± 2 °C	ICP: 6 months Mercury: 28 days
Perchlorate	1	500-mL, polyethylene bottle	Cool to 4 ± 2 °C	28 days
AQUEOUS WASTE CHARACTERIZATION				
TCLP Volatile Organic Compounds	3	40-mL, glass vials, Teflon®-lined septum cap, zero headspace	Cool to 4 ± 2 °C	Leaching: 7 days Analysis: 14 days
TCLP Semivolatile Organic Compounds (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
TCLP 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
Chemical Oxygen Demand	1	250-ml, polyethylene container	H_2SO_4 to pH<2, Cool to 4 ± 2 °C	28 days

Notes:
TAL = Target Analyte List
TCL = Target Compound List
mL = milliliter
g = gram
HNO_3 = Nitric Acid
H_2SO_4 = Sulfuric Acid
HCl = Hydrochloric Acid
°C = Degrees Celsius

2.4.3 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 off-site analytical activities. Analytical methods to be used and associated MDLs and RLs are identified in Table 2-5 through 2-12. Laboratory analyses will be in accordance with USEPA SW-846 Test Methods for the analysis of the following:

- TAL Inorganics;
- TCL VOCs;
- TCL SVOCs;
- PAHs;
- TCL Pesticides;
- TCL PCBs;
- Perchlorate (aqueous);
- Explosives; and
- Dioxin/furans.

Note that Paradigm Laboratories, Inc., has been subcontracted to perform the analysis of dioxin/furans.

Samples of IDM (decontamination water and soil) will be characterized for disposal purposes by analyzing for the following:

- TCLP Organic;
- TCLP Inorganic;
- Ignitability;
- Corrosivity;
- Chemical Oxygen Demand (aqueous); and
- Paint Filter Test (solids).

Table 2-5
Summary of Analyte Method Detection Limits, Reporting Limits, and Risk Screening Criteria for TCL VOCs (by EPA Method 8260B)
Soil and Water Samples
SSP WPA for Nine SWMUs and Three AOCs
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 Draft BTAG Screening Levels		
		Soil		Water												
		MDL mg/kg	Reporting Limit mg/kg	MDL µg/L	Reporting Limit µg/L	µg/L	C/N	Tap water RBC µg/L	Adjusted Tap Water RBC µg/L	Soil RBC (Industrial) mg/kg	Adjusted Soil RBC (Industrial) mg/kg	Soil RBC (Residential) mg/kg	Adjusted Soil RBC (Residential) mg/kg	Aqueous Fresh Water µg/L	Soil mg/kg	Sediment mg/kg
1,1,1-Trichloroethane	71-55-6	0.000326	0.005	0.184	1	2.0E+02	N	3.2E+03	3.2E+02	2.9E+05	2.9E+04	2.2E+04	2.2E+03	9.4E+03	3.0E-01	3.1E-02
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	0.000275	0.005	0.137	1	--	N	5.9E+04	5.9E+03	3.1E+07	3.1E+06	2.3E+06	2.3E+05	--	--	--
1,1,2,2-Tetrachloroethane	79-34-5	0.000219	0.005	0.197	1	--	C	5.3E-02	5.3E-02	1.4E+01	1.4E+01	3.2E+00	3.2E+00	2.4E+03	3.0E-01	--
1,1,2-Trichloroethane	79-00-5	0.000294	0.005	0.223	1	5.0E+00	C	1.9E-01	1.9E-01	5.0E+01	5.0E+01	1.1E+01	1.1E+01	9.4E+03	3.0E-01	3.1E-02
1,1-Dichloroethane	75-34-3	0.000249	0.005	0.126	1	--	N	8.0E+02	8.0E+01	1.0E+05	1.0E+04	7.8E+03	7.8E+02	1.6E+05	3.0E-01	--
1,1-Dichloroethene	75-35-4	0.000443	0.005	0.276	1	7.0E+00	N	3.5E+02	3.5E+01	5.1E+04	5.1E+03	3.9E+03	3.9E+02	1.2E+04	--	--
1,2-Dibromoethane	106-93-4	0.000101	0.005	0.221	1	5.0E-02	C	7.5E-04	7.5E-04	3.4E-02	3.4E-02	7.5E-03	7.5E-03	1.8E+04	5.0E+00	--
1,2-Dibromo-3-chloropropane	96-12-8	0.000267	0.010	0.439	5	2.0E-01	C/C	4.2E-01	4.2E-02	2.0E+00	2.0E+00	4.6E-01	4.6E-01	--	--	--
1,2-Dichlorobenzene	95-50-1	0.000175	0.005	0.210	1	6.0E+02	N	2.7E+02	2.7E+01	9.2E+04	9.2E+03	7.0E+03	7.0E+02	7.6E+02	1.0E-01	3.5E-02
1,2-Dichloroethane	107-06-2	0.000274	0.005	0.074	1	5.0E+00	C	1.2E-01	1.2E-01	3.1E+01	3.1E+01	7.0E+00	7.0E+00	2.0E+04	8.7E+02	--
cis-1,2-Dichloroethene	156-59-2	0.000074	0.005	0.112	1	7.0E+01	N	6.1E+01	6.1E+00	1.0E+04	1.0E+03	7.8E+02	7.8E+01	1.2E+04	3.0E-01	--
trans-1,2-Dichloroethene	156-60-5	0.000381	0.005	0.175	1	1.0E+02	N	1.2E+02	1.2E+01	2.0E+04	2.0E+03	1.6E+03	1.6E+02	1.2E+04	3.0E-01	--
1,2-Dichloropropane	78-87-5	0.000265	0.005	0.210	1	5.0E+00	C	1.6E-01	1.6E-01	4.2E+01	4.2E+01	9.4E+00	9.4E+00	5.7E+03	3.0E-01	--
1,2,3-Trichlorobenzene	87-61-6	0.000536	0.005	0.158	1	--	--	--	--	--	--	--	--	5.0E+01	1.0E-01	4.0E-02
1,2,4-Trichlorobenzene	120-82-1	0.000134	0.005	0.260	1	7.0E+01	N	7.2E+00	7.2E-01	1.0E+04	1.0E+03	7.8E+02	7.8E+01	5.0E+01	1.0E-01	4.0E-02
1,3-Dichlorobenzene	541-73-1	0.000102	0.005	0.054	1	--	N	1.8E+02	1.8E+01	3.1E+04	3.1E+03	2.3E+03	2.3E+02	7.6E+02	--	--
1,4-Dichlorobenzene	106-46-7	0.000235	0.005	0.085	1	7.5E+01	C	4.7E-01	4.7E-01	1.2E+02	1.2E+02	2.7E+01	2.7E+01	7.6E+02	1.0E-01	1.1E-01
2-Butanone	78-93-3	0.001250	0.010	2.240	20	--	N	1.9E+03	1.9E+02	6.1E+05	6.1E+04	4.7E+04	4.7E+03	3.2E+06	--	--
2-Hexanone	591-78-6	0.000447	0.010	1.932	20	--	N	1.5E+03	1.5E+02	4.1E+04	4.1E+03	3.1E+03	3.1E+02	4.3E+05	--	--
4-Methyl-2-pentanone	108-10-1	0.000852	0.010	0.463	20	--	N	2.0E+03	2.0E+02	8.2E+04	8.2E+03	6.3E+03	6.3E+02	4.6E+05	1.0E+02	--
Acetone	67-64-1	0.004510	0.010	4.148	20	--	N	6.1E+02	6.1E+01	1.0E+05	1.0E+04	7.8E+03	7.8E+02	9.0E+06	--	--
Benzene	71-43-2	0.000273	0.005	0.121	1	5.0E+00	C	3.4E-01	3.4E-01	5.2E+01	5.2E+01	1.2E+01	1.2E+01	5.3E+03	1.0E-01	--
Bromochloromethane	74-97-5	0.000570	0.005	0.122	1	--	--	--	--	--	--	--	--	1.1E+04	3.0E+03	--
Bromodichloromethane	75-27-4	0.000245	0.005	0.136	1	--	C	1.7E-01	1.7E-01	4.6E+01	4.6E+01	1.0E+01	1.0E+01	1.1E+04	4.5E+02	--
Bromoform	75-25-2	0.000131	0.005	0.228	1	--	C	8.5E+00	8.5E+00	3.6E+02	3.6E+02	8.1E+01	8.1E+01	--	--	--
Bromomethane	74-83-9	0.000343	0.005	0.304	1	--	N	8.5E+00	8.5E-01	1.4E+03	1.4E+02	1.1E+02	1.1E+01	--	--	--
Carbon disulfide	75-15-0	0.000733	0.005	0.153	5	--	N	1.0E+03	1.0E+02	1.0E+05	1.0E+04	7.8E+03	7.8E+02	2.0E+00	--	--
Carbon tetrachloride	56-23-5	0.000305	0.005	0.142	1	5.0E+00	C	1.6E-01	1.6E-01	2.2E+01	2.2E+01	4.9E+00	4.9E+00	3.5E+04	3.0E-01	--
Chlorobenzene	108-90-7	0.000107	0.005	0.115	1	1.0E+02	N	1.1E+02	1.1E+01	2.0E+04	2.0E+03	1.6E+03	1.6E+02	5.0E+01	1.0E-01	--
Chloroethane	75-00-3	0.000395	0.005	0.225	1	--	C	3.6E+00	3.6E+00	9.9E+02	9.9E+02	2.2E+02	2.2E+02	--	--	--
Chloroform	67-66-3	0.000246	0.005	0.238	1	--	C/N	1.5E-01	1.5E-01	1.0E+04	1.0E+03	7.8E+02	7.8E+01	1.2E+03	3.0E-01	--
Chloromethane	74-87-3	0.000395	0.005	0.250	1	--	N	1.9E+02	1.9E+01	--	--	--	--	--	--	--
Cyclohexane	110-82-7	0.000319	0.010	0.258	5	--	--	--	--	--	--	--	--	--	--	--
cis-1,3-Dichloropropene[1]	10061-01-5	0.000392	0.005	0.114	1	--	C	4.4E-01	4.4E-01	2.9E+01	2.9E+01	6.4E+00	6.4E+00	2.4E+02	3.0E-01	--
trans-1,3-Dichloropropene[1]	10061-02-6	0.000341	0.005	0.110	1	--	C	4.4E-01	4.4E-01	2.9E+01	2.9E+01	6.4E+00	6.4E+00	2.4E+02	3.0E-01	--
Dichlorodifluoromethane	75-71-8	0.000493	0.005	0.162	1	--	N	3.5E+02	3.5E+01	2.0E+05	2.0E+04	1.6E+04	1.6E+03	1.1E+04	--	--
Dibromochloromethane	124-48-1	0.000493	0.005	0.162	1	--	C	1.3E-01	1.3E-01	3.4E+01	3.4E+01	7.6E+00	7.6E+00	1.1E+04	--	--
Ethylbenzene	100-41-4	0.000218	0.005	0.112	1	7.0E+02	N	1.3E+03	1.3E+02	1.0E+05	1.0E+04	7.8E+03	7.8E+02	3.2E+04	1.0E-01	1.0E-02
Isopropylbenzene	98-82-8	0.000189	0.005	0.138	1	--	N	6.6E+02	6.6E+01	1.0E+05	1.0E+04	7.8E+03	7.8E+02	--	--	--
Methyl acetate	79-20-9	0.000668	0.010	1.974	10	--	N	6.1E+03	6.1E+02	1.0E+06	1.0E+05	7.8E+04	7.8E+03	--	--	--
Methylcyclohexane	108-87-2	0.000167	0.010	0.283	5	--	N	6.3E+03	6.3E+02	--	--	--	--	--	--	--
methyl tert-Butyl ether	1634-04-4	0.000580	0.005	0.074	1	--	C	2.6E+00	2.6E+00	7.2E+02	7.2E+02	1.6E+02	1.6E+02	--	--	--
Methylene chloride	75-09-2	0.000318	0.005	0.135	4	5.0E+00	C	4.1E+00	4.1E+00	3.8E+02	3.8E+02	8.5E+01	8.5E+01	1.1E+04	3.0E-01	--

Table 2-5 (Continued)
Summary of Analyte Method Detection Limits, Reporting Limits, and Risk Screening Criteria for
TCL VOCs (by EPA Method 8260B)
Soil and Water Samples
SSP WPA for Nine SWMUs and Three AOCs
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 Draft BTAG Screening Levels		
		Soil		Water												
		MDL mg/kg	Reporting Limit mg/kg	MDL µg/L	Reporting Limit µg/L	µg/L	C/N	Tap water RBC µg/L	Adjusted Tap Water RBC µg/L	Soil RBC (Industrial) mg/kg	Adjusted Soil RBC (Industrial) mg/kg	Soil RBC (Residential) mg/kg	Adjusted Soil RBC (Residential) mg/kg	Aqueous Fresh Water µg/L	Soil mg/kg	Sediment mg/kg
Styrene	100-42-5	0.000277	0.005	0.201	1	1.0E+02	N	1.6E+03	1.6E+02	2.0E+05	2.0E+04	1.6E+04	1.6E+03	--	1.0E-01	--
Tetrachloroethene	127-18-4	0.000238	0.005	0.115	1	5.0E+00	C	5.3E-01	5.3E-01	1.4E+02	1.4E+02	3.2E+01	3.2E+01	8.4E+02	3.0E-01	5.7E-02
Toluene	108-88-3	0.000219	0.005	0.101	1	1.0E+03	N	7.5E+02	7.5E+01	2.0E+05	2.0E+04	1.6E+04	1.6E+03	1.7E+04	1.0E-01	--
Trichloroethene	79-01-6	0.000386	0.005	0.106	1	5.0E+00	C	2.6E-02	2.6E-02	7.2E+00	7.2E+00	1.6E+00	1.6E+00	2.2E+04	3.0E-01	--
Trichlorofluoromethane	75-69-4	0.000390	0.005	0.240	1	--	N	1.3E+03	1.3E+02	3.1E+05	3.1E+04	2.3E+04	2.3E+03	1.1E+04	--	--
Vinyl Chloride[2]	75-01-4	0.000180	0.005	0.290	1	2.0E+00	C	1.5E-02	1.5E-02	4.0E+00	4.0E+00	9.0E-02	9.0E-02	1.2E+04	3.0E-01	--
Xylenes	1330-20-7	0.000735	0.005	0.405	3	1.0E+04	N	2.1E+02	2.1E+01	2.0E+05	2.0E+04	1.6E+04	1.6E+03	6.0E+03	1.0E-01	4.0E-02

Notes:

BTAG = Biological Technical Assistance Group Screening Level, Draft 1995
CAS = Chemical Abstract Service
MCL = Maximum Contaminant Level
MDL = Method Detection Limit
Method Detection and Reporting Limits Provided by TriMatrix
mg/kg = Milligram Per Kilogram
µg/L = Microgram Per Liter
RBC = Risk-Based Concentration
USEPA = U.S. Environmental Protection Agency
USEPA Region III Risk-Based Concentration (RBC) values from the April 25, 2003 RBC Table
-- = No Risk Criteria Available

C/N = Carcinogenic or Non-Carcinogenic Status
C = Carcinogenic
CI = Carcinogenic with a hazard quotient of 0.1; non-carcinogenic RBCs taken from Alternate RBC table; see USEPA Region III guidance
N = Non-Carcinogenic
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
(1) = RBC value is for 1,3-Dichloropropene
(2) = RBCs presented are for early-life, except industrial soil RBC, which is for adult
TCL = Target Compound List
VOC = Volatile Organic Compound
bold = Reporting limit was not low enough to meet screening criteria - but MDL does
= Screening criteria cannot be met

Table 2-6
Summary of Analyte Method Detection Limits, Reporting Limits, and Risk Screening Criteria for
TCL SVOCs (by EPA Method 8270C)
Soil and Water Samples
SSP WPA for Nine SWMUs and Three AOCs
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 Draft BTAG Screening Levels		
		Soil		Water												
		MDL mg/kg	Reporting Limit mg/kg	MDL µg/L	Reporting Limit µg/L	µg/L	C/N	Tap water RBC µg/L	Adjusted Tap Water RBC µg/L	Soil RBC (Industrial) mg/kg	Adjusted Soil RBC (Industrial) mg/kg	Soil RBC (Residential) mg/kg	Adjusted Soil RBC (Residential) mg/kg	Aqueous Fresh Water µg/L	Soil mg/kg	Sediment mg/kg
1,1'-Biphenyl	92-52-4	0.00418	0.17	0.0690	5	--	N	3.0E+02	3.0E+01	5.1E+04	5.1E+03	3.9E+03	3.9E+02	--	--	--
1,2,4,5-Tetrachlorobenzene	95-94-3	0.00657	0.17	**0.3088**	5	--	N	1.1E+01	1.1E+00	3.1E+02	3.1E+01	2.3E+01	2.3E+00	5.0E+01	1.0E-01	--
2,2'-oxybis(1-Chloropropane)	108-60-1	0.00434	0.17	**0.0477**	5	--	C	2.6E-01	2.6E-01	4.1E+01	4.1E+01	9.1E+00	9.1E+00	--	--	--
2,4,5-Trichlorophenol	95-95-4	0.00305	0.17	0.0431	5	--	N	3.7E+03	3.7E+02	1.0E+05	1.0E+04	7.8E+03	7.8E+02	6.3E+01	1.0E-01	--
2,4,6-Trichlorophenol	88-06-2	0.00319	0.17	0.0341	5	--	C	6.1E+00	6.1E+00	2.6E+02	2.6E+02	5.8E+01	5.8E+01	9.7E+02	1.0E-01	--
2,4-Dichlorophenol	120-83-2	0.00279	0.17	0.0456	5	--	N	1.1E+02	1.1E+01	3.1E+03	3.1E+02	2.3E+02	2.3E+01	3.7E+02	1.0E-01	--
2,4-Dimethylphenol	105-67-9	0.00594	0.17	0.0483	5	--	N	7.3E+02	7.3E+01	2.0E+04	2.0E+03	1.6E+03	1.6E+02	2.1E+03	1.0E-01	2.9E-02
2,4-Dinitrophenol	51-28-5	0.00520	0.33	**0.0817**	10	--	N	7.3E+01	7.3E+00	2.0E+03	2.0E+02	1.6E+02	1.6E+01	1.5E+02	1.0E-01	--
2,4-Dinitrotoluene	121-14-2	0.00367	0.17	0.0343	5	--	N	7.3E+01	7.3E+00	2.0E+03	2.0E+02	1.6E+02	1.6E+01	2.3E+02	--	--
2,6-Dinitrotoluene	606-20-2	0.00349	0.17	**0.0305**	5	--	N	3.7E+01	3.7E+00	1.0E+03	1.0E+02	7.8E+01	7.8E+00	--	--	--
2-Chloronaphthalene	91-58-7	0.00253	0.17	0.0455	5	--	N	4.9E+02	4.9E+01	8.2E+04	8.2E+03	6.3E+03	6.3E+02	6.2E+02	--	--
2-Chlorophenol	95-57-8	0.00378	0.17	**0.0376**	5	--	N	3.0E+01	3.0E+00	5.1E+03	5.1E+02	3.9E+02	3.9E+01	9.7E+02	1.0E-01	--
2-Methylnaphthalene	91-57-6	0.00312	0.17	0.0381	5	--	N	1.2E+02	1.2E+01	2.0E+04	2.0E+03	1.6E+03	1.6E+02	--	--	7.0E-02
2-Methylphenol	95-48-7	0.00405	0.17	0.0319	5	--	N	1.8E+03	1.8E+02	5.1E+04	5.1E+03	3.9E+03	3.9E+02	--	1.0E-01	6.3E-02
2-Nitroaniline	88-74-4	0.00369	0.17	0.0638	5	--	--	--	--	--	--	--	--	--	--	--
2-Nitrophenol	88-75-5	0.00561	0.17	0.0584	5	--	--	--	--	--	--	--	--	--	--	--
3,3'-Dichlorobenzidine	91-94-1	0.00477	0.17	**0.0570**	5	--	C	1.5E-01	1.5E-01	6.4E+00	6.4E+00	1.4E+00	1.4E+00	--	--	--
3-Nitroaniline	99-09-2	0.00293	0.17	**0.0638**	5	--	C/N	1.1E+01	1.1E+00	3.1E+02	3.1E+01	2.3E+01	2.3E+00	--	--	--
4,6-Dinitro-2-methylphenol	534-52-1	0.00353	0.17	**0.0805**	5	--	N	3.7E+00	3.7E-01	1.0E+02	1.0E+01	7.8E+00	7.8E-01	--	--	--
4-Bromophenyl-phenylether	101-55-3	0.00323	0.17	0.0417	5	--	--	--	--	--	--	--	--	--	--	--
4-Chloro-3-Methylphenol	59-50-7	0.00389	0.17	0.1530	5	--	--	--	--	--	--	--	--	--	--	--
4-Chloroaniline	106-47-8	0.00142	0.17	0.0467	5	--	N	1.5E+02	1.5E+01	4.1E+03	4.1E+02	3.1E+02	3.1E+01	--	--	--
4-Chlorophenyl-phenylether	7005-72-3	0.00491	0.17	0.0435	5	--	--	--	--	--	--	--	--	--	--	--
4-Methylphenol	106-44-5	0.00305	0.17	0.0361	5	--	N	1.8E+02	1.8E+01	5.1E+03	5.1E+02	3.9E+02	3.9E+01	--	1.0E-01	6.7E-01
4-Nitroaniline	100-01-6	0.00524	0.17	**0.0494**	5	--	C/C!	3.3E+00	3.3E+00	1.4E+02	1.4E+02	2.4E+02	2.4E+01	--	--	--
4-Nitrophenol	100-02-7	0.00546	0.33	0.0656	10	--	N	2.9E+02	2.9E+01	8.2E+03	8.2E+02	6.3E+02	6.3E+01	1.5E+02	1.0E-01	--
Acenaphthene	83-32-9	0.00407	0.17	0.0725	5	--	N	3.7E+02	3.7E+01	6.1E+04	6.1E+03	4.7E+03	4.7E+02	5.2E+02	1.0E-01	1.6E-02
Acenaphthylene [1]	208-96-8	0.00364	0.17	0.0334	5	--	N	1.8E+02	1.8E+01	3.1E+04	3.1E+03	2.3E+03	2.3E+02	--	1.0E-01	4.4E-02
Acetophenone	98-86-2	0.00232	0.17	0.1028	5	--	N	4.2E-02	4.2E-03	1.0E+05	1.0E+04	7.8E+03	7.8E+02	--	--	--
Anthracene	120-12-7	0.00244	0.17	0.0412	5	--	N	1.8E+03	1.8E+02	3.1E+05	3.1E+04	2.3E+04	2.3E+03	1.0E-01	1.0E-01	8.5E-02
Atrazine	1912-24-9	0.00384	0.17	**0.0828**	5	3.0E+00	C	3.0E-01	3.0E-01	1.3E+01	1.3E+01	2.9E+00	2.9E+00	--	--	--
Benzaldehyde	100-52-7	0.00428	0.17	0.1523	5	--	N	3.7E+03	3.7E+02	1.0E+05	1.0E+04	7.8E+03	7.8E+02	--	--	--
Benzo(a)anthracene	56-55-3	0.00435	0.17	**0.0500**	5	--	C	9.2E-02	9.2E-02	3.9E+00	3.9E+00	8.7E-01	8.7E-01	6.3E+00	1.0E-01	2.6E-01
Benzo(a)pyrene	50-32-8	**0.00386**	0.17	**0.0349**	5	2.0E-01	C	9.2E-03	9.2E-03	3.9E-01	3.9E-01	8.7E-02	8.7E-02	--	1.0E-01	4.3E-01
Benzo(b)fluoranthene	205-99-2	0.00487	0.17	**0.0519**	5	--	C	9.2E-02	9.2E-02	3.9E+00	3.9E+00	8.7E-01	8.7E-01	--	1.0E-01	3.2E+00
Benzo(g,h,i)perylene [1&2]	191-24-2	0.00179	0.17	0.0436	5	--	N	1.8E+02	1.8E+01	3.1E+04	3.1E+03	2.3E+03	2.3E+02	--	1.0E-01	6.7E-01
Benzo(k)fluoranthene	207-08-9	0.00235	0.17	**0.0267**	5	--	C	9.2E-01	9.2E-01	3.9E+01	3.9E+01	8.7E+00	8.7E+00	--	1.0E-01	--
Bis(2-chloroethoxy)methane	111-91-1	0.00279	0.17	0.0433	5	--	--	--	--	--	--	--	--	1.1E+04	--	--
Bis(2-chloroethyl)ether	111-44-4	0.00462	0.17	0.0596	5	--	C	9.6E-03	9.6E-03	2.6E+00	2.6E+00	5.8E-01	5.8E-01	--	--	--

Table 2-6 (Continued)
Summary of Analyte Method Detection Limits, Reporting Limits, and Risk Screening Criteria for
TCL SVOCs (by EPA Method 8270C)
Soil and Water Samples
SSP WPA for Nine SWMUs and Three AOCs
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 Draft BTAG Screening Levels		
		Soil		Water												
		MDL mg/kg	Reporting Limit mg/kg	MDL µg/L	Reporting Limit µg/L	µg/L	C/N	Tap water RBC µg/L	Adjusted Tap Water RBC µg/L	Soil RBC (Industrial) mg/kg	Adjusted Soil RBC (Industrial) mg/kg	Soil RBC (Residential) mg/kg	Adjusted Soil RBC (Residential) mg/kg	Aqueous Fresh Water µg/L	Soil mg/kg	Sediment mg/kg
Bis(2-ethylhexyl)phthalate	117-81-7	0.00406	0.17	**0.1400**	5	6.0E+00	C	4.8E+00	4.8E+00	2.0E+02	2.0E+02	4.6E+01	4.6E+01	3.0E+01	--	1.3E+00
Butylbenzylphthalate	85-68-7	0.00469	0.17	0.0485	5	--	N	7.3E+03	7.3E+02	2.0E+05	2.0E+04	1.6E+04	1.6E+03	3.0E+00	--	6.3E-02
Caprolactam	105-60-2	0.00383	0.33	0.1052	5	--	N	1.8E+04	1.8E+03	5.1E+05	5.1E+04	3.9E+04	3.9E+03	--	--	--
Carbazole	86-74-8	0.00348	0.17	**0.0341**	5	--	C	3.3E+00	3.3E+00	1.4E+02	1.4E+02	3.2E+01	3.2E+01	--	--	--
Chrysene	218-01-9	0.00365	0.17	0.0367	5	--	C	9.2E+00	9.2E+00	3.9E+02	3.9E+02	8.7E+01	8.7E+01	--	1.0E-01	3.8E-01
Dibenz(a,h)anthracene	53-70-3	**0.00422**	0.17	0.0527	5	--	C	9.2E-03	**9.2E-03**	3.9E-01	3.9E-01	8.7E-02	8.7E-02	--	1.0E-01	6.3E-02
Dibenzofuran	132-64-9	0.00275	0.17	**0.0453**	5	--	N	1.2E+01	1.2E+00	2.0E+03	2.0E+02	1.6E+02	1.6E+01	--	--	5.4E-01
Diethylphthalate	84-66-2	0.00339	0.17	0.0543	5	--	N	2.9E+04	2.9E+03	8.2E+05	8.2E+04	6.3E+04	6.3E+03	3.0E+00	--	2.0E-01
Dimethylphthalate	131-11-3	0.00355	0.17	0.0373	5	--	N	3.7E+05	3.7E+04	1.0E+07	1.0E+06	7.8E+05	7.8E+04	3.0E+00	--	7.1E-02
Di-n-butylphthalate	84-74-2	0.00883	0.17	0.1370	5	--	N	3.7E+03	3.7E+02	1.0E+05	1.0E+04	7.8E+03	7.8E+02	3.0E-01	--	1.4E+00
Di-n-octylphthalate	117-84-0	0.00360	0.17	0.0313	5	--	N	7.3E+02	7.3E+01	2.0E+04	2.0E+03	1.6E+03	1.6E+02	3.0E-01	--	6.2E+00
Fluoranthene	206-44-0	0.00284	0.17	0.0478	5	--	N	1.5E+03	1.5E+02	4.1E+04	4.1E+03	3.1E+03	3.1E+02	4.0E+03	1.0E-01	6.0E-01
Fluorene	86-73-7	0.00508	0.17	0.0316	5	--	N	2.4E+02	2.4E+01	4.1E+04	4.1E+03	3.1E+03	3.1E+02	4.3E+02	1.0E-01	1.9E-02
Hexachlorobenzene	118-74-1	0.00469	0.17	**0.0365**	5	1.0E+00	C	4.2E-02	4.2E-02	1.8E+00	1.8E+00	4.0E-01	4.0E-01	3.7E+00	--	2.2E-02
Hexachlorobutadiene	87-68-3	0.00331	0.17	**0.0391**	5	--	CI	7.3E+00	7.3E-01	2.0E+02	2.0E+01	1.6E+01	1.6E+00	9.3E+00	--	1.1E-02
Hexachlorocyclopentadiene	77-47-4	0.00381	0.17	0.0238	5	5.0E+01	N	2.2E+02	2.2E+01	6.1E+03	6.1E+02	4.7E+02	4.7E+01	5.2E+00	--	--
Hexachloroethane	67-72-1	0.00506	0.17	**0.0500**	5	--	CI	3.7E+01	3.7E+00	1.0E+03	1.0E+02	7.8E+01	7.8E+00	5.4E+02	--	--
Indeno(1,2,3-cd)pyrene	193-39-5	0.00393	0.17	**0.0384**	5	--	C	9.2E-02	9.2E-02	3.9E+00	3.9E+00	8.7E-01	8.7E-01	--	1.0E-01	6.0E-01
Isophorone	78-59-1	0.00239	0.17	0.0990	5	--	C	7.0E+01	7.0E+01	3.0E+03	3.0E+03	6.7E+02	6.7E+02	1.2E+05	--	--
Naphthalene	91-20-3	0.00316	0.17	**0.0397**	5	--	N	6.5E+00	6.5E-01	2.0E+04	2.0E+03	1.6E+03	1.6E+02	1.0E+02	1.0E-01	1.6E-01
Nitrobenzene	98-95-3	0.00399	0.17	**0.0615**	5	--	N	3.5E+00	3.5E-01	5.1E+02	5.1E+01	3.9E+01	3.9E+00	2.7E+04	--	--
N-Nitrosodi-n-propylamine	621-64-7	**0.00305**	0.17	0.0345	5	--	C	9.6E-03	**9.6E-03**	4.1E-01	4.1E-01	9.1E-02	9.1E-02	--	--	--
N-Nitrosodiphenylamine	86-30-6	0.00338	0.17	0.0645	5	--	C	1.4E+01	1.4E+01	5.8E+02	5.8E+02	1.3E+02	1.3E+02	5.9E+03	--	2.8E-02
Pentachlorophenol	87-86-5	0.00278	0.33	**0.0400**	10	1.0E+00	C	5.6E-01	5.6E-01	2.4E+01	2.4E+01	5.3E+00	5.3E+00	1.3E+01	1.0E-01	3.6E-01
Phenanthrene [1]	85-01-8	0.00248	0.17	0.0439	5	--	N	1.8E+02	1.8E+01	3.1E+04	3.1E+03	2.3E+03	2.3E+02	6.3E+00	1.0E-01	2.4E-01
Phenol	108-95-2	0.00602	0.17	0.0247	5	--	N	1.1E+04	1.1E+03	3.1E+05	3.1E+04	2.3E+04	2.3E+03	7.9E+01	1.0E-01	4.2E-01
Pyrene	129-00-0	0.00321	0.17	0.0455	5	--	N	1.8E+02	1.8E+01	3.1E+04	3.1E+03	2.3E+03	2.3E+02	--	1.0E-01	6.7E-01

Notes:
BTAG = Biological Technical Assistance Group Screening Level, Draft 1995
CAS = Chemical Abstract Service
MCL = Maximum Contaminant Level
MDL = Method Detection Limit
Method Detection and Reporting Limits Provided by TriMatrix
mg/kg = Milligram Per Kilogram
µg/L = Microgram Per liter
RBC = Risk-Based Concentration
USEPA = U.S. Environmental Protection Agency
USEPA Region III Risk-Based Concentration (RBC) values from the April 25, 2003 RBC Table
-- = No Risk Criteria Available
C/N = Carcinogenic or Non-Carcinogenic Status
C = Carcinogenic
CI = Carcinogenic with a hazard quotient of 0.1; non-carcinogenic RBCs taken from Alternate RBC table; see USEPA Region III guidance
N = Non-Carcinogenic
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
1 = RBC value for pyrene was used for these compounds
TCL = Target Compound List
SVOC = Semivolatile Organic Compound
bold = Reporting limit was not low enough to meet screening criteria - but MDL does
= Screening criteria cannot be met

Table 2-7
Summary of Method Detection Limits, Reporting Limits, and Risk Screening Criteria for PAHs (by EPA Method 8310)
Soil and Water Samples
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, VA

Compound	CAS Number	Laboratory-Specific Method Detection and Reporting Limits				USEPA MCLs	USEPA Region III Risk-Based Concentrations							USEPA Region III Draft BTAG Screening Levels		
		Soil		Water												
		MDL	Reporting Limit	MDL	Reporting Limit		C/N	Tap water RBC	Adjusted Tap Water RBC	Soil RBC (Industrial)	Adjusted Soil RBC (Industrial)	Soil RBC (Residential)	Adjusted Soil RBC (Residential)	Aquatic Fresh Water	Soil	Sediment
		mg/kg	mg/kg	µg/L	µg/L	µg/L		µg/L	µg/L	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	mg/kg	mg/kg
Acenaphthene	83329	0.0269	0.10	0.2060	1.2	–	N	3.7E+02	3.7E+01	6.1E+04	6.1E+03	4.7E+03	4.7E+02	5.2E+02	1.0E-01	1.6E-02
Acenaphthylene [1]	208968	0.0233	0.21	0.3140	1.2	–	N	1.8E+02	1.8E+01	3.1E+04	3.1E+03	2.3E+03	2.3E+02	–	1.0E-01	4.4E-02
Anthracene	120127	0.0003	0.021	0.0092	1.2	–	N	1.8E+03	1.8E+02	3.1E+05	3.1E+04	2.3E+04	2.3E+03	1.0E-01	1.0E-01	8.5E-02
Benzo(a)anthracene	56553	0.0007	0.021	0.0179	0.062	–	C	9.2E-02	9.2E-02	3.9E+00	3.9E+00	8.7E-01	8.7E-01	6.3E+00	1.0E-01	2.6E-01
Benzo(a)pyrene	50328	0.0020	0.021	0.0175	0.062	2.0E-01	C	9.2E-03	9.2E-03	3.9E-01	3.9E-01	8.7E-02	8.7E-02	–	1.0E-01	4.3E-01
Benzo(b)fluoranthene	205992	0.0014	0.021	0.0278	0.09	–	C	9.2E-02	9.2E-02	3.9E+00	3.9E+00	8.7E-01	8.7E-01	–	1.0E-01	3.2E+00
Benzo(g,h,i)perylene [1]	191242	0.0054	0.021	0.0444	1.2	–	N	1.8E+02	1.8E+01	3.1E+04	3.1E+03	2.3E+03	2.3E+02	–	1.0E-01	6.7E-01
Benzo(k)fluoranthene	207089	0.0012	0.021	0.0169	0.12	–	C	9.2E-01	9.2E-01	3.9E+01	3.9E+01	8.7E+00	8.7E+00	–	1.0E-01	–
Chrysene	218019	0.0016	0.021	0.0152	1.2	–	C	9.2E+00	9.2E+00	3.9E+02	3.9E+02	8.7E+01	8.7E+01	–	1.0E-01	3.8E-01
Dibenzo(a,h)anthracene	53703	0.0037	0.021	0.0634	0.24	–	C	9.2E-03	9.2E-03	3.9E-01	3.9E-01	8.7E-02	8.7E-02	–	1.0E-01	6.3E-02
Fluoranthene	206440	0.0038	0.021	0.0476	1.2	–	N	1.5E+03	1.5E+02	4.1E+04	4.1E+03	3.1E+03	3.1E+02	4.0E+03	1.0E-01	6.0E-01
Fluorene	86737	0.0013	0.021	0.0335	1.2	–	N	2.4E+02	2.4E+01	4.1E+04	4.1E+03	3.1E+03	3.1E+02	4.3E+02	1.0E-01	1.9E-02
Indeno(1,2,3-cd)pyrene	193395	0.0017	0.021	0.0174	0.062	–	C	9.2E-02	9.2E-02	3.9E+00	3.9E+00	8.7E-01	8.7E-01	–	1.0E-01	6.0E-01
Naphthalene	91203	0.0204	0.10	0.2080	0.62	–	N	6.5E+00	6.5E-01	2.0E+04	2.0E+03	1.6E+03	1.6E+02	1.0E+02	1.0E-01	1.6E-01
Phenanthrene [1]	85018	0.0015	0.021	0.0212	1.2	–	N	1.8E+02	1.8E+01	3.1E+04	3.1E+03	2.3E+03	2.3E+02	6.3E+00	1.0E-01	2.4E-01
Pyrene	129000	0.0037	0.021	0.0233	1.2	–	N	1.8E+02	1.8E+01	3.1E+04	3.1E+03	2.3E+03	2.3E+02	–	1.0E-01	6.7E-01

Notes:

BTAG = Biological Technical Assistance Group Screening Level, Draft 1995
CAS = Chemical Abstract Service
MCL = Maximum Contaminant Level
MDL = Method Detection Limit
Method Detection and Reporting Limits Provided by TriMatrix
mg/kg = Milligram Per Kilogram
µg/L = Microgram Per Liter
RBC = Risk-Based Concentration
USEPA = U.S. Environmental Protection Agency
USEPA Region III Risk-Based Concentration (RBC) values from the April 25, 2003 RBC Table
– = No Risk Criteria Available

C/N = Carcinogenic or Non-Carcinogenic Status
C = Carcinogenic
CI = Carcinogenic with a hazard quotient of 0.1; non-carcinogenic RBCs taken from Alternate RBC table; see USEPA Region III guidance
N = Non-Carcinogenic
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
1 = the RBC for pyrene was used for these compounds
PAH = Polynuclear Aromatic Hydrocarbon
bold = Reporting limit was not low enough to meet screening criteria - but MDL does
= Screeing critiera cannot be met

Table 2-8
Summary of Analyte Method Detection Limits, Reporting Limits, and Risk Screening Criteria for
TCL Pesticides (by EPA Method 8081A)
Soil and Water Samples
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammuniton Plant, Radford, Virginia

Compound	CAS Number	Laboratory-Specific Method Detection and Reporting Limits				USEPA MCLs	USEPA Region III Risk-Based Concentrations							USEPA Region III Draft BTAG Screening Levels		
		Soil		Water												
		MDL mg/kg	Reporting Limit mg/kg	MDL µg/L	Reporting Limit µg/L	µg/L	C/N	Tap water RBC µg/L	Adjusted Tap Water RBC µg/L	Soil RBC (Industrial) mg/kg	Adjusted Soil RBC (Industrial) mg/kg	Soil RBC (Residential) mg/kg	Adjusted Soil RBC (Residential) mg/kg	Aquatic Fresh Water µg/L	Soil mg/kg	Sediment mg/kg
4,4'-DDD	72-54-8	0.000238	0.020	0.0016	0.10	--	C	2.8E-01	2.8E-01	1.2E+01	1.2E+01	2.7E+00	2.7E+00	6.0E-01	1.0E-01	1.6E-02
4,4'-DDE	72-55-9	0.000175	0.020	0.0025	0.10	--	C	2.0E-01	2.0E-01	8.4E+00	8.4E+00	1.9E+00	1.9E+00	1.1E+03	1.0E-01	2.2E-03
4,4'-DDT	50-29-3	0.000180	0.020	0.0018	0.10	--	C	2.0E-01	2.0E-01	8.4E+00	8.4E+00	1.9E+00	1.9E+00	1.0E-03	1.0E-01	1.6E-03
Aldrin	309-00-2	0.000304	0.020	0.0019	0.05	--	C	3.9E-03	3.9E-03	1.7E-01	1.7E-01	3.8E-02	3.8E-02	3.0E+00	1.0E-01	--
alpha-BHC	319-84-6	0.000303	0.020	0.0015	0.05	--	C	1.1E-02	1.1E-02	4.5E-01	4.5E-01	1.0E-01	1.0E-01	--	--	--
alpha-Chlordane[1]	5103-71-9	0.000434	0.020	0.0024	0.05	2.0E+00	C	1.9E-01	1.9E-01	8.2E+00	8.2E+00	1.8E+00	1.8E+00	4.3E-03	1.0E-01	--
gamma-Chlordane[1]	5103-74-2	0.000703	0.020	0.0023	0.05	2.0E+00	C	1.9E-01	1.9E-01	8.2E+00	8.2E+00	1.8E+00	1.8E+00	4.3E-03	1.0E-01	--
beta-BHC	319-85-7	0.001130	0.020	0.0039	0.05	--	C	3.7E-02	3.7E-02	1.6E+00	1.6E+00	3.5E-01	3.5E-01	--	--	--
delta-BHC	319-86-8	0.000818	0.020	0.0025	0.05	--	--	--	--	--	--	--	--	--	--	--
Dieldrin	60-57-1	0.000309	0.020	0.0034	0.10	--	C	4.2E-03	4.2E-03	1.8E-01	1.8E-01	4.0E-02	4.0E-02	1.9E-03	1.0E-01	--
Endosulfan I[2]	959-98-8	0.000910	0.020	0.0026	0.05	--	N	2.2E+02	2.2E+01	6.1E+03	6.1E+02	4.7E+02	4.7E+01	5.6E-02	--	--
Endosulfan II[2]	33213-65-9	0.000214	0.020	0.0021	0.10	--	N	2.2E+02	2.2E+01	6.1E+03	6.1E+02	4.7E+02	4.7E+01	5.6E-02	--	--
Endosulfan sulfate	1031-07-8	0.000503	0.020	0.0022	0.10	--	--	--	--	--	--	--	--	--	--	--
Endrin	72-20-8	0.000298	0.020	0.0038	0.10	2.0E+00	N	1.1E+01	1.1E+00	3.1E+02	3.1E+01	2.3E+01	2.3E+00	2.3E-03	1.0E-01	--
Endrin aldehyde	7421-93-4	0.00110	0.020	0.0053	0.10	--	--	--	--	--	--	--	--	--	--	--
Endrin ketone	53494-70-5	0.000275	0.020	0.0020	0.10	--	--	--	--	--	--	--	--	--	--	--
gamma-BHC (Lindane)	58-59-9	0.000194	0.020	0.0016	0.05	2.0E-01	C	5.2E-02	5.2E-02	2.2E+00	2.2E+00	4.9E-01	4.9E-01	8.0E-02	1.0E-01	--
Heptachlor	76-44-8	0.000705	0.020	0.0021	0.05	4.0E-01	C	1.5E-02	1.5E-02	6.4E-01	6.4E-01	1.4E-01	1.4E-01	3.8E-03	--	--
Heptachlor epoxide	1024-57-3	0.000455	0.020	0.0022	0.05	2.0E-01	C	7.4E-03	7.4E-03	3.1E-01	3.1E-01	7.0E-02	7.0E-02	3.8E-03	1.0E-01	--
Methoxychlor	72-43-5	0.001590	0.020	0.0032	0.50	4.0E+01	N	1.8E+02	1.8E+01	5.1E+03	5.1E+02	3.9E+02	3.9E+01	3.0E-02	1.0E-01	--
Toxaphene	8001-35-2	0.023345	0.170	0.066	1.0	3.0E+00	C	6.1E-02	6.1E-02	2.6E+00	2.6E+00	5.8E-01	5.8E-01	2.0E-04	--	--

Notes:
BTAG = Biological Technical Assistance Group Screening Level, Draft 1995
CAS = Chemical Abstract Service
MCL = Maximum Contaminant Level
MDL = Method Detection Limit
Method Detection and Reporting Limits Provided by TriMatrix
mg/kg = Milligram Per Kilogram
µg/L = Microgram Per Liter
RBC = Risk-Based Concentration
USEPA = U.S. Environmental Protection Agency
USEPA Region III Risk-Based Concentration (RBC) values from the April 25, 2003 RBC Table
-- = No Risk Criteria Available

C/N = Carcinogenic or Non-Carcinogenic Status
C = Carcinogenic
C! = Carcinogenic with a hazard quotient of 0.1; non-carcinogenic RBCs taken from Alternate RBC table; see USEPA Region III guidance
N = Non-Carcinogenic
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
1 = Chlordane value is for sum of isomers
2 = Endosulfan value is for sum of isomers
TCL = Target Compound List
bold = Reporting limit was not low enough to meet screening criteria - but MDL does
= Screening criteria cannot be met

Table 2-9
Summary of Analyte Method Detection Limits, Reporting Limits, and Risk Screening Criteria for PCBs (by EPA Method 8082) and Perchlorate (by EPA Method 314.0)
Soil and Water Samples
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammuniton Plant, Radford, Virginia

Compound	CAS Number	Laboratory-Specific Method Detection and Reporting Limits				USEPA MCLs	USEPA Region III Risk-Based Concentrations							USEPA Region III Draft BTAG Screening Levels		
		Soil		Water		Water										
		MDL mg/kg	Reporting Limit mg/kg	MDL µg/L	Reporting Limit µg/L	µg/L	C/N	Tap water RBC ug/L	Adjusted Tap Water RBC ug/L	Soil RBC (Industrial) mg/kg	Adjusted Soil RBC (Industrial) mg/kg	Soil RBC (Residential) mg/kg	Adjusted Soil RBC (Residential) mg/kg	Aqueous Fresh Water µg/L	Soil mg/kg	Sediment mg/kg
Aroclor 1016	12674-11-2	0.017	0.066	0.0753	0.3	5.0E-01	CI	2.6E+00	2.6E-01	7.2E+01	7.2E+00	5.5E+00	5.5E-01	1.4E-02	1.0E-01	2.3E-02
Aroclor 1221	11104-28-2	0.005	0.033	0.1470	0.5	5.0E-01	C	3.3E-02	3.3E-02	1.4E+00	1.4E+00	3.2E-01	3.2E-01	1.4E-02	1.0E-01	2.3E-02
Aroclor 1232	11141-16-5	0.005	0.033	0.0794	0.3	5.0E-01	C	3.3E-02	3.3E-02	1.4E+00	1.4E+00	3.2E-01	3.2E-01	1.4E-02	1.0E-01	2.3E-02
Aroclor 1242	53469-21-9	0.004	0.033	0.0809	0.3	5.0E-01	C	3.3E-02	3.3E-02	1.4E+00	1.4E+00	3.2E-01	3.2E-01	1.4E-02	1.0E-01	2.3E-02
Aroclor 1248	12672-29-6	0.006	0.033	0.0432	0.2	5.0E-01	C	3.3E-02	3.3E-02	1.4E+00	1.4E+00	3.2E-01	3.2E-01	1.4E-02	1.0E-01	2.3E-02
Aroclor 1254	11097-69-1	0.003	0.033	0.0341	0.1	5.0E-01	C/CI	3.3E-02	3.3E-02	1.4E+00	1.4E+00	1.6E+00	1.6E-01	1.4E-02	1.0E-01	2.3E-02
Aroclor 1260	11096-82-5	0.007	0.033	0.0481	0.2	5.0E-01	C	3.3E-02	3.3E-02	1.4E+00	1.4E+00	3.2E-01	3.2E-01	1.4E-02	1.0E-01	2.3E-02
Perchlorate	--	n/a	n/a	0.54	2.0	*USEPA screening criteria under development*										

Notes:
BTAG = Biological Technical Assistance Group Screening Level, Draft 1995
CAS = Chemical Abstract Service
MCL = Maximum Contaminant Level
MDL = Method Detection Limit
Method Detection and Reporting Limits Provided by TriMatrix (except Perchlorate)
Perchlorate Method Detection and Reporting Limits Provided by STL Laboratories
mg/kg = Milligram Per Kilogram
µg/L = Microgram Per Liter
RBC = Risk-Based Concentration
USEPA = U.S. Environmental Protection Agency
USEPA Region III Risk-Based Concentration (RBC) values from the April 25, 2003 RBC Table

-- = No Risk Criteria Available
C/N = Carcinogenic or Non-Carcinogenic Status
C = Carcinogenic
CI = Carcinogenic with a hazard quotient of 0.1; non-carcinogenic RBCs taken from Alternate RBC table; see USEPA Region III guidance
N = Non-Carcinogenic
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
PCB = Polychlorinated Biphenyls
bold = Reporting limit was not low enough to meet screening criteria - but MDL does
= Screening criteria cannot be met

Table 2-10
Summary of Analyte Method Detection Limits, Reporting Limits, and Risk Screening Criteria for Explosives (by EPA Method 8330 and 8332)
Soil and Water Samples
SSP WPA for Nine SWMUs and Three AOCs
Radford Army Ammunition Plant, Radford, Virginia

Compounds by Method 8330	CAS Number	Laboratory-Specific Method Detection and Reporting Limits				USEPA MCLs	USEPA Region III Risk-Based Concentrations							USEPA Region III Draft BTAG Screening Levels		
		Soil		Water												
		MDL mg/kg	Reporting Limit mg/kg	MDL µg/L	Reporting Limit µg/L	µg/L	C/N	Tap water RBC µg/L	Adjusted Tap Water RBC µg/L	Soil RBC (Industrial) mg/kg	Adjusted Soil RBC (Industrial) mg/kg	Soil RBC (Residential) mg/kg	Adjusted Soil RBC (Residential) mg/kg	Aqueous Fresh Water µg/L	Soil mg/kg	Sediment mg/kg
1,3,5-Trinitrobenzene	99-35-4	0.140	0.50	0.150	0.65	--	N	1.1E+03	1.1E+02	3.1E+04	3.1E+03	2.3E+03	2.3E+02	--	--	--
1,3-Dinitrobenzene	99-65-0	0.159	0.50	**0.185**	0.65	--	N	3.7E+00	3.7E-01	1.0E+02	1.0E+01	7.8E+00	7.8E-01	1.2E+03	--	--
2,4,6-Trinitrotoluene	118-96-7	0.167	0.50	0.118	0.65	--	CI	1.8E+01	1.8E+00	5.1E+02	5.1E+01	3.9E+01	3.9E+00	--	--	--
2,4-Dinitrotoluene	121-14-2	0.142	0.50	0.150	0.65	--	N	7.3E+01	7.3E+00	2.0E+03	2.0E+02	1.6E+02	1.6E+01	2.3E+02	--	--
2,6-Dinitrotoluene	606-20-2	0.250	1.0	0.217	0.65	--	N	3.7E+01	3.7E+00	1.0E+03	1.0E+02	7.8E+01	7.8E+00	--	--	--
2-Amino-4, 6-dinitrotoluene[1]	355-72-78-2	**0.151**	0.50	0.261	1.0	--	N	2.2E+00	**2.2E-01**	6.1E+01	6.1E+00	4.7E+00	4.7E-01	--	--	--
2-Nitrotoluene	88-72-2	0.266	1.0	0.175	0.65	--	N	6.1E+01	6.1E+00	1.0E+04	1.0E+03	7.8E+02	7.8E+01	--	--	--
3-Nitrotoluene	99-08-1	0.184	1.0	0.413	2.0	--	N	1.2E+02	1.2E+01	2.0E+04	2.0E+03	1.6E+03	1.6E+02	--	--	--
4-Amino-2,6-dinitrotoluene[1]	1946-51-0	**0.162**	0.50	0.283	1.0	--	N	2.2E+00	**2.2E-01**	6.1E+01	6.1E+00	4.7E+00	4.7E-01	--	--	--
4-Nitrotoluene	99-99-0	0.251	1.0	0.488	2.0	--	N	6.1E+01	6.1E+00	1.0E+04	1.0E+03	7.8E+02	7.8E+01	--	--	--
HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine)	2691-41-0	0.229	1.0	0.277	1.0	--	N	1.8E+03	1.8E+02	5.1E+04	5.1E+03	3.9E+03	3.9E+02	--	--	--
Nitrobenzene	98-95-3	0.102	0.50	**0.142**	0.65	--	N	3.5E+00	3.5E-01	5.1E+02	5.1E+01	3.9E+01	3.9E+00	2.7E+04	--	--
RDX (Hexahydro-1,3,5-trinitro-1,3,5-triazine)	121-82-4	0.158	0.50	**0.109**	0.65	--	C	6.1E-01	6.1E-01	2.6E+01	2.6E+01	5.8E+00	5.8E+00	--	--	--
Tetryl (Methyl-2,4,6-trinitrophenylnitramine)	479-45-8	0.169	1.0	0.433	2.0	--	N	3.7E+02	3.7E+01	1.0E+04	1.0E+03	7.8E+02	7.8E+01	--	--	--
Compound by Method 8332																
Nitroglycerin	55-63-0	1.99	10	20.0	60	--	C	4.8E+00	**4.8E+00**	2.0E+02	2.0E+02	4.6E+01	4.6E+01	--	--	--

Notes:

BTAG = Biological Technical Assistance Group Screening Level, Draft 1995
CAS = Chemical Abstract Service
MCL = Maximum Contaminant Level
MDL = Method Detection Limit
Method Detection and Reporting Limits for 8330 Provided by TriMatrix
Method Detection and Reporting Limit for 8332 Provided by CompuChem
mg/kg = Milligram Per Kilogram
µg/L = Microgram Per Liter
RBC = Risk-Based Concentration
USEPA = U.S. Environmental Protection Agency
USEPA Region III Risk-Based Concentration (RBC) values from the April 25, 2003 RBC Table

-- = No Risk Criteria Available
C/N = Carcinogenic or Non-Carcinogenic Status
C = Carcinogenic
CI = Carcinogenic with a hazard quotient of 0.1; non-carcinogenic RBCs taken from Alternate RBC table; see USEPA Region III guidance
N = Non-Carcinogenic
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
1 = RBC value is for the sum of the isomers called aminodinitrotoluenes
bold = Reporting limit was not low enough to meet screening criteria - but MDL does
= Screening criteria cannot be met

Table 2-11
Summary of Analyte Method Detection Limits, Reporting Limits, and Risk Screening Criteria for Dioxins/Furans (by EPA Method 8290)
Soil and Water Samples
SSP WPA for Nine SWMUs and Three AOCs
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 Draft BTAG Screening Levels		
		Soil		Water												
		MDL pg/g	Reporting Limit pg/g	MDL ppq	Reporting Limit ppq	ppq	C/N	Tap water RBC ppq	Adjusted Tap Water RBC ppq	Soil RBC (Industrial) pg/g	Adjusted Soil RBC (Industrial) pg/g	Soil RBC (Residential) pg/g	Adjusted Soil RBC (Residential) pg/g	Aquatic Fresh Water µg/L	Soil mg/kg	Sediment mg/kg
2,3,7,8-TCDD	1746-01-6	0.137	1	2.95	10	3.00E+01	C	4.5E-01	4.5E-01	1.9E+01	1.9E+01	4.3E+00	4.3E+00	1.0E-05	1.0E-02	--
1,2,3,7,8-PeCDD	40321-76-4	0.155	5	7.61	50	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,7,8-HxCDD	39227-28-6	0.225	5	5.08	50	--	--	--	--	--	--	--	--	--	--	--
1,2,3,6,7,8-HxCDD	57653-85-7	0.106	5	4.20	50	--	--	--	--	--	--	--	--	--	--	--
1,2,3,7,8,9-HxCDD	19408-74-3	0.520	5	6.73	50	--	C	1.1E+01	1.1E+01	4.6E+02	4.6E+02	1.0E+02	1.0E+02	--	--	--
1,2,3,4,6,7,8-HpCDD	35822-39-4	0.302	5	8.30	50	--	--	--	--	--	--	--	--	--	--	--
OCDD	3268-87-9	1.050	10	18.4	100	--	--	--	--	--	--	--	--	--	--	--
2,3,7,8-TCDF	51207-31-9	0.153	1	2.87	10	--	--	--	--	--	--	--	--	--	--	--
1,2,3,7,8-PeCDF	57117-41-6	0.331	5	11.1	50	--	--	--	--	--	--	--	--	--	--	--
2,3,4,7,8-PeCDF	57117-31-4	0.299	5	16.8	50	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,7,8-HxCDF	70648-26-9	0.270	5	9.27	50	--	--	--	--	--	--	--	--	--	--	--
1,2,3,6,7,8-HxCDF	57117-44-9	0.243	5	8.03	50	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6,7,8-HxCDF	60851-34-5	0.349	5	7.08	50	--	--	--	--	--	--	--	--	--	--	--
1,2,3,7,8,9-HxCDF	72918-21-9	0.503	5	9.57	50	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-HpCDF	67562-39-4	0.254	5	9.11	50	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,7,8,9-HpCDF	55673-89-7	0.134	5	7.07	50	--	--	--	--	--	--	--	--	--	--	--
OCDF	39001-02-0	0.553	10	9.28	100	--	--	--	--	--	--	--	--	--	--	--

Notes:

BTAG = Biological Technical Assistance Group Screening Level, Draft 1995
CAS = Chemical Abstract Service
MCL = Maximum Contaminant Level
MDL = Method Detection Limit
Method Detection and Reporting Limits Provided by TriMatrix
pg/g = Picogram Per Gram
ppq = Parts Per Quadrillion
RBC = Risk-Based Concentration
USEPA = U.S. Environmental Protection Agency
USEPA Region III Risk-Based Concentration (RBC) values from the April 25, 2003 RBC Table

-- = No Risk Criteria Available
C/N = Carcinogenic or Non-Carcinogenic Status
C = Carcinogenic
C! = Carcinogenic with a hazard quotient of 0.1; non-carcinogenic RBCs taken from Alternate RBC table; see USEPA Region III guidance
N = Non-Carcinogenic
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
bold = Reporting limit was not low enough to meet screening criteria - but MDL does
= Screening critiera cannot be met

Table 2-12
Summary of Analyte Method Detection Limits, Reporting Limits, and Risk Screening Criteria for TAL Metals (by EPA Method 6020/6010B/7000 Series)
Soil and Water Samples
SSP WPA for Nine SWMUs and Three AOCs
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 Draft BTAG Screening Levels		
		Soil			Water														
		Analytical Method	MDL mg/kg	Reporting Limit mg/kg	Analytical Method	MDL µg/L	Reporting Limit µg/L	µg/L	C/N	Tap water RBC µg/L	Adjusted Tap Water RBC µg/L	Soil RBC (Industrial) mg/kg	Adjusted Soil RBC (Industrial) mg/kg	Soil RBC (Residential) mg/kg	Adjusted Soil RBC (Residential) mg/kg	Aquatic Fresh Water µg/L	Soil mg/kg	Sediment mg/kg
Aluminum	7429-90-5	6010B	1.935	10	6010B	20.7	100	–	N	3.7E+04	3.7E+03	1.0E+06	1.0E+05	7.8E+04	7.8E+03	2.5E+01	1.0E+00	–
Antimony	7440-36-0	6020	0.016	0.50	6020	0.083	1.0	6.0E+00	N	1.5E+01	1.5E+00	4.1E+02	4.1E+01	3.1E+01	3.1E+00	3.0E+01	4.8E-01	1.5E+02
Arsenic	7440-38-2	6020	0.047	0.40	6020	0.0623	1.0	1.0E+01	C	4.5E-02	4.6E-02	1.9E+00	1.9E+00	4.3E-01	4.3E-01	4.8E+01	3.3E+02	5.7E-02
Barium	7440-39-3	6010B	0.185	1.0	6010B	2.59	10	2.0E+03	N	2.6E+03	2.6E+02	7.2E+04	7.2E+03	5.5E+03	5.5E+02	1.0E+04	4.4E+02	–
Beryllium	7440-41-7	6010B	0.022	1.0	6010B	0.295	4.0	4.0E+00	N	7.3E+01	7.3E+00	2.0E+03	2.0E+02	1.6E+02	1.6E+01	5.3E+00	2.0E-02	–
Cadmium	7440-43-9	6010B	0.293	1.0	6020	0.033	0.50	5.0E+00	N	1.8E+01	1.8E+00	5.1E+02	5.1E+01	3.9E+01	3.9E+00	5.3E-01	2.5E+00	1.2E+00
Calcium	7440-70-2	6010B	5.243	50	6010B	30.8	200	–	–	–	–	–	–	–	–	–	–	–
Chromium (VI)[1]	7440-47-3	6010B	0.507	5.0	6020	0.150	1.0	1.0E+02	N	1.1E+02	1.1E+01	3.1E+03	3.1E+02	2.3E+02	2.3E+01	2.0E+00	7.5E-03	5.0E-03
Cobalt	7440-48-4	6010B	0.213	1.0	6010B	2.05	10	–	N	7.3E+02	7.3E+01	2.0E+04	2.0E+03	1.6E+03	1.6E+02	3.5E+04	1.0E+02	–
Copper	7440-50-8	6010B	0.236	1.0	6010B	3.22	10	1.3E+03	N	1.5E+03	1.5E+02	4.1E+04	4.1E+03	3.1E+03	3.1E+02	6.5E+00	1.5E+01	3.4E+01
Cyanide	57-12-5	9012A	0.0356	0.50	9012A	3.36	10.0	2.0E+02	N	7.3E+02	7.3E+01	2.0E+04	2.0E+03	1.6E+03	1.6E+02	5.2E+00	5.0E-03	–
Iron	7439-89-6	6010B	0.366	2.0	6010B	5.66	100	–	N	1.1E+04	1.1E+03	3.1E+05	3.1E+04	2.3E+04	2.3E+03	3.2E+02	1.2E+01	–
Lead[2]	7439-92-1	6020	0.013	1.0	6020	0.080	1.0	1.5E+01	–	–	–	1.0E+03	1.0E+03	4.0E+02	4.0E+02	3.2E+00	1.0E-02	4.7E+01
Magnesium	7439-95-4	6010B	2.699	50	6010B	50.5	200	–	–	–	–	–	–	–	–	–	4.4E+03	–
Manganese (non-food)	7439-96-5	6010B	0.122	1.0	6010B	2.02	10	–	N	7.3E+02	7.3E+01	2.0E+04	2.0E+03	1.6E+03	1.6E+02	1.5E+04	3.3E+02	–
Mercury[3]	7439-97-6	7471A	0.008	0.10	7470A	0.115	0.40	2.0E+00	N	1.1E+01	1.1E+00	3.1E+02	3.1E+01	2.3E+01	2.3E+00	1.2E-02	5.8E-02	1.5E-01
Nickel	7440-02-0	6020	0.025	0.50	6020	0.158	1.0	–	N	7.3E+02	7.3E+01	2.0E+04	2.0E+03	1.6E+03	1.6E+02	1.6E+02	2.0E+00	2.1E+01
Potassium	7440-09-7	6010B	5.39	20	6010B	48.0	200	–	–	–	–	–	–	–	–	–	–	–
Selenium	7782-49-2	6020	0.300	1.0	6020	0.146	2.0	5.0E+01	N	1.8E+02	1.8E+01	5.1E+03	5.1E+02	3.9E+02	3.9E+01	5.0E+00	1.8E+00	–
Silver	7440-22-4	6020	0.006	3.0	6020	0.015	0.50	–	N	1.8E+02	1.8E+01	5.1E+03	5.1E+02	3.9E+02	3.9E+01	1.0E-04	9.8E-06	1.0E+00
Sodium	7440-23-5	6010B	24.469	100	6010B	41.3	200	–	–	–	–	–	–	–	–	–	–	–
Thallium	7440-28-0	6020	0.029	0.50	6020	0.045	0.20	2.0E+00	N	2.6E+00	2.6E-01	7.2E+01	7.2E+00	5.5E+00	5.5E-01	4.0E+01	1.0E-03	–
Vanadium	7440-62-2	6010B	0.200	1.0	6010B	3.14	10	–	N	2.6E+02	2.6E+01	7.2E+03	7.2E+02	5.5E+02	5.5E+01	1.0E+04	5.0E-01	–
Zinc	7440-66-6	6010B	0.724	4.0	6010B	5.28	20	–	N	1.1E+04	1.1E+03	3.1E+05	3.1E+04	2.3E+04	2.3E+03	3.0E+01	1.0E+01	1.5E+02

Notes:

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Method Detection and Reporting Limits Provided by TriMatrix
mg/kg = Milligram Per Kilogram
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RBC = Risk-Based Concentration
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USEPA Region III Risk-Based Concentration (RBC) values from the April 25, 2003 RBC Table
– = No Risk Criteria Available

C/N = Carcinogenic or Non-Carcinogenic Status
C = Carcinogenic
CI = Carcinogenic with a hazard quotient of 0.1; non-carcinogenic RBCs taken from Alternate RBC table; see USEPA Region III guidance
N = Non-Carcinogenic
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
1 = Chromium MCL is for total
2 = Lead criteria are Action Levels; see USEPA Region III guidance
3 = Mercuric chloride soil RBC value used
TAL = Target Analyte List
bold = Reporting limit was not low enough to meet screening criteria - but MDL does
= Screening criteria cannot be met

2.5.1 Organics

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

2.5.1.1 VOCs by SW8260B

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 (see Section 1.2 of Method SW8260B). The analytes are introduced directly to a wide-bore capillary column or cryo-focused 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 mass spectrometer (MS) interfaced to the gas chromatograph (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.

2.5.1.2 SVOCs by SW8270C

The samples are prepared for analysis by GC/MS using Method 3520C for aqueous media and Method 3540C for solid media, or other appropriate methods. The semivolatile 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.

2.5.1.3 Pesticides by SW8081A

A measured volume or weight of sample (approximately one liter for liquids, and two to 30 g (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.

2.5.1.4 PCBs by SW8082

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. Aqueous samples are

extracted at neutral pH using Method 3520C (continuous liquid-liquid extractor), or other appropriate technique. Solid samples are extracted using Method 3540C (Soxhlet) or other appropriate technique. Extracts for PCB analysis may be subjected to a sulfuric acid/potassium permanganate cleanup (Method 3665) or sulfuric acid cleanup (Method 3660 B) designed specifically for these analytes. This cleanup technique will remove (destroy) many single component organochlorine or organophosphate pesticides. Therefore, Method 8082 is not applicable to the analysis of those compounds. Instead, use Method 8081. After cleanup, the extract is analyzed by injecting a 2 µL aliquot into a gas chromatograph with a narrow- or wide-bore fused silica capillary column. An electron capture detector (ECD) detects analytes eluted from the capillary column. Comparing and summing the response of at least three peaks within specified retention time windows to a five-point calibration curve accomplishes quantitation. The chromatographic data may be used to identify the seven Arochlors found in Section 1.1 of Method SW8082, individual PCB congeners, or total PCBs.

2.5.1.5 Dioxin and Furans by SW8290

Method 8290 provides procedures for the detection and quantitative measurement of polychlorinated dibenzo-p-dioxins (tetra- though octa-chlorinated homologues; PCDDs) and polychlorinated dibenzofurans (tetra- though octa-chlorinated homologues; PCDFs) in a variety of environmental matrices and at parts-per-trillion (ppt) to parts-per-quadrillion (ppq) concentrations. A specified amount of sample is spiked with a solution containing specified amounts of each of the nine isotopically ($^{13}C_{12}$) labeled PCDDs/PCDFs. The sample is then extracted according to a matrix specific extraction procedure. The samples are prepared for analysis by high-resolution gas chromatography/high-resolution mass spectrometry (HRGC/HRMS) using the matrix specific extraction (refer to Method 8290) and analyte specific cleanup procedures (refer to Method 8290). A high-resolution capillary column (60 m DB-5, J&W Scientific, or equivalent) is used in this method. However, no single column is known to resolve all isomers.

In order to ascertain the concentration of the 2,3,7,8-TCDF (if detected on the DB-5 column), the sample extract must be reanalyzed on a column capable of 2,3,7,8-TCDF isomer specificity (e.g., DB-225, SP-2330, SP-2331, or equivalent). Quantitation of the individual congeners, total PCDDs and total PCDFs is achieved in conjunction with the establishment of a multi-point (five points) calibration curve for each homologue, during which each calibration solution is analyzed once. The identification of 1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD) and nine of the fifteen substituted congeners, for which a ^{13}C-labeled standard is available in the sample fortification and recovery standard solutions, is based on their elution at their exact retention time (within 0.005 retention time units measured in the routine calibration) and simultaneous detection of the two most abundant ions in the molecular ion region. The remaining six substituted congeners (i.e., 2,3,4,7,8-Pentachlorodibenzofuran(PeCDF); 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD); 1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF); 1,2,3,7,8,9-HxCDF; 2,3,4,6,7,8-HxCDF, and 1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)), for which no carbon-labeled internal standards are available in the sample fortification solution, and other identified PCDD/PCDF congeners are identified by their relative retention times from the routine calibration data, and the simultaneous detection of the two most abundant ions in the molecular ion region. The identification of 1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF) is based on its retention time relative to $^{13}C_{12}$-OCDD and the simultaneous detection of the two most abundant ions in the molecular ion region. Confirmation is based on a comparison of the ratios of the integrated ion abundance of the molecular ion species to their theoretical abundance ratios. A calculation of the toxicity equivalent concentration (TEQ) of each sample is made using international consensus toxicity equivalence factors (TEFs), and the TEQ is used to identify if the concentrations of target compounds in the sample are high enough to warrant confirmation of the results on a second GC column.

Confirmation is based on a comparison of the ratios of the integrated ion abundance of the molecular ion species to their theoretical abundance ratios. A calculation of the toxicity equivalent concentration (TEQ) of each sample is made using international consensus toxicity equivalence factors (TEFs), and the TEQ is used to establish if the concentrations of target compounds in the sample are high enough to warrant confirmation of the results on a second GC column.

2.5.1.6 PAHs by SW8310

Method 8310 provides high performance liquid chromatographic (HPLC) conditions for the detection of part per billion (ppb) levels of certain polynuclear aromatic hydrocarbons (PAHs) in water, soil and sediment matrix. Aqueous samples are extracted at neutral pH with methylene chloride using Method 3520C (continuous liquid-liquid extractor), or other appropriate method. Solid samples are extracted using Method 3540C (Soxhlet), or other appropriate technique. Prior to HPLC analysis, the extraction solvent must be exchanged to acetonitrile. To achieve maximum sensitivity with this method, the extract must be concentrated to one milliliter. If interferences prevent proper detection of the analytes of interest, the method may also be performed on extracts that have undergone cleanup using silica gel column cleanup (Method 3630). A five to 25-µL aliquot of the extract is injected into an HPLC, and compounds in the effluent are detected by ultraviolet (UV) and fluorescence detectors.

2.5.1.7 Explosives by SW8330 and SW8332

Method 8330 and 8332 provide HPLC conditions for the detection of ppb levels of certain explosives residues in water, soil and sediment matrix. Prior to use of these methods, appropriate 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, identified at 254 nanometer (nm), and confirmed on a CN reverse phase column.

2) High-level Direct Injection Method: Aqueous samples of higher concentration can be diluted 1/1 (v/v) with methanol or acetonitrile, filtered, separated on a C-18 reverse phase column, identified at 254 nm, and confirmed on a CN reverse phase column. If HMX is an important target analyte, methanol is preferred. Soil and sediment samples are extracted using acetonitrile in an ultrasonic bath, filtered and-chromatographed as described above.

2.5.2 Inorganics

The following techniques will be used for determination of inorganic constituents.

2.5.2.1 Metals by ICP SW6010/7000 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 the intensities of the emission lines are monitored by photosensitive devices.

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 Target Analyte List Metals by ICP SW6020 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.

2.5.2.3 Cyanide by SW9010C and SW9012B

Samples will be analyzed for total cyanide by SW-846 Test Methods 9010C and 9012B, distillation followed by colorimetric analysis. Hydrocyanic acid (HCN) is released through reflux-distillation and absorbed in a scrubber containing sodium hydroxide solution. The cyanide ion is determined colorimetrically by converting it to cyanogen chloride (CNCl).

2.5.2.4 Perchlorate by EPA 314.0

This method covers the identification of perchlorate in reagent water, surface water, ground water, and finished drinking water using ion chromatograph. A one-milliliter volume of sample is introduced into an ion chromatograph. The exact volume is not critical since standard and samples will be used the same sample loop. However, the volume should be verified to be within 5% of this volume be weighing the

sample loop empty, filling the loop with deionized water and re-weighing the loop. Perchlorate is separated and measured, using a system composed of an ion chromatographic pump, sample injection valve, guard column, analytical column, suppressor device, and conductivity detector. Reagent solutions, samples, and laboratory blanks must be filtered through no larger than a 0.45-micrometer nominal pore size membrane to remove particulate and prevent damage to the instrument, columns, and flow systems.

Sample matrices with high concentrations of common anions such as chloride, sulfate, and carbonate can make the analysis problematic by destabilizing the baseline in the retention time window for perchlorate. This is evidenced by observing a protracted tailing following the initial elution of the more weakly retained anion (chloride, sulfate, and carbonate) that extends into the perchlorate retention time window. These common anion levels can be indirectly assessed by monitoring the conductivity of the matrix. Consequently, sample matrices must be monitored for conductivity prior to analysis. When the laboratory Matrix Conductivity Threshold (MCT) is exceeded, procedures incorporating sample dilution and/or pretreatment must be performed.

2.5.2.5 Mercury by SW7470A (aqueous samples) and SW7471A (soil/solid samples)

Prior to analysis, the liquid, solid, or semi-solid samples must be prepared according to the procedure discussed in the method. Methods 7470 and 7471, 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) is measured as a function of mercury concentration.

2.5.3 Waste Samples

2.5.3.1 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-micrometer (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.

2.5.3.2 Ignitability by SW1010 (Aqueous) and SW1030 (Solid)

For liquid wastes, the sample is heated at a slow, constant rate with continual stirring. A small flame is directed into the cup at regular intervals with simultaneous interruption of stirring. The flash point is the lowest temperature at which application of the test flame ignites the vapor above the sample. For solid wastes, in a preliminary test, the test material is formed into an unbroken strip or powder train 250 millimeters (mm) in length. An ignition source is applied to one end of the test material to learn whether combustion will propagate along 200 mm of the strip within a specified time. Materials that propagate burning along a 200-mm strip within the specified time are then subjected to a burning rate test. Materials that do not ignite or propagate combustion as described above do not require further testing. In the burning rate test, the burning time is measured over a distance of 100 mm and the rate of burning is

calculated. The test method described here is based on the test procedure adopted by the U.S. Department of Transportation from the United Nations regulations for the international transportation of dangerous goods and is contained in Appendix E to Part 173 of Title 49 of the Code of Federal Regulations (CFR).

2.5.3.3 Corrosivity by SW9040B (Aqueous) and SW9045C (Solids)

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. The same procedure is used for pH determination of water and soil samples.

2.5.3.4 Chemical Oxygen Demand by USEPA Method 410.4 (Aqueous)

COD will be analyzed using USEPA Method of Chemical Analysis of Water and Wastes Method 410.4. A sample is heated under acidic conditions at a slow, constant rate in an oven or block digester in the presence of dichromate at 150°C for two hours. The COD is measured at 600 nm spectrophotometrically.

2.5.4 Physical/Geotechnical Analysis

As discussed in the Planned Field Activities Sections, soil samples will be collected for analysis of physical/geotechnical parameters. Analysis will be conducted by a USACE-approved laboratory. Analyses will be conducted for the following:

- Grain-size analysis (ASTM D 422-98);
- Atterburg limits (ASTM D 4318-00);
- Soil moisture content (ASTM D 2216-98e1);
- Total organic content (ASTM D 2974-00); and
- Soil bulk density (ASTM D 4253-00).

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 2-13 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 2-14.

Table 2-13
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 2-14
Field Quality Control Elements Acceptance Criteria

Item	DQO	Parameter	Frequency of Association	Criteria Goal
Field Duplicate	P	Inorganics	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 2-15. Specific laboratory analytical QC criteria and corrective actions are summarized in Tables 2-16 through 2-24 for the parameters specified in Section 2.5.

Table 2-15
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 analytes detected in the method blanks greater than RL
Laboratory Control Spike	A	Entire	Each lot/batch	Must meet criteria as defined in Tables 2-16 through 2-25
Matrix Spikes and Duplicates	A,P	Entire	Each lot/batch	Must meet criteria as defined in Tables 2-16 through 2-25
Surrogates	A	Entire	Organic fractions, including QC samples	Must meet criteria as defined in Tables 2-16 through 2-25
Serial dilution	A	Metals	Inorganic Fractions, Each lot/batch	Must meet criteria as defined in Table 2-20

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

Table 2-16
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° order)	Set-up, major maintenance, or for drift correction	RRF > 0.10/0.30 for SPCCs RSD ≤ 30% for CCCs response factors RSD for all analytes ≤ 15% or r>0.995 (linear) or r>0.99 (2° 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	Every 12 hours	RRF > 0.10/0.30 for SPCCs %Difference for RF of CCCs ±30% from initial calibration. Mean for all 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.
Method Blank	Every day/batch.	No target analytes greater than the RL		Document source of contamination. Re-analysis is required for all 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 of 50-150% or RPD of 50%	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 50-150%	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 of 50-150% or RPD of 50%	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 2-17
Quality Control Method Criteria for Semivolatile Organic Compounds by USEPA SW-846 8270C

Procedure	Frequency	Acceptance Criteria		Corrective Action
Initial calibration 5-pt curve (linear) 6-pt curve (2° order)	Set-up, major maintenance, or for drift correction	RRF > 0.05 for SPCCs RSD ≤30% for CCC compounds RSD for all target analytes ≤ 15% or r>0.995 (linear) or r>0.99 (2° 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 = 70-130%		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 all 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 the RL		Document source of contamination. Re-extraction/re-analysis is required for all 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 of 10-150% or RPD of 50%	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 10-150%	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 of 10-150% or RPD of 60%	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 Polynuclear Aromatic Hydrocarbons by USEPA SW-846 8310

Procedure	Frequency of QC Procedure	Acceptance Criteria		Corrective Action
Initial calibration 5-pt curve (linear) 6-pt curve (2° order)	Set-up, major maintenance, or for drift correction for each column used during analysis	%RSD<20% or r>0.995 (linear) or r>0.99 (2° 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	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 the reporting limit		Document source of contamination. Re-extraction/re-analysis is required for all 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 of 40-150% or RPD of 60%	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 30-150%	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 of 40-150% or RPD of 60%	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 2-19
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 (2° order)	Set-up, major maintenance, or for drift correction for each column used for analysis	%RSD<20% or r>0.995 (linear) or r>0.99 (2° 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	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 the reporting limit		Document source of contamination. Re-extraction/re-analysis is required for all 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 of 40-150% or RPD of 60%	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 30-150%	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 of 40-150% or RPD of 60%	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 2-20
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
Tune (MS)	Daily	Analyzed a minimum four times with RSD < 5% for analytes in the solution.		Sample analysis cannot begin until this criterion is met.
Mass Calibration (MS)	Daily	Difference < 0.1 amu from true value.		Adjust to the correct value.
Resolution Check (MS)	Daily	Peak width <0.9 amu at 10% peak height		Sample analysis cannot begin until this criterion is met.
Initial Calibration Curve (MS, ICP, Hg, & CN)	Daily, major maintenance, or to correct drift.	MS & ICP Option 1: 1-standard and a blank with a low level standard at RL.	Low level check standard ± 20%.	The standards for that element must be re-prepared and re-analyzed again.
		MS & ICP Option 2: 3-standards and a blank	r > 0.99 for each element	
		Hg - 5-standards and a blank	r > 0.99	
		CN - 6 standards and a blank	r > 0.99	
Distilled Standards (CN)	Once per calibration	One high and one low distilled standard within ± 10% of the true value		Sample analysis cannot begin until this criterion is met.
Initial Calibration Verification (MS, ICP, Hg, & CN)	Immediately following initial calibration.	MS & ICP - A second source full compliment of target list with a percent recovery = 90-110%		Sample analysis cannot begin until this criterion is met.
		Hg - A second source full compliment of target list with a percent recovery = 80-120%		
		CN - A second source full compliment of target list with a percent recovery = 85-115%		
Initial Calibration Blank (MS, ICP, Hg, & CN)	Immediately following initial calibration verification.	No target analytes detected at concentration above the RL.		Sample analysis cannot proceed until this criterion is met.
Interference Check (MS & ICP)	Beginning of each sample analytical run.	Recovery ±20% of true value.		Terminate the analysis, correct the problem, re-calibrate, re-verify the calibration, and reanalyze associated samples.
Continuing Calibration Check (MS, ICP, Hg, & CN)	Every 10 samples and end of analytical run.	MS & ICP - Recovery ±10%.		Reanalyze; if the CCV fails again, stop analysis, the problem corrected, the instrument recalibrated, and the calibration re-verified prior to continuing sample analyses.
		Hg - Recovery ±20%.		
		CN - Recovery ±15%.		
Continuing Calibration Blank (MS, ICP, Hg, & CN)	Every 10 samples and end of analytical run.	No target analytes detected at concentration above the RL.		Sample sequence should not continue until this criterion is met. Demonstrate "clean". Affected samples will be reanalyzed.
Preparation Blank (MS, ICP, Hg, & CN)	1 per batch per matrix	No target analytes detected at concentration above the RL.		Document source of contamination. Re-digestion/re-analysis is required for all positive results associated with blank contamination, unless DQOs are still met.
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 2-21
Quality Control Method Criteria for Dioxin/Furans by USEPA SW-846 8290

Procedure	Frequency	Acceptance Criteria	Corrective Action
Perfluorokerosene (PFK) Tune	Prior to initial calibration and every 12 hours	Minimum resolving power 10,000 Deviation between exact and theoretical m/z shall be <0.005 amu or 5 ppm.	Re-tune, re-calibrate.
Window Defining Mix (WDM)	Prior to initial and continuing calibration	No criteria, defines descriptor switching times of scan range (m/z).	Must meet criteria prior to sample analysis.
Isomer Specificity Check (ISC)	Prior to initial and continuing calibration	DB5 column: 2,3,7,8-TCDD:1,2,3,9-TCDD peaks resolved with a valley ≤25%. DB225: 2,3,7,8: 2,3,4,7-TCDF and 1,2,3,9-TCDF peaks resolved with a valley ≤25%.	Must meet criteria prior to sample analysis.
Initial calibration curve (5-pt curve)	Set-up, major maintenance	RSD ±20% for standard compounds RSD ±30% for reference compounds. The signal to noise ratio must be ≥2.5 for each selected ion current profile. Isotopic ratio must be within the following established control limits.	Must meet criteria prior to sample analysis. Data reviewer should review and judge the target compounds against the acceptance criteria.
Continuing calibration standard	Prior and closing every 12 hours	%D ±20% for standard compounds, or mean with no individual >25%. %D ±30% for reference compounds, or mean with no individual >35%. The signal to noise ratio must be ≥10. Isotopic ratio must be within the preceding established control limits.	If criteria are not met, reanalyze the daily standard. If the daily standard fails a second time, calibration must be repeated. Data reviewer should review and judge the target compounds against the acceptance criteria.
Internal standards	Every sample	% Recovery between 40-135%	Inspect for malfunction. Demonstrate that system is functioning properly. Reanalyze samples with standards outside criteria.
Method blanks	Per extraction batch	No target analytes detected greater than the RL.	Document source of contamination.
LCS	Every batch	Standards: Full compliment target list. — ±20% for standard compounds. ±30% for reference compounds.	Recoveries indicating a low bias require a re-extraction/reanalysis. Qualify associated data biased high or biased low as appropriate.
Surrogate Spike or Recovery Standard	Every sample	% Recovery between 40-135%	Investigate to identify cause and document actions taken; data are acceptable.
Matrix spike and duplicate	1 per 20 samples per matrix	Standards: Full compliment target list. — ±20% for standard compounds. ±30% for reference compounds. RPD ≤ 25%	If 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.

Isotopic ratio must be within the following established control limits.

# of Cl ions atoms	Ion Type	Theoretical Ratio	Control limits
4	M/M+2	0.77	0.65 - 0.89
5	M+2/M+4	1.55	1.32 - 1.78
6	M+2/M+2	1.24	1.05 – 1.43
(13)C-HxCDF	M/M+2	0.51	0.43 – 0.59
(13)C-HpCDF	M/M+2	0.44	0.37 – 0.51
7	M+2/M+4	1.04	0.88 – 1.20
8	M+2	0.89	0.76 – 1.02

Table 2-22
Quality Control Method Criteria for Perchlorate by USEPA 314.0

Procedure	Frequency of QC Procedure	Acceptance Criteria	Corrective Action
Initial calibration curve 5-pt curve	Major maintenance, instrument modification, per manufacturer's specifications	r > 0.99	If outside criteria, the standards must be reanalyzed until correlation passes. Must meet criteria prior to sample analysis.
Matrix Conductivity Threshold (MCT)	Prior to sample analysis	Conductivity of the matrix < MCT. Perchlorate recovery ± 20%. Perchlorate retention time shift from mid-point of initial calibration < 5%.	Sample must be pretreated.
Instrument Performance Check Standard	Start of each sequence	Must have a conductance within ± 10% of MCT.	
Initial calibration verification	1 per batch	Recovery ±10% of true value.	If outside criteria, the standard must be reanalyzed. Must meet criteria prior to sample analysis.
Continuing calibration verification (CCV)	Every 10 samples, end of analytical run	Recovery ±15% of true value.	Reanalyze CCV. If the CCV 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 (CCB)	Every 10 samples, end of analytical run	Not 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	Not detected greater than the RL.	Re-prep and analyze whole batch after source of contamination is found and eliminated.
Laboratory Control Sample	1 per 20 samples	85-115%.	Recoveries indicating a low bias require a re-extraction/reanalysis. *Qualify* associated data biased high or biased low as appropriate.
Matrix spike and duplicate	1 per 20 samples per batch	% Recovery - 80-120%. RPD ≥ 15%.	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 2-23
Quality Control Method Criteria for Pesticides and PCBs by USEPA SW-846 8081A & 8082

Procedure	Frequency of QC Procedure	Acceptance Criteria		Corrective Action
Initial calibration curve 5-pt curve (linear) 6-pt curve (2° order)	Set-up, major maintenance	%RSD<20% or r>0.995 (linear) or r>0.99 (2° 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 the RL.		Demonstrate "clean". Affected samples will be reanalyzed.
Method Blank	Per extraction batch	No target analytes detected greater than the RL.		Document source of contamination. Re-extraction/re-analysis is required for all 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 recovery limits of 30-150% or RPD of 60%	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 30-150%	Investigate to determine 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.
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 recovery limits of 30-150% or RPD of 60%	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 ≤ 40%		Report the higher of the two concentrations unless a positive bias is apparent and qualify.

Table 2-24

Quality Control Method Criteria for Chemical Oxygen Demand by USEPA Method of Chemical Analysis of 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° 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 all 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 USACE-validated 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 Soil Sampling Investigation 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, the USACE Shell Document - Appendix I to the Engineer Manual 200-1-3 (USACE 1994), 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. Mr. John Kearns, 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 (Paradigm Analytical Laboratories for dioxin/furan analyses). 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 field investigation work at the SWMUs associated with the SSP Program.

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, 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
SSP WPA For 9 SWMUS and 3 AOCs
Radford Army Ammunition Plant, Radford, Virginia

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. 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 2000). 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 each of the eleven SWMUs associated with the SSP Program. 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

- Cold stress – refer to Section 3.2.2 of the MHSP;
- Subsurface utilities;
- 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
- Main Manufacturing Area – 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 Confined Space Entry Training

There will be no confined spaces entered during this investigation, therefore, confined space entry training will not be required for fieldwork

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 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 PID equipped with an 11.7 eV lamp 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 forth 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
SSP WPA For 9 SWMUS and 3 AOCs
Radford Army Ammunition Plant, Radford, Virginia

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 US Route 11 South and go across the bridge over the New River. Turn left after crossing the bridge, go 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 2000).

4.0 REFERENCES

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APPENDIX A

STANDARD OPERATING PROCEDURES

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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
20.0	**SUBSURFACE INVESTIGATION**
20.11	Drilling Methods and Procedures
30.0	**SAMPLING**
30.1	Soil Sampling
30.3	Surface Water Sampling
30.4	Sediment Sampling with Scoop or Tube Sampler
30.6	Containerized Material
30.7	Sampling Strategies
30.9	Collection of Soil Samples By USEPA SW-846 Method 5035 Using Disposable Samplers
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

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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 Standards D 422-63 and D 643-78) 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 surface lusterless and stained	Moderate or localized and intense	Thin coatings or stains
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 1586–84 (1992). 1992. *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.*

ASTM Standard D 2488-93. 1993. *Standard Practice for Description and Identification of Soils Visual-Manual Procedure).*

ASTM Standard D 5434-93. 1993. *Guide for Field Logging of Subsurface Explorations of Soil and Rock.*

ASTM Standard D 6032-96. 1996. *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.

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 20.11
DRILLING METHODS AND PROCEDURES

1.0 SCOPE AND APPLICATION

The use of an appropriate drilling procedure is contingent upon the existing conditions at the project site. The purpose of this standard operating procedure (SOP) is to outline procedures for the various methods of soil and rock drilling identified in the Master Work Plan. In addition it provides procedures for using sampling devices commonly used during soil and rock drilling such as split-barrel sampling, thin walled tube sampling, direct push samplers, and rock coring. For a particular site investigation, the associated work plan addendum will identify the appropriate drilling method and method of sampling, along with proposed sampling depths and intervals and any special procedures or methods.

2.0 MATERIALS

The following types of materials are generally appropriate for drilling:

2.1 SPLIT-BARREL SAMPLING

- Split barrel sampler;
- Borehole logging materials per SOP 10.3 and sampling equipment and materials, as appropriate per SOP 30.1;
- Containers to manage investigation-derived material per SOP 70.1; and
- Decontamination supplies and equipment per SOP 80.1.

2.2 THIN WALLED TUBE SAMPLING

- Thin walled tubes;
- Sealing materials for sample such as sealing wax, metal disks, wood disks, tape, cheesecloth, caps, etc;
- Borehole logging materials per SOP 10.3 and sampling equipment and materials, as appropriate per SOP 30.1;
- Containers to manage investigation-derived material per SOP 70.1; and
- Decontamination supplies and equipment per SOP 80.1.

2.3 DIRECT PUSH SAMPLING

- Direct push unit with hydraulic ram, hammer, etc;
- Sample collection devices, associated equipment and expendable supplies such as sample liners, sample retainers, appropriate lubricants, etc;
- Hollow extension rods;
- Auxiliary tools for handling, assembling, and disassembling tools and samplers;

- Borehole logging materials per SOP 10.3 and sampling equipment and materials, as appropriate per SOP 30.1;
- Containers to manage investigation-derived material per SOP 70.1; and
- Decontamination supplies and equipment per SOP 80.1.

2.4 HOLLOW-STEM AUGER DRILLING

- Drill rig and associated equipment;
- Hollow stem auger assemblies for drilling to appropriate depth including auger heads, drive assembly, pilot assembly, and hollow-stem auger sections;
- Auxiliary devices such as wrenches, auger forks, hoisting hooks, swivels, and adaptors;
- Borehole logging materials per SOP 10.3 and sampling equipment and materials, as appropriate per SOP 30.1;
- Containers to manage investigation-derived material per SOP 70.1; and
- Decontamination supplies and equipment per SOP 80.1.

2.5 DIRECT AIR ROTARY DRILLING

- Drill rig with rotary table and Kelly or top-head drive unit;
- Drill rods, bits, and core barrels (as appropriate);
- Casing;
- Sampling devices and equipment, as appropriate;
- Air compressor and filters, pressure lines, discharge hose, swivel, dust collector, and air-cleaning device (cyclone separator);
- Auxiliary tools for handling, assembling, and disassembling tools and samplers;
- Borehole logging materials per SOP 10.3 and sampling equipment and materials, as appropriate per SOP 30.1;
- Containers to manage investigation-derived material per SOP 70.1; and
- Decontamination supplies and equipment per SOP 80.1.

2.6 DRILL-THROUGH CASING DRIVER

- Drill rig equipped with a mast-mounted, percussion driver;
- Casing, drill rods, and drill bits or hammers;
- Air compressor and filters, pressure lines, discharge hose, swivel, dust collector, and air-cleaning device (cyclone separator);
- Sampling devices and equipment, as appropriate;
- Auxiliary tools for handling, assembling, and disassembling tools and samplers;
- Welding equipment and materials for installation of casing;

- Borehole logging materials per SOP 10.3 and sampling equipment and materials, as appropriate per SOP 30.1;
- Containers to manage investigation-derived material per SOP 70.1; and
- Decontamination supplies and equipment per SOP 80.1.

2.7 DIRECT WATER-BASED ROTARY DRILLING

- Drill rig with derrick, rotary table and Kelly or top-head drive unit;
- Drill rods, bits, and core barrels (as appropriate);
- Casing;
- Water based drilling fluid, with approved additives as appropriate;
- Mud tub, suction hose, cyclone de-sander(s), drilling fluid circulation pump, pressure hose, and swivel;
- Auxiliary tools for handling, assembling, and disassembling tools and samplers;
- Borehole logging materials per SOP 10.3 and sampling equipment and materials, as appropriate per SOP 30.1;
- Containers to manage investigation-derived material per SOP 70.1.
- Decontamination supplies and equipment per SOP 80.1.

2.8 DIRECT ROTARY WIRELINE-CASING ADVANCEMENT DRILLING

- Drill rig with either hollow spindle or top-head drive;
- Drill rods, coring or casing bits, overshot assembly, pilot bit, and core barrel;
- Water based drilling fluid, with approved additives as appropriate;
- Mud tub, suction hose, drilling fluid circulation pump, pressure hose, and swivel;
- Auxiliary tools for handling, assembling, and disassembling tools and samplers;
- Borehole logging materials per SOP 10.3 and sampling equipment and materials, as appropriate per SOP 30.1;
- Containers to manage investigation-derived material per SOP 70.1; and
- Decontamination supplies and equipment per SOP 80.1.

2.9 DIAMOND CORE DRILLING

- Direct rotary drill rig and associated equipment (see Sections 2.4, 2.5 or 2.6);
- Core barrels and core bits;
- Core lifters;
- Core boxes, engineers scale, permanent marking pen, and camera for photographing cores;
- Auxiliary tools for handling, assembling, and disassembling tools and samplers;
- Borehole logging materials per SOP 10.3 and sampling equipment and materials, as appropriate per SOP 30.1;

- Containers to manage investigation-derived material per SOP 70.1; and
- Decontamination supplies and equipment per SOP 80.1.

3.0 PROCEDURES

3.1 PENETRATION TEST AND SPLIT-BARREL SAMPLING OF SOILS

The following general procedure may be followed as outlined in ASTM Standard Test Method D 1586-84.

1. Advance the boring to the desired sampling depth using an appropriate drilling method (see sections below) and remove excessive cuttings from the borehole.
2. Attach the split-barrel sampler to the sampling rods and lower into the borehole. Do not allow the sampler to drop onto the soil to be sampled.
3. Position the hammer above and attach the anvil to the top of the drilling rods.
4. Rest the dead weight of the sampler, rods, anvil, and drive weight on the bottom of the boring and apply a seating blow. If excessive cuttings are encountered at the bottom of the borehole, remove the sampler and rods from borehole and remove the cuttings.
5. Mark the drill rods in three successive 6-inch increments so that the advance of the sampler can be observed.
6. Drive the sampler with blow from the 140 pound hammer and count the number of blows applied in each 6-inch increment until:
   a. Fifty (50) blows have been applied during one of the three 6-inch increments.
   b. A total of 100 blows have been applied.
   c. There is no observed advance of the sampler during the application of 10 successive blows of the hammer.
7. The sampler is advanced the complete 18-inches without the limiting blow counts occurring as described above.
8. Record the number of blows that is required to achieve each 6-inch increment of penetration or fraction of this increment on the boring.
   a. The first 6 inches is considered the seating driver.
   b. The sum of the second and third 6-inch penetration intervals is termed the "standard penetration resistance" or "N-value."
   c. If the sampler is driven less than 18 inches as discussed in No. 6, then the number of blow for each partial increment will be recorded.
   d. For partial increments, the depth of penetration should be recorded to the nearest 1-inch on the boring log.
   e. If the sampler advances below the bottom of the boring under the weight of rods (static) and/or hammer, then this information will be recorded on the boring log.
9. The raising and dropping of the 140 pound hammer may be accomplished by:
   a. Using a trip, automatic, or semi-automatic hammer drop system that lifts the hammer and allows it to drop 30± 1 inches.

b. Using a cathead shall be essentially free of rust, oil, or grease and have a diameter in the range of 6 to 10 inches. The cathead should be operated at a minimum speed of rotation of 100 revolutions per minute. No more than 2-1/4 rope turns on the cathead may be used when conducting the penetration test.

10. For each hammer blow, a 30-inch lift and drop shall be used.

11. After completing the penetration test, retrieve the sampler and open. Record the percent recovery or the length of sample recovered. Following the procedures outlined in SOP 30.1 when collecting environmental soil samples.

12. Borehole logging should be completed per SOP 10.3.

13. Split-barrel samples must be decontaminated before and after each use per the requirements of SOP 80.1.

3.2 THIN WALLED TUBE SAMPLING

The following general procedure may be followed for collection of relatively undisturbed, thin walled tube samples (e.g., Shelby tube) as outlined in ASTM Standard Practice D 1587-94.

1. Clean out the borehole to targeted sampling depth using most appropriate method, which avoids disturbing the material to be sampled. If groundwater is encountered, maintain the liquid level in the borehole at or above the groundwater level during sampling.
2. Place the sample tub so that its bottom rests on the bottom of the borehole.
3. Advance the sampler without rotation by a continuous relatively rapid motion.
4. Determine the length of the advance by the resistance and condition of the formation, the length of the advance should never exceed 5 to 10 diameters of the tube in sands and 10 to 15 diameters of the tube in clay.
5. When the formation is too hard for push type of sampling, the tube may be driven or the practice used for ring-lined barrel sampling may be used per ASTM Standard D 3550-84 (1995). When a sample is driven, the weight and fall of the hammer must be recorded along with the penetration achieved.
6. The maximum length of sample advance will be no longer than the sample-tube length minus an allowance for the sample head and a minimum of 3-inches for sludge-end cuttings.
7. Upon removal of the tube, measure the length of the sample in the tube. Remove the disturbed material in the upper end of the tube and re-measure the sample length.
8. Remove at least one-inch of material from the lower end of the tube for soil description and identification per SOP 10.3. Measure the overall sample length. Seal the lower end of the tube. If directed, the material from the end of the tube will not be removed for soil identification and description; in this case the tube will be sealed promptly.
9. Prepare sample labels and affix (or markings) on the tube.

3.3 DIRECT PUSH SOIL BORING

The following general procedures outlined in this section may be followed as described in ASTM Standard Test Method D 6282-98.

General considerations for this method include the following:

- A variety of direct push drive systems may be used to advance soil borings based on the intended sampling depths and subsurface conditions and include the following:

  Shallower Depths and Less Difficult Conditions

  - Percussive driving systems – use hydraulically operated hammers and mechanically operated hammers.
  - Static push drive systems – use hydraulic rams to apply pressure and exert static pull (e.g., cone penetrometer systems).
  - Vibratory/sonic systems – use a vibratory device, which is attached to the top of the sampler extension rods.

  Greater Depths and More Difficult Conditions

  - Sonic or resonance drilling systems – use a high power vibratory system to advance larger diameter single or dual tube systems.
  - Rotary drilling equipment – use hydraulic system of drill rig for direct push.

- The equipment used for direct push must be capable of apply sufficient static force, or dynamic force, or both, to advance the sampler to the required depth of collection. Additionally, this equipment must have adequate retraction force to remove the sampler and extension/drive rods once the sample has been collected.
- Avoid using excessive down pressure when advancing the drilling tools/sampler. Excessive pressure may cause the direct push unit to offset from the boring location and may damage drilling tools and samplers.
- Sample liners should be compatible with the material being sampled and the type of analysis to be conducted on the sample. Sealing of liners for submittal to the laboratory for physical testing should be accomplished according to ASTM Standard D 4220-95 (Standard Practice for Preserving and Transporting Soil Samples).
- The general procedure for completing direct push soil borings is the following:

1. Stabilize direct push unit and raise mast at desired location.
2. Attach the hammer assembly to the drill head if not permanently attached. Attach the anvil assembly in the prescribed manner, slide the direct push unit the position over the borehole, and ready the tools for insertion.
3. Inspect the direct push tools before and after use. Decontaminate all down hole tools before and after use per SOP 80.1.
4. Inspect drive shoes for damaged cutting edges, dents or thread failures and these conditions could cause loss of sample recovery and slow the rate of advancement.
5. Assemble samplers and install where required, install sample retainers where needed, and install and secure sampler pistons to ensure proper operation where needed (see Steps 14 through 20 for the various sampler assembly procedures, etc.).
6. After sampler has been appropriately installed (see Steps 14 through 20 for installation procedures, etc.) advance the boring to the target sampling depth using an appropriate direct push technique, as identified above under general considerations.
7. Collect the soil sample from the target sampling depth using one of the methods identified in Steps 14 through 20.

8. Retrieve the sampler and appropriately process the soil sample as identified in Steps 14 through 20 below and in SOP 30.1.
9. Log the borehole per the requirements of SOP 10.3.
10. If collecting another soil sample, decontaminate the sampler for reuse per the requirements of SOP 80.1 or use another decontaminated sampler.
11. Appropriately manage investigation-derived material (discarded samples, decontamination fluids, etc.) per SOP 70.1.
12. Upon completion of the boring and collection of the desired soil samples, abandon the boring per the requirements of SOP 20.2.
13. The following single tube sampling systems (generally piston rod) may be used to collect soil samples (see Steps 14 through 16 below):
    a. Open Solid Barrel Sampler;
    b. Closed Solid Barrel Sampler (e.g. Geoprobe Macro-Core® Piston Rod Sampler); and
    c. Standard Split Barrel Sampler (see Section 3.1).
14. The following two tube sampling systems may be used to collect soil samples (see Steps 17 through 20 below):
    a. Split Barrel Sampler;
    b. Thin Wall Tubes;
    c. Thin Wall Tube Piston Sampler; and
    d. Open Solid Barrel Samplers.
15. Sampling with the single tube, open solid barrel sampler:
    a. Attach the required liner to the cutting shoe by insertion into the machined receptacle are or by sliding over the machined tube.
    b. Insert the liner and shoe into the solid barrel and attach the shoe.
    c. Attach the sampler head to the sampler barrel.
    d. Attach the sampler assembly to the drive rod and the drive head to the drive rod.
    e. Position the sampler assembly under the hammer anvil and advance the sampler assembly into the soil at a steady rate slow enough to allow the soil to be cut by the shoe and move up into the sample barrel.
    f. At the completion of the sampling interval, removal the sampler from the borehole. Remove the filled sampler liner from the barrel by unscrewing the shoe. Cap the liner for laboratory testing or split open for field processing (see SOP 30.1).
    g. Log the borehole per the requirements of SOP 10.3.
16. Sampling with the closed, solid barrel sampler (e.g., Macro-Core® sampler).
    a. Insert or attach the sample liner to the shoe and insert the assembly into the solid barrel sampler. Install the sample, retaining basket, if desired.
    b. Attach the latch coupling or sampler head to the sampler barrel, and attach the piston assembly with point and "O" rings if free water is present, to the latching mechanism.
    c. Insert the piston or packer into the liner to its proper position so that the point leads the sampler shoe. Set latch, charge packer, or install locking pin, and attach assembled sampler to drive rod.
    d. Add drive head and position under the hammer anvil. Apply down pressure, and hammer if needed, to penetrate the soil strata above the targeted sampling interval.

e. When the sampling interval is reached, insert the piston latch release and recovery tool, removing the piston, or insert the locking pin removal/extension rods through the drive rods, turn counter clockwise, and remove the piston locking pin so the piston can float on top of the sample, or release any other piston holding device.

f. Direct push or activate the hammer to advance the sampler the desired interval.

g. Retrieve the sampler from the borehole by removing the extension/drive rods. Remove the shoe, and withdraw the sample line with sample for processing (see SOP 30.1).

h. Clean and decontaminate the sampler, reload as described above and repeat the same procedure for collection of addition samples.

i. Log the borehole per the requirements of SOP 10.3.

17. Sampling with standard split barrel (split spoon) sampler generally consists of the following:

a. Attach the split barrel sampler to an extension rod or drill rod.

b. Using a mechanical or hydraulic hammer drive the ampler into the soil the desired interval. The maximum interval that should be driven is equal to the sample chamber length of the split barrel sampler, which is either 18-inches or 24-inches.

c. Retrieve the sampler from the borehole by removing the extension/drive rods.

d. Split the sampler open for field processing (see SOP 30.1).

e. Clean and decontaminate the sampler (SOP 80.1), re-attach and repeat the same procedure for collection of additional samples.

f. Log the borehole per the requirements of SOP 10.3.

18. Sampling with a two tube, split barrel sampler generally consists of the following:

a. Assemble the outer casing with the drive shoe on the bottom, attach the drive head to the top of the outer casing, and attach the sampler to the extension rods.

b. Connect the drive head to the top of the sampler extension rods, and insert the sampler assembly into the outer casing.

c. The cutting shoe of the sampler should contact the soil ahead of the outer casing to minimize sample disturbance.

d. The sample barrel should extend a minimum of 0.25 inches ahead of the outer casing.

e. Mark the outer casing to identify the required drive length, position the outer casing and sampler assembly under the drill head.

f. Move the drill head downward to apply pressure on the tool string. Advance the casing assembly into the soil at a steady rate, which is slow enough to allow the soil to be cut by the shoe and move up inside the sample barrel.

g. Occasional hammer action during the push may assist recovery.

h. If smooth push advancement is not possible because of subsurface conditions, use the hammer to advance the sampler.

i. Stop the application of pressure or hammering when target interval has been sampled. Move the drill head off the drive head. Attach a pulling device to the extension rods or position the hammer bail and retrieve the sampler from the borehole.

j. At the surface, remove the sampler from the extension rods and process the sample per Section 3.01 and SOP 30.1.

k. Log the borehole per the requirements of SOP 10.3.

19. Sampling with a two tube, thin wall tube sampler generally consists of the following:
    a. Attach the tube to the tube head using removable screws.
    b. Attach the tube assembly to the extension rods and position at the base of the outer casing shoe protruding a minimum of 0.25 inches to contact the soil ahead of the outer casing.
    c. Advance the tube with or without the outer casing at a steady rate.
    d. After completing the sampling interval, let the tube remain stationary for one minute. Rotate the tube slowly two revolutions to shear off the sample.
    e. Remove the tube from the borehole and measure the recovery, and log the borehole per the requirements of SOP 10.3.
    f. For field processing, extrude the sample from the tube sampler and process per SOP 30.1. Alternatively, the tube may be sealed and shipped to the laboratory.
20. Sampling with two tube, thin wall tube, piston sampler generally consists of the following:
    a. Check the fixed piston sampling equipment for proper operation of the cone clamping assembly and the condition of the "O" rings.
    b. Slide the thin wall tube over the piston, and attach it to the tube head. Position the piston at the sharpened end of the thin wall tube just above the sample relief bend.
    c. Attach the tube assembly to the extension rods and lower the sampler into position through the outer casing. Install the actuator rods through the extension rod, and attach to the actuator rod in the sampler assembly.
    d. Attach a holding ring to the to top of the actuator rod string and hook the winch cable or other hook to the holding ring to hold the actuator rods in a fixed position.
    e. Attach the pushing fork to the drill head/probe hammer and slowly apply downward pressure to the extension rods advancing the thin wall tube over the fixed piston into the soil for the length of the sampling interval.
    f. After completing the sampling interval, let the tube remain stationary for one minute. Rotate the tube slowly one revolution to shear off the sample.
    g. Remove the tube sampler from the borehole and measure the recovery, and log the borehole per the requirements of SOP 10.3.
    h. For field processing, extrude the sample from the tube sampler and process per SOP 30.1.
21. Sampling with an two tube, open solid barrel sampler generally consists of the following:
    a. This sampling technique may be used when soil conditions prevent advancement of a split barrel sampler or advancement of an outer casing.
    b. The solid, single, or segmented barrel sampler requires the use of a liner.
    c. Use sampler in advance of outer casing when this casing cannot be advanced.
    d. Follow the procedures outlined for two tube, split barrel sampling.

3.4 HOLLOW-STEM AUGER DRILLING

The following general procedure may be followed as outlined in ASTM Standard Guide D 5784.

1. Stabilize drill rig and raise mast at desired location.
2. Attach an initial assembly of hollow-stem auger components (hollow stem auger, hollow auger head, center rod and pilot assembly, as appropriate) to the rotary drive of the drill rig.
3. Push the auger assembly below the ground surface and initiate rotation at a low velocity.

4. Decontamination of auger head may be necessary after this initial penetration if this surface soil is contaminated.
5. Continue drilling from the surface, usually at a rotary velocity of 50 to 100 rotations per minute to the depth where sampling or in-situ testing is required or until the drive assembly is within approximately 6- to 18 inches of the ground surface.
6. As appropriate, collect a soil sample from the required depth interval. The sample may be conducted by
    a. Removing the pilot assembly, if used, and inserting and driving a sampler through the hollow stem auger of the auger column; or
    b. Using a continuous sampling device within the lead auger section, where the sampler barrel fills with material as the auger is advanced.
7. Additional sections of hollow stems augers may be added to drill to a greater depth. After these auger sections are added, rotation of the hollow-stem auger assembly may be resumed.
8. When drilling through material suspected of being contaminated, the installation of single or multiple (nested) outer casings may be required to isolate zones suspected contamination (see SOP 20.1). Outer casings may be installed in a pre-drilled borehole or using a method in which casing is advanced at the same of drilling.

    Monitoring wells or piezometers may be installed using hollow-stem augers by:

    a. Drilling with or without sampling to the target depth.
    b. Removal of the pilot assembly, if used, and insertion of the monitoring well (or piezometer) assembly.
    c. The hollow stem auger column should be removed incrementally as the monitoring well (or piezometer) completion materials are placed (see SOP 20.1 for grouting).
9. If materials enter the bottom of the auger hollow stem during the removal of the pilot assembly, it should be removed with a drive sampler or other appropriate device.
10. If sampling or *in-situ* testing is not required during completion of the boring, the boring may be advanced with an expendable knock out plate or plug of an appropriate material instead of a pilot assembly.
11. Drill cuttings should be appropriately controlled and contained as IDM per SOP 70.1. It may be necessary to drill through a hole of sheet of plywood or similar material to prevent cuttings from contacting the ground surface.
12. The hollow-auger assembly and sampling devices must be decontaminated before and after each use per the methods specified in SOP 80.1.
13. Borehole logging should be completed per SOP 10.3.
14. Borehole abandonment, when required, should be conducted according to SOP 20.3.

3.5 DIRECT AIR ROTARY DRILLING

The following general procedure may be followed as outlined in ASTM Standard Guide D 5784-95.

1. Stabilize drill rig and raise mast at desired location. Appropriately position the cyclone separator and seal it to the ground surface considering the prevailing wind direction (exhaust).
2. Establish point for borehole measurements.
3. Attach an initial assembly of a bit, down hole hammer, or core barrel with a single section of drill rod, below the rotary table or top-head drive unit, with the bit placed below the top of the dust collector.
4. Activate the air compressor to circulate air through system.

5. Initiate rotation of bit.
6. Continue with air circulation and rotation of the drill-rod column to the depth where sampling or in-situ testing is required or until the length of the drill rod section limits further penetration.
7. Monitor air pressure during drilling operations. Maintain low air pressure at bit to prevent fracturing of surrounding material.
8. Stop rotation and lift the bit slightly off the bottom of the hole to facilitate removal of drill cuttings and continue air circulation until the drill cuttings are removed from the borehole annulus.
9. Open reaching a desired depth of sampling, stop the air circulation and rest bit on bottom of hole to determine the depth. Record the borehole depth and any resultant caving in. If borehole caving is apparent set a decontaminated casing to protect the boring.
10. When sampling, remove the drill rod column from the borehole or leave the drill rod assembly in place if the sampling can be performed through the hollow axis of the drill rods and bit.
11. Compare the sampling depth to clean-out depth by first resting the sampler on the bottom of the hole and compare that measurement with the clean-out depth measurement.
12. If bottom-hole contamination is apparent (indicated by comparison of sample depth to clean-out depth), it is recommended that the minimum depth below the sampler/bit be 18 inches for testing. Record the depth of sampling or in-situ testing and the depth below the sampler/bit.
13. The procedure described in Steps 8 through 12 should be conducted for each sampling or testing interval.
14. Drilling to a greater depth may be accomplished by attaching an additional drill rod section to the top of the previously advanced drill-rod column and resuming drilling operations as described above.
15. When drilling through material suspected of being contaminated, the installation of single or multiple (nested) outer casings may be required to isolate zones suspected contamination (see SOP 20.1 for grouting requirements). Outer casings may be installed in a pre-drilled borehole or using a method in which casing is advanced at the same of drilling.
16. Monitoring wells or piezometers may be installed by:
    a. Drilling with or without sampling to the target depth.
    b. Removal of the drill rod assembly and insertion of the monitoring well (or piezometer) assembly.
    c. Addition of monitoring well (or piezometer) completion materials (see SOP 20.1).
17. Drill cuttings should be appropriately controlled and contained as IDM per SOP 70.1.
18. The drill rod assembly, sampling devices, and other drilling equipment contacting potentially contaminated material must be decontaminated before and after each use per the methods specified in SOP 80.1.
19. Borehole logging should be completed per SOP 10.3.
20. Borehole abandonment, when required, should be conducted according to SOP 20.3

3.6 DRILL-THROUGH CASING DRILLING

The following general procedure may be followed as outlined in ASTM Standard Guide D 5872-95.

1. Stabilize drill rig and raise mast at desired location. Appropriately position the cyclone separator and seal it to the ground surface considering the prevailing wind direction (exhaust).
2. Establish point for borehole measurements.
3. Attach an initial assembly of a bit or down hole hammer with a single section of drill rod and casing to the top-head drive unit.

4. Activate the air compressor to circulate air through system.
5. Drilling may be accomplished by
    a. Method 1- the casing will fall, or can be pushed downward behind the bit.
    b. To drill using Drive the casing first followed by drilling out the plug inside the casing.
    c. Method 2 - Advancing the casing and bit as a unit, with the drill bit or hammer, extending up to 12-inches below the casing.
6. Method 3 - Under reaming method where bit or hammer pens a hole slightly larger than the casing so that Method 1, drive the casing first and drill out the plug in the casing by moving the bit or hammer beyond the casing and then withdrawing it into the casing. Air exiting the bit will remove the cuttings up the hole. Separate cuttings from the return air with a cyclone separator or similar device.
7. To drill using Method 2, advance casing and bit as unit with the bit or hammer extending up to 12-inches beyond the casing depending on the conditions. While drilling, occasionally stop the casing advancement, retract the bit or hammer inside the casing to clear and maintain air circulation to clear cuttings.
8. To drill using Method 3, use a special down hole bit or hammer to open a hole slightly larger than the outside diameter of the casing so that the casing will fall or can be pushed downward immediately behind the bit. After advancing the casing, retract the radial dimension of the drill bit to facilitate removal of the down hole bit or hammer and drill tools inside the casing. Cuttings are removed from the borehole with the air that operates the bit or hammer and can be separated from the air with a cyclone separator or similar device.
9. Monitor air pressure during drilling operations. Maintain low air pressure at bit or hammer to prevent fracturing of surrounding material.
10. Continue air circulation and rotation of the drill rod column until drilling is completed to the target depth (for sampling, in-situ sampling, etc.) or until the length of the drill-rod section limits further penetration.
11. Stop rotation and lift bit or hammer slightly off the bottom of the hole to facilitate removal of drill cuttings and continue air circulation until the drill cuttings are removed from the borehole annulus.
12. After reaching a desired depth of sampling, stop the air circulation and rest the bit on bottom of hole to determine the depth. Record the borehole depth and any resultant caving in. If borehole caving is apparent set a decontaminated casing to protect the boring.
13. When sampling, remove the drill rod column from the borehole. Compare the sampling depth to clean-out depth by first resting the sampler on the bottom of the hole and compare that measurement with the clean-out depth measurement.
14. If bottom-hole contamination is apparent (indicated by comparison of sample depth to clean-out depth), it is recommended that the minimum depth below the sampler/bit be 18 inches for testing. Record the depth of sampling or in-situ testing and the depth below the sampler/bit.
15. The procedure described in Steps 11 through 14 should be conducted for each sampling or testing interval.
16. Drilling to a greater depth may be accomplished by attaching an additional drill rod section and casing section to the top of the previously advanced drill-rod column/casing and resuming drilling operations as described above.
17. Monitoring wells or piezometers may be installed by:
    a. Casing advancement in increments, with or without sampling to the target depth.
    b. Removal of the drill rods and the attached drill bit while the casing is temporarily left in place to support the borehole wall.

c. Insertion of the monitoring well (or piezometer) assembly.

d. Addition of monitoring well (or piezometer) completion materials (see SOP 20.1).

18. Drill cuttings should be appropriately controlled and contained as IDM per SOP 70.1.

19. The drill rod assembly, casing, sampling devices, and other drilling equipment contacting potentially contaminated material must be decontaminated before and after each use per the methods specified in SOP 80.1.

20. Borehole logging should be completed per SOP 10.3.

21. Borehole abandonment, when required, should be conducted according to SOP 20.3.

3.7 DIRECT WATER-BASED ROTARY DRILLING

The following general procedure may be followed as outlined in ASTM Standard Guide D 5783-95.

1. Stabilize drill rig and raise mast at desired location. Appropriately position the mud tub and install surface casing and seal at the ground surface.
2. Establish point for borehole measurements.
3. Attach an initial assembly of a bit or core barrel with a single section of drill rod, below the rotary table or top-head drive unit, with the bit placed with the top of the surface casing.
4. Activate the drilling-fluid circulation pump to circulate drill fluid through the system.
5. Initiate rotation of bit and apply axial force to bit.
6. Document drilling conditions and sequence (fluid loss, circulation pressures, depths of lost circulation, etc.) as described in SOP 10.3.
7. Continue with drill fluid circulation as rotation and axial force are applied to the bit until drilling to the depth
   a) Where sampling or in-situ testing is required;
   b) Until the length of the drill rod section limits further penetration; or
   c) Until core specimen has completely entered the core barrel (when coring) or blockage has occurred.
8. Stop rotation and the lift bit slightly off the bottom of the hole to facilitate removal of drill cuttings and continue fluid circulation until the drill cuttings are removed from the borehole annulus.
9. After reaching a desired depth of sampling, stop the fluid circulation and rest the bit on bottom of hole to determine the depth. Record the borehole depth and any resultant caving in. If borehole caving is apparent set a decontaminated casing to protect the boring.
10. When sampling, drill rod removal is not necessary if the sampling can be performed through the hollow axis of the drill rods and bit.
11. Compare the sampling depth to clean-out depth by first resting the sampler on the bottom of the hole and compare that measurement with the clean-out depth measurement.
12. If bottom-hole contamination is apparent (indicated by comparison of sample depth to clean-out depth), it is recommended that the minimum depth below the sampler/bit be 18 inches for testing. Record the depth of sampling or in-situ testing and the depth below the sampler/bit.
13. The procedure described in Steps 8 through 11 should be conducted for each sampling or testing interval.
14. Drilling to a greater depth may be accomplished by attaching an additional drill rod section to the top of the previously advanced drill-rod column and resuming drilling operations as described above.

15. When drilling through material suspected of being contaminated, the installation of single or multiple (nested) outer casings may be required to isolate zones suspected contamination (see SOP 20.1 for grouting requirements). Outer casings may be installed in a pre-drilled borehole or using a method in which casing is advanced at the same of drilling.
16. Monitoring wells or piezometers may be installed using hollow-stem augers by:
    a. Drilling with or without sampling to the target depth.
    b. Removal of the drill rod assembly and insertion of the monitoring well (or piezometer) assembly.
    c. Addition of monitoring well (or piezometer) completion materials (see SOP 20.1).
17. Drill cuttings and fluids should be appropriately controlled and contained as IDM per SOP 70.1.
18. The drill rod assembly, sampling devices, and other drilling equipment contacting potentially contaminated material must be decontaminated before and after each use per the methods specified in SOP 80.1.
19. Borehole logging should be completed per SOP 10.3.
20. Borehole abandonment, when required, should be conducted according to SOP 20.3.

3.8 DIRECT ROTARY WIRELINE CASING ADVANCEMENT DRILLING

The following general procedure may be followed as outlined in ASTM Standard Guide D 5876-95.

1. Stabilize drill rig and raise mast at desired location. Appropriately position the mud tub (for water based rotary) and install surface casing and seal at the ground surface.
2. Record the hole depth by knowing the length of the rod-bit assemblies and comparing its position relative to the established surface datum.
3. Attach an initial assembly of a lead drill rod and a bit or core barrel below the top-head drive unit, with the bit placed with the top of the surface casing.
4. Activate the drilling-fluid circulation pump to circulate drill fluid through the system.
5. Initiate rotation of bit and apply axial force to bit.
6. Document drilling conditions and sequence (fluid loss, circulation pressures, depths of lost circulation, down feed pressures etc.) as described in SOP 10.3.
7. In general, the pilot bit or core barrel can be inserted or removed at any time during the drilling process and the large inside diameter rods can act as a temporary casing for testing or installation of monitoring devices.
8. Continue with drill fluid circulation as rotation and axial force are applied to the bit until drilling to the depth
    a) Where sampling or in-situ testing is required;
    b) Until the length of the drill rod section limits further penetration; or
    c) Until core specimen has completely entered the core barrel (when coring) or blockage has occurred.
9. Stop rotation and lift the bit slightly off the bottom of the hole to facilitate removal of drill cuttings and continue fluid circulation until the drill cuttings are removed from the borehole annulus.
10. After reaching a desired depth of sampling, stop the fluid circulation and rest the bit on bottom of hole to determine the depth. Record the borehole depth and any resultant caving in. If borehole caving is apparent set a decontaminated casing to protect the boring.

11. When sampling, drill rod removal is not necessary if the sampling can be performed through the hollow axis of the drill rods and bit.
12. Compare the sampling depth to clean-out depth by first resting the sampler on the bottom of the hole and compare that measurement with the clean-out depth measurement.
13. If bottom-hole contamination is apparent (indicated by comparison of sample depth to clean-out depth), it may be necessary to further clean the hole by rotary recirculation.
14. Continuous sampling may be conducted with a soil core barrel or rock core barrel (see Section 1.7).
15. The pilot bit or core barrel may need to be removed during drilling such as when core barrels are full or there is evidence of core blocking. Before the drill string is reinserted, the depth of the boring should be rechecked to evaluate hole quality and determine whether casing may be required.
16. Water testing may be performed in consolidated deposits by pulling back on the drill rods and passing inflatable packer(s) with pressure fitting to test the open borehole wall (see ASTM Standards D 4630 and D 4631).
17. Drilling to a greater depth may be accomplished by attaching an additional drill rod section to the top of the previously advanced drill-rod column and resuming drilling operations as described above.
18. When drilling through material suspected of being contaminated, the installation of single or multiple (nested) outer casings might be required to isolate zones suspected contamination (see SOP 20.1 for grouting requirements). Outer casings may be installed in a pre-drilled borehole or using a method in which casing is advanced at the same of drilling.
19. Monitoring wells or piezometers may be installed by:
    a. Drilling with or without sampling to the target depth.
    b. Removal of the pilot bit or core barrel and insertion of the monitoring well (or piezometer) assembly.
    c. Addition of monitoring well (or piezometer) completion materials (see SOP 20.1).
20. Drill cuttings and fluids should be appropriately controlled and contained as IDM per SOP 70.1.
21. The drill rod assembly, sampling devices, and other drilling equipment contacting potentially contaminated material must be decontaminated before and after each use per the methods specified in SOP 80.1.
22. Borehole logging should be completed per SOP 10.3.
23. Borehole abandonment, when required, should be conducted according to SOP 20.3.

3.9 DIAMOND CORE DRILLING

The following general procedure may be followed as outlined in ASTM Standard Practice D 2113-83 (1993).

1. Use core-drilling procedures, such as the water-rotary drilling method outlined in Section 3.6.
2. Seat the casing on bedrock or firm formation to prevent raveling of the borehole and to prevent loss of drilling fluid. Level the formation that the casing will be seated on as needed.
3. Begin core drilling using an N-size double-tube, swivel-type core barrel or other approved size or type. Continue core drilling until core blockage occurs or until the net length of the core has been drilled.
4. Remove the core barrel from the borehole, and dis-assemble the core barrel as necessary to remove the core.
5. Reassemble the core barrel and return it to hole.
6. Continue core drilling.

7. Place the recovered core in the core box with the upper (surface) end of the core at the upper-left corner of the core box. Wrap soft or friable cores, etc. as needed or required. Use spacer blocks or slugs properly marked to indicate any noticeable gap in recovered core that might indicate a change or void in the formation. Fit fracture, bedded, or jointed pieces of core together as they naturally occurred.
8. The core within each completed box should be photographed after core surface has been cleaned or peeled, as appropriate, and wetted. Each photo should be in sharp focus and contain a legible scale in feet and tenths of feet (or metric if appropriate). The core should be oriented so that the top of the core is at the top of the photograph. A color chart should be included in the photograph frame as a check on photographic accuracy. The inside lid of the box should also be shown.
9. The inside of the box lid should be labeled at a minimum with the facility name, project name, boring number, box number, and core interval.
10. A preliminary field log of the core must be completed before the core box has been packed for transport (see SOP 10.3). Detailed logging may be conducted at a later time providing the core is appropriately handled and transported.
11. Four levels of sample protection may be used depending on character of the rock and the intended use of the rock core including:
    a. *Routine care* – for rock cored in 5 to 10 foot runs. Consists of placing in structurally sound boxes. Lay flat tubing may be used prior to placing the core.
    b. *Special care* – for rock samples to be tested that are potentially moisture sensitive, such as shale. This care consists of sealing with a tight fitting wrapping of plastic film and application of wax at the ends of the sample.
    c. *Critical care* – for rock samples that may be sensitive to shock and vibration and/or temperature. Protect by encasing each sample in cushioning material, such as sawdust, rubber, polystyrene, foam, etc. A minimum one-inch thick layer of cushioning material should be used. Thermally insulate samples that are potentially sensitive to changes in temperature.
    d. *Soil-Like care* – handle per ASTM Standard D 4220-95.
12. Drilling conditions and sequence (fluid loss, circulation pressures, depths of lost circulation, down feed pressures, core blockage etc.) should be documented on the boring log as described in SOP 10.3.
13. Drill cuttings and fluids should be appropriately controlled and contained as investigation-derived material per SOP 70.1.
14. The drill rod assembly, sampling devices, and other drilling equipment contacting potentially contaminated material must be decontaminated before and after each use per the methods specified in SOP 80.1.
15. Borehole logging should be completed per SOP 10.3.
16. Borehole abandonment, when required, should be conducted according to SOP 20.3.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

Refer to site-specific health and safety plan included in work plan addenda.

6.0 REFERENCES

ASTM Standard D 2113-83 (1993). 1993. *Standard Practice for Diamond Core Drilling for Site Investigation.*

ASTM Standard D 1586-84 (1992). 1992. *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.*

ASTM Standard D 1587-94. 1994. *Standard Practice for Thin-Walled Tube Geotechnical Sampling of Soils.*

ASTM Standard D 4220-95. 1995. *Standard Practices for Preserving and Transporting Soil Samples.*

ASTM Standard D 5079-90. 1995. *Standard Practices for Preserving and Transporting Rock Core Samples.*

ASTM Standard D 5782-95. 1995. *Standard Guide for Use of Direct Air-Rotary Drilling for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices.*

ASTM Standard D 5783-95. 1995. *Standard Guide for Use of Direct Rotary Drilling with Water-Based Drilling Fluid for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices.*

ASTM Standard D 5784-95. 1995. *Standard Guide for Use of Hollow-Stem Augers for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices.*

ASTM Standard D 5872-95. 1995. *Standard Guide for Use of Casing Advancement Drilling Methods for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices.*

ASTM Standard D 5876-95. 1995. *Standard Guide for Use of Direct Rotary Wireline Casing Advancement Drilling Methods for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices.*

ASTM Standard D 6282-98. 1998. *Standard Guide for Direct Push Soil Sampling for Environmental Site Characterizations.*

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

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 1586-84. 1984. *Penetration Test and Split-Barrel Sampling of Soils.*

ASTM Standard D 1587-83. 1983. *Thin Walled Sampling of Soils.*

ASTM Standard D 5633-94. 1994. *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 30.3
SURFACE WATER SAMPLING

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for collecting grab samples of surface water. This procedure can be applied to the collection of surface water samples from streams, rivers, ditches, lakes, ponds, and lagoons.

2.0 MATERIALS

- Work Plans;
- Field logbooks;
- Photoionization detector (PID) or other appropriate monitoring instrument as specified site-specific health and safety plan;
- Appropriate sample bottles, labels, chain-of-custody forms, and sample shipping supplies etc;
- Long-handled dip sampler (polytetrafluoroethylene (PTFE) or stainless steel), as applicable;
- Short-handled dip sampler (PTFE or stainless steel), as applicable;
- Pond sampler (PTFE or stainless steel), as applicable;
- Boat, other stable working platform, personal flotation device, as applicable;
- Sample filtration apparatus, as applicable;
- Peristaltic pump with 0.45-μm filters and disposable PTFE tubing, as applicable;
- Personal protective equipment and clothing (PPE) per site specific health and safety plan; and
- Appropriate containers for investigation-derived material.

3.0 PROCEDURE

3.1 CONSIDERATIONS

Factors that will need to be considered for selection of a surface water sampler include the width, depth, and flow of the surface water body, and whether the sample will be collected from the shore or a vessel. The most appropriate method(s) of sample collection and the appropriate depths of sampling (sampling strategies) will be specified in work plan addenda based on site-specific conditions and data quality objectives (DQOs).

3.2 DOCUMENTATION

Surface water sampling information should be recorded in the field logbooks as described in SOPs 10.1 and 10.2. This information should include a description of the water body characteristics (size, depth, flow, etc.).

Sampling locations should be marked on a site map. Describe each location and place a numbered stake above the visible high water mark on the bank closest to the sampling location and/or mark adjacent trees with surveyor's flagging. The descriptions must be adequate to allow the sampling station to be relocated at some future date by someone other than the original sampling crew.

3.3 SAMPLE LOCATION AND TIMING

Sampling should proceed from downstream locations to upstream locations so that disturbance related to sampling does not affect the samples collected upstream. In addition, if sediment samples are to be collected at the same locations as the surface water samples, the water samples must be collected first. Sampling should be performed quickly and in a manner that minimizes disturbance of bottom sediments to ensure a representative sample.

In general, surface water samples should be collected and containerized in the order of the volatilization sensitivity of the parameters. A preferred collection order for some common parameters is volatile organic compounds (VOCs), extractable organics, metals, cyanide, sulfate and chloride, turbidity, and nitrate and ammonia. The parameters to be collected at any location are site-specific and are specified in work plan addenda.

3.4 SAMPLING METHODS

Various methods may be used to collect samples of surface water and the method used will depend on the considerations discussed in Section 3.1. Some of the more common methods used to collect surface water samples from shallow depths include:

- Submergence of sampling containers;
- Dipper and pond sampler; and
- Peristaltic pump (for non-volatile parameters).

Submergence of Sampling Container

Direct filling the sample containers by submergence is advantageous when the sample might be significantly altered during transfer from a collection device into another container. This method would not be appropriate for sampling at depth.

1. All sampling equipment should be appropriately decontaminated before and after use according to the requirements of the work plan addendum and SOP 80.1.
2. Spread new plastic sheeting on the ground at each sampling location to prevent cross-contamination. If sample access is restricted, use appropriate vessel or another stable working platform adjacent to the area to be sampled.
3. Samples should be collected in order specified in the work plan addenda prepared for the site-specific investigation (also see Section 3.3).
4. Submerge an appropriate sample container with the cap in place with minimal surface disturbance so that the open end is pointing upstream. Sample container requirements are specified in work plan addenda.
5. Allow the container to fill slowly and continuously using the cap to regulate the inflow of water.
6. Retrieve the sample from the surface water with minimal disturbance.
7. Preserve the sample as specified in work plan addenda. Secure the cap on the sample container tightly.

8. Appropriately, label the samples (SOP 50.1), complete the chain-of-custody (SOP 10.4), and package the samples for shipping (SOP 50.2).

Sampling with Dip and Pond Sampler

Dipper and pond samplers prevent unnecessary contamination of the outer surface of the sample container that would occur with the direct submergence method of sampling.

A long handled dipper sampler or a pond sampler can be used to remotely obtain samples where access is poor or non-contact with water is suggested in the health and safety plan.
Sampling with the PTFE or stainless steel dipper or pond sampler (long-handled or measuring cup type):

1. All sampling equipment should be appropriately decontaminated before and after use according to the requirements of the work plan addendum and SOP 80.1.
2. Spread new plastic sheeting on the ground at each sampling location to prevent cross-contamination. If sample access is restricted, use appropriate vessel or another stable working platform adjacent to the area to be sampled.
3. Assemble the sampler.
4. Samples should be collected in order specified in the work plan addenda prepared for the site-specific investigation (also see Section 3.3).
5. Collect samples by slowly submerging the pre-cleaned dipper or pond sampler with minimal surface disturbance. Make sure the open end is pointing upstream.
6. Remove the cap from the sample container and slightly tilt the mouth of the bottle below the edge of the sampler. Sample container requirements are specified in work plan addenda.
7. Empty the sampler slowly. Allow the sample stream to flow gently down the side of the bottle with entry turbulence. Avoid aerating the sample.
8. Continue filling the sample container until the container is filled.
9. Preserve the sample as specified in work plan addenda. Secure the cap on the sample container tightly.
10. Appropriately, label the samples (SOP 50.1), complete the chain-of-custody (SOP 10.4), and package the samples for shipping (SOP 50.2).

Sampling with a Peristaltic Pump

Sampling with a peristaltic pump will extend the lateral reach of the sampler and allow sampling from depths below the water surface. A disadvantage of this method is that it cannot be used to sample for volatile organic compounds because of potential degassing effects.

1. All sampling equipment should be appropriately decontaminated before and after use according to the requirements of the work plan addendum and SOP 80.1.
2. Spread new plastic sheeting on the ground at each sampling location to prevent cross-contamination. If sample access is restricted, use appropriate vessel or another stable working platform adjacent to the area to be sampled.
3. Install clean medical grade silicone tubing in the pump head, as instructed by the manufacturer.
4. Select the length of appropriate suction tubing (PFTE or other) necessary to reach the required sample location/depth and attach to the pump intake or extended section of silicone tubing emanating from the intake side of the pump head.

5. Turn on pump and adjust flow to draw water through tubing. If possible, allow several liters of sample to pass through the system before actual sample collection.
6. Samples should be collected in order specified in the work plan addenda prepared for the site-specific investigation (also see Section 3.3).
7. VOC samples, if required, will be collected using another type of sampling device, as specified in the work plan addenda.
8. Collect surface water samples directly from the end of the tubing into clean laboratory-prepared (preserved) containers. Allowing the pump discharge to flow gently down the inside of the container with minimal turbulence should fill all sample containers. Sample container requirements are specified in work plan addenda.
9. Preserve the sample as specified in work plan addenda. Secure the cap on the sample container tightly.
10. Appropriately, label the samples (SOP 50.1), complete the chain-of-custody (SOP 10.4), and package the samples for shipping (SOP 50.2).

3.5 SAMPLE FILTRATION

If specified in work plan addenda, certain parameters such as metals may need to be collected for both total and dissolved fractions. In this case, filtration will be performed immediately after collecting sample. Set up filtration equipment before collecting sample. Filtration may be accomplished by gravity or, if necessary, due to slow filtering, a peristaltic pump can be used to pressure filter the sample. Vacuum filtration will not be used due to the possibility of analyte volatilization.

Gravity Filtration

1. Using decontaminated forceps, place a 0.45-µm membrane in a decontaminated filter funnel.
2. Slowly pour sample into the funnel and collect filtrate directly into appropriate sample container(s).
3. Preserve the sample as specified in work plan addenda. Secure the cap on the sample container tightly.
4. Appropriately, label the samples (SOP 50.1), complete the chain-of-custody (SOP 10.4), and package the samples for shipping (SOP 50.2).
5. Appropriately dispose of filter membrane.

Filter with a Peristaltic Pump

1. Using previously assembled disposable tubing, 0.45-µm in-line filter, and peristaltic pump, filter sample from collection bucket into appropriate container.
2. Adjust pump rate to avoid aeration of sample.
3. Preserve the sample as specified in work plan addenda. Secure the cap on the sample container tightly.
4. Appropriately, label the samples (SOP 50.1), complete the chain-of-custody (SOP 10.4), and package the samples for shipping (SOP 50.2).

4.0 MAINTENANCE

Refer to manufacturer's specifications for maintenance procedures on generators and pumps.

5.0 PRECAUTIONS

Refer to the site-specific health and safety plan.

6.0 REFERENCES

ASTM Standard D 5358-93. 1993. *Standard Practice for Sampling with a Dipper or Pond Sampler.*

Environmental Monitoring System Laboratory (EMSL), ORD, U.S. Environmental Protection Agency. *Characterization of Hazardous Waste Site-A Method Manual, Volume II-Available Sampling Methods.* 1983.

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

STANDARD OPERATING PROCEDURE 30.4
SEDIMENT SAMPLING WITH SCOOP OR TUBE SAMPLER

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for obtaining representative sediments sampling using a scoop or hand corer.

Sediments include solid matter derived from rocks or biological materials that are suspended in, or settled from, water. This procedure can be applied to the collection of sediment samples from areas of deposition such as streams, rivers, ditches, lakes, ponds, and lagoons.

SOP 30.5 describes two methods of grab sampling (Ekman and Ponar) that are suitable for sampling surface or deep sediments. SOP 30.12 describes a method of sampling deep sediments by using a Vibracore sampler.

2.0 MATERIALS

- Work Plans;
- Field logbooks;
- Photoionization detector (PID) or other appropriate monitoring instruments as specified in site-specific health and safety plan;
- Appropriate sample bottles, labels, chain-of-custody forms, and sample shipping supplies etc;
- Stainless steel bowls;
- Stainless steel or polytetrafluoroethylene (PTFE) scoops, trowels, spoons, and knives;
- Hand core sediment sampler, liners (optional) and extensions;
- Hand auger with buckets, rods, and T-handles;
- Rubber boots/waders;
- Decontamination equipment and supplies (SOP 80.1);
- Plastic sheeting;
- Utility knife;
- Boat or other stable work platform, and personal flotation devices, as applicable; and
- Personal protective equipment and clothing (PPE) as specified in site-specific health and safety plan.

3.0 PROCEDURE

The water content of the sediment may vary greatly. Likewise, the sediments themselves may range from very soft to dense. It may be necessary to use a variety of equipment to obtain the required samples, even at a single site.

3.1 CONSIDERATIONS

Factors that determine the type of sediment water sampler used are primarily related to project objectives of surficial versus subsurface samples, site constraints of the water depth, sampling and sediment conditions, and cost-effectiveness of the sampler.

The most appropriate method(s) of sample collection and the appropriate depths of sampling (sampling strategies) will be specified in the work plan addendum based on site-specific conditions and data quality objectives (DQOs).

3.2 DOCUMENTATION

Sediment sampling information should be recorded in the field logbooks as described in SOPs 10.1 and 10.2. This information should include a description of the water body characteristics (size, depth, flow, etc.) and nature of sediments.

Sampling locations should be marked on a site map. Describe each location and place a numbered stake above the visible high water mark on the bank closest to the sampling location and/or mark adjacent trees with surveyor's flagging. The descriptions must be adequate to allow the sampling station to be relocated at some future date by someone other than the original sampling crew.

3.3 SAMPLE LOCATION AND TIMING

Sampling should proceed from downstream locations to upstream locations so that disturbance related to sampling does not affect the samples collected upstream. In addition, if surface water samples are to be collected at the same locations as the sediment samples, the surface water samples must be collected first. Sampling should be conducting using appropriate sampling devices that minimize disturbance and sample washing as the sample is retrieved through the liquid column.

In general, sediment samples should be collected and containerized in the order of the volatilization sensitivity of the parameters. A preferred collection order for some common parameters is volatile organic compounds (VOCs), extractable organics, metals, cyanide, sulfate and chloride, turbidity, and nitrate and ammonia. The parameters to be collected at any location are site-specific and are specified in work plan addenda.

3.4 LOCATION

For all samples, mark the sampling location on a site map. Photograph (optional, recommended) and describe each location, and place a numbered stake above the visible high water mark on the bank closest to the sampling location. The photographs and description must be adequate to allow the sampling station to be relocated at some future date.

3.5 GENERAL PROCEDURES

1. All sampling equipment should be appropriately decontaminated before and after use according to the requirements of work plan addenda and SOP 80.1.
2. Spread new plastic sheeting on the ground at each sampling location to prevent cross-contamination. If sample access is restricted, use appropriate vessel or another stable working platform adjacent to the area to be sampled.
3. Document sample location and conditions appropriately in the field logbooks and on site maps.
4. Collect surface water sample as described in the work plan addenda and SOP 30.3, as necessary.
5. Collect sediment sample using the appropriate sampling device as described in the following sections.

3.6 SCOOP OR TROWEL METHOD

The scoop or trowel method is a very accurate procedure for collecting representative samples, but is limited to sampling exposed sediments or sediments in surface water less than 6-inches deep, with nominal flow.

1. Insert scoop or trowel into material and remove sample.
2. 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.
3. The method of collection for VOC samples 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 and sampling conditions.
4. Field screen the sample with properly calibrated photoionization detector (PID) or other appropriate instrument. Based on the screening results collect the VOC fraction, as applicable.
5. 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.
6. 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. Secure the cap of each container tightly. Sample container requirements are specified in work plan addenda.
7. Appropriately, label and package the samples according to the requirements specified in SOPs 50.1 and 50.2, respectively, and with any additional sample handling requirements specified in work plan addenda.

3.7 TUBE SAMPLER

Tube samplers are a simple and direct method for obtaining sediment samples. The tube sampler is forced into the sediment and then withdrawn and the sample collected. Non-cohesive sediments may limit the effectiveness of this type of sampler.

1. Ensure that the corers and (optional) liners are properly cleaned.
2. Gradually force the corer into the sediment.
3. Carefully retrieve the tube sampler.
4. Remove the sediment core from the tube sampler and place core on a clean working surface.
5. Begin sampling with the acquisition of any discrete sample(s) for analysis of VOCs, with as little disturbance as possible. VOC samples will not be composited or homogenized.
6. The method of collection for VOC samples 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 and sampling conditions.
7. Field screen the sample with properly calibrated photoionization detector (PID) or other appropriate instrument. Based on the screening results collect the VOC fraction, as applicable.

8. 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.
9. 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. Secure the cap of each container tightly. Sample container requirements are specified in work plan addenda.
10. Appropriately, label and package the samples according to the requirements specified in SOPs 50.1 and 50.2, respectively, and with any additional sample handling requirements specified in work plan addenda.

3.8 HAND AUGER AND TUBE SAMPLER

In general, the use of a hand auger and tube sampler will allow for sampling deeper sediments than possible with the tube sampling method described in Section 3.7. A potential disadvantage of using this method is that it limited to use for water bodies of limited depth and hand augers may not be an effective method for penetrating soft sediments since the borehole may collapse prior to sampling.

1. Attach the auger bucket to a drill rod extension and attach the T-handle to the drill rod.
2. Begin drilling with the auger. Periodically remove accumulated sediment from the bucket.
3. After reaching the desired depth, slowly and carefully remove the auger from the boring.
4. Remove the auger bucket from the drill rod(s) and replace with a clean thin-wall tube sampler.
5. Remove the sediment core from the tube sampler and place core on a clean working surface.
6. Carefully lower the tube sampler down the borehole and gradually force it into the sediment, avoiding scraping the borehole sides.
7. Carefully retrieve the tube sampler and unscrew the drill rod(s).
8. Begin sampling with the acquisition of any discrete sample(s) for analysis of VOCs, with as little disturbance as possible. VOC samples will not be composited or homogenized.
9. The method of collection for VOC samples 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 and sampling conditions.
10. Field screen the sample with properly calibrated photoionization detector (PID) or other appropriate instrument. Based on the screening results collect the VOC fraction, as applicable.
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. Appropriately, label and package the samples according to the requirements specified in SOPs 50.1 and 50.2, respectively, and with any additional sample handling requirements specified in work plan addenda.

3.9 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.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

Refer to the site-specific health and safety plan.

6.0 REFERENCES

ASTM Standard D 4700-91. 1991. *Standard Guide for Soil Sampling from the Vadose Zone.*

ASTM Standard D 5633-94. 1994. *Standard Practice for Sampling with a Scoop.*

USEPA. 1987. *A Compendium of Superfund Field Operations Methods.* EPA/540/P-87/001.

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

STANDARD OPERATING PROCEDURE 30.6
CONTAINERIZED MATERIAL

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for the opening and sampling of containerized liquids of potentially unknown substances.

2.0 MATERIALS

- Work Plans;
- Field logbooks;
- Personal protective equipment and clothing per the site-specific health and safety plan;
- Monitoring instruments per the site-specific health and safety plan;
- Decontamination equipment and supplies (SOP 80.1);
- Tools;
- Historical data, if available;
- Sampling tube; and
- Remote samplers, as required.

3.0 PROCEDURE

Sealed containers with unknown contents represent potential severely hazardous situations for sampling teams. Even when the original identity of the contents is reasonably certain, contents may be under pressure or in a decomposed state and may readily react (sometimes violently) with air or water vapor in the atmosphere.

Only hazardous material specialists that have appropriate training and experience will inspect and sample unidentifiable drums or containers. Specialist team members will use extreme caution and care when opening sealed drums or cans of unknown content for purposes of inspection and sampling.

Efforts will be made to determine the identity of the contents, through markings, history of activities at the site, and similarity and proximity to containers of known contents. The range of possible hazards will dictate which specific procedure will be followed, and specific procedures will be identified in work plan addenda. All predetermined procedures will be strictly followed as designated by the site-specific conditions.

Using this SOP and appropriate health and safety protocols, field personnel will use extreme caution and care in opening sealed drums or cans of unknown contents for purposes of inspection and sampling. Specific activities include the following:

- Determine the identity of the contents through markings, history of activities at the site, and similarity and proximity to containers of known contents. The range of possible hazards will dictate which specific procedure should be followed.
- Handle containers as little as possible; however, if it is necessary to reorient a drum to allow access to a bung or cap, perform this activity using remote-handling forklift equipment with special drum-holding attachments.
- If contents are deemed to be under pressure, highly reactive, or highly toxic (or if these possibilities cannot be disproven), perform initial opening of the container remotely.
- Air monitoring stations will be established as necessary, using the following procedures:
  1. Affix a remote bung opener to the drum.
  2. Evacuate personnel to a safe distance or station them behind a barricade.
  3. Activate the non-sparking motor of the opener.
  4. After the bung is removed, monitor the drum for potential activity of the contents, such as vapor emission, smoking, or audible reaction.
  5. Approach cautiously while monitoring for toxic levels of airborne contaminants.
- If the contents of the drum pose acceptable hazards, accomplish opening (or inspection if previously opened remotely) and sampling with one of three approved devices. The preferred method is to use a clean glass tube, with or without bottom stopper, which can be placed in the drum (breaking it if necessary) after sampling is complete. Alternately (if a bung has been removed), a well sampler such as a Kemmererbailer can be used (but would require removal and cleaning or disposal according to the nature of the waste). By opening either of these devices at a desirable depth, stratified sampling can be performed. Also, the sampling tubes can be made with a plunger rod and O-ring seals at selected intervals, allowing simultaneous collection of multiple samples in a stratified medium.
- Following sampling, the drum will be resealed and/or overpacked to prevent any possibility of leakage while analysis determines the identity of the contents.
- Drums that do not have removable bungs may be opened remotely with a solenoid-activated punch (this requires that the drum be recontainerized or overpacked after sampling is complete).

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

Not applicable.

6.0 REFERENCE

USEPA, 1989. A Compendium of Superfund Field Operation Methods. EPA/540/P-87/001. December.

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

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 30.9
COLLECTION OF SOIL SAMPLES BY USEPA SW 846 METHOD 5035 USING DISPOSABLE SAMPLERS

1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) outlines the recommended protocol and equipment for collection of representative soil samples to monitor potential volatile organic contamination in soil samples.

This method of sampling is appropriate for surface or subsurface soils contaminated with low to high levels of volatile organic compounds (VOCs). This sampling procedure may be used in conjunction with any appropriate determinative gas chromatographic procedure, including, but not necessarily limited to, SW-846 Method 8015, 8021, and 8260.

2.0 MATERIALS

- Work Plans;
- Field Logbook;
- Photoionization Detector (PID) or other monitoring instrument(s) per site-specific health and safety plan;
- Personal protective equipment and clothing per site-specific health and safety plan;
- Soil sampling equipment, as applicable (SOP 30.1);
- Disposable sampler;
- T-handle and/or Extrusion Tool; and
- Decontamination equipment and supplies (SOP 80.1).

3.0 PROCEDURE

3.1 METHOD SUMMARY

Disposable samplers are sent to the field to be used to collect soil samples. Three samplers must be filled for each soil sampling location, two for the low-level method (sodium bisulfate preservation) and one for the high level method (methanol preservation). After sample collection, disposable samplers are immediately shipped back to the laboratory for preservation (adding soil sample into methanol and sodium bisulfate solution). The ratio of volume of methanol to weight of soil is 1:1 as specified in SW-846 Method 5035 (Section 2.2.2). The amount of preservative in the solution corresponds to approximately 0.2 g of preservative for each 1 g of sample. Enough sodium bisulfate should be present to ensure a sample pH of ≤ 2.

If quality assurance/quality control (QA/QC) samples are needed, seven samplers will be needed for the original, matrix spike, and matrix spike duplicate analysis. Soil samples are collected in the field using the

disposable samplers, sealed and returned to the laboratory. A separate aliquot of soil is collected in a 125-mL container for dry weight determination.

3.2 SAMPLE CONTAINERS, PRESERVATION, HANDLING AND STORAGE

After sample collection, the disposable samplers must be cooled to and maintained at 4°C. The contents of the samplers will be analyzed using EPA methods 8015, 8021, and/or 8260. The **disposable** sampler is a single use device. It cannot be cleaned and/or reused.

Disposable samplers have a 48 hour holding time from sample collection to sample preparation in the laboratory. Return the samplers to the laboratory immediately after sampling.

3.3 SAMPLE PROCEDURES

Before sampling, the disposable sampler should be prepared as follows:

1. Unpack the cooler/sampling kit received from the laboratory. Disposable samplers are packed in sealed aluminized bags. These should be over packed in plastic zip lock bags. A T-Handle will also be needed to collect samples with the disposable sampler.
2. Hold coring body and push plunger rod down until small 0-ring rests against tabs. This will assure that plunger moves freely.
3. Depress locking lever on the sampler T-Handle (or other extraction device). Place coring body, plungers end first, into the open end of the T-Handle, aligning the two slots on the coring body with the two locking pins in the T-Handle. Twist the coring body clockwise to lock the pins in the slots. Check to ensure the sampler is locked in place. Sampler is ready for use.

The following procedure should be followed when using a disposable sampler to sample for VOCs in soil:

1. After the soil-sampling device (split spoon, corer, etc.) is opened, the sampling process should be completed in a minimum amount of time with the least amount of disruption.
2. Visual inspection and soil screening should be conducted after the sampler is opened and a fresh surface is exposed to the atmosphere. Soil screening should be conducted with an appropriate instrument (PID or FID).
3. 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.
4. Orient the T-Handle with the T-up and the coring body down. This positions the plunger bottom flush with bottom of coring body (ensure that plunger bottom is in position). Using T-Handle, push sampler into soil until the coring body is completely full taking care not to trap air behind the sampler. When full, the small o-ring will be centered in the T-Handle viewing hole. Remove sampler from soil. Wipe excess soil from coring body exterior with a clean disposable paper towel.
5. Cap coring body while it is still on the T-Handle. ***Push*** cap over flat area of ridge ***and twist*** to lock cap in place. ***Cap must be seated to seal sampler.***
6. Remove the capped sampler by depressing locking lever on T-Handle while twisting and pulling sampler from T-Handle.
7. Lock plunger by rotating extended plunger rod fully counterclockwise until wings rest firmly against tabs.

8. Fill the 125-mL wide mouth jar for the non-preserved portion of the sample to be used for a moisture determination. These may be in a cardboard box. Retain all packaging to return the samples.
9. The disposable sampler should collect approximately 5 grams of soil (not necessary to weigh in the field). After a sample has been collected and capped, tear off the identification tag found at the bottom of the label on the aluminized bag. This tag is added to the sampler on the cap used to seal the sampler.
10. Place the sampler back in the aluminized bag and seal the top (a zip-lock seal). Make sure all the appropriate information is on the label. Record the sampler ID number on the chain-of-custody. Make sure each sampler and 125-mL container is labeled with the same location identification. The sampler should be placed inside the plastic zip-lock bags.
11. Place the 125-mL wide mouth jars in the cooler with the sampler on top. These should be sandwiched between bags of ice to maintain the correct temperature. If sent with the jars and samplers, a temperature bottle (used to evaluate the temperature on receipt) should be placed in the middle of the jars. The sample temperature should be 4°C during shipment.
12. Ship the samples so that they will be received within 24 hours of sampling. The laboratory must receive the sampler within 40 hours of the collection so that they can be correctly preserved.

3.4 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

1. All data must be documented on chain-of-custody forms, field data sheets and in the field logbook.
2. An equipment blank is a QA/QC sample that will determine potential contamination from sampling equipment used to collect and transfer samples from the point of collection to the sample container. An equipment blank is performed by pouring demonstrated analyte free water from one sample container, over a sampler, and into a separate set of identical sample containers. The equipment blank is optional when sampling with the methanol preservation technique. It may be required on a site-specific basis if elevated analytical results are suspected to be due to cross contamination from sampling equipment.
3. A trip blank is a QA/QC sample, which will determine additional sources of contamination that may potentially influence the samples. The sources of the contamination may be from the laboratory, sample containers, or during shipment. The laboratory prepares a trip blank at the same time and in the same manner as the sample containers. The trip blank must accompany the sample containers to the field and back to the laboratory along with the collected samples for analysis. It must remain sealed at all times until it is analyzed at the laboratory. The frequency of collection for the trip blank must be at a rate of one per sample shipment.

3.5 LIMITATIONS IN SAMPLING

This sampling protocol will not be applicable to all solid environmental matrices, such as those that cannot be cored including non-cohesive granular material, gravel, or hard dry clay. In this case, the procedure for collecting VOC samples using Methanol Preservation should be used (see SOP 30.8).

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

None.

6.0 REFERENCES

En Novative Technologies, Inc. 2000. Users Manual for En Core® Sampler. February 2001.

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

USEPA. 1997. *Test Methods for Evaluating Solid Waste, Volume IB: Laboratory Manual Physical/Chemical Methods,* Third Edition, (as updated through update IIIA). Office of Solid Waste and Emergency Response, Washington, DC.

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

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 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, 1995. 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.

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APPENDIX B
SITE PHOTOGRAPHS

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PHOTO 1: SWMU 37 facing southwest



PHOTO 2: SWMU 38 facing southwest



PHOTO 3: Adjacent to Area Q facing south toward SWMU 38



PHOTO 4: SWMU 46 facing southeast



PHOTO 5: SWMU 75 facing south



PHOTO 6: SWMU 76 facing southwest



PHOTO 7: SWMU 76 facing northwest, SWMU 17 is located in center right of the photo



PHOTO 8: SWMU 13 Settling Lagoon



PHOTO 9: SMWU 13 Burning Pans, New River left of rock berm



PHOTO 10: SWMU 57 terra cotta pipe leading to the pond



PHOTO 11: SWMU 68 facing northwest



PHOTO 12: SWMU 69 facing northwest toward the perennial stream flowing to the New River



PHOTO 13: Area A facing along the rainwater ditch adjacent to the building



PHOTO 14: Area F facing west, area F is the gravel area to the left of the person in the photo

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APPENDIX C
SUPPORTING DOCUMENTS

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SWMU 68

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REPORT DOCUMENTATION PAGE

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1. AGENCY USE ONLY (*Leave blank*)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	April 1998	Site Closure Report, 1998

4. TITLE AND SUBTITLE
SWMU 68 Closure Report, Radford Army Ammunition Plant

5. FUNDING NUMBERS
U.S. Army Environmental Center
Contract No. DACA31-94-D-0064
Task Order 0008

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8. PERFORMING ORGANIZATION REPORT NUMBER
ESPS08-4

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Environmental Center
Aberdeen Proving Ground, MD 21010

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
See DoDD 5230.24 "Distribution Statements on Technical Documents."

12b. DISTRIBUTION CODE

13. ABSTRACT (*Maximum 200 words*)

This Closure Report for SWMU 68 summarizes the activities performed at the site and presents the results of these activities in support of final site closure. Activities included upgradient soil characterization, removal activities, and a subsurface investigation. Surface and subsurface upgradient soil samples were collected to assess the correlation between facility-wide and site-specific background concentrations. Removal activities included the handling and disposal of two ASTs and appurtenant piping in order to evaluate subsurface soil characteristics. Removing the materials also eliminated potential sources for future contamination. The soil below the tanks was removed to a depth of 4 feet bgs. Subsurface investigations included the sampling and analysis of 24 confirmation samples and 1 contingency sample. All analytical soil results were either less than RCRA permit HBNs, upland background levels, and/or generic soil screening levels which demonstrates the absence of subsurface process-related contamination. Site restoration was accomplished by backfilling with clean soil, regrading to compliment the natural terrain of the surrounding area, and reseeding with grass talatable to the resident deer population. Based on sample evaluation, SWMU 68 is recommended for no further action and site closure.

14. SUBJECT TERMS	15. NUMBER OF PAGES
RFAAP, Master Work Plan, SWMU 68, background characterization, no further action, site closure.	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	None

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LIST OF ACRONYMS

ACM..... asbestos-containing material
AST ..... aboveground storage tank
bgs ..... below ground surface
CFR ..... Code of Federal Regulations
HBN ..... health-based number
IDW..... investigation-derived waste
NG2 ..... Nitroglycerin Area #2
NPL ..... National Priorities List
RCRA ..... Resource Conservation and Recovery Act
RFAAP..... Radford Army Ammunition Plant
SPSS..... Statistical Package for the Social Sciences
SSL..... Soil Screening Level
SVOC..... semi-volatile organic compound
SWMU ..... solid waste management unit
TAL ..... Target Analyte List
TCLP..... Toxicity Characteristic Leachate Procedure
USEPA ..... U.S. Environmental Protection Agency
VI ..... Verification Investigation

EXECUTIVE SUMMARY

Investigation objectives at Solid Waste Management Unit (SWMU) 68 were to evaluate background metals concentrations exceeding health-based numbers (HBNs), verify previous investigation results, and determine whether process operations had adversely impacted subsurface soils beneath the site.

Two aboveground storage tanks (ASTs) located on the SWMU had been used to process chromic acid wastewater generated after rocket encasement cleaning. Hexavalent chromic acid was batch treated in the ASTs and subsequently reduced to the less toxic chromium III state. The treated wastewater was discharged to SWMU 69.

During the Verification Investigation (VI) (Dames & Moore, 1992), samples collected in the vicinity of SWMU 68 exceeded Resource Conservation and Recovery Act (RCRA) permit HBNs for arsenic, beryllium, cobalt, and thallium. Inconsistencies associated with the previous assessment of background results necessitated the statistical reevaluation of background in the vicinity of the SWMU. For example, the U.S. Environmental Protection Agency (USEPA) identified deficiencies in the soil type sample and the validity of comparisons with samples taken at depth. Upgradient and cross-gradient background samples were collected and analyzed for full Target Analyte List (TAL) metals to evaluate upland background concentrations at the site against upgradient site-specific characteristics.

Access to subsurface soils was effected through the removal of the ASTs, wooden structures, and appurtenant piping. During this phase of the investigation, several types of materials were encountered that were handled and disposed of in accordance with applicable federal and state regulations. Materials included lead-based paint, asbestos, and solid and investigation-derived waste (IDW).

Test pits were advanced downgradient from the ASTs and sampled to depths of 5 feet below ground surface (bgs) for target analyte metals. Duplicate samples were collected within each homogenous 8'x 8'x 4' sampling grid. All sample results were evaluated against HBNs, upland soil background levels(Parsons, 1994), and generic soil screening levels. Additionally, samples upgradient of the SWMU 68 were collected and evaluated using the Shapiro-Wilk model to evaluate the correlation between facility-wide and site-specific background concentrations. These results were then evaluated against generic soil screening levels (USEPA, 1996). It was determined that test pit samples were not statistically different from background samples, and no further action is recommended at the site.

Site investigation activities were completed within a three-week period consistent with the initial milestone projection. All activities were completed within budget and schedule. Site restoration activities were completed to integrate the site with the natural habitat. The site was re-graded to complement the natural terrain of the surrounding area and was reseeded with orchard grass and clover, a ground cover palatable to the resident deer population.

1.0 INTRODUCTION

The purpose of this Closure Report is to summarize the activities performed at SWMU 68 in support of Contract Number DACA31-94-D-0064, Delivery Order 0008, and to present the results of these activities in support of final closure of the site.

This closure report presents decisions affecting SWMU 68 based on site investigation activities. The report details investigation activities, the nature and extent of contamination at the site, and the process used to derive investigation conclusions. Site photographs and maps are included to depict current site conditions.

1.1 INVESTIGATION OBJECTIVES

Investigation objectives presented in Addendum 001 to the Master Work Plan (USAEC, 1997) include:

- Background characterization. Surface and subsurface soil samples were collected upgradient of SWMU 68 to establish background concentrations for metals. These background concentrations were used to determine if metal concentrations at the SWMU are naturally-occurring or related to previous operations. In this report, the subsurface background concentrations are compared to test pit soil results that exceeded HBNs specified in the RCRA permit (USEPA, 1989).
- Removal action. Two ASTs and appurtenant piping were removed to access the soil below. Some of the materials removed demanded appropriate waste management handling and disposal, as discussed in this report. Removal action contributes to the closure of the site by eliminating the tanks and piping as potential sources of future contamination.
- Subsurface investigation. Soil samples were collected, analyzed, and evaluated to determine the nature and extent of contamination in subsurface soil at SWMU 68.

This report discusses how these objectives were accomplished and presents the investigation findings. Table 1-1 presents the analytical data results obtained during the Verification Investigation (Dames and Moore, 1992).

1.2 SITE CLOSURE

Site Closure consists of (1) removing contamination or contaminated media that were determined to be above levels of concern, (2) removing all sources of contamination, and (3) restoring the site to a state harmonious with its surroundings. Having achieved investigation objectives, investigation findings confirm and support site closure. This report recommends closure for SWMU 68.

Table 1-1
SWMU 68 Verification Sample Results

SITE ID FIELD ID SAMPLING DATE MATRIX DEPTH (ft) ELEMENT UNIT	FREQUENCY hits/#sample	PQLs mg/kg	HBN mg/kg	68SS1 RVFS*59 4-Feb-92 Surface Soil 0	68SS2 RVFS*60 4-Feb-92 Surface Soil 0
Metals					
Aluminum	2/2	14.1	230000*	9450	18500
Antimony	1/2	20	30	<20	26.3
Arsenic	2/2	0.3	0.5	2.4	7.3
Barium	2/2	1	1000	118	61.3
Beryllium	2/2	0.2	0.1	1.10	1.90
Cadmium	1/2	2	40	1.60	<2
Calcium	2/2	100	na	624	2270
Chromium	2/2	4	400	26.9	49.2
Cobalt	2/2	3	0.8*	11.5	16.6
Copper	2/2	7	2900	10.0	20.0
Iron	2/2	1000	na	12600	33900
Lead	2/2	2	200	16.5	28.7
Magnesium	2/2	50	na	642	1610
Manganese	2/2	0.275	8000*	1250	885
Mercury	1/2	0.1	20	<0.1	0.4
Nickel	2/2	3	1000	8.8	10.7
Potassium	2/2	37.5	na	538	1010
Silver	2/2	4	200	0.8	1.1
Sodium	2/2	0.5	na	650	188
Thallium	2/2	20	6	9.6	21.1
Vanadium	2/2	0.775	560*	30.5	75.8
Zinc	2/2	30.2	16000*	54.1	87.4
Wet Chemistry					
pH	2/2	na	na	8.5	7.4

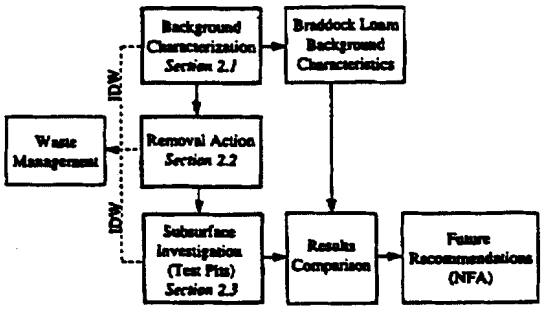
LEGEND:

* - HBN values were derived
shading - values exceed HBN
na - not applicable

2.0 INVESTIGATION ACTIVITIES

Investigation activities include background characterization, AST removal, and subsurface characterization. Figure 2-1 depicts the relationship of the definable features of work associated with the site investigation. Changes to the proposed work plan that were made in the field as the work progressed to accommodate unanticipated conditions are discussed in the respective sections below.

Figure 2-1. Flowchart of Investigation Activities



2.1 UPGRADIENT CHARACTERIZATION

2.1.1 Sampling Rationale

Upgradient soil samples were collected for metals for comparison to HBNs and upland soil background comparison levels (Parsons, 1994). Sampling locations are shown in Figure 2-2. Although eight sampling locations were proposed, only six locations were sampled (refer to Table 2-1), including the following:

- Six samples at three near-upgradient locations were collected as controls.
- Four samples at two cross-gradient locations were collected to determine whether process fluids had spilled from the tanks or had migrated in a cross-gradient direction.
- Two samples at one far-upgradient location were collected to determine whether background levels showed consistent distribution within the soil type.

One surface (0-6 inches bgs) and one subsurface (4-5 feet bgs) sample were collected at each location to assess vertical distribution of upgradient metal concentrations within the soil profile.

2.1.2 Upgradient Sample Results

According to the Soil Conservation Service Soil Survey of Montgomery and Pulaski Counties, as sited by Parsons Engineering Science, Inc. (1996), soil upgradient of SWMU 68 is classified as Braddock Loam. The SWMU, however, is located on the boundary of the Braddock Loam and the Wheeling Sandy Loam. A comparison between the upgradient soil samples, the Braddock Loam, and the Wheeling Sandy Loam type descriptions is presented in Table 2-2. Based on this comparison, upgradient soil correlates well with the Braddock classification but also exhibits some characteristics of the Wheeling. An analysis of the upgradient soil samples demonstrates they are from the Braddock and not the Wheeling for the following reasons:

- The sampling locations exhibited steep and variable slope. The Braddock is also described as steep and variable sloped, whereas the Wheeling is nearly level.
- The samples were medium- to fine-grained loams. The Braddock is a fine-grained loam, whereas the Wheeling is more pervasively coarse-grained.
- The samples were light-colored, much like the Braddock. The Wheeling is described as dark brown throughout.

Upgradient soil samples were analyzed for metals using Methods 6010, 6020, and 7470 (mercury). The sample results are presented in Table 2-3. Data was validated in accordance with Region III Modifications to the National Functional Guidelines. Data validation reports are presented in Appendix A. Raw analytical results are presented in Appendix B.

Table 2-1
Background Characterization
Modifications from Scope Presented in Work Plan Addendum 001

Item	Proposed	Performed	Rationale for Changes
Near upgradient borings	5 borings	3 borings	• 1 boring (2 samples) not collected due to auger refusal • 1 boring (2 samples) not collected because average 8-foot sample spacing achieved with 3 borings
Total number of borings	8 borings	6 borings	• 2 near upgradient borings not sampled
Paint chip sample	0 samples	1 sample	• unexpected hazardous material encountered
Sludge sample	0 samples	1 sample	• unexpected hazardous material encountered

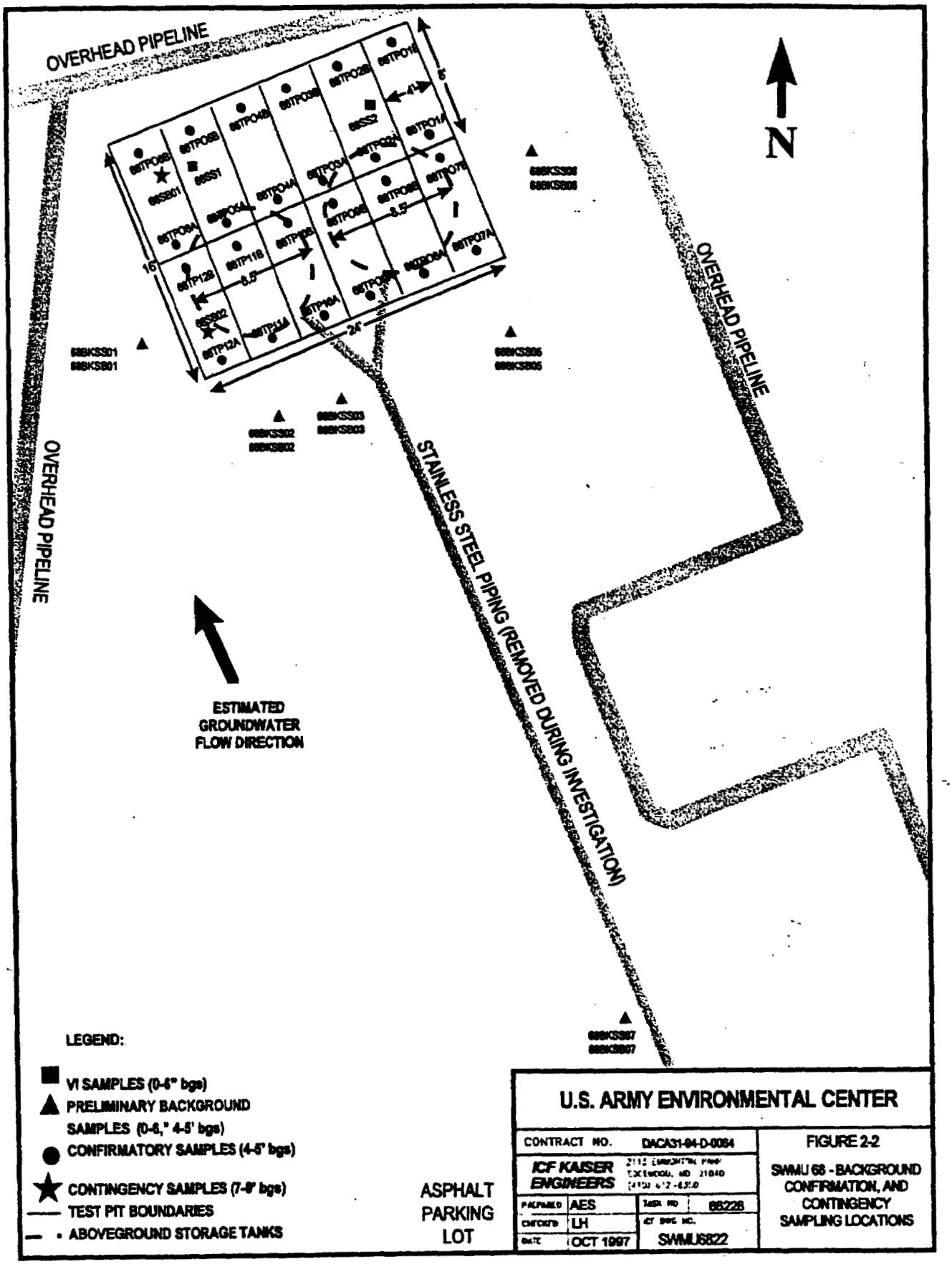

OVERHEAD PIPELINE
OVERHEAD PIPELINE
OVERHEAD PIPELINE
STAINLESS STEEL PIPING (REMOVED DURING INVESTIGATION)
N
ESTIMATED GROUNDWATER FLOW DIRECTION
ASPHALT PARKING LOT
16
24
8.5
8.5
5
4
LEGEND:
VI SAMPLES (0-6" bgs)
PRELIMINARY BACKGROUND SAMPLES (0-6," 4-5' bgs)
CONFIRMATORY SAMPLES (4-5' bgs)
CONTINGENCY SAMPLES (7-9' bgs)
TEST PIT BOUNDARIES
ABOVEGROUND STORAGE TANKS
U.S. ARMY ENVIRONMENTAL CENTER
CONTRACT NO. DACA31-94-D-0064
ICF KAISER ENGINEERS
PREPARED AES
CHECKED LH
DATE OCT 1997
TASK NO. 66226
SWMU6822
FIGURE 2-2
SWMU 68 - BACKGROUND CONFIRMATION, AND CONTINGENCY SAMPLING LOCATIONS

Table 2-2
Comparison of Upgradient Samples, Braddock Loam, and Wheeling Sandy Loam

Generalized Description for Background Soil Samples	Type Description for the Braddock Loam	Type Description for the Wheeling Sandy Loam
• variable slope	• variable slope (2-30%)	• slight slope (0-2%)
• no bedrock encountered to 8.5 feet bgs	• more than 5 feet to bedrock	• more than 5 feet to bedrock
• no water table encountered to 8.5 feet bgs	• more than 6 feet to water table	• more than 6 feet to water table
• surface soil: yellow-orange, orange-brown, and light brown loam; some organics and trace gravel; grades into subsurface soil	• surface soil: dark yellowish-brown loam, less than one foot thick	• surface soil: dark brown sandy loam; less than one foot thick
• subsurface soil: orange to orange-brown clay and silt, lenses of fine sand; deeper than 8.5 feet	• subsurface soil: yellowish-red and red clay; 5 feet deep or more	• subsurface soil: dark brown sandy clay loam coarsening with depth to gravelly sandy loam; 5 feet deep or more
• clay-rich layer not encountered within 8.5 feet of ground surface	• variable red-brown to orange-brown clay-rich layer at depth (reported only at SWMU 48, 12-20 feet bgs)	• sand and gravel layer (reported only at SWMU 54, 15 feet bgs)

2.2 REMOVAL ACTION AND WASTE MANAGEMENT

The purpose of removal was to allow access to subsurface soil to determine the nature and extent of potential contamination below the tanks. Figure 2-3 depicts the nature (hazardous vs. nonhazardous) of the waste materials produced during disassembly and removal activities. The order of disassembly is shown in the photographic progression presented in Figure 2-4.

All removal activities conducted during this investigation complied with relevant Occupational Safety and Health Administration and EPA regulations regarding the identification, handling, and disposal of nonhazardous IDW and hazardous materials. Removal activities were performed by qualified personnel licensed in the Commonwealth of Virginia and experienced in the safe handling of hazardous materials. In addition, activities were performed in accordance with installation safety rules and protocol, and field personnel attended a prework safety meeting given by the Alliant Techsystems Safety Office prior to working onsite. Daily Worker Location Forms were completed each morning and given to the Alliant Techsystems Security Department. Clearance from the appropriate installation personnel was received before the transport or disposal of any materials onsite. Specific compliance issues confronted during this investigation include:

- Waste characterization. Materials were sampled prior to disposal to determine waste characteristics, in accordance with 40 CFR 264 and Virginia Hazardous Waste Management Regulations. Waste characterization analyses were performed by Quanterra, Inc. using EPA-approved SW846 Methods (USEPA, 1996). Sample results are presented in Appendix B. Materials with waste characterization results below regulatory limits were treated as nonhazardous, while materials with results above regulatory limits were treated as hazardous.

- Disposal of nonhazardous materials. On-site disposal was approved by the installation for nonhazardous materials. Following analysis, nonhazardous materials were segregated by material and disposed as directed by the installation. Handling and disposal of nonhazardous materials are presented in Table 2-4.

- Investigation-Derived Waste. IDW included soil, water, and piping from the AST. Handling and disposal of these materials is presented in Table 2-4.

- Handling and disposal of hazardous materials. The principle hazardous materials encountered included lead paint, asbestos insulation, sludge, and creosote poles. Required licenses and applicable regulatory procedures were observed. For example, Department of Professional and Occupational Regulation licenses for the Commonwealth of Virginia were current for supervisors and workers involved in lead and asbestos abatement and hazardous materials handling. Asbestos-containing materials (ACMs) and lead-based paint were disposed offsite in accordance with the regulatory specifications indicated in Table 2-5. Handling and disposal of hazardous materials are presented in Table 2-6.

- Handling and disposal of hazardous waste. Hazardous waste was not encountered during investigation activities.

Table 2-3
Analytical Results for Surface and Subsurface Upgradient Soil Samples
Page 1 of 3

SITE I.D. SAMPLING DATE DEPTH (ft) MATRIX UNITS	FREQUENCY hits/#sample	PQLs mg/kg	HBN mg/kg	FACILITY-WIDE BACKGROUND* mg/kg	SSL mg/kg	68BKSS01 15-Jul-97 0.0-0.5 SOIL mg/kg	68BKSB01 15-Jul-97 4.0-5.0 SOIL mg/kg	68BKSS02 15-Jul-97 0.0-0.5 SOIL mg/kg	68BKSB02 15-Jul-97 4.0-5.0 SOIL mg/kg
Metals									
Aluminum	12/12	10 [5]	230,000 [1]	22,921	nv	11800	26500	8000	30800
Antimony	2/12	20	30	7.14	0.3	<0.61 L	<0.62 L	<0.59 L	<0.70 L
Arsenic	12/12	30	0.5	9	1	14.4	3.8	2.7	14.5
Barium	12/12	1	1000	109	82	78.2	69.3	82.8	60.5
Beryllium	12/12	0.2	0.1	1.1	3	0.63	0.59	0.46	0.61
Cadmium	3/12	2	40	0.7	0.4	<0.61 L	<0.62 L	0.73 L	<0.70 L
Calcium	12/12	50 [5]	na [4]	109,994	nv	1540 L	220 L	1130 L	729 L
Chromium	12/12	4	400	47.46	nc	23.7	27.7	21.3	32.7
Cobalt	12/12	0.8 [5]	0.8 [1]	27.9	nv	8.2	30.7	7.2	10.3
Copper	12/12	2 [5]	3,000 [1]	29.69	nv	11.4	16.3	10.3	18.3
Iron	12/12	10 [5]	23,000 [2]	39,707	nv	21600	40200	12700	45900
Lead	12/12	2	400 [3]	282.84	400	17.7	24.9	16.7	14.3
Magnesium	12/12	50 [5]	na [4]	45,931	nv	1900	1310	584	1370
Manganese	12/12	1 [5]	8,000 [1]	978	nv	550	905	665	187
Mercury	2/12	0.1	20	0.05	nv	<0.12	<0.12	<0.12	0.25
Nickel	12/12	3	1000	37.23	7	10.1	12.5	6.6	12.6
Potassium	8/12	500 [5]	na [4]	3,864	nv	952	1450	<588	1220
Selenium	0/12	40	200	nv	nv	<24.4	<24.8	<23.5	<28.2
Silver	0/12	4	200	1.75	2	<1.2	<1.2	<1.2	<1.4
Sodium	0/12	500	nv	313.2	nv	<609	<619	<588	<704
Vanadium	12/12	1 [5]	560 [1]	73.89	300	35.4	79.5	25.3	85.0
Zinc	12/12	2 [5]	16,000 [1]	373.56	620	54.9 L	42.5 L	23.4 L	47.6 L

* - Parsons, 1994
L - Data is biased low.
PQL - Practical Quantitation Limit
HBN - Health-Based Number (from RCRA permit)
1 - HBN calculated (Dames & Moore, 1992)
2 - EPA Residential Soil RBC (USEPA, April 1997)
3 - Office of Solid Waste (USEPA, April 1997)
4 - No value given for essential nutrients
5 - laboratory reporting limit
na - not applicable

shading - values exceed HBN
SSL - Soil Screening Level
< - not detected over the detection limit shown
nv - no value
nc - chemical specific properties are such that pathway is not of concern at any soil concentration

Table 2-3
Analytical Results for Surface and Subsurface Upgradient Soil Samples

SITE I.D. SAMPLING DATE DEPTH (ft) MATRIX UNITS	FREQUENCY hits/#sample	PQLs mg/kg	HBN mg/kg	FACILITY-WIDE BACKGROUND* mg/kg	SSL mg/kg	68BKSS03 15-Jul-97 0.0-0.5 SOIL mg/kg	68BKSB03 15-Jul-97 4.0-5.0 SOIL mg/kg	68BKSS05 15-Jul-97 0.0-0.5 SOIL mg/kg	68BKSB05 15-Jul-97 3.5-4.0 SOIL mg/kg
Metals									
Aluminum	12/12	10 [3]	230,000 [1]	22,921	nv	9740	33600	11700	14100
Antimony	2/12	20	30	7.14	0.3	<0.68 L	<0.84 L	<0.59 L	<0.58 L
Arsenic	12/12	30	0.5	9	1	3.1	4.4	4.3	4.9
Barium	12/12	1	1000	109	82	95.1	66.7	100	45.7
Beryllium	12/12	0.2	0.1	1.1	3	0.51	0.65	0.60	0.33
Cadmium	3/12	2	40	0.7	0.4	<0.68 L	<0.84 L	<0.59 L	<0.58 L
Calcium	12/12	50 [3]	na [4]	109,994	nv	1300 L	6530 L	753 L	169 L
Chromium	12/12	4	400	47.46	nc	29.0	41.1	24.3	38.7
Cobalt	12/12	0.8 [5]	0.8 [1]	27.9	nv	8.2	7.7	8.8	10.2
Copper	12/12	2 [3]	3,000 [1]	29.69	nv	6.8	19.7	9.2	10.1
Iron	12/12	10 [3]	23,000 [2]	39,707	nv	13900	45500	16700	21500
Lead	12/12	2	400 [3]	282.84	400	14.2	14.2	24.9	15.5
Magnesium	12/12	50 [5]	na [4]	45,931	nv	860	3870	616	539
Manganese	12/12	1 [5]	8,000 [1]	978	nv	739	216	1140	583
Mercury	2/12	0.1	20	0.05	nv	<0.14	<0.17	<0.12	<0.12
Nickel	12/12	3	1000	37.23	7	6.1	17.3	8.3	8.3
Potassium	8/12	500 [3]	na [4]	3,864	nv	<684	1450	<592	<577
Selenium	0/12	40	200	nv	nv	<27.3	<33.5	<23.7	<23.1
Silver	0/12	4	200	1.75	2	<1.4	<1.7	<1.2	<1.2
Sodium	0/12	500	nv	313.2	nv	<684	<837	<592	<577
Vanadium	12/12	1 [5]	560 [1]	73.89	300	28.7	86.4	34.1	47.6
Zinc	12/12	2 [3]	16,000 [1]	373.56	620	22.4 L	50.2 L	33.9 L	27.9 L

* - Parsons, 1994
L - Data is biased low.
PQL - Practical Quantitation Limit
HBN - Health-Based Number (from RCRA permit)
1 - HBN calculated (Dames & Moore, 1992)
2 - EPA Residential Soil RBC (USEPA, April 1997)
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SSL - Soil Screening Level
< - not detected over the detection limit shown
nv - no value
nc - chemical specific properties are such that pathway is not of concern at any soil concentration

Table 2-3
Analytical Results for Surface and Subsurface Upgradient Soil Samples
Page 3 of 3

SITE I.D. SAMPLING DATE DEPTH (ft) MATRIX UNITS	FREQUENCY hits/#sample	PQLs mg/kg	HBN mg/kg	FACILITY-WIDE BACKGROUND* mg/kg	SSL mg/kg	68BKSS06 15-Jul-97 0.0-0.5 SOIL mg/kg	68BKSB06 15-Jul-97 4.0-5.0 SOIL mg/kg	68BKSS07 15-Jul-97 0.0-0.5 SOIL mg/kg	68BKSB07 15-Jul-97 4.0-5.0 SOIL mg/kg
Metals									
Aluminum	12/12	10 [5]	230,000 [1]	22,921	nv	12700	29300	18800	11900
Antimony	2/12	20	30	7.14	0.3	1.64 L	<0.74 L	9.1 L	<0.61 L
Arsenic	12/12	30	0.5	9	1	3.8	3.0	3.5	3.6
Barium	12/12	1	1000	109	82	78.1	62.3	108	33.7
Beryllium	12/12	0.2	0.1	1.1	3	0.51	0.56	0.74	0.20
Cadmium	3/12	2	40	0.7	0.4	2.3 L	<0.74 L	2.6 L	<0.61 L
Calcium	12/12	50 [5]	na [4]	109,994	nv	47200 L	235 L	18900 L	856 L
Chromium	12/12	4	400	47.46	nc	88.0	28.0	29.8	21.5
Cobalt	12/12	0.8 [5]	0.8 [1]	27.9	nv	17.6	3.5	17.7	12.7
Copper	12/12	2 [5]	3,000 [1]	29.69	nv	14.7	17.9	16.8	6.7
Iron	12/12	10 [5]	23,000 [2]	39,707	nv	18200	36900	21900	12900
Lead	12/12	2	400 [3]	282.84	400	47.6	14.8	47.3	14.8
Magnesium	12/12	50 [5]	na [4]	45,931	nv	9950	1180	11300	916
Manganese	12/12	1 [5]	8,000 [1]	978	nv	492	140	444	568
Mercury	2/12	0.1	20	0.05	nv	<0.12	<0.15	0.20	<0.12
Nickel	12/12	3	1000	37.23	7	11.1	12.8	13.4	6.0
Potassium	8/12	500 [5]	na [4]	3,864	nv	1020	1300	1830	617
Selenium	0/12	40	200	nv	nv	<23.2	<29.4	<25.4	<24.3
Silver	0/12	4	200	1.75	2	<1.2	<1.5	<1.3	<1.2
Sodium	0/12	500	nv	313.2	nv	<579	<736	<635	<607
Vanadium	12/12	1 [5]	560 [1]	73.89	300	36.4	90.5	41.6	30.8
Zinc	12/12	2 [5]	16,000 [1]	373.56	620	191 L	40.0 L	95.0 L	22.1 L

* - Parsons, 1994
L - Data is biased low.
PQL - Practical Quantitation Limit
HBN - Health-Based Number (from RCRA permit)
1 - HBN calculated (Dames & Moore, 1992)
2 - EPA Residential Soil RBC (USEPA, April 1997)
3 - Office of Solid Waste (USEPA, April 1997)
4 - No value given for essential nutrients
5 - laboratory reporting limit
na - not applicable

shading - values exceed HBN
SSL - Soil Screening Level
< - not detected over the detection limit shown
nv - no value
nc - chemical specific properties are such that pathway is not of concern at any soil concentration

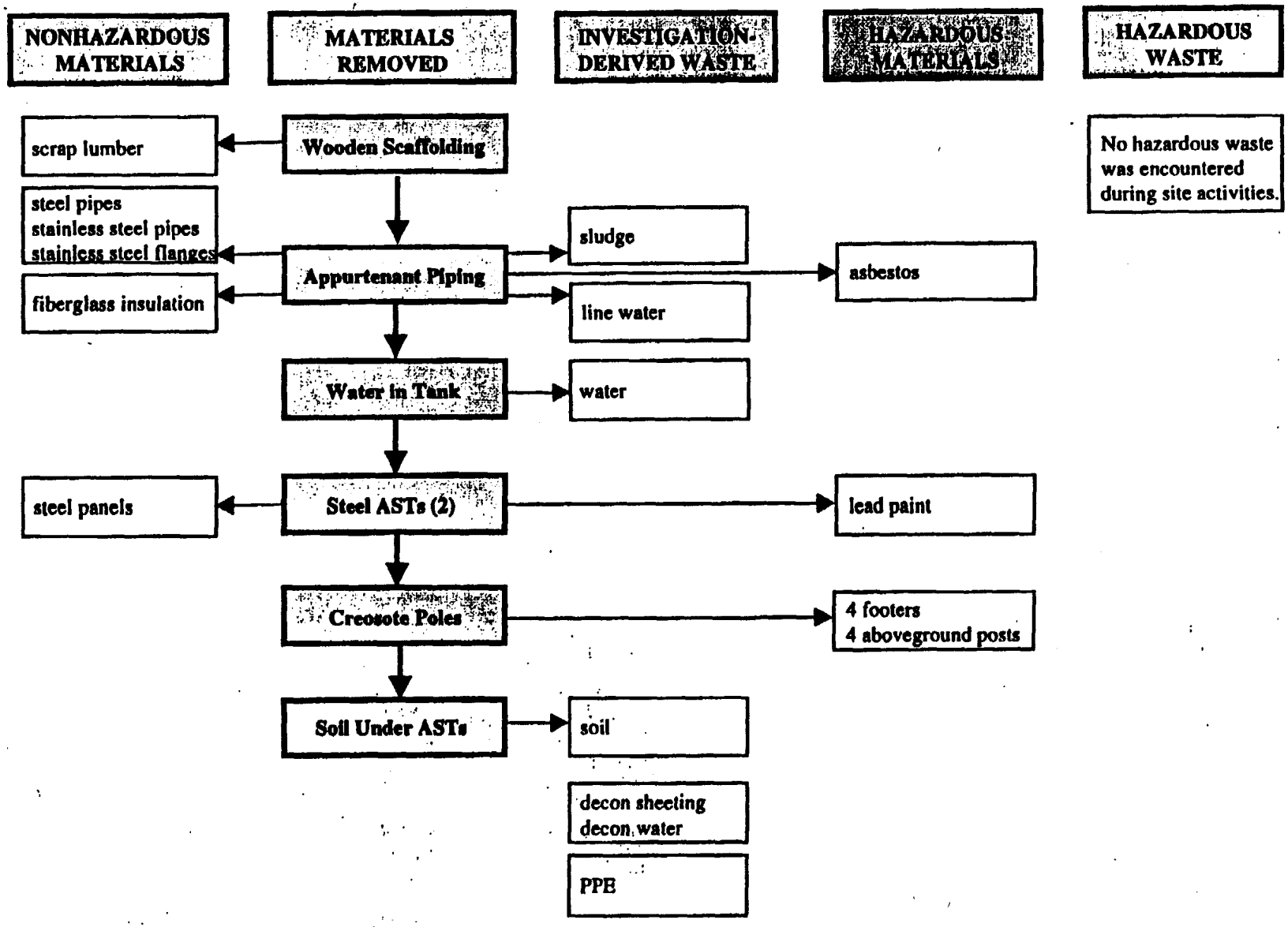


Figure 2-3. Flowchart of Nature of Materials Produced During Disassembly and Removal Actions

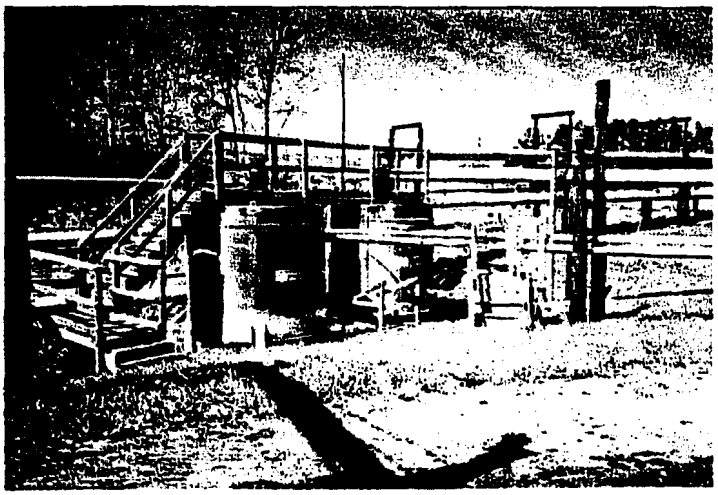


Figure 2-4*a*. Tanks, scaffolding, and appurtenant piping prior to investigative activities. Background samples collected.

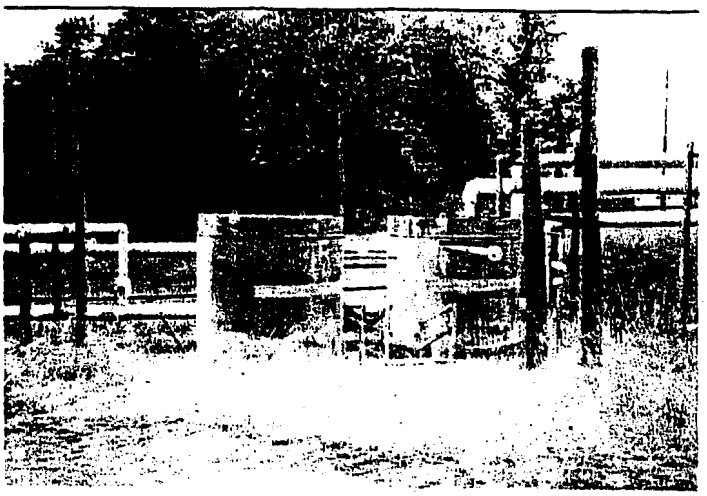


Figure 2-4*b*. Tanks after removal of overhead scaffolding, motors, and piping.

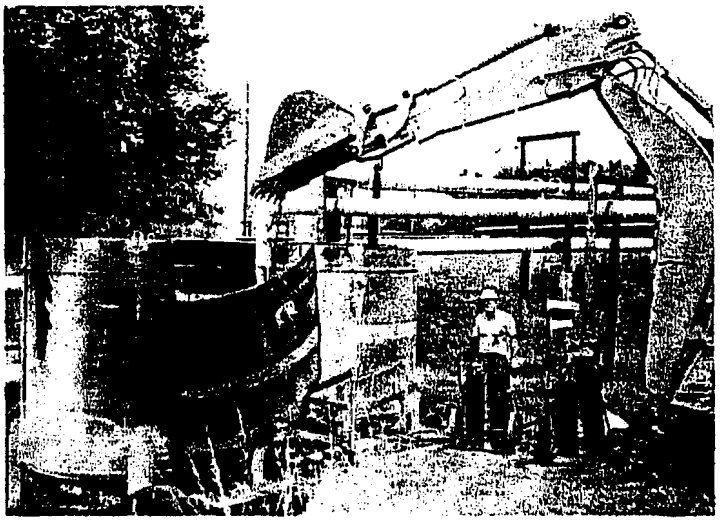


Figure 2-4*c*. Disassembly of tank by panels using welding and a backhoe.

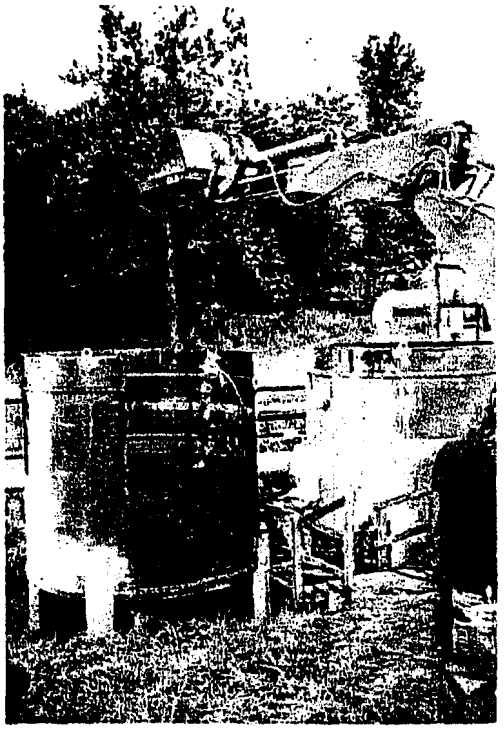


Figure 2-4*d*. Mechanical rotor wrapped in sludge-covered rags removed from tank.

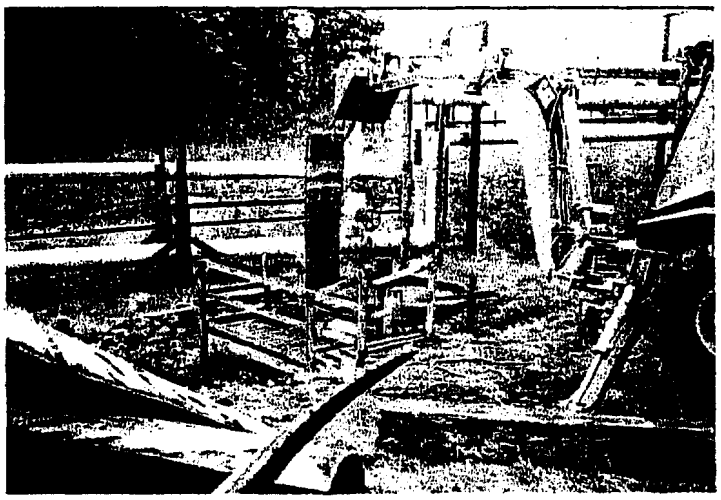


Figure 2-4*e*. Removal of the last tank panel. Tank panels staged in foreground.

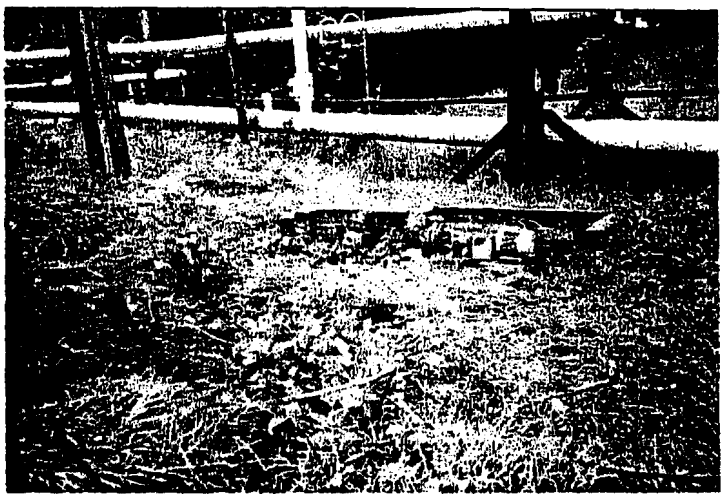


Figure 2-4*f*. Exposed soil within the berm after tank removal. Cinder block retaining wall and pump shown.

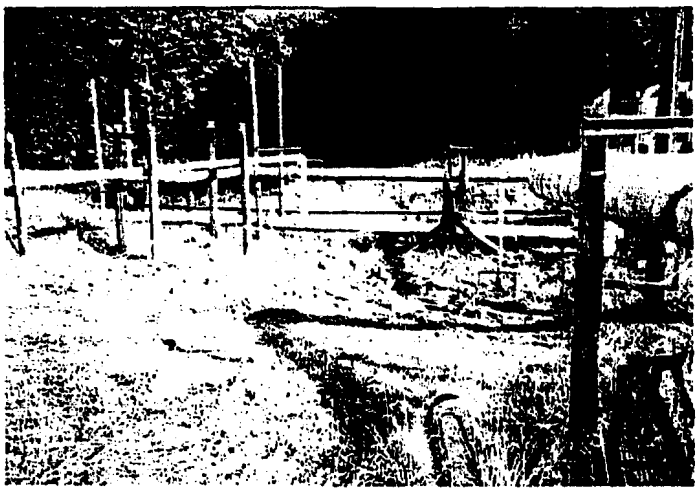


Figure 2-4*g*. Confirmation and contingency samples collected from test pits in the bermed area. Cinder block wall and concrete footer staged on left.

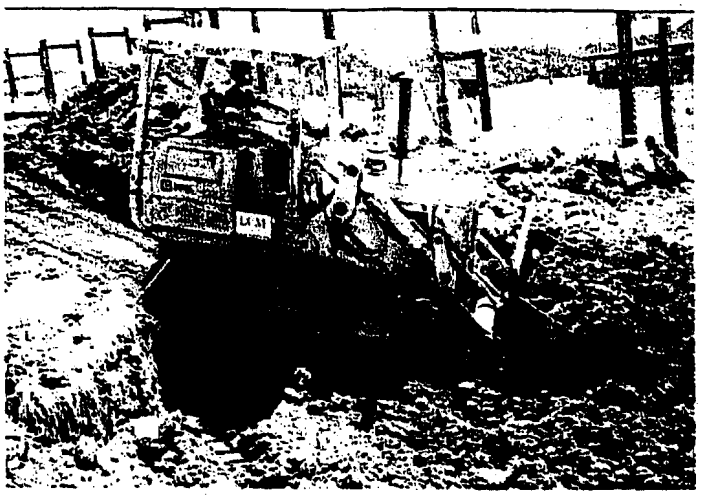


Figure 2-4*h*. Test pit soil removed and loaded directly into truck. Ramp into test pits excavated; clean soil staged in background.



Figure 2-4*i*. Soil transported directly to Fly Ash Landfill #2 and disposed on active tier.



Figure 2-4*j*. Soil removed to 4 feet bgs. Total test pit area measured 24'x16'. (Drainage pipe shown was removed prior to backfilling.)

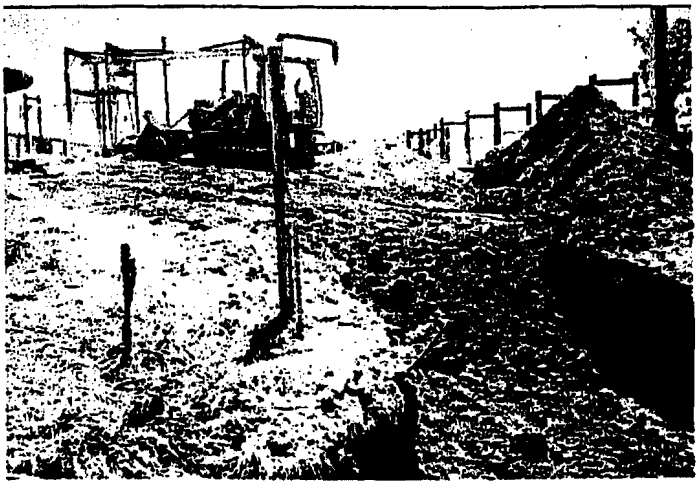


Figure 2-4*k*. Ramp backfilled with clean native soil; test pits backfilled with soil from installation borrow pit.

Table 2-4
Handling and Disposal of Nonhazardous Materials

Material	Description	Quantity	Concern	Action	Final Disposition	Notes
Scaffolding	wood	1/3 rolloff box	creosote	sampled for TCLP metals, TCLP SVOCs	mulch/kindling pile (SWMU 71)	Disposal coordinated through RFAAP
Pipes and flanges	stainless steel	approx. 75 LF	corrosive sludge	steam cleaned to remove corrosive sludge	off-site	RFAAP-approved
Insulated pipes	steel pipes with fiberglass insulation	approx. 60 LF	surficial process-related material	steam cleaned	off-site	Fiberglass removed from pipes
Fiberglass insulation	fiberglass with metallic cover and metal fittings	various	none	bagged	off-site	Fiberglass removed from pipes
Water in AST	water	2,000 gal.	process-related metals	sampled for TCLP metals, pH	on-site, sewer lift station at NG2	Filtered prior to disposal
Mechanical rotor	steel rod with blades	1	surficial process-related material	steam cleaned to remove corrosive sludge	off-site	RFAAP-approved
Machinery	motors pump	2 1	none	removed	installation	Returned to RFAAP possession
Cuttings from background soil borings	soil	10 gal.	none	sampled for total metals	Fly Ash Landfill #2 (SWMU 29)	Mixed with test pit soil
Soil in test pits	soil	60 CY	process-related waste	sampled for TCLP metals	Fly Ash Landfill #2 (SWMU 29)	On-site disposal coordinated through Alliant Techsystems and DoD
Water from the decontamination pad	water	1 55-gal. drum	investigation-derived waste	analyzed for TCLP metals	off-site	RFAAP-approved

CY cubic yard
DoD Department of Defense
LF linear feet

Table 2-5
Regulations for Handling and Disposal of Hazardous Materials Encountered Onsite

Hazardous Material	Regulation	Title
Asbestos	40 CFR 763 Subpart G 29 CFR 1910.1001 29 CFR 1926.58	Asbestos Abatement Projects
	40 CFR61.150	Standard for Waste Disposal for Manufacturing, Fabricating, Demolition, Renovation, and Spraying Operations
	16VAC25-20-30	Notification and Permit Fee
	18VAC15-20-330	Qualification for Licensure
	18VAC15-20-120	Asbestos Contractor Responsibilities
	18VAC15-20-760	Refresher Training Course
	18VAC15-20-860	Project Monitor Training
Lead-based paint	29 CFR 1926.62	Methods of Compliance, Respiratory Protection, and Protective Clothing and Equipment
	18VAC15-30-460	Initial Training Criteria for Supervisor for Target Housing, Superstructures, and Public and Commercial Buildings

Table 2-6
Handling and Disposal of Hazardous Materials

Material	Description	Quantity	Concern	Action	Final Disposition	Notes
ASTs	painted steel	18,000 lbs.	lead paint	paint chip sample	off-site	Paint contained lead; RFAAP-approved
Asbestos	steel pipes with asbestos insulation	approx. 20 LF	asbestos insulation	handled and disposed as ACM	off-site	Asbestos insulation remained on pipes; RFAAP-approved
Poles	wood with creosote	4	creosote	none	installation pole pile	Possession retained by RFAAP
Footers	wood with creosote	4	creosote	none	installation pole pile	Possession retained by RFAAP
Retaining wall	cinder block	2 CY	process-related material	none	Construction Debris Landfill	Not sampled
Footer from pump	non-reinforced concrete	1 CY	process-related material	none	Construction Debris Landfill	Not sampled
Decontamination sludge	sludge and various sludge-covered materials	1 55-gal. drum	investigation-derived waste	assumed similar to sludge in pipes	Biological Treatment Plant (SWMU 10)	Characterization sample taken of sludge in steel pipe; RFAAP-approved
PPE	miscellaneous IDW	1 55-gal. drum	investigation-derived waste	none	off-site	

CY cubic yard
LF linear feet
PPE personal protective equipment

2.2.1 Nonhazardous Materials

Specific information on nonhazardous materials including description, quantity, and final disposition, are presented in Table 2-4. Handling and disposal of nonhazardous materials associated with tank removal and subsurface investigation activities included the following:

- Wooden scaffolding surrounded the ASTs. A wood chip sample (SWMU 68 WOOD) was collected and analyzed for Toxicity Characteristic Leachate Procedure (TCLP) metals and semi-volatile organic compounds (SVOCs). Waste characterization results demonstrated the wood to be nonhazardous. The installation directed ICF Kaiser to dispose of the scrap wood in the Bulk Material Recycling Storage Area (SWMU 71).

- Approximately 2,000 gallons of water were pumped from one of the ASTs into a vacuum truck. TCLP metals results were non-hazardous (SWMU 68 WATER), and the water was disposed in the sewer lift station in Nitroglycerin Area #2 (NG2).

- A mechanical rotor wrapped in a sludge-covered rag was removed from one of the tanks. The cloth was removed and placed in a decontamination drum. The metal rotor was steam cleaned and disposed offsite as scrap metal.

- Two motors were removed from the top of the tanks, and a pump, mounted on a concrete footer, was removed from inside the earthen berm. These items were marked with Radford Army Ammunition Plant (RFAAP) inventory numbers and were delivered into the possession of the installation.

- Appurtenant piping was removed from the ASTs and included steel pipes covered in fiberglass insulation and stainless steel pipes and flanges containing sludge. Stainless steel pipes and flanges were steam cleaned on-site to remove all sludge in preparation for disposal. Sludge was removed and drummed for disposal as IDW.

- After the ASTs were removed, a cinder block retaining wall (refer to Figure 2-4*f*) and the concrete footer from the pump were removed from the test pit area and disposed onsite in the Construction Debris Landfill.

2.2.2 Investigation-Derived Waste

- Soil samples collected from test pits were analyzed for TCLP metals and determined to be nonhazardous. The soil was removed using a front-end loader, hauled to Fly Ash Landfill #2, and disposed on the active tier of the landfill (refer to Figure 2-4*i*).

- Water from the decontamination pad was collected and stored onsite in a 55-gallon drum. Another drum contained water collected from the water line leading to the ASTs when the pipes were cut. A sample was collected from each drum and analyzed for TCLP metals. Both sample results were nonhazardous, and were disposed in the sewer lift station at NG2.

- While the steel pipes that were feeder lines to the ASTs were being cut, a green, gritty sludge was found in the line. A sample of the sludge was collected from the lines and submitted for waste characterization. It exhibited a low pH and contained high concentrations of arsenic, chromium, iron, lead, and nickel. The sludge was washed from all piping using a steam cleaning apparatus at the decontamination pad. A large mechanical rotor removed from one of the ASTs was covered with similar sludge. It was also steam cleaned. The water collected in the decontamination pad contained small quantities of this sludge. The sludge from the decontamination pad was collected in a 55-gallon drum. The contents of the drum were analyzed and determined to be nonhazardous. The decon water was disposed onsite in the sewer lift station at NG2.

2.2.3 Hazardous Material

Specific information on hazardous materials including description, quantity, and final disposition are presented in Table 2-6. Handling and disposal of hazardous materials associated with tank removal and subsurface investigation activities included the following:

- Disturbance and handling of ACM was minimized during removal. Pipes were cut at the seams of existing insulation and ACM was not removed from the pipes. ACM was segregated, bagged, containerized, and disposed offsite in accordance with all pursuant regulations.

- Wooden poles visibly stained with creosote were removed. The poles are reusable for on-site purposes and were taken to a pole storage area and transferred to Installation possession.

- A composite paint chip sample was collected from the exterior surface of the ASTs to determine if the paint was lead-based for health and safety and waste characterization purposes. Sample results verified that the paint was lead-based, and work proceeded using appropriate respiratory protection. After the tanks were cut into transportable pieces, the scrap steel was transported offsite for salvage.

2.2.4 Hazardous Waste

Hazardous waste was not encountered during this investigation.

2.3 SUBSURFACE EVALUATION

Background, confirmation, and contingency samples were collected and analyzed to evaluate subsurface conditions at the SWMU. Analytical results obtained from these samples were used to establish a profile of subsurface characteristics and to substantiate site closure.

2.3.1 Confirmation Samples

Twelve test pits were advanced beneath the former ASTs to determine if the subsurface soil had been adversely impacted by process-related metals below 4 feet bgs. Test pits were considered to be homogenous within the 8' by 8' by 4' sampling units. One confirmation sample and one duplicate sample was collected from each test pit (refer to Figure 2-2). Each sample was collected from approximately 4.0 to 5.0 feet bgs and was analyzed for metals using Methods 6010, 6020, and 7470 (mercury).

Variances from the Addendum Work Plan are presented in Table 2-7. Data were validated in accordance with Region III Modifications to the National Functional Guidelines (USEPA, 1994). Data validation reports are presented in Appendix A. Raw analytical results are presented in Appendix B. Analytical results are presented in Table 2-8 for each duplicate pair (A/B designations). Results are summarized in Table 2-9.

2.3.2 Analysis of Background, Upgradient and Confirmation Samples

In order to determine if detected, metals were representative of naturally-occurring background levels. Test pit data were compared to upland background levels and upgradient soil data.

Upland soil samples were determined to be representative of facility-wide metal background concentrations (Parsons, 1994). The upland soil samples were collected from five locations at RFAAP. Background comparison levels were selected from the upper 95 percent confidence interval of the background data set. This value is equivalent to the mean ± two standard deviations. These results are presented in data tables 2-3, 2-8, and 2-10 in the facility-wide background column.

To statistically evaluate upgradient results, site and upgradient soil data were evaluated using the Shapiro and Wilk W test to determine the distribution of the data sets. Data were tested using the Statistical Package for the Social Sciences (SPSS) at the 95% significance level (alpha = 0.05).

A two-tailed variance ratio (F-test) was performed to determine whether on-site and background variances were similar for arsenic and cobalt data. Variances were determined to be similar for arsenic but dissimilar for cobalt. The one-tailed pooled variance t-test was considered appropriate to test for similarity between on-site and background arsenic levels. The non-parametric Mann-Whitney test was used to test for similarity between on-site and background levels for cobalt and beryllium.

Test pit concentrations were determined to be within background concentrations for arsenic as evidenced from the calculated t-value (derived using the SYSTAT statistical software program) being less than the critical t-value (Zar, 1984). Similarly beryllium and cobalt test pit concentrations were determined to be within background values based on the calculated test pit rank sum (SYSTAT) being less than the calculated Mann-Whitney test statistic (Conover, 1980).

2.3.3 Contingency Samples

Two contingency samples were collected below the test pits in the northwest and southwest quadrants. The samples were collected from 8.0 to 8.5 feet bgs using a hand auger. Contingency samples were not collected under the northeast and southeast quadrants because gravel prohibited auger advancement. The contingency sample from the northwest quadrant was analyzed for TAL metals to evaluate the potential for further subsurface migration. Contingency sample results are presented in Table 2-10. The same three metals (i.e., arsenic, beryllium, and cobalt) were detected over their respective HBNs. A comparison to upland background results indicated that contingency sample metal results were within background values. The contingency sample confirmed that contaminants had not migrated deeper into the subsurface.

Table 2-7
Subsurface Investigations
Modifications from Scope Presented in Work Plan Addendum

Item	Proposed	Performed	Rationale for Changes
Contingency Samples	4 samples	2 samples	• 2 samples were not collected due to auger refusal in gravel. • Sample depths varied.
Contingency Samples	contingent on confirmation results	1 sample analyzed	• 1 sample was analyzed to evaluate the potential for further subsurface migration.

Table 2-8
Analytical Results for Confirmation Soil Samples
Page 1 of 4

SITE I.D. SAMPLING DATE DEPTH (ft) MATRIX UNITS	FREQUENCY hits/#sample	PQL mg/kg	HBN mg/kg	FACILITY-WIDE BACKGROUND* mg/kg	SSL mg/kg	68TP01A 23-Jul-97 4-4.5 SOIL mg/kg	68TP01B 23-Jul-97 4-4.5 SOIL mg/kg	68TP02A 23-Jul-97 4-4.5 SOIL mg/kg	68TP02B 23-Jul-97 4-4.5 SOIL mg/kg	68TP03A 23-Jul-97 4-4.5 SOIL mg/kg	68TP03B 23-Jul-97 4-4.5 SOIL mg/kg
Metals											
Aluminum	24/24	10 [3]	230,000 [1]	22,921	nv	32100	28600	19900	18300	18900	11800
Antimony	13/24	20	30	7.14	0.3	1.0 L	1.6 L	0.66 L	0.77 L	0.71 L	0.60 L
Arsenic	24/24	30	0.5	9	1	5.1	5.1	5.3	5.8	4.1	6.1
Barium	23/24	1	1000	109	82	63.8	64.3	50.7	45.0	39.1	34.6
Beryllium	24/24	0.2	0.1	1.1	3	0.60	0.59	0.52	0.48	0.58	0.39
Cadmium	15/24	2	40	0.7	0.4	0.94	<0.61	1.3	0.86	0.84	<0.60
Calcium	17/24	50 [3]	na [4]	109,994	nv	1330 L	4080 L	1360 L	<605 L	1060 L	<597 L
Chromium	24/24	4	400	47.46	nc	30.0 K	34.8 K	37.3 K	43.1 K	26.3 K	53.8 K
Cobalt	24/24	0.8 [3]	0.8 [1]	27.9	nv	8.8	10.6	10.3	12.8	6.3	12.8
Copper	24/24	2 [3]	3,000 [1]	29.69	nv	20.9	17.5	16.4	17.9	22.1	11.3
Iron	24/24	10 [3]	23,000 [2]	39,707	nv	34700	32200	31600	25700	23500	25100
Lead	8/24	2	400 [3]	282.84	400	<13.0	13.1	12.5	13.7	<12.1	19.3
Magnesium	23/24	50 [3]	na [4]	45,931	nv	1370	2610	984	836	977	<597
Manganese	24/24	1 [3]	8,000 [1]	978	nv	316	458	391	631	227	990
Mercury	1/24	0.1	20	0.05	nv	0.15	<0.12	<0.12	<0.12	<0.12	<0.12
Nickel	24/24	3	1000	37.23	7	15.4	14.0	36.7	9.0	9.3	5.8
Potassium	24/24	500 [3]	na [4]	3,864	nv	1290	1240	1100	1020	1560	644
Selenium	0/24	40	200	nv	nv	<32.6	<30.5	<30.2	<30.2	<30.3	<29.8
Sodium	3/24	500 [3]	na [4]	1.75	2	<652	<609	<603	<605	<605	<597
Silver	0/24	4	200	313.2	nv	<1.3	<1.2	<1.2	<1.2	<1.2	<1.2
Vanadium	24/24	1 [3]	560 [1]	73.89	300	63.5	54.6	54.4	52.8	38.7	49.8
Zinc	24/24	2 [5]	16,000 [1]	373.56	620	60.5	58.9	57.2	44.1	36.2	25.8

* - Parsons, 1994
K - Data is biased high.
L - Data is biased low.
PQL - Practical Quantitation Limit
HBN - Health-Based Number
RBC - Risk-Based Concentration
SSL - Soil Screening Level
1 - HBN calculated (Dames & Moore, 1992)
2 - EPA Residential Soil RBC (USEPA, April 1997)
3 - Office of Solid Waste (USEPA, April 1997)
4 - No value given for essential nutrients
5 - laboratory reporting limit
shading - values exceed HBN
na - not applicable
< - not detected above the detection limit shown
nv - no value
nc - chemical specific properties are such that pathway is not a concern at any soil concentration

Table 2-8
Analytical Results for Confirmation Soil Samples
Page 2 of 4

SITE I.D. SAMPLING DATE DEPTH (ft) MATRIX UNITS	FREQUENCY hits/#sample	PQL mg/kg	HBN mg/kg	FACILITY-WIDE BACKGROUND* mg/kg	SSL mg/kg	68TP04A 23-Jul-97 4-4.5 SOIL mg/kg	68TP04B 23-Jul-97 4-4.5 SOIL mg/kg	68TP05A 23-Jul-97 4-4.5 SOIL mg/kg	68TP05B 23-Jul-97 4-4.5 SOIL mg/kg	68TP06A 23-Jul-97 4-4.5 SOIL mg/kg	68TP06B 23-Jul-97 4-4.5 SOIL mg/kg
Metals											
Aluminum	24/24	10 [5]	230,000 [1]	22,921	nv	23200	25700	29800	30100	29300	30000
Antimony	13/24	20	30	7.14	0.3	0.76 L	1.1 L	1.3 L	<0.67 L	0.96 L	<0.66 L
Arsenic	24/24	30	0.5	9	1	4.0	4.8	4.4	2.4	3.5	4.2
Barium	23/24	1	1000	109	82	47.2	44.6	81.6	28.6	28.8	27.3
Beryllium	24/24	0.2	0.1	1.1	3	1.1	0.98	1.1	0.96	0.98	1.4
Cadmium	15/24	2	40	0.7	0.4	0.96	1.0	0.82	0.68	0.77	0.74
Calcium	17/24	50 [5]	na [4]	109,994	nv	2600 L	1540 L	2190 L	<668 L	1170 L	697 L
Chromium	24/24	4	400	47.46	nc	13.6 K	18.9 K	21.4 K	15.7 K	25.0 K	22.9 K
Cobalt	24/24	0.8 [5]	0.8 [1]	27.9	nv	11.2	17.0	29.9	3.8	4.4	4.8
Copper	24/24	2 [3]	3,000 [1]	29.69	nv	16.2	21.5	19.5	14.1	39.6	14.5
Iron	24/24	10 [5]	23,000 [2]	39,707	nv	35200	33800	41600	38800	43600	38100
Lead	8/24	2	400 [3]	282.84	400	<13.4	<14.0	16.3	<13.4	<13.7	<13.3
Magnesium	23/24	50 [5]	na [4]	45,931	nv	1110	1130	1660	1170	1390	2030
Manganese	24/24	1 [5]	8,000 [1]	978	nv	694	216	1420	111	86.0	57.1
Mercury	1/24	0.1	20	0.05	nv	<0.13	<0.14	<0.13	<0.13	<0.14	<0.13
Nickel	24/24	3	1000	37.23	7	11.2	11.4	31.3	12.8	11.8	11.4
Potassium	24/24	500 [5]	na [4]	3,864	nv	1850	1990	3460	2080	1670	4060
Selenium	0/24	40	200	nv	nv	<33.6	<35	<33.4	<33.4	<34.2	<33.2
Sodium	3/24	500 [5]	na [4]	1.75	2	<671	<699	<668	<668	1170	<664
Silver	0/24	4	200	313.2	nv	<1.3	<1.4	<1.3	<1.3	<1.4	<1.3
Vanadium	24/24	1 [5]	560 [1]	73.89	300	28.5	35.9	36.1	29.1	48.4	28.7
Zinc	24/24	2 [5]	16,000 [1]	373.56	620	31.6	37.7	31.8	22.4	26.0	20.3

* - Parsons, 1994
K - Data is biased high.
L - Data is biased low.
PQL - Practical Quantitation Limit
HBN - Health-Based Number
RBC - Risk-Based Concentration
SSL - Soil Screening Level
1 - HBN calculated (Dames & Moore, 1992)
2 - EPA Residential Soil RBC (USEPA, April 1997)
3 - Office of Solid Waste (USEPA, April 1997)
4 - No value given for essential nutrients
5 - laboratory reporting limit
shading - values exceed HBN
na - not applicable
< - not detected above the detection limit shown
nv - no value
nc - chemical specific properties are such that pathway is not a concern at any soil concentration

Table 2-8
Analytical Results for Confirmation Soil Samples
Page 3 of 4

SITE I.D. SAMPLING DATE DEPTH (ft) MATRIX UNITS	FREQUENCY hits/#sample	PQL mg/kg	HBN mg/kg	FACILITY-WIDE BACKGROUND* mg/kg	SSL mg/kg	68TP07A 23-Jul-97 4-4.5 SOIL mg/kg	68TP07B 23-Jul-97 4-4.5 SOIL mg/kg	68TP08A 23-Jul-97 4-4.5 SOIL mg/kg	68TP08B 23-Jul-97 4-4.5 SOIL mg/kg	68TP09A 23-Jul-97 4-4.5 SOIL mg/kg	68TP09B 23-Jul-97 4-4.5 SOIL mg/kg
Metals											
Aluminum	24/24	10 [5]	230,000 [1]	22,921	nv	39300	25000	34800	32900	26800	23200
Antimony	13/24	20	30	7.14	0.3	<0.64 L	0.81 L	<0.65 L	<0.64 L	<0.63 L	<0.66 L
Arsenic	24/24	30	0.5	9	1	7.6	2.8	2.8	3.5	2.4	2.7
Barium	23/24	1	1000	109	82	76.1	40.4	64.0	51.1	44.9	28.2
Beryllium	24/24	0.2	0.1	1.1	3	0.56	0.38	0.46	0.55	0.56	0.95
Cadmium	15/24	2	40	0.7	0.4	<0.64	<0.63	<0.65	0.81	<0.63	<0.66
Calcium	17/24	50 [5]	na [4]	109,994	nv	1210 L	816 L	1240 L	1180 L	798 L	1270 L
Chromium	24/24	4	400	47.46	nc	25.7 K	22.1 K	26.6 K	29.0 K	20.4 K	26.0 K
Cobalt	24/24	0.8 [5]	0.8 [1]	27.9	nv	7.6	9.8	8.5	12.5	5.0	9.5
Copper	24/24	2 [5]	3,000 [1]	29.69	nv	17.5	13.4	15.4	15.6	13.8	8.2
Iron	24/24	10 [5]	23,000 [2]	39,707	nv	29700	23500	30100	24700	30700	40900
Lead	8/24	2	400 [3]	282.84	400	<12.7	<12.6	<13.0	<12.8	<12.6	<13.2
Magnesium	23/24	50 [5]	na [4]	45,931	nv	1930	857	1360	1110	1100	1080
Manganese	24/24	1 [5]	8,000 [1]	978	nv	242	78.0	79.7	398	103	339
Mercury	1/24	0.1	20	0.05	nv	<0.13	<0.13	<0.13	<0.13	<0.13	<0.13
Nickel	24/24	3	1000	37.23	7	18.0	11.4	14.4	13.6	12.3	10.5
Potassium	24/24	500 [5]	na [4]	3,864	nv	2080	948	1470	1110	1200	1910
Selenium	0/24	40	200	nv	nv	<31.8	<31.4	<32.6	<31.9	<31.6	<33.0
Sodium	3/24	500 [5]	na [4]	1.75	2	<637	<629	<651	<639	<631	<660
Silver	0/24	4	200	313.2	nv	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
Vanadium	24/24	1 [5]	560 [1]	73.89	300	74.9	44.3	74.1	49.2	72.8	29.0
Zinc	24/24	2 [5]	16,000 [1]	373.56	620	55.6	38.2	49.1	57.7	39.6	21.7

* - Parsons, 1994
K - Data is biased high.
L - Data is biased low.
PQL - Practical Quantitation Limit
HBN - Health-Based Number
RBC - Risk-Based Concentration
SSL - Soil Screening Level
1 - HBN calculated (Dames & Moore, 1992)
2 - EPA Residential Soil RBC (USEPA, April 1997)
3 - Office of Solid Waste (USEPA, April 1997)
4 - No value given for essential nutrients
5 - laboratory reporting limit
shading - values exceed HBN
na - not applicable
< - not detected above the detection limit shown
nv - no value
nc - chemical specific properties are such that pathway is not a concern at any soil concentration

Table 2-8
Analytical Results for Confirmation Soil Samples
Page 4 of 4

SITE I.D. SAMPLING DATE DEPTH (ft) MATRIX UNITS	FREQUENCY hits/#sample	PQL mg/kg	HBN mg/kg	FACILITY-WIDE BACKGROUND* mg/kg	SSL mg/kg	68TP10A 24-Jul-97 4-4.5 SOIL mg/kg	68TP10B 24-Jul-97 4-4.5 SOIL mg/kg	68TP11A 24-Jul-97 4-4.5 SOIL mg/kg	68TP11B 24-Jul-97 4-4.5 SOIL mg/kg	68TP12A 24-Jul-97 4-4.5 SOIL mg/kg	68TP12B 24-Jul-97 4-4.5 SOIL mg/kg
Metals											
Aluminum	24/24	10 [3]	230,000 [1]	22,921	nv	39000	29500	28000	40300	24100	28600
Antimony	13/24	20	30	7.14	0.3	<0.69 L	0.94 L	<0.61 L	0.80 L	<0.61 L	<0.66 L
Arsenic	24/24	30	0.5	9	1	8.9	4.0	3.6	10.4	2.2	3.3
Barium	23/24	1	1000	109	82	45.4	28.1	51.7	52.9	44.4	<26.2
Beryllium	24/24	0.2	0.1	1.1	3	1.1	1.1	0.49	0.98	0.45	1.1
Cadmium	15/24	2	40	0.7	0.4	1.9	1.2	<0.61	1.2	<0.61	0.74
Calcium	17/24	50 [3]	na [4]	109,994	nv	1350	1510 L	<606	<775 L	<608	<655 L
Chromium	24/24	4	400	47.46	nc	52.9 K	31.4 K	35.4 K	34.6 K	21.5 K	19.7 K
Cobalt	24/24	0.8 [3]	0.8 [1]	27.9	nv	8.5	5.5	13.9	9.9	6.1	8.6
Copper	24/24	2 [3]	3,000 [1]	29.69	nv	37.3	14.2	17.5	37.9	10.7	34.3
Iron	24/24	10 [3]	23,000 [2]	39,707	nv	53300	43900	26400	55100	22700	37300
Lead	8/24	2	400 [3]	282.84	400	14.0	<13.8	13.9	15.6	<12.2	<13.1
Magnesium	23/24	50 [3]	na [4]	45,931	nv	2740	1540	909	6900	816	1690
Manganese	24/24	1 [3]	8,000 [1]	978	nv	160	80.0	349	170	181	359
Mercury	1/24	0.1	20	0.05	nv	<0.14	<0.14	<0.12	<0.16	<0.12	<0.13
Nickel	24/24	3	1000	37.23	7	25.3	15.6	13.4	32.8	13.0	8.7
Potassium	24/24	500 [3]	na [4]	3,864	nv	2060	2510	859	3980	1040	3590
Selenium	0/24	40	200	nv	nv	<34.6	<34.4	<30.3	<38.8	<30.4	<32.8
Sodium	3/24	500 [3]	na [4]	1.75	2	<692	<689	726	<775	<608	1510
Silver	0/24	4	200	313.2	nv	<1.4	<1.4	<1.2	<1.6	<1.2	<1.3
Vanadium	24/24	1 [3]	560 [1]	73.89	300	77.0	42.5	40.7	78.7	50.6	24.3
Zinc	24/24	2 [3]	16,000 [1]	373.56	620	82.9	46.1	29.9	42.6	31.6	17.4

* - Parsons, 1994
K - Data is biased high.
L - Data is biased low.
PQL - Practical Quantitation Limit
HBN - Health-Based Number
RBC - Risk-Based Concentration
SSL - Soil Screening Level
1 - HBN calculated (Dames & Moore, 1992)
2 - EPA Residential Soil RBC (USEPA, April 1997)
3 - Office of Solid Waste (USEPA, April 1997)
4 - No value given for essential nutrients
5 - laboratory reporting limit
shading - values exceed HBN
na - not applicable
< - not detected above the detection limit shown
nv - no value
nc - chemical specific properties are such that pathway is not a concern at any soil concentration

Table 2-9
Confirmation Sample Summary

UNITS	FREQUENCY hits/#sample	AVERAGE* mg/kg	RANGE Minimum mg/kg	RANGE Maximum mg/kg	NON-DETECT Maximum mg/kg
Metals					
Aluminum	24/24	27,883	11,800	40,300	
Antimony	13/24	15.4	0.6	96.0	0.69
Arsenic	24/24	4.3	2.2	10.4	
Barium	23/24	46.2	26.2	81.6	26.2
Beryllium	24/24	0.8	0.4	1.4	
Cadmium	15/24	0.9	0.68	1.9	0.66
Calcium	17/24	1,246	697	4,080	775
Chromium	24/24	28.7	13.6	53.8	
Cobalt	24/24	9.1	3.8	29.9	
Copper	24/24	19.5	8.2	39.6	
Iron	24/24	34,175	21,500	55,100	
Lead	8/24	10.7	2.5	19.3	14
Magnesium	23/24	1,579	597	6,900	597
Manganese	24/24	339	57	1,420	
Mercury	1/24	0.1	0.15	0.15	0.16
Nickel	24/24	15.4	5.8	36.7	
Potassium	24/24	1,863	644	4,060	
Selenium	0/24	32.5	na	na	38.8
Sodium	3/24	711	597	1,510	775
Silver	0/24	1.3	na	na	1.6
Vanadium	24/24	49.1	24.3	78.7	
Zinc	24/24	40.2	17.4	82.9	

This table summarizes data presented in Table 2-8.

* - Averages were computed with detection limit values for non-detects

na - not applicable

Table 2-10
Analytical Results for Contingency Soil Samples

SITE I.D. SAMPLING DATE DEPTH (ft) MATRIX UNITS	FREQUENCY hits/#sample	PQL mg/kg	HBN mg/kg	FACILITY-WIDE BACKGROUND* mg/kg	SSL mg/kg	68SB01 23-Jul-97 8.0-8.5 SOIL mg/kg
Metals						
Aluminum	1/1	10 [5]	230,000 [1]	22,921	nv	14,900
Antimony	0/1	20	30	7.14	0.3	<0.63
Arsenic	1/1	30	0.5	9	1	4.6
Barium	1/1	1	1000	109	82	17.1
Beryllium	1/1	0.2	0.1	1.1	3	0.80
Cadmium	0/1	2	40	0.7	0.4	<0.63
Calcium	1/1	50 [5]	na [4]	109,994	nv	200
Chromium	1/1	4	400	47.46	nc	12.1
Cobalt	1/1	0.8 [5]	0.8 [1]	27.9	nv	14.0
Copper	1/1	2 [5]	3,000 [1]	29.69	nv	14.0
Iron	1/1	10 [5]	23,000 [2]	39,707	nv	75,000
Lead	0/1	2	400 [3]	282.84	400	<6.3
Magnesium	1/1	50 [5]	na [4]	45,931	nv	942
Manganese	1/1	1 [5]	8,000 [1]	978	nv	165
Mercury	0/1	0.1	20	0.05	nv	<0.13
Nickel	1/1	3	1000	37.23	7	12.8
Potassium	1/1	500 [5]	na [4]	3,864	nv	1,270
Selenium	0/1	nv	200	nv	nv	<25.1
Silver	0/1	313.2	200	1.75	2	<1.3
Sodium	1/1	500 [5]	na [4]	313.2	nv	877
Vanadium	1/1	1 [5]	560 [1]	73.89	300	17.8
Zinc	1/1	2 [5]	16,000 [1]	373.56	620	12.0

* - Parsons, 1994

PQL - Practical Quantitation Limit
HBN - Health-Based Number
RBC - Risk-Based Concentration
SSL - Soil Screening Level
1 - HBN calculated (Dames & Moore, 1992)
2 - EPA Residential Soil RBC (USEPA, April 1997)
3 - Office of Solid Waste (USEPA, April 1997)
4 - No value given for essential nutrients
5 - laboratory reporting limit
shading - values exceed HBN
na - not applicable
< - not detected above the detection limit shown
nv - no value
nc - chemical specific properties are such that pathway is not a concern at any soil concentration

2.3.4 Contaminant Migration from Soil to Groundwater

The potential migration of soil contaminants to groundwater was evaluated for subsurface soil sample results. Contaminant migration from soil to groundwater is assumed to consist of a two-stage process. Step 1 would involve the release of contamination in the soil leachate, and Step 2 is the transport of the contaminant through subsurface soil and aquifer to a receptor well (USEPA, 1996).

Soil Screening Guidance is a tool developed by USEPA to standardize and accelerate the evaluation of contaminated soils at National Priorities List (NPL) sites with anticipated future residential land use scenarios. Although the RFAAP Main Manufacturing facility is not included on the NPL and the future land use scenario is industrial, EPA Region III (RCRA) recommended the use of generic soil screening levels (SSLs) to evaluate the potential for ingestion of contaminated groundwater caused by migration of contaminants through soil to an underlying potable aquifer.

Although the application of SSLs during the site investigation is not mandatory, USEPA recommends SSL use to determine areas not requiring additional Federal attention. The Soil Screening Guidance encourages the use of site-specific guidance, but has defined generic SSLs for site with limited data. These generic SSLs are designed to be protective of most site conditions and are therefore inherently conservative.

Generic S

3.0 CONCLUSIONS

3.1 SUMMARY OF INVESTIGATION RESULTS

During this investigation, analytical results were obtained for upgradient soil samples, test pit confirmation samples, and a subsurface contingency sample. Upgradient soil samples, both surface and subsurface were collected from the Braddock Loam from near-upgradient, far-upgradient, and cross-gradient locations. Metal concentrations from far-upgradient samples were consistent with concentrations in near-upgradient samples. A comparison between facility-wide and site-specific background levels demonstrated a positive correlation (refer to Table 2-3). Concentrations in cross-gradient samples were also consistent with near-upgradient samples, thereby demonstrating cross-gradient migration had not occurred.

A sludge sample (68SLUDGE) was collected from the feeder pipes to the former ASTs. The sludge was assumed to be representative of process-related metals that would be found at the site. The sample was analyzed for TAL metals and pH, and was found to contain high concentrations of arsenic, lead, chromium, iron, and nickel. To determine if process-related metals had impacted the soil beneath the former ASTs, 12 test pits were advanced and confirmation samples were collected and analyzed for TAL metals.

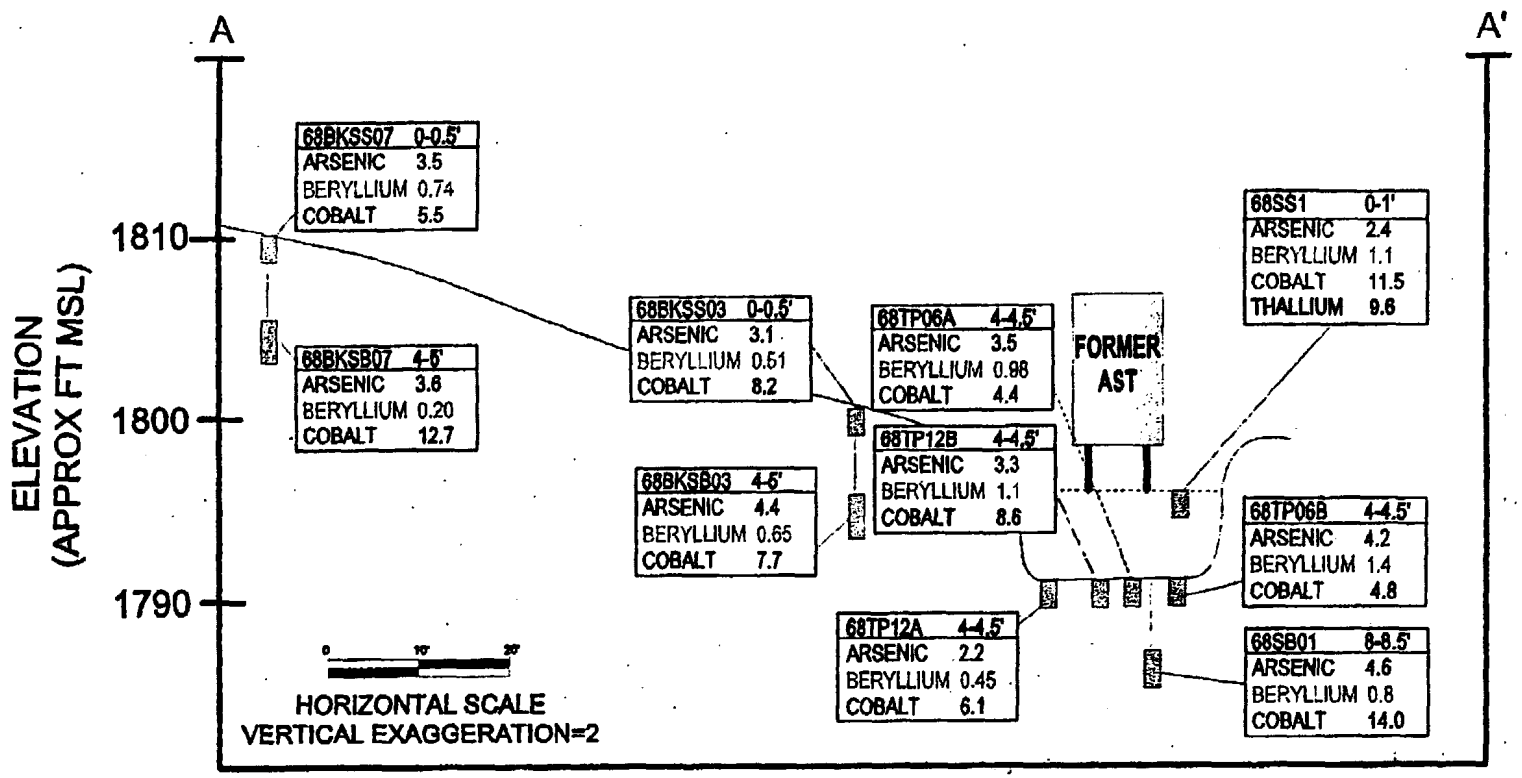
A comparison of confirmation results to upland background concentrations (Parsons, 1994) demonstrated that the confirmation sample results were not significantly greater than facility-wide background concentrations (Refer to Table 2-8).

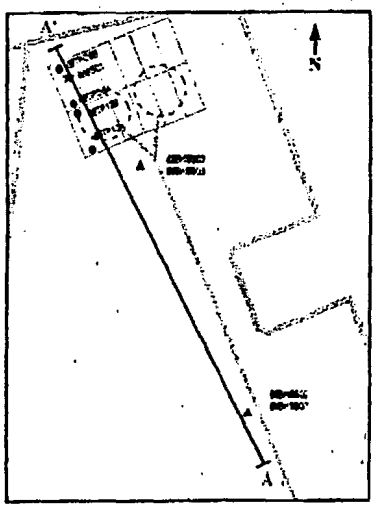
Figure 3-1 presents a cross section of the SWMU and upgradient area showing relative sample locations and representative sample results exceeding HBNs. The cross section suggests the likely pathway for migration of process-related metals from the ASTs into the subsurface soil, and includes upgradient values for comparison. The figure demonstrates that migration is not indicated by the sample results.

Analysis of confirmation samples and their comparison with the background values have resulted in a more complete picture of metals distribution at and around SWMU 68. The distribution of metals demonstrates that several metals, including arsenic, beryllium, and cobalt, are naturally-occurring at concentrations that exceed their HBNs. The data also supports the conclusion that previous SWMU process-related activities have not impacted subsurface conditions.

3.2 SITE CLOSURE

Based on the results of this investigation, no further action is recommended for this site. Subsurface results were determined to be below the levels of concern. The potential sources of contamination have been removed and disposed of at projected cost and ahead of schedule expectations (Figure 3-2). The site was re-graded to complement the natural terrain of the surrounding area and was seeded with orchard grass and clover, a ground cover palatable to the resident deer population. Site conditions at SWMU 68 do not pose a threat to human health or the surrounding environment.





Note:
- All analytes that exceed HBNs are shown.
- All concentrations are in Mg/Kg.
- Sample 68SS01 was collected during the VI (Dames & Moore, 1992).

U.S. ARMY ENVIRONMENTAL CENTER			
CONTRACT NO. DACA31-94-D-0064			FIGURE 3-1
ICF KAISER ENGINEERS	2723 EMMORTON PARK EDGEWOOD, MD. 21040 (410) 612-8350		CROSS SECTION OF SAMPLE RESULTS
PREPARED	AES	TASK NO 66228	
CHECKED	LH	ICF DWG NO. CROSSSEC	
DATE	OCT 1997		

4.0 REFERENCES

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Zar, J.H. 1984. *Biostatistical Analysis.* Second Edition. Prentice-Hall, Inc., Englewood Cliffs, NJ.

APPENDIX A

DATA VALIDATION REPORTS

ICF KAISER

ICF Kaiser Engineers, Inc.
2113 Emmorton Park Road, Suite 100
Edgewood, Maryland 21040
410/612-6350 Fax 410/612-6351
http://www.icfkaiser.com

MEMORANDUM

TO: Davida Trumbo

FROM: Eric Malarek

SUBJECT: Radford Army Ammunition Plant Data Validation - Inorganic
Quanterra Project #: 094277

DATE: October 1, 1997

The purpose of this memorandum is to present the data validation report for samples collected at the Radford Army Ammunition Plant on 7/24/97. Samples were analyzed for inorganic TAL compounds (except cyanide) using EPA SW846 methods 6010A, 6010 modified, and 7471. A total 6 soil samples were analyzed. The field sample ID(s) are:

68TP10A 68TP10B 68TP11A 68TP11B 68TP12A 68TP12B

The data was reviewed by Eric Malarek and validated using a combination of method-specific criteria and the USEPA Region III Modifications to the National Functional Guidelines for Inorganic Data Review. Table 1 includes the parameters evaluated. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1. Laboratory Performance Criteria

Qualified		Parameter
Yes	No	
	x	Holding Times
	x	Blank Analysis
	x	Instrument Calibration
	x	Initial and Continuing Calibration
	x	Precision Evaluation
	x	ICP Interference Check
x		Matrix Spike Analysis
	x	Laboratory Control Samples
	x	ICP Serial Dilution

The quality of data collected in support of this sampling activity is considered acceptable.

Attachments
cc: Samar Khoury (w/o attachments)
Project File

ARMY AMMUNITION VALIDATION REPORT
INORGANIC REVIEW
094277

I. HOLDING TIMES AND PRESERVATION

Holding time criteria: 28 days for mercury and 180 days for all other metals. The dates and times were compared between the sample collection and laboratory analysis. All criteria were met.

Preservation: Cool, 4° C for all soil metals. No discrepancies were noted.

II. INITIAL AND CONTINUING CALIBRATION

Bench and run summary sheets were reviewed to determine whether calibration was performed at the beginning of sample analysis and at a frequency of 10% or every two hours using the following criteria. Mercury analysis was performed on 7/31/97, ICP metals on 7/31/97, and the Trace ICP metals on 8/1/97. The trace metals were Sb, As, Be, Co, and Tl. The correlation coefficient for the mercury was 0.9999. All criteria were met.

ICP:	1- blank	Hg:	1 - blank
	1 - standard		5 - standards ($r \geq 0.995$)

Percent recoveries for initial and continuing calibration were reviewed and determined to be in compliance with control limits: mercury (80-120); and metals (90-110). All criteria were met.

The CRDL standards were evaluated using the following criteria:

CRI- CRDL for ICP
Concentration at 2 times CRDL or IDL for all analytes (except Al, Ba, Ca, Fe, Mg, Na, and K)
Frequency: beginning and at end of sample run or a minimum of twice per 8 hours
Recovery: 90-110%

CRA - CRDL for AA
Concentration equal to CRDL or IDL
Frequency: Beginning of each sample run
Recovery: 90-110%

All criteria were met with the exception of the CRI-CRDL frequency. The CRI-CRDL was analyzed only at the beginning of the analytical run. There is no action per USEPA region III guidelines, and the data should not be qualified.

III. BLANK ANALYSIS

The following analytes were detected in associated blanks and sample results are qualified "B" as follows:

	Soil	94277-2,4,6	Soil	94277-3,5,7
Analyte	Concentration (ug)	Qualify less than	Concentration (ug)	Qualify less than
Al		320		323
Sb		9.5		17
As		26.5		
Ba		29.5		
Be		39.5		

	Soil	94277-2,4,6	Soil	94277-3,5,7
Analyte	Concentration (ug)	Qualify less than	Concentration (ug)	Qualify less than
Cd		20.5		
Ca		320		1195
Cr		20.5		9.85
Co		6.8		
Cu		15		
Fe		140		278
Mg				373
Mn				9.85
Hg		11.5		40
Ag		7.75		7
Na		1245		
Tl		4.2		16.05
Zn		6.25		109

The sample had concentrations exceeding the 5X maximum blank criteria, or less than the reporting limit (RL). No qualification is required.

IV. ICP INTERFERENCE CHECK

Performed to verify interelement and background correction factors. Run at beginning and end of each sample analysis run. Control limit (80-120%).

Analytes in ICSA - interferents Al, Ca, Mg at 500 mg/L; Fe at 200 mg/L

Analytes in ICSAB - analytes mixed with interferents
Ag, As, Cd, Ni, Pb, Sb, Se, Zn (1.0 mg/L)
Ba, Be, Co, Cr, Cu, V, Mn (0.5 mg/L)
Na, K, Tl (10 mg/L)

All criteria were met.

V. MATRIX SPIKE SAMPLE ANALYSIS

Spike recoveries must be within 80-120%, with the exception of samples that have concentrations exceeding the spike concentration by a factor of four or more. When matrix spike recovery limits are not met, a post-digestion spike must be performed at twice the sample concentration or CRDL, whichever is greater. This does not apply to silver or mercury.

Pertaining to samples 94277-2,4,6, sample 094277-04 was used as laboratory matrix spike and matrix spike duplicate sample. All criteria were met except for the following elements out of control: Sb and Cr. Post digestion spikes were not analyzed for the failing spiked samples. Sample results with failing spikes low (Sb) were qualified as "L" and "K" for high (Cr).

Pertaining to samples 94277-3,5,7, sample 094258-02 was used as laboratory matrix spike and matrix spike duplicate sample. All criteria were met except for the following elements out of control: Sb, Ca, Mg, and Cr. Post digestion spikes were not analyzed for the failing spiked samples. Sample results with failing spikes low (Sb, Ca) were qualified as "L" and "K" for high (Cr).

VI. LABORATORY CONTROL SAMPLES

All aqueous LCS results must fall within the control limits of 80-120%, with the exception of Sb and Ag. All solid LCS results must fall within the established limits.

The solid LCS results were in control.

VII. DUPLICATE SAMPLE ANALYSIS

A control limit of ± 2 times CRDL for soil for values less then 5 times CRDL.
A control limit of 35% solid RPD is used for sample values >5 times the CRDL.

The laboratory did not perform a sample duplicate as required in Section 8 of SW846 6010A. The laboratory performed a matrix spike duplicate for precision evaluation.

Soil: all analytes were within 35% RPD.

VIII. ICP SERIAL DILUTION

Concentration in sample is a factor of 50 above IDL. An analysis of a 4-fold dilution should agree within 10% difference of the original result.

The serial dilution was only analyzed for sample 94277-04 in the 8/1/97 ICP run for the ICP metals, except K, Cr, and Na. The serial dilution passed the set criteria of <10% difference between the initial and diluted values. No other run had serial dilutions performed on 94277.

IX. CALCULATION VERIFICATION

The following calculations were performed for verification:

Sample ID	Analyte	Raw Data (mg/L)	Amt Dig.(g)	Final Vol. (L)	% Solids	Calc. Value(mg/kg)	Rpt. Value (mg/kg)
94277-03	Al	214	1	0.1	73	29300	29500
94277-03	Co	0.0398	1	0.1	73	5.45	5.5

where:

mg/kg = ((mg/L*1000)*(Final Volume L)) / ((Amount Digested g)*(Percent Solids/100))

*Al taken from ICP run dated 7/31/97 and Co taken from trace ICP run 8/1/97.

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MEMORANDUM

TO: Davida Trumbo

FROM: Eric Malarek

SUBJECT: Radford Army Ammunition Plant Data Validation - Inorganic
Quanterra Project #: 094258

DATE: October 1, 1997

The purpose of this memorandum is to present the data validation report for sample(s) collected at the Radford Army Ammunition Plant on 7/23/97. Samples were analyzed for inorganic TAL compounds (except cyanide) using EPA SW846 methods 6010A, and 7471. A total of 18 soil samples were analyzed. The field sample ID(s) are:

68TP01B	68TP02A	68TP04A	68TP05B	68TP07A	68TP09B
68TP08B	68TP01A	68TP03B	68TP04B	68TP06B	68TP09A
68TP07B	68TP08A	68TP02B	68TP03A	68TP05A	68TP06A

The data was reviewed by Eric Malarek and validated using a combination of method-specific criteria and USEPA Region III Modifications to the National Functional Guidelines for Inorganic Data Review. Table 1 includes the parameters evaluated. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1. Laboratory Performance Criteria

Qualified		Parameter
Yes	No	
	x	Holding Times
	x	Blank Analysis
	x	Instrument Calibration
	x	Initial and Continuing Calibration
	x	Precision Evaluation
	x	ICP Interference Check
x		Matrix Spike Analysis
	x	Laboratory Control Samples
	x	ICP Serial Dilution

The quality of data collected in support of this sampling activity is considered acceptable.

Attachments
cc: Samar Khoury (w/o attachments)
Project File

ARMY AMMUNITION VALIDATION REPORT
INORGANIC REVIEW
094258

I. HOLDING TIMES AND PRESERVATION

Holding time criteria: 28 days for mercury and 180 days for all other metals. The dates and times were compared between the sample collection and laboratory analysis. All criteria were met.

Preservation: Cool, 4° C for all soil metals. No discrepancies were noted.

II. INITIAL AND CONTINUING CALIBRATION

Bench and run summary sheets were reviewed to determine whether calibration was performed at the beginning of sample analysis and at a frequency of 10% or every two hours using the following criteria. Mercury analysis was performed on 7/28/97, and the ICP metals on 7/28/97 and 7/29/97. The correlation coefficient for the mercury was 0.9999. All criteria were met.

ICP:	1- blank	Hg:	1 - blank
	1 - standard		5 - standards ($r \geq 0.995$)

Percent recoveries for initial and continuing calibration were reviewed and determined to be in compliance with control limits: mercury (80-120); and metals (90-110). All criteria were met.

The CRDL standards were evaluated using the following criteria:

CRI- CRDL for ICP
Concentration at 2 times CRDL or IDL for all analytes (except Al, Ba, Ca, Fe, Mg, Na, and K)
Frequency: beginning and at end of sample run or a minimum of twice per 8 hours
Recovery: 90-110%

CRA - CRDL for AA
Concentration equal to CRDL or IDL
Frequency: Beginning of each sample run
Recovery: 90-110%

All criteria were met with the exception of the CRI-CRDL frequency. The CRI-CRDL was analyzed only at the beginning of the analytical run. There is no action per USEPA region III guidelines, and the data should not be qualified.

III. BLANK ANALYSIS

The following analytes were detected in associated blanks and sample results are qualified "B" as follows:

	Soil	94258-2 to -19
Analyte	**Concentration (ug)**	**Qualify less than**
Al		268.5
Ca		1195
Cr		11
Cu		23.5
Fe		278

	Soil	94258-2 to -19
Analyte	Concentration (ug)	Qualify less than
Mg		145
Mn		9.85
Hg		0.13
Na		420
Zn		108.5

The sample had concentrations exceeding the 5X maximum blank criteria, or less than the reporting limit (RL). No qualification is required.

IV. ICP INTERFERENCE CHECK

Performed to verify interelement and background correction factors. Run at beginning and end of each sample analysis run. Control limit (80-120%).

Analytes in ICSA - interferents Al, Ca, Mg at 500 mg/L; Fe at 200 mg/L

Analytes in ICSAB - analytes mixed with interferents
Ag, As, Cd, Ni, Pb, Sb, Se, Zn (1.0 mg/L)
Ba, Be, Co, Cr, Cu, V, Mn (0.5 mg/L)
Na, K, Tl (10 mg/L)

All criteria were met.

V. MATRIX SPIKE SAMPLE ANALYSIS

Spike recoveries must be within 80-120%, with the exception of samples that have concentrations exceeding the spike concentration by a factor of four or more. When matrix spike recovery limits are not met, a post-digestion spike must be performed at twice the sample concentration or CRDL, whichever is greater. This does not apply to silver or mercury.

Pertaining to samples 94258-2 to -19, sample 094258-02 was used as laboratory matrix spike and matrix spike duplicate sample. All criteria were met except for the following elements out of control: Sb, Ca, Mg, and Cr. Post digestion spikes were not analyzed for the failing spiked samples. Sample results with failing spikes low (Sb, Ca) were qualified as "L" and "K" for high (Cr).

VI. LABORATORY CONTROL SAMPLES

All aqueous LCS results must fall within the control limits of 80-120%, with the exception of Sb and Ag.
All solid LCS results must fall within the established limits.

The solid LCS results were in control.

VII. DUPLICATE SAMPLE ANALYSIS

A control limit of $\pm$ 2 times CRDL for soil for values less then 5 times CRDL.
A control limit of 35% solid RPD is used for sample values >5 times the CRDL.

The laboratory did not perform a sample duplicate as required in Section 8 of SW846 6010A. The laboratory performed a matrix spike duplicate for precision evaluation.

Soil: all analytes were within 35% RPD.

VIII. ICP SERIAL DILUTION

Concentration in sample is a factor of 50 above IDL. An analysis of a 4-fold dilution should agree within 10% difference of the original result.

The serial dilution was only analyzed for sample 94258-02 in the 7/28/97 and 7/29/97 ICP runs. The serial dilution passed the set criteria of <10% difference between the initial and diluted values.

IX. CALCULATION VERIFICATION

The following calculations were performed for verification:

Sample ID	Analyte	Raw Data (mg/L)	Amt Dig.(g)	Final Vol. (L)	% Solids	Calc. Value(mg/kg)	Rpt. Value (mg/kg)
94258-06	K*	5.39	1	0.1	84	642	644
94258-06	Mn*	8.30	1	0.1	84	988	990

where:

mg/kg = ((mg/L*1000)*(Final Volume L)) / ((Amount Digested g)*(Percent Solids/100))

*K taken from ICP run 7/29/97 and Mn taken from ICP run 7/28/97.

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MEMORANDUM

TO: Davida Trumbo

FROM: Eric Malarek

SUBJECT: Radford Army Ammunition Plant Data Validation - Inorganic

DATE: October 1, 1997

The purpose of this memorandum is to present the data validation report for samples collected at the Radford Army Ammunition Plant on 7/23/97. The samples were analyzed for inorganic TAL compounds (except cyanide) using EPA SW846 methods 6010A, 6010 and 7471. A total of 1 water sample and 12 soil samples were analyzed. The field sample ID(s) are:

68BKSB05	68BKSS01	68BKSS06	071597R1
68BKSS07	68BKSB01	68BKSB06	
68BKSB07	68BKSS02	68BKSS03	
68BKSB03	68BKSB02	68BKSS05	

The data was reviewed by Eric Malarek and validated using a combination of method-specific criteria and USEPA Region III Modifications to the National Functional Guidelines for Inorganic Data Review. Table 1 includes the parameters evaluated. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1. Laboratory Performance Criteria

Qualified		Parameter
Yes	No	
	x	Holding Times
	x	Blank Analysis
	x	Instrument Calibration
	x	Initial and Continuing Calibration
	x	Precision Evaluation
	x	ICP Interference Check
x		Matrix Spike Analysis
	x	Laboratory Control Samples
	x	ICP Serial Dilution

The quality of data collected in support of this sampling activity is considered acceptable.

Attachments
cc: Samar Khoury (w/o attachments)
Project File

ARMY AMMUNITION VALIDATION REPORT
INORGANIC REVIEW
094167

I. HOLDING TIMES AND PRESERVATION

Holding time criteria: 28 days for mercury and 180 days for all other metals. The dates and times were compared between the sample collection and laboratory analysis. All criteria were met.

Preservation: Cool, 4° C for all soil metals. No discrepancies were noted.

II. INITIAL AND CONTINUING CALIBRATION

Bench and run summary sheets were reviewed to determine whether calibration was performed at the beginning of sample analysis and at a frequency of 10% or every two hours using the following criteria. Mercury analysis was performed on 8/8/97, ICP metals on 8/13/97, and the Trace ICP metals on 8/14/97. The trace metals were Sb, As, Be, Co, and Tl. The correlation coefficient for the mercury was 0.9965. All criteria were met.

ICP:	1- blank	Hg:	1 - blank
	1 - standard		5 - standards ($r \geq 0.995$)

Percent recoveries for initial and continuing calibration were reviewed and determined to be in compliance with control limits: mercury (80-120); and metals (90-110). All criteria were met.

The CRDL standards were evaluated using the following criteria:

CRI- CRDL for ICP
Concentration at 2 times CRDL or IDL for all analytes (except Al, Ba, Ca, Fe, Mg, Na, and K)
Frequency: beginning and at end of sample run or a minimum of twice per 8 hours
Recovery: 90-110%

CRA - CRDL for AA
Concentration equal to CRDL or IDL
Frequency: Beginning of each sample run
Recovery: 90-110%

All criteria were met with the exception of the CRI-CRDL frequency. The CRI-CRDL was analyzed only at the beginning of the analytical run. There is no action per USEPA region III guidelines, and the data should not be qualified.

III. BLANK ANALYSIS

The following analytes were detected in associated blanks and sample results are qualified "B" as follows:

	Soil	094167-02 to -13
Analyte	Concentration (ug)	Qualify less than
Ba		1.8
Ca		280.5
Co		5.65
Fe		117.5
Pb		96.5

	Soil	094167-02 to -13
Analyte	Concentration (ug)	Qualify less than
Mg		136.5
Mn		9.5
K		3825
Na		923
Zn		30

The sample had concentrations exceeding the 5X maximum blank criteria, or less than the reporting limit (RL). No qualification is required

IV. ICP INTERFERENCE CHECK

Performed to verify interelement and background correction factors. Run at beginning and end of each sample analysis run. Control limit (80-120%).

Analytes in ICSA - interferents Al, Ca, Mg at 500 mg/L; Fe at 200 mg/L

Analytes in ICSAB - analytes mixed with interferents
Ag, As, Cd, Ni, Pb, Sb, Se, Zn (1.0 mg/L)
Ba, Be, Co, Cr, Cu, V, Mn (0.5 mg/L)
Na, K, Tl (10 mg/L)

All criteria were met.

V. MATRIX SPIKE SAMPLE ANALYSIS

Spike recoveries must be within 80-120%, with the exception of samples that have concentrations exceeding the spike concentration by a factor of four or more. When matrix spike recovery limits are not met, a post-digestion spike must be performed at twice the sample concentration or CRDL, whichever is greater. This does not apply to silver or mercury.

Sample 094167-02 was used as laboratory matrix spike and matrix spike duplicate sample. All criteria were met except for the following elements out of control: Sb, Cd, Ca, Mg,, K, and Zn. Post digestion spikes were not analyzed for the failing spiked samples. Sample results with failing spikes low (Sb, Cd, Ca and Zn) were qualified as "L".

VI. LABORATORY CONTROL SAMPLES

All aqueous LCS results must fall within the control limits of 80-120%, with the exception of Sb and Ag.
All solid LCS results must fall within the established limits.

The solid LCS results were in control.

VII. DUPLICATE SAMPLE ANALYSIS

A control limit of $\pm$ 2 times CRDL for soil for values less then 5 times CRDL.
A control limit of 35% solid RPD is used for sample values >5 times the CRDL.

The laboratory did not perform a sample duplicate as required in Section 8 of SW846 M6010A. The laboratory performed a matrix spike duplicate for precision evaluation.

Soil: all analytes were within 35%.

VIII. ICP SERIAL DILUTION

Concentration in sample is a factor of 50 above IDL. An analysis of a 4-fold dilution should agree within 10% difference of the original result.

The serial dilution was analyzed for sample 94167-02 in the 8/13/97 ICP run for the ICP metals Al, Ba, Cd, Ca, Cr, Cu, Fe, Pb, Mg, Mn, Ni, K, De, Ag, Na, V, and Zn. The trace ICP 8/14/97 had a serial dilution analyzed for sample 94167-02 for As, Sb., Tl, Co, and Be. The serial dilution passed the set criteria of <10% difference between the initial and diluted values.

IX. CALCULATION VERIFICATION

The following calculations were performed for verification:

Sample ID	Analyte	Raw Data (mg/L)	Amt Dig.(g)	Final Vol. (L)	% Solids	Calc. Value(mg/kg)	Rpt. Value (mg/kg)
94167-01	Al	122	1	0.1	86.7	14100	14100
94167-01	Co	0.0881	1	0.1	86.7	10.2	10.2

where:

mg/kg = ((mg/L*1000)*(Final Volume L)) / ((Amount Digested g)*(Percent Solids/100))

*Al taken from ICP run dated 8/13/97 and Co taken from trace ICP run 8/14/97.

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MEMORANDUM

TO: Davida Trumbo

FROM: Eric Malarek

SUBJECT: Radford Army Ammunition Plant Data Validation - Inorganic
Quanterra Project #: 094396

DATE: October 1, 1997

The purpose of this memorandum is to present the data validation report for sample 68SB01 collected at the Radford Army Ammunition Plant on 7/23/97. The samples was analyzed for inorganic TAL compounds (except cyanide) using EPA SW846 methods 6010A, 6010 modified, and 7471. A total 1 soil sample was analyzed. The field sample ID is:

68SB01

The data was reviewed by Eric Malarek and validated using a combination of method-specific criteria and the USEPA Region III Modifications to the National Functional Guidelines for Inorganic Data Review. Table 1 includes the parameters evaluated. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1. Laboratory Performance Criteria

Qualified		Parameter
Yes	No	
	x	Holding Times
	x	Blank Analysis
	x	Instrument Calibration
	x	Initial and Continuing Calibration
	x	Precision Evaluation
	x	ICP Interference Check
	x	Matrix Spike Analysis
	x	Laboratory Control Samples
	x	ICP Serial Dilution

The quality of data collected in support of this sampling activity is considered acceptable.

Attachments

cc: Samar Khoury (w/o attachments)
Project File

ARMY AMMUNITION VALIDATION REPORT
INORGANIC REVIEW
094396

I. HOLDING TIMES AND PRESERVATION

Holding time criteria: 28 days for mercury and 180 days for all other metals. The dates and times were compared between the sample collection and laboratory analysis. All criteria were met.

Preservation: Cool, 4° C for all soil metals. The project receipt checklist indicated that the sample temperature had exceeded the preservation guidelines of 4 ± 2° C. No actual temperature was recorded. Please note that this was a contingency sample, and may not be impacted by the temperature deviation.

II. INITIAL AND CONTINUING CALIBRATION

Bench and run summary sheets were reviewed to determine whether calibration was performed at the beginning of sample analysis and at a frequency of 10% or every two hours using the following criteria. Mercury analysis was performed on 8/13/97, ICP metals on 8/14/97, and the Trace ICP metals on 8/18/97. The trace metals were Sb, As, Be, Co, and Tl. The correlation coefficient for the mercury was 0.9998. All criteria were met.

ICP:	1- blank	Hg:	1 - blank
	1 - standard		5 - standards ($r \geq 0.995$)

Percent recoveries for initial and continuing calibration were reviewed and determined to be in compliance with control limits: mercury (80-120); and metals (90-110). All criteria were met.

The CRDL standards were evaluated using the following criteria:

CRI- CRDL for ICP
Concentration at 2 times CRDL or IDL for all analytes (except Al, Ba, Ca, Fe, Mg, Na, and K)
Frequency: beginning and at end of sample run or a minimum of twice per 8 hours
Recovery: 90-110%

CRA - CRDL for AA
Concentration equal to CRDL or IDL
Frequency: Beginning of each sample run
Recovery: 90-110%

All criteria were met with the exception of the CRI-CRDL frequency. The CRI-CRDL was analyzed only at the beginning of the analytical run. There is no action per USEPA region III guidelines, and the data should not be qualified.

III. BLANK ANALYSIS

The following analytes were detected in associated blanks:

	Soil	094396-01
Analyte	**Concentration (ug)**	**Qualify less than**
Al		180
Ba		25.0
Be		1.90

Analyte	Soil Concentration (ug)	Qualify less than
Cd		20.0
Ca		345
Cr		15.0.
Cu		3.85
Fe		45.0
Pb		105
Mn		202
K		2540
Se		123
Ag		35.0
Na		420
Tl		20.6
V		10.5
Zn		20.0

The sample had concentrations exceeding the 5X maximum blank criteria, or less than the reporting limit (RL). No qualification is required.

IV. ICP INTERFERENCE CHECK

Performed to verify interelement and background correction factors. Run at beginning and end of each sample analysis run. Control limit (80-120%).

Analytes in ICSA - interferents Al, Ca, Mg at 500 mg/L; Fe at 200 mg/L

Analytes in ICSAB - analytes mixed with interferents
Ag, As, Cd, Ni, Pb, Sb, Se, Zn (1.0 mg/L)
Ba, Be, Co, Cr, Cu, V, Mn (0.5 mg/L)
Na, K, Tl (10 mg/L)

All criteria were met.

V. MATRIX SPIKE SAMPLE ANALYSIS

Spike recoveries must be within 80-120%, with the exception of samples that have concentrations exceeding the spike concentration by a factor of four or more. When matrix spike recovery limits are not met, a post-digestion spike must be performed at twice the sample concentration or CRDL, whichever is greater. This does not apply to silver or mercury.

Sample 094392-08 was used as the laboratory matrix spike and matrix spike duplicate sample. This was not a ICF Kaiser sample. All criteria were met except for the following elements that were out of control: Sb, Cd, Cr, Ni, and V. Post digestion spikes were not analyzed for the failing spiked samples. Although the criteria was not met , it is my professional judjement that ICF Kaiser sample was not effected being that the ICF Kaiser sample was not spiked.

VI. LABORATORY CONTROL SAMPLES

All aqueous LCS results must fall within the control limits of 80-120%, with the exception of Sb and Ag.
All solid LCS results must fall within established limits.

Both aqueous and solid LCS results were in control.

VII. DUPLICATE SAMPLE ANALYSIS

A control limit of ± 2 times CRDL for soil for values less then 5 times CRDL.
A control limit of 35% solid RPD is used for sample values >5 times the CRDL.

The laboratory did not perform a sample duplicate as required in Section 8 of SW846 6010A. The laboratory performed a matrix spike duplicate for precision evaluation.

Soil: all analytes were within 35%.

VIII. ICP SERIAL DILUTION

Concentration in sample is a factor of 50 above IDL. An analysis of a 4-fold dilution should agree within 10% difference of the original result.

The serial dilution was not analyzed for the 8/14/97 ICP run on the ICF sample. The trace ICP 8/18/97 had a serial dilution analyzed for sample 94396-01 for Co. The serial dilution passed the set criteria of <10% difference between the initial and diluted values.

IX. CALCULATION VERIFICATION

The following calculations were performed for verification:

Sample ID	Analyte	Raw Data (mg/L)	Amt Dig.(g)	Final Vol. (L)	% Solids	Calc. Value(mg/kg)	Rpt. Value (mg/kg)
94396-01	V*	0.118	1	0.1	79.8	14.8	14.8
94396-01	Co*	0.112	1	0.1	79.8	14.0	14.0

where:

mg/kg = ((mg/L*1000)*(Final Volume L)) / ((Amount Digested g)*(Percent Solids/100))

*V taken from ICP run dated 8/14/97 and Co taken from trace ICP run 8/18/97.

APPENDIX B

ANALYTICAL RESULTS

APPENDIX B
ANALYTICAL RESULTS

SAMPLE ID	ANALYSES	VALIDATED	SDG
BACKGROUND SAMPLES			
68BKSS01	TAL Metals	yes	091467
68BKSB01	TAL Metals	yes	091467
68BKSS02	TAL Metals	yes	091467
68BKSB02	TAL Metals	yes	091467
68BKSS03	TAL Metals	yes	091467
68BKSB03	TAL Metals	yes	091467
68BKSS05	TAL Metals	yes	091467
68BKSB05	TAL Metals	yes	091467
68BKSS06	TAL Metals	yes	091467
68BKSB06	TAL Metals	yes	091467
68BKSS07	TAL Metals	yes	091467
68BKSB07	TAL Metals	yes	091467
CONFIRMATION (TEST PIT) SAMPLES			
68TP01A	TAL Metals	yes	094258
68TP01B	TAL Metals	yes	094258
68TP02A	TAL Metals	yes	094258
68TP02B	TAL Metals	yes	094258
68TP03A	TAL Metals	yes	094258
68TP03B	TAL Metals	yes	094258
68TP04A	TAL Metals	yes	094258
68TP04B	TAL Metals	yes	094258
68TP05A	TAL Metals	yes	094258
68TP05B	TAL Metals	yes	094258
68TP06A	TAL Metals	yes	094258
68TP06B	TAL Metals	yes	094258
68TP07A	TAL Metals	yes	094258
68TP07B	TAL Metals	yes	094258
68TP08A	TAL Metals	yes	094258
68TP08B	TAL Metals	yes	094258
68TP09A	TAL Metals	yes	094258
68TP09B	TAL Metals	yes	094258
68TP10A	TAL Metals	yes	094277
68TP10B	TAL Metals	yes	094277
68TP11A	TAL Metals	yes	094277
68TP11B	TAL Metals	yes	094277
68TP12A	TAL Metals	yes	094277
68TP12B	TAL Metals	yes	094277
CONTINGENCY SAMPLE			
68SB01	TAL Metals	yes	094398

APPENDIX B
ANALYTICAL RESULTS (cont'd.)

SAMPLE ID	ANALYSES	VALIDATED	SDG
WASTE CHARACTERIZATION SAMPLES			
SWMU 68 WATER	TCLP Metals, pH	no preliminary results	na
SWMU 68 WOOD	TCLP Metals, TCLP SVOCs	no preliminary results	na
68PAINT	Total Lead	no	na
68SLUDGE	Total Metals, pH	no	na
68SOIL01	TCLP Metals	no	094278
68SOIL02	TCLP Metals	no	094278
68SOIL03	TCLP Metals	no	094278
68SOIL04	TCLP Metals	no	094278
DECON WATER	TCLP Metals (aqueous)	no	094476
LINE WATER	TCLP Metals (aqueous)	no	094476
QA/QC SAMPLES			
SOURCEWATER	TAL Metals, SVOCs (aqueous)	no	094168
071597R1	TAL Metals (aqueous)	no	091467
072397R1	TAL Metals (aqueous)	no	na
072497R1	TAL Metals (aqueous)	no	na

Quanterra
Environmental Services

ICP Scan

(soil)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68BKSS01 (0.0,68BK01,BORE,)
Lab ID: 094167-0006-SA
Matrix: SOIL Sampled: 15 JUL 97 Received: 17 JUL 97
Authorized: 18 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry Weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	11800	mg/kg	12.2	6010A	11 AUG 97	13 AUG 97
Antimony	ND	mg/kg	0.61	6010 Modified	11 AUG 97	14 AUG 97
Arsenic	4.4	mg/kg	0.61	6010 Modified	11 AUG 97	14 AUG 97
Barium	78.2	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Beryllium	0.63	mg/kg	0.12	6010 Modified	11 AUG 97	14 AUG 97
Cadmium	ND	mg/kg	0.61	6010A	11 AUG 97	13 AUG 97
Calcium	1540	mg/kg	60.9	6010A	11 AUG 97	13 AUG 97
Chromium	23.7	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Cobalt	8.4	mg/kg	0.97	6010 Modified	11 AUG 97	14 AUG 97
Copper	11.4	mg/kg	2.4	6010A	11 AUG 97	13 AUG 97
Iron	21600	mg/kg	12.2	6010A	11 AUG 97	13 AUG 97
Lead	17.7	mg/kg	6.1	6010A	11 AUG 97	13 AUG 97
Magnesium	1900	mg/kg	60.9	6010A	11 AUG 97	13 AUG 97
Manganese	550	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Mercury	ND	mg/kg	0.12	7471	08 AUG 97	08 AUG 97
Nickel	10.1	mg/kg	4.9	6010A	11 AUG 97	13 AUG 97
Potassium	952	mg/kg	609	6010A	11 AUG 97	13 AUG 97
Selenium	ND	mg/kg	24.4	6010A	11 AUG 97	13 AUG 97
Silver	ND	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Sodium	ND	mg/kg	609	6010A	11 AUG 97	13 AUG 97
Thallium	ND	mg/kg	1.2	6010 Modified	11 AUG 97	14 AUG 97
Vanadium	35.4	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Zinc	54.9	mg/kg	2.4	6010A	11 AUG 97	13 AUG 97

Percent Moisture is 17.9%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: Allan Wong Approved By: Mei Lai

The cover letter is an integral part of this report.
Rev 230787

Quanterra
Environmental Services

ICP Scan

(soil)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68BKSB01 (4.0,68BK01,BORE,)
Lab ID: 094167-0007-SA
Matrix: SOIL Sampled: 15 JUL 97 Received: 17 JUL 97
Authorized: 18 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry Weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	26500	mg/kg	12.4	6010A	11 AUG 97	13 AUG 97
Antimony	ND	mg/kg	0.62	6010 Modified	11 AUG 97	14 AUG 97
Arsenic	3.8	mg/kg	0.62	6010 Modified	11 AUG 97	14 AUG 97
Barium	69.3	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Beryllium	0.59	mg/kg	0.12	6010 Modified	11 AUG 97	14 AUG 97
Cadmium	ND	mg/kg	0.62	6010A	11 AUG 97	13 AUG 97
Calcium	220	mg/kg	61.9	6010A	11 AUG 97	13 AUG 97
Chromium	27.7	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Cobalt	30.7	mg/kg	0.99	6010 Modified	11 AUG 97	14 AUG 97
Copper	16.3	mg/kg	2.5	6010A	11 AUG 97	13 AUG 97
Iron	40200	mg/kg	12.4	6010A	11 AUG 97	13 AUG 97
Lead	24.9	mg/kg	6.2	6010A	11 AUG 97	13 AUG 97
Magnesium	1310	mg/kg	61.9	6010A	11 AUG 97	13 AUG 97
Manganese	905	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Mercury	ND	mg/kg	0.12	7471	08 AUG 97	08 AUG 97
Nickel	12.5	mg/kg	5.0	6010A	11 AUG 97	13 AUG 97
Potassium	1450	mg/kg	619	6010A	11 AUG 97	13 AUG 97
Selenium	ND	mg/kg	24.8	6010A	11 AUG 97	13 AUG 97
Silver	ND	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Sodium	ND	mg/kg	619	6010A	11 AUG 97	13 AUG 97
Thallium	ND	mg/kg	1.2	6010 Modified	11 AUG 97	14 AUG 97
Vanadium	79.5	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Zinc	42.5	mg/kg	2.5	6010A	11 AUG 97	13 AUG 97

Percent Moisture is 19.2%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: Allan Wong Approved By: Mei Lai

The cover letter is an integral part of this report.
Rev 230787

Quanterra
Environmental Services

ICP Scan

(soil)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68BKSS02 (0.0,68BK02,BORE,)
Lab ID: 094167-0008-SA
Matrix: SOIL Sampled: 15 JUL 97 Received: 17 JUL 97
Authorized: 18 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry Weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	8000	mg/kg	11.8	6010A	11 AUG 97	13 AUG 97
Antimony	ND	mg/kg	0.59	6010 Modified	11 AUG 97	14 AUG 97
Arsenic	2.7	mg/kg	0.59	6010 Modified	11 AUG 97	14 AUG 97
Barium	82.8	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Beryllium	0.46	mg/kg	0.12	6010 Modified	11 AUG 97	14 AUG 97
Cadmium	0.73	mg/kg	0.59	6010A	11 AUG 97	13 AUG 97 1
Calcium	1130	mg/kg	58.8	6010A	11 AUG 97	13 AUG 97
Chromium	21.3	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Cobalt	7.2	mg/kg	0.94	6010 Modified	11 AUG 97	14 AUG 97
Copper	10.3	mg/kg	2.4	6010A	11 AUG 97	13 AUG 97
Iron	12700	mg/kg	11.8	6010A	11 AUG 97	13 AUG 97
Lead	16.7	mg/kg	5.9	6010A	11 AUG 97	13 AUG 97
Magnesium	584	mg/kg	58.8	6010A	11 AUG 97	13 AUG 97
Manganese	665	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Mercury	ND	mg/kg	0.12	7471	08 AUG 97	08 AUG 97
Nickel	6.6	mg/kg	4.7	6010A	11 AUG 97	13 AUG 97
Potassium	ND	mg/kg	588	6010A	11 AUG 97	13 AUG 97
Selenium	ND	mg/kg	23.5	6010A	11 AUG 97	13 AUG 97
Silver	ND	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Sodium	ND	mg/kg	588	6010A	11 AUG 97	13 AUG 97
Thallium	ND	mg/kg	1.2	6010 Modified	11 AUG 97	14 AUG 97
Vanadium	25.3	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Zinc	23.4	mg/kg	2.4	6010A	11 AUG 97	13 AUG 97

Percent Moisture is 15.0%. All results and limits are reported on a dry weight basis.

Note 1 : Analysis time = 14:24

ND = Not detected
NA = Not applicable

Reported By: Allan Wong Approved By: Mei Lai

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Quanterra
Environmental Services

ICP Scan

(soil)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68BKSS03 (0.0,68BK03,BORE,)
Lab ID: 094167-0012-SA
Matrix: SOIL Sampled: 15 JUL 97 Received: 17 JUL 97
Authorized: 18 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry Weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	9740	mg/kg	13.7	6010A	11 AUG 97	13 AUG 97
Antimony	ND	mg/kg	0.68	6010 Modified	11 AUG 97	14 AUG 97
Arsenic	3.1	mg/kg	0.68	6010 Modified	11 AUG 97	14 AUG 97
Barium	95.1	mg/kg	1.4	6010A	11 AUG 97	13 AUG 97
Beryllium	0.51	mg/kg	0.14	6010 Modified	11 AUG 97	14 AUG 97
Cadmium	ND	mg/kg	0.68	6010A	11 AUG 97	13 AUG 97
Calcium	1300	mg/kg	68.4	6010A	11 AUG 97	13 AUG 97
Chromium	29.0	mg/kg	1.4	6010A	11 AUG 97	13 AUG 97
Cobalt	8.2	mg/kg	1.1	6010 Modified	11 AUG 97	14 AUG 97
Copper	6.8	mg/kg	2.7	6010A	11 AUG 97	13 AUG 97
Iron	13900	mg/kg	13.7	6010A	11 AUG 97	13 AUG 97
Lead	14.2	mg/kg	6.8	6010A	11 AUG 97	13 AUG 97
Magnesium	860	mg/kg	68.4	6010A	11 AUG 97	13 AUG 97
Manganese	739	mg/kg	1.4	6010A	11 AUG 97	13 AUG 97
Mercury	ND	mg/kg	0.14	7471	08 AUG 97	08 AUG 97
Nickel	6.1	mg/kg	5.5	6010A	11 AUG 97	13 AUG 97
Potassium	ND	mg/kg	684	6010A	11 AUG 97	13 AUG 97
Selenium	ND	mg/kg	27.3	6010A	11 AUG 97	13 AUG 97
Silver	ND	mg/kg	1.4	6010A	11 AUG 97	13 AUG 97
Sodium	ND	mg/kg	684	6010A	11 AUG 97	13 AUG 97
Thallium	ND	mg/kg	1.4	6010 Modified	11 AUG 97	14 AUG 97
Vanadium	28.7	mg/kg	1.4	6010A	11 AUG 97	13 AUG 97
Zinc	22.4	mg/kg	2.7	6010A	11 AUG 97	13 AUG 97

Percent Moisture is 26.8%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: Allan Wong Approved By: Mei Lai

The cover letter is an integral part of this report.
Rev 230787

Quanterra
Environmental Services

ICP Scan

(soil)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68BKSB03 (4.0,68BKSB03,BORE,)
Lab ID: 094167-0004-SA
Matrix: SOIL Sampled: 15 JUL 97 Received: 17 JUL 97
Authorized: 18 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry Weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date	
Aluminum	33600	mg/kg	16.7	6010A	11 AUG 97	13 AUG 97	
Antimony	ND	mg/kg	0.84	6010 Modified	11 AUG 97	14 AUG 97	
Arsenic	4.4	mg/kg	0.84	6010 Modified	11 AUG 97	14 AUG 97	
Barium	66.7	mg/kg	1.7	6010A	11 AUG 97	13 AUG 97	
Beryllium	0.65	mg/kg	0.17	6010 Modified	11 AUG 97	14 AUG 97	
Cadmium	ND	mg/kg	0.84	6010A	11 AUG 97	13 AUG 97	1
Calcium	6530	mg/kg	83.7	6010A	11 AUG 97	13 AUG 97	
Chromium	41.1	mg/kg	1.7	6010A	11 AUG 97	13 AUG 97	
Cobalt	7.7	mg/kg	1.3	6010 Modified	11 AUG 97	14 AUG 97	
Copper	19.7	mg/kg	3.3	6010A	11 AUG 97	13 AUG 97	
Iron	45500	mg/kg	16.7	6010A	11 AUG 97	13 AUG 97	
Lead	14.2	mg/kg	8.4	6010A	11 AUG 97	13 AUG 97	
Magnesium	3870	mg/kg	83.7	6010A	11 AUG 97	13 AUG 97	
Manganese	216	mg/kg	1.7	6010A	11 AUG 97	13 AUG 97	
Mercury	ND	mg/kg	0.17	7471	08 AUG 97	08 AUG 97	
Nickel	17.3	mg/kg	6.7	6010A	11 AUG 97	13 AUG 97	
Potassium	1450	mg/kg	837	6010A	11 AUG 97	13 AUG 97	
Selenium	ND	mg/kg	33.5	6010A	11 AUG 97	13 AUG 97	
Silver	ND	mg/kg	1.7	6010A	11 AUG 97	13 AUG 97	
Sodium	ND	mg/kg	837	6010A	11 AUG 97	13 AUG 97	
Thallium	ND	mg/kg	1.7	6010 Modified	11 AUG 97	14 AUG 97	
Vanadium	86.4	mg/kg	1.7	6010A	11 AUG 97	13 AUG 97	
Zinc	50.2	mg/kg	3.3	6010A	11 AUG 97	13 AUG 97	

Percent Moisture is 40.3%. All results and limits are reported on a dry weight basis.

Note 1 : Analysis time = 14:20

ND = Not detected
NA = Not applicable

Reported By: Allan Wong Approved By: Mei Lai

The cover letter is an integral part of this report.
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Quanterra
Environmental Services

ICP Scan

(soil)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68BKSS05 (0.0,68BK05,BORE,)
Lab ID: 094167-0013-SA
Matrix: SOIL Sampled: 15 JUL 97 Received: 17 JUL 97
Authorized: 18 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry Weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	11700	mg/kg	11.8	6010A	11 AUG 97	13 AUG 97
Antimony	ND	mg/kg	0.59	6010 Modified	11 AUG 97	14 AUG 97
Arsenic	4.3	mg/kg	0.59	6010 Modified	11 AUG 97	14 AUG 97
Barium	100	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Beryllium	0.60	mg/kg	0.12	6010 Modified	11 AUG 97	14 AUG 97
Cadmium	ND	mg/kg	0.59	6010A	11 AUG 97	13 AUG 97
Calcium	753	mg/kg	59.2	6010A	11 AUG 97	13 AUG 97
Chromium	24.3	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Cobalt	8.8	mg/kg	0.95	6010 Modified	11 AUG 97	14 AUG 97
Copper	9.2	mg/kg	2.4	6010A	11 AUG 97	13 AUG 97
Iron	16700	mg/kg	11.8	6010A	11 AUG 97	13 AUG 97
Lead	24.9	mg/kg	5.9	6010A	11 AUG 97	13 AUG 97
Magnesium	616	mg/kg	59.2	6010A	11 AUG 97	13 AUG 97
Manganese	1140	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Mercury	ND	mg/kg	0.12	7471	08 AUG 97	08 AUG 97
Nickel	8.3	mg/kg	4.7	6010A	11 AUG 97	13 AUG 97
Potassium	ND	mg/kg	592	6010A	11 AUG 97	13 AUG 97
Selenium	ND	mg/kg	23.7	6010A	11 AUG 97	13 AUG 97
Silver	ND	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Sodium	ND	mg/kg	592	6010A	11 AUG 97	13 AUG 97
Thallium	ND	mg/kg	1.2	6010 Modified	11 AUG 97	14 AUG 97
Vanadium	34.1	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Zinc	33.9	mg/kg	2.4	6010A	11 AUG 97	13 AUG 97

Percent Moisture is 15.5%. All results and limits are reported on a dry weight basi-

ND = Not detected
NA = Not applicable

Reported By: Allan Wong Approved By: Mei Lai

The cover letter is an integral part of this report.
Rev 230787

Quanterra
Environmental Services

ICP Scan

(soil)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68BKSB05 (0.0,68BKSB05,BORE,)
Lab ID: 094167-0001-SA
Matrix: SOIL Sampled: 15 JUL 97 Received: 17 JUL 97
Authorized: 18 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry Weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	14100	mg/kg	11.5	6010A	11 AUG 97	13 AUG 97
Antimony	ND	mg/kg	0.58	6010 Modified	11 AUG 97	14 AUG 97
Arsenic	4.9	mg/kg	0.58	6010 Modified	11 AUG 97	14 AUG 97
Barium	45.7	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Beryllium	0.33	mg/kg	0.12	6010 Modified	11 AUG 97	14 AUG 97
Cadmium	ND	mg/kg	0.58	6010A	11 AUG 97	13 AUG 97
Calcium	169	mg/kg	57.7	6010A	11 AUG 97	13 AUG 97
Chromium	38.7	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Cobalt	10.2	mg/kg	0.92	6010 Modified	11 AUG 97	14 AUG 97
Copper	10.1	mg/kg	2.3	6010A	11 AUG 97	13 AUG 97
Iron	21500	mg/kg	11.5	6010A	11 AUG 97	13 AUG 97
Lead	15.5	mg/kg	5.8	6010A	11 AUG 97	13 AUG 97
Magnesium	539	mg/kg	57.7	6010A	11 AUG 97	13 AUG 97
Manganese	583	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Mercury	ND	mg/kg	0.12	7471	08 AUG 97	08 AUG 97
Nickel	8.3	mg/kg	4.6	6010A	11 AUG 97	13 AUG 97
Potassium	ND	mg/kg	577	6010A	11 AUG 97	13 AUG 97
Selenium	ND	mg/kg	23.1	6010A	11 AUG 97	13 AUG 97
Silver	ND	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Sodium	ND	mg/kg	577	6010A	11 AUG 97	13 AUG 97
Thallium	ND	mg/kg	1.2	6010 Modified	11 AUG 97	14 AUG 97
Vanadium	47.6	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Zinc	27.9	mg/kg	2.3	6010A	11 AUG 97	13 AUG 97

Percent Moisture is 13.3%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: Allan Wong Approved By: Mei Lai

The cover letter is an integral part of this report.
Rev 230787

Quanterra
Environmental Services

ICP Scan

(soil)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68BKSS06 (0.0,68BK06,BORE,)
Lab ID: 094167-0010-SA
Matrix: SOIL Sampled: 15 JUL 97 Received: 17 JUL 97
Authorized: 18 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry Weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	12700	mg/kg	11.6	6010A	11 AUG 97	13 AUG 97
Antimony	164	mg/kg	0.58	6010 Modified	11 AUG 97	14 AUG 97
Arsenic	3.8	mg/kg	0.58	6010 Modified	11 AUG 97	14 AUG 97
Barium	78.1	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Beryllium	0.51	mg/kg	0.12	6010 Modified	11 AUG 97	14 AUG 97
Cadmium	2.3	mg/kg	0.58	6010A	11 AUG 97	13 AUG 97
Calcium	47200	mg/kg	57.9	6010A	11 AUG 97	13 AUG 97
Chromium	88.0	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Cobalt	7.6	mg/kg	0.93	6010 Modified	11 AUG 97	14 AUG 97
Copper	14.7	mg/kg	2.3	6010A	11 AUG 97	13 AUG 97
Iron	18200	mg/kg	11.6	6010A	11 AUG 97	13 AUG 97
Lead	47.6	mg/kg	5.8	6010A	11 AUG 97	13 AUG 97
Magnesium	9950	mg/kg	57.9	6010A	11 AUG 97	13 AUG 97
Manganese	492	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Mercury	ND	mg/kg	0.12	7471	08 AUG 97	08 AUG 97
Nickel	11.1	mg/kg	4.6	6010A	11 AUG 97	13 AUG 97
Potassium	1020	mg/kg	579	6010A	11 AUG 97	13 AUG 97
Selenium	ND	mg/kg	23.2	6010A	11 AUG 97	13 AUG 97
Silver	ND	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Sodium	ND	mg/kg	579	6010A	11 AUG 97	13 AUG 97
Thallium	ND	mg/kg	1.2	6010 Modified	11 AUG 97	14 AUG 97
Vanadium	36.4	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Zinc	191	mg/kg	2.3	6010A	11 AUG 97	13 AUG 97

Percent Moisture is 13.6%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: Allan Wong Approved By: Mei Lai

The cover letter is an integral part of this report.
Rev 230787

Quanterra
Environmental Services

ICP Scan

(soil)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68BKSB06 (4.0,68BK06,BORE,)
Lab ID: 094167-0011-SA
Matrix: SOIL Sampled: 15 JUL 97 Received: 17 JUL 97
Authorized: 18 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry Weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	29300	mg/kg	14.7	6010A	11 AUG 97	13 AUG 97
Antimony	ND	mg/kg	0.74	6010 Modified	11 AUG 97	14 AUG 97
Arsenic	3.0	mg/kg	0.74	6010 Modified	11 AUG 97	14 AUG 97
Barium	62.3	mg/kg	1.5	6010A	11 AUG 97	13 AUG 97
Beryllium	0.56	mg/kg	0.15	6010 Modified	11 AUG 97	14 AUG 97
Cadmium	ND	mg/kg	0.74	6010A	11 AUG 97	13 AUG 97
Calcium	235	mg/kg	73.6	6010A	11 AUG 97	13 AUG 97
Chromium	28.0	mg/kg	1.5	6010A	11 AUG 97	13 AUG 97
Cobalt	5.5	mg/kg	1.2	6010 Modified	11 AUG 97	14 AUG 97
Copper	17.9	mg/kg	2.9	6010A	11 AUG 97	13 AUG 97
Iron	36900	mg/kg	14.7	6010A	11 AUG 97	13 AUG 97
Lead	14.8	mg/kg	7.4	6010A	11 AUG 97	13 AUG 97
Magnesium	1180	mg/kg	73.6	6010A	11 AUG 97	13 AUG 97
Manganese	140	mg/kg	1.5	6010A	11 AUG 97	13 AUG 97
Mercury	ND	mg/kg	0.15	7471	08 AUG 97	08 AUG 97
Nickel	12.8	mg/kg	5.9	6010A	11 AUG 97	13 AUG 97
Potassium	1300	mg/kg	736	6010A	11 AUG 97	13 AUG 97
Selenium	ND	mg/kg	29.4	6010A	11 AUG 97	13 AUG 97
Silver	ND	mg/kg	1.5	6010A	11 AUG 97	13 AUG 97
Sodium	ND	mg/kg	736	6010A	11 AUG 97	13 AUG 97
Thallium	ND	mg/kg	1.5	6010 Modified	11 AUG 97	14 AUG 97
Vanadium	90.5	mg/kg	1.5	6010A	11 AUG 97	13 AUG 97
Zinc	40.0	mg/kg	2.9	6010A	11 AUG 97	13 AUG 97

Percent Moisture is 32.0%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: Allan Wong Approved By: Mei Lai

The cover letter is an integral part of this report.
Rev 230787

Quanterra
Environmental Services

ICP Scan

(soil)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68BKSS07 (0.0,68BKSS07,BORE,)
Lab ID: 094167-0002-SA
Matrix: SOIL Sampled: 15 JUL 97 Received: 17 JUL 97
Authorized: 18 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry Weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	18800	mg/kg	12.7	6010A	11 AUG 97	13 AUG 97
Antimony	9.1	mg/kg	0.63	6010 Modified	11 AUG 97	14 AUG 97
Arsenic	3.5	mg/kg	0.63	6010 Modified	11 AUG 97	14 AUG 97
Barium	108	mg/kg	1.3	6010A	11 AUG 97	13 AUG 97
Beryllium	0.74	mg/kg	0.13	6010 Modified	11 AUG 97	14 AUG 97
Cadmium	2.6	mg/kg	0.63	6010A	11 AUG 97	13 AUG 97
Calcium	18900	mg/kg	63.5	6010A	11 AUG 97	13 AUG 97
Chromium	29.8	mg/kg	1.3	6010A	11 AUG 97	13 AUG 97
Cobalt	7.7	mg/kg	1.0	6010 Modified	11 AUG 97	14 AUG 97
Copper	16.8	mg/kg	2.5	6010A	11 AUG 97	13 AUG 97
Iron	21900	mg/kg	12.7	6010A	11 AUG 97	13 AUG 97
Lead	47.3	mg/kg	6.3	6010A	11 AUG 97	13 AUG 97
Magnesium	11300	mg/kg	63.5	6010A	11 AUG 97	13 AUG 97
Manganese	444	mg/kg	1.3	6010A	11 AUG 97	13 AUG 97
Mercury	0.20	mg/kg	0.13	7471	08 AUG 97	08 AUG 97
Nickel	13.4	mg/kg	5.1	6010A	11 AUG 97	13 AUG 97
Potassium	1830	mg/kg	635	6010A	11 AUG 97	13 AUG 97
Selenium	ND	mg/kg	25.4	6010A	11 AUG 97	13 AUG 97
Silver	ND	mg/kg	1.3	6010A	11 AUG 97	13 AUG 97
Sodium	ND	mg/kg	635	6010A	11 AUG 97	13 AUG 97
Thallium	ND	mg/kg	1.3	6010 Modified	11 AUG 97	14 AUG 97
Vanadium	41.6	mg/kg	1.3	6010A	11 AUG 97	13 AUG 97
Zinc	95.0	mg/kg	2.5	6010A	11 AUG 97	13 AUG 97

Percent Moisture is 21.2%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: Allan Wong Approved By: Mei Lai

The cover letter is an integral part of this report.
Rev 230787

Quanterra
Environmental Services

ICP Scan

(soil)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68BKSB07 (0.0,68BKSB07,BORE,)
Lab ID: 094167-0003-SA
Matrix: SOIL Sampled: 15 JUL 97 Received: 17 JUL 97
Authorized: 18 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry Weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	11900	mg/kg	12.1	6010A	11 AUG 97	13 AUG 97
Antimony	ND	mg/kg	0.61	6010 Modified	11 AUG 97	14 AUG 97
Arsenic	3.6	mg/kg	0.61	6010 Modified	11 AUG 97	14 AUG 97
Barium	33.7	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Beryllium	0.20	mg/kg	0.12	6010 Modified	11 AUG 97	14 AUG 97
Cadmium	ND	mg/kg	0.61	6010A	11 AUG 97	13 AUG 97
Calcium	856	mg/kg	60.7	6010A	11 AUG 97	13 AUG 97
Chromium	21.5	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Cobalt	12.7	mg/kg	0.97	6010 Modified	11 AUG 97	14 AUG 97
Copper	6.7	mg/kg	2.4	6010A	11 AUG 97	13 AUG 97
Iron	12900	mg/kg	12.1	6010A	11 AUG 97	13 AUG 97
Lead	14.8	mg/kg	6.1	6010A	11 AUG 97	13 AUG 97
Magnesium	916	mg/kg	60.7	6010A	11 AUG 97	13 AUG 97
Manganese	568	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Mercury	ND	mg/kg	0.12	7471	08 AUG 97	08 AUG 97
Nickel	6.0	mg/kg	4.9	6010A	11 AUG 97	13 AUG 97
Potassium	617	mg/kg	607	6010A	11 AUG 97	13 AUG 97
Selenium	ND	mg/kg	24.3	6010A	11 AUG 97	13 AUG 97
Silver	ND	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Sodium	ND	mg/kg	607	6010A	11 AUG 97	13 AUG 97
Thallium	ND	mg/kg	1.2	6010 Modified	11 AUG 97	14 AUG 97
Vanadium	30.8	mg/kg	1.2	6010A	11 AUG 97	13 AUG 97
Zinc	22.1	mg/kg	2.4	6010A	11 AUG 97	13 AUG 97

Percent Moisture is 17.7%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: Allan Wong Approved By: Mei Lai

The cover letter is an integral part of this report.
Rev 230787

Quanterra
Environmental Services

METALS

(Soil/Solid - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68TP01A (4.0,68TP01,BORE,)
Lab ID: 094258-0003-SA
Matrix: SOIL Sampled: 23 JUL 97 Received: 24 JUL 97
Authorized: 24 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	32100	mg/kg	26.1	6010A	28 JUL 97	28 JUL 97
Antimony	1.0	mg/kg	0.65	6010A	28 JUL 97	28 JUL 97
Arsenic	5.1	mg/kg	0.65	6010A	28 JUL 97	28 JUL 97
Barium	63.8	mg/kg	26.1	6010A	28 JUL 97	28 JUL 97
Beryllium	0.60	mg/kg	0.13	6010A	28 JUL 97	28 JUL 97
Cadmium	0.94	mg/kg	0.65	6010A	28 JUL 97	28 JUL 97
Calcium	1330	mg/kg	652	6010A	28 JUL 97	28 JUL 97
Chromium	30.0	mg/kg	1.3	6010A	28 JUL 97	28 JUL 97
Cobalt	8.8	mg/kg	1.0	6010A	28 JUL 97	28 JUL 97
Copper	20.9	mg/kg	3.3	6010A	28 JUL 97	28 JUL 97
Iron	34700	mg/kg	13.0	6010A	28 JUL 97	28 JUL 97
Lead	ND	mg/kg	13.0	6010A	28 JUL 97	28 JUL 97
Magnesium	1370	mg/kg	652	6010A	28 JUL 97	28 JUL 97
Manganese	316	mg/kg	2.0	6010A	28 JUL 97	28 JUL 97
Mercury	0.15	mg/kg	0.13	SW7471A	28 JUL 97	28 JUL 97
Nickel	15.4	mg/kg	5.2	6010A	28 JUL 97	28 JUL 97
Potassium	1290	mg/kg	652	6010A	28 JUL 97	29 JUL 9
Selenium	ND	mg/kg	32.6	6010A	28 JUL 97	28 JUL 9
Silver	ND	mg/kg	1.3	6010A	28 JUL 97	28 JUL 9
Sodium	ND	mg/kg	652	6010A	28 JUL 97	29 JUL 97
Thallium	ND	mg/kg	1.3	6010A	28 JUL 97	28 JUL 97
Vanadium	63.5	mg/kg	6.5	6010A	28 JUL 97	28 JUL 97
Zinc	60.5	mg/kg	5.2	6010A	28 JUL 97	28 JUL 97

Percent Moisture is 23%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: TVU Approved By: Sonia Tabirara

The cover letter is an integral part of this report.
Rev 230787

Quanterra
Environmental Services

METALS

(Soil/Solid - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68TP01B (4.0,68TP01,BORE,)
Lab ID: 094258-0002-SA
Matrix: SOIL Sampled: 23 JUL 97 Received: 24 JUL 97
Authorized: 24 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	28600	mg/kg	24.4	6010A	28 JUL 97	28 JUL 97
Antimony	1.6	mg/kg	0.61	6010A	28 JUL 97	28 JUL 97
Arsenic	5.1	mg/kg	0.61	6010A	28 JUL 97	28 JUL 97
Barium	64.3	mg/kg	24.4	6010A	28 JUL 97	28 JUL 97
Beryllium	0.59	mg/kg	0.12	6010A	28 JUL 97	28 JUL 97
Cadmium	ND	mg/kg	0.61	6010A	28 JUL 97	28 JUL 97
Calcium	4080	mg/kg	609	6010A	28 JUL 97	28 JUL 97
Chromium	34.8	mg/kg	1.2	6010A	28 JUL 97	28 JUL 97
Cobalt	10.6	mg/kg	0.97	6010A	28 JUL 97	28 JUL 97
Copper	17.5	mg/kg	3.0	6010A	28 JUL 97	28 JUL 97
Iron	32200	mg/kg	12.2	6010A	28 JUL 97	28 JUL 97
Lead	13.1	mg/kg	12.2	6010A	28 JUL 97	28 JUL 97
Magnesium	2610	mg/kg	609	6010A	28 JUL 97	28 JUL 97
Manganese	458	mg/kg	1.8	6010A	28 JUL 97	28 JUL 97
Mercury	ND	mg/kg	0.12	SW7471A	28 JUL 97	28 JUL 97
Nickel	14.0	mg/kg	4.9	6010A	28 JUL 97	28 JUL 97
Potassium	1240	mg/kg	609	6010A	28 JUL 97	29 JUL 97
Selenium	ND	mg/kg	30.5	6010A	28 JUL 97	28 JUL 97
Silver	ND	mg/kg	1.2	6010A	28 JUL 97	28 JUL 97
Sodium	ND	mg/kg	609	6010A	28 JUL 97	29 JUL 97
Thallium	ND	mg/kg	1.2	6010A	28 JUL 97	28 JUL 97
Vanadium	54.6	mg/kg	6.1	6010A	28 JUL 97	28 JUL 97
Zinc	58.9	mg/kg	4.9	6010A	28 JUL 97	28 JUL 97

Percent Moisture is 18%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: TVU Approved By: Sonia Tabirara

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Quanterra
Environmental Services

METALS

(Soil/Solid - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68TP02A (4.0,68TP02,BORE,)
Lab ID: 094258-0005-SA
Matrix: SOIL Sampled: 23 JUL 97 Received: 24 JUL 97
Authorized: 24 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	19900	mg/kg	24.1	6010A	28 JUL 97	28 JUL 97
Antimony	0.66	mg/kg	0.60	6010A	28 JUL 97	28 JUL 97
Arsenic	5.3	mg/kg	0.60	6010A	28 JUL 97	28 JUL 97
Barium	50.7	mg/kg	24.1	6010A	28 JUL 97	28 JUL 97
Beryllium	0.52	mg/kg	0.12	6010A	28 JUL 97	28 JUL 97
Cadmium	1.3	mg/kg	0.60	6010A	28 JUL 97	28 JUL 97
Calcium	1360	mg/kg	603	6010A	28 JUL 97	28 JUL 97
Chromium	37.3	mg/kg	1.2	6010A	28 JUL 97	28 JUL 97
Cobalt	10.3	mg/kg	0.97	6010A	28 JUL 97	28 JUL 97
Copper	16.4	mg/kg	3.0	6010A	28 JUL 97	28 JUL 97
Iron	31600	mg/kg	12.1	6010A	28 JUL 97	28 JUL 97
Lead	12.5	mg/kg	12.1	6010A	28 JUL 97	28 JUL 97
Magnesium	984	mg/kg	603	6010A	28 JUL 97	28 JUL 97
Manganese	391	mg/kg	1.8	6010A	28 JUL 97	28 JUL 97
Mercury	ND	mg/kg	0.12	SW7471A	28 JUL 97	28 JUL 97
Nickel	36.7	mg/kg	4.8	6010A	28 JUL 97	28 JUL 97
Potassium	1100	mg/kg	603	6010A	28 JUL 97	29 JUL 9
Selenium	ND	mg/kg	30.2	6010A	28 JUL 97	28 JUL 9
Silver	ND	mg/kg	1.2	6010A	28 JUL 97	28 JUL 9,
Sodium	ND	mg/kg	603	6010A	28 JUL 97	29 JUL 97
Thallium	ND	mg/kg	1.2	6010A	28 JUL 97	28 JUL 97
Vanadium	54.4	mg/kg	6.0	6010A	28 JUL 97	28 JUL 97
Zinc	57.2	mg/kg	4.8	6010A	28 JUL 97	28 JUL 97

Percent Moisture is 17%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: TVU Approved By: Sonia Tabirara

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Quanterra
Environmental Services

METALS

(Soil/Solid - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68TP02B (4.0,68TP02,BORE,)
Lab ID: 094258-0004-SA
Matrix: SOIL Sampled: 23 JUL 97 Received: 24 JUL 97
Authorized: 24 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	18300	mg/kg	24.2	6010A	28 JUL 97	28 JUL 97
Antimony	0.77	mg/kg	0.60	6010A	28 JUL 97	28 JUL 97
Arsenic	5.8	mg/kg	0.60	6010A	28 JUL 97	28 JUL 97
Barium	45.0	mg/kg	24.2	6010A	28 JUL 97	28 JUL 97
Beryllium	0.48	mg/kg	0.12	6010A	28 JUL 97	28 JUL 97
Cadmium	0.86	mg/kg	0.60	6010A	28 JUL 97	28 JUL 97
Calcium	ND	mg/kg	605	6010A	28 JUL 97	28 JUL 97
Chromium	43.1	mg/kg	1.2	6010A	28 JUL 97	28 JUL 97
Cobalt	12.8	mg/kg	0.97	6010A	28 JUL 97	28 JUL 97
Copper	17.9	mg/kg	3.0	6010A	28 JUL 97	28 JUL 97
Iron	25700	mg/kg	12.1	6010A	28 JUL 97	28 JUL 97
Lead	13.7	mg/kg	12.1	6010A	28 JUL 97	28 JUL 97
Magnesium	836	mg/kg	605	6010A	28 JUL 97	28 JUL 97
Manganese	631	mg/kg	1.8	6010A	28 JUL 97	28 JUL 97
Mercury	ND	mg/kg	0.12	SW7471A	28 JUL 97	28 JUL 97
Nickel	9.0	mg/kg	4.8	6010A	28 JUL 97	28 JUL 97
Potassium	1020	mg/kg	605	6010A	28 JUL 97	29 JUL 97
Selenium	ND	mg/kg	30.2	6010A	28 JUL 97	28 JUL 97
Silver	ND	mg/kg	1.2	6010A	28 JUL 97	28 JUL 97
Sodium	ND	mg/kg	605	6010A	28 JUL 97	29 JUL 97
Thallium	ND	mg/kg	1.2	6010A	28 JUL 97	28 JUL 97
Vanadium	52.8	mg/kg	6.0	6010A	28 JUL 97	28 JUL 97
Zinc	44.1	mg/kg	4.8	6010A	28 JUL 97	28 JUL 97

Percent Moisture is 17%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: TVU Approved By: Sonia Tabirara

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Quanterra
Environmental Services

METALS

(Soil/Solid - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68TP03A (4.0,68TP03,BORE,)
Lab ID: 094258-0007-SA
Matrix: SOIL Sampled: 23 JUL 97 Received: 24 JUL 97
Authorized: 24 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	18900	mg/kg	24.2	6010A	28 JUL 97	28 JUL 97
Antimony	0.71	mg/kg	0.61	6010A	28 JUL 97	28 JUL 97
Arsenic	4.1	mg/kg	0.61	6010A	28 JUL 97	28 JUL 97
Barium	39.1	mg/kg	24.2	6010A	28 JUL 97	28 JUL 97
Beryllium	0.58	mg/kg	0.12	6010A	28 JUL 97	28 JUL 97
Cadmium	0.84	mg/kg	0.61	6010A	28 JUL 97	28 JUL 97
Calcium	1060	mg/kg	605	6010A	28 JUL 97	28 JUL 97
Chromium	26.3	mg/kg	1.2	6010A	28 JUL 97	28 JUL 97
Cobalt	6.3	mg/kg	0.97	6010A	28 JUL 97	28 JUL 97
Copper	22.1	mg/kg	3.0	6010A	28 JUL 97	28 JUL 97
Iron	23500	mg/kg	12.1	6010A	28 JUL 97	28 JUL 97
Lead	ND	mg/kg	12.1	6010A	28 JUL 97	28 JUL 97
Magnesium	977	mg/kg	605	6010A	28 JUL 97	28 JUL 97
Manganese	227	mg/kg	1.8	6010A	28 JUL 97	28 JUL 97
Mercury	ND	mg/kg	0.12	SW7471A	28 JUL 97	28 JUL 97
Nickel	9.3	mg/kg	4.8	6010A	28 JUL 97	28 JUL 97
Potassium	1560	mg/kg	605	6010A	28 JUL 97	29 JUL 97
Selenium	ND	mg/kg	30.3	6010A	28 JUL 97	28 JUL 97
Silver	ND	mg/kg	1.2	6010A	28 JUL 97	28 JUL 97
Sodium	ND	mg/kg	605	6010A	28 JUL 97	29 JUL 97
Thallium	ND	mg/kg	1.2	6010A	28 JUL 97	28 JUL 97
Vanadium	38.7	mg/kg	6.1	6010A	28 JUL 97	28 JUL 97
Zinc	36.2	mg/kg	4.8	6010A	28 JUL 97	28 JUL 97

Percent Moisture is 17%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: TVU Approved By: Sonia Tabirara

The cover letter is an integral part of this report.
Rev 230787

Quanterra
Environmental Services

METALS

(Soil/Solid - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68TP03B (4.0,68TP03,BORE,)
Lab ID: 094258-0006-SA
Matrix: SOIL Sampled: 23 JUL 97 Received: 24 JUL 97
Authorized: 24 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	11800	mg/kg	23.9	6010A	28 JUL 97	28 JUL 97
Antimony	0.60	mg/kg	0.60	6010A	28 JUL 97	28 JUL 97
Arsenic	6.1	mg/kg	0.60	6010A	28 JUL 97	28 JUL 97
Barium	34.6	mg/kg	23.9	6010A	28 JUL 97	28 JUL 97
Beryllium	0.39	mg/kg	0.12	6010A	28 JUL 97	28 JUL 97
Cadmium	ND	mg/kg	0.60	6010A	28 JUL 97	28 JUL 97
Calcium	ND	mg/kg	597	6010A	28 JUL 97	28 JUL 97
Chromium	53.8	mg/kg	1.2	6010A	28 JUL 97	28 JUL 97
Cobalt	12.8	mg/kg	0.95	6010A	28 JUL 97	28 JUL 97
Copper	11.3	mg/kg	3.0	6010A	28 JUL 97	28 JUL 97
Iron	25100	mg/kg	11.9	6010A	28 JUL 97	28 JUL 97
Lead	19.3	mg/kg	11.9	6010A	28 JUL 97	28 JUL 97
Magnesium	ND	mg/kg	597	6010A	28 JUL 97	28 JUL 97
Manganese	990	mg/kg	1.8	6010A	28 JUL 97	28 JUL 97
Mercury	ND	mg/kg	0.12	SW7471A	28 JUL 97	28 JUL 97
Nickel	5.8	mg/kg	4.8	6010A	28 JUL 97	28 JUL 97
Potassium	644	mg/kg	597	6010A	28 JUL 97	29 JUL 97
Selenium	ND	mg/kg	29.8	6010A	28 JUL 97	28 JUL 97
Silver	ND	mg/kg	1.2	6010A	28 JUL 97	28 JUL 97
Sodium	ND	mg/kg	597	6010A	28 JUL 97	29 JUL 97
Thallium	ND	mg/kg	1.2	6010A	28 JUL 97	28 JUL 97
Vanadium	49.8	mg/kg	6.0	6010A	28 JUL 97	28 JUL 97
Zinc	25.8	mg/kg	4.8	6010A	28 JUL 97	28 JUL 97

Percent Moisture is 16%. All results and limits are reported on a dry weight basi

ND = Not detected
NA = Not applicable

Reported By: TVU Approved By: Sonia Tabirara

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Quanterra
Environmental Services

METALS

(Soil/Solid - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68TP04A (4.0,68TP04,BORE,)
Lab ID: 094258-0009-SA
Matrix: SOIL Sampled: 23 JUL 97 Received: 24 JUL 97
Authorized: 24 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	23200	mg/kg	26.8	6010A	28 JUL 97	28 JUL 97
Antimony	0.76	mg/kg	0.67	6010A	28 JUL 97	28 JUL 97
Arsenic	4.0	mg/kg	0.67	6010A	28 JUL 97	28 JUL 97
Barium	47.2	mg/kg	26.8	6010A	28 JUL 97	28 JUL 97
Beryllium	1.1	mg/kg	0.13	6010A	28 JUL 97	28 JUL 97
Cadmium	0.96	mg/kg	0.67	6010A	28 JUL 97	28 JUL 97
Calcium	2600	mg/kg	671	6010A	28 JUL 97	28 JUL 97
Chromium	13.6	mg/kg	1.3	6010A	28 JUL 97	28 JUL 97
Cobalt	11.2	mg/kg	1.1	6010A	28 JUL 97	28 JUL 97
Copper	16.2	mg/kg	3.4	6010A	28 JUL 97	28 JUL 97
Iron	35200	mg/kg	13.4	6010A	28 JUL 97	28 JUL 97
Lead	ND	mg/kg	13.4	6010A	28 JUL 97	28 JUL 97
Magnesium	1110	mg/kg	671	6010A	28 JUL 97	28 JUL 97
Manganese	694	mg/kg	2.0	6010A	28 JUL 97	28 JUL 97
Mercury	ND	mg/kg	0.13	SW7471A	28 JUL 97	28 JUL 97
Nickel	11.2	mg/kg	5.4	6010A	28 JUL 97	28 JUL 97
Potassium	1850	mg/kg	671	6010A	28 JUL 97	29 JUL
Selenium	ND	mg/kg	33.6	6010A	28 JUL 97	28 JUL
Silver	ND	mg/kg	1.3	6010A	28 JUL 97	28 JUL 97
Sodium	ND	mg/kg	671	6010A	28 JUL 97	29 JUL 97
Thallium	ND	mg/kg	1.3	6010A	28 JUL 97	28 JUL 97
Vanadium	28.5	mg/kg	6.7	6010A	28 JUL 97	28 JUL 97
Zinc	31.6	mg/kg	5.4	6010A	28 JUL 97	28 JUL 97

Percent Moisture is 26%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: TVU Approved By: Sonia Tabirara

The cover letter is an integral part of this report.
Rev 230787

Quanterra Environmental Services

METALS

(Soil/Solid - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68TP04B (4.0,68TP04,BORE,)
Lab ID: 094258-0008-SA
Matrix: SOIL Sampled: 23 JUL 97 Received: 24 JUL 97
Authorized: 24 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	25700	mg/kg	28.0	6010A	28 JUL 97	28 JUL 97
Antimony	1.1	mg/kg	0.70	6010A	28 JUL 97	28 JUL 97
Arsenic	4.8	mg/kg	0.70	6010A	28 JUL 97	28 JUL 97
Barium	44.6	mg/kg	28.0	6010A	28 JUL 97	28 JUL 97
Beryllium	0.98	mg/kg	0.14	6010A	28 JUL 97	28 JUL 97
Cadmium	1.0	mg/kg	0.70	6010A	28 JUL 97	28 JUL 97
Calcium	1540	mg/kg	699	6010A	28 JUL 97	28 JUL 97
Chromium	18.9	mg/kg	1.4	6010A	28 JUL 97	28 JUL 97
Cobalt	7.0	mg/kg	1.1	6010A	28 JUL 97	28 JUL 97
Copper	21.5	mg/kg	3.5	6010A	28 JUL 97	28 JUL 97
Iron	33800	mg/kg	14.0	6010A	28 JUL 97	28 JUL 97
Lead	ND	mg/kg	14.0	6010A	28 JUL 97	28 JUL 97
Magnesium	1130	mg/kg	699	6010A	28 JUL 97	28 JUL 97
Manganese	216	mg/kg	2.1	6010A	28 JUL 97	28 JUL 97
Mercury	ND	mg/kg	0.14	SW7471A	28 JUL 97	28 JUL 97
Nickel	11.4	mg/kg	5.6	6010A	28 JUL 97	28 JUL 97
Potassium	1990	mg/kg	699	6010A	28 JUL 97	29 JUL 97
Selenium	ND	mg/kg	35.0	6010A	28 JUL 97	28 JUL 97
Silver	ND	mg/kg	1.4	6010A	28 JUL 97	28 JUL 97
Sodium	ND	mg/kg	699	6010A	28 JUL 97	29 JUL 97
Thallium	ND	mg/kg	1.4	6010A	28 JUL 97	28 JUL 97
Vanadium	35.9	mg/kg	7.0	6010A	28 JUL 97	28 JUL 97
Zinc	37.7	mg/kg	5.6	6010A	28 JUL 97	28 JUL 97

Percent Moisture is 28%. All results and limits are reported on a dry weight basi

ND = Not detected
NA = Not applicable

Reported By: TVU Approved By: Sonia Tabirara

The cover letter is an integral part of this report.

Quanterra
Environmental Services

METALS

(Soil/Solid - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68TP05A (4.0,68TP05,BORE,)
Lab ID: 094258-0011-SA
Matrix: SOIL Sampled: 23 JUL 97 Received: 24 JUL 97
Authorized: 24 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	29800	mg/kg	26.7	6010A	28 JUL 97	28 JUL 97
Antimony	1.3	mg/kg	0.67	6010A	28 JUL 97	28 JUL 97
Arsenic	4.4	mg/kg	0.67	6010A	28 JUL 97	28 JUL 97
Barium	81.6	mg/kg	26.7	6010A	28 JUL 97	28 JUL 97
Beryllium	1.1	mg/kg	0.13	6010A	28 JUL 97	28 JUL 97
Cadmium	0.82	mg/kg	0.67	6010A	28 JUL 97	28 JUL 97
Calcium	2190	mg/kg	668	6010A	28 JUL 97	28 JUL 97
Chromium	21.4	mg/kg	1.3	6010A	28 JUL 97	28 JUL 97
Cobalt	29.9	mg/kg	1.1	6010A	28 JUL 97	28 JUL 97
Copper	19.5	mg/kg	3.3	6010A	28 JUL 97	28 JUL 97
Iron	41600	mg/kg	13.4	6010A	28 JUL 97	28 JUL 97
Lead	16.3	mg/kg	13.4	6010A	28 JUL 97	28 JUL 97
Magnesium	1660	mg/kg	668	6010A	28 JUL 97	28 JUL 97
Manganese	1420	mg/kg	2.0	6010A	28 JUL 97	28 JUL 97
Mercury	ND	mg/kg	0.13	SW7471A	28 JUL 97	28 JUL 97
Nickel	31.3	mg/kg	5.3	6010A	28 JUL 97	28 JUL 97
Potassium	3460	mg/kg	668	6010A	28 JUL 97	29 JUL 9
Selenium	ND	mg/kg	33.4	6010A	28 JUL 97	28 JUL 9
Silver	ND	mg/kg	1.3	6010A	28 JUL 97	28 JUL 9
Sodium	ND	mg/kg	668	6010A	28 JUL 97	29 JUL 97
Thallium	ND	mg/kg	1.3	6010A	28 JUL 97	28 JUL 97
Vanadium	36.1	mg/kg	6.7	6010A	28 JUL 97	28 JUL 97
Zinc	31.8	mg/kg	5.3	6010A	28 JUL 97	28 JUL 97

Percent Moisture is 25%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: TVU Approved By: Sonia Tabirara

The cover letter is an integral part of this report.
Rev 230787

Quanterra Environmental Services

METALS

(Soil/Solid - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68TP05B (4.0,68TP05,BORE,)
Lab ID: 094258-0010-SA
Matrix: SOIL Sampled: 23 JUL 97 Received: 24 JUL 97
Authorized: 24 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	30100	mg/kg	26.7	6010A	28 JUL 97	28 JUL 97
Antimony	ND	mg/kg	0.67	6010A	28 JUL 97	28 JUL 97
Arsenic	2.4	mg/kg	0.67	6010A	28 JUL 97	28 JUL 97
Barium	28.6	mg/kg	26.7	6010A	28 JUL 97	28 JUL 97
Beryllium	0.96	mg/kg	0.13	6010A	28 JUL 97	28 JUL 97
Cadmium	0.68	mg/kg	0.67	6010A	28 JUL 97	28 JUL 97
Calcium	ND	mg/kg	668	6010A	28 JUL 97	28 JUL 97
Chromium	15.7	mg/kg	1.3	6010A	28 JUL 97	28 JUL 97
Cobalt	3.8	mg/kg	1.1	6010A	28 JUL 97	28 JUL 97
Copper	14.1	mg/kg	3.3	6010A	28 JUL 97	28 JUL 97
Iron	38800	mg/kg	13.4	6010A	28 JUL 97	28 JUL 97
Lead	ND	mg/kg	13.4	6010A	28 JUL 97	28 JUL 97
Magnesium	1170	mg/kg	668	6010A	28 JUL 97	28 JUL 97
Manganese	111	mg/kg	2.0	6010A	28 JUL 97	28 JUL 97
Mercury	ND	mg/kg	0.13	SW7471A	28 JUL 97	28 JUL 97
Nickel	12.8	mg/kg	5.3	6010A	28 JUL 97	28 JUL 97
Potassium	2080	mg/kg	668	6010A	28 JUL 97	29 JUL 97
Selenium	ND	mg/kg	33.4	6010A	28 JUL 97	28 JUL 97
Silver	ND	mg/kg	1.3	6010A	28 JUL 97	28 JUL 97
Sodium	ND	mg/kg	668	6010A	28 JUL 97	29 JUL 97
Thallium	ND	mg/kg	1.3	6010A	28 JUL 97	28 JUL 97
Vanadium	29.1	mg/kg	6.7	6010A	28 JUL 97	28 JUL 97
Zinc	22.4	mg/kg	5.3	6010A	28 JUL 97	28 JUL 97

Percent Moisture is 25%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: TVU Approved By: Sonia Tabirara

The cover letter is an integral part of this report.

Quanterra
Environmental Services

METALS

(Soil/Solid - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68TP06A (4.0,68TP06,BORE,)
Lab ID: 094258-0013-SA
Matrix: SOIL Sampled: 23 JUL 97 Received: 24 JUL 97
Authorized: 24 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	29300	mg/kg	27.3	6010A	28 JUL 97	28 JUL 97
Antimony	0.96	mg/kg	0.68	6010A	28 JUL 97	28 JUL 97
Arsenic	3.5	mg/kg	0.68	6010A	28 JUL 97	28 JUL 97
Barium	28.8	mg/kg	27.3	6010A	28 JUL 97	28 JUL 97
Beryllium	0.98	mg/kg	0.14	6010A	28 JUL 97	28 JUL 97
Cadmium	0.77	mg/kg	0.68	6010A	28 JUL 97	28 JUL 97
Calcium	1170	mg/kg	683	6010A	28 JUL 97	28 JUL 97
Chromium	25.0	mg/kg	1.4	6010A	28 JUL 97	28 JUL 97
Cobalt	4.4	mg/kg	1.1	6010A	28 JUL 97	28 JUL 97
Copper	39.6	mg/kg	3.4	6010A	28 JUL 97	28 JUL 97
Iron	43600	mg/kg	13.7	6010A	28 JUL 97	28 JUL 97
Lead	ND	mg/kg	13.7	6010A	28 JUL 97	28 JUL 97
Magnesium	1390	mg/kg	683	6010A	28 JUL 97	28 JUL 97
Manganese	86.0	mg/kg	2.0	6010A	28 JUL 97	28 JUL 97
Mercury	ND	mg/kg	0.14	SW7471A	28 JUL 97	28 JUL 97
Nickel	11.8	mg/kg	5.5	6010A	28 JUL 97	28 JUL 97
Potassium	1670	mg/kg	683	6010A	28 JUL 97	29 JUL 97
Selenium	ND	mg/kg	34.2	6010A	28 JUL 97	28 JUL 97
Silver	ND	mg/kg	1.4	6010A	28 JUL 97	28 JUL 97
Sodium	1170	mg/kg	683	6010A	28 JUL 97	29 JUL 97
Thallium	ND	mg/kg	1.4	6010A	28 JUL 97	28 JUL 97
Vanadium	48.4	mg/kg	6.8	6010A	28 JUL 97	28 JUL 97
Zinc	26.0	mg/kg	5.5	6010A	28 JUL 97	28 JUL 97

Percent Moisture is 27%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: TVU Approved By: Sonia Tabirara

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Rev 230787

Quanterra
Environmental Services

METALS

(Soil/Solid - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68TP06B (4.0,68TP06,BORE,)
Lab ID: 094258-0012-SA
Matrix: SOIL Sampled: 23 JUL 97 Received: 24 JUL 97
Authorized: 24 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	30000	mg/kg	26.6	6010A	28 JUL 97	28 JUL 97
Antimony	ND	mg/kg	0.66	6010A	28 JUL 97	28 JUL 97
Arsenic	4.2	mg/kg	0.66	6010A	28 JUL 97	28 JUL 97
Barium	27.3	mg/kg	26.6	6010A	28 JUL 97	28 JUL 97
Beryllium	1.4	mg/kg	0.13	6010A	28 JUL 97	28 JUL 97
Cadmium	0.74	mg/kg	0.66	6010A	28 JUL 97	28 JUL 97
Calcium	697	mg/kg	664	6010A	28 JUL 97	28 JUL 97
Chromium	22.9	mg/kg	1.3	6010A	28 JUL 97	28 JUL 97
Cobalt	4.8	mg/kg	1.1	6010A	28 JUL 97	28 JUL 97
Copper	14.5	mg/kg	3.3	6010A	28 JUL 97	28 JUL 97
Iron	38100	mg/kg	13.3	6010A	28 JUL 97	28 JUL 97
Lead	ND	mg/kg	13.3	6010A	28 JUL 97	28 JUL 97
Magnesium	2030	mg/kg	664	6010A	28 JUL 97	28 JUL 97
Manganese	57.1	mg/kg	2.0	6010A	28 JUL 97	28 JUL 97
Mercury	ND	mg/kg	0.13	SW7471A	28 JUL 97	28 JUL 97
Nickel	11.4	mg/kg	5.3	6010A	28 JUL 97	28 JUL 97
Potassium	4060	mg/kg	664	6010A	28 JUL 97	29 JUL 97
Selenium	ND	mg/kg	33.2	6010A	28 JUL 97	28 JUL 97
Silver	ND	mg/kg	1.3	6010A	28 JUL 97	28 JUL 97
Sodium	ND	mg/kg	664	6010A	28 JUL 97	29 JUL 97
Thallium	ND	mg/kg	1.3	6010A	28 JUL 97	28 JUL 97
Vanadium	28.7	mg/kg	6.6	6010A	28 JUL 97	28 JUL 97
Zinc	20.3	mg/kg	5.3	6010A	28 JUL 97	28 JUL 97

Percent Moisture is 25%. All results and limits are reported on a dry weight basi

ND = Not detected
NA = Not applicable

Reported By: TVU Approved By: Sonia Tabirara

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Rev 230787

Quanterra
Environmental Services

METALS

(Soil/Solid - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68TP07A (4.0,68TP07,BORE,)
Lab ID: 094258-0016-SA
Matrix: SOIL Sampled: 23 JUL 97 Received: 24 JUL 97
Authorized: 24 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	39300	mg/kg	25.5	6010A	28 JUL 97	29 JUL 97
Antimony	ND	mg/kg	0.64	6010A	28 JUL 97	29 JUL 97
Arsenic	2.6	mg/kg	0.64	6010A	28 JUL 97	29 JUL 97
Barium	76.1	mg/kg	25.5	6010A	28 JUL 97	29 JUL 97
Beryllium	0.56	mg/kg	0.13	6010A	28 JUL 97	29 JUL 97
Cadmium	ND	mg/kg	0.64	6010A	28 JUL 97	29 JUL 97
Calcium	1210	mg/kg	637	6010A	28 JUL 97	29 JUL 97
Chromium	25.7	mg/kg	1.3	6010A	28 JUL 97	29 JUL 97
Cobalt	7.6	mg/kg	1.0	6010A	28 JUL 97	29 JUL 97
Copper	17.5	mg/kg	3.2	6010A	28 JUL 97	29 JUL 97
Iron	29700	mg/kg	12.7	6010A	28 JUL 97	29 JUL 97
Lead	ND	mg/kg	12.7	6010A	28 JUL 97	29 JUL 97
Magnesium	1930	mg/kg	637	6010A	28 JUL 97	29 JUL 97
Manganese	242	mg/kg	1.9	6010A	28 JUL 97	29 JUL 97
Mercury	ND	mg/kg	0.13	SW7471A	28 JUL 97	28 JUL 97
Nickel	18.0	mg/kg	5.1	6010A	28 JUL 97	29 JUL 97
Potassium	2080	mg/kg	637	6010A	28 JUL 97	29 JUL 9
Selenium	ND	mg/kg	31.8	6010A	28 JUL 97	29 JUL
Silver	ND	mg/kg	1.3	6010A	28 JUL 97	29 JUL 9
Sodium	ND	mg/kg	637	6010A	28 JUL 97	29 JUL 97
Thallium	ND	mg/kg	1.3	6010A	28 JUL 97	29 JUL 97
Vanadium	74.9	mg/kg	6.4	6010A	28 JUL 97	29 JUL 97
Zinc	55.6	mg/kg	5.1	6010A	28 JUL 97	29 JUL 97

Percent Moisture is 22%. All results and limits are reported on a dry weight basi

ND = Not detected
NA = Not applicable

Reported By: TVU Approved By: Sonia Tabirara

The cover letter is an integral part of this report.
Rev 230787

Quanterra
Environmental Services

METALS

(Soil/Solid - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68TP07B (4.0,68TP07,BORE,)
Lab ID: 094258-0014-SA
Matrix: SOIL Sampled: 23 JUL 97 Received: 24 JUL 97
Authorized: 24 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	25000	mg/kg	25.2	6010A	28 JUL 97	28 JUL 97
Antimony	0.81	mg/kg	0.63	6010A	28 JUL 97	28 JUL 97
Arsenic	2.8	mg/kg	0.63	6010A	28 JUL 97	28 JUL 97
Barium	40.4	mg/kg	25.2	6010A	28 JUL 97	28 JUL 97
Beryllium	0.38	mg/kg	0.13	6010A	28 JUL 97	28 JUL 97
Cadmium	ND	mg/kg	0.63	6010A	28 JUL 97	28 JUL 97
Calcium	816	mg/kg	629	6010A	28 JUL 97	28 JUL 97
Chromium	22.1	mg/kg	1.3	6010A	28 JUL 97	28 JUL 97
Cobalt	3.8	mg/kg	1.0	6010A	28 JUL 97	28 JUL 97
Copper	13.4	mg/kg	3.1	6010A	28 JUL 97	28 JUL 97
Iron	21500	mg/kg	12.6	6010A	28 JUL 97	28 JUL 97
Lead	ND	mg/kg	12.6	6010A	28 JUL 97	28 JUL 97
Magnesium	857	mg/kg	629	6010A	28 JUL 97	28 JUL 97
Manganese	78.0	mg/kg	1.9	6010A	28 JUL 97	28 JUL 97
Mercury	ND	mg/kg	0.13	SW7471A	28 JUL 97	28 JUL 97
Nickel	11.4	mg/kg	5.0	6010A	28 JUL 97	28 JUL 97
Potassium	948	mg/kg	629	6010A	28 JUL 97	29 JUL 97
Selenium	ND	mg/kg	31.4	6010A	28 JUL 97	28 JUL 97
Silver	ND	mg/kg	1.3	6010A	28 JUL 97	28 JUL 97
Sodium	ND	mg/kg	629	6010A	28 JUL 97	29 JUL 97
Thallium	ND	mg/kg	1.3	6010A	28 JUL 97	28 JUL 97
Vanadium	44.3	mg/kg	6.3	6010A	28 JUL 97	28 JUL 97
Zinc	38.2	mg/kg	5.0	6010A	28 JUL 97	28 JUL 97

Percent Moisture is 20%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: TVU Approved By: Sonia Tabirara

The cover letter is an integral part of this report.
Rev 230787

Quanterra
Environmental Services

METALS

(Soil/Solid - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68TP08A (4.0,68TP08,BORE,)
Lab ID: 094258-0017-SA
Matrix: SOIL Sampled: 23 JUL 97 Received: 24 JUL 97
Authorized: 24 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	34800	mg/kg	26.0	6010A	28 JUL 97	29 JUL 97
Antimony	ND	mg/kg	0.65	6010A	28 JUL 97	29 JUL 97
Arsenic	2.8	mg/kg	0.65	6010A	28 JUL 97	29 JUL 97
Barium	64.0	mg/kg	26.0	6010A	28 JUL 97	29 JUL 97
Beryllium	0.48	mg/kg	0.13	6010A	28 JUL 97	29 JUL 97
Cadmium	ND	mg/kg	0.65	6010A	28 JUL 97	29 JUL 97
Calcium	1240	mg/kg	651	6010A	28 JUL 97	29 JUL 97
Chromium	26.6	mg/kg	1.3	6010A	28 JUL 97	29 JUL 97
Cobalt	4.5	mg/kg	1.0	6010A	28 JUL 97	29 JUL 97
Copper	15.4	mg/kg	3.3	6010A	28 JUL 97	29 JUL 97
Iron	30100	mg/kg	13.0	6010A	28 JUL 97	29 JUL 97
Lead	ND	mg/kg	13.0	6010A	28 JUL 97	29 JUL 97
Magnesium	1360	mg/kg	651	6010A	28 JUL 97	29 JUL 97
Manganese	79.7	mg/kg	2.0	6010A	28 JUL 97	29 JUL 97
Mercury	ND	mg/kg	0.13	SW7471A	28 JUL 97	28 JUL 97
Nickel	14.4	mg/kg	5.2	6010A	28 JUL 97	29 JUL 97
Potassium	1470	mg/kg	651	6010A	28 JUL 97	29 JUL 97
Selenium	ND	mg/kg	32.6	6010A	28 JUL 97	29 JUL 97
Silver	ND	mg/kg	1.3	6010A	28 JUL 97	29 JUL 97
Sodium	ND	mg/kg	651	6010A	28 JUL 97	29 JUL 97
Thallium	ND	mg/kg	1.3	6010A	28 JUL 97	29 JUL 97
Vanadium	74.1	mg/kg	6.5	6010A	28 JUL 97	29 JUL 97
Zinc	49.1	mg/kg	5.2	6010A	28 JUL 97	29 JUL 97

Percent Moisture is 23%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: TVU Approved By: Sonia Tabirara

The cover letter is an integral part of this report.
Rev 230787

Quanterra
Environmental Services

METALS

(Soil/Solid - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68TP08B (4.0,68TP08,BORE,)
Lab ID: 094258-0015-SA
Matrix: SOIL Sampled: 23 JUL 97 Received: 24 JUL 97
Authorized: 24 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	32900	mg/kg	25.5	6010A	28 JUL 97	29 JUL 97
Antimony	ND	mg/kg	0.64	6010A	28 JUL 97	29 JUL 97
Arsenic	3.5	mg/kg	0.64	6010A	28 JUL 97	29 JUL 97
Barium	51.1	mg/kg	25.5	6010A	28 JUL 97	29 JUL 97
Beryllium	0.55	mg/kg	0.13	6010A	28 JUL 97	29 JUL 97
Cadmium	0.81	mg/kg	0.64	6010A	28 JUL 97	29 JUL 97
Calcium	1180	mg/kg	639	6010A	28 JUL 97	29 JUL 97
Chromium	29.0	mg/kg	1.3	6010A	28 JUL 97	29 JUL 97
Cobalt	12.5	mg/kg	1.0	6010A	28 JUL 97	29 JUL 97
Copper	15.6	mg/kg	3.2	6010A	28 JUL 97	29 JUL 97
Iron	24700	mg/kg	12.8	6010A	28 JUL 97	29 JUL 97
Lead	ND	mg/kg	12.8	6010A	28 JUL 97	29 JUL 97
Magnesium	1110	mg/kg	639	6010A	28 JUL 97	29 JUL 97
Manganese	398	mg/kg	1.9	6010A	28 JUL 97	29 JUL 97
Mercury	ND	mg/kg	0.13	SW7471A	28 JUL 97	28 JUL 97
Nickel	13.6	mg/kg	5.1	6010A	28 JUL 97	29 JUL 97
Potassium	1110	mg/kg	639	6010A	28 JUL 97	29 JUL 97
Selenium	ND	mg/kg	31.9	6010A	28 JUL 97	29 JUL 97
Silver	ND	mg/kg	1.3	6010A	28 JUL 97	29 JUL 97
Sodium	ND	mg/kg	639	6010A	28 JUL 97	29 JUL 97
Thallium	ND	mg/kg	1.3	6010A	28 JUL 97	29 JUL 97
Vanadium	49.2	mg/kg	6.4	6010A	28 JUL 97	29 JUL 97
Zinc	57.7	mg/kg	5.1	6010A	28 JUL 97	29 JUL 97

Percent Moisture is 22%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: TVU Approved By: Sonia Tabirara

The cover letter is an integral part of this report.
Rev 230787

Quanterra
Environmental Services

METALS

(Soil/Solid - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68TP09A (4.0,68TP09,BORE,)
Lab ID: 094258-0018-SA
Matrix: SOIL Sampled: 23 JUL 97 Received: 24 JUL 97
Authorized: 24 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	26800	mg/kg	25.3	6010A	28 JUL 97	29 JUL 97
Antimony	ND	mg/kg	0.63	6010A	28 JUL 97	29 JUL 97
Arsenic	2.4	mg/kg	0.63	6010A	28 JUL 97	29 JUL 97
Barium	44.9	mg/kg	25.3	6010A	28 JUL 97	29 JUL 97
Beryllium	0.56	mg/kg	0.13	6010A	28 JUL 97	29 JUL 97
Cadmium	ND	mg/kg	0.63	6010A	28 JUL 97	29 JUL 97
Calcium	798	mg/kg	631	6010A	28 JUL 97	29 JUL 97
Chromium	20.4	mg/kg	1.3	6010A	28 JUL 97	29 JUL 97
Cobalt	5.0	mg/kg	1.0	6010A	28 JUL 97	29 JUL 97
Copper	13.8	mg/kg	3.2	6010A	28 JUL 97	29 JUL 97
Iron	30700	mg/kg	12.6	6010A	28 JUL 97	29 JUL 97
Lead	ND	mg/kg	12.6	6010A	28 JUL 97	29 JUL 97
Magnesium	1100	mg/kg	631	6010A	28 JUL 97	29 JUL 97
Manganese	103	mg/kg	1.9	6010A	28 JUL 97	29 JUL 97
Mercury	ND	mg/kg	0.13	SW7471A	28 JUL 97	28 JUL 97
Nickel	12.3	mg/kg	5.1	6010A	28 JUL 97	29 JUL 97
Potassium	1200	mg/kg	631	6010A	28 JUL 97	29 JUL 97
Selenium	ND	mg/kg	31.6	6010A	28 JUL 97	29 JUL 9
Silver	ND	mg/kg	1.3	6010A	28 JUL 97	29 JUL 97
Sodium	ND	mg/kg	631	6010A	28 JUL 97	29 JUL 97
Thallium	ND	mg/kg	1.3	6010A	28 JUL 97	29 JUL 97
Vanadium	72.8	mg/kg	6.3	6010A	28 JUL 97	29 JUL 97
Zinc	39.6	mg/kg	5.1	6010A	28 JUL 97	29 JUL 97

Percent Moisture is 21%. All results and limits are reported on a dry weight basis

ND = Not detected
NA = Not applicable

Reported By: TVU Approved By: Sonia Tabirara

The cover letter is an integral part of this report.
Rev 230787

Quanterra
Environmental Services

METALS

(Soil/Solid - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68TP09B (4.0,68TP09,BORE,)
Lab ID: 094258-0019-SA
Matrix: SOIL Sampled: 23 JUL 97 Received: 24 JUL 97
Authorized: 24 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	23200	mg/kg	26.4	6010A	28 JUL 97	29 JUL 97
Antimony	ND	mg/kg	0.66	6010A	28 JUL 97	29 JUL 97
Arsenic	2.7	mg/kg	0.66	6010A	28 JUL 97	29 JUL 97
Barium	28.2	mg/kg	26.4	6010A	28 JUL 97	29 JUL 97
Beryllium	0.95	mg/kg	0.13	6010A	28 JUL 97	29 JUL 97
Cadmium	ND	mg/kg	0.66	6010A	28 JUL 97	29 JUL 97
Calcium	1270	mg/kg	660	6010A	28 JUL 97	29 JUL 97
Chromium	26.0	mg/kg	1.3	6010A	28 JUL 97	29 JUL 97
Cobalt	9.3	mg/kg	1.1	6010A	28 JUL 97	29 JUL 97
Copper	8.2	mg/kg	3.3	6010A	28 JUL 97	29 JUL 97
Iron	40900	mg/kg	13.2	6010A	28 JUL 97	29 JUL 97
Lead	ND	mg/kg	13.2	6010A	28 JUL 97	29 JUL 97
Magnesium	1080	mg/kg	660	6010A	28 JUL 97	29 JUL 97
Manganese	339	mg/kg	2.0	6010A	28 JUL 97	29 JUL 97
Mercury	ND	mg/kg	0.13	SW7471A	28 JUL 97	28 JUL 97
Nickel	10.5	mg/kg	5.3	6010A	28 JUL 97	29 JUL 97
Potassium	1910	mg/kg	660	6010A	28 JUL 97	29 JUL 97
Selenium	ND	mg/kg	33.0	6010A	28 JUL 97	29 JUL 97
Silver	ND	mg/kg	1.3	6010A	28 JUL 97	29 JUL 97
Sodium	ND	mg/kg	660	6010A	28 JUL 97	29 JUL 97
Thallium	ND	mg/kg	1.3	6010A	28 JUL 97	29 JUL 97
Vanadium	29.0	mg/kg	6.6	6010A	28 JUL 97	29 JUL 97
Zinc	21.7	mg/kg	5.3	6010A	28 JUL 97	29 JUL 97

Percent Moisture is 24%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: TVU Approved By: Sonia Tabirara

The cover letter is an integral part of this report.
Rev 230787

Quanterra
Environmental Services

METALS

(Soil/Solid - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68TP10A (4.0,68TP10,BORE,)
Lab ID: 094277-0002-SA
Matrix: SOIL Sampled: 24 JUL 97 Received: 25 JUL 97
Authorized: 25 JUL 97 Prepared: See Below. Analyzed: See Below

Parameter	Result	Dry Weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	39000	mg/kg	27.7	6010A	01 AUG 97	01 AUG 97
Antimony	ND	mg/kg	0.69	6010A	01 AUG 97	01 AUG 97
Arsenic	8.9	mg/kg	0.69	6010A	01 AUG 97	01 AUG 97
Barium	45.4	mg/kg	27.7	6010A	01 AUG 97	01 AUG 97
Beryllium	1.1	mg/kg	0.14	6010A	01 AUG 97	01 AUG 97
Cadmium	1.9	mg/kg	0.69	6010A	01 AUG 97	01 AUG 97
Calcium	1350	mg/kg	692	6010A	01 AUG 97	01 AUG 97
Chromium	52.9	mg/kg	1.4	6010A	01 AUG 97	02 AUG 97
Cobalt	8.5	mg/kg	1.1	6010A	01 AUG 97	01 AUG 97
Copper	37.3	mg/kg	3.5	6010A	01 AUG 97	01 AUG 97
Iron	53300	mg/kg	13.8	6010A	01 AUG 97	01 AUG 97
Lead	14.0	mg/kg	13.8	6010A	01 AUG 97	01 AUG 97
Magnesium	2740	mg/kg	692	6010A	01 AUG 97	01 AUG 97
Manganese	160	mg/kg	2.1	6010A	01 AUG 97	01 AUG 97
Mercury	ND	mg/kg	0.14	SW7471A	01 AUG 97	04 AUG 97
Nickel	25.3	mg/kg	5.5	6010A	01 AUG 97	01 AUG 97
Potassium	2060	mg/kg	692	6010A	01 AUG 97	02 AUG 97
Selenium	ND	mg/kg	34.6	6010A	01 AUG 97	01 AUG 97
Silver	ND	mg/kg	1.4	6010A	01 AUG 97	01 AUG 97
Sodium	ND	mg/kg	692	6010A	01 AUG 97	02 AUG 97
Thallium	ND	mg/kg	1.4	6010A	01 AUG 97	01 AUG 97
Vanadium	77.0	mg/kg	6.9	6010A	01 AUG 97	01 AUG 97
Zinc	82.9	mg/kg	5.5	6010A	01 AUG 97	01 AUG 97

Percent Moisture is 28%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: EGRANT Approved By: Sonia Tabirara

The cover letter is an integral part of this report.
Rev 230787

Quanterra
Environmental Services

METALS

(Soil/Solid - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68TP10B (4.0,68TP10,BORE,)
Lab ID: 094277-0003-SA
Matrix: SOIL Sampled: 24 JUL 97 Received: 25 JUL 97
Authorized: 25 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	29500	mg/kg	27.5	6010A	28 JUL 97	29 JUL 97
Antimony	0.94	mg/kg	0.69	6010A	28 JUL 97	29 JUL 97
Arsenic	4.0	mg/kg	0.69	6010A	28 JUL 97	29 JUL 97
Barium	28.1	mg/kg	27.5	6010A	28 JUL 97	29 JUL 97
Beryllium	1.1	mg/kg	0.14	6010A	28 JUL 97	29 JUL 97
Cadmium	1.2	mg/kg	0.69	6010A	28 JUL 97	29 JUL 97
Calcium	1510	mg/kg	689	6010A	28 JUL 97	29 JUL 97
Chromium	31.4	mg/kg	1.4	6010A	28 JUL 97	29 JUL 97
Cobalt	5.5	mg/kg	1.1	6010A	28 JUL 97	29 JUL 97
Copper	14.2	mg/kg	3.4	6010A	28 JUL 97	29 JUL 97
Iron	43900	mg/kg	13.8	6010A	28 JUL 97	29 JUL 97
Lead	ND	mg/kg	13.8	6010A	28 JUL 97	29 JUL 97
Magnesium	1540	mg/kg	689	6010A	28 JUL 97	29 JUL 97
Manganese	80.0	mg/kg	2.1	6010A	28 JUL 97	29 JUL 97
Mercury	ND	mg/kg	0.14	SW7471A	28 JUL 97	28 JUL 97
Nickel	15.6	mg/kg	5.5	6010A	28 JUL 97	29 JUL 97
Potassium	2510	mg/kg	689	6010A	28 JUL 97	29 JUL 97
Selenium	ND	mg/kg	34.4	6010A	28 JUL 97	29 JUL 97
Silver	ND	mg/kg	1.4	6010A	28 JUL 97	29 JUL 97
Sodium	ND	mg/kg	689	6010A	28 JUL 97	29 JUL 97
Thallium	ND	mg/kg	1.4	6010A	28 JUL 97	29 JUL 97
Vanadium	42.5	mg/kg	6.9	6010A	28 JUL 97	29 JUL 97
Zinc	46.1	mg/kg	5.5	6010A	28 JUL 97	29 JUL 97

Percent Moisture is 27%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: TVU Approved By: Sonia Tabirara

The cover letter is an integral part of this report.

Quanterra
Environmental Services

METALS

(Soil/Solid - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68TP11A (4.0,68PT11,BORE,)
Lab ID: 094277-0004-SA
Matrix: SOIL Sampled: 24 JUL 97 Received: 25 JUL 97
Authorized: 25 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry Weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	28000	mg/kg	24.2	6010A	01 AUG 97	01 AUG 97
Antimony	ND	mg/kg	0.61	6010A	01 AUG 97	01 AUG 97
Arsenic	3.6	mg/kg	0.61	6010A	01 AUG 97	01 AUG 97
Barium	51.7	mg/kg	24.2	6010A	01 AUG 97	01 AUG 97
Beryllium	0.49	mg/kg	0.12	6010A	01 AUG 97	01 AUG 97
Cadmium	ND	mg/kg	0.61	6010A	01 AUG 97	01 AUG 97
Calcium	ND	mg/kg	606	6010A	01 AUG 97	01 AUG 97
Chromium	35.4	mg/kg	1.2	6010A	01 AUG 97	02 AUG 97
Cobalt	13.9	mg/kg	0.97	6010A	01 AUG 97	01 AUG 97
Copper	17.5	mg/kg	3.0	6010A	01 AUG 97	01 AUG 97
Iron	26400	mg/kg	12.1	6010A	01 AUG 97	01 AUG 97
Lead	13.9	mg/kg	12.1	6010A	01 AUG 97	01 AUG 97
Magnesium	909	mg/kg	606	6010A	01 AUG 97	01 AUG 97
Manganese	349	mg/kg	1.8	6010A	01 AUG 97	01 AUG 97
Mercury	ND	mg/kg	0.12	SW7471A	01 AUG 97	04 AUG 97
Nickel	13.4	mg/kg	4.8	6010A	01 AUG 97	01 AUG 97
Potassium	859	mg/kg	606	6010A	01 AUG 97	02 AUG 9
Selenium	ND	mg/kg	30.3	6010A	01 AUG 97	01 AUG
Silver	ND	mg/kg	1.2	6010A	01 AUG 97	01 AUG
Sodium	726	mg/kg	606	6010A	01 AUG 97	02 AUG 9
Thallium	ND	mg/kg	1.2	6010A	01 AUG 97	01 AUG 97
Vanadium	40.7	mg/kg	6.1	6010A	01 AUG 97	01 AUG 97
Zinc	29.9	mg/kg	4.8	6010A	01 AUG 97	01 AUG 97

Percent Moisture is 18%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: EGRANT Approved By: Sonia Tabirara

The cover letter is an integral part of this report.
Rev 230787

Quanterra
Environmental Services

METALS

(Soil/Solid - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68TP11B (4.0,68PT11,BORE,)
Lab ID: 094277-0005-SA
Matrix: SOIL Sampled: 24 JUL 97 Received: 25 JUL 97
Authorized: 25 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	40300	mg/kg	31.0	6010A	28 JUL 97	29 JUL 97
Antimony	0.80	mg/kg	0.78	6010A	28 JUL 97	29 JUL 97
Arsenic	10.4	mg/kg	0.78	6010A	28 JUL 97	29 JUL 97
Barium	52.9	mg/kg	31.0	6010A	28 JUL 97	29 JUL 97
Beryllium	0.98	mg/kg	0.16	6010A	28 JUL 97	29 JUL 97
Cadmium	1.2	mg/kg	0.78	6010A	28 JUL 97	29 JUL 97
Calcium	ND	mg/kg	775	6010A	28 JUL 97	29 JUL 97
Chromium	34.6	mg/kg	1.6	6010A	28 JUL 97	29 JUL 97
Cobalt	9.9	mg/kg	1.2	6010A	28 JUL 97	29 JUL 97
Copper	37.9	mg/kg	3.9	6010A	28 JUL 97	29 JUL 97
Iron	55100	mg/kg	15.5	6010A	28 JUL 97	29 JUL 97
Lead	15.6	mg/kg	15.5	6010A	28 JUL 97	29 JUL 97
Magnesium	6900	mg/kg	775	6010A	28 JUL 97	29 JUL 97
Manganese	170	mg/kg	2.3	6010A	28 JUL 97	29 JUL 97
Mercury	ND	mg/kg	0.16	SW7471A	28 JUL 97	28 JUL 97
Nickel	32.8	mg/kg	6.2	6010A	28 JUL 97	29 JUL 97
Potassium	3980	mg/kg	775	6010A	28 JUL 97	29 JUL 97
Selenium	ND	mg/kg	38.8	6010A	28 JUL 97	29 JUL 97
Silver	ND	mg/kg	1.6	6010A	28 JUL 97	29 JUL 97
Sodium	ND	mg/kg	775	6010A	28 JUL 97	29 JUL 97
Thallium	ND	mg/kg	1.6	6010A	28 JUL 97	29 JUL 97
Vanadium	78.7	mg/kg	7.8	6010A	28 JUL 97	29 JUL 97
Zinc	42.6	mg/kg	6.2	6010A	28 JUL 97	29 JUL 97

Percent Moisture is 36%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: TVU Approved By: Sonia Tabirara

The cover letter is an integral part of this report.

Quanterra
Environmental Services

METALS

(Soil/Solid - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68TP12A (4.0,68PT12,BORE,)
Lab ID: 094277-0006-SA
Matrix: SOIL Sampled: 24 JUL 97 Received: 25 JUL 97
Authorized: 25 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry Weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	24100	mg/kg	24.3	6010A	01 AUG 97	01 AUG 97
Antimony	ND	mg/kg	0.61	6010A	01 AUG 97	01 AUG 97
Arsenic	2.2	mg/kg	0.61	6010A	01 AUG 97	01 AUG 97
Barium	44.4	mg/kg	24.3	6010A	01 AUG 97	01 AUG 97
Beryllium	0.45	mg/kg	0.12	6010A	01 AUG 97	01 AUG 97
Cadmium	ND	mg/kg	0.61	6010A	01 AUG 97	01 AUG 97
Calcium	ND	mg/kg	608	6010A	01 AUG 97	01 AUG 97
Chromium	21.5	mg/kg	1.2	6010A	01 AUG 97	02 AUG 97
Cobalt	6.1	mg/kg	0.97	6010A	01 AUG 97	01 AUG 97
Copper	10.7	mg/kg	3.0	6010A	01 AUG 97	01 AUG 97
Iron	22700	mg/kg	12.2	6010A	01 AUG 97	01 AUG 97
Lead	ND	mg/kg	12.2	6010A	01 AUG 97	01 AUG 97
Magnesium	816	mg/kg	608	6010A	01 AUG 97	01 AUG 97
Manganese	181	mg/kg	1.8	6010A	01 AUG 97	01 AUG 97
Mercury	ND	mg/kg	0.12	SW7471A	01 AUG 97	04 AUG 97
Nickel	13.0	mg/kg	4.9	6010A	01 AUG 97	01 AUG 97
Potassium	1040	mg/kg	608	6010A	01 AUG 97	02 AUG
Selenium	ND	mg/kg	30.4	6010A	01 AUG 97	01 AUG
Silver	ND	mg/kg	1.2	6010A	01 AUG 97	01 AUG
Sodium	ND	mg/kg	608	6010A	01 AUG 97	02 AUG 97
Thallium	ND	mg/kg	1.2	6010A	01 AUG 97	01 AUG 97
Vanadium	50.6	mg/kg	6.1	6010A	01 AUG 97	01 AUG 97
Zinc	31.6	mg/kg	4.9	6010A	01 AUG 97	01 AUG 97

Percent Moisture is 18%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: EGRANT Approved By: Sonia Tabirara

The cover letter is an integral part of this report.
Rev 230787

Quanterra
Environmental Services

METALS

(Soil/Solid - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68TP12B (4.0,68TP12,BORE,)
Lab ID: 094277-0007-SA
Matrix: SOIL Sampled: 24 JUL 97 Received: 25 JUL 97
Authorized: 25 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	28600	mg/kg	26.2	6010A	28 JUL 97	29 JUL 97
Antimony	ND	mg/kg	0.66	6010A	28 JUL 97	29 JUL 97
Arsenic	3.3	mg/kg	0.66	6010A	28 JUL 97	29 JUL 97
Barium	ND	mg/kg	26.2	6010A	28 JUL 97	29 JUL 97
Beryllium	1.1	mg/kg	0.13	6010A	28 JUL 97	29 JUL 97
Cadmium	0.74	mg/kg	0.66	6010A	28 JUL 97	29 JUL 97
Calcium	ND	mg/kg	655	6010A	28 JUL 97	29 JUL 97
Chromium	19.7	mg/kg	1.3	6010A	28 JUL 97	29 JUL 97
Cobalt	8.6	mg/kg	1.0	6010A	28 JUL 97	29 JUL 97
Copper	34.3	mg/kg	3.3	6010A	28 JUL 97	29 JUL 97
Iron	37300	mg/kg	13.1	6010A	28 JUL 97	29 JUL 97
Lead	ND	mg/kg	13.1	6010A	28 JUL 97	29 JUL 97
Magnesium	1690	mg/kg	655	6010A	28 JUL 97	29 JUL 97
Manganese	359	mg/kg	2.0	6010A	28 JUL 97	29 JUL 97
Mercury	ND	mg/kg	0.13	SW7471A	28 JUL 97	28 JUL 97
Nickel	8.7	mg/kg	5.2	6010A	28 JUL 97	29 JUL 97
Potassium	3590	mg/kg	655	6010A	28 JUL 97	29 JUL 97
Selenium	ND	mg/kg	32.8	6010A	28 JUL 97	29 JUL 97
Silver	ND	mg/kg	1.3	6010A	28 JUL 97	29 JUL 97
Sodium	1510	mg/kg	655	6010A	28 JUL 97	29 JUL 97
Thallium	ND	mg/kg	1.3	6010A	28 JUL 97	29 JUL 97
Vanadium	24.3	mg/kg	6.6	6010A	28 JUL 97	29 JUL 97
Zinc	17.4	mg/kg	5.2	6010A	28 JUL 97	29 JUL 97

Percent Moisture is 24%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: TVU Approved By: Sonia Tabirara

The cover letter is an integral part of this report.
Rev 230787

Quanterra
Environmental Services

METALS

(Soil/Solid - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68SB01 (8.0,68SB01,BORE,)
Lab ID: 094396-0001-SA
Matrix: SOIL Sampled: 23 JUL 97 Received: 04 AUG 97
Authorized: 04 AUG 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Dry Weight Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	14900	mg/kg	12.5	6010A	12 AUG 97	14 AUG 97
Antimony	ND	mg/kg	0.63	6010 Modified	12 AUG 97	18 AUG 97
Arsenic	4.6	mg/kg	0.63	6010 Modified	12 AUG 97	18 AUG 97
Barium	17.1	mg/kg	1.3	6010A	12 AUG 97	14 AUG 97
Beryllium	0.80	mg/kg	0.13	6010 Modified	12 AUG 97	18 AUG 97
Cadmium	ND	mg/kg	0.63	6010A	12 AUG 97	14 AUG 97
Calcium	200	mg/kg	62.7	6010A	12 AUG 97	14 AUG 97
Chromium	12.1	mg/kg	1.3	6010A	12 AUG 97	14 AUG 97
Cobalt	14.0	mg/kg	1.0	6010 Modified	12 AUG 97	18 AUG 97
Copper	14.0	mg/kg	2.5	6010A	12 AUG 97	14 AUG 97
Iron	25000	mg/kg	12.5	6010A	12 AUG 97	14 AUG 97
Lead	ND	mg/kg	6.3	6010A	12 AUG 97	14 AUG 97
Magnesium	942	mg/kg	62.7	6010A	12 AUG 97	14 AUG 97
Manganese	165	mg/kg	1.3	6010A	12 AUG 97	14 AUG 97
Mercury	ND	mg/kg	0.13	7471	13 AUG 97	13 AUG 97
Nickel	12.8	mg/kg	5.0	6010A	12 AUG 97	14 AUG 97
Potassium	1270	mg/kg	627	6010A	12 AUG 97	14 AUG 97
Selenium	ND	mg/kg	25.1	6010A	12 AUG 97	14 AUG 97
Silver	ND	mg/kg	1.3	6010A	12 AUG 97	14 AUG 97
Sodium	877	mg/kg	627	6010A	12 AUG 97	14 AUG 97
Thallium	ND	mg/kg	1.3	6010 Modified	12 AUG 97	18 AUG 97
Vanadium	14.8	mg/kg	1.3	6010A	12 AUG 97	14 AUG 97
Zinc	12.0	mg/kg	2.5	6010A	12 AUG 97	14 AUG 97

Percent Moisture is 20.2%. All results and limits are reported on a dry weight basis.

ND = Not detected
NA = Not applicable

Reported By: Allan Wong Approved By: Mei Lai

The cover letter is an integral part of this report.
Rev 230787

ENVIRONMENTAL DIRECTIONS, INC.
2727 PLANTATION ROAD, NE
ROANOKE, VA 24012
PHONE: 540-362-5636 FAX: 540-362-9447

-LABORATORY RESULTS-

07/24/1997 EDI REPORT:5949

TO: ALLIANT TECHSYSTEMS,INC.
PO BOX 1
RADFORD, VA 24141

ATTN: ARNE OLSEN FAX:540-639-7214

PURCHASE ORDER:VA900015-78
SAMPLE COLLECTION DATE:7/15/97 MATRIX:LIQUID
SAMPLE ID:WATER SWMU 68 WATER EDI LAB NO:EDI008783

PARAMETER		RESULT	TEST_ID
PH		4.38	150.1
ARSENIC		0.010 mg/L	TCLP_M
BARIUM	B	0.1 mg/L	TCLP_M
CADMIUM		0.02 mg/L	TCLP_M
CHROMIUM	B	0.05 mg/L	TCLP_M
LEAD		0.3 mg/L	TCLP_M
MERCURY	B	0.0005 mg/L	TCLP_M
SELENIUM		0.011 mg/L	TCLP_M
SILVER	B	0.01 mg/L	TCLP_M

SAMPLE COLLECTION DATE:7/15/97 MATRIX:SOLID
SAMPLE ID:WOOD SWMU 68 WOOD EDI LAB NO:EDI008784

PARAMETER		RESULT	TEST_ID
ARSENIC		1.560 mg/L	TCLP_M
BARIUM		1.6 mg/L	TCLP_M
CADMIUM		0.04 mg/L	TCLP_M
CHROMIUM		0.40 mg/L	TCLP_M
LEAD		0.7 mg/L	TCLP_M
MERCURY		0.0011 mg/L	TCLP_M
SELENIUM		0.325 mg/L	TCLP_M
SILVER	B	0.01 mg/L	TCLP_M
PYRIDINE	B	10.0 ug/L	TCLP-SV
HEXACHLOROETHANE	B	10.0 ug/L	TCLP-SV
NITROBENZENE	B	10.0 ug/L	TCLP-SV
2,4 DINITROTOLUENE	B	10.0 ug/L	TCLP-SV
HEXACHLOROBENZENE	B	10.0 ug/L	TCLP-SV
2 METHYLPHENOL	B	10.0 ug/L	TCLP-SV
4 METHYLPHENOL	B	10.0 ug/L	TCLP-SV
3 METHYLPHENOL	B	10.0 ug/L	TCLP-SV
2,4,5 TRICHLOROPHENOL	B	10.0 ug/L	TCLP-SV
2,4,6 TRICHLOROPHENOL	B	10.0 ug/L	TCLP-SV
PENTACHLOROPHENOL	B	10.0 ug/L	TCLP-SV
HEXACHLOROBUTADIENE	B	10.0 ug/L	TCLP-SV

B - BELOW DETECTION LIMIT

ALLIANT TECHSYSTEMS,INC.

IF YOU HAVE QUESTIONS REGARDING DATA PLEASE CALL. REVIEWED AND APPROVED BY:

KELLY B. GRUEY
ACTING LABORATORY MANAGER

QUALITY CONTROL DATA

PARAMETER	%STD	%SPIKE	%RD
TCLP-METALS			
ARSENIC	119.4	119.9	1.5
BARIUM	92	93.3	0
CADIUM	98.8	95.5	12.8
CHROMIUM	94.4	94.5	0
LEAD	107.4	84.8	15.9
MERCURY	85	100	0
SELENIUM	110	97.8	6.9
SILVER	98.6	89.5	0
TCLP SEMIVOLATILES			
MEAN SURROGATE RECOVERY		ACID 88%	BASE 99%

ICF KAISER ENGINEERS, INC.

Client Sample ID: 68 PAINT

TOTAL Metals

Lot-Sample #...: A7G170105-001 Matrix.....: SOLID
Date Sampled...: 07/15/97 15:05 Date Received..: 07/16/97

PARAMETER	RESULT	REPORTING LIMIT	UNITS	METHOD	PREPARATION-ANALYSIS DATE	WORK ORDER #
Prep Batch #...: 7198133						
Lead	39900	10.0	mg/kg	SW846 6010A	07/17-07/18/97	CAPDV101

Dilution Factor: 1

ICF KAISER ENGINEERS, INC.

Client Sample ID: 68 SLUDGE

TOTAL Metals

Lot-Sample #...: A7G170105-002 Matrix.....: SOLID
Date Sampled...: 07/15/97 00:00 Date Received..: 07/16/97
% Moisture.....: 58

PARAMETER	RESULT	REPORTING LIMIT	UNITS	METHOD	PREPARATION-ANALYSIS DATE	WORK ORDER #
Prep Batch #...: 7198133						
Mercury	ND	0.24	mg/kg	SW846 7471	07/17-07/18/97	CAPE510
		Dilution Factor: 1				
Aluminum	1960	47.8	mg/kg	SW846 6010A	07/17-07/18/97	CAPE510
		Dilution Factor: 1				
Arsenic	184	11.9	mg/kg	SW846 6010A	07/17-07/21/97	CAPE510
		Dilution Factor: 10				
Barium	124	47.8	mg/kg	SW846 6010A	07/17-07/18/97	CAPE51C
		Dilution Factor: 1				
Selenium	ND G	11.9	mg/kg	SW846 6010A	07/17-07/21/97	CAPE51C
		Dilution Factor: 10				
Beryllium	ND	1.2	mg/kg	SW846 6010A	07/17-07/18/97	CA
		Dilution Factor: 1				
Thallium	ND G	23.9	mg/kg	SW846 6010A	07/17-07/21/97	CAPE51C
		Dilution Factor: 10				
Cadmium	19.6	1.2	mg/kg	SW846 6010A	07/17-07/18/97	CAPE51C
		Dilution Factor: 1				
Calcium	8040	1190	mg/kg	SW846 6010A	07/17-07/18/97	CAPE51C
		Dilution Factor: 1				
Chromium	110000	23.9	mg/kg	SW846 6010A	07/17-07/21/97	CAPE51C
		Dilution Factor: 10				
Cobalt	ND	11.9	mg/kg	SW846 6010A	07/17-07/18/97	CAPE51C
		Dilution Factor: 1				
Copper	309	6.0	mg/kg	SW846 6010A	07/17-07/18/97	CAPE51C
		Dilution Factor: 1				
Iron	107000	239	mg/kg	SW846 6010A	07/17-07/18/97	CAPE51C
		Dilution Factor: 10				
Magnesium	ND	1190	mg/kg	SW846 6010A	07/17-07/18/97	CAPE51C
		Dilution Factor: 1				

(Continued on next page)

ICF KAISER ENGINEERS, INC.

Client Sample ID: 68 SLUDGE

TOTAL Metals

Lot-Sample #...: A7G170105-002 Matrix.....: SOLID

PARAMETER	RESULT	REPORTING LIMIT	UNITS	METHOD	PREPARATION-ANALYSIS DATE	WORK ORDER #
Manganese	759	3.6	mg/kg	SW846 6010A	07/17-07/18/97	CAPE510
		Dilution Factor: 1				
Nickel	2140	9.6	mg/kg	SW846 6010A	07/17-07/18/97	CAPE510
		Dilution Factor: 1				
Potassium	ND	1190	mg/kg	SW846 6010A	07/17-07/18/97	CAPE510
		Dilution Factor: 1				
Silver	ND	2.4	mg/kg	SW846 6010A	07/17-07/18/97	CAPE510
		Dilution Factor: 1				
Sodium	ND	1190	mg/kg	SW846 6010A	07/17-07/18/97	CAPE510
		Dilution Factor: 1				
Vanadium	252	11.9	mg/kg	SW846 6010A	07/17-07/18/97	CAPE510
		Dilution Factor: 1				
Zinc	387	11.9	mg/kg	SW846 6010A	07/17-07/18/97	CAPE510
		Dilution Factor: 1				
Antimony	ND G	11.9	mg/kg	SW846 6010A	07/17-07/22/97	CAPE510
		Dilution Factor: 10				
Lead	2060 MBB	7.2	mg/kg	SW846 6010A	07/17-07/21/97	CAPE510
		Dilution Factor: 10				

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

G Elevated reporting limit. The reporting limit is elevated due to matrix interference.

MBB This analyte is present at a reportable level in the associated method blank but is less than 5% of the sample amount.

ICF KAISER ENGINEERS, INC.

Client Sample ID: 68 SLUDGE

General Chemistry

Lot-Sample #...: A7G170105-002 Work Order #...: CAPE5 Matrix.....: SOLID
Date Sampled...: 07/15/97 00:00 Date Received..: 07/16/97
% Moisture.....: 58

PARAMETER	RESULT	RL	UNITS	METHOD	PREPARATION-ANALYSIS DATE	PREP BATCH #
pH (solid)	2.7		No Units	SW846 9045A	07/18/97	7199226
	Dilution Factor: 1					
Percent Solids	41.9	0.10	%	MCAWW 160.3 MOD	07/18-07/21/97	7199117
	Dilution Factor: 1					

NOTE(S):

RL Reporting Limit

Results and reporting limits have been adjusted for dry weight.

Quanterra
Environmental Services

Metals
TCLP Leachate

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68SOIL01 (0.0,68SOIL,BORE,)
Lab ID: 094278-0001-SA
Matrix: SOIL

Sampled: 24 JUL 97
Received: 25 JUL 97
Authorized: 25 JUL 97

Leached: 28 JUL 97
Prepared: See Below
Analyzed: See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Arsenic	ND	mg/L	0.50	6010A	29 JUL 97	30 JUL 97
Barium	ND	mg/L	10.0	6010A	29 JUL 97	30 JUL 97
Cadmium	ND	mg/L	0.10	6010A	29 JUL 97	30 JUL 97
Chromium	ND	mg/L	0.50	6010A	29 JUL 97	30 JUL 97
Lead	ND	mg/L	0.50	6010A	29 JUL 97	30 JUL 97
Selenium	ND	mg/L	0.25	6010A	29 JUL 97	30 JUL 97
Silver	ND	mg/L	0.50	6010A	29 JUL 97	30 JUL 97

ND = Not detected
NA = Not applicable

Reported By: TVU

Approved By: Sonia Tabirara

The cover letter is an integral part of this report.
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Quanterra
Environmental Services

Metals
TCLP Leachate

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68SOIL02 (0.0,68SOIL,BORE,)
Lab ID: 094278-0002-SA
Matrix: SOIL

Sampled: 24 JUL 97
Received: 25 JUL 97
Authorized: 25 JUL 97

Leached: 28 JUL 97
Prepared: See Below
Analyzed: See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Arsenic	ND	mg/L	0.50	6010A	29 JUL 97	30 JUL 97
Barium	ND	mg/L	10.0	6010A	29 JUL 97	30 JUL 97
Cadmium	ND	mg/L	0.10	6010A	29 JUL 97	30 JUL 97
Chromium	ND	mg/L	0.50	6010A	29 JUL 97	30 JUL 97
Lead	ND	mg/L	0.50	6010A	29 JUL 97	30 JUL 97
Selenium	ND	mg/L	0.25	6010A	29 JUL 97	30 JUL 97
Silver	ND	mg/L	0.50	6010A	29 JUL 97	30 JUL 97

ND = Not detected
NA = Not applicable

Reported By: TVU

Approved By: Sonia Tabirara

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Quanterra
Environmental Services

Metals
TCLP Leachate

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68SOIL03 (0.0,68SOIL,BORE,)
Lab ID: 094278-0003-SA
Matrix: SOIL

Sampled: 24 JUL 97
Received: 25 JUL 97
Authorized: 25 JUL 97

Leached: 28 JUL 97
Prepared: See Below
Analyzed: See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Arsenic	ND	mg/L	0.50	6010A	29 JUL 97	30 JUL 97
Barium	ND	mg/L	10.0	6010A	29 JUL 97	30 JUL 97
Cadmium	ND	mg/L	0.10	6010A	29 JUL 97	30 JUL 97
Chromium	ND	mg/L	0.50	6010A	29 JUL 97	30 JUL 97
Lead	ND	mg/L	0.50	6010A	29 JUL 97	30 JUL 97
Selenium	ND	mg/L	0.25	6010A	29 JUL 97	30 JUL 97
Silver	ND	mg/L	0.50	6010A	29 JUL 97	30 JUL 97

ND = Not detected
NA = Not applicable

Reported By: TVU

Approved By: Sonia Tabirara

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Quanterra
Environmental Services

Metals
TCLP Leachate

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 68SOIL04 (0.0,68SOIL,BORE,)
Lab ID: 094278-0004-SA
Matrix: SOIL

Sampled: 24 JUL 97
Received: 25 JUL 97
Authorized: 25 JUL 97

Leached: 28 JUL 97
Prepared: See Below
Analyzed: See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Arsenic	ND	mg/L	0.50	6010A	29 JUL 97	30 JUL 97
Barium	ND	mg/L	10.0	6010A	29 JUL 97	30 JUL 97
Cadmium	ND	mg/L	0.10	6010A	29 JUL 97	30 JUL 97
Chromium	ND	mg/L	0.50	6010A	29 JUL 97	30 JUL 97
Lead	ND	mg/L	0.50	6010A	29 JUL 97	30 JUL 97
Selenium	ND	mg/L	0.25	6010A	29 JUL 97	30 JUL 97
Silver	ND	mg/L	0.50	6010A	29 JUL 97	30 JUL 97

ND = Not detected
NA = Not applicable

Reported By: TVU

Approved By: Sonia Tabirara

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Quanterra
Environmental Services

466

TCLP Metals by ICP
TCLP Leachate

Client Name: ICF Kaiser Engineers, Inc.
Client ID: Decon Water (0.0,CQC,FBLK,)
Lab ID: 094476-0001-SA
Matrix: AQUEOUS
Sampled: 06 AUG 97
Received: 08 AUG 97
Authorized: 08 AUG 97
Leached: 13 AUG 97
Prepared: See Below
Analyzed: See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Arsenic	ND	mg/L	0.50	6010A	14 AUG 97	15 AUG 97
Barium	ND	mg/L	10.0	6010A	14 AUG 97	15 AUG 97
Cadmium	ND	mg/L	0.10	6010A	14 AUG 97	15 AUG 97
Chromium	ND	mg/L	0.50	6010A	14 AUG 97	15 AUG 97
Lead	ND	mg/L	0.50	6010A	14 AUG 97	15 AUG 97
Mercury	ND	mg/L	0.0020	7470A	15 AUG 97	15 AUG 97 1
Selenium	ND	mg/L	0.25	6010A	14 AUG 97	15 AUG 97
Silver	ND	mg/L	0.50	6010A	14 AUG 97	15 AUG 97

Note 1 : TCLP extraction date 08/15/97.

ND = Not detected
NA = Not applicable

Reported By: TVU
Approved By: Sonia Tabirara

The cover letter is an integral part of this report.
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Quanterra
Environmental Services

TCLP Metals by ICP
TCLP Leachate

Client Name: ICF Kaiser Engineers, Inc.
Client ID: Line Water (0.0,CQC,FBLK,)
Lab ID: 094476-0002-SA
Matrix: AQUEOUS

Sampled: 06 AUG 97
Received: 08 AUG 97
Authorized: 08 AUG 97

Leached: 13 AUG 97
Prepared: See Below
Analyzed: See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date	
Arsenic	ND	mg/L	0.50	6010A	14 AUG 97	15 AUG 97	
Barium	ND	mg/L	10.0	6010A	14 AUG 97	15 AUG 97	
Cadmium	ND	mg/L	0.10	6010A	14 AUG 97	15 AUG 97	
Chromium	ND	mg/L	0.50	6010A	14 AUG 97	15 AUG 97	
Lead	ND	mg/L	0.50	6010A	14 AUG 97	15 AUG 97	
Mercury	ND	mg/L	0.0020	7470A	15 AUG 97	15 AUG 97	1
Selenium	ND	mg/L	0.25	6010A	14 AUG 97	15 AUG 97	
Silver	ND	mg/L	0.50	6010A	14 AUG 97	15 AUG 97	

Note 1 : TCLP extraction date 08/15/97.

ND = Not detected
NA = Not applicable

Reported By: TVU

Approved By: Sonia Tabirara

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Quanterra
Environmental Services

Semivolatile Organics
Target Compound List (TCL)
Method 8270

Client Name: ICF Kaiser Engineers, Inc.
Client ID: SOURCEWATER (0.0,SOURCEWA,FBLK,)
Lab ID: 094168-0001-SA
Matrix: AQUEOUS Sampled: 16 JUL 97 Received: 18 JUL 97
Authorized: 18 JUL 97 Prepared: 23 JUL 97 Analyzed: 01 AUG 97

Parameter	Result	Units	Reporting Limit
Acenaphthene	ND	ug/L	10
Acenaphthylene	ND	ug/L	10
Carbazole	ND	ug/L	100
Anthracene	ND	ug/L	10
Benzo(a)anthracene	ND	ug/L	10
Benzo(b)fluoranthene	ND	ug/L	10
Benzo(k)fluoranthene	ND	ug/L	10
Benzo(g,h,i)perylene	ND	ug/L	10
Benzo(a)pyrene	ND	ug/L	10
4-Bromophenyl phenyl ether	ND	ug/L	10
Butyl benzyl phthalate	ND	ug/L	10
4-Chloroaniline	ND	ug/L	10
bis(2-Chloroethoxy)-methane	ND	ug/L	10
bis(2-Chloroethyl)ether	ND	ug/L	10
2,2'-Oxybis(1-chloropropane)	ND	ug/L	10
-Chloro-3-methylphenol	ND	ug/L	10
-Chloronaphthalene	ND	ug/L	10
2-Chlorophenol	ND	ug/L	10
4-Chlorophenyl phenyl ether	ND	ug/L	10
Chrysene	ND	ug/L	10
Dibenz(a,h)anthracene	ND	ug/L	10
Dibenzofuran	ND	ug/L	10
Di-n-butyl phthalate	ND	ug/L	10
1,2-Dichlorobenzene	ND	ug/L	10
1,3-Dichlorobenzene	ND	ug/L	10
1,4-Dichlorobenzene	ND	ug/L	10
3,3'-Dichlorobenzidine	ND	ug/L	20
2,4-Dichlorophenol	ND	ug/L	10
Diethyl phthalate	ND	ug/L	10
2,4-Dimethylphenol	ND	ug/L	10
Dimethyl phthalate	ND	ug/L	10
4,6-Dinitro-2-methylphenol	ND	ug/L	50
2,4-Dinitrophenol	ND	ug/L	50
2,4-Dinitrotoluene	ND	ug/L	10
2,6-Dinitrotoluene	ND	ug/L	10
Di-n-octyl phthalate	ND	ug/L	10

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Emily Uebelhoer Approved By: Harlan Loui

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Quanterra
Environmental Services

Semivolatile Organics
Target Compound List (TCL)
Method 8270

Client Name: ICF Kaiser Engineers, Inc.
Client ID: SOURCEWATER (0.0,SOURCEWA,FBLK,)
Lab ID: 094168-0001-SA
Matrix: AQUEOUS Sampled: 16 JUL 97 Received: 18 JUL 97
Authorized: 18 JUL 97 Prepared: 23 JUL 97 Analyzed: 01 AUG 97

Parameter	Result	Units	Reporting Limit
bis(2-Ethylhexyl)-phthalate	ND	ug/L	10
Fluoranthene	ND	ug/L	10
Fluorene	ND	ug/L	10
Hexachlorobenzene	ND	ug/L	10
Hexachlorobutadiene	ND	ug/L	10
Hexachlorocyclopentadiene	ND	ug/L	10
Hexachloroethane	ND	ug/L	10
Indeno(1,2,3-cd)pyrene	ND	ug/L	10
Isophorone	ND	ug/L	10
2-Methylnaphthalene	ND	ug/L	10
2-Methylphenol	ND	ug/L	10
4-Methylphenol	ND	ug/L	10
Naphthalene	ND	ug/L	10
2-Nitroaniline	ND	ug/L	50
3-Nitroaniline	ND	ug/L	50
4-Nitroaniline	ND	ug/L	50
Nitrobenzene	ND	ug/L	10
2-Nitrophenol	ND	ug/L	10
4-Nitrophenol	ND	ug/L	50
N-Nitrosodiphenylamine	ND	ug/L	10
N-Nitroso-di-n-propylamine	ND	ug/L	10
Pentachlorophenol	ND	ug/L	50
Phenanthrene	ND	ug/L	10
Phenol	ND	ug/L	10
Pyrene	ND	ug/L	10
1,2,4-Trichlorobenzene	ND	ug/L	10
2,4,5-Trichlorophenol	ND	ug/L	10
2,4,6-Trichlorophenol	ND	ug/L	10

Surrogate	Recovery	
Nitrobenzene-d5	78	%
2-Fluorobiphenyl	88	%
Terphenyl-d14	97	%
Phenol-d5	ND	%
2-Fluorophenol	31	%
2,4,6-Tribromophenol	58	%

ND = Not detected
NA = Not applicable

Reported By: Emily Uebelhoer Approved By: Harlan Loui

The cover letter is an integral part of this report.
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Quanterra
Environmental Services

Acids Library Search (10 Compound TID)

Method 8270

Client Name: ICF Kaiser Engineers, Inc.
Client ID: SOURCEWATER (0.0,SOURCEWA,FBLK,)
Lab ID: 094168-0001-SA
Matrix: AQUEOUS Sampled: 16 JUL 97 Received: 18 JUL 97
Authorized: 18 JUL 97 Prepared: NA Analyzed: 01 AUG 97

Parameter	Result	Units	Reporting Limit
Unknown	6.4	ug/L	--
TID Compound 2	ND	ug/L	--
TID Compound 3	ND	ug/L	--
TID Compound 4	ND	ug/L	--
TID Compound 5	ND	ug/L	--
TID Compound 6	ND	ug/L	--
TID Compound 7	ND	ug/L	--
TID Compound 8	ND	ug/L	--
TID Compound 9	ND	ug/L	--
TID Compound 10	ND	ug/L	--

ND = Not detected
NA = Not applicable

Reported By: Emily Uebelhoer Approved By: Harlan Loui

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Quanterra
Environmental Services

METALS

(Water - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 071597R1 (0.0,071597R1,FBLK,)
Lab ID: 094167-0005-SA
Matrix: AQUEOUS Sampled: 15 JUL 97 Received: 17 JUL 97
Authorized: 18 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	ND	mg/L	0.10	6010A	08 AUG 97	11 AUG 97
Antimony	ND	mg/L	0.010	6010 Modified	08 AUG 97	11 AUG 97
Arsenic	ND	mg/L	0.010	6010 Modified	08 AUG 97	11 AUG 97
Barium	ND	mg/L	0.010	6010A	08 AUG 97	11 AUG 97
Beryllium	ND	mg/L	0.0050	6010 Modified	08 AUG 97	11 AUG 97
Cadmium	ND	mg/L	0.0050	6010A	08 AUG 97	11 AUG 97
Calcium	ND	mg/L	0.50	6010A	08 AUG 97	11 AUG 97
Chromium	ND	mg/L	0.010	6010A	08 AUG 97	11 AUG 97
Cobalt	ND	mg/L	0.050	6010 Modified	08 AUG 97	11 AUG 97
Copper	ND	mg/L	0.020	6010A	08 AUG 97	11 AUG 97
Iron	ND	mg/L	0.10	6010A	08 AUG 97	11 AUG 97
Lead	ND	mg/L	0.050	6010A	08 AUG 97	11 AUG 97
Magnesium	ND	mg/L	0.50	6010A	08 AUG 97	11 AUG 97
Manganese	ND	mg/L	0.010	6010A	08 AUG 97	11 AUG 97
Mercury	ND	mg/L	0.00020	245.1	31 JUL 97	31 JUL 97
Nickel	ND	mg/L	0.040	6010A	08 AUG 97	11 AUG 97
Potassium	ND	mg/L	5.0	6010A	08 AUG 97	11 AUG 97
Selenium	ND	mg/L	0.20	6010A	08 AUG 97	11 AUG 97
Silver	ND	mg/L	0.010	6010A	08 AUG 97	11 AUG 97
Sodium	ND	mg/L	5.0	6010A	08 AUG 97	11 AUG 97
Thallium	ND	mg/L	0.010	6010 Modified	08 AUG 97	11 AUG 97
Vanadium	ND	mg/L	0.010	6010A	08 AUG 97	11 AUG 97
Zinc	ND	mg/L	0.020	6010A	08 AUG 97	11 AUG 97

ND = Not detected
NA = Not applicable

Reported By: Allan Wong Approved By: Mei Lai

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METALS

(Water - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 072397R1 (0.0,072397R1,FBLK,)
Lab ID: 094258-0001-SA
Matrix: AQUEOUS Sampled: 23 JUL 97 Received: 24 JUL 97
Authorized: 24 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	ND	mg/L	0.10	6010A	08 AUG 97	11 AUG 97
Antimony	ND	mg/L	0.010	6010 Modified	08 AUG 97	11 AUG 97
Arsenic	ND	mg/L	0.010	6010 Modified	08 AUG 97	11 AUG 97
Barium	ND	mg/L	0.010	6010A	08 AUG 97	11 AUG 97
Beryllium	ND	mg/L	0.0050	6010 Modified	08 AUG 97	11 AUG 97
Cadmium	ND	mg/L	0.0050	6010A	08 AUG 97	11 AUG 97
Calcium	ND	mg/L	0.50	6010A	08 AUG 97	11 AUG 97
Chromium	ND	mg/L	0.010	6010A	08 AUG 97	11 AUG 97
Cobalt	ND	mg/L	0.050	6010 Modified	08 AUG 97	11 AUG 97
Copper	ND	mg/L	0.020	6010A	08 AUG 97	11 AUG 97
Iron	ND	mg/L	0.10	6010A	08 AUG 97	11 AUG 97
Lead	ND	mg/L	0.050	6010A	08 AUG 97	11 AUG 97
Magnesium	ND	mg/L	0.50	6010A	08 AUG 97	11 AUG 97
Manganese	ND	mg/L	0.010	6010A	08 AUG 97	11 AUG 97
Mercury	ND	mg/L	0.00020	245.1	08 AUG 97	09 AUG 97
Nickel	ND	mg/L	0.040	6010A	08 AUG 97	11 AUG 97
Potassium	ND	mg/L	5.0	6010A	08 AUG 97	11 AUG 97
Selenium	ND	mg/L	0.20	6010A	08 AUG 97	11 AUG 97
Silver	ND	mg/L	0.010	6010A	08 AUG 97	11 AUG 97
Sodium	ND	mg/L	5.0	6010A	08 AUG 97	11 AUG 97
Thallium	ND	mg/L	0.010	6010 Modified	08 AUG 97	11 AUG 97
Vanadium	ND	mg/L	0.010	6010A	08 AUG 97	11 AUG 97
Zinc	ND	mg/L	0.020	6010A	08 AUG 97	11 AUG 97

ND = Not detected
NA = Not applicable

Reported By: Allan Wong Approved By: Mei Lai

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Quanterra
Environmental Services

METALS

(Water - Total)

Client Name: ICF Kaiser Engineers, Inc.
Client ID: 072497R1 (0.0,072497R1,FBLK,)
Lab ID: 094277-0001-SA
Matrix: AQUEOUS Sampled: 24 JUL 97 Received: 25 JUL 97
Authorized: 25 JUL 97 Prepared: See Below Analyzed: See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Aluminum	ND	mg/L	0.10	6010A	29 JUL 97	31 JUL 97
Antimony	ND	mg/L	0.010	6010 Modified	29 JUL 97	01 AUG 97
Arsenic	ND	mg/L	0.010	6010 Modified	29 JUL 97	01 AUG 97
Barium	ND	mg/L	0.010	6010A	29 JUL 97	31 JUL 97
Beryllium	ND	mg/L	0.0050	6010 Modified	29 JUL 97	01 AUG 97
Cadmium	ND	mg/L	0.0050	6010A	29 JUL 97	31 JUL 97
Calcium	ND	mg/L	0.50	6010A	29 JUL 97	31 JUL 97
Chromium	ND	mg/L	0.010	6010A	29 JUL 97	31 JUL 97
Cobalt	ND	mg/L	0.050	6010 Modified	29 JUL 97	01 AUG 97
Copper	ND	mg/L	0.020	6010A	29 JUL 97	31 JUL 97
Iron	ND	mg/L	0.10	6010A	29 JUL 97	31 JUL 97
Lead	ND	mg/L	0.050	6010A	29 JUL 97	31 JUL 97
Magnesium	ND	mg/L	0.50	6010A	29 JUL 97	31 JUL 97
Manganese	ND	mg/L	0.010	6010A	29 JUL 97	31 JUL 97
Mercury	ND	mg/L	0.00020	245.1	31 JUL 97	31 JUL 97
Nickel	ND	mg/L	0.040	6010A	29 JUL 97	31 JUL 97
Potassium	ND	mg/L	5.0	6010A	29 JUL 97	31 JUL 9
Selenium	ND	mg/L	0.20	6010A	29 JUL 97	31 JUL 9
Silver	ND	mg/L	0.010	6010A	29 JUL 97	31 JUL 9.
Sodium	ND	mg/L	5.0	6010A	29 JUL 97	31 JUL 97
Thallium	ND	mg/L	0.010	6010 Modified	29 JUL 97	01 AUG 97
Vanadium	ND	mg/L	0.010	6010A	29 JUL 97	31 JUL 97
Zinc	ND	mg/L	0.020	6010A	29 JUL 97	31 JUL 97

ND = Not detected
NA = Not applicable

Reported By: Allan Wong Approved By: Mei Lai

The cover letter is an integral part of this report.
Rev 230787

APPENDIX C

LEVEL OF CONCERN TABLES FOR METALS AND SVOCs

Table C-2
Levels of Concern for TCLP SVOCs at SWMU 68

TCLP SVOC Analyte	TCLP Waste Characterization Criteria (µg/L)
Pyridine	5.0
Hexachloroethane	3.0
Nitrobenzene	2.0
2,4-Dinitrotoluene	0.13
Hexachlorobenzene	0.13
1,4-Dichlorobenzene	7.5
2-Methylphenol (o-creosol)	200
4-Methylphenol (p-creosol)	200
3-Methylphenol (m-creosol)	200
Methylphenol (total creosol)	200
2,4,5-Trichlorophenol	400
2,4,6-Trichlorophenol	2.0
Pentachlorophenol	100
Hexachlorobutadiene	0.5

Table C-1
Levels of Concern for Metals in Soil at SWMU 68

Metal Analyte	Analytical Performance Standards[1]		Cleanup Criteria			TCLP Waste Characterization Criteria (µg/L)
	Permit PQL (µg/g)	Laboratory Detection Limit (µg/g)	Permit HBN[2] (µg/g)	Calculated HBN[2] (µg/g)	Residential Soil RBC[3] (µg/g)	
Aluminum		10		230,000	78,000	
Antimony	20	0.5	30		31	
Arsenic	30	0.5	0.5		23	5.0
Arsenic (carcinogen)	30	0.5	0.5		.43	5.0
Barium	1.0	1	1000		5,500	100
Beryllium	0.2	0.1	0.1		0.15	
Cadmium	2.0	0.5	40		39	1.0
Calcium		50			nv	
Chromium	4.0	1	400		390	5.0
Cobalt		0.8		0.8	4,700	
Copper		2		3,000	3,100	
Iron		10			23,000	
Lead	2.0	5			400[4]	5.0
Magnesium		50			nv	
Manganese		1		8,000	1,800	
Mercury	0.1	0.1	20		23	0.2
Nickel	3.0	4	1000		1,600	
Potassium		500			nv	
Selenium	40	20	200		390	1.0
Silver	4.0	1	200		390	5.0
Sodium		500			nv	
Thallium	20	1	6		0	
Vanadium		1			550	
Zinc		2		16,000	23,000	

[1] PQLs given in the RCRA permit (USEPA, 1989) take precedence as analytical performance standards. Where no value was given in the permit, laboratory detection limits (for wet weight) are used.
[2] Calculated HBNs. RFI, Appendix D (Dames & Moore, 1992).
[3] For metals that do not have a Permit or Calculated HBN, the Residential Soil RBC is used as the cleanup criteria (USEPA, 1997).
[4] Cleanup criterion for lead is a *de facto* standard given by the Office of Waste Management (USEPA, 1991 and 1997).
[5] TCLP values are given for the eight RCRA metals analyzed for waste characterization.
nv - No cleanup criteria are given for essential nutrients.

SWMU 69

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CLOSURE REPORT
SWMU 69, Pond by Chromic Acid Treatment Tanks
Radford Army Ammunition Plant, Virginia
Task Order No. 4
(DRAFT)

Prepared for:

U.S. Army Environmental Center
Aberdeen Proving Ground, Maryland 21010-5401
Contract No. DAAA15-90-D-0015

DAMES & MOORE
2807 N. Parham Road, Suite 114, Richmond, VA 23294

August 30, 1994

CLOSURE REPORT

SWMU 69, Pond by Chromic Acid Treatment Tanks

(Draft)

Task Order No. 4
Radford Army Ammunition Plant, Virginia

Submitted to:

Commander, U.S. Army Environmental Center
Aberdeen Proving Ground, Maryland 21010-5401

Contract No. DAAA15-90-D-0015

Prepared by:

Dames & Moore
2807 N. Parham Road, Suite 114
Richmond, Virginia 23294

August 30, 1994

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DAMES & MOORE

2807 N. PARHAM ROAD, SUITE 114, RICHMOND, VIRGINIA 23294
(804) 965-9000 FAX: (804) 965-9764

August 31, 1994

Harry R. Kleiser
U.S. Army Environmental Center
Installation Restoration Division
Building E4480
Aberdeen Proving Ground, MD 21010-5401

Re: Revised VI Section Report
SWMU Closure Report
Radford Army Ammunition Plant, VA

Dear Harry:

Enclosed are one revised section report for the VI at RAAP and the closure report for SWMU 69; one bound and one unbound for each report. These reports include the 1993 data collected at SWMU 39 (Section 11.0) and the documentation for excavating SWMU 69 and landfilling the soil at the RAAP Fly Ash Landfill. Please review these draft documents and provide comments as necessary. A copy of the SWMU 69 report was sent to Bill Hendon (RAAP) for his review. Revised section reports for SWMU O and SWMUs 10/35 are being prepared now and should be out in a week or two. Our plan is still to send the revised section reports to you for comment, give you a week or so to review them and have them returned to us for a final draft of each to be prepared before the end of September. We plan on providing the study on using the onsite soils data to create background concentrations to you in late September.

Please call to discuss any changes or extras to the reports. I will contact you within the next few days if I do not get a call from you or Dennis.

Sincerely,

DAMES & MOORE, INC.

Anthony J. Duda
Sr. Hydrogeologist

Enclosures

ACRONYMS AND ABBREVIATIONS

bgs	Below Ground Surface
HBN	Health Based Number
msl	Mean sea level
RAAP	Radford Army Ammunition Plant
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TCLP	Toxicity Characteristic Leaching Procedure
TOC	Total Organic Carbon
TOX	Total Organic Halogen
ug/g	Micrograms per gram
ug/L	Micrograms per Liter
USAEC	U.S. Army Environmental Center
USEPA	U.S. Environmental Protection Agency
VI	Verification Investigation
XRF	X-Ray Fluorescence

1.0 BACKGROUND INFORMATION

Solid Waste Management Unit (SWMU) 69 was a retention facility at Radford Army Ammunition Plant (RAAP), Virginia identified in the RAAP Resource Conservation and Recovery Act (RCRA) Facility Assessment (USEPA,1987) as having the potential for releasing contaminants into the environment and was included in the RCRA Permit for Corrective Action and Incinerator Operation (USEPA, 1989) issued to RAAP by the U.S. Environmental Protection Agency as warranting investigation. The actions undertaken by Dames & Moore at SWMU 69 were authorized by the U.S. Army Environmental Center (USAEC) under Contract No. DAAA15-90-D-0015, Task Order 4.

In accordance with the RCRA Permit for Corrective Action and Incineration Operation, a Verification Investigation (VI) was performed in 1992. As part of the VI, samples were collected from the surface water and sediment located in SWMU 69 and analyzed to evaluate whether hazardous constituents were present from discharges associated with the chromium tanks at SWMU 68, approximately 25 feet upgradient and southeast of SWMU 69. Additional soil samples were collected downgradient of the retention facility to evaluate the presence of hazardous constituents transported through overflows of the retention facility. (See Figure 1 for VI sample locations). Soil and sediment samples were analyzed for pH and Target Analyte List (TAL) metals. The water sample was analyzed for pH, TAL metals, Total Organic Carbon (TOC) and Total Organic Halogen (TOX).

The sediment and soil sample results from the 1992 VI indicated concentrations of antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, and thallium exceeding (HBN) criteria. The laboratory analyses of the surface water in the pond indicated that antimony, cadmium, chromium, cobalt, copper, lead, manganese, nickel and zinc exceeded the permit HBNs. The recommendations of the VI report included the removal of all accumulated water, sediment and surficial soils associated with SWMU 69 that are known to be adversely impacted. RAAP personnel collected additional samples of the pond sediment for chemical analysis and demonstrated that these materials were compatible to the flyash being disposed into Fly Ash Landfill No. 2 (FAL No. 2). Based on this demonstration, the Virginia Department of Environmental Quality modified the permit for FAL No. 2 to allow the sediment and soil at

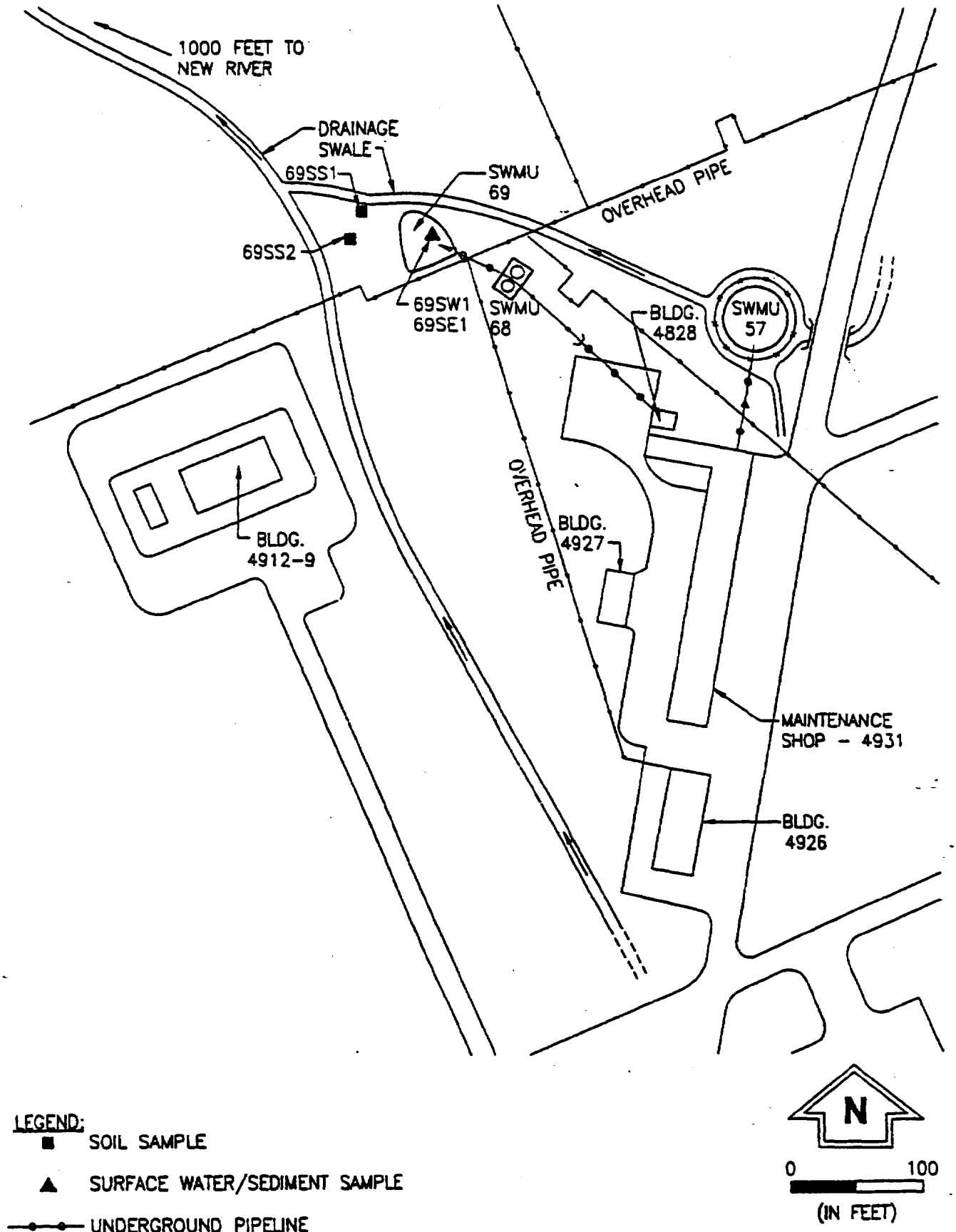


FIGURE 1
LOCATION MAP
SWMU 69-POND BY CHROMIC ACID TREATMENT TANKS
RADFORD ARMY AMMUNITION PLANT, VA

Dames & Moore

SWMU 69 to be disposed of into the landfill. The excavation activities were initiated after the permit modifications were approved.

2.0 ENVIRONMENTAL SETTING

The topography in the area of SWMU 69 is moderately sloping towards the northwest. The area further north of SWMU 69 is moderately steeply sloping toward the west. The elevation at SWMU 69 is approximately 1,790 to 1,800 feet above mean sea level (msl). There are buildings, paved roads, and overhead pipes in the vicinity of SWMU 69. The topographic survey of conditions prior to excavation activities was performed by Anderson and Associates, Blacksburg, VA. Insert 1 presents the topographic survey of the site and adjacent areas. Figure 2 presents the pond and areas to be disturbed from the excavations.

No site-specific groundwater conditions have been investigated in this area. However, groundwater is likely found at a depth of 20 to 40 feet below ground surface (bgs) with flow northwestward and discharge into the New River.

Based on topography, the surface water in the area of SWMU 69 appears to flow westward towards a tributary to the New River. The tributary flows north and discharges into the New River which is approximately 1,400 feet from SWMU 69. Based on the review of RAAP utility maps, no manholes, catch basins, or storm drains were evident in the immediate vicinity of SWMU 69. Overflow from the pond traveled through a weir which discharges to the northwest.

3.0 EXCAVATION AND SOIL SCREENING PROGRAM

In accordance with the recommendation included in the final draft VI report for SWMU 69, interim measures were undertaken at SWMU 69 to remove impacted soil. An X-Ray fluorescence (XRF) method was selected as the appropriate field method to delineate the limits of the area to be excavated. Lead was selected as the indicator for field screening of soils due to excessive levels present in pond sediment and ease of testing using the XRF method. The corrective action consisted of developmental sampling, excavation and disposal of contaminated sediment and soils, on-site sampling and analysis during excavation activities, confirmatory sampling and analysis, and backfilling and grading operations.

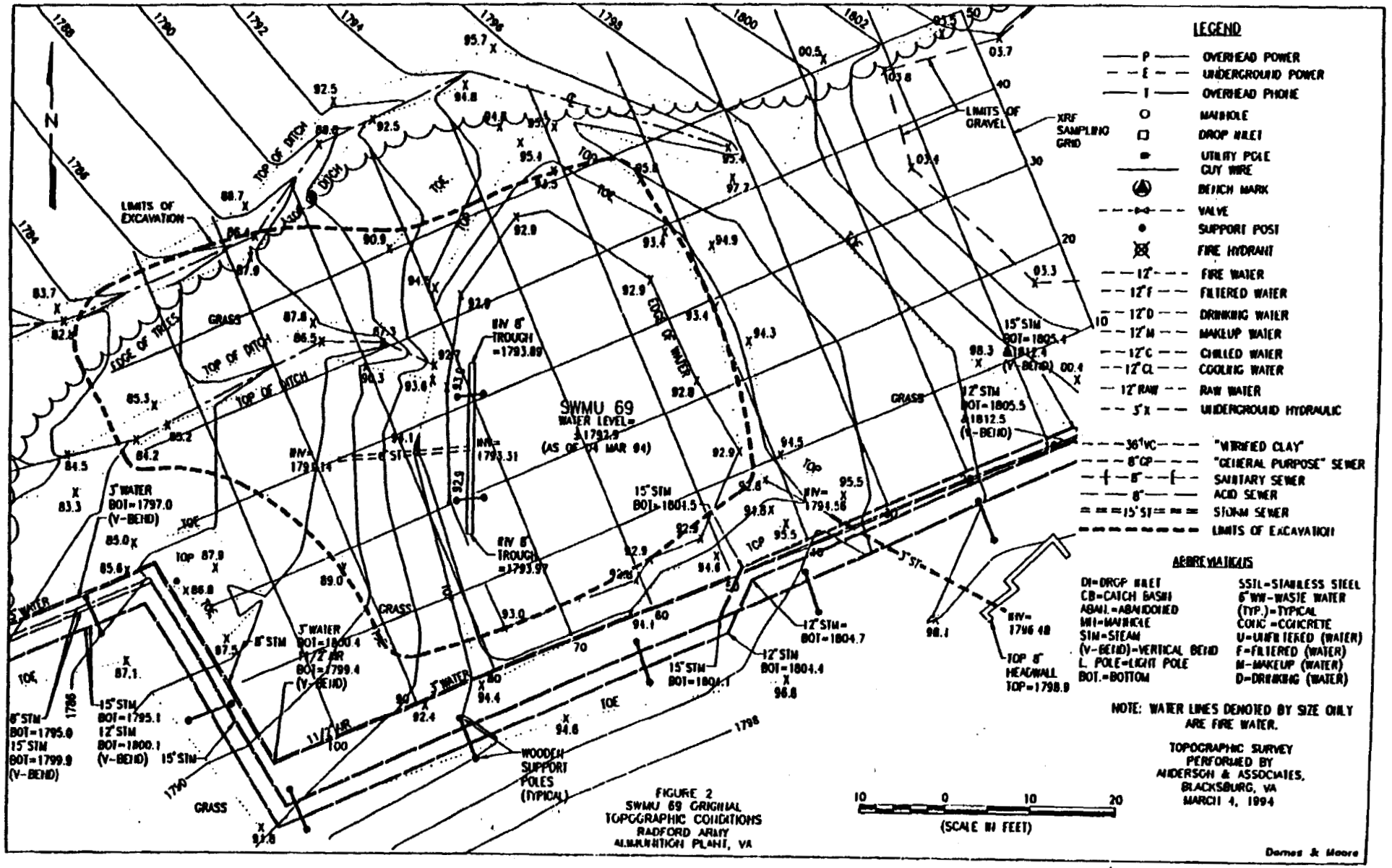


FIGURE 2
SWMU 69 ORIGINAL TOPOGRAPHIC CONDITIONS
RADFORD ARMY AMMUNITION PLANT, VA

3.1 Developmental Sampling

Prior to undertaking the excavation activities, developmental sampling activities took place to establish a lead XRF standard to be utilized for analysis of samples collected during excavation activities.

3.1.1 XRF Instrumentation

The XRF instrument used for the soils screening was the MAP 3, manufactured by Scitec Corporation. The instrument uses a radioactive cadmium^{109} source to excite the elements in the samples, causing the elements to emit their own characteristic (in terms of wavelength and energy) fluorescent x-radiation. The instrument detector sorts the fluorescent x-rays by energies, and the concentrations of the elements are calculated by comparing the fluorescent intensities in the sample unknowns to those in standard samples. The form of the metal analyte in the samples is unimportant (e.g., amorphous versus crystalline, organically versus inorganically bound, silicate versus oxide, etc.). Analytical accuracy is greatly enhanced if the matrix composition of the sample unknowns is similar to that of the standards (in terms of bulk elemental composition), and similar particle size distributions also contribute to improved accuracy.

3.1.2 Lead XRF Standard Preparation

Site-specific lead calibration standards were prepared from "clean" soil collected in the immediate vicinity of the pond. Two sets of standards were made using two different soil types identified at the site (one soil appeared to contain more clay than the other). An analysis of the two soils for metals content revealed the concentrations presented in Table 1. Elementally, the two soils are not substantially different; the lead contents were 38 and 17 micrograms/gram (ug/g). The standards were made by doping the soils with lead atomic absorption reference solutions (1,000 ug/g and 10,000 ug/g) to yield soil lead concentrations scanning the expected

Table 1
Summary of Analytical Results for Calibration Soils
SWMU 69, Pond by Chromic Acid Treatment Tanks
RAAP, Virginia

Metal Analyte	Metals Concentrations (micrograms/grams) Soil No. 1	Soil No. 2
Silver	BDL	BDL
Aluminum	36,800	34,200
Arsenic	1,990	6,350
Barium	285	248
Beryllium	3	3
Calcium	581	1,080
Cadmium	BDL	BDL
Cobalt	9	11
Chromium	161	347
Copper	23	22
Iron	22,400	23,600
Potassium	6,090	9,340
Magnesium	1,410	2,480
Molybdenum	BDL	BDL
Sodium	864	1,090
Nickel	47	41
Lead	38	17
Antimony	170	200
Selenium	250	261
Silicon	228,000	26,500
Thallium	248	299
Vanadium	63	51
Zinc	73	50

BDL = Below Detection Limit.

concentration range of lead in the sample unknowns (0 to 2,500 ug/g). The samples were air-dried and then homogenized and placed in plastic zip-lock bags.

3.1.3 XRF Calibration

The exact calibration procedures for the MAP 3 are proprietary. In general terms, the sample standards were analyzed with the XRF unit to generate fluorescence yield data for lead. The standard samples were analyzed through the walls of the plastic zip-lock bags. The fluorescence yields and the known lead concentrations were used to develop calibration curves (models) for lead in the two soils; the models were simply linear (or near linear) plots of fluorescence yield versus lead concentration. The two models were stored in the MAP 3 internal computer for use in the field. Based on the linear plots of the laboratory derived lead calibration standards, the lead concentrations of the field samples could be estimated to plus or minus 25 ug/g.

3.2 Onsite Sampling and Analysis

The objective of the XRF screening of soils was to identify soils for which lead concentrations were greater than the permit specified HBN of 200 ug/g. Soils were collected and screened before excavation began in order to establish a baseline database to define areas from which soils needed to be removed. The soils continued to be screened during excavation so that the areas needing excavation could be continously redefined based on the detected lead concentrations. Once an area yielded soil with lead concentrations consistently below the HBN, soil excavation was discontinued and excavation begun on the adjacent soils. This process of screening soils, adjusting excavation areas and final screening of soils was continued until the area needing soil removal was defined and fully excavated.

3.2.1 Soil and Sampling Locations

During the excavation process, samples were collected to determine and limit the excavation process. Samples were collected and located on a locally developed grid coordinate pattern, (see Figure 2 for grid layout). The samples shown on Table 2 are identified by their westing coordinate followed by their northing coordinate. The sample coordinates were

Table 2
Summary of XRF Lead Results
SWMU 69, Pond by Chromic Acid Treatment Tanks
RAAP, Virginia

Sample Identification	Estimated Lead Concentrations (micrograms/grams) Model 1	Model 2
Samples Screened Prior to Excavation		
69SE2	1910	1729
69SO1-2	131	112
69SO2-2	244	213
Red/upslope	99	84
Brown/downslope	182	158
100W10N	148	128
100W20N	191	166
100W30N	233	203
100W40N	205	178
100W50N	329	288
40W10N	139	119
40W20N	131	113
40W30N	150	129
40W40N	128	109
40W50N	89	75
80W50N	148	127
80W60N	257	225
90W50N	160	138
90W60N	440	388
100W60N	330	290
90W10N	124	106
90W20N	0	0
90W30N	62	52
90W40N	34	27

Table 2 (Cont'd)

Sample Identification	Estimated Lead Concentrations (micrograms/grams) Model 1	Model 2
Samples Screened During Excavation		
Black sediment 1	35	27
Black sediment 2	17	12
Flyash/black sed mix	382	336
Flyash	521	461
50W15N–bottom6'	78	66
50W25N–bottom6'	0	0
40W15N–wall2'	3	1
40W35N–wall2'	0	0
40W25N–wall2'	0	0
80W20N–wall	9	7
85W35N–wall	32	25
85W45N–westwall	66	54
80W50N–wall	54	45
90W15N–insidewall	83	70
110W50N	35	28
110W60N	37	29
100W50N	45	36
100W60N	134	115
90W5N	95	81
85W10N	84	70
83W5N	79	66
80W5N–1400	83	73
75W5N–1400	62	51
70W5N–1400	19	13
65W5N–1400	125	104
60W5N–1400	66	55
90W40N–1445	31	24
90W50N–1445	64	53
100W40N–1445	108	102
100W50N–1445	52	43
100W60N–1445	110	94

Table 2 (Cont'd)

Sample Identification	Estimated Lead Concentrations (micrograms/grams) Model 1	Model 2
Samples Screened After Excavation		
70W3N–5'deep		
60W5N–5'deep	0	0
65W3N–5'deep	0	0
75W3N–5'deep	0	0
50W20N–bot–1800	0	0
50W30N–bot–1800	0	0
60W20N–bot–1800	19	14
70W10N–bot–1800	0	0
70W20N–bot–1800	0	0
80W30N–bottom	0	0
45W30N–eastwall	0	0
50W35N–bottom	0	0
80W20N–bottom	0	0
55W25N–bottom	0	0
70W30N–bottom	0	0
60W30N–bottom	0	0
80W40N–bottom	0	0
60W40N–bottom	0	0
70W50N–northwall	0	0
60W50N–northwall	0	0
100W60N	101	86
85W25N–westwall	0	0
75W55N–northwall	0	0
100W50N	15	11
90W40N	34	26
90W50N	74	63
90W60N	71	59

approximated using visual alignments of the westing coordinate and an approximation of the distance north of the west coordinate line. The coordinates are used mostly for sample identification; field determination of where to excavate was based on the actual sample collection location. Where applicable, descriptions such as "wall" or "bottom" have been added to further locate the sample. Screening samples were also collected from the flyash used to stabilize wet sediments and sediment with and without flyash for comparison to background levels and levels of lead in the soils.

3.2.2 Soil and Sediment Sampling Procedures

Soil and sediment samples were collected by placing samples into plastic sealable zip-lock bags using stainless steel spoons decontaminated between uses with distilled water, scrubbing with brushes (if needed) and drying with paper towels. Once collected, samples were transported to the on-site laboratory facilities for XRF analysis for lead. The laboratory was set-up in an office room in Building 4926. After sampling, the soil was returned to the excavation site and added to the soil transported to the landfill.

3.2.3 XRF Analysis for Lead

The unknown soil and sediment XRF screenings were performed through the walls of the plastic bags to simulate the analyses performed on the sample standards. No sample preparation was conducted (i.e., drying, sieving, or grinding), although noncohesive soil/sediment was homogenized inside the baggie by shaking and kneading immediately prior to analysis. From the outset, it was apparent that soil matrix composition and particle size distributions were extremely variable between samples, and also somewhat dissimilar to the two soil types provided for standard preparation. To compensate for the variability, both calibration models were used for each analysis. Calibration model 1 usually yielded slightly higher lead concentrations for the sample unknowns than did calibration model 2. The analyses were performed by "counting" each sample twice for 255 seconds each; the sample was either turned over to expose a new surface for analysis (if cohesive) or remixed (if noncohesive) between runs. The final concentration was taken as the average of the two readings. The laboratory prepared calibration samples were screened periodically during testing to insure that the XRF unit was functioning properly.

3.3 Excavation and Disposal of Contaminated Soil

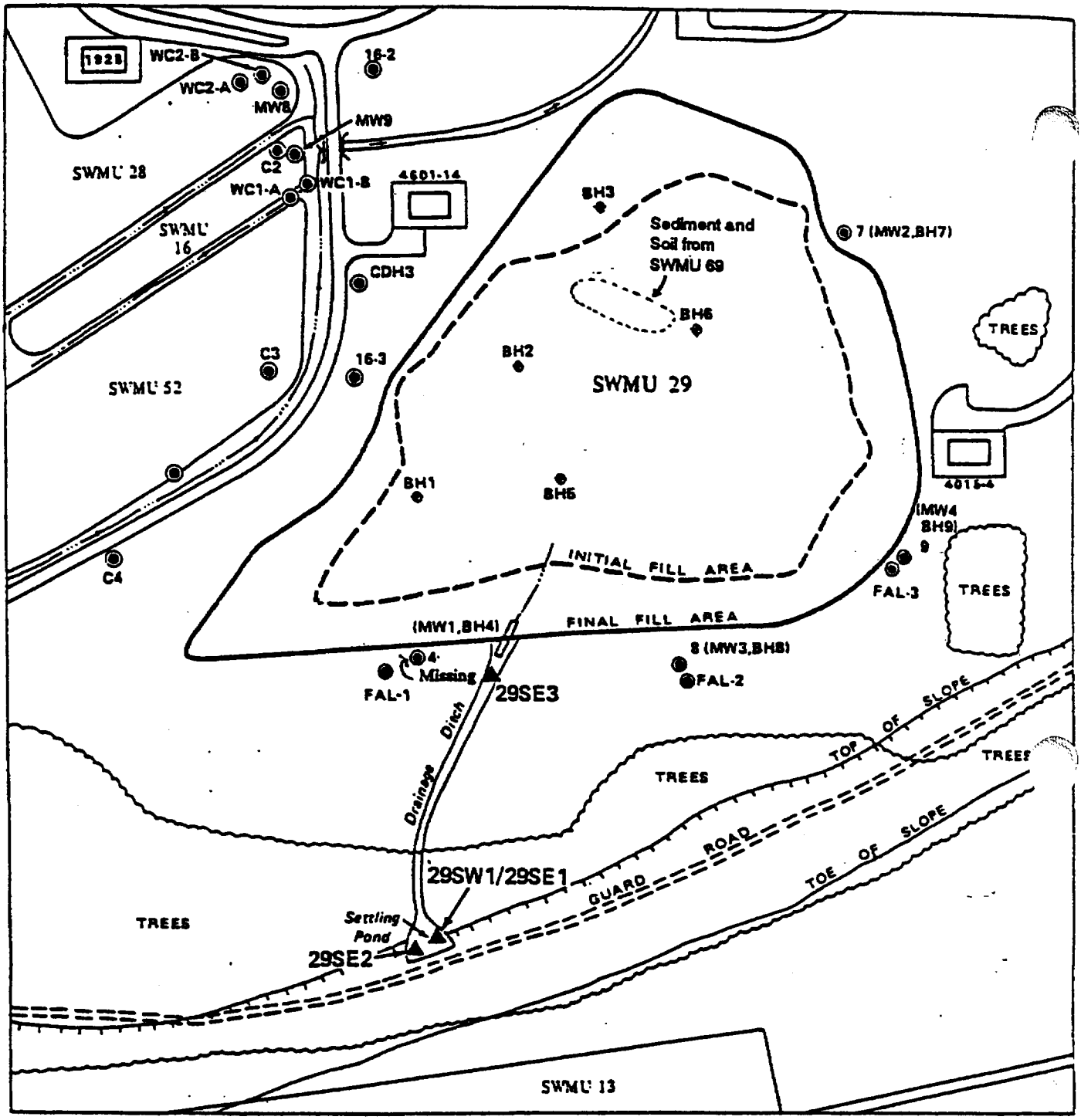
Excavation activities were undertaken to remove sediment and soils with lead constituents. Approximately 3,500 square feet of surface area was disturbed during the excavation of sediment and soil.

The excavated sediments were wet due to water trapped within the low permeability soils underlying the pond and in the berm. Flyash supplied by RAAP, was introduced into the excavation, as necessary, to absorb the water. The flyash was mixed with the sediment and soils and subsequently removed. With the flyash added, approximately 700 cubic yards of material were removed. Excavated materials were hauled to the existing Fly Ash Landfill No. 2, located on-site at RAAP approximately 2 miles east of the site (Figure 3).

4.0 CONFIRMATORY SAMPLING

Eight soil samples were collected from the excavation pit after the soils delineated as material for removal and landfilling were taken to the landfill. One sample (69SO1) was taken from the center of the south wall of the excavation and seven samples (69SO2 through 69SO8) were taken from the floor of the excavation pit (Figure 4). These samples were analyzed for total TAL metals and full TCLP analyses to confirm the XRF screening data, indicating that the lead impacted soils have been identified and removed. Insert 2 in the map pocket is the full size topograhic map of the excavation pit.

As shown on Table 3, only four TCLP parameters were detected in the eight soil samples (barium, cadmium, 2,4-D and chloroform) and no detection exceeded TCLP criteria. The greatest concentration of TCLP of barium detected was 190 ug/L, the greatest cadmium concentration was 5.2 ug/L versus the criterion of 1,000 ug/L, the greatest 2,4-D concentration was 0.37 ug/L versus the criterion of 10,000 ug/L and the greatest chloroform concentration was 6.4 ug/L versus the criterion of 6,000 ug/L. These results agree with the two samples of the pond sediment also submitted for TCLP analysis. Sample 69SE2 was of pond sediment prior to flyash being added and sample 69SL1 was of a mixture of pond sediment and flyash. Concentrations of TCLP barium, 2,4-D and chloroform in these samples were as low as the post excavation soil samples and TCLP cadmium was not detected.



LEGEND:

- Boring
- Monitoring Well
- Surface Water and/or Sediment Sample

N

0 200 Feet

FIGURE 3
DISPOSAL LOCATION OF SWMU 69 SOIL AND SEDIMENT
SWMU 29 – FLY ASH LANDFILL NO. 2
RADFORD ARMY AMMUNITION PLANT, VIRGINIA

Dames & Moore

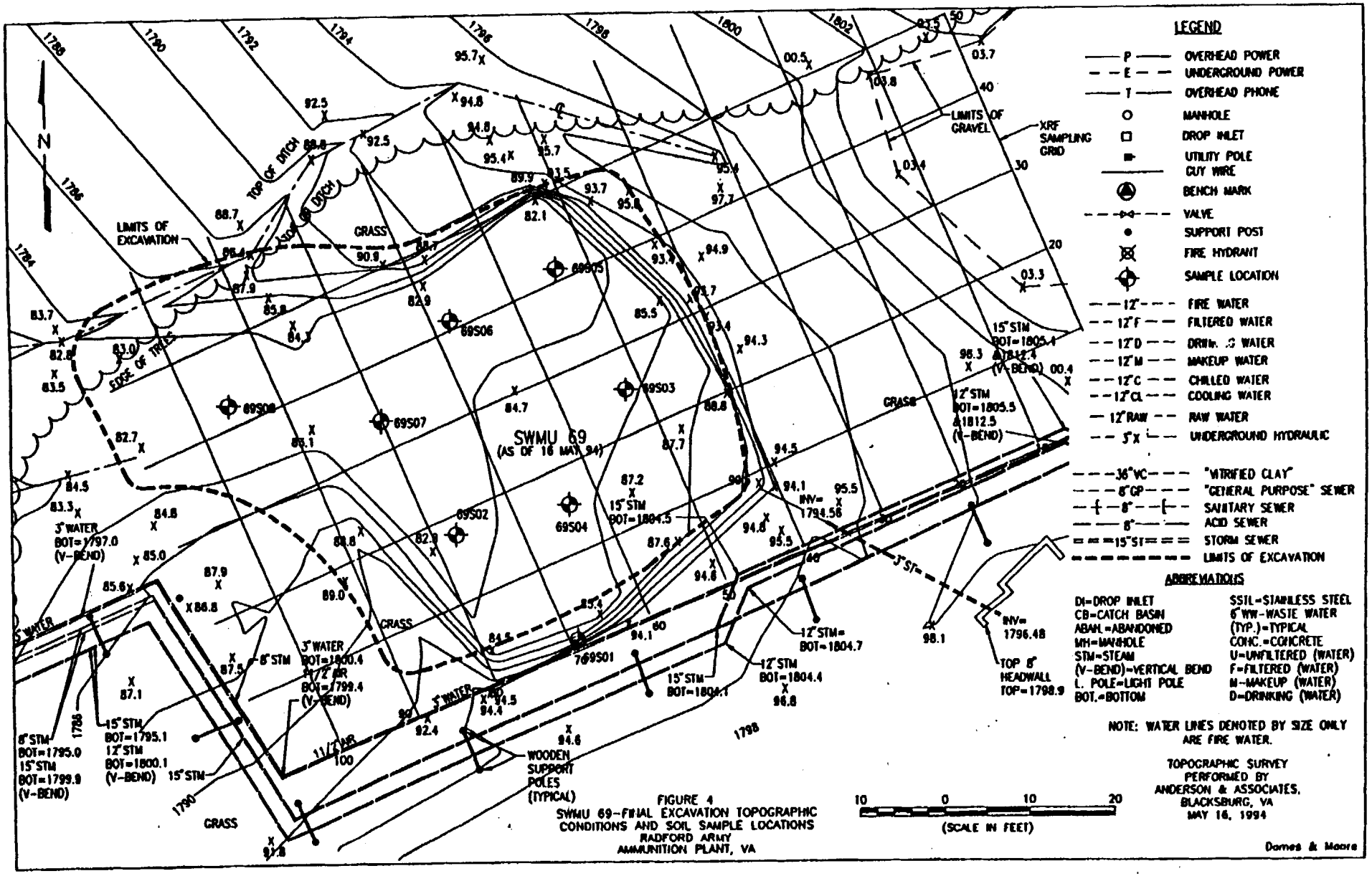


FIGURE 4
SWMU 69-FINAL EXCAVATION TOPOGRAPHIC CONDITIONS AND SOIL SAMPLE LOCATIONS
RADFORD ARMY AMMUNITION PLANT, VA

Table 3
Summary of Analytical Data For Sediment and Confirmatory Soil Samples
SWMU 69 – Pond by Chromic Acid Treatment Tanks
Radford Army Ammunition Plant, Virginia

SITE ID		69SE2	69SL1	69SO1	69SO2	69SO3	
FIELD ID		RDSW*27	RDSW*28	RDSX*17	RDSX*18	RDSX*19	
S. DATE		28-apr-94	29-apr-94	02-may-94	03-may-94	03-may-94	
DEPTH (ft)		3.0	3.0	5.0	0.5	0.5	
MATRIX	PQLs	CSE	CSE	CSO	CSO	CSO	HBN
UNITS	UGG	UGG	UGG	UGG	UGG	UGG	UGG
TAL Metals							
ALUMINUM	14.1	9500	11200	30500	25300	31300	230000
ANTIMONY	20	[60.5]	[83.4]	[64.2]	<7.14	<7.14	30
ARSENIC	30	[1.21]	[1.77]	[3.01]	[3.94]	[4.79]	0.5
BARIUM	1	62.3	90.9	40.6	43.1	45.4	1000
BERYLLIUM	0.2	[0.694]	[1.05]	[1.49]	[2.34]	[2.6]	0.1
CADMIUM	2	<0.7	[65.1]	8.79	<0.7	<0.7	40
CALCIUM	500	4480	12800	3350	577	1120	NSA
CHROMIUM	4	75.9	[443]	50.9	29.9	51.7	400
COBALT	3	[3.14]	[8.7]	[5.84]	[7.41]	[19.7]	0.8
COPPER	7	7.04	43.7	21.6	21.3	28.7	2900
IRON	1000	16200	22600	38700	44600	46500	NSA
LEAD	2	<10.5	169	<10.5	<10.5	<10.5	200
MAGNESIUM	50	966	997	1320	4720	2350	NSA
MANGANESE	0.275	345	647	328	81.8	132	8000
MERCURY	0.1	<0.05	0.0703	0.122	<0.05	<0.05	20
NICKEL	3	13.2	27.5	25.6	29.9	32.7	1000
POTASSIUM	37.5	919	769	1410	2620	1720	NSA
SELENIUM	40	<0.5	1.1	<0.5	<0.5	<0.5	200
SILVER	4	<0.589	<0.589	<0.589	<0.589	<0.589	200
SODIUM	150	1430	4020	4860	3990	4500	NSA
THALLIUM	4	<6.62	[33.2]	[39.1]	[44.9]	[49.5]	6
VANADIUM	0.775	31.9	43.4	64.8	84.9	68.9	560
ZINC	30.2	160	1110	119	28.2	32.7	16000
							TCLP
TCLP Metals	UGL						UGL
BARIUM	20	20	<20	56	79	180	100000
CADMIUM	1	<5	<5	<5	<5	<5	1000
TCLP Organics							
2,4-D	0.2	0.5	0.37	<0.2	0.22	0.21	10000
CHLOROFORM	5	5.3	5.3	5.1	5.4	5.1	6000
Non-TCLP Volatiles[1]							
ACETONE	100	33	GT 50	NT	NT	NT	NSA
METHYLENE CHLORIDE	5	6.1	7.2	NT	NT	NT	NSA
CARBON DISULFIDE	5	4.6	1.7	NT	NT	NT	NSA
TOTAL UNKNOWNS[2]	NA	50(2)	68(4)	NT	NT	NT	NSA

Table 3 (Cont'd)

SITE ID		69SO4	69SO5	69SO6	69SO7	69SO8	
FIELD ID		RDSX*20	RDSX*21	RDSX*22	RDSX*23	RDSX*24	
S. DATE		03-may-94	03-may-94	03-may-94	03-may-94	03-may-94	
DEPTH (ft)		0.5	0.5	0.5	0.5	0.5	
MATRIX	PQLs	CSO	CSO	CSO	CSO	CSO	HBN
UNITS	UGG	UGG	UGG	UGG	UGG	UGG	UGG
TAL Metals							
ALUMINUM	14.1	31700	27500	23600	11400	12700	230000
ANTIMONY	20	24	21.2	<7.14	<7.14	9.91	30
ARSENIC	30	[3.16]	[7.98]	[2.78]	[2.44]	[2.7]	0.5
BARIUM	1	58.3	47.2	53.5	33.4	38	1000
BERYLLIUM	0.2	[2.51]	[2.89]	[2.89]	[1.05]	[1.06]	0.1
CADMIUM	2	<0.7	6.9	<0.7	<0.7	<0.7	40
CALCIUM	500	1530	604	1110	214	556	NSA
CHROMIUM	4	56.7	75.2	41.6	38.2	29.5	400
COBALT	3	[6.94]	[9.25]	[9.69]	[5.76]	[10.4]	0.8
COPPER	7	32.4	27.3	25.6	9.12	9.84	2900
IRON	1000	49500	51500	43000	23600	21900	NSA
LEAD	2	<10.5	24.5	<10.5	<10.5	18.3	200
MAGNESIUM	50	2240	5540	6620	654	940	NSA
MANGANESE	0.275	184	168	243	580	758	8000
MERCURY	0.1	0.124	0.0801	<0.05	0.0701	0.0674	20
NICKEL	3	29.4	29.9	25.9	6.86	5.87	1000
POTASSIUM	37.5	1850	3400	3260	767	781	NSA
SELENIUM	40	<0.5	1	<0.5	<0.5	<0.5	200
SILVER	4	<0.589	<0.589	<0.589	<0.589	<0.589	200
SODIUM	150	4770	4720	3730	2540	1400	NSA
THALLIUM	4	[53.1]	[54.6]	[62.6]	[27.5]	[22.3]	6
VANADIUM	0.775	89.8	74.7	83	49.5	47.5	560
ZINC	30.2	69.1	140	46.8	22.4	33	16000
							TCLP
TCLP Metals	UGL						UGL
BARIUM	20	190	86	120	120	91	100000
CADMIUM	1	<5	<5	<5	5.2	<5	1000
TCLP Organics							
2,4-D	0.2	<0.2	<0.2	<0.2	<0.2	0.37	10000
CHLOROFORM	5	4.9	6.4	5.6	5.8	5.2	6000
Non-TCLP Volatiles							
ACETONE	10	NT	NT	NT	NT	NT	NSA
METHYLENE CHLORIDE	5	NT	NT	NT	NT	NT	NSA
CARBON DISULFIDE	5	NT	NT	NT	NT	NT	NSA
TOTAL UNKNOWNS	NA	NT	NT	NT	NT	NT	NSA

Footnotes :

CSO = Chemical soil. CSE = Chemical sediment. UGG = Micrograms per gram. UGL = Micrograms per liter.

TAL = Target Analyte List. TCLP = Toxicity Characteristic Leaching Procedure

HBN = Health based number as defined in the RCRA permit. HBNs not specified in the permit were derived using standard exposure and intake assumptions consistent with EPA guidelines (51 Federal Register 33992, 34006, 34014, and 34028).

NSA = No standard (HBN) available; health effects data were not available for the calculation of a HBN; or volatile was analyzed from TCLP extraction leachate.

NA = Not available. NT = Not tested.

GT = Greater than equipment calibration range. < = Less than method detection limit.

PQL = Practical quantitation limit; the lowest concentration that can be reliably detected at a defined level of precision for a given analytical method.

[1] = TCLP extraction leachate analyzed for TCL volatiles for pond sediment samples.

[2] = Total concentation of unknowns with number of detected unknowns in parenthesis.

[ ] = Brackets indicate that the detected concentration exceeds the HBN.

The samples of the sediment and sediment/flyash mixture were collected during the excavation of the pond and surrounding soils. During excavation, it was noted that the pond appeared to have two layers of material; 1) a 1 foot thick, light gray top layer which was tested in 1992 and found to have excessive lead concentration, and 2) several feet of dark greenish gray to black sediments underlying the gray layer and extending to the bottom of the engineered pond. Analyses of the pond material indicated that the sediments also contained low concentrations of two common cleaning solvents (acetone and methylene chloride) and low concentrations of carbon disulfide which is usally associated with decompositon of organic material.

The eight soil samples were analyzed for total TAL metals to document that the lead concentrations were below the permit HBN of 200 ug/g. Lead was detected above the detection limit (10.5 ug/g) in only two samples at concentrations of 24.5 ug/g and 18.3 ug/g. The concentrations of four metals (arsenic, beryllium, cobalt and thallium) exceeded the permit HBNs in each of the eight samples, but the detected concentrations appear to be natural since they vary very little from sample to sample. Arsenic ranged from 2.44 to 7.98 ug/g, beryllium ranged from 1.05 to 2.89 ug/g, cobalt ranged from 5.76 to 19.7 ug/g and thallium ranged from 22.3 to 62.6 ug/g. The only other exceedance of a permit HBN was for antimony in sample 69SO1. This antimony concentration is similar to the concentrations detected in the pond sediment and sediment/flyash mixture which could indicate that the sampled soil may have included some pond sediment or flyash. However, the lead concentration in this sample was below the detection limit.

In summary, the analytical data for the confirmatory samples show that the impacted pond soils were adequately defined by the XRF screening and subsequently removed for disposal in the RAAP landfill.

5.0 BACKFILL AND FINAL GRADING

After the confirmatory sampling activities were completed, the excavation was backfilled with clean fill as supplied by RAAP. The site was regraded to provide a natural drainage course in conformance with upstream and downstream conditions. A final survey of the regraded area is shown in Figure 5 and the full size topographic map of the final graded site is included as Insert 3.

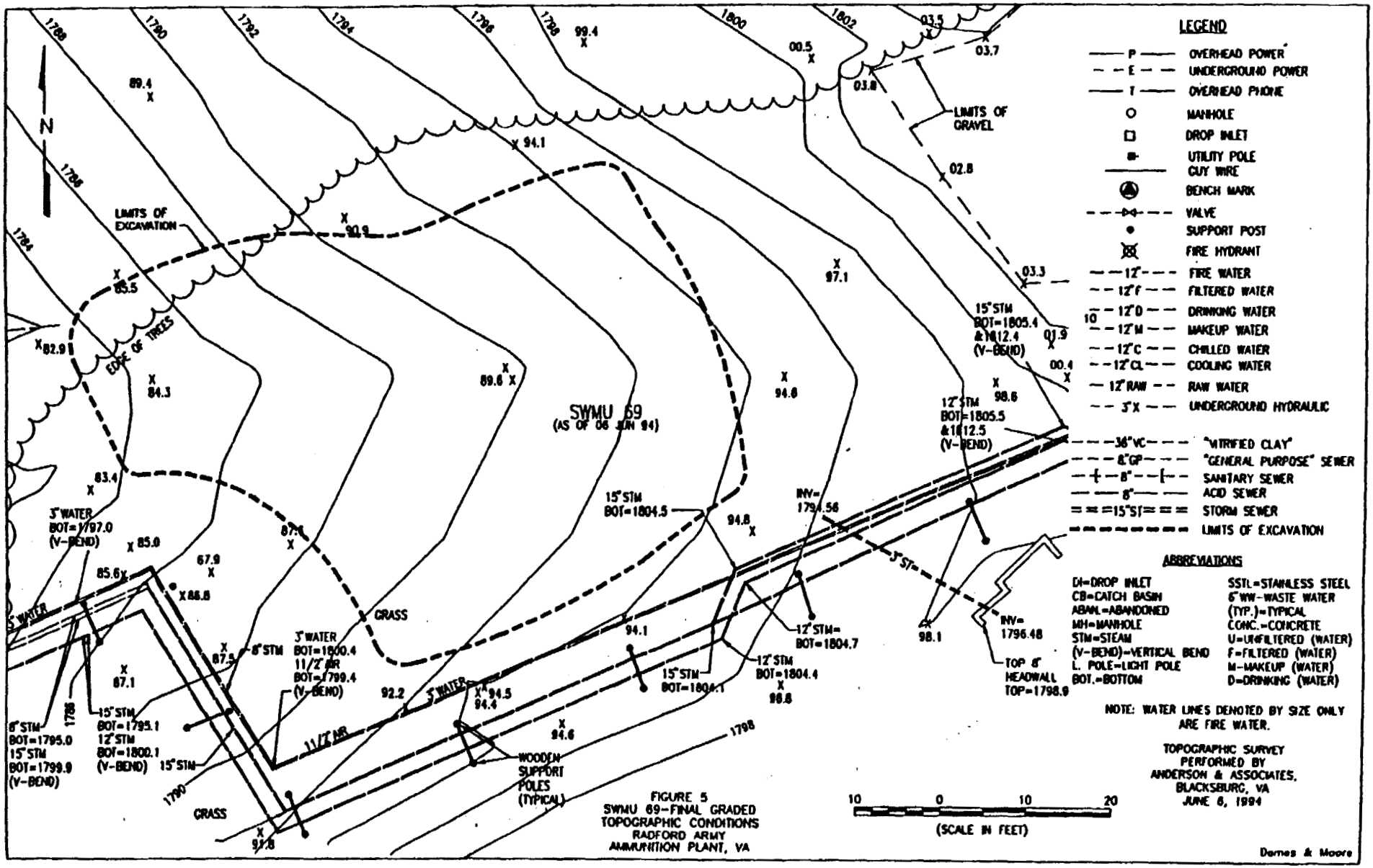


FIGURE 5
SWMU 69-FINAL GRADED TOPOGRAPHIC CONDITIONS
RADFORD ARMY AMMUNITION PLANT, VA

6.0 CONCLUSIONS

Based upon the interim measures taken and the corresponding confirmatory sampling activities, impacted pond sediments and associated soils containing lead above the HBN have been removed from SWMU 69 and the surrounding vicinity. Analytical data of samples of the pond sediment and sediment/flyash mixture indicate that all TCLP parameters were below TCLP criteria. Analytical data for soil samples collected indicates that the concentrations of metals in soils remaining at the site after excavation were also below TCLP criteria.

BIBLIOGRAPHY

Dames & Moore, 1992. Verification Investigation, Radford Army Ammunition Plant, Radford, Virginia (Final Draft). Prepared for the U.S. Army Toxic and Hazardous Materials Agency.

U.S. Environmental Protection Agency (USEPA), 1987. RCRA Facility Assessment of Radford Army Ammunition Plant, Radford, Virginia.

U.S. Environmental Protection Agency (USEPA), 1987. Permit for Corrective Action and Incinertor Operation, Radford Army Ammunition Plant, Radford, Virginia.

APPENDIX A

Laboratory Analytical Data

Final Documentation Appendix Report
Installation :Radford AAP, VA (RD)
File Type: CSE
Sampling Date Range: 01-JAN-94 23-AUG-94

Site Type	Site ID	Field Sample No.	Depth	Sample Date	Lab	Lab Anly. No.	Meth/ Matrix	CAS No.	Analyte Description	Meas. Qual.	Conc.	Unit Meas.	Flag Codes	Data Quals
BASN	69SE2	RDSX*27	3.0	28-APR-94	ES	RDSX*27	JB01/S	39-97-6	Mercury	LT	5.00 E -2	UGG		
							JD15/S	82-49-2	Selenium	LT	.5	UGG		
							JD19/S	40-38-2	Arsenic		1.21	UGG		
							JS16/S	29-90-5	Aluminum		9500	UGG		
								39-89-6	Iron		16200	UGG		
								39-92-1	Lead	LT	10.5	UGG		
								39-95-4	Magnesium		966	UGG		
								39-96-5	Manganese		345	UGG		
								40-02-0	Nickel		13.2	UGG		
								40-09-7	Potassium		919	UGG		
								40-22-4	Silver	LT	.589	UGG		
								40-23-5	Sodium		1430	UGG		
								40-28-0	Thallium	LT	6.62	UGG		
								40-36-0	Antimony		60.5	UGG		
								40-39-3	Barium		62.3	UGG		
								40-41-7	Beryllium		.694	UGG		
								40-43-9	Cadmium	LT	.7	UGG		
								40-47-3	Chromium		75.9	UGG		
								40-48-4	Cobalt		3.14	UGG		
								40-50-8	Copper		7.04	UGG		
								40-62-2	Vanadium		31.9	UGG		
								40-66-6	Zinc		160	UGG		
								40-70-2	Calcium		4480	UGG		
		RDSXL*15	3.0	10-MAY-94	ES	RDSXL*15	UM20/W	00-41-4	Ethylbenzene	LT	.5	UGL		
								00-42-5	Styrene / Ethenylbenzene / Styrol / Styrolene / Cinnamene *	LT	.5	UGL		
								07-02-8	Acrolein	ND	100	UGL	R	
								07-06-2	1,2-Dichloroethane	LT	.5	UGL		
								07-13-1	Acrylonitrile	ND	100	UGL	R	
								08-05-4	Vinyl acetate / Acetic acid vinyl ester	LT	8.3	UGL		
								08-10-1	Methyl isobutyl ketone / Isopropylacetone / 4-Methyl-2-pen*	LT	3	UGL		
								08-88-3	Toluene	LT	.5	UGL		
								08-90-7	Chlorobenzene / Monochlorobenzene	LT	.5	UGL		
								10-75-8	2-Chloroethyl vinyl ether / (2-Chloroethoxy)ethene	LT	.71	UGL		
								10061-01-5	cis-1,3-Dichloropropylene / cis-1,3-Dichloropropene	LT	.58	UGL		
								1330-20-7	Xylenes	LT	.84	UGL		
								24-48-1	Dibromochloromethane / Chlorodibromomethane	LT	.67	UGL		
								27-18-4	Tetrachloroethylene / Tetrachloroethene / Perchloroethylen*	LT	1.6	UGL		

* - Analyte Description has been truncated. See Data Dictionary

88)

BIBLIOGRAPHY

Dames & Moore, 1992. Verification Investigation, Radford Army Ammunition Plant, Radford, Virginia (Final Draft). Prepared for the U.S. Army Toxic and Hazardous Materials Agency.

U.S. Environmental Protection Agency (USEPA), 1987. RCRA Facility Assessment of Radford Army Ammunition Plant, Radford, Virginia.

U.S. Environmental Protection Agency (USEPA), 1987. Permit for Corrective Action and Incinertor Operation, Radford Army Ammunition Plant, Radford, Virginia.

Final Documentation Appendix Report
Installation :Redford AAP, VA (RD)
File Type: CSE
Sampling Date Range: 01-JAN-94 23-AUG-94

Site Type	Site ID	Field Sample No.	Depth	Sample Date	Lab	Lab Anly. No.	Meth/ Matrix	CAS No.	Analyte Description	Meas. Bool.	Conc.	Unit Meas.	Flag Codes	Data Quals
BASN	69SE2	RDSX*27	3.0	28-APR-94	ES	RDSX*27	JB01/S	39-97-6	Mercury	LT	5.00 E -2	UGG		
							JD15/S	82-49-2	Selenium	LT	.5	UGG		
							JD19/S	40-38-2	Arsenic		1.21	UGG		
							JS16/S	29-90-5	Aluminum		9500	UGG		
								39-89-6	Iron		16200	UGG		
								39-92-1	Lead	LT	10.5	UGG		
								39-95-4	Magnesium		966	UGG		
								39-96-5	Manganese		345	UGG		
								40-02-0	Nickel		13.2	UGG		
								40-09-7	Potassium		919	UGG		
								40-22-4	Silver	LT	.589	UGG		
								40-23-5	Sodium		1430	UGG		
								40-28-0	Thallium	LT	6.62	UGG		
								40-36-0	Antimony		60.5	UGG		
								40-39-3	Barium		62.3	UGG		
								40-41-7	Beryllium		.694	UGG		
								40-43-9	Cadmium	LT	.7	UGG		
								40-47-3	Chromium		75.9	UGG		
								40-48-4	Cobalt		3.14	UGG		
								40-50-8	Copper		7.04	UGG		
								40-62-2	Vanadium		31.9	UGG		
								40-66-6	Zinc		160	UGG		
								40-70-2	Calcium		4480	UGG		
		RDSXL*15	3.0	10-MAY-94	ES	RDSXL*15	UM20/W	00-41-4	Ethylbenzene	LT	.5	UGL		
								00-42-5	Styrene / Ethenylbenzene / Styrol / Styrolene / Cinnamene *	LT	.5	UGL		
								07-02-8	Acrolein	ND	100	UGL	R	
								07-06-2	1,2-Dichloroethane	LT	.5	UGL		
								07-13-1	Acrylonitrile	ND	100	UGL	R	
								08-05-4	Vinyl acetate / Acetic acid vinyl ester	LT	8.3	UGL		
								08-10-1	Methyl isobutyl ketone / Isopropylacetone / 4-Methyl-2-pen*	LT	3	UGL		
								08-88-3	Toluene	LT	.5	UGL		
								08-90-7	Chlorobenzene / Monochlorobenzene	LT	.5	UGL		
								10-75-8	2-Chloroethyl vinyl ether / (2-Chloroethoxy)ethene	LT	.71	UGL		
								10061-01-5	cis-1,3-Dichloropropylene / cis-1,3-Dichloropropene	LT	.58	UGL		
								1330-20-7	Xylenes	LT	.84	UGL		
								24-48-1	Dibromochloromethane / Chlorodibromomethane	LT	.67	UGL		
								27-18-4	Tetrachloroethylene / Tetrachloroethene / Perchloroethylen*	LT	1.6	UGL		

* - Analyte Description has been truncated. See Data Dictionary

Final Documentation Appendix Report
Installation :Radford AAP, VA (RD)
File Type: CSE
Sampling Date Range: 01-JAN-94 23-AUG-94

Site Type	Site ID	Field Sample No.	Depth	Sample Date	Lab	Lab Anly. No.	Meth/ Matrix	CAS No.	Analyte Description	Meas. Bool.	Conc.	Unit Meas.	Flag Codes	Data Quali
BASN	69SE2	RDSXL*15	3.0	10-MAY-94	ES	RDSXL*15	UM20/W	56-23-5	Carbon tetrachloride	LT	.58	UGL		
								591-78-6	Methyl n-butyl ketone / 2-Hexanone	LT	3.6	UGL		
								67-64-1	Acetone		33	UGL		
								67-66-3	Chloroform		5.3	UGL		
								71-43-2	Benzene	LT	.5	UGL		
								71-55-6	1,1,1-Trichloroethane	LT	.5	UGL		
								74-83-9	Bromomethane	LT	5.8	UGL		
								74-87-3	Chloromethane	LT	3.2	UGL		
								75-00-3	Chloroethane	LT	1.9	UGL		
								75-01-4	Vinyl chloride / Chloroethene	LT	2.6	UGL		
								75-09-2	Methylene chloride / Dichloromethane		6.1	UGL		
								75-15-0	Carbon disulfide		4.6	UGL		
								75-25-2	Bromoform	LT	2.6	UGL		
								75-27-4	Bromodichloromethane	LT	.59	UGL		
								75-34-3	1,1-Dichloroethane	LT	.68	UGL		
								75-35-4	1,1-Dichloroethylene / 1,1-Dichloroethene	LT	.5	UGL		
								75-69-4	Trichlorofluoromethane	LT	1.4	UGL		
								78-87-5	1,2-Dichloropropene	LT	.5	UGL		
								78-93-3	Methyl ethyl ketone / 2-Butanone	LT	6.4	UGL		
								79-00-5	1,1,2-Trichloroethane	LT	1.2	UGL		
								79-01-6	Trichloroethylene /Trichloroethene / Ethinyl trichloride /T*	LT	.5	UGL		
								79-34-5	Tetrachloroethane / 1,1,2,2-Tetrachloroethane / Acetylene *	LT	.51	UGL		
									1,2-Dichloroethylenes (cis and trans isomers) / Acetylene *	LT	.5	UGL		
									Dichlorobenzenes	ND	10	UGL	R	
									Unknown compound 097		30	UGL	S	
									Unknown compound 112		20	UGL	S	
									trans-1,3-Dichloropropene	LT	.7	UGL		
		RDSXL*27	3.0	09-MAY-94	ES	RDSXL*27	1311/W	39-92-1	Lead	LT	50	UGL		
								39-97-6	Mercury	LT	.2	UGL		
								40-22-4	Silver	LT	5	UGL		
								40-38-2	Arsenic	LT	100	UGL		
								40-39-3	Barium		20	UGL		
								40-43-9	Cadmium	LT	5	UGL		
								40-47-3	Chromium	LT	10	UGL		
								82-49-2	Selenium	LT	100	UGL		
							8080/W	01-35-2	Toxaphene / Chlorinated camphene / Camphechlor / Alltox / *	LT	5	UGL		
								24-57-3	Heptachlor epoxide	LT	5.0 E -2	UGL		
								57-74-9	Chlordane	LT	.25	UGL		
								58-89-9						

* - Analyte Description has been truncated. See Data Dictionary

Final Documentation Appendix Report
Installation :Radford AAP, VA (RD)
File Type: CSE
Sampling Date Range: 01-JAN-94 23-AUG-94

Site Type	Site ID	Field Sample No.	Depth	Sample Date	Lab	Lab Anly. No.	Meth/ Metrix	CAS No.	Analyte Description	Meas. Bool.	Conc.	Unit Meas.	Flag Codes	Data Quals
BASN	69SE2	RDSXL*27	3.0	09-MAY-94	ES	RDSXL*27	8080/W	58-89-9	Lindane / gamma-Benzene hexachloride / gamma-Hexachlorocyc*	LT	5.0 E -2	UGL		
								72-20-8	Endrin	LT	5.0 E -2	UGL		
								72-43-5	Methoxychlor / Methoxy-DDT / 1,1'-(2,2,2-Trichloroethylide*	LT	5.0 E -2	UGL		
								76-44-8	Heptachlor / 1H-1,4,5,6,7,8,8-Heptachloro-3a,4,7,7a-tetrah*	LT	5.0 E -2	UGL		
							8150/W	93-72-1	245TP / silvex / 2-(2,4,5-Trichlorophenoxy)propionic acid *	LT	.2	UGL		
								94-75-7	2,4-D / 2,4-Dichlorophenoxyacetic acid		.5	UGL		
							8270/W	06-44-5	p-Cresol / 4-Cresol / 4-Methylphenol	LT	20	UGL		
								06-46-7	1,4-Dichlorobenzene	LT	10	UGL		
								08-39-4	m-Cresol / 3-Cresol / 3-Methylphenol	LT	10	UGL		
								10-86-1	Pyridine	LT	100	UGL		
								18-74-1	Hexachlorobenzene	LT	20	UGL		
								21-14-2	2,4-Dinitrotoluene	LT	20	UGL		
								67-72-1	Hexachloroethane	LT	20	UGL		
								87-68-3	Hexachlorobutadiene / Hexachloro-1,3-butadiene	LT	20	UGL		
								87-86-5	Pentachlorophenol	LT	40	UGL		
								88-06-2	2,4,6-Trichlorophenol	LT	30	UGL		
								95-48-7	o-Cresol / 2-Cresol / 2-Methylphenol	LT	20	UGL		
								95-95-4	2,4,5-Trichlorophenol	LT	30	UGL		
								98-95-3	Nitrobenzene / Essence of mirbane / Oil of mirbane	LT	10	UGL		
	69SL1	RDSX*28	3.0	29-APR-94	ES	RDSX*28	JB01/S	39-97-6	Mercury		7.03 E -2	UGG		
							JD15/S	82-49-2	Selenium		1.1	UGG		
							JD19/S	40-38-2	Arsenic		1.77	UGG		
							JS16/S	29-90-5	Aluminum		11200	UGG		
								39-89-6	Iron		22600	UGG		
								39-92-1	Lead		169	UGG		
								39-95-4	Magnesium		997	UGG		
								39-96-5	Manganese		647	UGG		
								40-02-0	Nickel		27.5	UGG		
								40-09-7	Potassium		769	UGG		
								40-22-4	Silver	LT	.589	UGG		
								40-23-5	Sodium		4020	UGG		
								40-28-0	Thallium		33.2	UGG		
								40-36-0	Antimony		83.4	UGG		
								40-39-3	Barium		90.9	UGG		
								40-41-7	Beryllium		1.05	UGG		
								40-43-9	Cadmium		65.1	UGG		
								40-47-3	Chromium		443	UGG		

* - Analyte Description has been truncated. See Data Dictionary

Final Documentation Appendix Report
Installation :Radford AAP, VA (RD)
File Type: CSE
Sampling Date Range: 01-JAN-94 23-AUG-94

Site Type	Site ID	Field Sample No.	Depth	Sample Date	Lab	Lab Anly. No.	Meth/ Matrix	CAS No.	Analyte Description	Meas. Bool.	Conc.	Unit Meas.	Flag Codes	Data Quals
BASN	69SL1	RDSX*28	3.0	29-APR-94	ES	RDSX*28	JS16/S	40-48-4	Cobalt		8.7	UGG		
								40-50-8	Copper		43.7	UGG		
								40-62-2	Vanadium		43.4	UGG		
								40-66-6	Zinc		1110	UGG		
								40-70-2	Calcium		12800	UGG		
		RDSXL*16	3.0	10-MAY-94	ES	RDSXL*16	UM20/W	00-41-4	Ethylbenzene	LT	.5	UGL		
								00-42-5	Styrene / Ethenylbenzene / Styrol / Styrolene / Cinnamene *	LT	.5	UGL		
								07-02-8	Acrolein	ND	100	UGL	R	
								07-06-2	1,2-Dichloroethene	LT	.5	UGL		
								07-13-1	Acrylonitrile	ND	100	UGL	R	
								08-05-4	Vinyl acetate / Acetic acid vinyl ester	LT	8.3	UGL		
								08-10-1	Methyl isobutyl ketone / Isopropylacetone / 4-Methyl-2-pen*	LT	3	UGL		
								08-88-3	Toluene	LT	.5	UGL		
								08-90-7	Chlorobenzene / Monochlorobenzene	LT	.5	UGL		
								10-75-8	2-Chloroethyl vinyl ether / (2-Chloroethoxy)ethene	LT	.71	UGL		
								10061-01-5	cis-1,3-Dichloropropylene / cis-1,3-Dichloropropene	LT	.58	UGL		
								1330-20-7	Xylenes	LT	.84	UGL		
								24-48-1	Dibromochloromethane / Chlorodibromomethane	LT	.67	UGL		
								27-18-4	Tetrachloroethylene / Tetrachloroethene / Perchloroethylen*	LT	1.6	UGL		
								56-23-5	Carbon tetrachloride	LT	.58	UGL		
								591-78-6	Methyl n-butyl ketone / 2-Hexanone	LT	3.6	UGL		
								67-64-1	Acetone	GT	50	UGL		
								67-66-3	Chloroform		5.3	UGL		
								71-43-2	Benzene	LT	.5	UGL		
								71-55-6	1,1,1-Trichloroethane	LT	.5	UGL		
								74-83-9	Bromomethane	LT	5.8	UGL		
								74-87-3	Chloromethane	LT	3.2	UGL		
								75-00-3	Chloroethane	LT	1.9	UGL		
								75-01-4	Vinyl chloride / Chloroethene	LT	2.6	UGL		
								75-09-2	Methylene chloride / Dichloromethane		7.2	UGL		
								75-15-0	Carbon disulfide		1.7	UGL		
								75-25-2	Bromoform	LT	2.6	UGL		
								75-27-4	Bromodichloromethane	LT	.59	UGL		
								75-34-3	1,1-Dichloroethane	LT	.68	UGL		
								75-35-4	1,1-Dichloroethylene / 1,1-Dichloroethene	LT	.5	UGL		
								75-69-4	Trichlorofluoromethane	LT	1.4	UGL		

* - Analyte Description has been truncated. See Data Dictionary

Final Documentation Appendix Report
Installation :Radford AAP, VA (RD)
File Type: CSE
Sampling Date Range: 01-JAN-94 23-AUG-94

Site Type	Site ID	Field Sample No.	Depth	Sample Date	Lab	Lab Anly. No.	Meth/ Matrix	CAS No.	Analyte Description	Meas. Bool.	Conc.	Unit Meas.	Flag Codes	Data Quals
BASN	69SL1	RDSXL*16	3.0	10-MAY-94	ES	RDSXL*16	UM20/W	78-87-5	1,2-Dichloropropane	LT	.5	UGL		
								78-93-3	Methyl ethyl ketone / 2-Butanone	LT	6.4	UGL		
								79-00-5	1,1,2-Trichloroethane	LT	1.2	UGL		
								79-01-6	Trichloroethylene /Trichloroethene / Ethinyl trichloride /T*	LT	.5	UGL		
								79-34-5	Tetrachloroethene / 1,1,2,2-Tetrachloroethane / Acetylene *	LT	.51	UGL		
									1,2-Dichloroethylenes (cis and trans isomers) / Acetylene *	LT	.5	UGL		
									Dichlorobenzenes	ND	10	UGL	R	
									Unknown compound 075		10	UGL	S	
									Unknown compound 097		30	UGL	S	
									Unknown compound 112		20	UGL	S	
									Unknown compound 144		8	UGL	S	
									trans-1,3-Dichloropropene	LT	.7	UGL		
		RDSXL*28	3.0	09-MAY-94	ES	RDSXL*28	1311/W	39-92-1	Lead	LT	50	UGL		
								39-97-6	Mercury	LT	.2	UGL		
								40-22-4	Silver	LT	5	UGL		
								40-38-2	Arsenic	LT	100	UGL		
								40-39-3	Barium	LT	20	UGL		
								40-43-9	Cadmium	LT	5	UGL		
								40-47-3	Chromium	LT	10	UGL		
								82-49-2	Selenium	LT	100	UGL		
							8080/W	01-35-2	Toxaphene / Chlorinated camphene / Camphechlor / Alltox / *	LT	5	UGL		
								24-57-3	Heptachlor epoxide	LT	5.0 E -2	UGL		
								57-74-9	Chlordane	LT	.25	UGL		
								58-89-9	Lindane / gamma-Benzene hexachloride / gamma-Hexachlorocyc*	LT	5.0 E -2	UGL		
								72-20-8	Endrin	LT	5.0 E -2	UGL		
								72-43-5	Methoxychlor / Methoxy-DDT / 1,1'-(2,2,2-Trichloroethylide*	LT	5.0 E -2	UGL		
								76-44-8	Heptachlor / 1H-1,4,5,6,7,8,8-Heptachloro-3a,4,7,7a-tetrah*	LT	5.0 E -2	UGL		
							8150/W	93-72-1	245TP / Silvex / 2-(2,4,5-Trichlorophenoxy)propionic acid *	LT	.2	UGL		
								94-75-7	2,4-D / 2,4-Dichlorophenoxyacetic acid		.37	UGL		
							8270/W	06-44-5	p-Cresol / 4-Cresol / 4-Methylphenol	LT	20	UGL		
								06-46-7	1,4-Dichlorobenzene	LT	10	UGL		
								08-39-4	m-Cresol / 3-Cresol / 3-Methylphenol	LT	10	UGL		
								10-86-1	Pyridine	LT	100	UGL		
								18-74-1	Hexachlorobenzene	LT	20	UGL		
								21-14-2	2,4-Dinitrotoluene	LT	20	UGL		

* - Analyte Description has been truncated. See Data Dictionary

Final Documentation Appendix Report
Installation :Redford AAP, VA (RD)
File Type: CSE
Sampling Date Range: 01-JAN-94 23-AUG-94

Site Type	Site ID	Field Sample No.	Depth	Sample Date	Lab	Lab Anly. No.	Meth/ Matrix	CAS No.	Analyte Description	Meas. Bool.	Conc.	Unit Meas.	Flag Codes	Data Quals
BASN	69SL1	RDSXL*28	3.0	09-MAY-94	ES	RDSXL*28	8270/W	67-72-1	Hexachloroethane	LT	20	UGL		
								87-68-3	Hexachlorobutadiene / Hexachloro-1,3-butadiene	LT	20	UGL		
								87-86-5	Pentachlorophenol	LT	40	UGL		
								88-06-2	2,4,6-Trichlorophenol	LT	30	UGL		
								95-48-7	o-Cresol / 2-Cresol / 2-Methylphenol	LT	20	UGL		
								95-95-4	2,4,5-Trichlorophenol	LT	30	UGL		
								98-95-3	Nitrobenzene / Essence of mirbane / Oil of mirbane	LT	10	UGL		

** End of Report - 190 Records Found **

* - Analyte Description has been truncated. See Data Dictionary

Installation :Radford AAP, VA (RD)
File Type: CSO
Sampling Date Range: 01-JAN-94 23-AUG-94

Site Type	Site ID	Field Sample No.	Depth	Sample Date	Lab	Lab Anly. No.	Meth/ Matrix	CAS No.	Analyte Description	Meas. Bool.	Conc.	Unit Meas.	Flag Codes	Data Quals
PLUG	69501	RDSX*17	5.0	02-MAY-94	ES	RDSX*17	JB01/S	39-97-6	Mercury		.122	UGG		
							JD15/S	82-49-2	Selenium	LT	.5	UGG		
							JD19/S	40-38-2	Arsenic		3.01	UGG		
							JS16/S	29-90-5	Aluminum		30500	UGG		
								39-89-6	Iron		38700	UGG		
								39-92-1	Lead	LT	10.5	UGG		
								39-95-4	Magnesium		1320	UGG		
								39-96-5	Manganese		328	UGG		
								40-02-0	Nickel		25.6	UGG		
								40-09-7	Potassium		1410	UGG		
								40-22-4	Silver	LT	.589	UGG		
								40-23-5	Sodium		4860	UGG		
								40-28-0	Thallium		39.1	UGG		
								40-36-0	Antimony		64.2	UGG		
								40-39-3	Barium		40.6	UGG		
								40-41-7	Beryllium		1.49	UGG		
								40-43-9	Cadmium		8.79	UGG		
								40-47-3	Chromium		50.9	UGG		
								40-48-4	Cobalt		5.84	UGG		
								40-50-8	Copper		21.6	UGG		
								40-62-2	Vanadium		64.8	UGG		
								40-66-6	Zinc		119	UGG		
								40-70-2	Calcium		3350	UGG		
		RDSXL*17	5.0	09-MAY-94	ES	RDSXL*17	1311/W	39-92-1	Lead	LT	50	UGL		
								39-97-6	Mercury	LT	.2	UGL		
								40-22-4	Silver	LT	5	UGL		
								40-38-2	Arsenic	LT	100	UGL		
								40-39-3	Barium		56	UGL		
								40-43-9	Cadmium	LT	5	UGL		
								40-47-3	Chromium	LT	10	UGL		
								82-49-2	Selenium	LT	100	UGL		
							8080/W	01-35-2	Toxaphene / Chlorinated camphene / Camphechlor / Alltox / *	LT	5	UGL		
								24-57-3	Heptachlor epoxide	LT	5.0 E -2	UGL		
								57-74-9	Chlordane	LT	.25	UGL		
								58-89-9	Lindane / gamma-Benzene hexachloride / gamma-Hexachlorocyc*	LT	5.0 E -2	UGL		
								72-20-8	Endrin	LT	5.0 E -2	UGL		
								72-43-5	Methoxychlor / Methoxy-DDT / 1,1'-(2,2,2-Trichloroethylide*	LT	5.0 E -2	UGL		
								76-44-8	Heptachlor / 1H-1,4,5,6,7,8,8-Heptachloro-3a,4,7,7a-tetrah*	LT	5.0 E -2	UGL		
							8150/W	93-72-1	245TP / Silvex / 2-(2,4,5-Trichlorophenoxy)propionic acid *	LT	.2	UGL		

* - Analyte Description has been truncated. See Data Dictionary

Final Documentation Appendix Report
Installation :Radford AAP, VA (RD)
File Type: CSO
Sampling Date Range: 01-JAN-94 23-AUG-94

Site Type	Site ID	Field Sample No.	Depth	Sample Date	Lab	Lab Anly. No.	Meth/ Matrix	CAS No.	Analyte Description	Meas. Bool.	Conc.	Unit Meas.	Flag Codes	Data Quals
PLUG	69S01	RDSXL*17	5.0	09-MAY-94	ES	RDSXL*17	8150/W	94-75-7	2,4-D / 2,4-Dichlorophenoxyacetic acid	LT	.2	UGL		
							8240/W	07-06-2	1,2-Dichloroethane	LT	2.5	UGL		
								08-90-7	Chlorobenzene / Monochlorobenzene	LT	1.4	UGL		
								27-18-4	Tetrachloroethylene / Tetrachloroethene / Perchloroethylen*	LT	1.9	UGL		
								56-23-5	Carbon tetrachloride	LT	2.6	UGL		
								67-66-3	Chloroform		5.1	UGL		
								71-43-2	Benzene	LT	1	UGL		
								75-01-4	Vinyl chloride / Chloroethene	LT	4.6	UGL		
								75-35-4	1,1-Dichloroethylene / 1,1-Dichloroethene	LT	3.2	UGL		
								78-93-3	Methyl ethyl ketone / 2-Butanone	LT	10	UGL		
								79-01-6	Trichloroethylene /Trichloroethene / Ethinyl trichloride /T*	LT	3	UGL		
							8270/W	06-44-5	p-Cresol / 4-Cresol / 4-Methylphenol	LT	20	UGL		
								06-46-7	1,4-Dichlorobenzene	LT	10	UGL		
								08-39-4	m-Cresol / 3-Cresol / 3-Methylphenol	LT	10	UGL		
								10-86-1	Pyridine	LT	100	UGL		
								18-74-1	Hexachlorobenzene	LT	20	UGL		
								21-14-2	2,4-Dinitrotoluene	LT	20	UGL		
								67-72-1	Hexachloroethane	LT	20	UGL		
								87-68-3	Hexachlorobutadiene / Hexachloro-1,3-butadiene	LT	20	UGL		
								87-86-5	Pentachlorophenol	LT	40	UGL		
								88-06-2	2,4,6-Trichlorophenol	LT	30	UGL		
								95-48-7	o-Cresol / 2-Cresol / 2-Methylphenol	LT	20	UGL		
								95-95-4	2,4,5-Trichlorophenol	LT	30	UGL		
								98-95-3	Nitrobenzene / Essence of mirbane / Oil of mirbane	LT	10	UGL		
	69S02	RDSX*18	0.5	03-MAY-94	ES	RDSX*18	JB01/S	39-97-6	Mercury	LT	5.00 E -2	UGG		
							JD15/S	82-49-2	Selenium	LT	.5	UGG		
							JD19/S	40-38-2	Arsenic		3.94	UGG		
							JS16/S	29-90-5	Aluminum		25300	UGG		
								39-89-6	Iron		44600	UGG		
								39-92-1	Lead	LT	10.5	UGG		
								39-95-4	Magnesium		4720	UGG		
								39-96-5	Manganese		81.8	UGG		
								40-02-0	Nickel		29.9	UGG		
								40-09-7	Potassium		2620	UGG		
								40-22-4	Silver	LT	.589	UGG		
								40-23-5	Sodium		3990	UGG		
								40-28-0	Thallium		44.9	UGG		
								40-36-0	Antimony	LT	7.14	UGG		

* - Analyte Description has been truncated. See Data Dictionary

Final Documentation Appendix Report
Installation :Radford AAP, VA (RD)
File Type: CSO
Sampling Date Range: 01-JAN-94 23-AUG-94

Site Type	Site ID	Field Sample No.	Depth	Sample Date	Lab	Lab Anly. No.	Meth/ Matrix	CAS No.	Analyte Description	Meas. Bool.	Conc.	Unit Meas.	Flag Codes	Data Quals
PLUG	69S02	RDSX*18	0.5	03-MAY-94	ES	RDSX*18	JS16/S	40-39-3	Barium		43.1	UGG		
								40-41-7	Beryllium		2.34	UGG		
								40-43-9	Cadmium	LT	.7	UGG		
								40-47-3	Chromium		29.9	UGG		
								40-48-4	Cobalt		7.41	UGG		
								40-50-8	Copper		21.3	UGG		
								40-62-2	Vanadium		84.9	UGG		
								40-66-6	Zinc		28.2	UGG		
								40-70-2	Calcium		577	UGG		
		RDSXL*18	0.5	09-MAY-94	ES	RDSXL*18	1311/W	39-92-1	Lead	LT	50	UGL		
								39-97-6	Mercury	LT	.2	UGL		
								40-22-4	Silver	LT	5	UGL		
								40-38-2	Arsenic	LT	100	UGL		
								40-39-3	Barium		79	UGL		
								40-43-9	Cadmium	LT	5	UGL		
								40-47-3	Chromium	LT	10	UGL		
								82-49-2	Selenium	LT	100	UGL		
							8080/W	01-35-2	Toxaphene / Chlorinated camphene / Camphechlor / Alltox / *	LT	5	UGL		
								24-57-3	Heptachlor epoxide	LT	5.0 E -2	UGL		
								57-74-9	Chlordane	LT	.25	UGL		
								58-89-9	Lindane / gamma-Benzene hexachloride / gamma-Hexachlorocyc*	LT	5.0 E -2	UGL		
								72-20-8	Endrin	LT	5.0 E -2	UGL		
								72-43-5	Methoxychlor / Methoxy-DDT / 1,1'-(2,2,2-Trichloroethylide*	LT	5.0 E -2	UGL		
								76-44-8	Heptachlor / 1H-1,4,5,6,7,8,8-Heptachloro-3a,4,7,7a-tetrah*	LT	5.0 E -2	UGL		
							8150/W	93-72-1	245TP / silvex / 2-(2,4,5-Trichlorophenoxy)propionic acid *	LT	.2	UGL		
								94-75-7	2,4-D / 2,4-Dichlorophenoxyacetic acid		.22	UGL		
							8240/W	07-06-2	1,2-Dichloroethene	LT	2.5	UGL		
								08-90-7	Chlorobenzene / Monochlorobenzene	LT	1.4	UGL		
								27-18-4	Tetrachloroethylene / Tetrachloroethene / Perchloroethylen*	LT	1.9	UGL		
								56-23-5	Carbon tetrachloride	LT	2.6	UGL		
								67-66-3	Chloroform		5.4	UGL		
								71-43-2	Benzene	LT	1	UGL		
								75-01-4	Vinyl chloride / Chloroethene	LT	4.6	UGL		
								75-35-4	1,1-Dichloroethylene / 1,1-Dichloroethene	LT	3.2	UGL		
								78-93-3	Methyl ethyl ketone / 2-Butanone	LT	10	UGL		
								79-01-6						

* - Analyte Description has been truncated. See Data Dictionary

Final Documentation Appendix Report
Installation :Radford AAP, VA (RD)
File Type: CSO
Sampling Date Range: 01-JAN-94 23-AUG-94

Site Type	Site ID	Field Sample No.	Depth	Sample Date	Lab	Lab Anly. No.	Meth/ Matrix	CAS No.	Analyte Description	Meas. Bool.	Conc.	Unit Meas.	Flag Codes	Data Quals
PLUG	69S02	RDSXL*18	0.5	09-MAY-94	ES	RDSXL*18	8240/W	79-01-6	Trichloroethylene /Trichloroethene / Ethinyl trichloride /T*	LT	3	UGL		
							8270/W	06-44-5	p-Cresol / 4-Cresol / 4-Methylphenol	LT	20	UGL		
								06-46-7	1,4-Dichlorobenzene	LT	10	UGL		
								08-39-4	m-Cresol / 3-Cresol / 3-Methylphenol	LT	10	UGL		
								10-86-1	Pyridine	LT	100	UGL		
								18-74-1	Hexachlorobenzene	LT	20	UGL		
								21-14-2	2,4-Dinitrotoluene	LT	20	UGL		
								67-72-1	Hexachloroethane	LT	20	UGL		
								87-68-3	Hexachlorobutadiene / Hexachloro-1,3-butadiene	LT	20	UGL		
								87-86-5	Pentachlorophenol	LT	40	UGL		
								88-06-2	2,4,6-Trichlorophenol	LT	30	UGL		
								95-48-7	o-Cresol / 2-Cresol / 2-Methylphenol	LT	20	UGL		
								95-95-4	2,4,5-Trichlorophenol	LT	30	UGL		
								98-95-3	Nitrobenzene / Essence of mirbane / Oil of mirbane	LT	10	UGL		
	69S03	RDSX*19	0.5	03-MAY-94	ES	RDSX*19	JB01/S	39-97-6	Mercury	LT	5.00 E -2	UGG		
							JD15/S	82-49-2	Selenium	LT	.5	UGG		
							JD19/S	40-38-2	Arsenic		4.79	UGG		
							JS16/S	29-90-5	Aluminum		31300	UGG		
								39-89-6	Iron		46500	UGG		
								39-92-1	Lead	LT	10.5	UGG		
								39-95-4	Magnesium		2350	UGG		
								39-96-5	Manganese		132	UGG		
								40-02-0	Nickel		32.7	UGG		
								40-09-7	Potassium		1720	UGG		
								40-22-4	Silver	LT	.589	UGG		
								40-23-5	Sodium		4500	UGG		
								40-28-0	Thallium		49.5	UGG		
								40-36-0	Antimony	LT	7.14	UGG		
								40-39-3	Barium		45.4	UGG		
								40-41-7	Beryllium		2.6	UGG		
								40-43-9	Cadmium	LT	.7	UGG		
								40-47-3	Chromium		51.7	UGG		
								40-48-4	Cobalt		19.7	UGG		
								40-50-8	Copper		28.7	UGG		
								40-62-2	Vanadium		68.9	UGG		
								40-66-6	Zinc		32.7	UGG		
								40-70-2	Calcium		1120	UGG		
		RDSXL*19	0.5	09-MAY-94	ES	RDSXL*19	1311/W	39-92-1	Lead	LT	50	UGL		
								39-97-6	Mercury	LT	.2	UGL		
								40-22-4	Silver	LT	5	UGL		
								40-38-2	Arsenic	LT	100	UGL		

* - Analyte Description has been truncated. See Data Dictionary

Final Documentation Appendix Report
Installation :Radford AAP, VA (RD)
File Type: CSO
Sampling Date Range: 01-JAN-94 23-AUG-94

Site Type	Site ID	Field Sample No.	Depth	Sample Date	Lab	Lab Anly. No.	Meth/ Matrix	CAS No.	Analyte Description	Meas. Bool.	Conc.	Unit Meas.	Flag Codes	Data Quals
PLUG	69603	RDSXL*19	0.5	09-MAY-94	ES	RDSXL*19	1311/W	40-39-3	Barium		180	UGL		
								40-43-9	Cadmium	LT	5	UGL		
								40-47-3	Chromium	LT	10	UGL		
								82-49-2	Selenium	LT	100	UGL		
							8080/W	01-35-2	Toxaphene / Chlorinated camphene / Camphechlor / Alltox / *	LT	5	UGL		
								24-57-3	Heptachlor epoxide	LT	5.0 E -2	UGL		
								57-74-9	Chlordane	LT	.25	UGL		
								58-89-9	Lindane / gamma-Benzene hexachloride / gamma-Hexachlorocyc*	LT	5.0 E -2	UGL		
								72-20-8	Endrin	LT	5.0 E -2	UGL		
								72-43-5	Methoxychlor / Methoxy-DDT / 1,1'-(2,2,2-Trichloroethylide*	LT	5.0 E -2	UGL		
								76-44-8	Heptachlor / 1H-1,4,5,6,7,8,8-Heptachloro-3a,4,7,7a-tetrah*	LT	5.0 E -2	UGL		
							8150/W	93-72-1	245TP / Silvex / 2-(2,4,5-Trichlorophenoxy)propionic acid *	LT	.2	UGL		
								94-75-7	2,4-D / 2,4-Dichlorophenoxyacetic acid		.21	UGL		
							8240/W	07-06-2	1,2-Dichloroethane	LT	2.5	UGL		
								08-90-7	Chlorobenzene / Monochlorobenzene	LT	1.4	UGL		
								27-18-4	Tetrachloroethylene / Tetrachloroethene / Perchloroethylen*	LT	1.9	UGL		
								56-23-5	Carbon tetrachloride	LT	2.6	UGL		
								67-66-3	Chloroform		5.1	UGL		
								71-43-2	Benzene	LT	1	UGL		
								75-01-4	Vinyl chloride / Chloroethene	LT	4.6	UGL		
								75-35-4	1,1-Dichloroethylene / 1,1-Dichloroethene	LT	3.2	UGL		
								78-93-3	Methyl ethyl ketone / 2-Butanone	LT	10	UGL		
								79-01-6	Trichloroethylene /Trichloroethene / Ethinyl trichloride /T*	LT	3	UGL		
							8270/W	06-44-5	p-Cresol / 4-Cresol / 4-Methylphenol	LT	20	UGL		
								06-46-7	1,4-Dichlorobenzene	LT	10	UGL		
								08-39-4	m-Cresol / 3-Cresol / 3-Methylphenol	LT	10	UGL		
								10-86-1	Pyridine	LT	100	UGL		
								18-74-1	Hexachlorobenzene	LT	20	UGL		
								21-14-2	2,4-Dinitrotoluene	LT	20	UGL		
								67-72-1	Hexachloroethane	LT	20	UGL		
								87-68-3	Hexachlorobutadiene / Hexachloro-1,3-butadiene	LT	20	UGL		
								87-86-5	Pentachlorophenol	LT	40	UGL		
								88-06-2	2,4,6-Trichlorophenol	LT	30	UGL		
								95-48-7	o-Cresol / 2-Cresol / 2-Methylphenol	LT	20	UGL		

* - Analyte Description has been truncated. See Data Dictionary

Final Documentation Appendix Report
Installation :Radford AAP, VA (RD)
File Type: CSO
Sampling Date Range: 01-JAN-94 23-AUG-94

Site Type	Site ID	Field Sample No.	Depth	Sample Date	Lab	Lab Anly. No.	Meth/ Matrix	CAS No.	Analyte Description	Meas. Bool.	Conc.	Unit Meas.	Flag Codes	Data Quals
PLUG	69S03	RDSXL*19	0.5	09-MAY-94	ES	RDSXL*19	8270/W	95-95-4	2,4,5-Trichlorophenol	LT	30	UGL		
								98-95-3	Nitrobenzene / Essence of mirbane / Oil of mirbane	LT	10	UGL		
	69S04	RDSX*20	0.5	03-MAY-94	ES	RDSX*20	JB01/S	39-97-6	Mercury		.124	UGG		
							JD15/S	82-49-2	Selenium	LT	.5	UGG		
							JD19/S	40-38-2	Arsenic		3.16	UGG		
							JS16/S	29-90-5	Aluminum		31700	UGG		
								39-89-6	Iron		49500	UGG		
								39-92-1	Lead	LT	10.5	UGG		
								39-95-4	Magnesium		2240	UGG		
								39-96-5	Manganese		184	UGG		
								40-02-0	Nickel		29.4	UGG		
								40-09-7	Potassium		1850	UGG		
								40-22-4	Silver	LT	.589	UGG		
								40-23-5	Sodium		4770	UGG		
								40-28-0	Thallium		53.1	UGG		
								40-36-0	Antimony		24	UGG		
								40-39-3	Barium		58.3	UGG		
								40-41-7	Beryllium		2.51	UGG		
								40-43-9	Cadmium	LT	.7	UGG		
								40-47-3	Chromium		56.7	UGG		
								40-48-4	Cobalt		6.94	UGG		
								40-50-8	Copper		32.4	UGG		
								40-62-2	Vanadium		89.8	UGG		
								40-66-6	Zinc		69.1	UGG		
								40-70-2	Calcium		1530	UGG		
		RDSXL*20	0.5	09-MAY-94	ES	RDSXL*20	1311/W	39-92-1	Lead	LT	50	UGL		
								39-97-6	Mercury	LT	.2	UGL		
								40-22-4	Silver	LT	5	UGL		
								40-38-2	Arsenic	LT	100	UGL		
								40-39-3	Barium		190	UGL		
								40-43-9	Cadmium	LT	5	UGL		
								40-47-3	Chromium	LT	10	UGL		
								82-49-2	Selenium	LT	100	UGL		
							8080/W	01-35-2	Toxaphene / Chlorinated camphene / Camphechlor / Alltox / *	LT	5	UGL		
								24-57-3	Heptachlor epoxide	LT	5.0 E -2	UGL		
								57-74-9	Chlordane	LT	.25	UGL		
								58-89-9	Lindane / gamma-Benzene hexachloride / gamma-Hexachlorocyc*	LT	5.0 E -2	UGL		
								72-20-8	Endrin	LT	5.0 E -2	UGL		
								72-43-5	Methoxychlor / Methoxy-DDT / 1,1'-(2,2,2-Trichloroethylide*	LT	5.0 E -2	UGL		
								76-44-8						

* - Analyte Description has been truncated. See Data Dictionary

Final Documentation Appendix Report
Installation :Radford AAP, VA (RD)
File Type: CSO
Sampling Date Range: 01-JAN-94 23-AUG-94

Site Type	Site ID	Field Sample No.	Depth	Sample Date	Lab	Lab Anly. No.	Meth/ Matrix	CAS No.	Analyte Description	Meas. Bool.	Conc.	Unit Meas.	Flag Codes	Data Quals
PLUG	69S04	RDSXL*20	0.5	09-MAY-94	ES	RDSXL*20	8080/W	76-44-8	Heptachlor / 1H-1,4,5,6,7,8,8-Heptachloro-3a,4,7,7a-tetrah*	LT	5.0 E -2	UGL		
							8150/W	93-72-1	245TP / Silvex / 2-(2,4,5-Trichlorophenoxy)propionic acid *	LT	.2	UGL		
								94-75-7	2,4-D / 2,4-Dichlorophenoxyacetic acid	LT	.2	UGL		
							8240/W	07-06-2	1,2-Dichloroethane	LT	2.5	UGL		
								08-90-7	Chlorobenzene / Monochlorobenzene	LT	1.4	UGL		
								27-18-4	Tetrachloroethylene / Tetrachloroethene / Perchloroethylen*	LT	1.9	UGL		
								56-23-5	Carbon tetrachloride	LT	2.6	UGL		
								67-66-3	Chloroform		4.9	UGL		
								71-43-2	Benzene	LT	1	UGL		
								75-01-4	Vinyl chloride / Chloroethene	LT	4.6	UGL		
								75-35-4	1,1-Dichloroethylene / 1,1-Dichloroethene	LT	3.2	UGL		
								78-93-3	Methyl ethyl ketone / 2-Butanone	LT	10	UGL		
								79-01-6	Trichloroethylene /Trichloroethene / Ethinyl trichloride /T*	LT	3	UGL		
							8270/W	06-44-5	p-Cresol / 4-Cresol / 4-Methylphenol	LT	20	UGL		
								06-46-7	1,4-Dichlorobenzene	LT	10	UGL		
								08-39-4	m-Cresol / 3-Cresol / 3-Methylphenol	LT	10	UGL		
								10-86-1	Pyridine	LT	100	UGL		
								18-74-1	Hexachlorobenzene	LT	20	UGL		
								21-14-2	2,4-Dinitrotoluene	LT	20	UGL		
								67-72-1	Hexachloroethane	LT	20	UGL		
								87-68-3	Hexachlorobutadiene / Hexachloro-1,3-butadiene	LT	20	UGL		
								87-86-5	Pentachlorophenol	LT	40	UGL		
								88-06-2	2,4,6-Trichlorophenol	LT	30	UGL		
								95-48-7	o-Cresol / 2-Cresol / 2-Methylphenol	LT	20	UGL		
								95-95-4	2,4,5-Trichlorophenol	LT	30	UGL		
								98-95-3	Nitrobenzene / Essence of mirbane / Oil of mirbane	LT	10	UGL		
	69S05	RDSX*21	0.5	03-MAY-94	ES	RDSX*21	J801/S	39-97-6	Mercury		8.01 E -2	UGG		
							J015/S	82-49-2	Selenium		1	UGG		
							J019/S	40-38-2	Arsenic		7.98	UGG		
							J816/S	29-90-5	Aluminum		27500	UGG		
								39-89-6	Iron		51500	UGG		
								39-92-1	Lead		24.5	UGG		
								39-95-4	Magnesium		5540	UGG		
								39-96-5	Manganese		168	UGG		
								40-02-0	Nickel		29.9	UGG		
								40-09-7	Potassium		3400	UGG		

* - Analyte Description has been truncated. See Data Dictionary

Final Documentation Appendix Report
Installation :Radford AAP, VA (RD)
File Type: CSO
Sampling Date Range: 01-JAN-94 23-AUG-94

Site Type	Site ID	Field Sample No.	Depth	Sample Date	Lab	Lab Anly. No.	Meth/ Matrix	CAS No.	Analyte Description	Meas. Bool.	Conc.	Unit Meas.	Flag Codes	Data Quals
PLUG	69S05	RDSX*21	0.5	03-MAY-94	ES	RDSX*21	JS16/S	40-22-4	Silver	LT	.589	UGG		
								40-23-5	Sodium		4720	UGG		
								40-28-0	Thallium		54.6	UGG		
								40-36-0	Antimony		21.2	UGG		
								40-39-3	Barium		47.2	UGG		
								40-41-7	Beryllium		2.89	UGG		
								40-43-9	Cadmium		6.9	UGG		
								40-47-3	Chromium		75.2	UGG		
								40-48-4	Cobalt		9.25	UGG		
								40-50-8	Copper		27.3	UGG		
								40-62-2	Vanadium		74.7	UGG		
								40-66-6	Zinc		140	UGG		
								40-70-2	Calcium		604	UGG		
		RDSXL*21	0.5	09-MAY-94	ES	RDSXL*21	1311/W	39-92-1	Lead	LT	50	UGL		
								39-97-6	Mercury	LT	.2	UGL		
								40-22-4	Silver	LT	5	UGL		
								40-38-2	Arsenic	LT	100	UGL		
								40-39-3	Barium		86	UGL		
								40-43-9	Cadmium	LT	5	UGL		
								40-47-3	Chromium	LT	10	UGL		
								82-49-2	Selenium	LT	100	UGL		
							8080/W	01-35-2	Toxaphene / Chlorinated camphene / Camphechlor / Alltox / *	LT	5	UGL		
								24-57-3	Heptachlor epoxide	LT	5.0 E -2	UGL		
								57-74-9	Chlordane	LT	.25	UGL		
								58-89-9	Lindane / gamma-Benzene hexachloride / gamma-Hexachlorocyc*	LT	5.0 E -2	UGL		
								72-20-8	Endrin	LT	5.0 E -2	UGL		
								72-43-5	Methoxychlor / Methoxy-DDT / 1,1'-(2,2,2-Trichloroethylide*	LT	5.0 E -2	UGL		
								76-44-8	Heptachlor / 1H-1,4,5,6,7,8,8-Heptechloro-3a,4,7,7a-tetrah*	LT	5.0 E -2	UGL		
							8150/W	93-72-1	245TP / Silvex / 2-(2,4,5-Trichlorophenoxy)propionic acid *	LT	.2	UGL		
								94-75-7	2,4-D / 2,4-Dichlorophenoxyacetic acid	LT	.2	UGL		
							8240/W	07-06-2	1,2-Dichloroethane	LT	2.5	UGL		
								08-90-7	Chlorobenzene / Monochlorobenzene	LT	1.4	UGL		
								27-18-4	Tetrachloroethylene / Tetrachloroethene / Perchloroethylen*	LT	1.9	UGL		
								56-23-5	Carbon tetrachloride	LT	2.6	UGL		
								67-66-3	Chloroform		6.4	UGL		
								71-43-2	Benzene	LT	1	UGL		
								75-01-4	Vinyl chloride / Chloroethene	LT	4.6	UGL		

* - Analyte Description has been truncated. See Date Dictionary

Final Documentation Appendix Report
Installation :Radford AAP, VA (RD)
File Type: CSO
Sampling Date Range: 01-JAN-94 23-AUG-94

Site Type	Site ID	Field Sample No.	Depth	Sample Date	Lab	Lab Anly. No.	Meth/ Matrix	CAS No.	Analyte Description	Meas. Bool.	Conc.	Unit Meas.	Flag Codes	Data Quali
PLUG	69S05	RDSXL*21	0.5	09-MAY-94	ES	RDSXL*21	8240/W	75-35-4	1,1-Dichloroethylene / 1,1-Dichloroethene	LT	3.2	UGL		
								78-93-3	Methyl ethyl ketone / 2-Butanone	LT	10	UGL		
								79-01-6	Trichloroethylene /Trichloroethene / Ethinyl trichloride /T*	LT	3	UGL		
							8270/W	06-44-5	p-Cresol / 4-Cresol / 4-Methylphenol	LT	20	UGL		
								06-46-7	1,4-Dichlorobenzene	LT	10	UGL		
								08-39-4	m-Cresol / 3-Cresol / 3-Methylphenol	LT	10	UGL		
								10-86-1	Pyridine	LT	100	UGL		
								18-74-1	Hexachlorobenzene	LT	20	UGL		
								21-14-2	2,4-Dinitrotoluene	LT	20	UGL		
								67-72-1	Hexachloroethane	LT	20	UGL		
								87-68-3	Hexachlorobutadiene / Hexachloro-1,3-butadiene	LT	20	UGL		
								87-86-5	Pentachlorophenol	LT	40	UGL		
								88-06-2	2,4,6-Trichlorophenol	LT	30	UGL		
								95-48-7	o-Cresol / 2-Cresol / 2-Methylphenol	LT	20	UGL		
								95-95-4	2,4,5-Trichlorophenol	LT	30	UGL		
								98-95-3	Nitrobenzene / Essence of mirbane / Oil of mirbane	LT	10	UGL		
	69S06	RDSX*22	0.5	03-MAY-94	ES	RDSX*22	JB01/S	39-97-6	Mercury	LT	5.00 E -2	UGG		
							JD15/S	82-49-2	Selenium	LT	.5	UGG		
							JD19/S	40-38-2	Arsenic		2.78	UGG		
							JS16/S	29-90-5	Aluminum		23600	UGG		
								39-89-6	Iron		43000	UGG		
								39-92-1	Lead	LT	10.5	UGG		
								39-95-4	Magnesium		6620	UGG		
								39-96-5	Manganese		243	UGG		
								40-02-0	Nickel		25.9	UGG		
								40-09-7	Potassium		3260	UGG		
								40-22-4	Silver	LT	.589	UGG		
								40-23-5	Sodium		3730	UGG		
								40-28-0	Thallium		62.6	UGG		
								40-36-0	Antimony	LT	7.14	UGG		
								40-39-3	Barium		53.5	UGG		
								40-41-7	Beryllium		2.89	UGG		
								40-43-9	Cadmium	LT	.7	UGG		
								40-47-3	Chromium		41.6	UGG		
								40-48-4	Cobalt		9.69	UGG		
								40-50-8	Copper		25.6	UGG		
								40-62-2	Vanadium		83	UGG		
								40-66-6	Zinc		46.8	UGG		
								40-70-2	Calcium		1110	UGG		
		RDSXL*22	0.5	09-MAY-94	ES	RDSXL*22	1311/W	39-92-1	Lead	LT	50	UGL		

* - Analyte Description has been truncated. See Data Dictionary

Final Documentation Appendix Report
Installation :Radford AAP, VA (RD)
File Type: CSO
Sampling Date Range: 01-JAN-94 23-AUG-94

Site Type	Site ID	Field Sample No.	Depth	Sample Date	Lab	Lab Anly. No.	Meth/ Matrix	CAS No.	Analyte Description	Meas. Bool.	Conc.	Unit Meas.	Flag Codes	Data Quals
PLUG	69S06	RDSXL*22	0.5	09-MAY-94	ES	RDSXL*22	1311/W	39-97-6	Mercury	LT	.2	UGL		
								40-22-4	Silver	LT	5	UGL		
								40-38-2	Arsenic	LT	100	UGL		
								40-39-3	Barium		120	UGL		
								40-43-9	Cadmium	LT	5	UGL		
								40-47-3	Chromium	LT	10	UGL		
								82-49-2	Selenium	LT	100	UGL		
							8080/W	01-35-2	Toxaphene / Chlorinated camphene / Camphechlor / Alltox / *	LT	5	UGL		
								24-57-3	Heptachlor epoxide	LT	5.0 E -2	UGL		
								57-74-9	Chlordane	LT	.25	UGL		
								58-89-9	Lindane / gamma-Benzene hexachloride / gamma-Hexachlorocyc*	LT	5.0 E -2	UGL		
								72-20-8	Endrin	LT	5.0 E -2	UGL		
								72-43-5	Methoxychlor / Methoxy-DDT / 1,1'-(2,2,2-Trichloroethylide*	LT	5.0 E -2	UGL		
								76-44-8	Heptachlor / 1H-1,4,5,6,7,8,8-Heptachloro-3a,4,7,7a-tetrah*	LT	5.0 E -2	UGL		
							8150/W	93-72-1	245TP / Silvex / 2-(2,4,5-Trichlorophenoxy)propionic acid *	LT	.2	UGL		
								94-75-7	2,4-D / 2,4-Dichlorophenoxyacetic acid	LT	.2	UGL		
							8240/W	07-06-2	1,2-Dichloroethane	LT	2.5	UGL		
								08-90-7	Chlorobenzene / Monochlorobenzene	LT	1.4	UGL		
								27-18-4	Tetrachloroethylene / Tetrachloroethene / Perchloroethylen*	LT	1.9	UGL		
								56-23-5	Carbon tetrachloride	LT	2.6	UGL		
								67-66-3	Chloroform		5.6	UGL		
								71-43-2	Benzene	LT	1	UGL		
								75-01-4	Vinyl chloride / Chloroethene	LT	4.6	UGL		
								75-35-4	1,1-Dichloroethylene / 1,1-Dichloroethene	LT	3.2	UGL		
								78-93-3	Methyl ethyl ketone / 2-Butanone	LT	10	UGL		
								79-01-6	Trichloroethylene /Trichloroethene / Ethinyl trichloride /T*	LT	3	UGL		
							8270/W	06-44-5	p-Cresol / 4-Cresol / 4-Methylphenol	LT	20	UGL		
								06-46-7	1,4-Dichlorobenzene	LT	10	UGL		
								08-39-4	m-Cresol / 3-Cresol / 3-Methylphenol	LT	10	UGL		
								10-86-1	Pyridine	LT	100	UGL		
								18-74-1	Hexachlorobenzene	LT	20	UGL		
								21-14-2	2,4-Dinitrotoluene	LT	20	UGL		
								67-72-1	Hexechloroethene	LT	20	UGL		
								87-68-3	Hexachlorobutadiene / Hexachloro-1,3-butadiene	LT	20	UGL		

* - Analyte Description has been truncated. See Data Dictionary

Final Documentation Appendix Report
Installation :Radford AAP, VA (RD)
File Type: CSO
Sampling Date Range: 01-JAN-94 23-AUG-94

Site Type	Site ID	Field Sample No.	Depth	Sample Date	Lab	Lab Anly. No.	Meth/ Matrix	CAS No.	Analyte Description	Meas. Bool.	Conc.	Unit Meas.	Flag Codes	Data Quali
PLUG	69S06	RDSXL*22	0.5	09-MAY-94	ES	RDSXL*22	8270/W	87-86-5	Pentachlorophenol	LT	40	UGL		
								88-06-2	2,4,6-Trichlorophenol	LT	30	UGL		
								95-48-7	o-Cresol / 2-Cresol / 2-Methylphenol	LT	20	UGL		
								95-95-4	2,4,5-Trichlorophenol	LT	30	UGL		
								98-95-3	Nitrobenzene / Essence of mirbane / Oil of mirbane	LT	10	UGL		
	69S07	RDSX*23	0.5	03-MAY-94	ES	RDSX*23	JB01/S	39-97-6	Mercury		7.01 E -2	UGG		
							JD15/S	82-49-2	Selenium	LT	.5	UGG		
							JD19/S	40-38-2	Arsenic		2.44	UGG		
							JS16/S	29-90-5	Aluminum		11400	UGG		
								39-89-6	Iron		23600	UGG		
								39-92-1	Lead	LT	10.5	UGG		
								39-95-4	Magnesium		654	UGG		
								39-96-5	Manganese		580	UGG		
								40-02-0	Nickel		6.86	UGG		
								40-09-7	Potassium		767	UGG		
								40-22-4	Silver	LT	.589	UGG		
								40-23-5	Sodium		2540	UGG		
								40-28-0	Thellium		27.5	UGG		
								40-36-0	Antimony	LT	7.14	UGG		
								40-39-3	Barium		33.4	UGG		
								40-41-7	Beryllium		1.05	UGG		
								40-43-9	Cadmium	LT	.7	UGG		
								40-47-3	Chromium		38.2	UGG		
								40-48-4	Cobalt		5.76	UGG		
								40-50-8	Copper		9.12	UGG		
								40-62-2	Venadium		49.5	UGG		
								40-66-6	Zinc		22.4	UGG		
								40-70-2	Calcium		214	UGG		
		RDSXL*23	0.5	09-MAY-94	ES	RDSXL*23	1311/W	39-92-1	Lead	LT	50	UGL		
								39-97-6	Mercury	LT	.2	UGL		
								40-22-4	Silver	LT	5	UGL		
								40-38-2	Arsenic	LT	100	UGL		
								40-39-3	Barium		120	UGL		
								40-43-9	Cadmium		5.2	UGL		
								40-47-3	Chromium	LT	10	UGL		
								82-49-2	Selenium	LT	100	UGL		
							8080/W	01-35-2	Toxaphene / Chlorinated camphene / Camphechlor / Alltox / *	LT	5	UGL		
								24-57-3	Heptachlor epoxide	LT	5.0 E -2	UGL		
								57-74-9	Chlordane	LT	.25	UGL		
								58-89-9	Lindane / gamma-Benzene hexachloride / gamma-Hexachlorocyc*	LT	5.0 E -2	UGL		
								72-20-8	Endrin	LT	5.0 E -2	UGL		

* - Analyte Description has been truncated. See Data Dictionary

Final Documentation Appendix Report
Installation :Redford AAP, VA (RD)
File Type: CSO
Sampling Date Range: 01-JAN-94 23-AUG-94

Site Type	Site ID	Field Sample No.	Depth	Sample Date	Lab	Lab Anly. No.	Meth/ Matrix	CAS No.	Analyte Description	Meas. Bool.	Conc.	Unit Meas.	Flag Codes	Data Quals
PLUG	69S07	RDSXL*23	0.5	09-MAY-94	ES	RDSXL*23	8080/W	72-43-5	Methoxychlor / Methoxy-DDT / 1,1'-(2,2,2-Trichloroethylide*	LT	5.0 E -2	UGL		
								76-44-8	Heptachlor / 1H-1,4,5,6,7,8,8-Heptachloro-3a,4,7,7a-tetrah*	LT	5.0 E -2	UGL		
							8150/W	93-72-1	245TP / Silvex / 2-(2,4,5-Trichlorophenoxy)propionic acid *	LT	.2	UGL		
								94-75-7	2,4-D / 2,4-Dichlorophenoxyacetic acid	LT	.2	UGL		
							8240/W	07-06-2	1,2-Dichloroethane	LT	2.5	UGL		
								08-90-7	Chlorobenzene / Monochlorobenzene	LT	1.4	UGL		
								27-18-4	Tetrachloroethylene / Tetrachloroethene / Perchloroethylen*	LT	1.9	UGL		
								56-23-5	Carbon tetrachloride	LT	2.6	UGL		
								67-66-3	Chloroform		5.8	UGL		
								71-43-2	Benzene	LT	1	UGL		
								75-01-4	Vinyl chloride / Chloroethene	LT	4.6	UGL		
								75-35-4	1,1-Dichloroethylene / 1,1-Dichloroethene	LT	3.2	UGL		
								78-93-3	Methyl ethyl ketone / 2-Butanone	LT	10	UGL		
								79-01-6	Trichloroethylene /Trichloroethene / Ethinyl trichloride /T*	LT	3	UGL		
							8270/W	06-44-5	p-Cresol / 4-Cresol / 4-Methylphenol	LT	20	UGL		
								06-46-7	1,4-Dichlorobenzene	LT	10	UGL		
								08-39-4	m-Cresol / 3-Cresol / 3-Methylphenol	LT	10	UGL		
								10-86-1	Pyridine	LT	100	UGL		
								18-74-1	Hexachlorobenzene	LT	20	UGL		
								21-14-2	2,4-Dinitrotoluene	LT	20	UGL		
								67-72-1	Hexachloroethane	LT	20	UGL		
								87-68-3	Hexachlorobutadiene / Hexachloro-1,3-butadiene	LT	20	UGL		
								87-86-5	Pentachlorophenol	LT	40	UGL		
								88-06-2	2,4,6-Trichlorophenol	LT	30	UGL		
								95-48-7	o-Cresol / 2-Cresol / 2-Methylphenol	LT	20	UGL		
								95-95-4	2,4,5-Trichlorophenol	LT	30	UGL		
								98-95-3	Nitrobenzene / Essence of mirbane / Oil of mirbane	LT	10	UGL		
	69S08	RDSX*24	0.5	03-MAY-94	ES	RDSX*24	JB01/S	39-97-6	Mercury		6.74 E -2	UGG		
							JD15/S	82-49-2	Selenium	LT	.5	UGG		
							JD19/S	40-38-2	Arsenic		2.7	UGG		
							JS16/S	29-90-5	Aluminum		12700	UGG		
								39-89-6	Iron		21900	UGG		
								39-92-1	Lead		18.3	UGG		
								39-95-4	Magnesium		940	UGG		
								39-96-5	Manganese		758	UGG		

* - Analyte Description has been truncated. See Data Dictionary

Final Documentation Appendix Report
Installation :Redford AAP, VA (RD)
File Type: CSO
Sampling Date Range: 01-JAN-94 23-AUG-94

Site Type	Site ID	Field Sample No.	Depth	Sample Date	Lab	Lab Anly. No.	Meth/ Matrix	CAS No.	Analyte Description	Meas. Bool.	Conc.	Unit Meas.	Flag Codes	Data Qual
PLUG	69S08	RDSX*24	0.5	03-MAY-94	ES	RDSX*24	JS16/S	40-02-0	Nickel		5.87	UGG		
								40-09-7	Potassium		781	UGG		
								40-22-4	Silver	LT	.589	UGG		
								40-23-5	Sodium		1400	UGG		
								40-28-0	Thallium		22.3	UGG		
								40-36-0	Antimony		9.91	UGG		
								40-39-3	Barium		38	UGG		
								40-41-7	Beryllium		1.06	UGG		
								40-43-9	Cadmium	LT	.7	UGG		
								40-47-3	Chromium		29.5	UGG		
								40-48-4	Cobalt		10.4	UGG		
								40-50-8	Copper		9.84	UGG		
								40-62-2	Vanadium		47.5	UGG		
								40-66-6	Zinc		33	UGG		
								40-70-2	Calcium		556	UGG		
		RDSXL*24	0.5	09-MAY-94	ES	RDSXL*24	1311/W	39-92-1	Lead	LT	50	UGL		
								39-97-6	Mercury	LT	.2	UGL		
								40-22-4	Silver	LT	5	UGL		
								40-38-2	Arsenic	LT	100	UGL		
								40-39-3	Barium		91	UGL		
								40-43-9	Cadmium	LT	5	UGL		
								40-47-3	Chromium	LT	10	UGL		
								82-49-2	Selenium	LT	100	UGL		
							8080/W	01-35-2	Toxaphene / Chlorinated camphene / Camphechlor / Alltox / *	LT	5	UGL		
								24-57-3	Heptachlor epoxide	LT	5.0 E -2	UGL		
								57-74-9	Chlordane	LT	.25	UGL		
								58-89-9	Lindane / gamma-Benzene hexachloride / gamma-Hexachlorocyc*	LT	5.0 E -2	UGL		
								72-20-8	Endrin	LT	5.0 E -2	UGL		
								72-43-5	Methoxychlor / Methoxy-DDT / 1,1'-(2,2,2-Trichloroethylide*	LT	5.0 E -2	UGL		
								76-44-8	Heptachlor / 1H-1,4,5,6,7,8,8-Heptachloro-3a,4,7,7a-tetrah*	LT	5.0 E -2	UGL		
							8150/W	93-72-1	245TP / Silvex / 2-(2,4,5-Trichlorophenoxy)propionic acid *	LT	.2	UGL		
								94-75-7	2,4-D / 2,4-Dichlorophenoxyacetic acid		.37	UGL		
							8240/W	07-06-2	1,2-Dichloroethane	LT	2.5	UGL		
								08-90-7	Chlorobenzene / Monochlorobenzene	LT	1.4	UGL		
								27-18-4	Tetrachloroethylene / Tetrachloroethene / Perchloroethylen*	LT	1.9	UGL		
								56-23-5	Carbon tetrachloride	LT	2.6	UGL		
								67-66-3	Chloroform		5.2	UGL		

* - Analyte Description has been truncated. See Data Dictionary

Final Documentation Appendix Report
Installation :Radford AAP, VA (RD)
File Type: CSO
Sampling Date Range: 01-JAN-94 23-AUG-94

Site Type	Site ID	Field Sample No.	Depth	Sample Date	Lab	Lab Anly. No.	Meth/ Matrix	CAS No.	Analyte Description	Meas. Bool.	Conc.	Unit Meas.	Flag Codes	Data Quals
PLUG	69S08	RDSXL*24	0.5	09-MAY-94	ES	RDSXL*24	8240/W	71-43-2	Benzene	LT	1	UGL		
								75-01-4	Vinyl chloride / Chloroethene	LT	4.6	UGL		
								75-35-4	1,1-Dichloroethylene / 1,1-Dichloroethene	LT	3.2	UGL		
								78-93-3	Methyl ethyl ketone / 2-Butanone	LT	10	UGL		
								79-01-6	Trichloroethylene /Trichloroethene / Ethinyl trichloride /T*	LT	3	UGL		
							8270/W	06-44-5	p-Cresol / 4-Cresol / 4-Methylphenol	LT	20	UGL		
								06-46-7	1,4-Dichlorobenzene	LT	10	UGL		
								08-39-4	m-Cresol / 3-Cresol / 3-Methylphenol	LT	10	UGL		
								10-86-1	Pyridine	LT	100	UGL		
								18-74-1	Hexachlorobenzene	LT	20	UGL		
								21-14-2	2,4-Dinitrotoluene	LT	20	UGL		
								67-72-1	Hexachloroethane	LT	20	UGL		
								87-68-3	Hexachlorobutadiene / Hexachloro-1,3-butadiene	LT	20	UGL		
								87-86-5	Pentachlorophenol	LT	40	UGL		
								88-06-2	2,4,6-Trichlorophenol	LT	30	UGL		
								95-48-7	o-Cresol / 2-Cresol / 2-Methylphenol	LT	20	UGL		
								95-95-4	2,4,5-Trichlorophenol	LT	30	UGL		
								98-95-3	Nitrobenzene / Essence of mirbane / Oil of mirbane	LT	10	UGL		

** End of Report - 504 Records Found **

* - Analyte Description has been truncated. See Data Dictionary

Site ID	Field ID	Media	Date	Depth	Units	Analytical Method	Analyte Abbrv.	Value	Flag	Internal Std. Code
68SS1	RVFS*59	CSO	04-feb-1992	0.5	UGG	JB01	HG	0.050	LT	
68SS1	RVFS*59	CSO	04-feb-1992	0.5	UGG	JD19	AS	2.400		
68SS1	RVFS*59	CSO	04-feb-1992	0.5	UGG	JD15	SE	0.250	LT	
68SS1	RVFS*59	CSO	04-feb-1992	0.5	UGG	JS16	AG	0.779		
68SS1	RVFS*59	CSO	04-feb-1992	0.5	UGG	JS16	AL	9450.000		
68SS1	RVFS*59	CSO	04-feb-1992	0.5	UGG	JS16	BA	118.000		
68SS1	RVFS*59	CSO	04-feb-1992	0.5	UGG	JS16	BE	1.130		
68SS1	RVFS*59	CSO	04-feb-1992	0.5	UGG	JS16	CA	624.000		
68SS1	RVFS*59	CSO	04-feb-1992	0.5	UGG	JS16	CD	1.590		
68SS1	RVFS*59	CSO	04-feb-1992	0.5	UGG	JS16	CO	11.500		
68SS1	RVFS*59	CSO	04-feb-1992	0.5	UGG	JS16	CR	26.900		
68SS1	RVFS*59	CSO	04-feb-1992	0.5	UGG	JS16	CU	9.960		
68SS1	RVFS*59	CSO	04-feb-1992	0.5	UGG	JS16	FE	12600.000		
68SS1	RVFS*59	CSO	04-feb-1992	0.5	UGG	JS16	K	538.000		
68SS1	RVFS*59	CSO	04-feb-1992	0.5	UGG	JS16	MG	642.000		
68SS1	RVFS*59	CSO	04-feb-1992	0.5	UGG	JS16	MN	1250.000		
68SS1	RVFS*59	CSO	04-feb-1992	0.5	UGG	JS16	NA	650.000		
68SS1	RVFS*59	CSO	04-feb-1992	0.5	UGG	JS16	NI	8.770		
68SS1	RVFS*59	CSO	04-feb-1992	0.5	UGG	JS16	PB	16.500		
68SS1	RVFS*59	CSO	04-feb-1992	0.5	UGG	JS16	SB	7.140	LT	
68SS1	RVFS*59	CSO	04-feb-1992	0.5	UGG	JS16	TL	9.620		
68SS1	RVFS*59	CSO	04-feb-1992	0.5	UGG	JS16	V	30.500		
68SS1	RVFS*59	CSO	04-feb-1992	0.5	UGG	JS16	ZN	54.100		
68SS1	RVFS*59	CSO	04-feb-1992	0.5		00	PH	8.520		
68SS2	RVFS*60	CSO	04-feb-1992	0.5	UGG	JB01	HG	0.362		
68SS2	RVFS*60	CSO	04-feb-1992	0.5	UGG	JD19	AS	7.300		
68SS2	RVFS*60	CSO	04-feb-1992	0.5	UGG	JD15	SE	0.250	LT	
68SS2	RVFS*60	CSO	04-feb-1992	0.5	UGG	JS16	AG	1.100		
68SS2	RVFS*60	CSO	04-feb-1992	0.5	UGG	JS16	AL	18500.000		
68SS2	RVFS*60	CSO	04-feb-1992	0.5	UGG	JS16	BA	61.300		
68SS2	RVFS*60	CSO	04-feb-1992	0.5	UGG	JS16	BE	1.870		
68SS2	RVFS*60	CSO	04-feb-1992	0.5	UGG	JS16	CA	2270.000		
68SS2	RVFS*60	CSO	04-feb-1992	0.5	UGG	JS16	CD	0.700	LT	
68SS2	RVFS*60	CSO	04-feb-1992	0.5	UGG	JS16	CO	14.600		
68SS2	RVFS*60	CSO	04-feb-1992	0.5	UGG	JS16	CR	49.200		
68SS2	RVFS*60	CSO	04-feb-1992	0.5	UGG	JS16	CU	20.100		
68SS2	RVFS*60	CSO	04-feb-1992	0.5	UGG	JS16	FE	33900.000		
68SS2	RVFS*60	CSO	04-feb-1992	0.5	UGG	JS16	K	1010.000		
68SS2	RVFS*60	CSO	04-feb-1992	0.5	UGG	JS16	MG	1610.000		
68SS2	RVFS*60	CSO	04-feb-1992	0.5	UGG	JS16	MN	885.000		
68SS2	RVFS*60	CSO	04-feb-1992	0.5	UGG	JS16	NA	188.000		
68SS2	RVFS*60	CSO	04-feb-1992	0.5	UGG	JS16	NI	10.700		
68SS2	RVFS*60	CSO	04-feb-1992	0.5	UGG	JS16	PB	28.700		
68SS2	RVFS*60	CSO	04-feb-1992	0.5	UGG	JS16	SB	26.300		
68SS2	RVFS*60	CSO	04-feb-1992	0.5	UGG	JS16	TL	21.100		
68SS2	RVFS*60	CSO	04-feb-1992	0.5	UGG	JS16	V	75.800		
68SS2	RVFS*60	CSO	04-feb-1992	0.5	UGG	JS16	ZN	87.400		
68SS2	RVFS*60	CSO	04-feb-1992	0.5		00	PH	7.370		
69SE1	RVFS*61	CSE	10-feb-1992	0.5	UGG	JB01	HG	0.050	LT	
69SE1	RVFS*61	CSE	10-feb-1992	0.5	UGG	JD19	AS	2.130		
69SE1	RVFS*61	CSE	10-feb-1992	0.5	UGG	JD15	SE	0.250	LT	
69SE1	RVFS*61	CSE	10-feb-1992	0.5		00	PH	8.360		
69SE1	RVFS*61	CSE	10-feb-1992	0.5	UGG	JS16	AG	3.050		
69SE1	RVFS*61	CSE	10-feb-1992	0.5	UGG	JS16	AL	10900.000		
69SE1	RVFS*61	CSE	10-feb-1992	0.5	UGG	JS16	BA	165.000		
69SE1	RVFS*61	CSE	10-feb-1992	0.5	UGG	JS16	BE	0.500	LT	
69SE1	RVFS*61	CSE	10-feb-1992	0.5	UGG	JS16	CA	50200.000		
69SE1	RVFS*61	CSE	10-feb-1992	0.5	UGG	JS16	CD	610.000		
69SE1	RVFS*61	CSE	10-feb-1992	0.5	UGG	JS16	CO	20.700		
69SE1	RVFS*61	CSE	10-feb-1992	0.5	UGG	JS16	CR	2040.000		

Site ID	Field ID	Media	Date	Depth	Units	Analytical Method	Analyte Abbrv.	Value	Flag	Internal Std. Code
69SE1	RVFS*61	CSE	10-feb-1992	0.5	UGG	JS16	CU	818.000		
69SE1	RVFS*61	CSE	10-feb-1992	0.5	UGG	JS16	FE	34500.000		
69SE1	RVFS*61	CSE	10-feb-1992	0.5	UGG	JS16	K	522.000		
69SE1	RVFS*61	CSE	10-feb-1992	0.5	UGG	JS16	MG	2200.000		
69SE1	RVFS*61	CSE	10-feb-1992	0.5	UGG	JS16	MN	621.000		
69SE1	RVFS*61	CSE	10-feb-1992	0.5	UGG	JS16	NA	7990.000		
69SE1	RVFS*61	CSE	10-feb-1992	0.5	UGG	JS16	NI	77.000		
69SE1	RVFS*61	CSE	10-feb-1992	0.5	UGG	JS16	PB	1330.000		
69SE1	RVFS*61	CSE	10-feb-1992	0.5	UGG	JS16	SB	178.000		
69SE1	RVFS*61	CSE	10-feb-1992	0.5	UGG	JS16	TL	18.500		
69SE1	RVFS*61	CSE	10-feb-1992	0.5	UGG	JS16	V	25.100		
69SE1	RVFS*61	CSE	10-feb-1992	0.5	UGG	JS16	ZN	10000.000		
69SS1	RVFS*62	CSO	10-feb-1992	0.5	UGG	JB01	HG	0.117		
69SS1	RVFS*62	CSO	10-feb-1992	0.5	UGG	JD19	AS	3.270		
69SS1	RVFS*62	CSO	10-feb-1992	0.5	UGG	JD15	SE	0.250	LT	
69SS1	RVFS*62	CSO	10-feb-1992	0.5		00	PH	7.200		
69SS1	RVFS*62	CSO	10-feb-1992	0.5	UGG	JS16	AG	0.919		
69SS1	RVFS*62	CSO	10-feb-1992	0.5	UGG	JS16	AL	10500.000		
69SS1	RVFS*62	CSO	10-feb-1992	0.5	UGG	JS16	BA	138.000		
69SS1	RVFS*62	CSO	10-feb-1992	0.5	UGG	JS16	BE	0.981		
69SS1	RVFS*62	CSO	10-feb-1992	0.5	UGG	JS16	CA	4930.000		
69SS1	RVFS*62	CSO	10-feb-1992	0.5	UGG	JS16	CD	31.000		
69SS1	RVFS*62	CSO	10-feb-1992	0.5	UGG	JS16	CO	9.980		
69SS1	RVFS*62	CSO	10-feb-1992	0.5	UGG	JS16	CR	159.000		
69SS1	RVFS*62	CSO	10-feb-1992	0.5	UGG	JS16	CU	26.600		
69SS1	RVFS*62	CSO	10-feb-1992	0.5	UGG	JS16	FE	20600.000		
69SS1	RVFS*62	CSO	10-feb-1992	0.5	UGG	JS16	K	868.000		
69SS1	RVFS*62	CSO	10-feb-1992	0.5	UGG	JS16	MG	6430.000		
69SS1	RVFS*62	CSO	10-feb-1992	0.5	UGG	JS16	MN	765.000		
69SS1	RVFS*62	CSO	10-feb-1992	0.5	UGG	JS16	NA	334.000		
69SS1	RVFS*62	CSO	10-feb-1992	0.5	UGG	JS16	NI	46.600		
69SS1	RVFS*62	CSO	10-feb-1992	0.5	UGG	JS16	PB	307.000		
69SS1	RVFS*62	CSO	10-feb-1992	0.5	UGG	JS16	SB	859.000		
69SS1	RVFS*62	CSO	10-feb-1992	0.5	UGG	JS16	TL	10.600		
69SS1	RVFS*62	CSO	10-feb-1992	0.5	UGG	JS16	V	36.300		
69SS1	RVFS*62	CSO	10-feb-1992	0.5	UGG	JS16	ZN	2500.000		
69SS2	RVFS*63	CSO	10-feb-1992	0.5	UGG	JB01	HG	0.050	LT	
69SS2	RVFS*63	CSO	10-feb-1992	0.5	UGG	JD19	AS	6.030		
69SS2	RVFS*63	CSO	10-feb-1992	0.5	UGG	JD15	SE	0.250	LT	
69SS2	RVFS*63	CSO	10-feb-1992	0.5		00	PH	6.950		
69SS2	RVFS*63	CSO	10-feb-1992	0.5	UGG	JS16	AG	0.589	LT	
69SS2	RVFS*63	CSO	10-feb-1992	0.5	UGG	JS16	AL	9340.000		
69SS2	RVFS*63	CSO	10-feb-1992	0.5	UGG	JS16	BA	92.700		
69SS2	RVFS*63	CSO	10-feb-1992	0.5	UGG	JS16	BE	0.500	LT	
69SS2	RVFS*63	CSO	10-feb-1992	0.5	UGG	JS16	CA	1620.000		
69SS2	RVFS*63	CSO	10-feb-1992	0.5	UGG	JS16	CD	3.730		
69SS2	RVFS*63	CSO	10-feb-1992	0.5	UGG	JS16	CO	6.490		
69SS2	RVFS*63	CSO	10-feb-1992	0.5	UGG	JS16	CR	145.000		
69SS2	RVFS*63	CSO	10-feb-1992	0.5	UGG	JS16	CU	14.700		
69SS2	RVFS*63	CSO	10-feb-1992	0.5	UGG	JS16	FE	19100.000		
69SS2	RVFS*63	CSO	10-feb-1992	0.5	UGG	JS16	K	710.000		
69SS2	RVFS*63	CSO	10-feb-1992	0.5	UGG	JS16	MG	972.000		
69SS2	RVFS*63	CSO	10-feb-1992	0.5	UGG	JS16	MN	766.000		
69SS2	RVFS*63	CSO	10-feb-1992	0.5	UGG	JS16	NA	208.000		
69SS2	RVFS*63	CSO	10-feb-1992	0.5	UGG	JS16	NI	11.700		
69SS2	RVFS*63	CSO	10-feb-1992	0.5	UGG	JS16	PB	162.000		
69SS2	RVFS*63	CSO	10-feb-1992	0.5	UGG	JS16	SB	25.300		
69SS2	RVFS*63	CSO	10-feb-1992	0.5	UGG	JS16	TL	6.620	LT	
69SS2	RVFS*63	CSO	10-feb-1992	0.5	UGG	JS16	V	36.600		
69SS2	RVFS*63	CSO	10-feb-1992	0.5	UGG	JS16	ZN	261.000		
69SW1	RDWD*2	CSW	10-feb-1992	0.0	UGL	SS10	AL	9800.000		
69SW1	RDWD*2	CSW	10-feb-1992	0.0	UGL	SS10	BA	159.000		
69SW1	RDWD*2	CSW	10-feb-1992	0.0	UGL	SS10	BE	5.000	LT	
69SW1	RDWD*2	CSW	10-feb-1992	0.0	UGL	SS10	CA	268000.000		
69SW1	RDWD*2	CSW	10-feb-1992	0.0	UGL	SS10	CD	2540.000		
69SW1	RDWD*2	CSW	10-feb-1992	0.0	UGL	SS10	CO	1640.000		
69SW1	RDWD*2	CSW	10-feb-1992	0.0	UGL	SS10	CR	25000.000		
69SW1	RDWD*2	CSW	10-feb-1992	0.0	UGL	SS10	CU	1450.000		
69SW1	RDWD*2	CSW	10-feb-1992	0.0	UGL	SS10	FE	650000.000		
69SW1	RDWD*2	CSW	10-feb-1992	0.0	UGL	SS10	K	3210.000		
69SW1	RDWD*2	CSW	10-feb-1992	0.0	UGL	SS10	MG	29300.000		
69SW1	RDWD*2	CSW	10-feb-1992	0.0	UGL	SS10	MN	25300.000		
69SW1	RDWD*2	CSW	10-feb-1992	0.0	UGL	SS10	NA	950000.000		
69SW1	RDWD*2	CSW	10-feb-1992	0.0	UGL	SS10	NI	120000.000		

Site ID	Field ID	Media	Date	Depth	Units	Analytical Method	Analyte Abbrv.	Value	Flag	Internal Std. Code
69SW1	RDWD*2	CSW	10-feb-1992	0.0	UGL	SS10	SB	269.000		
69SW1	RDWD*2	CSW	10-feb-1992	0.0	UGL	SS10	V	161.000		
69SW1	RDWD*2	CSW	10-feb-1992	0.0	UGL	SS10	ZN	61000.000		
69SW1	RDWD*2	CSW	10-feb-1992	0.0	UGL	SB01	HG	0.243	LT	
69SW1	RDWD*2	CSW	10-feb-1992	0.0	UGL	SD09	TL	6.990	LT	
69SW1	RDWD*2	CSW	10-feb-1992	0.0	UGL	SD22	AS	3.620		
69SW1	RDWD*2	CSW	10-feb-1992	0.0	UGL	SD21	SE	3.020	LT	
69SW1	RDWD*2	CSW	10-feb-1992	0.0		00	PH	6.330		
69SW1	RDWD*2	CSW	10-feb-1992	0.0	UGL	SD20	PB	7900.000		
69SW1	RDWD*2	CSW	10-feb-1992	0.0	UGL	SD23	AG	5.830		
69SW1	RDWD*2	CSW	10-feb-1992	0.0	UGL	00	TOX	110.000		
69SW1	RDWD*2	CSW	10-feb-1992	0.0	UGL	00	TOC	22300.000		

APPENDIX A

Laboratory Analytical Data

SWMU 75

ALLIANT TECHSYSTEMS

Alliant Techsystems Inc.
Radford Army Ammunition Plant
Route 114
P.O. Box 1
Radford, VA 24141-0100

June 22, 1995

95-815-236

SWMU 75
Bldg. 421 UST

Department of Environmental Quality
Water Division - UST Program
P. O. Box 11143
Richmond, VA 23230

Attention: Ms. Amy Harshman

Subject: UST Notification for RAAP UST Program

Reference: Telephone Conversation on June 20 with Mr. Ken Chapman (Roanoke) and Ms. Amy Harshman (Richmond)

Dear Madam:

Attached is the notification form for the following underground storage tanks (USTs):

503 (PC-95-1086)	9222 #1 and #2
421 (PC-95-1099)	1524 #1 and #2
442 (PC-95-1098)	1525 #1 and #2
T-4700	3525 #1 and #2
3751	

RAAP is preparing Site Characterization Reports for Sites 503, 421 and 442. Site T-4700 will be closed soon and Site 3751 has been reviewed by the Montgomery County Building Official and has been closed. Sites 9222, 1524, 1525 and 3525 are solvent railcar unloading stations which, each, have two "sump tanks" or USTs. The "heel sump tanks" are used to collect any remaining product after the majority of the product has been drawn from the railcar via suction. A funnel under the car's drain valve is used to collect the remaining product into "sump tank" by gravity. The product in the "sump tank" is immediately pumped to an above ground tank with the rest of the product. As discussed with your office, these tanks must be registered and monitored since they do hold product on a regular basis even though the product is removed expeditiously after the railcar has been emptied.

Thank you for your time and consideration in this matter.

Very truly yours,

C. A. Jake
Environmental Manager

Coordination:

J. E. Woolwine

J. Wilson

c: Department of Environmental Quality
Water Regional Office
3015 Peters Creek Road
P. O. Box 7017
Roanoke, Virginia 24019

Attachment

bc: Administrative File
J. Wilson
D. W. Ratcliff
C. A. Jake
M. A. Lee
Env. File

MALee:gps

VA VWCB Form 7230-1 (5/93)

Notification for Underground Storage Tanks

STATE USE ONLY
ID NUMBER
DATE RECEIVED
A. NEW ____
B. AMENDED ____
C. ENTERED INTO UST-DMS ____
D. Comments: ____

State Agency Name and Address
DEQ-Water Division-UST Program P.O. Box No. 11143 Richmond, VA 23230

TYPE OF NOTIFICATION

☐ A. NEW FACILITY ☒ B. AMENDED ☒ C. CLOSURE

35 No. of tanks at facility ____ No. of continuation sheets attached

INSTRUCTIONS

Please type or print in ink all items except "signature" in section VIII. This form must be completed for each location containing underground storage tanks. If more than five (5) tanks are owned at this location, photocopy pages 3, 4 and 5, and staple continuation sheets to the form.

GENERAL INFORMATION

Notification is required by Virginia law for all underground storage tanks that have been used to store regulated substances and were in the ground as of May 8, 1986, or that are brought into use after May 8, 1986. The information requested is required by §62.1-44.34:9.6 & 7 of the Virginia State Water Control Law, Article 9.

The primary purpose of this notification program is to locate and evaluate underground storage tanks that store or have stored petroleum or hazardous substances. It is expected that the information you provide will be based on reasonable available records, or in the absence of such records, your knowledge, belief, or recollection.

Who Must Notify?

A. Virginia State Water Control Law Article 9 § 62.1-44.34:8 & 7, requires that unless exempted, owners of underground storage tanks that store regulated substances must notify the State Water Control Board of the existence of their tanks. Owner means:

1) in the case of an underground storage tank in use on November 8, 1984, or brought into use after that date, any person who owns an underground storage tank used for the storage, use or dispensing of regulated substances; and

2) in the case of any underground storage tank in use before November 8, 1984; but no longer in use after that date, any person who owned such tank immediately before the discontinuation of its use; and

B. Owners of property who have actual knowledge of underground storage tanks on such property that were taken out of service before January 1, 1974, yet still in the ground.

What UST's Must Be Notified? Underground storage tank or "UST" means any one combination of tanks (including underground pipes connected thereto) that is used to contain an accumulation of regulated substances, and the volume of which (including the volume of underground pipes connected thereto) is 10% or more beneath the surface of the ground.

What UST's Are Excluded From Notification Requirements?

1. Farm or residential tank of 1,100 gallons or less capacity used for storing motor fuel for noncommercial purposes;
2. Tank used for storing heating oil for consumption on the premises where stored, except for tanks having a capacity of more than 5,000 gallons and used for storing heating oil;
3. Septic tank;
4. Pipeline facility (including gathering lines) regulated under:
   a. The Natural Gas Pipeline Safety Act of 1968 (49 U.S.C. App. 1671, et seq.), or
   b. The Hazardous Liquid Pipeline Safety Act of 1979 (49 U.S.C. App. 2001, et seq.), or
   c. Which is an intrastate pipeline facility regulated under state laws comparable to the provisions of the law referred to in subdivisions 4.a or 4.b of this definition;
5. Surface impoundment, pit, pond, or lagoon;
6. Storm-water or wastewater collection system;
7. Flow-through process tank;
8. Liquid trap or associated gathering lines directly related to oil or gas production and gathering operations; or
9. Storage tank situated in an underground area (such as a basement, cellar, mineworking, drift, shaft, or tunnel) if the storage tank is situated upon or above the surface of the floor.

The Following Need Not Notify, But May Be Regulated.

10. Wastewater treatment tank systems;
11. Any UST systems containing radioactive material that are regulated under the Atomic Energy Act of 1954 (42 USC 2011 and following);
12. Any UST system that is part of an emergency generator system at nuclear power generation facilities regulated by the Nuclear Regulatory Commission under 10 CFR Part 50, Appendix A;
13. Airport hydrant fuel distribution systems; and
14. UST systems with field-constructed tanks

What Substances Are Covered? "Regulated substance" means an element, compound, mixture, solution, or substance that, when released into the environment, may present substantial danger to the public health or welfare, or the environment. The term "regulated substance" includes:

1. Any substance defined in § 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, but not any substance regulated as a hazardous waste under subtitle C of the Resource Conservation and Recovery Act (RCRA) of 1976; and
2. Petroleum, including crude oil or any fraction thereof, that is liquid at standard conditions of temperature and pressure (60 degrees Fahrenheit and 14.7 pounds per square inch absolute). The term "regulated substance" includes but is not limited to petroleum and petroleum-based substances comprised of a complex blend of hydrocarbons derived from crude oil through processes of separation, conversion, upgrading, and finishing, such as motor fuels, jet fuels, distillate fuel oils, residual fuel oils, lubricants, petroleum solvents, and used oils.

When to Notify?

A. Any owner who brings an underground storage tank system into use must within 30 days of bringing such tank into use, submit a notice of existence of such tank system to the board. Any change in: ownership; tank status (e.g., temporarily / permanently closed out); tank/piping systems (e.g., upgrades such as addition of corrosion protection, internal lining, release detection); substance stored (e.g., change from petroleum to hazardous substance) requires the UST owner to submit an amended notification form within 30 days after such change/upgrade occurs or is brought into use. Owners may provide notice for several tanks using one notification form, but owners with tanks located at more than one place of operation must file a separate notification form for each separate place of operation.

Under Virginia UST notification requirements effective July 1, 1987, owners of property who have actual knowledge of underground storage tanks on such property that were taken out of service before January 1, 1974, yet still in the ground, must notify the board on the notification form.

Notices required to be submitted must provide all of the information in Sections I through IX of this form (Section X as required) for each tank for which notice must be given. Notices for tanks installed after December 22, 1988, must also provide all of the information in Section XI of this form for each tank for which notice must be given.

B. All owners and operators of new UST systems must certify in the notification form compliance with the following requirements of Virginia Regulation VR 680-13-02:

1. Installation of tanks and piping under subsection E of § 2.1;
2. Cathodic protection of steel tanks and piping under subsections A and B of § 2.1;
3. Release detection under §§ 4.2. and 4.3
4. Financial responsibility under Virginia Regulation VR 680-13-03.

C. All owners and operators of new UST systems must ensure that the installer certifies in the notification form that the methods used to install the tanks and piping comply with the requirements in subsection D of § 2.1 of VR 680-13-02.

D. Beginning October 24, 1988, any person who sells a tank intended to be used as an underground storage tank must notify the purchaser of such tank of the owner's notification obligations under subsection A of this section. The statement provided in Appendix II of VR 680-13-02 may be used to comply with this requirement.

I. OWNERSHIP OF TANK(S)

U. S. Army
Owner Name (Corporation, Individual, Public Agency, or Other Entity)

Radford Army Ammunition Plant
Street Address

Rt. 114 (P. O. Box 1)

Radford, Virginia 24141
City State ZIP Code

Montgomery/Pulaski Counties
County

(703) 639-7631
Phone Number (Include Area Code)

II. LOCATION OF TANK(S)

If known, give the geographic location of tank(s) by degrees, minutes, and seconds. Example Lat. 42, 38, 12N Long. 88, 24, 17W

Latitude 37°10'14" Longitude 80°31'17"

(If same as Section I, mark box here) ☐

Facility or Company Site Identifier, as applicable

Street Address (P. O. Box not acceptable)

City State ZIP Code

County Municipality

IX. DESCRIPTION OF UNDERGROUND STORAGE TANKS (Complete for each tank at this location.)

Tank Identification Number	Tank No. T-4700	Tank No. 503	Tank No. 421	Tank No. 442	Tank No. 3751
1. Status of Tank (Mark only one) — Currently in Use					
Temporarily Out of Use (Remember to fill out section X.)					
Permanently Out of Use (Remember to fill out section X.)	X	X	X	X	X
Amendment of Information					
2. Date of Installation (mo./year)	-/46	-/69	-/73	-/82	5/84
3. Estimated Total Capacity (gallons)	2000	1000	750	275	2000
4. Tank Material of Construction (Mark all that apply)					
Asphalt Coated or Bare Steel	X	X	X	X	X
Cathodically Protected Steel					
Epoxy Coated Steel					
Composite (Steel with Fiberglass)					
Fiberglass Reinforced Plastic					
Lined Interior					
Double Walled					
Polyethylene Tank Jacket					
Concrete					
Excavation Liner					
Unknown					
Other (Please specify)					
Has tank been repaired?					
5. Piping Material of Construction (Mark all that apply) — Bare Steel	X	X	X	X	X
Galvanized Steel					
Fiberglass Reinforced Plastic					
Copper					
Cathodically Protected					
Double Walled					
Secondary Containment					
Unknown					
Other (Please specify)					
Has piping been repaired?					
6. Piping (Type) (Mark only one) — Suction: no valve at tank	X	X			
Suction: valve at tank					
Pressure					
Gravity Fed			X	X	X

IX. DESCRIPTION OF UNDERGROUND STORAGE TANKS (Complete for each tank at this location.)

Tank Identification Number	1524 #1 Tank No. ____	1524 #2 Tank No. ____	1525 #1 Tank No. ____	1525 #2 Tank No. ____	3525 #1 Tank No. ____
Status of Tank (Mark only one) Currently in Use	X	X	X	X	X
Temporarily Out of Use (Remember to fill out section XI.)					
Permanently Out of Use (Remember to fill out section XI.)					
Amendment of Information					
2. Date of Installation (mo./year)	3/59	3/59	3/59	3/59	4/64
3. Estimated Total Capacity (gallons)	550	550	560	560	560
4. Tank Material of Construction (Mark all that apply)					
Asphalt Coated or Bare Steel	X	X	X	X	X
Cathodically Protected Steel					
Epoxy Coated Steel					
Composite (Steel with Fiberglass)					
Fiberglass Reinforced Plastic					
Lined Interior					
Double Walled					
Polyethylene Tank Jacket					
Concrete					
Excavation Liner					
Unknown					
Other (Please specify)					
Has tank been repaired?					
5. Piping Material of Construction (Mark all that apply) Bare Steel	X	X	X	X	X
Galvanized Steel					
Fiberglass Reinforced Plastic					
Copper					
Cathodically Protected					
Double Walled					
Secondary Containment					
Unknown					
Other (Please specify)					
Has piping been repaired?					
6. Piping (Type) (Mark only one)					
Suction: no valve at tank					
Suction: valve at tank					
Pressure					
Gravity Fed	X	X	X	X	X

IX. DESCRIPTION OF UNDERGROUND STORAGE TANKS (Complete for each tank at this location.)

Tank Identification Number	Tank No. 3525 #2	Tank No. 9222 #1	Tank No. 9222 #2	Tank No.	Tank No.
Status of Tank (Mark only one) — Currently in Use	X	X	X		
Temporarily Out of Use (Remember to fill out section XI.)					
Permanently Out of Use (Remember to fill out section XI.)					
Amendment of Information					
2. Date of Installation (mo./year)	4/64	11/83	11/83		
3. Estimated Total Capacity (gallons)	560	1155	1155		
4. Tank Material of Construction (Mark all that apply)					
Asphalt Coated or Bare Steel	X	X	X		
Cathodically Protected Steel					
Epoxy Coated Steel					
Composite (Steel with Fiberglass)					
Fiberglass Reinforced Plastic					
Lined Interior					
Double Walled					
Polyethylene Tank Jacket					
Concrete					
Excavation Liner					
Unknown					
Other (Please specify)					
Has tank been repaired?					
5. Piping Material of Construction (Mark all that apply) — Bare Steel	X	X	X		
Galvanized Steel					
Fiberglass Reinforced Plastic					
Copper					
Cathodically Protected					
Double Walled					
Secondary Containment					
Unknown					
Other (Please specify)					
Has piping been repaired?					
6. Piping (Type) (Mark only one)					
Suction: no valve at tank					
Suction: valve at tank					
Pressure					
Gravity Fed	X	X	X		

BUILDING PERMIT

3420

Montgomery County Department of Planning and Inspections
P.O. Box 806 Christiansburg, Va. 24073 Phone: 382-5750

Note: This Permit is VOID if work is not commenced within six (6) months from the date of issuance. PAID
All work must comply with the Code of Ordinances of Montgomery County, Virginia

PAID

Building Permit No. 3420 Date April 21, 1995
Name of Owner Radford Army Ammunition Plant Address P.O Box 1 Ph 639-7631
Name of Contractor Alliant Techsystems, Inc Address Radford, VA 24141-0100 Ph
State of Contrs. Regist. No.
Name of SubContractor Address Ph
State Contrs. Regist. No.
Name of Architect Address Ph

Permanent
USE: (8) Tank Removals

LOCATION OF CONSTRUCTION:

N E S W side of St. Rd. No. about miles from #421,442,503,3751,224-1 241-1 (#1), 241-1 (#2) and T-4700 (Permanent Closure)

Subdivision Section Lot No.
Size of lot or Acreage of land 4350 acres Magist. Dist. Prices Fork
Front street foundation setback ft. Side street setback ft.
Left side yard ft. Right side yard ft. Rear yard ft.

Total Sq. Ft. Estimated Cost: $ 50,000.00
Use Group Classification: PERMIT FEE: $ 160.00
Construction: Dept. Approval: Wayne D. Flanary
Date: 4-24-95

REQUIRED INSPECTION - STRUCTURES

FOOTERS: Inspection to be made after footers are dug, grade stakes in place, all forms and bulkheads in place and reinforcement steel in footers.

FOUNDATION & FRAMING: Inspection to be made on Forms and Reinforcement steel in place (poured concrete foundations) Inspect Block Walls, inspect all drain tile around foundations. Framing to be inspected after the roof, all framing, fire blocking and bracing are in place.

ROUGH-IN-PLUMBING: Inspection after all plumbing is installed before insulation is put in walls. All underground plumbing to be inspected before covered with concrete slab.

ROUGH-IN-ELECTRICAL: All wiring to be inspected before insulating walls or covering in any manner. All underground wiring (conduit etc.) to be inspected before covering.

MECHANICAL: All mechanical work (heat systems duct work etc. to be inspected before covering in any manner.

SLAB INSPECTION: All concrete slabs basement, floors, garage floors, carport floors, patios etc. inspections will be made when all base stone is in place, reinforcement wire, and grade stakes are in place.

FINAL INSPECTION: Inspection to be made after the building is complete and before being occupied. An occupancy permit will be issued after the final inspection of the building is made.

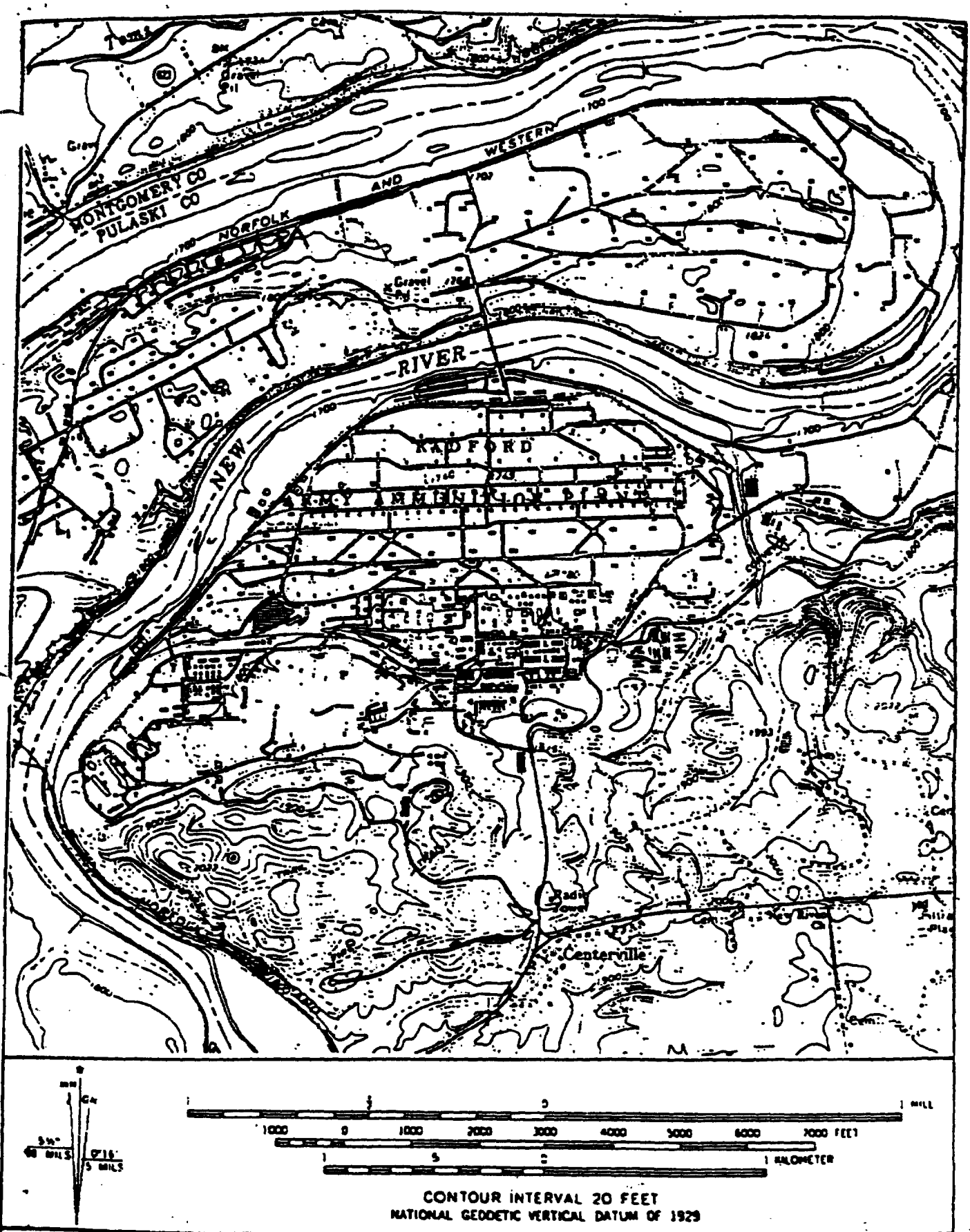
REQUIRED INSPECTIONS - MOBILE HOMES

MOBILE HOMES: One inspection covers footers for piers, tie downs, water and sewer connections and the electrical service for the home.

DOUBLE-WIDE MOBILE HOMES: Footer Inspection - This is made on footers before moving the two halves of the home to the site. Second Inspection - This covers the Water and Sewer connections, tie downs, set-up of the home, and the electrical service for the home.

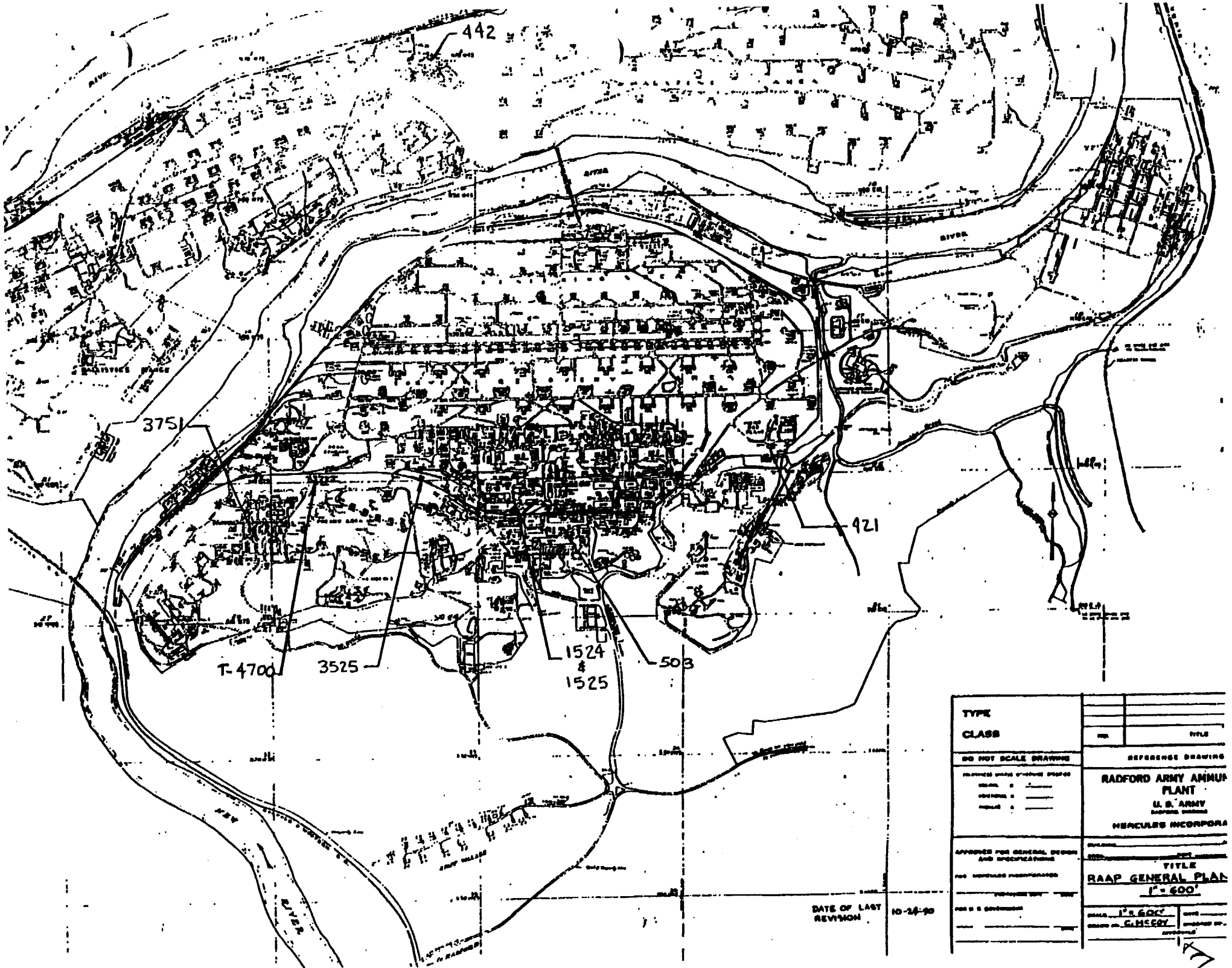
NOTICE: The Owner of this Permit shall be responsible for notifying this Department for ALL inspections as required above.
A MINIMUM of 24 HOURS NOTICE IS REQUIRED FOR ALL INSPECTION REQUESTS.

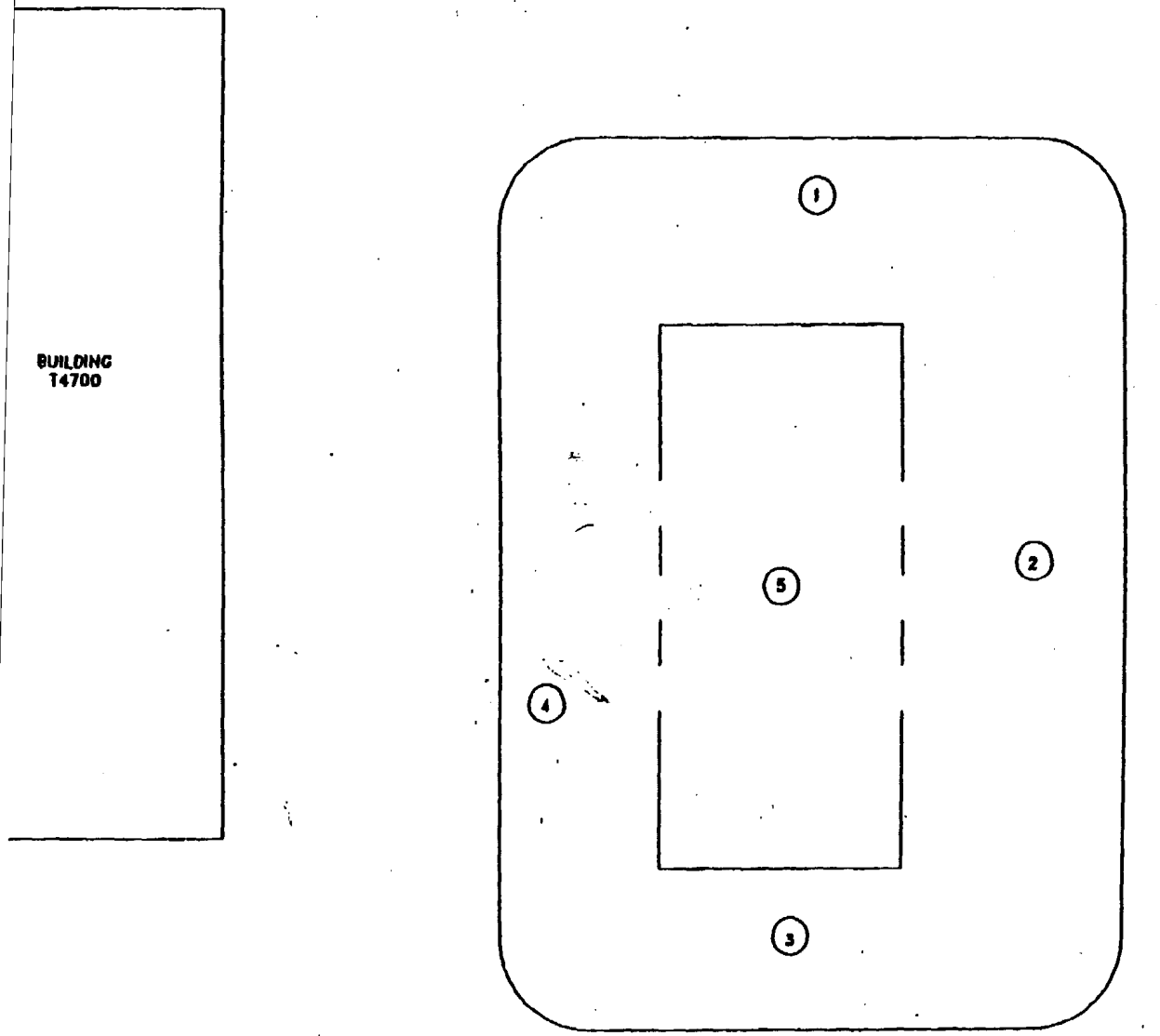
WHITE - APPLICANT'S COPY PINK - INSPECTOR'S COPY YELLOW - COMMISSIONER OF REVENUE'S COPY GREEN - TREASURER'S COPY



HERCULES

Figure 1. Site Diagram of Radford Army Ammunition Plant


442
375
T-4700
3525
1524
&
1525
503
421
RIVER
RIVER
RIVER
TYPE
CLASS
DO NOT SCALE DRAWING
REFERENCE DRAWING
RADFORD ARMY AMMUN
PLANT
U. S. ARMY
HERCULES INCORPORA
TITLE
RAAP GENERAL PLAN
1" = 600'
DATE OF LAST REVISION
10-24-90



PLAN VIEW OF EXCAVATION

DATE: 6/16/95

SAMPLE I.D.	SAMPLE LOCATION	TEST RESULTS
#1	WALL - NORTH FACE	800 mg/kg
#2	WALL - EAST FACE	BDL
#3	WALL - SOUTH FACE	150 mg/kg
#4	WALL - WEST FACE	180 mg/kg
#5	FLOOR OF PIT	BDL

SOIL SAMPLING DIAGRAM
SITE- UST T4700
RADFORD AAP
US ROUTE 114 (P. O. BOX 1)
RADFORD, VA 24141

EnviroTech Mid-Atlantic Laboratories
1861 Pratt Dr. • Blacksburg, VA 24060
(703) 231-3983 • Fax (703) 231-3984

May 31, 1995

Client Contact

Attn.:	C.C. Lane
Fax No.:	703-639-4361

Report Information

Report #:	9815
Date Rec'd:	5/12/95

Client Information

Name:	Alliant Techsystems
Address:	Post Office Box 1
	Radford, VA 24141

Sample Information

Project:	T4700
Project #:	
P.O. #	RA-59938

Sample Identification

Sample submitted and identified by client:

Sample	Field Identification	Matrix	Date	Time Collected
9815A	T4700-SF	Soil	5/16/95	1117
9815B	T4700-EF	Soil	5/16/95	1120
9815C	T4700-NF	Soil	5/16/95	1123
9815D	T4700-WF	Soil	5/16/95	1130
9815E	T4700-Pile-W	Soil	5/16/95	1150
9815F	T4700-Pile-E	Soil	5/16/95	1157
9815G	T4700-FLR	Soil	5/16/95	1410

EnviroTech Mid-Atlantic

05/31/95

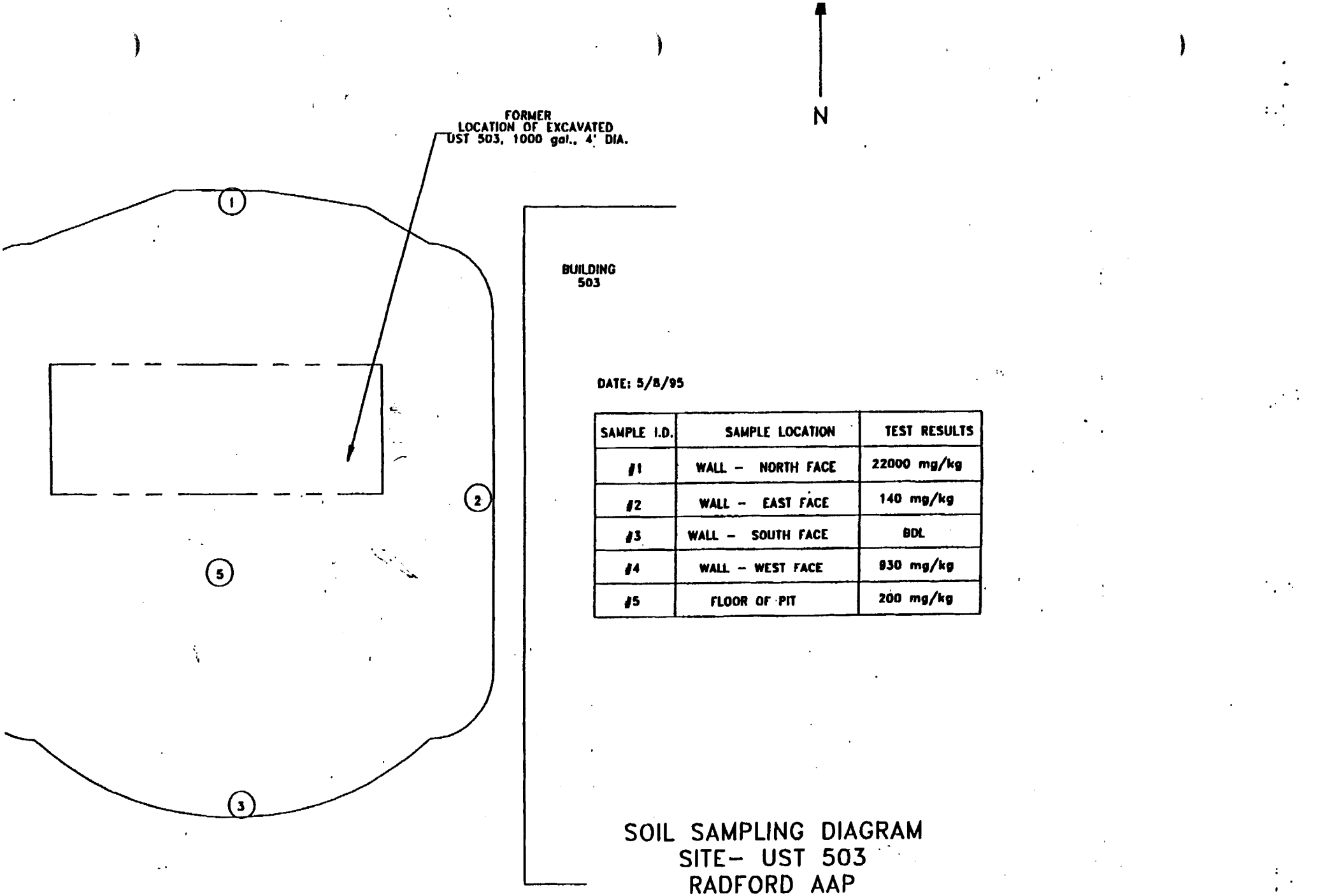
Laboratory Analyses

Project: T4700

Analysis	D/L	9815A *T4700-SF*	D/L	9815B *T4700-EF*	D/L	9815C *T4700-NF*
TPH-GC (mg/kg)			10	BDL		
Kerosene / Diesel Range	10	150			10	600

Analysis	D/L	9815D *T4700-WF*	D/L	9815F *T4700-Pile-E*	D/L	9815G *T4700-FLR*
TPH-GC (mg/kg)					10	BDL
Kerosene / Diesel Range	10	180	10	170		

Analysis	D/L	9815E *T4700-Pile-W*
TPH-GC (mg/kg)		
Kerosene / Diesel Range	10	BDL
Oil Range	10	41
TCLP Metals (mg/L)		
Arsenic (As)	0.002	BDL
Mercury (Hg)	0.0001	BDL
Selenium (Se)	0.002	0.002
TCLP Metals by ICP (mg/L)		
Barium (Ba)	0.01	1.1
Cadmium (Cd)	0.01	0.01
Chromium (Cr)	0.01	0.02
Lead (Pb)	0.10	BDL
Silver (Ag)	0.01	0.04
BTEX (mg/kg)		
Benzene	100	BDL
Toluene	100	BDL
Ethylbenzene	100	BDL
Xylenes	100	BDL



DATE: 5/8/95

SAMPLE I.D.	SAMPLE LOCATION	TEST RESULTS
#1	WALL - NORTH FACE	22000 mg/kg
#2	WALL - EAST FACE	140 mg/kg
#3	WALL - SOUTH FACE	BDL
#4	WALL - WEST FACE	930 mg/kg
#5	FLOOR OF PIT	200 mg/kg

SOIL SAMPLING DIAGRAM
SITE- UST 503
RADFORD AAP
US ROUTE 114 (P. O. BOX 1)
RADFORD, VA 24141

PLAN VIEW OF EXCAVATION

EnviroTech Mid-Atlantic Laboratories
1861 Pratt Dr. • Blacksburg, VA 24060
(703) 231-3983 • Fax (703) 231-3984

May 22, 1995

Client Contact

Attn.: C.C. Lane
Fax No.: 703-639-4361

Report Information

Report #: 9754
Date Rec'd: 5/10/95

Client Information

Name: Alliant Techsystems
Address: Post Office Box 1
Radford, VA 24141

Report Information

Project: Site 503
Project #:
P.O. # VA 10547

Sample Identification

Sample submitted and identified by client:

Sample	Field Identification	Matrix	Date	Time Collected
9754A	503-WF	Soil	5/8/95	1425
9754B	503-EF	Soil	5/8/95	1427
9754C	503-NF	Soil	5/8/95	1430
9754D	503-SF	Soil	5/8/95	1434
9754E	503-FLR	Soil	5/8/95	1440

All analyses were performed in accordance with EPA methods referenced in "Methods for Chemical Analysis of Water and

EnviroTech Mid-Atlantic

05/22/95

Laboratory Analyses

Project: Site 503

Analysis	D/L	9754A *503-WF*	D/L	9754B *503-EF*	D/L	9754C *503-NF*
TPH-GC (mg/kg)						
Kero-Diesel Range	500	930	10	140	1000	22000
Oil Range	10	160	—	—	10	130

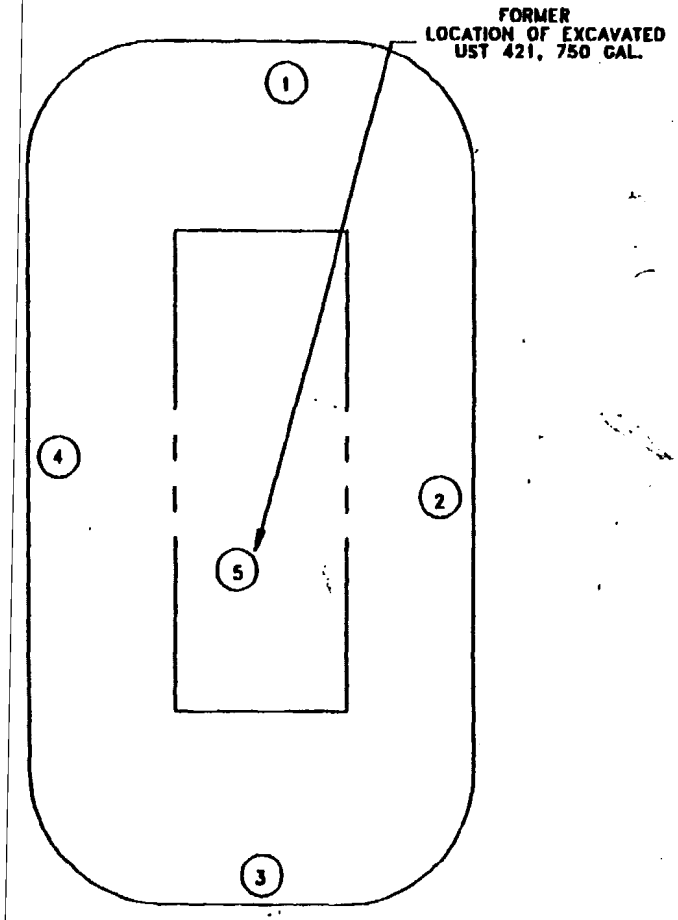
Analysis	D/L	9754D *503-SF*
TPH-GC (mg/kg)	10	BDL

Analysis	D/L	9754E *503-FLR*
TPH-GC (mg/kg)		
Kero-Diesel Range	200	1200
Oil Range	10	200

Quality Control Data

Analysis	%STD	%Spike	%RD	EPA #	Analysist	Date Analyzed
TPH-GC	109	107	<1	3550	C. Smith	5/22/95

Elizabeth J. Smiley
Laboratory Director



PLAN VIEW OF EXCAVATION

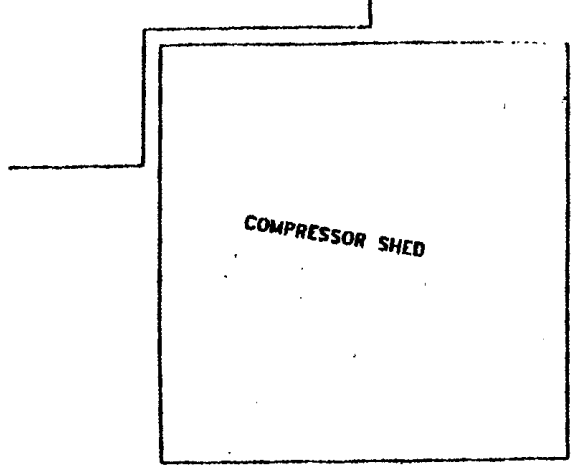


BLDG.
421

DATE: 5/24/95

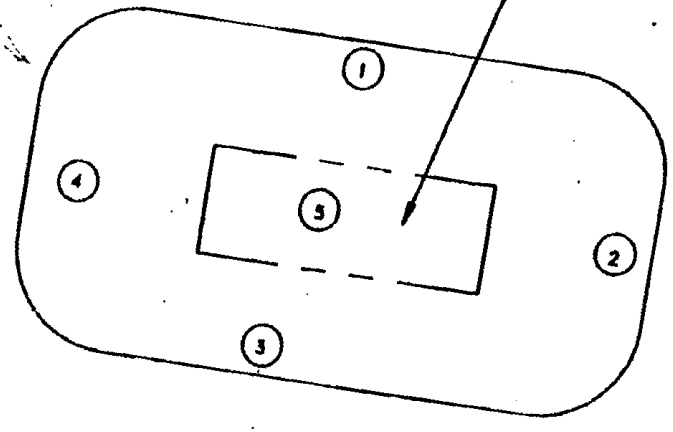
SAMPLE I.D.	SAMPLE LOCATION	TEST RESULTS
#1	WALL - NORTH FACE	BDL
#2	WALL - EAST FACE	BDL
#3	WALL - SOUTH FACE	1400 mg/kg
#4	WALL - WEST FACE	BDL
#5	FLOOR OF PIT	130 mg/kg

SOIL SAMPLING DIAGRAM
SITE- UST 421
RADFORD AAP
US ROUTE 114 (P. O. BOX 1)
RADFORD, VA 24141



N

FORMER
LOCATION OF EXCAVATED
UST 442, 275 GAL.



DATE: 5/24/95

SAMPLE I.D.	SAMPLE LOCATION	TEST RESULTS
#1	WALL - NORTH FACE	BDL
#2	WALL - EAST FACE	43000 mg/kg
#3	WALL - SOUTH FACE	5400 mg/kg
#4	WALL - WEST FACE	16000 mg/kg
#5	FLOOR OF PIT	300 mg/kg

VIEW OF EXCAVATION

SOIL SAMPLING DIAGRAM
SITE- UST 442
RADFORD AAP
US ROUTE 114 (P. O. BOX 1)
RADFORD, VA 24141

EnviroTech Mid-Atlantic Laboratories
1861 Pratt Dr. • Blacksburg, VA 24060
(703) 231-3983 • Fax (703) 231-3984

May 24, 1995
Page 1 of 2

Client Contact

Attn.: C.C. Lane
Fax No.: 703-639-4361

Report Information

Report #: 9777
Date Rec'd: 5/12/95

Client Information

Name: Alliant Techsystems
Address: Post Office Box 1
Radford, VA 24141

Sample Information

Project: Sites 442 & 421
Project #:
P.O. # VA 10547

Sample Identification

Sample submitted and identified by client:

Sample	Field Identification	Matrix	Date	Time Collected
9777A	442-SF	Soil	5/11/95	1120
9777B	442-EF	Soil	5/11/95	1130
9777C	442-NF	Soil	5/11/95	1110
9777D	442-FLR	Soil	5/11/95	1345
9777E	442-WF	Soil	5/11/95	1347
9777F	421-EF	Soil	5/11/95	1500
9777G	421-FLR	Soil	5/11/95	1502
9777H	421-NF	Soil	5/11/95	1505
9777I	421-SF	Soil	5/11/95	1507
9777J	421-WF	Soil	5/11/95	1508

All analyses were performed in accordance with EPA methods referenced in "Methods for Chemical Analysis of Water and

EnviroTech Mid-Atlantic

05/24/95

Laboratory Analyses

Project: Sites 442 & 421

Analysis	D/L	9777C 442-NF	9777D 442-FLR	9777F 421-EF	9777G 421-FLR	9777H 421-NF
TPFH-GC (mg/kg)	10	BDL	300	BDL	130	BDL

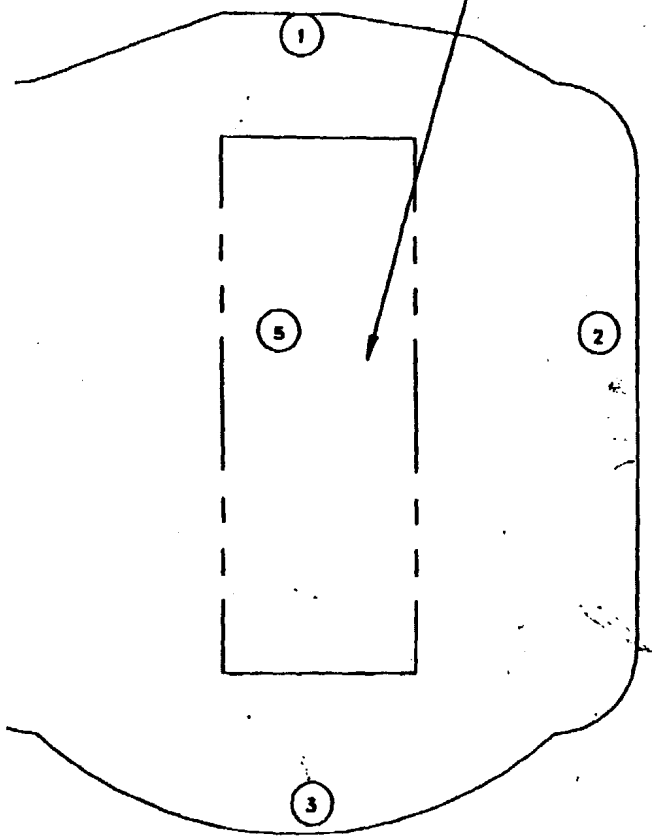
Analysis	D/L	9777A 442-SF	D/L	9777B 442-EF	D/L	9777E 442-WF
TPFH-GC (mg/kg)	200	5400	1000	43000	500	16000

Analysis	D/L	9777I 421-SF	D/L	9777J 421-WF
TPFH-GC (mg/kg)	100	1400	10	BDL

Quality Control Data

Analysis	%STD	%Spike	%RD	EPA #	Analysist	Date Analyzed
TPH-GC	106	114	<1	3550	C. Smith	5/24/95

Elizabeth J. Smiley
Laboratory Director



PLAN VIEW OF EXCAVATION

N

BUILDING
3751

DATE: 4/5/95

SAMPLE I.D.	SAMPLE LOCATION	TEST RESULTS
#1	WALL - NORTH FACE	BDL
#2	WALL - EAST FACE	BDL
#3	WALL - SOUTH FACE	BDL
#4	WALL - WEST FACE	BDL
#5	FLOOR OF PIT	BDL

SOIL SAMPLING DIAGRAM
SITE- UST 3751
RADFORD AAP
US ROUTE 114 (P. O. BOX 1)
RADFORD, VA 24141

EnviroTech Mid-Atlantic Laboratories
1861 Pratt Dr. • Blacksburg, VA 24060
(703) 231-3983 • Fax (703) 231-3984

April 11, 1995

Client: Alliant Techsystems, Inc.
Post Office Box 1
Radford, VA 24141

Attention: C. C. Lane

Fax: 703-639-4361

Report #: 9521
Project: Site 3751
P.O. #:

Date Received: 4/05/95
Project #: VA 10547
Page 1 of 2

Sample Identification

Samples submitted and identified by client as:

Sample	Matrix	Field Identification	Date	Time Collected
9521A	Soil	3751 - WF	4/04/95	15:07
9521B	Soil	3751 - SF	4/04/95	15:10
9521C	Soil	3751 - NF	4/04/95	15:12
9521D	Soil	3751 - EF	4/04/95	15:15
9521E	Soil	3751 - FLR	4/04/95	15:20

All analyses were performed in accordance with EPA methods referenced in "Methods for Chemical Analysis of Water and Wastes", EPA 600/4-79 revised March 1983 and/or "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", SW-846, 3rd Edition.

Analysis	D/L	9521A 3751-WF	9521B 3751-SF	9521C 3751-NF	9521D 3751-EF	9521E 3751-FLR
TPH-GC (mg/kg)	10	BDL	BDL	BDL	BDL	BDL

Quality Control Data

Analysis	%STD	%Spike	%RD	EPA#	Analyst	Date Analyzed
TPH-GC	123	120	<1	3550 Mod CA Method	C. Smith	4/10/95

Elizabeth J. Smiley
Laboratory Director

D/L - Detection Limit BDL - Below Detection Limit

Soil results are reported on a dry weight basis unless otherwise noted.

SWMU 76

HERCULES

Hercules Aerospace Company
Radford Army Ammunition Plant
Caller Service 1
Radford, VA 24141-0299

July 1, 1991

91-815-134

bc: Administrative File
J. A. Morris
H. L. Stull

Administrative Contracting Officer
Radford Army Ammunition Plant
Radford, Virginia 24141

Dear Sir:

Oily Waste Water Spill - Building 7219

Reference: SMCRA-EN Letter Dated June 12, 1991
SMCRA-EN Letter Dated June 26, 1991

On May 29, 1991 at approximately 1500 hours, a spill of oily waste water and sludge occurred while removing a 5500 gallon underground storage tank. As the tank was being lifted by a crane from its resting place (this tank was not on saddles), it tilted, putting excessive strain on the discharge elbow connection causing a 9 foot section of 4 inch drain line to break off. Approximately 250 gallons of the oily waste water sludge, which was not removed prior to the tank removal, drained out into a trench alongside the tank as the tank was being raised.

The entire spill was contained within an area 20 feet long, 3.5 feet wide and 6 inches deep. Samples were taken of the oily waste water sludge spill for laboratory analysis. The tests confirmed the spilled material is hazardous for lead and chromium..

The oily waste water sludge was removed from the containment area using a suction pump and placed in a waste oil storage tank in the solvents area for off plant treatment. The remaining material within the trench was absorbed with an absorbent compound and removed from the area using a "Gradeall". Approximately 13 cubic yards of dirt/absorbed material were removed from the area and is currently being held on a dump truck for disposal. Cleanup of the

Oily Waste Water Spill - Building 7219

area was completed by 1800 hours. Also, approximately one cubic yard of dirt was removed from in front of the tank where the original sample was taken for petroleum hydrocarbon analysis. All the material will be manifested off site as a hazardous waste.

Attached as Figures 1 and 2 are sketches of the spill area showing sampling points, along with a soil characterization of the spill area.

Samples were taken of the oily waste water, soil from one foot below the tank level (for petroleum hydrocarbon analysis prior to the spill), and soil after the cleanup had been completed (for total petroleum hydrocarbon analysis).

Analysis of the oily waste water which was spilled showed the presence of lead (Pb) and chromium (Cr). Analysis for these two metals was included on the soil samples taken from under the spill area. All samples taken after the spill was cleaned up were clear of petroleum hydrocarbon.

Attached Table 1 shows results of oily waste water sludge analysis. Attached Table 2 shows a summary of soil analysis with Central Virginia Laboratories sheets attached.

The soil samples taken from under the spill area show relatively high lead (Pb) content. Research into the history of this area revealed that a lead furnace was in operation during World War II in this area (note Figure 1). This area is part of a Solid Waste Management Unit (SWMU) which is currently under investigation by the U. S. Army Toxic and Hazardous Material Agency (USATHAMA), and designed SWMU Number 17. This work is authorized under the Resource Conversation and Recovery Act (RCRA) investigation of hazardous waste site at RAAP. Site remediation will be performed under the USATHAMA study.

Very truly yours,

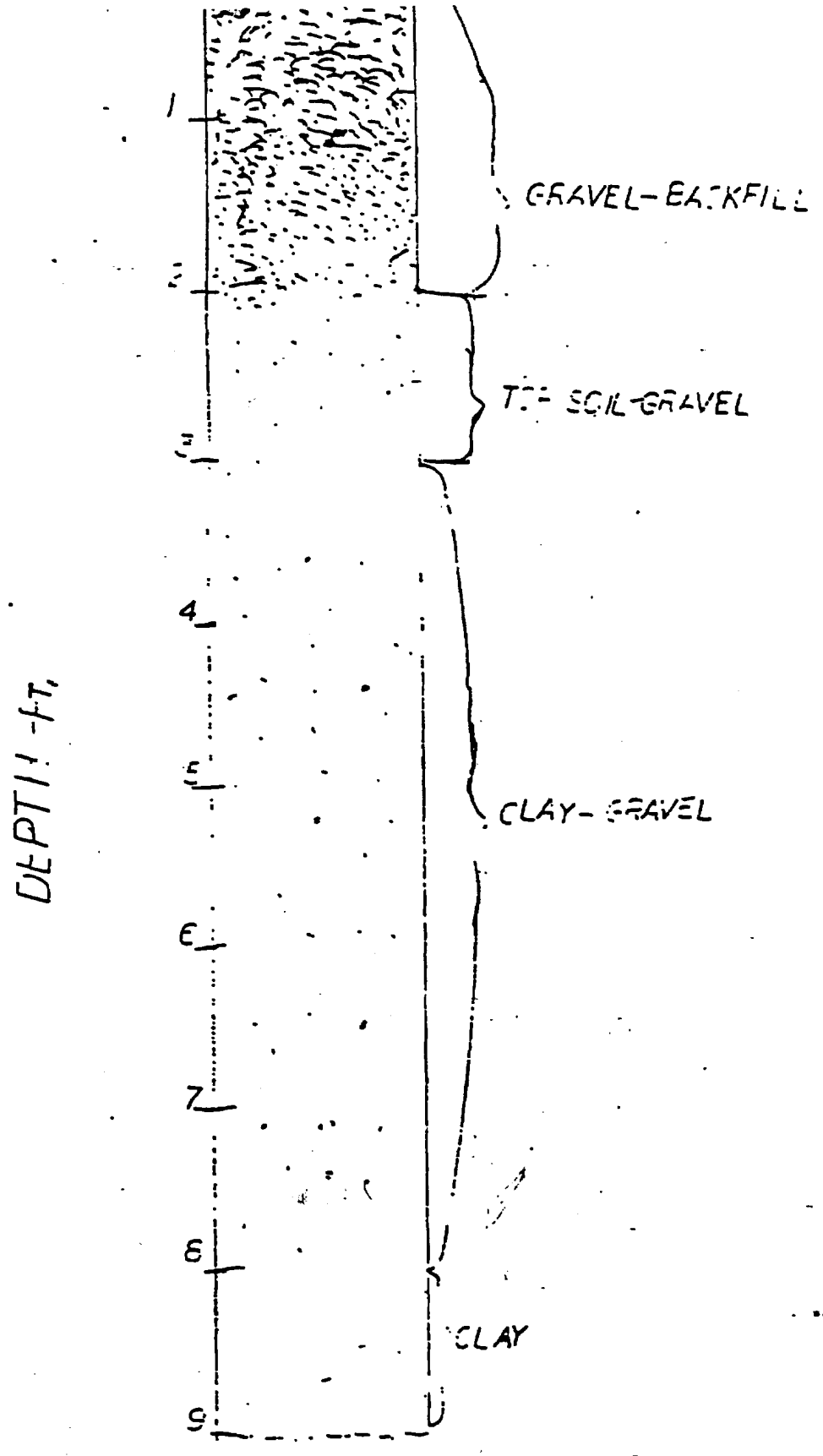
E. M. SOUCEK, DIRECTOR
ENGINEERING, MAINTENANCE AND UTILITIES

HLS:hsg/gps
5213b

Coordination:

H. M. Harvey, Jr.

FIG. 2



SOIL CHARACTERIZATION — SPILL AREA

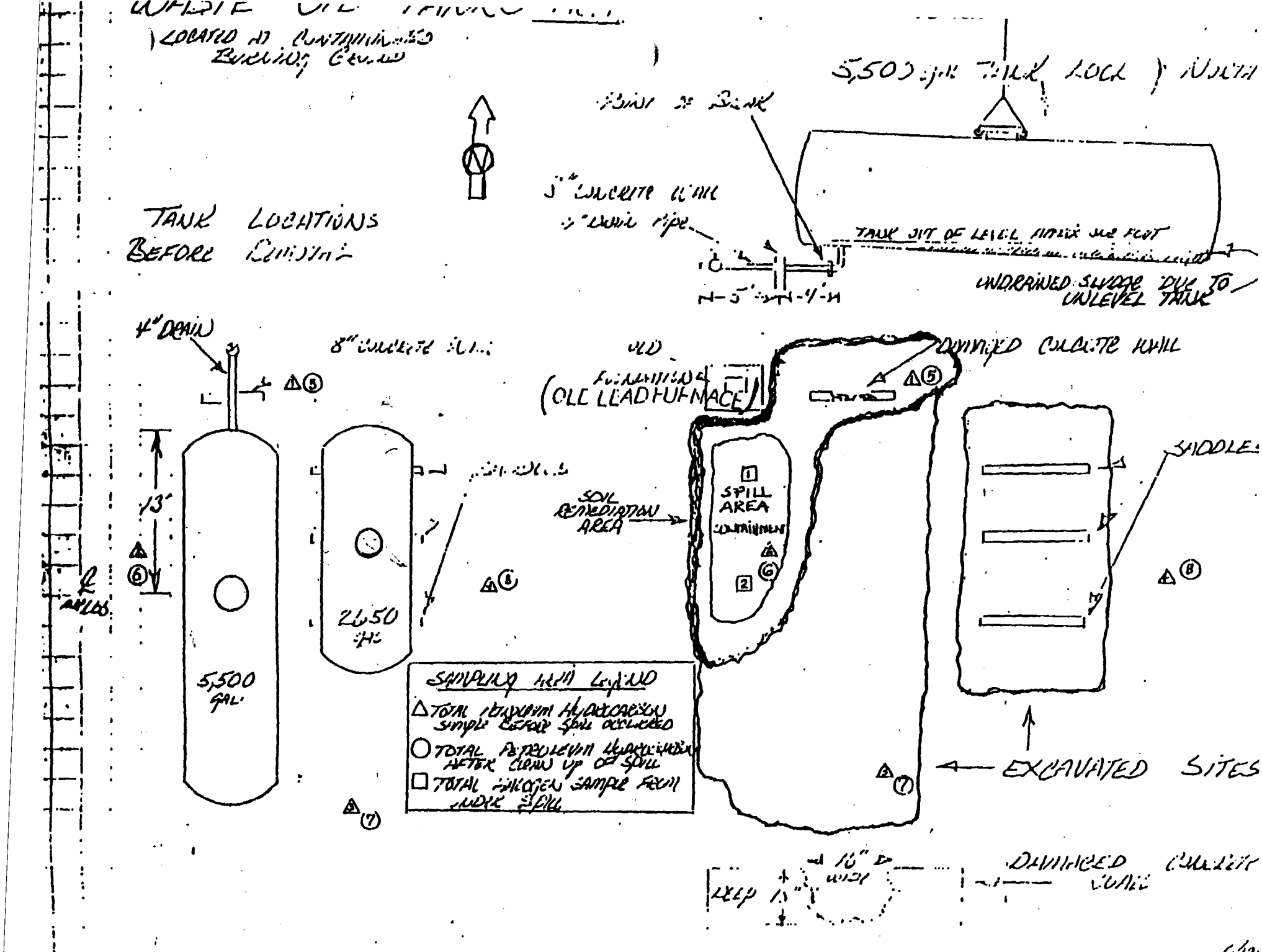

TANK LOCATIONS
BEFORE EXCAVATION
4" DRAIN
13'
5,500 GAL.
2,050 GAL.
SOIL REMEDIATION AREA
1 SPILL AREA
2
SAMPLING HOLE LOCATED
TOTAL PETROLEUM HYDROCARBON SAMPLE TAKEN BEFORE SOIL EXCAVATED
TOTAL PETROLEUM HYDROCARBON AFTER CLEAN UP OF SOIL
TOTAL HALOGEN SAMPLE FROM UNDER SPILL
DAMMED CONCRETE WALL
OLD LEAD FURNACE
SADDLES
EXCAVATED SITES
DAMMED CONCRETE WALL
UNDRAINED SLUDGE DUE TO UNLEVEL TANK
TANK BIT OF LEVEL FLOAT
5,500 GAL TANK

TABLE 1

CITY WASTE WATER SLUDGE ANALYSIS

SAMPLE CARD

TEST	RESULTS
takyD	0.17 %
lubricant	no flash @ 4 to 10.1°C
oil	20 - 40 %
[redacted]	
Suspended Solids	40 %
romium	0.003 %

PRODUCT: Spilled Oil - UST

LOT:

QAP/WO NO:

126936

SAMPLE QUANTITY	SIGNATURE	DATE	SHIFT	TIME
PULLED				AM PM
RELEASED FOR DELIVERY				AM PM
RECEIVED				AM PM
DELIVERED				AM PM
RECEIVED AT BLDG				AM PM

ACCEPTANCE ...
CONTROL ...
QAP/WO ...
SPECIAL ...

MAIN LAB: Comp Chemical, H_2O, TV, M & V, BS; STABILIZER, STABILITY, AD, BULK DENSITY, PHYSICALS

RBL: HOI, CB, SBP; TALIANI, SLD, TENSILE

RANGE: FLIGHT, STATIC

OTHER TESTS/REMARKS

MEETS SPECIFICATION REQUIREMENTS: YES ☐ NO ☐

Send Results To: RBL ☐ PPI ☐ OTHER ☐

ENGINEER: Mark Sullivan PHONE: 8705

COPY 1: TO LAB - IN TURN TO AGENCY NEEDING TEST RESULTS

TABLE 2

WASTE OIL TANKS — SPILL AREA — SOIL ANALYSIS

SAMPLE LOCATION	TOTAL PETROLEUM HYDROCARBON		METALS IN SOIL — AFTER CLEANUP			
	BEFORE SPILL	AFTER SPILL CLEANUP	TOTAL HALIDES	LEAD PB	CHROMIUM CR	ANTIMONY SB
NORTHWEST CORNER	15% mg/Kg.	< 10 mg/Kg.				
NORTHEAST CORNER	53 mg/Kg.	20 mg/Kg.				
UNDER SPILL AREA			< 10 mg/Kg *	(TOTAL) 3200 mg/Kg 230 mg/L *	* < 0.05 mg/L	* 0.50
SOUTHEAST CORNER	< 10 mg/Kg	< 10 mg/Kg.				
UNDER SPILL AREA			< 10 mg/Kg *	63000 (TOTAL) mg/Kg 2900 mg/L *	* < 0.05 mg/L	* 0.50 mg
SOUTHWEST CORNER	14 mg/Kg	60 mg/Kg.				

* EXTRACTABLE'S REPORTED AS MG/L. — OTHER ANALYSIS AS MG./KG.

NOTE — ALL SOIL SAMPLE'S TAKEN ONE FT. BELOW TANK LEVEL
AFTER SPILL CLEANUP SAMPLE'S TAKEN UNDER SPILL AREA,
SEE SKETCH FOR LOCATION

CENTRAL VIRGINIA
LABORATORIES & CONSULTANTS

P.O. Box 10938 Lynchburg, Virginia 24506
OFFICE: 2418 Langhorne Road • 804-847-2832

ORiginAL

June 3, 1991

HARVEY STULL
RCULES INCORPORATED
DFORM ARMY AMMUNITION PLANT
LLER SERVICE 1
DFORD VIRGINIA 24141-0299

bject: Analysis results

MPLE IDENTIFICATION: CVLC #5382 CUSTOMER: #1

mple Collected: 05/28/91 1330 hours
mple Relinquished: date & time not given
mple Received: 05/30/91 0930 hours
mple Location: NW Corner

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	1590

MPLE IDENTIFICATION: CLVC #5383 CUSTOMER: #1

mple Collection: 05/28/91 1330 hours
mpl Relinquished: time and date not given
my Received: 05/30/91 0930 hours
mp Location: NE Corner

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	53

MPLE IDENTIFICATION: CLVC #5384 CUSTOMER: #2

mple Collection: 05/28/91 1330 hours
mple Relinquished: time and date not given
mple Received: 05/30/91 0930 hours
mple Location: SE Corner

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	<10

Reference Method: METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA-600/4-79-020 (Revised March 1983 Method 418.1 (Modified for soil)

CENTRAL VIRGINIA
LABORATORIES & CONSULTANTS

P.O. Box 10958 Lynchburg, Virginia 24506
OFFICE: 2418 Langhorne Road • 804-847-2832

PLE IDENTIFICATION: CLVC #5385 CUSTOMER: #2

ple Collection: 05/28/91 1330 hours
ple Relinquished: time and date not given
ple Received: 05/30/91 0930 hours
ple Location: SW Corner

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	14

eference Method: METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA-600/4-79-020 (Revised March 1983 .. Method 418.1 (Modified for soil)

Sincerely,

Janet M. Zweifitz
Laboratory Manager

Z/ n

CENTRAL VIRGINIA
LABORATORIES & CONSULTANTS
P.O. Box 10996 Lynchburg, Virginia 24506
OFFICE: Zeid Industrial Park 804-847-2847

June 17, 1991
Corrected June 25, 1991

R HARVEY STULL
HERCULES INCORPORATED
RADFORD ARMY AMMUNITION PLANT
ALLEN SERVICE 1
RADFORD VIRGINIA 24141-0299

Subject: Analysis Results

SAMPLE IDENTIFICATION: CVLC #5787 CUSTOMER: #1

Sample Collected: 06/06/91 time not given
Sample Relinquished: date & time not given
Sample Received: 06/07/91 1000 hours

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	<10

SAMPLE IDENTIFICATION: CLVC #5788 CUSTOMER: #2

Sample Collection: 06/06/91 time not given
Sample Relinquished: date and time not given
Sample Received: 06/07/91 1000 hours

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	20

SAMPLE IDENTIFICATION: CLVC #5789 CUSTOMER: #3

Sample Collection: 06/06/91 time not given
Sample Relinquished: date and time not given
Sample Received: 06/07/91 1000 hours

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	<10

*Reference Method: METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA-600/4-79-020 (Revised March 1983 Method 418.1 (Modified for soil)

CENTRAL VIRGINIA
LABORATORIES & CONSULTANTS

VLC Page 2
ercules
une 17, 1991
orrected June 25, 1991

SAMPLE IDENTIFICATION: CLVC #5790 CUSTOMER: #4

Sample Collection: 06/06/91 time not given
Sample Relinquished: date and time not given
Sample Received: 06/07/91 1000 hours

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	60

SA E IDENTIFICATION: CLVC #5791 CUSTOMER: #5

Sample Collection: 06/06/91 time not given
Sample Relinquished: date and time not given
Sample Received: 06/07/91 1000 hours

ANALYSIS	RESULTS(mg/kg)
Total Halides	10
Lead, Total	3200

SW-846 Method 1311 Toxicity Characteristic Leachate Procedure

METALS : Sample Weight 45.53 grams
Extraction Solution #1

CONTAMINANT	CONCENTRATION (mg/l)	REGULATORY LEVEL (mg/l)
Antimony	0.5	NA
Chromium	<0.05	5.0
Lead	2300	5.0

*Reference Method: METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA-600/4-79-020 (Revised March 1983 Method 418.1 (Modified for soil)

NA = Not Applicable

CENTRAL VIRGINIA
LABORATORIES & CONSULTANTS
P.O. Box 10791, Lynchburg, Virginia 24506
OFFICE: 2413 Langhorne Road • 804-847-2852

Hercules
June 17, 1991
Corrected June 25, 1991

SAMPLE IDENTIFICATION: CLVC #5792 CUSTOMER: #6

Sample Collection: 06/06/91 time not given
Sample Relinquished: date and time not given
Sample Received: 06/07/91 1000 hours

ANALYSIS	RESULTS(mg/kg)
~~Total Halides~~	~~<10~~
Lead, Total	63000

~~T-846~~ Method 1311 Toxicity Characteristic Leachate Procedure

METALS : Sample Weight 43.18 grams
Extraction Solution #1

CONTAMINANT	CONCENTRATION (mg/l)	REGULATORY LEVEL (mg/l)
Antimony	0.5	NA
Chromium	<0.05	5.0
Lead	2900	5.0

NA = Not Applicable

Sincerely,

Janet M. Kwestin
Laboratory Manager

JMK/kbm

COMMONWEALTH of VIRGINIA

STATE WATER CONTROL BOARD

Richard N. Burton
Executive Director

P O Box 11143
Richmond, Virginia 23230-1143
(804) 527-5000
TDD (804) 527-4261

West Central Regional Office
Brammer Village
3015-C Peters Creek Road
P. O. Box 7017
Roanoke, Virginia 24019
(703) 857-7432
FAX (703) 857-7338

September 9, 1992

Mr. E. M. Soucek
Raford Army Ammunition Plant
Radford, VA 24141-0299

RE: Initial Abatement Measures and Site Characterization Close-Out, Radford Army Ammunition Plant, Radford, Virginia, LUST PC-91-1777

Dear Mr. Soucek:

The State Water Control Board, West Central Regional staff has completed a technical review of the Site Check Report prepared by Hercules Aerospace Company.

Based on the information provided, it appears that acceptable site check measures for the suspected petroleum UST release have been achieved, and no further UST investigation is required at this time. However, the staff of West Central Regional Office will inform the Department of Waste Management (DWM) in Richmond of the subsurface contamination resulting from releases of lead, chromium, and halide at the Radford Army Ammunition Plant. We strongly advise you to immediately contact DWM regarding this problem.

Should you have questions, don't hesitate to call us at (703) 857-7432.

Sincerely,

David M. Miles

David M. Miles, CPG
Ground Water Program Manager

29-0012k

cc: Jim Smith, OECA
LUST PC-91-1777 File
Lisa Hu, WCRO.

(Swmu 76)

Printed on Recycled Paper

ALLIANT TECHSYSTEMS

Radford Army Ammunition Plant
Route 114, P.O. Box 1
Radford, VA 24141
USA

September 27, 2001

Mr. Robert Thomson
U. S. Environmental Protection Agency
Region III
1650 Arch Street
Philadelphia, PA 19103-2029

Subject: Documents for SWMU 76
Radford Army Ammunition Plant,
EPA ID# VA 1 210020730

Dear Mr. Thomson:

Enclosed are copies of the following:

July 1, 1991 transmittal of information concerning a spill at SWMU 76 and subsequent cleanup to the Army.
July 17, 1991 transmittal of EPA form 7530 to the Army.
July 29, 1991 transmittal of EPA form 7530 to the VA Water Control Board.
January 23, 1992 transmittal of hazardous waste manifest to the Army.

From the above transmittals it can be documented that the USTs were removed and minor soil analysis was conducted. If we expand our WPA 12 effort to collect a data gap sample at both the FLFA and SWMU 76 we should be able to close SWMU 76 as well as FLFA.

Please coordinate with and provide any questions or comments to myself at (540) 639-8266, Jerry Redder of my staff (540) 639-7536 or Jim McKenna, ACO Staff (540) 639-8641.

Sincerely,

C. A. Jake, Environmental Manager
Alliant Ammunition and Powder Company LLC

Enclosure

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

01-815-187
JJRedder

Coordination: J. McKenna

bc: Administrative File
J. McKenna, ACO Staff
J. E. Tesher, Baltimore Corps of Engineers
C. A. Jake
J. J. Redder
Env. File

01-815-187
JJRedder

HERCULES

Hercules Aerospace Company
Radford Army Ammunition Plant
Caller Service 1
Radford, VA 24141-0299

July 1, 1991

91-815-134

bc: Administrative File
J. A. Morris
H. L. Stull

Administrative Contracting Officer
Radford Army Ammunition Plant
Radford, Virginia 24141

Dear Sir:

Oily Waste Water Spill - Building 7219

Reference: SMCRA-EN Letter Dated June 12, 1991
SMCRA-EN Letter Dated June 26, 1991

On May 29, 1991 at approximately 1500 hours, a spill of oily waste water and sludge occurred while removing a 5500 gallon underground storage tank. As the tank was being lifted by a crane from its resting place (this tank was not on saddles), it tilted, putting excessive strain on the discharge elbow connection causing a 9 foot section of 4 inch drain line to break off. Approximately 250 gallons of the oily waste water sludge, which was not removed prior to the tank removal, drained out into a trench alongside the tank as the tank was being raised.

The entire spill was contained within an area 20 feet long, 3.5 feet wide and 6 inches deep. Samples were taken of the oily waste water sludge spill for laboratory analysis. The tests confirmed the spilled material is hazardous for lead and chromium.

The oily waste water sludge was removed from the containment area using a suction pump and placed in a waste oil storage tank in the solvents area for off plant treatment. The remaining material within the trench was absorbed with an absorbent compound and removed from the area using a "Gradeall". Approximately 13 cubic yards of dirt/absorbed material were removed from the area and is currently being held on a dump truck for disposal. Cleanup of the

Oily Waste Water Spill - Building 7219

area was completed by 1800 hours. Also, approximately one cubic yard of dirt was removed from in front of the tank where the original sample was taken for petroleum hydrocarbon analysis. All the material will be manifested off site as a hazardous waste.

Attached as Figures 1 and 2 are sketches of the spill area showing sampling points, along with a soil characterization of the spill area.

Samples were taken of the oily waste water, soil from one foot below the tank level (for petroleum hydrocarbon analysis prior to the spill), and soil after the cleanup had been completed (for total petroleum hydrocarbon analysis).

Analysis of the oily waste water which was spilled showed the presence of lead (Pb) and chromium (Cr). Analysis for these two metals was included on the soil samples taken from under the spill area. All samples taken after the spill was cleaned up were clear of petroleum hydrocarbon.

Attached Table 1 shows results of oily waste water sludge analysis. Attached Table 2 shows a summary of soil analysis with Central Virginia Laboratories sheets attached.

The soil samples taken from under the spill area show relatively high lead (Pb) content. Research into the history of this area revealed that a lead furnace was in operation during World War II in this area (note Figure 1). This area is part of a Solid Waste Management Unit (SWMU) which is currently under investigation by the U. S. Army Toxic and Hazardous Material Agency (USATHAMA), and designed SWMU Number 17. This work is authorized under the Resource Conversation and Recovery Act (RCRA) investigation of hazardous waste site at RAAP. Site remediation will be performed under the USATHAMA study.

Very truly yours,

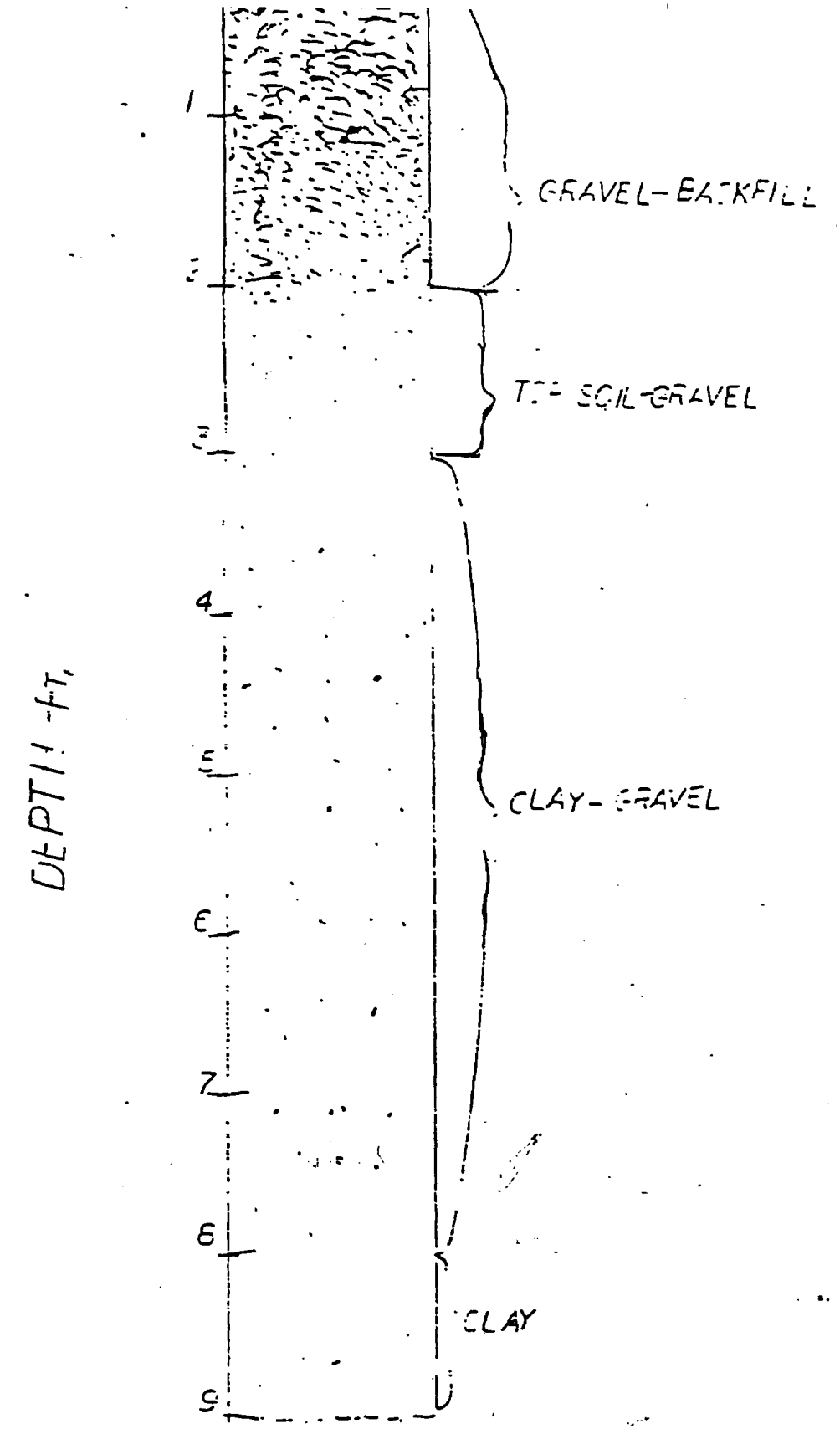
E. M. SOUCEK, DIRECTOR
ENGINEERING, MAINTENANCE AND UTILITIES

HLS:hsg/gps
5213b

Coordination:

H. M. Harvey, Jr.

FIG. 2



SOIL CHARACTERIZATION — SFILL AREA

WASTE OIL TANKS FIG. 1
LOCATED AT CONTAMINATED BURNING GROUND

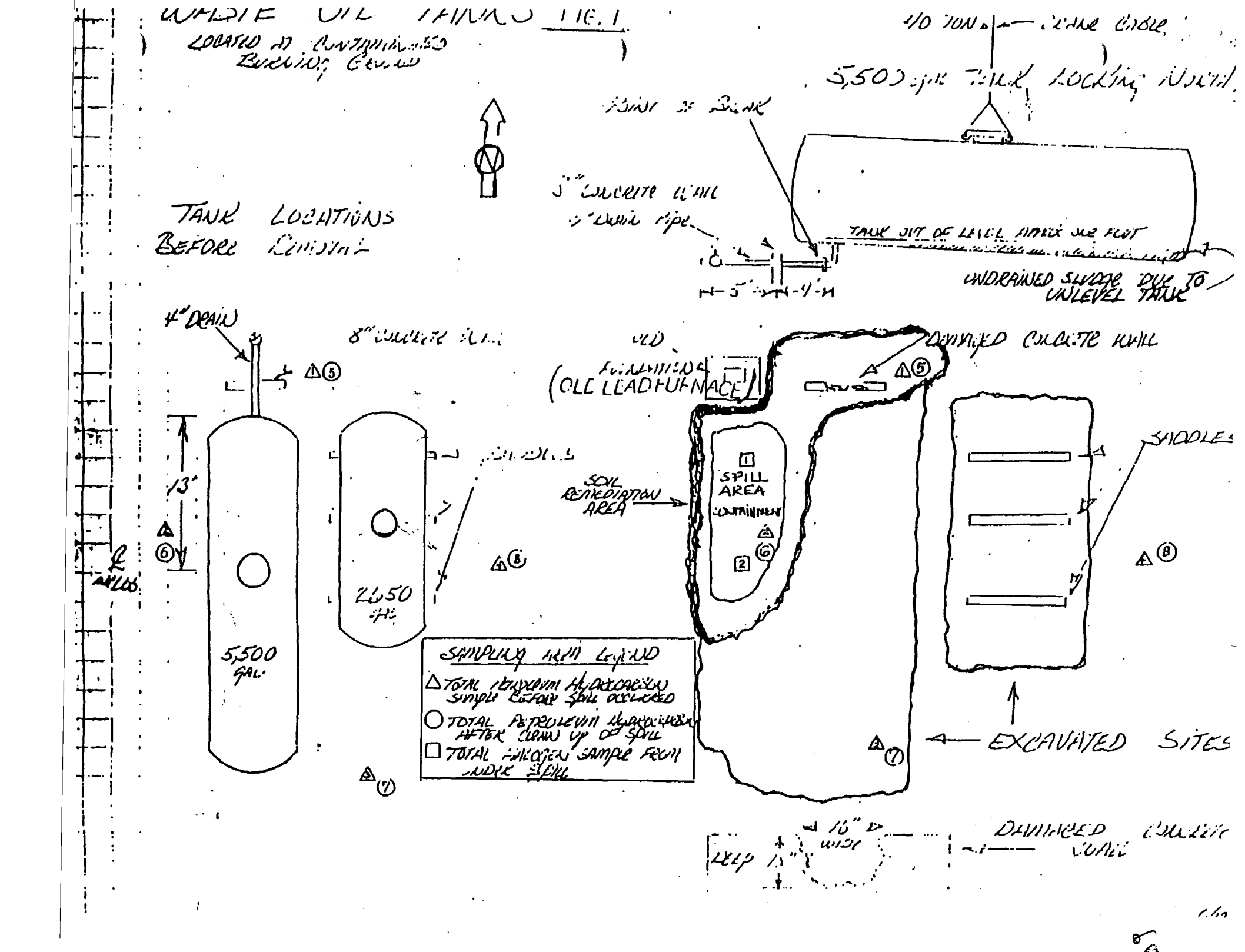


TABLE 1

CITY WASTE WATER SLUDGE ANALYSIS

SAMPLE CARD

TEST	RESULTS
Total Pb	0.17 %
Flash pt	inc flash @ 40 to 70.1°C
Oil	20 - 40%
[redacted]	
Total Suspended Solids	40%
Cadmium	0.003%

1 Identification — PRODUCT: Spilled Oil - UST (FORMULATION AND GRANULATION); LOT; SS BATCH; BOL ETC; QA/PWO NO; BLDG NO SAMPLED

2 SAMPLE NO: 126936 — P–; L–

3 SAMPLING — SAMPLE QUANTITY; BY *SIGNATURE; DATE; SHIFT; TIME

	PROC O C	BY *SIGNATURE	DATE	SHIFT	TIME
PULLED					AM PM
RELEASED FOR DELIVERY*					AM PM
RECEIVED					AM PM
DELIVERED					AM PM
RECEIVED AT BLDG					AM PM

4 TYPE SAMPLE — ACCEPTANCE; CONTROL; QA/PWO; SPECIAL

5 REQUEST FOR SPECIAL ANALYSIS — APPROVAL

6 TEST

MAIN LAB				RBL			RANGE	
Comp Chemical		STABILIZER		MOE		TALIANI		FLIGHT
H_2O		STABILITY						STATIC
TV		AD		CB		SLD		
M & V		BULK DENSITY				TENSILE		
BS		PHYSICALS		SBP		@ %F @ %F		@ %F

OTHER TESTS/REMARKS

MEETS SPECIFICATION REQUIREMENTS: YES ☐ NO ☐

AGI CODE 20070

SIGNATURE: Mark Sullivan

7 Send Results To — REL ☐ PPE ☐ OTHER ☐

ENGINEER Mark Sullivan PHONE 8705

COPY 1: TO LAB - IN TURN TO AGENCY NEEDING TEST RESULTS

TABLE 2

WASTE OIL TANKS — SPILL AREA — SOIL ANALYSIS

SAMPLE LOCATION	TOTAL PETROLEUM HYDROCARBON		METALS IN SOIL — AFTER CLEANUP			
	BEFORE SPILL	AFTER SPILL CLEANUP	TOTAL HALIDES	LEAD PB	CHROMIUM CR	ANTIMONY SB
NORTHWEST CORNER	15% mg/Kg.	< 10 mg/Kg.				
NORTHEAST CORNER	53 mg/Kg.	20 mg/Kg.				
UNDER SPILL AREA			< 10 mg/Kg *	(TOTAL) 3240 mg/Kg 2300 mg/L *	* < 0.05 mg/L	* 0.50
SOUTHEAST CORNER	< 10 mg/Kg	< 10 mg/Kg.				
UNDER SPILL AREA			< 10 mg/Kg *	63000 (TOTAL) mg/Kg 2900 mg/L *	* < 0.05 mg/L	* 0.50 mg
SOUTHWEST CORNER	14 mg/Kg	60 mg/Kg.				

* EXTRACTABLE'S REPORTED AS MG/L. — OTHER ANALYSIS AS MG./KG.

NOTE — ALL SOIL SAMPLE'S TAKEN ONE FT. BELOW TANK LEVEL AFTER SPILL CLEANUP SAMPLE'S TAKEN UNDER SPILL AREA, SEE SKETCH FOR LOCATION

6.p

CENTRAL VIRGINIA
LABORATORIES & CONSULTANTS

P.O. Box 10938 Lynchburg, Virginia 24506
OFFICE: 2418 Langhorne Road • 804-847-2832

ORiginal

June 3, 1991

HARVEY STULL
ERCULES INCORPORATED
ADFORM ARMY AMMUNITION PLANT
ALLER SERVICE 1
ADFORD VIRGINIA 24141-0299

bject: Analysis results

AMPLE IDENTIFICATION: CVLC #5382 CUSTOMER: #1

ample Collected: 05/28/91 1330 hours
ample Relinquished: date & time not given
ample Received: 05/30/91 0930 hours
ample Location: NW Corner

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	1590

AMPLE IDENTIFICATION: CLVC #5383 CUSTOMER: #1

ample Collection: 05/28/91 1330 hours
ample Relinquished: time and date not given
amp Received: 05/30/91 0930 hours
amp Location: NE Corner

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	53

AMPLE IDENTIFICATION: CLVC #5384 CUSTOMER: #2

ample Collection: 05/28/91 1330 hours
ample Relinquished: time and date not given
ample Received: 05/30/91 0930 hours
ample Location: SE Corner

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	<10

Reference Method: METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA-600/4-79-020 (Revised March 1983 Method 418.1 (Modified for soil)

CENTRAL VIRGINIA
LABORATORIES & CONSULTANTS

P.O. Box 10958 Lynchburg, Virginia 24506
OFFICE: 3418 Langhorne Road • 804-847-2852

MPLE IDENTIFICATION: CLVC #5385 CUSTOMER: #2

mple Collection: 05/28/91 1330 hours
mple Relinquished: time and date not given
mple Received: 05/30/91 0930 hours
mple Location: SW Corner

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	14

eference Method: METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA-600/4-79-020 (Revised March 1983 Method 418.1 (Modified for soil)

Sincerely,

Janet M. Zweiblitz
Laboratory Manager

Z/

CENTRAL VIRGINIA
LABORATORIES & CONSULTANTS
P.O. Box 10098 Lynchburg, Virginia 24506
OFFICE: 2648 Langhorne Road • 804-847-2857

MR HARVEY STULL
HERCULES INCORPORATED
RADFORM ARMY AMMUNITION PLANT
CALLER SERVICE 1
RADFORD VIRGINIA 24141-0299

June 17, 1991
Corrected June 25, 1991

Subject: Analysis Results

SAMPLE IDENTIFICATION: CVLC #5787 CUSTOMER: #1

Sample Collected: 06/06/91 time not given
Sample Relinquished: date & time not given
Sample Received: 06/07/91 1000 hours

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	<10

SAMPLE IDENTIFICATION: CLVC #5788 CUSTOMER: #2

Sample Collection: 06/06/91 time not given
Sample Relinquished: date and time not given
Sample Received: 06/07/91 1000 hours

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	20

SAMPLE IDENTIFICATION: CLVC #5789 CUSTOMER: #3

Sample Collection: 06/06/91 time not given
Sample Relinquished: date and time not given
Sample Received: 06/07/91 1000 hours

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	<10

*Reference Method: METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA-600/4-79-020 (Revised March 1983 Method 418.1 (Modified for soil)

CENTRAL VIRGINIA
LABORATORIES & CONSULTANTS
P.O. Box [illegible] Lynchburg, Virginia 24506
OFFICE: [illegible] Telephone Number: 804-847-7332

SAMPLE IDENTIFICATION: CLVC #5790 CUSTOMER: #4

Sample Collection: 06/06/91 time not given
Sample Relinquished: date and time not given
Sample Received: 06/07/91 1000 hours

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	60

SAMPLE IDENTIFICATION: CLVC #5791 CUSTOMER: #5

Sample Collection: 06/06/91 time not given
Sample Relinquished: date and time not given
Sample Received: 06/07/91 1000 hours

ANALYSIS	RESULTS(mg/kg)
Total Halides	10
Lead, Total	3200

SW-846 Method 1311 Toxicity Characteristic Leachate Procedure

METALS : Sample Weight 45.53 grams
Extraction Solution #1

CONTAMINANT	CONCENTRATION (mg/l)	REGULATORY LEVEL (mg/l)
Antimony	0.5	NA
Chromium	<0.05	5.0
Lead	2300	5.0

*Reference Method: METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA-600/4-79-020 (Revised March 1983 Method 418.1 (Modified for soil)

NA = Not Applicable

CENTRAL VIRGINIA
LABORATORIES & CONSULTANTS
P.O. Box 10738 Lynchburg, Virginia 24506
OFFICE: 2418 Langhorne Road • 804-847-2852

62

CVLC Page 3
Hercules
June 17, 1991
Corrected June 25, 1991

SAMPLE IDENTIFICATION: CLVC #5792 CUSTOMER: #6

Sample Collection: 06/06/91 time not given
Sample Relinquished: date and time not given
Sample Received: 06/07/91 1000 hours

ANALYSIS	RESULTS(mg/kg)
Total Halides	<10
Lead, Total	63000

SW-846 Method 1311 Toxicity Characteristic Leachate Procedure

M LS : Sample Weight 43.18 grams
Extraction Solution #1

CONTAMINANT	CONCENTRATION (mg/l)	REGULATORY LEVEL (mg/l)
Antimony	0.5	NA
Chromium	<0.05	5.0
Lead	2900	5.0

NA = Not Applicable

Sincerely,

Janet M. Swedlitz
Laboratory Manager

JMS/kcm

HERCULES

Hercules Aerospace Company
Radford Army Ammunition Plant
Caller Service 1
Radford, VA 24141-0299

July 17, 1991

91-815-151

bc: Administrative File
D. W. Ratcliff
J. A. Morris
H. L. Stull

Administrative Contracting Officer
Radford Army Ammunition Plant
Radford, Virginia 24141

Attention SMCRA-EN

Dear Sir:

Removal of Underground Storage Tanks 7219-1 and -2

In compliance with State Water Control Board Regulation VR680-13-02, Underground Storage Tanks 7219 Number 1 and 2 have been removed.

Attached is EPA Form 7530 to be filed with the State Water Control Board along with soil analysis and a history associated with this work.

A copy of this document should also be filed with the local county building official, County of Montgomery, Mr. Wayne E. Mannon, Courthouse Room 408, Christiansburg, Virginia 24073.

Very truly yours,

E. M. SOUCEK, DIRECTOR
ENGINEERING, MAINTENANCE AND UTILITIES

HLStull:gps
5348b

Coordination:

H. M. Harvey, Jr.

Attachment

BUILDING PERMIT

1159

Montgomery County Department of Planning and Inspections
P.O. Box 806 Christiansburg, Va. 24073 Phone: 382-5750

63

: Permit is VOID if work is not commenced within six (6) months from the date of issuance.
A rk must comply with the Code of Ordinances of Montgomery County, Virginia

PAID

ling Permit No. 1159 Date May 28, 1991
e of Owner Radford Army Ammunition Plant Address P.O. Box 1 Ph 639-8619
e of Contractor Self Address Radford, VA 24141 Ph
ate of Contrs. Regist. No.
ıe of SubContractor Address Ph
ate Contrs. Regist. No.
ıe of Architect Address Ph

LOCATION OF CONSTRUCTION:

: (2) Underground Tank Removals
S W side of St. Rd. No. 114 about miles from

ivision Section Lot No.
of lot or Acreage of land 3500 acres Magist. Dist. Prices Fork
t street foundation setback ft. Side street setback ft.
side yard ft. Right side yard ft. Rear yard ft.

l Sq. Ft Estimated Cost: $ -
Group Classification: PERMIT FEE: $ 40.00
: of Construction: Dept. Approval:
Date: 5-2-91

REQUIRED INSPECTION - STRUCTURES

FOOTERS: Inspection to be made after footers are dug, grade stakes in place, all forms and bulkheads in place and reinforcement steel in footers.

NDATION & FRAMING: Inspection to be made on Forms and Reinforcement steel in place (poured concrete foundations) Inspect Block Walls, inspect all drain tile around foundations. Framing to be inspected after the roof, all framing, fire blocking and bracing are in place.

ROUGH-IN-PLUMBING: Inspection after all plumbing is installed before insulation is put in walls. All underground plumbing to be inspected before covered with concrete slab.

)UGH-IN-ELECTRICAL: All wiring to be inspected before insulating walls or covering in any manner. All underground wiring (conduit etc.) to be inspected before covering.

MECHANICAL: All mechanical work (heat systems duct work etc. to be inspected before covering in any manner.

SLAB INSPECTION: All concrete slabs basement, floors, garage floors, carport floors, patios etc. Inspections will be made when all base stone is in place, reinforcement wire, and grade stakes are in place.

FINAL INSPECTION: Inspection to be made after the building is complete and before being occupied. An occupancy permit will be issued after the final inspection of the building is made.

REQUIRED INSPECTIONS - MOBILE HOMES

MOBILE HOMES: One inspection covers footers for piers, tie downs, water and sewer connections and the electrical service for the home.

DOUBLE-WIDE MOBILE HOMES: Footer Inspection - This is made on footers before moving the two halves of the home to the site. Second Inspection - This covers the Water and Sewer connections, tie downs, set-up of the home, and the electrical service for the home.

ПС The Owner of this Permit shall be responsible for notifying this Department for ALL inspections as required above.
A **MINIMUM** of **24 HOURS NOTICE** IS REQUIRED FOR ALL INSPECTION REQUESTS.

WHITE: APPLICANTS COPY; PINK: INSPECTORS COPY; YELLOW: COMMISSIONER OF REVENUE'S COPY; GREEN: TREASURER'S COPY

5 Commonwealth Press, Inc.

APPENDIX I to §280.3

Notification for Underground Storage Tanks

FORM APPROVED
OMB NO. 2050-0068
APPROVAL EXPIRES 8-31-88

I.D. Number

STATE USE ONLY

Date Received

GENERAL INFORMATION

Notification is required by Federal law for all underground tanks that have been used to store regulated substances since January 1, 1974, that are in the ground as of May 8, 1986, or that are brought into use after May 8, 1986. The information requested is required by Section 9002 of the Resource Conservation and Recovery Act (RCRA), as amended.

The primary purpose of this notification program is to locate and evaluate underground tanks that store or have stored petroleum or hazardous substances. It is expected that the information you provide will be based on reasonably available records, or, in the absence of such records, your knowledge, belief, or recollection.

Who Must Notify? Section 9002 of RCRA, as amended, requires that, unless exempted, owners of underground tanks that store regulated substances must notify designated State or local agencies of the existence of their tanks. Owner means

(a) in the case of an underground storage tank in use on November 8, 1984, or brought into use after that date, any person who owns an underground storage tank used for the storage, use, or dispensing of regulated substances; and

(b) in the case of any underground storage tank in use before November 8, 1984, but no longer in use on that date, any person who owned such tank immediately before the discontinuation of its use.

What Tanks Are Included? Underground storage tank is defined as any one or combination of tanks that (1) is used to contain an accumulation of "regulated substances," and (2) whose volume (including connected underground piping) is 10% or more beneath the ground. Some examples are underground tanks storing: 1. gasoline, used oil, or diesel fuel, and 2. industrial solvents, pesticides, herbicides or fumigants.

What Tanks Are Excluded? Tanks removed from the ground are not subject to notification. Other tanks excluded from notification are:

1. farm or residential tanks of 1,100 gallons or less capacity used for storing motor fuel for noncommercial purposes;
2. tanks used for storing heating oil for consumptive use on the premises where stored;
3. septic tanks;
4. pipeline facilities (including gathering lines) regulated under the Natural Gas Pipeline Safety Act of 1968, or the Hazardous Liquid Pipeline Safety Act of 1979, or which is an intrastate pipeline facility regulated under State laws;
5. surface impoundments, pits, ponds, or lagoons;
6. storm water or waste water collection systems;
7. flow-through process tanks;
8. liquid traps or associated gathering lines directly related to oil or gas production and gathering operations;
9. storage tanks situated in an underground area (such as a basement, cellar, mineworking, drift, shaft, or tunnel) if the storage tank is situated upon or above the surface of the floor.

What Substances Are Covered? The notification requirements apply to underground storage tanks that contain regulated substances. This includes any substance defined in hazardous in section 101 (14) of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), with the exception of those substances regulated as hazardous waste under Subtitle C of RCRA. It also includes petroleum, e.g., crude oil or any fraction thereof which is liquid at standard conditions of temperature and pressure (60 degrees Fahrenheit and 14.7 pounds per square inch absolute).

Where To Notify? Completed notification forms should be sent to the address given at the top of this page.

When To Notify? 1. Owners of underground storage tanks in use or that have been taken out of operations after January 1, 1974, but still in the ground, must notify by May 8, 1986. 2. Owners who bring underground storage tanks into use after May 8, 1986, must notify within 30 days of bringing the tanks into use.

Penalties: Any owner who knowingly fails to notify or submits false information shall be subject to a civil penalty not to exceed $10,000 for each tank for which notification is not given or for which false information is submitted.

INSTRUCTIONS

Please type or print in ink all items except "signature" in Section V. This form must by completed for each location containing underground storage tanks. If more than 5 tanks are owned at this location, copy the reverse side, and staple continuation sheets to this form.

Indicate number of continuation sheets attached: 2

I. OWNERSHIP OF TANK(S)

Owner Name (Corporation, Individual, Public Agency, or Other Entity)
Radford Army Ammunition Plant (RAAP)

Street Address
Box 1

County
Montgomery/Pulaski

City: Radford, State: VA ZIP Code: 24141

Area Code: 703 Phone Number: 639-8482

Type of Owner (Mark all that apply ☒)

☐ Current ☐ State or Local Gov't ☐ Private or Corporate
☐ Former ☒ Federal Gov't (GSA facility I.D. no. _____) ☐ Ownership uncertain

II. LOCATION OF TANK(S)

(If same as Section 1, mark box here ☐)

Facility Name or Company Site Identifier, as applicable

Street Address or State Road, as applicable

County

City (nearest) State ZIP Code

Indicate number of tanks at this location: 28

Mark box here if tank(s) are located on land within an Indian reservation or on other Indian trust lands ☐

III. CONTACT PERSON AT TANK LOCATION

Name (If same as Section I, mark box here ☐) | Job Title | Area Code | Phone Number

Shelley J. Barker | Engineer | 703 | 639-8482

IV. TYPE OF NOTIFICATION

☐ Mark box here only if this is an amended or subsequent notification for this location.

V. CERTIFICATION (Read and sign after completing Section VI.)

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete.

Name and official title of owner or owner's authorized representative	Signature	Date Signed

CONTINUE ON REVERSE SIDE

VI. DESCRIPTION OF UNDERGROUND STORAGE TANKS (Complete for each tank at this location)

Tank Identification No. (e.g., ABC-123), or Arbitrarily Assigned Sequential Number (e.g., 1,2,3...)	Tank No. 3332	Tank No. 5432	Tank No.	Tank No.	Tank No.
1. Status of Tank (Mark all that apply ☒) — Currently In Use	☐	☐	☐	☐	☐
Temporarily Out of Use	☐	☐	☐	☐	☐
Permanently Out of Use	XX	XX	☐	☐	☐
Brought into Use after 5/8/86	☐	☐	☐	☐	☐
2. Estimated Age (Years)	15	15			
3. Estimated Total Capacity (Gallons)	5000	2650			
4. Material of Construction (Mark one ☒) — Steel	XX	XX	☐	☐	☐
Concrete	☐	☐	☐	☐	☐
Fiberglass Reinforced Plastic	☐	☐	☐	☐	☐
Unknown	☐	☐	☐	☐	☐
Other. Please Specify					
5. Internal Protection (Mark all that apply ☒) — Cathodic Protection	☐	☐	☐	☐	☐
Interior Lining (e.g., epoxy resins)	☐	☐	☐	☐	☐
None	XX	XX	☐	☐	☐
Unknown	☐	☐	☐	☐	☐
Other. Please Specify					
6. External Protection (Mark all that apply ☒) — Cathodic Protection	☐	☐	☐	☐	☐
Painted (e.g., asphaltic)	☐	☐	☐	☐	☐
Fiberglass Reinforced Plastic Coated	☐	☐	☐	☐	☐
None	XX	XX	☐	☐	☐
Unknown	☐	☐	☐	☐	☐
Other. Please Specify					
7. Piping (Mark all that apply ☒) — Bare Steel	XX	XX	☐	☐	☐
Galvanized Steel	☐	☐	☐	☐	☐
Fiberglass Reinforced Plastic	☐	☐	☐	☐	☐
Cathodically Protected	☐	☐	☐	☐	☐
Unknown	☐	☐	☐	☐	☐
Other. Please Specify					
8. Substance Currently or Last Stored in Greatest Quantity by Volume (Mark all that apply ☒) — a. Empty	☐	☐	☐	☐	☐
b. Petroleum — Diesel	☐	☐	☐	☐	☐
Kerosene	☐	☐	☐	☐	☐
Gasoline (including alcohol blends)	☐	☐	☐	☐	☐
Used Oil	☐	☐	☐	☐	☐
Other. Please Specify	Waste Oil	Waste Oil			
c. Hazardous Substance	XX	XX	☐	☐	☐
Please Indicate Name of Principal CERCLA Substance					
OR Chemical Abstract Service (CAS) No.					
Mark box ☒ if tank stores a mixture of substances	☐	☐	☐	☐	☐
d. Unknown	☐	☐	☐	☐	☐
9. Additional Information (for tanks permanently taken out of service) — a. Estimated date last used (mo/yr)	5/91	5/91	/	/	/
b. Estimated quantity of substance remaining (gal.)	0	0			
c. Mark box ☒ if tank was filled with inert material (e.g., sand, concrete)	☐ Removed	☐ Removed	☐	☐	☐

AO	
SF	
SS	
QA	
TM	
EN	
OR	
CA	
XC	
XO	
CO	
CAF	
CAP	

July 29, 1991

Engineering Division

Mr. Mike Weaver
Virginia Water Control Board
2111 N. Hamilton Street
P. O. Box 11143
Richmond, Virginia 23230

Dear Mr. Weaver:

Enclosed please find notification of removal of two underground storage tanks by Building 7219 (in compliance with State Water Control Board Regulation VR 680-13-02). Accompanying the EPA Form 7530, you will find pertinent data involving said removals and the related spill.

If additional information is required, please contact Mr. Rou Tucker, AC 703 639-7628.

Sincerely,

ORIGINAL SIGNED BY

Joe D. Wilson
Chief Engineer

Enclosure

Copies Furnished (w/encl):

Mr. David Miles, State Water Control Board, P. O. Box 7017, Roanoke, VA 24019
Mr. Wayne Mannon, Courthouse Room 408, Christiansburg, VA 24073

BUILDING PERMIT

1159

Montgomery County Department of Planning and Inspections
P.O. Box 806 Christiansburg, Va. 24073 Phone: 382-5750

Note: This Permit is VOID if work is not commenced within six (6) months from the date of issuance.
All work must comply with the Code of Ordinances of Montgomery County, Virginia

PAID

Building Permit No. 1159 Date May 28, 1991
Name of Owner Radford Army Ammunition Plant Address P.O. Box 1 Ph 639-8619
Name of Contractor Self Address Radford, VA 24141 Ph
State of Contrs. Regist. No.
Name of SubContractor Address Ph
State Contrs. Regist. No.
Name of Architect Address Ph

LOCATION OF CONSTRUCTION:

USE: (2) Underground Tank Removals
E S W side of St. Rd. No. 114 about miles from

Subdivision Section Lot No.
Size of lot or Acreage of land 3500 acres Magist. Dist. Prices Fork
Front street foundation setback ft. Side street setback ft.
Left side yard ft. Right side yard ft. Rear yard ft.

Total Sq. Ft. Estimated Cost: $ -
Use Group Classification: PERMIT FEE: $ 40.00
Type of Construction: Dept. Approval:
Date: 5-28-91

REQUIRED INSPECTION - STRUCTURES

FOOTERS: Inspection to be made after footers are dug, grade stakes in place, all forms and bulkheads in place and reinforcement steel in footers.

FOUNDATION & FRAMING: Inspection to be made on Forms and Reinforcement steel in place (poured concrete foundations) Inspect Block Walls, inspect all drain tile around foundations. Framing to be inspected after the roof, all framing, fire blocking and bracing are in place.

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NOTE: The Owner of this Permit shall be responsible for notifying this Department for ALL inspections as required above.
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WHITE: APPLICANTS COPY; PINK: INSPECTORS COPY; YELLOW: COMMISSIONER OF REVENUE'S COPY; GREEN: TREASURER'S COPY

1075 Commonwealth Press, Inc.

APPENDIX I to §280.3

Notification for Underground Storage Tanks

FORM APPROVED OMB NO. 2050-0068 APPROVAL EXPIRES 8-31-88

STATE USE ONLY

I.D. Number

Date Received

GENERAL INFORMATION

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(2) in the case of any underground storage tank in use before November 8, 1984, but no longer in use on that date, any person who owned such tank immediately before the discontinuation of its use.

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1. farm or residential tanks of 1,100 gallons or less capacity used for storing motor fuel for noncommercial purposes;
2. tanks used for storing heating oil for consumptive use on the premises where stored;
3. septic tanks;
4. pipeline facilities (including gathering lines) regulated under the Natural Gas Pipeline Safety Act of 1968, or the Hazardous Liquid Pipeline Safety Act of 1979, or which is an intrastate pipeline facility regulated under State laws;
5. surface impoundments, pits, ponds, or lagoons;
6. storm water or wastewater collection systems;
7. flow-through process tanks;
8. liquid traps or associated gathering lines directly related to oil or gas production and gathering operations;
9. storage tanks situated in an underground area (such as a basement, cellar, mineworking, drift, shaft, or tunnel) if the storage tank is situated upon or above the surface of the floor.

What Substances Are Covered? The notification requirements apply to underground storage tanks that contain regulated substances. This includes any substance defined as hazardous in section 101 (14) of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) with the exception of those substances regulated as hazardous waste under Subtitle C of RCRA. It also includes petroleum, e.g., crude oil or any fraction thereof which is liquid at standard conditions of temperature and pressure (60 degrees Fahrenheit and 14.7 pounds per square inch absolute).

Where To Notify? Completed notification forms should be sent to the address given at the top of this page.

When To Notify? 1. Owners of underground storage tanks in use or that have been taken out of operation after January 1, 1974, but still in the ground, must notify by May 8, 1986. 2. Owners who bring underground storage tanks into use after May 8, 1986, must notify within 30 days of bringing the tanks into use.

Penalties: Any owner who knowingly fails to notify or submits false information shall be subject to a civil penalty not to exceed $10,000 for each tank for which notification is not given or for which false information is submitted.

INSTRUCTIONS

Please type or print in ink all items except "signature" in Section V. This form must by completed for location containing underground storage tanks. If more than 5 tanks are owned at this location, copy the reverse side, and staple continuation sheets to this form.

Indicate number of continuation sheets attached: 2

I. OWNERSHIP OF TANK(S)

Owner Name (Corporation, Individual, Public Agency, or Other Entity)
Radford Army Ammunition Plant (RAAP)

Street Address
Box 1

County
Montgomery/Pulaski

City: Radford, State: VA ZIP Code: 24141

Area Code: 703 Phone Number: 639-8482

Type of Owner (Mark all that apply ☒)

☐ Current ☐ State or Local Gov't ☐ Private or Corporate
☐ Former ☒ Federal Gov't (GSA facility I.D. no. _____) ☐ Ownership uncertain

II. LOCATION OF TANK(S)

(If same as Section 1, mark box here ☐)

Facility Name or Company Site Identifier, as applicable

Street Address or State Road, as applicable

County

City (nearest) State ZIP Code

Indicate number of tanks at this location: 28

Mark box here if tank(s) are located on land within an Indian reservation or on other Indian trust lands ☐

III. CONTACT PERSON AT TANK LOCATION

Name (If same as Section I, mark box here ☐): Shelley J. Barker

Job Title: Engineer

Area Code Phone Number: 703 639-8482

IV. TYPE OF NOTIFICATION

☐ Mark box here only if this is an amended or subsequent notification for this location.

V. CERTIFICATION (Read and sign after completing Section VI.)

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete.

Name and official title of owner or owner's authorized representative: Karl I. Gohlke, CPT, CO, Acting Commander

Signature: Karl I. Gohlke

Date Signed: July 29, 1991

CONTINUE ON REVERSE SIDE

Owner Name (from Section I) U. S. Army Location (from Section II) Bldg. 7219 - RAAP Page No. 2 of 2 Pages

VI. DESCRIPTION OF UNDERGROUND STORAGE TANKS (Complete for each tank at this location.)

Tank Identification No. (e.g., ABC-123), or Arbitrarily Assigned Sequential Number (e.g., 1,2,3...)	Tank No. 3332	Tank No. 5432	Tank No.	Tank No.	Tank No.
1. Status of Tank (Mark all that apply ☒) — Currently in Use					
Temporarily Out of Use					
Permanently Out of Use	XX	XX			
Brought into Use after 5/8/86					
2. Estimated Age (Years)	15	15			
3. Estimated Total Capacity (Gallons)	5000	2650			
4. Material of Construction (Mark one ☒) — Steel	XX	XX			
Concrete					
Fiberglass Reinforced Plastic					
Unknown					
Other, Please Specify					
5. Internal Protection (Mark all that apply ☒) — Cathodic Protection					
Interior Lining (e.g., epoxy resins)					
None	XX	XX			
Unknown					
Other, Please Specify					
6. External Protection (Mark all that apply ☒) — Cathodic Protection					
Painted (e.g., asphaltic)					
Fiberglass Reinforced Plastic Coated					
None	XX	XX			
Unknown					
Other, Please Specify					
7. Piping (Mark all that apply ☒) — Bare Steel	XX	XX			
Galvanized Steel					
Fiberglass Reinforced Plastic					
Cathodically Protected					
Unknown					
Other, Please Specify					
8. Substance Currently or Last Stored in Greatest Quantity by Volume (Mark all that apply ☒) — a. Empty					
b. Petroleum — Diesel					
Kerosene					
Gasoline (including alcohol blends)					
Used Oil					
Other, Please Specify	Waste Oil	Waste Oil			
c. Hazardous Substance	XX	XX			
Please Indicate Name of Principal CERCLA Substance OR Chemical Abstract Service (CAS) No.					
Mark box ☒ if tank stores a mixture of substances — d. Unknown					
9. Additional Information (for tanks permanently taken out of service) — a. Estimated date last used (mo./yr)	5/91	5/91	/	/	/
b. Estimated quantity of substance remaining (gal.)	0	0			
c. Mark box ☒ if tank was filled with inert material (e.g., sand, concrete)	Removed	Removed			

HERCULES

Hercules Aerospace Company
Radford Army Ammunition Plant
PO Box 1
Radford, VA 24141-0100

January 23, 1992

92-815-18

bc: Administrative File
D. W. Ratcliff
J. A. Morris
C. A. Jake
H. L. Stull

Administrative Contracting Officer
Radford Army Ammunition Plant
Radford, Virginia 24141

Attention SMCRA-EN

Dear Sir:

Removal of Underground Storage Tank 7219-1 & -2
Site Closure

Reference: Closure Notice of July 17, 1991

Enclosed for your inspection and transmittal to the Virginia State Water Control Board, Roanoke, Virginia, attention Mr. Ray Wirt, you will find the Hazardous Waste Manifest covering the disposition of soil contaminated with lead and petroleum from the spill which occurred while removing the U.S.T. at Building 7219-1 and -2.

A copy of this document should also be filed with the local county building official, County of Montgomery, Mr. Wayne E. Mannon, Court House Room 408, Christiansburg, Virginia 24073.

Very truly yours,

E. M. SOUCEK, DIRECTOR
ENGINEERING, MAINTENANCE AND UTILITIES

HLS:gps
1600q

Coordination:
H. M. Harvey, Jr.

Attachment

Please print or type

Form Approved OMB No 2050-0039 Expires 9-30-9

UNIFORM HAZARDOUS WASTE MANIFEST

1 Generator's US EPA ID No: VA 1121100207300 — Manifest Document No: 010386

2 Page 1 of 1

Information in the shaded areas is not required by Federal law.

3 Generator's Name and Mailing Address
HERCULES INCORPORATED
RADFORD ARMY AMMUNITION PLANT
P.O. BOX 1 (ROUTE 114)
RADFORD, VA 24141-0100
ATTN: MARK C. ALDERMAN

4 Generator's Phone: 703 639-7529

A State Manifest Document Number: MI 2235436

B. State Generator's ID: SAME

5 Transporter 1 Company Name: DART TRUCKING COMPANY
6 US EPA ID Number: OHD009865825

C. State Transporter's ID: OHD009865825
D. Transporter's Phone: (216) 533-984

7 Transporter 2 Company Name
8 US EPA ID Number

E. State Transporter's ID
F. Transporter's Phone

9 Designated Facility Name and Site Address
MICHIGAN DISPOSAL, INC.
49350 N. I-94 SERVICE DRIVE
BELLEVILEE, MI 48111
10 US EPA ID Number: MID000724831

G. State Facility's ID: MID000724831
H. Facility's Phone: (313) 699—7120

11 US DOT Description (including Proper Shipping Name, Hazard Class, and ID NUMBER)	HM	12 Containers No	12 Containers Type	13 Total Quantity	14 Unit Wt/Vol	I. Waste No.	
a. HAZARDOUS WASTE, SOLID, N.O.S. (SOIL CONTAMINATED WITH LEAD & PETROLIUM) ORM-E NA 9189	X	0101	MT	0014½	Y	D008	H
b.							
c.							
d.							

J. Additional Descriptions for Materials Listed Above
A) S,T 100%
EMERGENCY RESPONSE CONTACT R.W. SWINEY(804) 539-0005
EMERGENCY RESPONSE GUIDEBOOK # 31

K. Handling Codes for Wastes Listed Above
a/ /
b/ /
c/ /
d/ /

15. Special Handling Instructions and Additional Information
TRANSPORTERS VA STATE ID # OHD0098658257 a. 43,980 Lbs.

16. GENERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled and are in all respects in proper condition for transport by highway according to applicable international and national government regulations.

If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment; OR, if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.

Printed/Typed Name: HERCULES INCORPORATED BY: H. R. BLANKENSHIP
Signature: H R Blankenship
Date: Month Day Year

17 Transporter 1 Acknowledgement of Receipt of Materials
Printed/Typed Name: Rick Showers
Signature: Rick Showers
Date: Month Day Year 1 1 1 9 9 1

18 Transporter 2 Acknowledgement of Receipt of Materials
Printed/Typed Name:
Signature:
Date: Month Day Year

19 Discrepancy Indication Space
6757

20. Facility Owner or Operator Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19
Printed/Typed Name: Thomas Bray
Signature: Thomas Bray
Date: Month Day Year 1 1 9 9 1

A Form 8700-22 (Rev. 9/88)

PR 5110 Rev. 4/90

GENERATOR — TRANSPORTER — FACILITY

MICHIGAN AT 1 800 292-4706 OR OUT OF STATE AT 517 373 7660 AND THE NATIONAL RES...

...ILLS MUST BE REPORTED TO THE MICHIGAN POLLUTION EMERGENCY ALERTING S... ...ER AT 1-800 424 8802 24 HOURS PER DAY

SWMU 75

BLANK VERSO PAGE

ALLIANT TECHSYSTEMS

Alliant Techsystems Inc.
Radford Army Ammunition Plant
Route 114
P.O. Box 1
Radford, VA 24141-0100

June 22, 1995

95-815-236

Department of Environmental Quality
Water Division - UST Program
P. O. Box 11143
Richmond, VA 23230

SWMU 75
Bldg. 421 UST

Attention: Ms. Amy Harshman

Subject: UST Notification for RAAP UST Program

Reference: Telephone Conversation on June 20 with Mr. Ken Chapman (Roanoke) and Ms. Amy Harshman (Richmond)

Dear Madam:

Attached is the notification form for the following underground storage tanks (USTs):

503 (PC-95-1086)	9222 #1 and #2
421 (PC-95-1099)	1524 #1 and #2
442 (PC-95-1098)	1525 #1 and #2
T-4700	3525 #1 and #2
3751	

RAAP is preparing Site Characterization Reports for Sites 503, 421 and 442. Site T-4700 will be closed soon and Site 3751 has been reviewed by the Montgomery County Building Official and has been closed. Sites 9222, 1524, 1525 and 3525 are solvent railcar unloading stations which, each, have two "sump tanks" or USTs. The "heel sump tanks" are used to collect any remaining product after the majority of the product has been drawn from the railcar via suction. A funnel under the car's drain valve is used to collect the remaining product into "sump tank" by gravity. The product in the "sump tank" is immediately pumped to an above ground tank with the rest of the product. As discussed with your office, these tanks must be registered and monitored since they do hold product on a regular basis even though the product is removed expeditiously after the railcar has been emptied.

Thank you for your time and consideration in this matter.

Very truly yours,

C. A. Jake
Environmental Manager

Coordination:

J. E. Woolwine

J. Wilson

c: Department of Environmental Quality
Water Regional Office
3015 Peters Creek Road
P. O. Box 7017
Roanoke, Virginia 24019

Attachment

bc: Administrative File
J. Wilson
D. W. Ratcliff
C. A. Jake
M. A. Lee
Env. File

MALee:gps

VA VWCB Form 7530-1 (3/88)

Notification for Underground Storage Tanks

STATE USE ONLY
ID NUMBER
DATE RECEIVED
A. NEW
B. AMENDED
C. ENTERED INTO UST-DMS
D. Comments:

State Agency Name and Address
DEQ-Water Division-UST Program P.O. Box No. 11143 Richmond, VA 23230

TYPE OF NOTIFICATION

☐ A. NEW FACILITY ☒ B. AMENDED ☒ C. CLOSURE

35 No. of tanks at facility ____ No. of continuation sheets attached

INSTRUCTIONS

Please type or print in ink all items except "signature" in section VIII. This form must be completed for each location containing underground storage tanks. If more than five (5) tanks are owned at this location, photocopy pages 3, 4 and 5, and staple continuation sheets to the form.

GENERAL INFORMATION

Notification is required by Virginia law for all underground storage tanks that have been used to store regulated substances and were in the ground as of May 8, 1986, or that are brought into use after May 8, 1986. The information requested is required by §62.1-44.34:8.B & 7 of the Virginia State Water Control Law, Article 9.

The primary purpose of this notification program is to locate and evaluate underground storage tanks that store or have stored petroleum or hazardous substances. It is expected that the information you provide will be based on reasonable available records, or in the absence of such records, your knowledge, belief, or recollection.

Who Must Notify?

A. Virginia State Water Control Law Article 9 § 62.1-44.34:8.B & 7, requires that unless exempted, owners of underground storage tanks that store regulated substances must notify the State Water Control Board of the existence of their tanks. Owner means:

1) in the case of an underground storage tank in use on November 8, 1984, or brought into use after that date, any person who owns an underground storage tank used for the storage, use or dispensing of regulated substances, and

2) in the case of any underground storage tank in use before November 8, 1984, but no longer in use after that date, any person who owned such tank immediately before the discontinuation of its use, and

B. Owners of property who have actual knowledge of underground storage tanks on such property that were taken out of service before January 1, 1974, yet still in the ground.

What UST's Must Be Notified? Underground storage tank or "UST" means any one combination of tanks (including underground pipes connected thereto) that is used to contain an accumulation of regulated substances, and the volume of which (including the volume underground pipes connected thereto) is 10% or more beneath the surface of the ground.

What UST's Are Excluded From Notification Requirements?

1. Farm or residential tank of 1,100 gallons or less capacity used for storing motor fuel for noncommercial purposes;
2. Tank used for storing heating oil for consumption on the premises where stored, except for tanks having a capacity of more than 5,000 gallons and used for storing heating oil;
3. Septic tank;
4. Pipeline facility (including gathering lines) regulated under:
   a. The Natural Gas Pipeline Safety Act of 1968 (49 U.S.C. App. 1671, et seq.), or
   b. The Hazardous Liquid Pipeline Safety Act of 1979 (49 U.S.C. App. 2001, et seq.), or
   c. Which is an intrastate pipeline facility regulated under state laws comparable to the provisions of the law referred to in subdivisions 4.a or 4.b of this definition;
5. Surface impoundment, pit, pond, or lagoon;
6. Storm-water or wastewater collection system;
7. Flow-through process tank;
8. Liquid trap or associated gathering lines directly related to oil or gas production and gathering operations; or
9. Storage tank situated in an underground area (such as a basement, cellar, mineworking, drift, shaft, or tunnel) if the storage tank is situated upon or above the surface of the floor.

The Following Need Not Notify, But May Be Regulated.

10. Wastewater treatment tank systems;
11. Any UST systems containing radioactive material that are regulated under the Atomic Energy Act of 1954 (42 USC 2011 and following);
12. Any UST system that is part of an emergency generator system at nuclear power generation facilities regulated by the Nuclear Regulatory Commission under 10 CFR Part 50, Appendix A;
13. Airport hydrant fuel distribution systems; and
14. UST systems with field-constructed tanks

What Substances Are Covered? "Regulated substance" means an element, compound, mixture, solution, or substance that, when released into the environment, may present substantial danger to the public health or welfare, or the environment. The term "regulated substance" includes:

1. Any substance defined in § 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, but not any substance regulated as a hazardous waste under subtitle C of the Resource Conservation and Recovery Act (RCRA) of 1976; and
2. Petroleum, including crude oil or any fraction thereof, that is liquid at standard conditions of temperature and pressure (60 degrees Fahrenheit and 14.7 pounds per square inch absolute). The term "regulated substance" includes but is not limited to petroleum and petroleum-based substances comprised of a complex blend of hydrocarbons derived from crude oil through processes of separation, conversion, upgrading, and finishing, such as motor fuels, jet fuels, distillate fuel oils, residual fuel oils, lubricants, petroleum solvents, and used oils.

When to Notify?

A. Any owner who brings an underground storage tank system into use must within 30 days of bringing such tank into use, submit a notice of existence of such tank system to the board. Any change in: ownership; tank status (e.g., temporarily / permanently closed out); tank/piping systems (e.g., upgrades such as addition of corrosion protection, internal lining, release detection); substance stored (e.g., change from petroleum to hazardous substance) requires the UST owner to submit an amended notification form within 30 days after such change/upgrade occurs or is brought into use. Owners may provide notice for several tanks using one notification form, but owners with tanks located at more than one place of operation must file a separate notification form for each separate place of operation.

Under Virginia UST notification requirements effective July 1, 1987, owners of property who have actual knowledge of underground storage tanks on such property that were taken out of service before January 1, 1974, yet still in the ground, must notify the board on the notification form.

Notices required to be submitted must provide all of the information in Sections I through IX of this form (Section X as required) for each tank for which notice must be given. Notices for tanks installed after December 22, 1988, must also provide all of the information in Section XI of this form for each tank for which notice must be given.

B. All owners and operators of new UST systems must certify in the notification form compliance with the following requirements of Virginia Regulation VR 680-13-02:

1. Installation of tanks and piping under subsection E of § 2.1;
2. Cathodic protection of steel tanks and piping under subsections A and B of § 2.1;
3. Release detection under §§ 4.2 and 4.3
4. Financial responsibility under Virginia Regulation VR 680-13-03.

C. All owners and operators of new UST systems must ensure that the installer certifies in the notification form that the methods used to install the tanks and piping comply with the requirements in subsection D of § 2.1 of VR 680-13-02.

D. Beginning October 24, 1988, any person who sells a tank intended to be used as an underground storage tank must notify the purchaser of such tank of the owner's notification obligations under subsection A of this section. The statement provided in Appendix II of VR 680-13-02 may be used to comply with this requirement.

I. OWNERSHIP OF TANK(S)

U. S. Army
Owner Name (Corporation, Individual, Public Agency, or Other Entity)

Radford Army Ammunition Plant
Street Address

Rt. 114 (P. O. Box 1)

Radford, Virginia 24141
City State ZIP Code

ntgomery/Pulaski Counties
County

(703) 639-7631
Phone Number (Include Area Code)

II. LOCATION OF TANK(S)

If known, give the geographic location of tank(s) by degrees, minutes, and seconds. Example Lat. 42, 38, 12N Long. 88, 24, 17W

Latitude 37°10'14" Longitude 80°31'17"

(If same as Section I, mark box here) ☐

Facility or Company Site Identifier, as applicable

Street Address (P. O. Box not acceptable)

City State ZIP Code

County Municipality

IX. DESCRIPTION OF UNDERGROUND STORAGE TANKS (Complete for each tank at this location.)

Tank Identification Number	Tank No. T-4700	Tank No. 503	Tank No. 421	Tank No. 442	Tank No. 3751
1. Status of Tank (Mark only one) — Currently in Use					
Temporarily Out of Use (Remember to fill out section X.)					
Permanently Out of Use (Remember to fill out section X.)	X	X	X	X	X
Amendment of Information					
2. Date of installation (mo./year)	-/46	-/69	-/73	-/82	5/84
3. Estimated Total Capacity (gallons)	2000	1000	750	275	2000
4. Tank Material of Construction (Mark all that apply)					
Asphalt Coated or Bare Steel	X	X	X	X	X
Cathodically Protected Steel					
Epoxy Coated Steel					
Composite (Steel with Fiberglass)					
Fiberglass Reinforced Plastic					
Lined Interior					
Double Walled					
Polyethylene Tank Jacket					
Concrete					
Excavation Liner					
Unknown					
Other (Please specify)					
Has tank been repaired?					
5. Piping Material of Construction (Mark all that apply) — Bare Steel	X	X	X	X	X
Galvanized Steel					
Fiberglass Reinforced Plastic					
Copper					
Cathodically Protected					
Double Walled					
Secondary Containment					
Unknown					
Other (Please specify)					
Has piping been repaired?					
6. Piping (Type) (Mark only one)					
Suction: no valve at tank	X	X			
Suction: valve at tank					
Pressure					
Gravity Fed			X	X	X

IX. DESCRIPTION OF UNDERGROUND STORAGE TANKS (Complete for each tank at this location.)

Tank Identification Number	1524 #1 Tank No. ____	1524 #2 Tank No. ____	1525 #1 Tank No. ____	1525 #2 Tank No. ____	3525 #1 Tank No. ____
1. Status of Tank (Mark only one) Currently in Use	X	X	X	X	X
Temporarily Out of Use (Remember to fill out section X.)					
Permanently Out of Use (Remember to fill out section X.)					
Amendment of Information					
2. Date of Installation (mo./year)	3/59	3/59	3/59	3/59	4/64
3. Estimated Total Capacity (gallons)	550	550	560	560	560
4. Tank Material of Construction (Mark all that apply)					
Asphalt Coated or Bare Steel	X	X	X	X	X
Cathodically Protected Steel					
Epoxy Coated Steel					
Composite (Steel with Fiberglass)					
Fiberglass Reinforced Plastic					
Lined Interior					
Double Walled					
Polyethylene Tank Jacket					
Concrete					
Excavation Liner					
Unknown					
Other (Please specify)					
Has tank been repaired?					
5. Piping Material of Construction (Mark all that apply) Bare Steel	X	X	X	X	X
Galvanized Steel					
Fiberglass Reinforced Plastic					
Copper					
Cathodically Protected					
Double Walled					
Secondary Containment					
Unknown					
Other (Please specify)					
Has piping been repaired?					
6. Piping (Type) (Mark only one)					
Suction: no valve at tank					
Suction: valve at tank					
Pressure					
Gravity Fed	X	X	X	X	X

IX. DESCRIPTION OF UNDERGROUND STORAGE TANKS (Complete for each tank at this location.)

Tank Identification Number	Tank No. 3525 #2	Tank No. 9222 #1	Tank No. 9222 #2	Tank No.	Tank No.
1. Status of Tank (Mark only one) — Currently in Use	X	X	X		
Temporarily Out of Use (Remember to fill out section X.)					
Permanently Out of Use (Remember to fill out section X.)					
Amendment of Information					
2. Date of Installation (mo./year)	4/64	11/83	11/83		
3. Estimated Total Capacity (gallons)	560	1155	1155		
4. Tank Material of Construction (Mark all that apply)					
Asphalt Coated or Bare Steel	X	X	X		
Cathodically Protected Steel					
Epoxy Coated Steel					
Composite (Steel with Fiberglass)					
Fiberglass Reinforced Plastic					
Lined Interior					
Double Walled					
Polyethylene Tank Jacket					
Concrete					
Excavation Liner					
Unknown					
Other (Please specify)					
Has tank been repaired?					
5. Piping Material of Construction (Mark all that apply) — Bare Steel	X	X	X		
Galvanized Steel					
Fiberglass Reinforced Plastic					
Copper					
Cathodically Protected					
Double Walled					
Secondary Containment					
Unknown					
Other (Please specify)					
Has piping been repaired?					
6. Piping (Type) (Mark only one)					
Suction: no valve at tank					
Suction: valve at tank					
Pressure					
Gravity Fed	X	X	X		

BUILDING PERMIT

3420

Montgomery County Department of Planning and Inspections
P.O. Box 806 Christiansburg, Va. 24073 Phone: 382-5750

Note: This Permit is VOID if work is not commenced within six (6) months from the date of issuance. PAID
All work must comply with the Code of Ordinances of Montgomery County, Virginia

PAID

Building Permit No. 3420 Date April 21, 1995
Name of Owner Radford Army Ammunition Plant Address P.O Box 1 Ph 639-7631
Name of Contractor Alliant Techsystems, Inc Address Radford, VA 24141-0100 Ph
State of Contrs. Regist. No.
Name of SubContractor Address Ph
State Contrs. Regist. No.
Name of Architect Address Ph

USE: Permanent (8) Tank Removals

LOCATION OF CONSTRUCTION:

N E S W side of St. Rd. No. about miles from #421,442,503,3751,224-1 241-1 (#1), 241-1 (#2) and T-4700 (Permanent Closure)

Subdivision Section Lot No.
Size of lot or Acreage of land 4350 acres Magist. Dist. Prices Fork
Front street foundation setback ft. Side street setback ft.
Left side yard ft. Right side yard ft. Rear yard ft.

Total Sq. Ft. Estimated Cost: $ 50,000.00
Use Group Classification: PERMIT FEE: $ 160.00
Type of Construction: Dept. Approval: Wayne Thomas
Date: 4-24-95

REQUIRED INSPECTION - STRUCTURES

FOOTERS: Inspection to be made after footers are dug, grade stakes in place, all forms and bulkheads in place and reinforcement steel in footers.

FOUNDATION & FRAMING: Inspection to be made on Forms and Reinforcement steel in place (poured concrete foundations) Inspect Block Walls, inspect all drain tile around foundations. Framing to be inspected after the roof, all framing, fire blocking and bracing are in place.

ROUGH-IN-PLUMBING: Inspection after all plumbing is installed before insulation is put in walls. All underground plumbing to be inspected before covered with concrete slab.

ROUGH-IN-ELECTRICAL: All wiring to be inspected before insulating walls or covering in any manner. All underground wiring (conduit etc.) to be inspected before covering.

MECHANICAL: All mechanical work (heat systems duct work etc. to be inspected before covering in any manner.

SLAB INSPECTION: All concrete slabs basement, floors, garage floors, carport floors, patios etc. Inspections will be made when all base stone is in place, reinforcement wire, and grade stakes are in place.

FINAL INSPECTION: Inspection to be made after the building is complete and before being occupied. An occupancy permit will be issued after the final inspection of the building is made.

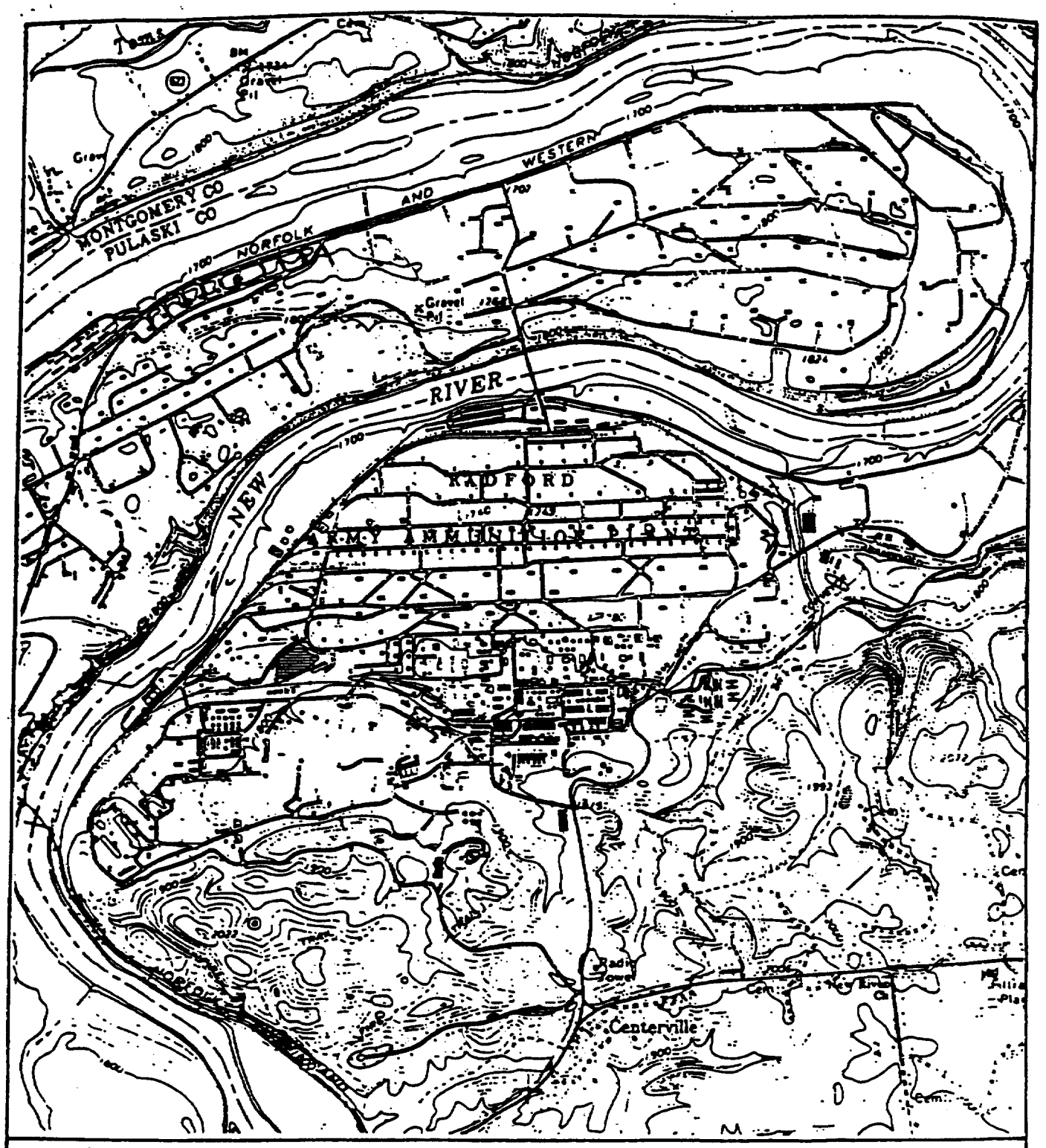
REQUIRED INSPECTIONS - MOBILE HOMES

MOBILE HOMES: One inspection covers footers for piers, tie downs, water and sewer connections and the electrical service for the home.

DOUBLE-WIDE MOBILE HOMES: Footer Inspection - This is made on footers before moving the two halves of the home to the site. Second Inspection - This covers the Water and Sewer connections, tie downs, set-up of the home, and the electrical service for the home.

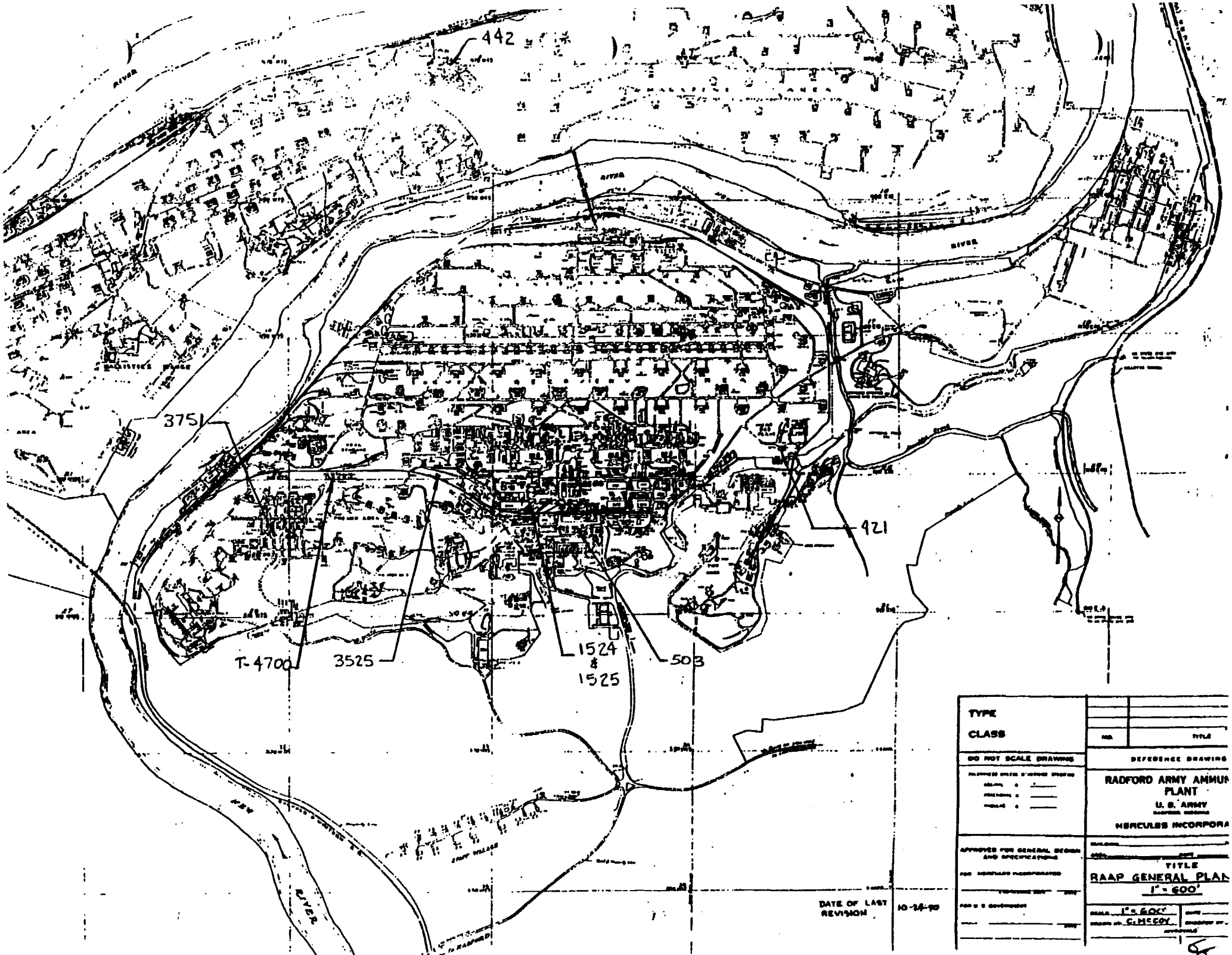
NOTICE: The Owner of this Permit shall be responsible for notifying this Department for ALL inspections as required above.
A MINIMUM of 24 HOURS NOTICE IS REQUIRED FOR ALL INSPECTION REQUESTS.

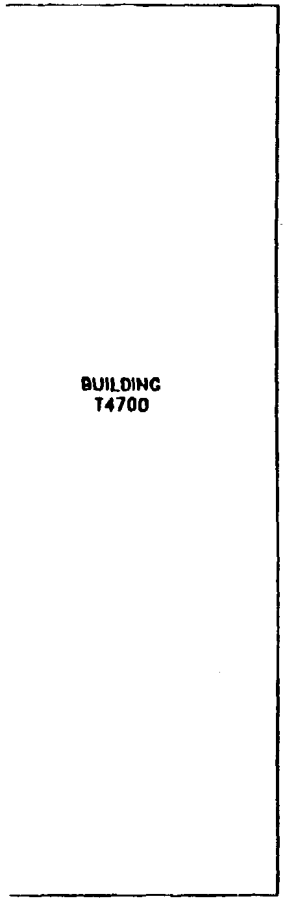
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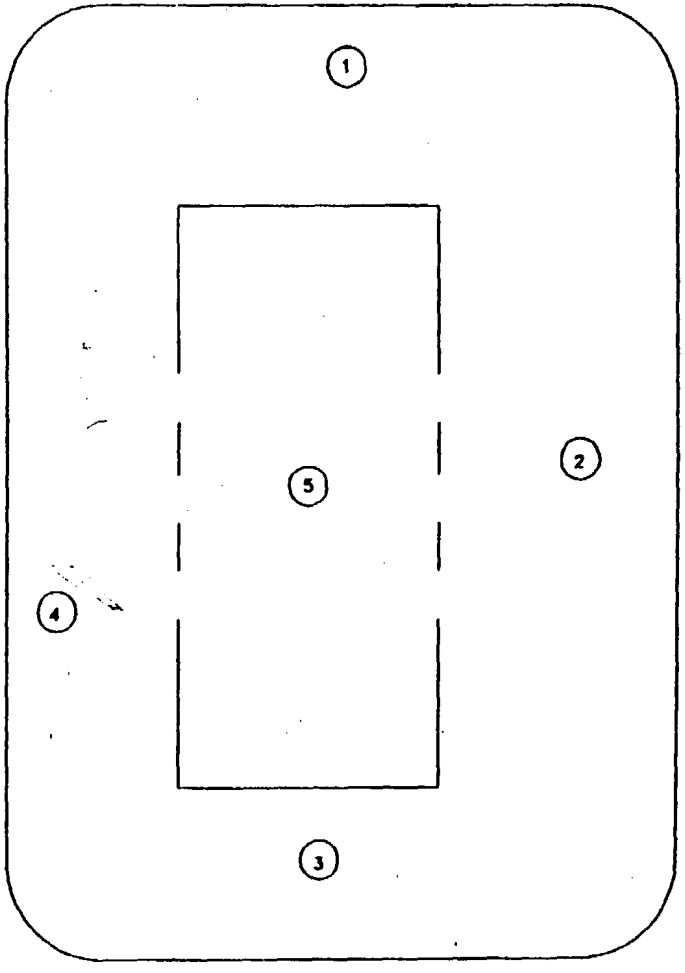


HERCULES

Figure 1. Site Diagram of Radford Army Ammunition Plant


442
375
T-4700
3525
1524
&
1525
503
421
RIVER
DATE OF LAST REVISION
10-14-90
TYPE
CLASS
DO NOT SCALE DRAWING
REFERENCE DRAWING
RADFORD ARMY AMMUNITION PLANT
U. S. ARMY
HERCULES INCORPORATED
APPROVED FOR GENERAL DESIGN AND SPECIFICATIONS
TITLE
RAAP GENERAL PLAN
1" = 600'
1" = 600'
C. McCOY





N

PLAN VIEW OF EXCAVATION

DATE: 8/16/95

SAMPLE I.D.	SAMPLE LOCATION	TEST RESULTS
#1	WALL - NORTH FACE	600 mg/kg
#2	WALL - EAST FACE	BDL
#3	WALL - SOUTH FACE	150 mg/kg
#4	WALL - WEST FACE	180 mg/kg
#5	FLOOR OF PIT	BDL

SOIL SAMPLING DIAGRAM
SITE- UST T4700
RADFORD AAP
US ROUTE 114 (P. O BOX 1)
RADFORD, VA 2 .41

EnviroTech Mid-Atlantic Laboratories
1861 Pratt Dr. • Blacksburg, VA 24060
(703) 231-3983 • Fax (703) 231-3984

May 31, 1995

Client Contact

Attn.:	C.C. Lane
Fax No.:	703-639-4361

Report Information

Report #:	9815
Date Rec'd:	5/12/95

Client Information

Name:	Alliant Techsystems
Address:	Post Office Box 1
	Radford, VA 24141

Sample Information

Project:	T4700
Project #:	
P.O. #	RA-59938

Sample Identification

Sample submitted and identified by client:

Sample	Field Identification	Matrix	Date	Time Collected
9815A	T4700-SF	Soil	5/16/95	1117
9815B	T4700-EF	Soil	5/16/95	1120
9815C	T4700-NF	Soil	5/16/95	1123
9815D	T4700-WF	Soil	5/16/95	1130
9815E	T4700-Pile-W	Soil	5/16/95	1150
9815F	T4700-Pile-E	Soil	5/16/95	1157
9815G	T4700-FLR	Soil	5/16/95	1410

EnviroTech Mid-Atlantic

05/31/95

Laboratory Analyses

Project: T4700

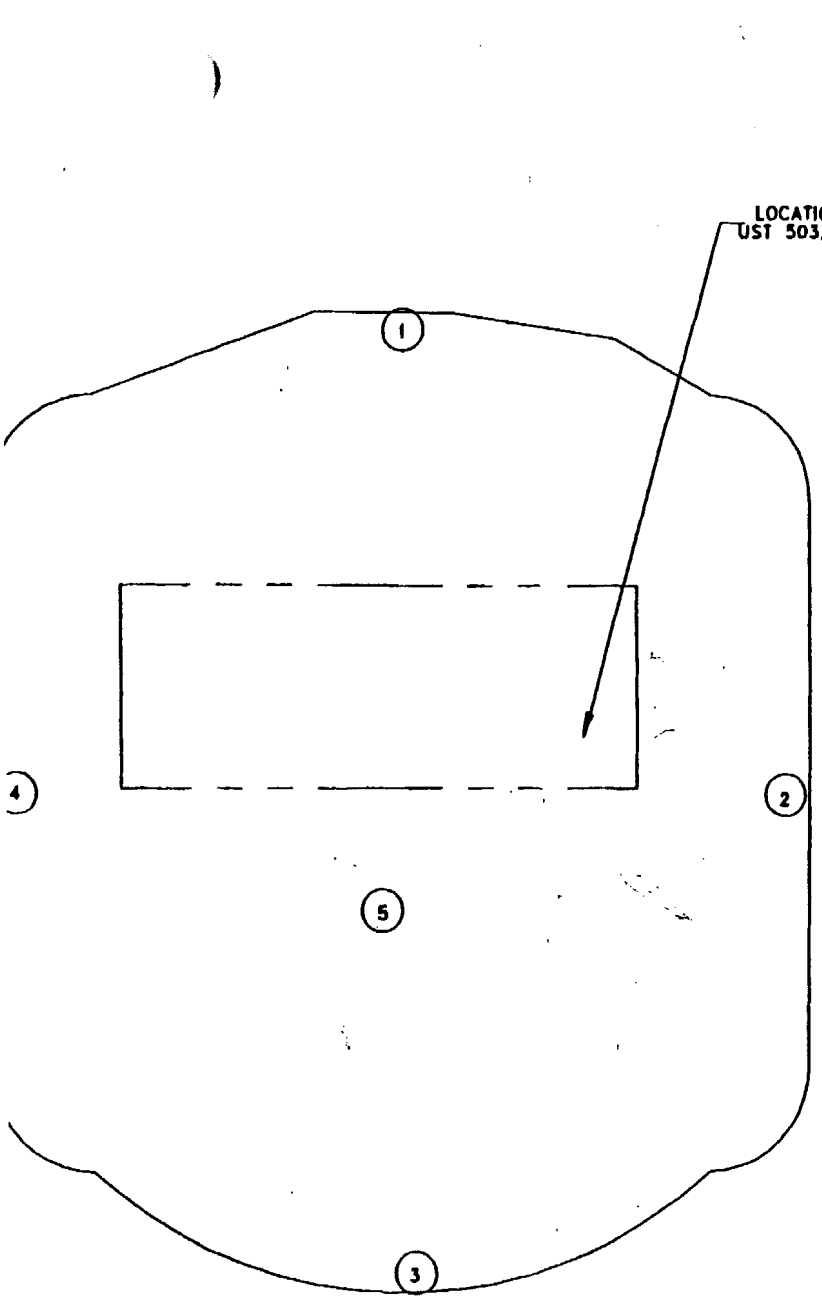
Analysis	D/L	9815A *T4700-SF*	D/L	9815B *T4700-EF*	D/L	9815C *T4700-NF*
TPH-GC (mg/kg)			10	BDL		
Kerosene / Diesel Range	10	150			10	600

Analysis	D/L	9815D *T4700-WF*	D/L	9815F *T4700-Pile-E*	D/L	9815G *T4700-FLR*
TPH-GC (mg/kg)					10	BDL
Kerosene / Diesel Range	10	180	10	170		

Analysis	D/L	9815E *T4700-Pile-W*
TPH-GC (mg/kg)		
Kerosene / Diesel Range	10	BDL
Oil Range	10	41
TCLP Metals (mg/L)		
Arsenic (As)	0.002	BDL
Mercury (Hg)	0.0001	BDL
Selenium (Se)	0.002	0.002
TCLP Metals by ICP (mg/L)		
Barium (Ba)	0.01	1.1
Cadmium (Cd)	0.01	0.01
Chromium (Cr)	0.01	0.02
Lead (Pb)	0.10	BDL
Silver (Ag)	0.01	0.04
BTEX (mg/kg)		
Benzene	100	BDL
Toluene	100	BDL
Ethylbenzene	100	BDL
Xylenes	100	BDL

D/L - Detection Limit *BDL - Below Detection Limit*

Soil samples were prepared on a dry



DATE: 5/8/95

SAMPLE I.D.	SAMPLE LOCATION	TEST RESULTS
#1	WALL - NORTH FACE	22000 mg/kg
#2	WALL - EAST FACE	140 mg/kg
#3	WALL - SOUTH FACE	BDL
#4	WALL - WEST FACE	930 mg/kg
#5	FLOOR OF PIT	200 mg/kg

SOIL SAMPLING DIAGRAM
SITE- UST 503
RADFORD AAP
US ROUTE 114 (P. O. BOX 1)
RADFORD, VA 24141

PLAN VIEW OF EXCAVATION

EnviroTech Mid-Atlantic Laboratories
1861 Pratt Dr. • Blacksburg, VA 24060
(703) 231-3983 • Fax (703) 231-3984

May 22, 1995

Client Contact

Attn.:	C.C. Lane
Fax No.:	703-639-4361

Report Information

Report #:	9754
Date Rec'd:	5/10/95

Client Information

Name:	Alliant Techsystems
Address:	Post Office Box 1
	Radford, VA 24141

Report Information

Project:	Site 503
Project #:	
P.O. #	VA 10547

Sample Identification

Sample submitted and identified by client:

Sample	Field Identification	Matrix	Date	Time Collected
9754A	503-WF	Soil	5/8/95	1425
9754B	503-EF	Soil	5/8/95	1427
9754C	503-NF	Soil	5/8/95	1430
9754D	503-SF	Soil	5/8/95	1434
9754E	503-FLR	Soil	5/8/95	1440

All analyses were performed in accordance with EPA methods referenced in "Methods for Chemical Analysis of Water and Wastes", EPA 600/4-79 revised March 1983 and/or "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", SW-

EnviroTech Mid-Atlantic

05/22/95

Laboratory Analyses

Project: Site 503

Analysis	D/L	9754A *503-WF*	D/L	9754B *503-EF*	D/L	9754C *503-NF*
TPH-GC (mg/kg)						
Kero-Diesel Range	500	930	10	140	1000	22000
Oil Range	10	160	—	—	10	130

Analysis	D/L	9754D *503-SF*
TPH-GC (mg/kg)	10	BDL

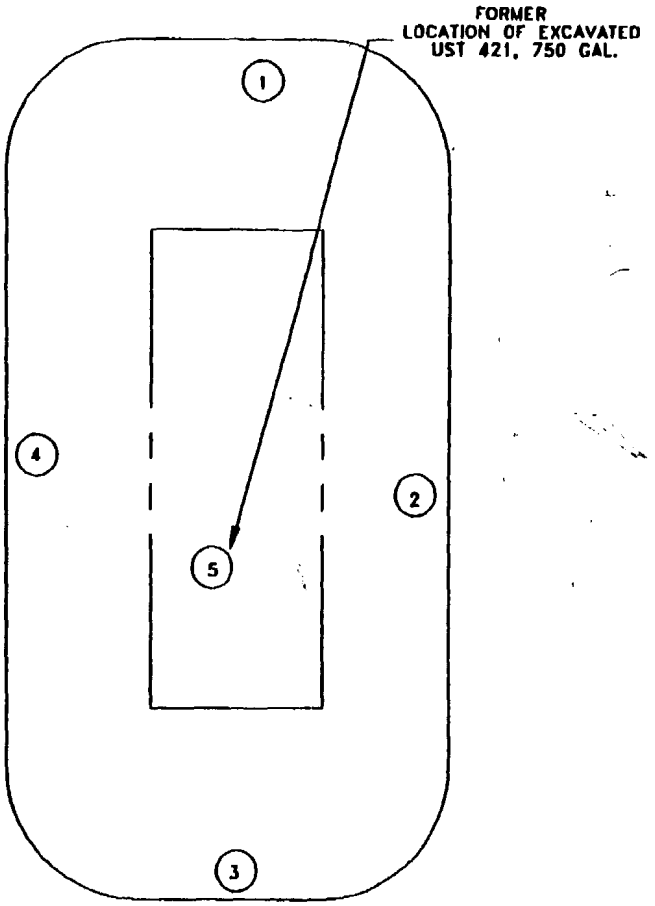
Analysis	D/L	9754E *503-FLR*
TPH-GC (mg/kg)		
Kero-Diesel Range	200	1200
Oil Range	10	200

Quality Control Data

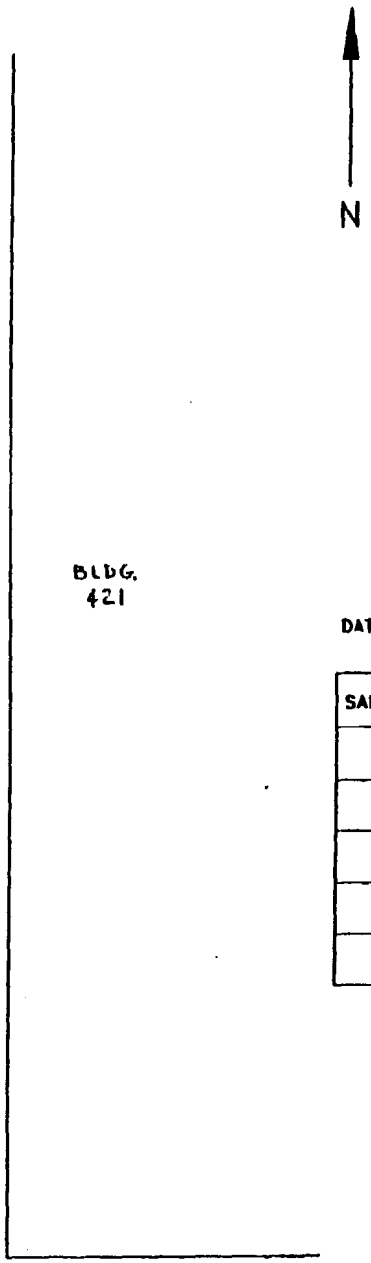
Analysis	%STD	%Spike	%RD	EPA #	Analysist	Date Analyzed
TPH-GC	109	107	<1	3550	C. Smith	5/22/95

Elizabeth J. Smiley
Laboratory Director

D/L - Detection Limit BDL - Below Detection Limit



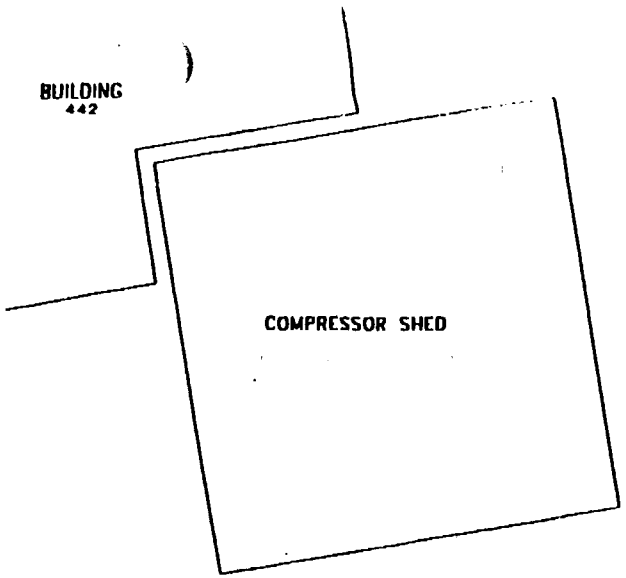
PLAN VIEW OF EXCAVATION



DATE: 5/24/95

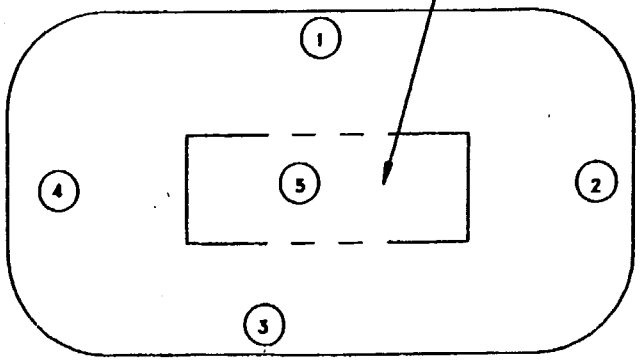
SAMPLE I.D.	SAMPLE LOCATION	TEST RESULTS
#1	WALL - NORTH FACE	BDL
#2	WALL - EAST FACE	BDL
#3	WALL - SOUTH FACE	1400 mg/kg
#4	WALL - WEST FACE	BDL
#5	FLOOR OF PIT	130 mg/kg

SOIL SAMPLING DIAGRAM
SITE- UST 421
RADFORD AAP
US ROUTE 114 (P. O. BOX 1)
RADFORD, VA 24141





FORMER
LOCATION OF EXCAVATED
UST 442, 275 GAL.



DATE: 5/24/95

SAMPLE I.D.	SAMPLE LOCATION	TEST RESULTS
#1	WALL - NORTH FACE	BDL
#2	WALL - EAST FACE	43000 mg/kg
#3	WALL - SOUTH FACE	5400 mg/kg
#4	WALL - WEST FACE	16000 mg/kg
#5	FLOOR OF PIT	300 mg/kg

SOIL SAMPLING DIAGRAM
SITE- UST 442
RADFORD AAP
US ROUTE 114 (P. O. BOX 1)
RADFORD, VA 24141

PLAN VIEW OF EXCAVATION

EnviroTech Mid-Atlantic Laboratories
1861 Pratt Dr. • Blacksburg, VA 24060
(703) 231-3983 • Fax (703) 231-3984

May 24, 1995

Client Contact

Attn.: C.C. Lane
Fax No.: 703-639-4361

Report Information

Report #: 9777
Date Rec'd: 5/12/95

Client Information

Name: Alliant Techsystems
Address: Post Office Box 1
Radford, VA 24141

Sample Information

Project: Sites 442 & 421
Project #:
P.O. # VA 10547

Sample Identification

Sample submitted and identified by client:

Sample	Field Identification	Matrix	Date	Time Collected
9777A	442-SF	Soil	5/11/95	1120
9777B	442-EF	Soil	5/11/95	1130
9777C	442-NF	Soil	5/11/95	1110
9777D	442-FLR	Soil	5/11/95	1345
9777E	442-WF	Soil	5/11/95	1347
9777F	421-EF	Soil	5/11/95	1500
9777G	421-FLR	Soil	5/11/95	1502
9777H	421-NF	Soil	5/11/95	1505
9777I	421-SF	Soil	5/11/95	1507
9777J	421-WF	Soil	5/11/95	1508

All analyses were performed in accordance with EPA methods referenced in "Methods for Chemical Analysis of Water and Wastes". EPA 600/4-79 revised March 1983 and/or "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", SW-

EnviroTech Mid-Atlantic

05/24/95

Laboratory Analyses

Project: Sites 442 & 421

Analysis	D/L	9777C *442-NF*	9777D *442-FLR*	9777F *421-EF*	9777G *421-FLR*	9777H *421-NF*
TPFH-GC (mg/kg)	10	BDL	300	BDL	130	BDL

Analysis	D/L	9777A *442-SF*	D/L	9777B *442-EF*	D/L	9777E *442-WF*
TPFH-GC (mg/kg)	200	5400	1000	43000	500	16000

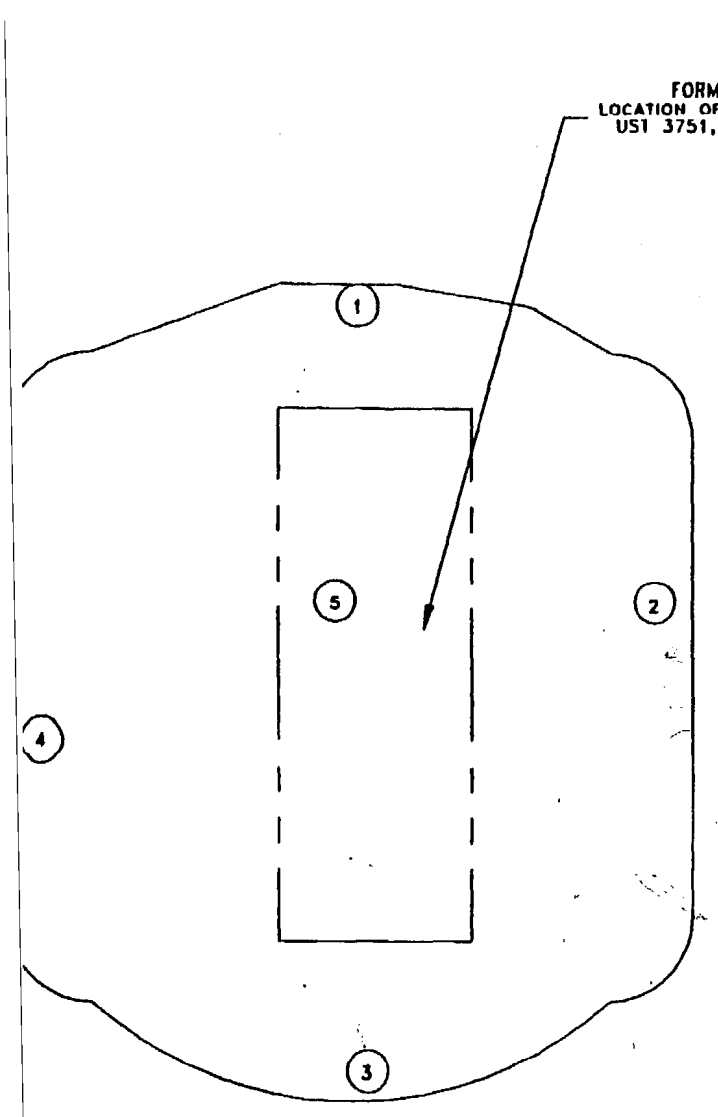
Analysis	D/L	9777I *421-SF*	D/L	9777J *421-WF*
TPFH-GC (mg/kg)	100	1400	10	BDL

Quality Control Data

Analysis	%STD	%Spike	%RD	EPA #	Analysist	Date Analyzed
TPH-GC	106	114	<1	3550	C. Smith	5/24/95

Elizabeth J. Smiley
Laboratory Director

D/L - Detection Limit *BDL - Below Detection Limit*



BUILDING
3751

DATE: 4/5/95

SAMPLE I.D.	SAMPLE LOCATION	TEST RESULTS
#1	WALL - NORTH FACE	BDL
#2	WALL - EAST FACE	BDL
#3	WALL - SOUTH FACE	BDL
#4	WALL - WEST FACE	BDL
#5	FLOOR OF PIT	BDL

SOIL SAMPLING DIAGRAM
SITE- UST 3751
RADFORD AAP
US ROUTE 114 (P. O. BOX 1)
RADFORD, VA 24141

PLAN ɛW OF EXCAVATION

EnviroTech Mid-Atlantic Laboratories
1861 Pratt Dr. • Blacksburg, VA 24060
(703) 231-3983 • Fax (703) 231-3984

April 11, 1995

Client: Alliant Techsystems, Inc.
Post Office Box 1
Radford, VA 24141

Attention: C. C. Lane

Fax: 703-639-4361

Report #: 9521
Project: Site 3751
P.O. #:

Date Received: 4/05/95
Project #: VA 10547
Page 1 of 2

Sample Identification

Samples submitted and identified by client as:

Sample	Matrix	Field Identification	Date	Time Collected
9521A	Soil	3751 - WF	4/04/95	15:07
9521B	Soil	3751 - SF	4/04/95	15:10
9521C	Soil	3751 - NF	4/04/95	15:12
9521D	Soil	3751 - EF	4/04/95	15:15
9521E	Soil	3751 - FLR	4/04/95	15:20

All analyses were performed in accordance with EPA methods referenced in "Methods for Chemical Analysis of Water and Wastes", EPA 600/4-79 revised March 1983 and/or "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", SW-846, 3rd Edition.

Analysis	D/L	9521A 3751-WF	9521B 3751-SF	9521C 3751-NF	9521D 3751-EF	9521E 3751-FLR
TPH-GC (mg/kg)	10	BDL	BDL	BDL	BDL	BDL

Quality Control Data

Analysis	%STD	%Spike	%RD	EPA#	Analyst	Date Analyzed
TPH-GC	123	120	<1	3550 Mod CA Method	C. Smith	4/10/95

Elizabeth J. Smiley
Laboratory Director

D/L - Detection Limit BDL - Below Detection Limit

Soil results are reported on a dry weight basis unless otherwise noted.

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

Peter W. Schmidt
Director

Water Regional Office
3015 Peters Creek Road
Post Office Box 7017
Roanoke, Virginia 24019
(703) 562-3666

Thomas L. Henderson
Regional Director

October 3, 1995

Mr. Joe Wilson Chief Engineer
Radford Army Ammunition Plant
P.O. Box 1
Radford, VA 24141

RE: Site Characterization and Abatement Measures Close-Out, R.A.A.P. UST No. 421 - 750 Gallon Compressor Condensate, Route 114, Montgomery County, Virginia, LUST PC-95-1099, FAC. I.D. No. 2-000051

Dear Mr. Wilson:

The Department of Environmental Quality, West Central Regional Office staff has completed a review of the Site Characterization Report prepared by Alliant Techsystems.

Based on the information provided, it appears that acceptable site characterization and abatement measures have been achieved. Specifically:

a. Free product, vapor and dissolved phases of petroleum contamination have not been identified during the investigation of this release incident.

b. A limited amount of contaminated soil has been excavated from the former UST basin. Apparently this soil has been properly disposed. Two post excavation soil boring samples document the extent of remaining contaminated soil appears limited to the area between the former UST basin and the sump pit.

c. Water supply wells and surface waters have not been identified within 1,000 feet of the release location. There does not appear to be a current or potential future risk to human health or the environment.

At this time, no further action with respect to this site's petroleum release characterization is required. If significant contamination associated with this facility is detected that presents environmental and/or human health/safety risk, then further investigation and corrective action may be required at that time.

Should you have questions our office will be glad to assist.

Sincerely,

Kenneth R. Chapman

Ken Chapman
Senior Geologist

LUSTCLOS.BL

cc: D. M. Miles, DEQ-WCRO
Jim Smith, OECA
LUST PC-95-1099 File
FAC. I.D. No. 2-000051

SWMU 76

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HERCULES

Hercules Aerospace Company
Radford Army Ammunition Plant
Caller Service 1
Radford, VA 24141-0299

July 1, 1991

91-815-134

bc: Administrative File
J. A. Morris
H. L. Stull

Administrative Contracting Officer
Radford Army Ammunition Plant
Radford, Virginia 24141

Dear Sir:

Oily Waste Water Spill - Building 7219

Reference: SMCRA-EN Letter Dated June 12, 1991
SMCRA-EN Letter Dated June 26, 1991

On May 29, 1991 at approximately 1500 hours, a spill of oily waste water and sludge occurred while removing a 5500 gallon underground storage tank. As the tank was being lifted by a crane from its resting place (this tank was not on saddles), it tilted, putting excessive strain on the discharge elbow connection causing a 9 foot section of 4 inch drain line to break off. Approximately 250 gallons of the oily waste water sludge, which was not removed prior to the tank removal, drained out into a trench alongside the tank as the tank was being raised.

The entire spill was contained within an area 20 feet long, 3.5 feet wide and 6 inches deep. Samples were taken of the oily waste water sludge spill for laboratory analysis. The tests confirmed the spilled material is hazardous for lead and chromium.

The oily waste water sludge was removed from the containment area using a suction pump and placed in a waste oil storage tank in the solvents area for off plant treatment. The remaining material within the trench was absorbed with an absorbent compound and removed from the area using a "Gradeall". Approximately 13 cubic yards of dirt/absorbed material were removed from the area and is currently being held on a dump truck for disposal. Cleanup of the

Oily Waste Water Spill - Building 7219

area was completed by 1800 hours. Also, approximately one cubic yard of dirt was removed from in front of the tank where the original sample was taken for petroleum hydrocarbon analysis. All the material will be manifested off site as a hazardous waste.

Attached as Figures 1 and 2 are sketches of the spill area showing sampling points, along with a soil characterization of the spill area.

Samples were taken of the oily waste water, soil from one foot below the tank level (for petroleum hydrocarbon analysis prior to the spill), and soil after the cleanup had been completed (for total petroleum hydrocarbon analysis).

Analysis of the oily waste water which was spilled showed the presence of lead (Pb) and chromium (Cr). Analysis for these two metals was included on the soil samples taken from under the spill area. All samples taken after the spill was cleaned up were clear of petroleum hydrocarbon.

Attached Table 1 shows results of oily waste water sludge analysis. Attached Table 2 shows a summary of soil analysis with Central Virginia Laboratories sheets attached.

The soil samples taken from under the spill area show relatively high lead (Pb) content. Research into the history of this area revealed that a lead furnace was in operation during World War II in this area (note Figure 1). This area is part of a Solid Waste Management Unit (SWMU) which is currently under investigation by the U. S. Army Toxic and Hazardous Material Agency (USATHAMA), and designed SWMU Number 17. This work is authorized under the Resource Conversation and Recovery Act (RCRA) investigation of hazardous waste site at RAAP. Site remediation will be performed under the USATHAMA study.

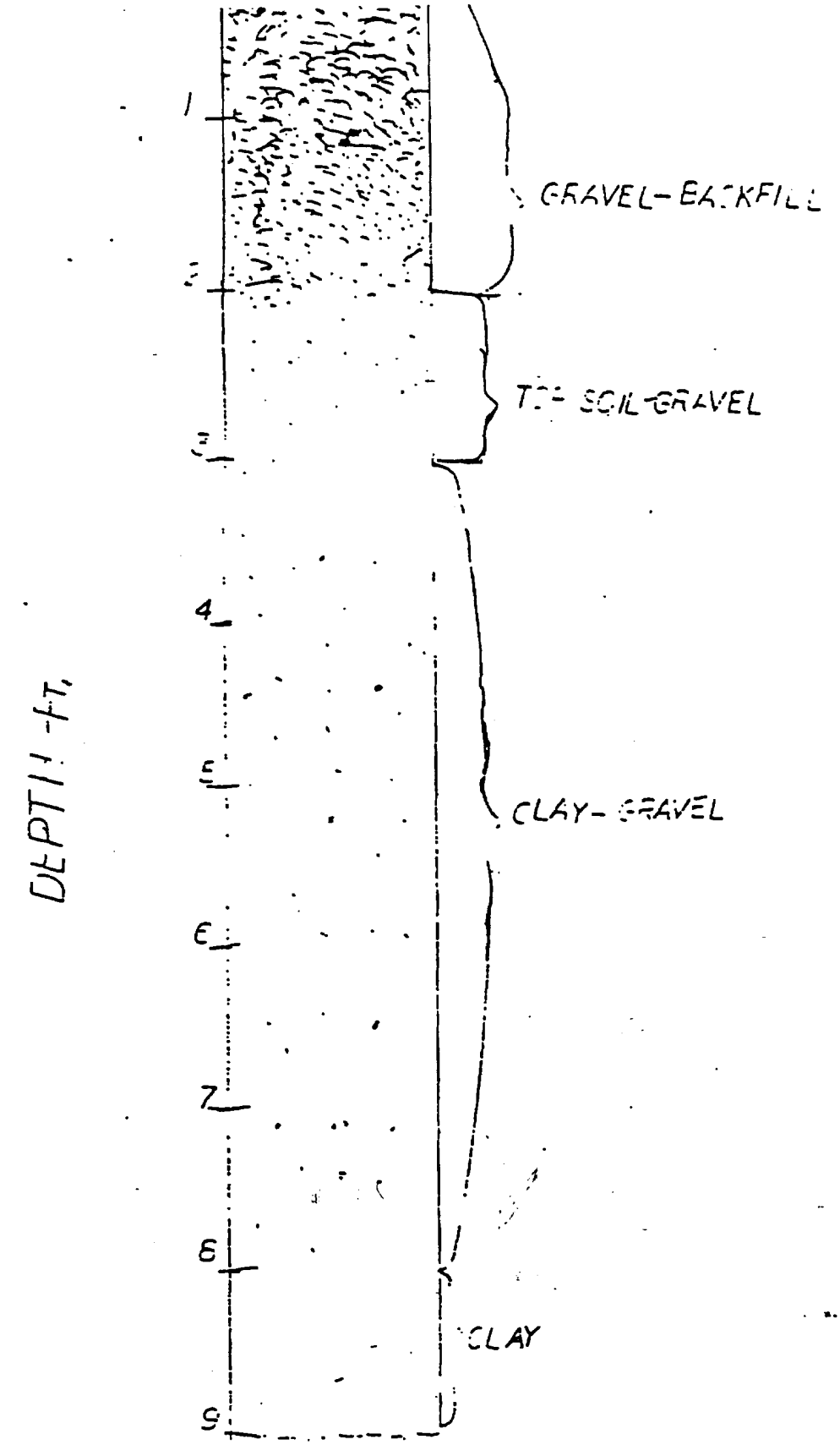
Very truly yours,

E. M. SOUCEK, DIRECTOR
ENGINEERING, MAINTENANCE AND UTILITIES

HLS:hsg/gps
5213b

Coordination:
H. M. Harvey, Jr.

FIG. 2



SOIL CHARACTERIZATION — SFILL AREA

WASTE OIL TANKS FIG. 1

LOCATED IN CONTAINMENT BUILDING

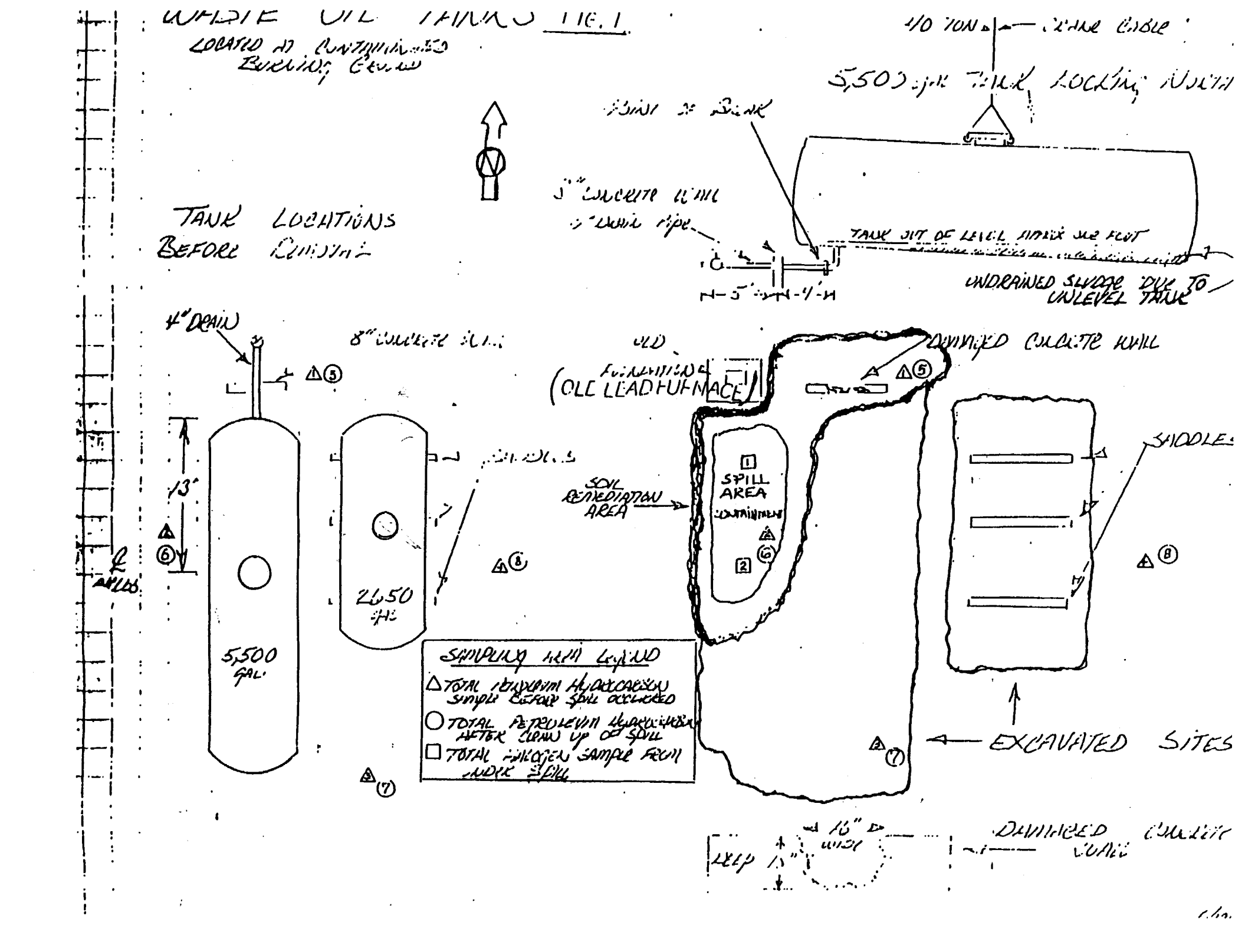


TABLE 1

CILY WASTE WATER SLUDGE ANALYSIS

SAMPLE CARD

TEST	RESULTS	
Total KPb	0.17	%
Flash Pt.	no flash @ 10.1°C	
Oil	20 - 40	%
[redacted]		
% Suspended Solids	40	%
Chromium	0.003	%

PRODUCT: Spilled Oil - UST
FORMULATION AND GRANULATION SH BATCH BOL ETC
LOT
GAI-PWO NO
BLDG NO SAMPLED
SAMPLE NO: 126936

SAMPLE QUANTITY	BY *SIGNATURE	DATE	SHIFT	TIME
PULLED PROD QC				AM PM
RELEASED FOR DELIVERY				AM PM
RECEIVED				AM PM
DELIVERED				AM PM
RECEIVED AT BLDG				AM PM

TYPE SAMPLE: ACCEPTANCE, CONTROL, GAI-PWO, SPECIAL
REQUEST FOR SPECIAL ANALYSIS
APPROVAL

MAIN LAB: Comp Chamber, H_2O, TV, M & V, RS, STABILIZER, STABILITY, AD, BULK DENSITY, PHYSICALS
RBL: MOE, CB, SBP, TALSANI, SLD, TENSILE
RANGE: FLIGHT, STATIC

OTHER TESTS/REMARKS

MEETS SPECIFICATION REQUIREMENTS: YES ☐ NO ☐

AGE CODE: 2 0 0 C 7 2
5 7 2 9 9 2
Signature: D. W. Smith

Send Results To: REL ☐ PPI ☐ OTHER ☐

ENGINEER: Mark Sullivan PHONE: 8705

COPY 1: TO LAB - IN TURN TO AGENCY NEEDING TEST RESULTS

TABLE 2

WASTE OIL TANKS — SPILL AREA — SOIL ANALYSIS

SAMPLE LOCATION	TOTAL PETROLEUM HYDROCARBON		METALS IN SOIL - AFTER CLEANUP			
	BEFORE SPILL	AFTER SPILL CLEANUP	TOTAL HALIDES	LEAD PB	CHROMIUM CR	ANTIMC SB
NORTHWEST CORNER	15% mg/Kg.	< 10 mg/Kg.				
NORTHEAST CORNER	53 mg/Kg.	20 mg/Kg.				
UNDER SPILL AREA			< 10 mg/Kg *	(TOTAL) 3200 mg/Kg 2300 mg/L *	* < 0.05 mg/L	* 0.50
SOUTHEAST CORNER	< 10 mg/Kg	< 10 mg/Kg.				
UNDER SPILL AREA			< 10 mg/Kg *	(TOTAL) 63000 mg/Kg 2900 mg/L *	* < 0.05 mg/L	* 0.50 mg
SOUTHWEST CORNER	14 mg/Kg	60 mg/Kg.				

* EXTRACTABLE'S REPORTED AS MG/L. — OTHER ANALYSIS AS MG./KG.

NOTE — ALL SOIL SAMPLE'S TAKEN ONE FT. BELOW TANK LEVEL
AFTER SPILL CLEANUP SAMPLE'S TAKEN UNDER SPILL AREA.
SEE SKETCH FOR LOCATION

CENTRAL VIRGINIA
LABORATORIES & CONSULTANTS

P.O. Box 10938 Lynchburg, Virginia 24506
OFFICE: 2418 Langhorne Road • 804-847-2852

ORiginal

June 3, 1991

HARVEY STULL
ERCULES INCORPORATED
ADFORM ARMY AMMUNITION PLANT
ALLER SERVICE 1
ADFORD VIRGINIA 24141-0299

bject: Analysis results

AMPLE IDENTIFICATION: CVLC #5382 CUSTOMER: #1

ample Collected: 05/28/91 1330 hours
ample Relinquished: date & time not given
ample Received: 05/30/91 0930 hours
ample Location: NW Corner

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	1590

AMPLE IDENTIFICATION: CLVC #5383 CUSTOMER: #1

ample Collection: 05/28/91 1330 hours
ample Relinquished: time and date not given
amp Received: 05/30/91 0930 hours
amp Location: NE Corner

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	53

AMPLE IDENTIFICATION: CLVC #5384 CUSTOMER: #2

ample Collection: 05/28/91 1330 hours
ample Relinquished: time and date not given
ample Received: 05/30/91 0930 hours
ample Location: SE Corner

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	<10

Reference Method: METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA-600/4-79-020 (Revised March 1983 Method 418.1 (Modified for soil)

CENTRAL VIRGINIA
LABORATORIES & CONSULTANTS

P.O. Box 10958 Lynchburg, Virginia 24506
OFFICE: 2418 Langhorne Road • 804-847-2832

MPLE IDENTIFICATION: CLVC #5385 CUSTOMER: #2

mple Collection: 05/28/91 1330 hours
mple Relinquished: time and date not given
mple Received: 05/30/91 0930 hours
mple Location: SW Corner

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	14

eference Method: METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA-600/4-79-020 (Revised March 1983 Method 418.1 (Modified for soil)

Sincerely,

Janet M. Zweerlitz
Laboratory Manager

Z/ n

CENTRAL VIRGINIA
LABORATORIES & CONSULTANTS
P.O. Box 10956 Lynchburg, Virginia 24506
OFFICE: 2640 Langhorne Road • 804-847-2837

June 17, 1991
Corrected June 25, 1991

MR HARVEY STULL
HERCULES INCORPORATED
RADFORD ARMY AMMUNITION PLANT
CALLER SERVICE 1
RADFORD VIRGINIA 24141-0299

Subject: Analysis Results

SAMPLE IDENTIFICATION: CVLC #5787 CUSTOMER: #1

Sample Collected: 06/06/91 time not given
Sample Relinquished: date & time not given
Sample Received: 06/07/91 1000 hours

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	<10

SAMPLE IDENTIFICATION: CLVC #5788 CUSTOMER: #2

Sample Collection: 06/06/91 time not given
Sample Relinquished: date and time not given
Sample Received: 06/07/91 1000 hours

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	20

SAMPLE IDENTIFICATION: CLVC #5789 CUSTOMER: #3

Sample Collection: 06/06/91 time not given
Sample Relinquished: date and time not given
Sample Received: 06/07/91 1000 hours

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	<10

*Reference Method: METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA-600/4-79-020 (Revised March 1983 Method 418.1 (Modified for soil)

CENTRAL VIRGINIA
LABORATORIES & CONSULTANTS
P.O. Box [illegible], Lynchburg, Virginia 24506
OFFICE: [illegible] Telephone Number [illegible]

SAMPLE IDENTIFICATION: CLVC #5790 CUSTOMER: #4

Sample Collection: 06/06/91 time not given
Sample Relinquished: date and time not given
Sample Received: 06/07/91 1000 hours

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	60

SAMPLE IDENTIFICATION: CLVC #5791 CUSTOMER: #5

Sample Collection: 06/06/91 time not given
Sample Relinquished: date and time not given
Sample Received: 06/07/91 1000 hours

ANALYSIS	RESULTS(mg/kg)
Total Halides	10
Lead, Total	3200

SW-846 Method 1311 Toxicity Characteristic Leachate Procedure

METALS : Sample Weight 45.53 grams
Extraction Solution #1

CONTAMINANT	CONCENTRATION (mg/l)	REGULATORY LEVEL (mg/l)
Antimony	0.5	NA
Chromium	<0.05	5.0
Lead	2300	5.0

*Reference Method: METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA-600/4-79-020 (Revised March 1983 Method 418.1 (Modified for soil)

NA = Not Applicable

CENTRAL VIRGINIA
LABORATORIES & CONSULTANTS
P.O. Box 10791, Lynchburg, Virginia 24506
OFFICE: 2418 Langhorne Road • 804-847-2871

SAMPLE IDENTIFICATION: CLVC #5792 CUSTOMER: #6

Sample Collection: 06/06/91 time not given
Sample Relinquished: date and time not given
Sample Received: 06/07/91 1000 hours

ANALYSIS	RESULTS(mg/kg)
Total Halides	<10
Lead, Total	63000

SW-846 Method 1311 Toxicity Characteristic Leachate Procedure

MI ,S : Sample Weight 43.18 grams
Extraction Solution #1

CONTAMINANT	CONCENTRATION (mg/l)	REGULATORY LEVEL (mg/l)
Antimony	0.5	NA
Chromium	<0.05	5.0
Lead	2900	5.0

NA = Not Applicable

Sincerely,

Janet M. Kredich
Laboratory Manager

JMK, kcm

COMMONWEALTH of VIRGINIA

STATE WATER CONTROL BOARD

Richard N. Burton
Executive Director

P. O. Box 11143
Richmond, Virginia 23230-1143
(804) 527-5000
TDD (804) 527-4261

West Central Regional Office
Brammer Village
3015-C Peters Creek Road
P. O. Box 7017
Roanoke, Virginia 24019
(703) 857-7432
FAX (703) 857-7338

September 9, 1992

Mr. E. M. Soucek
Raford Army Ammunition Plant
Radford, VA 24141-0299

RE: Initial Abatement Measures and Site Characterization Close-Out, Radford Army Ammunition Plant, Radford, Virginia, LUST PC-91-1777

Dear Mr. Soucek:

The State Water Control Board, West Central Regional staff has completed a technical review of the Site Check Report prepared by Hercules Aerospace Company.

Based on the information provided, it appears that acceptable site check measures for the suepected petroleum UST release have been achieved, and no further UST investigation is required at this time. However, the staff of West Central Regional Office will inform the Department of Waste Management (DWM) in Richmond of the subsurface contamination resulting from releases of lead, chromium, and halide at the Radford Army Ammunition Plant. We strongly advise you to immediately contact DWM regarding this problem.

Should you have questions, don't hesitate to call us at (703) 857-7432.

Sincerely,

David M. Miles

David M. Miles, CPG
Ground Water Program Manager

29-0012k

cc: Jim Smith, OECA
LUST PC-91-1777 File
Lisa Hu, WCRO.

(Swmu 76)

Printed on Recycled Paper

Radford Army Ammunition Plant
Route 114, P.O. Box 1
Radford, VA 24141
USA

September 27, 2001

Mr. Robert Thomson
U. S. Environmental Protection Agency
Region III
1650 Arch Street
Philadelphia, PA 19103-2029

Subject: Documents for SWMU 76
Radford Army Ammunition Plant,
EPA ID# VA 1 210020730

Dear Mr. Thomson:

Enclosed are copies of the following:

July 1, 1991 transmittal of information concerning a spill at SWMU 76 and subsequent cleanup to the Army.
July 17, 1991 transmittal of EPA form 7530 to the Army.
July 29, 1991 transmittal of EPA form 7530 to the VA Water Control Board.
January 23, 1992 transmittal of hazardous waste manifest to the Army.

From the above transmittals it can be documented that the USTs were removed and minor soil analysis was conducted. If we expand our WPA 12 effort to collect a data gap sample at both the FLFA and SWMU 76 we should be able to close SWMU 76 as well as FLFA.

Please coordinate with and provide any questions or comments to myself at (540) 639-8266, Jerry Redder of my staff (540) 639-7536 or Jim McKenna, ACO Staff (540) 639-8641.

Sincerely,

C. A. Jake, Environmental Manager
Alliant Ammunition and Powder Company LLC

Enclosure

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

01-815-187
JJRedder

Coordination: J McKenna

bc: Administrative File
J. McKenna, ACO Staff
J. E. Tesher, Baltimore Corps of Engineers
C. A. Jake
J. J. Redder
Env. File

01-815-187
JJRedder

HERCULES

Hercules Aerospace Company
Radford Army Ammunition Plant
Caller Service 1
Radford, VA 24141-0299

July 1, 1991

91-815-134

bc: Administrative File
J. A. Morris
H. L. Stull

Administrative Contracting Officer
Radford Army Ammunition Plant
Radford, Virginia 24141

Dear Sir:

Oily Waste Water Spill - Building 7219

Reference: SMCRA-EN Letter Dated June 12, 1991
SMCRA-EN Letter Dated June 26, 1991

On May 29, 1991 at approximately 1500 hours, a spill of oily waste water and sludge occurred while removing a 5500 gallon underground storage tank. As the tank was being lifted by a crane from its resting place (this tank was not on saddles), it tilted, putting excessive strain on the discharge elbow connection causing a 9 foot section of 4 inch drain line to break off. Approximately 250 gallons of the oily waste water sludge, which was not removed prior to the tank removal, drained out into a trench alongside the tank as the tank was being raised.

The entire spill was contained within an area 20 feet long, 3.5 feet wide and 6 inches deep. Samples were taken of the oily waste water sludge spill for laboratory analysis. The tests confirmed the spilled material is hazardous for lead and chromium.

The oily waste water sludge was removed from the containment area using a suction pump and placed in a waste oil storage tank in the solvents area for off plant treatment. The remaining material within the trench was absorbed with an absorbent compound and removed from the area using a "Gradeall". Approximately 13 cubic yards of dirt/absorbed material were removed from the area and is currently being held on a dump truck for disposal. Cleanup of the

Oily Waste Water Spill - Building 7219

area was completed by 1800 hours. Also, approximately one cubic yard of dirt was removed from in front of the tank where the original sample was taken for petroleum hydrocarbon analysis. All the material will be manifested off site as a hazardous waste.

Attached as Figures 1 and 2 are sketches of the spill area showing sampling points, along with a soil characterization of the spill area.

Samples were taken of the oily waste water, soil from one foot below the tank level (for petroleum hydrocarbon analysis prior to the spill), and soil after the cleanup had been completed (for total petroleum hydrocarbon analysis).

Analysis of the oily waste water which was spilled showed the presence of lead (Pb) and chromium (Cr). Analysis for these two metals was included on the soil samples taken from under the spill area. All samples taken after the spill was cleaned up were clear of petroleum hydrocarbon.

Attached Table 1 shows results of oily waste water sludge analysis. Attached Table 2 shows a summary of soil analysis with Central Virginia Laboratories sheets attached.

The soil samples taken from under the spill area show relatively high lead (Pb) content. Research into the history of this area revealed that a lead furnace was in operation during World War II in this area (note Figure 1). This area is part of a Solid Waste Management Unit (SWMU) which is currently under investigation by the U. S. Army Toxic and Hazardous Material Agency (USATHAMA), and designed SWMU Number 17. This work is authorized under the Resource Conversation and Recovery Act (RCRA) investigation of hazardous waste site at RAAP. Site remediation will be performed under the USATHAMA study.

Very truly yours,

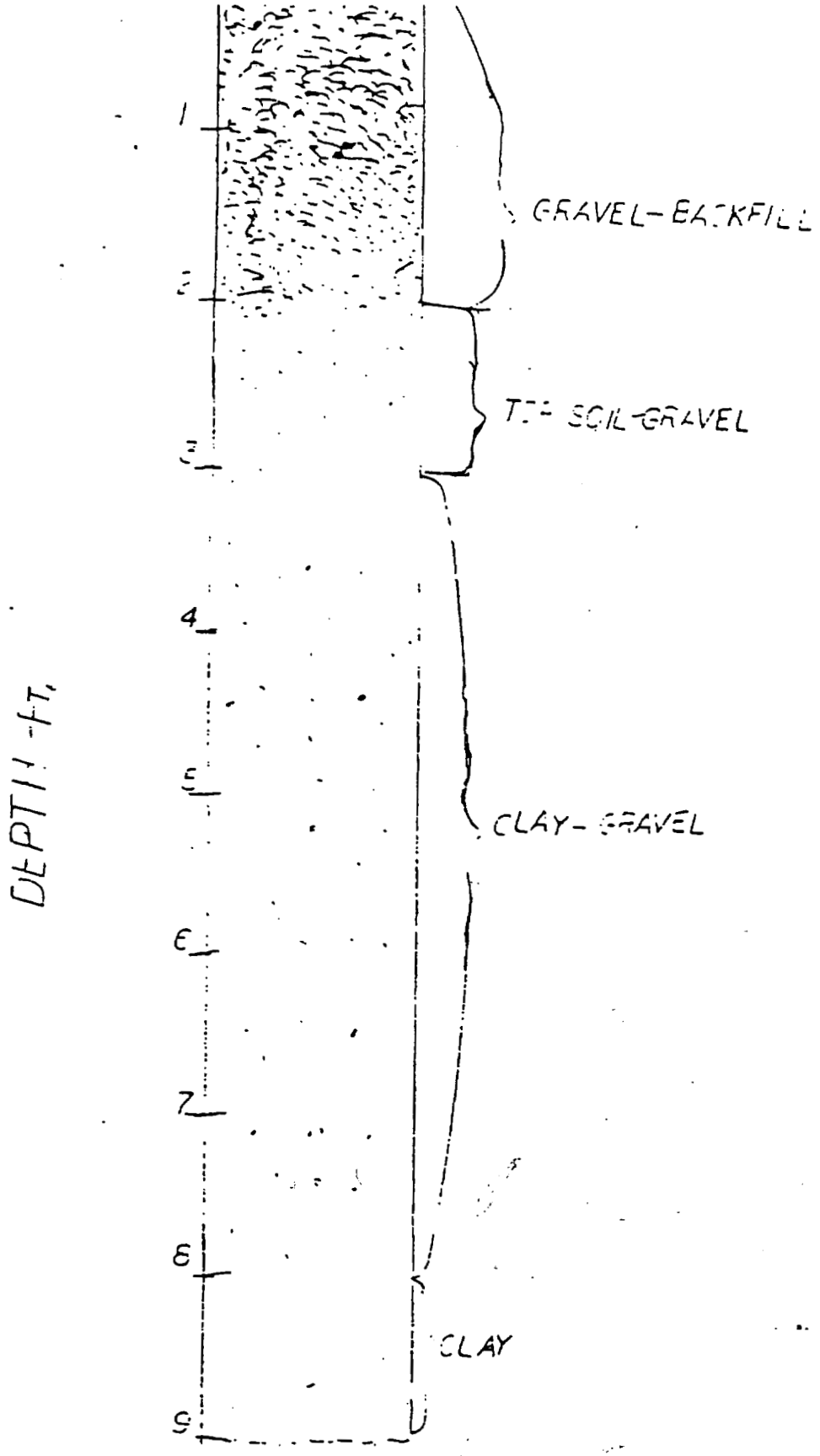
E. M. SOUCEK, DIRECTOR
ENGINEERING, MAINTENANCE AND UTILITIES

HLS:hsg/gps
5213b

Coordination:

H. M. Harvey, Jr.

FIG. 2



SOIL CHARACTERIZATION — SPILL AREA

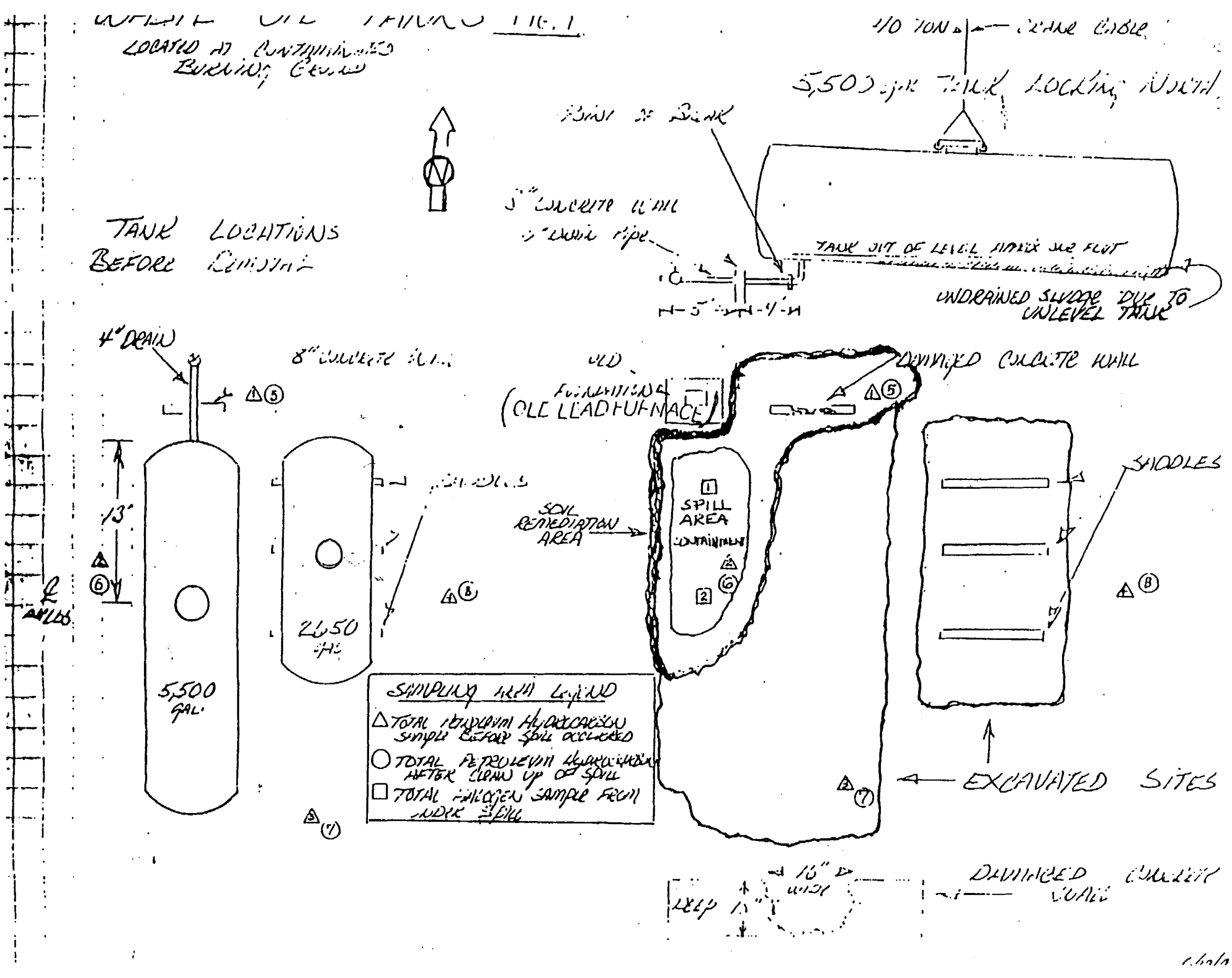

LOCATED AT CONTAMINATED BURNING GROUND
TANK LOCATIONS BEFORE REMOVAL
5,500 gal TANK LOCKING UNIT
1/2 TON
STEEL CABLE
POINT OF BANK
3" CONCRETE WALL
3" STEEL PIPE
TANK OUT OF LEVEL ALLOWS SLUDGE TO FLOAT
UNDRAINED SLUDGE DUE TO UNLEVEL TANK
4" DRAIN
8" CONCRETE WALL
OLD FOUNDATION OF OLD LEAD FURNACE
REINFORCED CONCRETE WALL
SOIL REMEDIATION AREA
SPILL AREA CONTAINMENT
SHUDDLES
13"
5,500 GAL.
2,050 GAL
SAMPLING AREA LEGEND
TOTAL PETROLEUM HYDROCARBON SAMPLE BEFORE SOIL EXCAVATED
TOTAL PETROLEUM HYDROCARBON AFTER CLEAN UP OF SPILL
TOTAL HALOGEN SAMPLE FROM UNDER SPILL
EXCAVATED SITES
16" WIDE
KEEP 1"
REINFORCED CONCRETE WALL

TABLE 1

CITY WASTE WATER SLUDGE ANALYSIS

SAMPLE CARD

TEST	RESULTS
Total [illegible]	0.17 %
Flash Pt.	no flash @ 4 to 10.1°C
Oil	20 - 40 %
[redacted]	
Total Suspended Solids	40%
Chromium	0.003 %

1 Identification: PRODUCT Spilled Oil - UST; FORMULATION AND GRANULATION; LOT; BOM ETC; QA/PWO NO; BLDG NO SAMPLED

2 SAMPLE NO: 126936; P –; L –

3 SAMPLING: SAMPLE QUANTITY; PULLED PROC O C; RELEASED FOR DELIVERY; RECEIVED; DELIVERED; RECEIVED AT BLDG; BY *SIGNATURE; DATE; SHIFT; TIME AM PM

4 TYPE SAMPLE: ACCEPTANCE; CONTROL; QA/PWO; SPECIAL

7 REQUEST FOR SPECIAL ANALYSIS; APPROVAL

5 TESTS:

MAIN LAB				HBL				RANGE	
Comp Chemical		STABILIZER		MOE		TALIANI		FLIGHT	
H_2O		STABILITY						STATIC	
TV		AD		CS		SLD			
M & V		BULK DENSITY				TENSILE			
RS		PHYSICALS		SBP		@	%F	@	%F
						@	%F		

OTHER TESTS/REMARKS

MEETS SPECIFICATION REQUIREMENTS: YES ☐ NO ☐

AGI CODE 20007

[illegible] 3-4-99

[illegible] Signature

6 Send Results To: REL ☐ PPE ☐ OTHER ☐

ENGINEER Mark Sullivan PHONE 8705

COPY 1: TO LAB - IN TURN TO AGENCY NEEDING TEST RESULTS

TABLE 2

WASTE OIL TANKS — SPILL AREA — SOIL ANALYSIS

SAMPLE LOCATION	TOTAL PETROLEUM HYDROCARBON		METALS IN SOIL — AFTER CLEANUP			
	BEFORE SPILL	AFTER SPILL CLEANUP	TOTAL HALIDES	LEAD PB	CHROMIUM CR	ANTIMONY SB
NORTHWEST CORNER	15% mg/Kg.	< 10 mg/Kg.				
NORTHEAST CORNER	53 mg/Kg.	20 mg/Kg.				
UNDER SPILL AREA			< 10 mg/Kg *	(TOTAL) 3200 mg/Kg 2300 mg/L	* < 0.05 mg/L	* 0.50 mg
SOUTHEAST CORNER	< 10 mg/Kg	< 10 mg/Kg.				
UNDER SPILL AREA			< 10 mg/Kg *	(TOTAL) 63000 mg/Kg 2900 mg/L	* < 0.05 mg/L	* 0.50 mg/
SOUTHWEST CORNER	14 mg/Kg	60 mg/Kg.				

* EXTRACTABLE'S REPORTED AS MG/L. — OTHER ANALYSIS AS MG./KG.

NOTE — ALL SOIL SAMPLE'S TAKEN ONE FT. BELOW TANK LEVEL
AFTER SPILL CLEANUP SAMPLE'S TAKEN UNDER SPILL AREA,
SEE SKETCH FOR LOCATION

CENTRAL VIRGINIA
LABORATORIES & CONSULTANTS

P.O. Box 10958 Lynchburg, Virginia 24506
OFFICE: 2418 Langhorne Road • 804-847-2852

ORiginAL

June 3, 1991

R HARVEY STULL
ERCULES INCORPORATED
ADFORM ARMY AMMUNITION PLANT
ALLER SERVICE 1
ADFORD VIRGINIA 24141-0299

Object: Analysis results

AMPLE IDENTIFICATION: CVLC #5382 CUSTOMER: #1

ample Collected: 05/28/91 1330 hours
ample Relinquished: date & time not given
ample Received: 05/30/91 0930 hours
ample Location: NW Corner

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	1590

AMPLE IDENTIFICATION: CLVC #5383 CUSTOMER: #1

ample Collection: 05/28/91 1330 hours
ample Relinquished: time and date not given
amp Received: 05/30/91 0930 hours
amp Location: NE Corner

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	53

AMPLE IDENTIFICATION: CLVC #5384 CUSTOMER: #2

ample Collection: 05/28/91 1330 hours
ample Relinquished: time and date not given
ample Received: 05/30/91 0930 hours
ample Location: SE Corner

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	<10

Reference Method: METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA-600/4-79-020 (Revised March 1983 Method 418.1 (Modified for soil)

CENTRAL VIRGINIA
LABORATORIES & CONSULTANTS

P.O. Box 10958 Lynchburg, Virginia 24506
OFFICE: 3418 Langhorne Road • 804-847-2852

MPLE IDENTIFICATION: CLVC #5385 CUSTOMER: #2

mple Collection: 05/28/91 1330 hours
mple Relinquished: time and date not given
mple Received: 05/30/91 0930 hours
mple Location: SW Corner

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	14

eference Method: METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA-600/4-79-020 (Revised March 1983. Method 418.1 (Modified for soil)

Sincerely,

Janet M. Zwetolitz
Laboratory Manager

Z/ n

CENTRAL VIRGINIA
LABORATORIES & CONSULTANTS
P.O. Box 10098 Lynchburg, Virginia 24506
OFFICE: 3616 Langhorne Road • 804-847-2851

June 17, 1991
Corrected June 25, 1991

MR HARVEY STULL
HERCULES INCORPORATED
RADFORM ARMY AMMUNITION PLANT
CALLER SERVICE 1
RADFORD VIRGINIA 24141-0299

Subject: Analysis Results

SAMPLE IDENTIFICATION: CVLC #5787 CUSTOMER: #1

Sample Collected: 06/06/91 time not given
Sample Relinquished: date & time not given
Sample Received: 06/07/91 1000 hours

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	<10

SAMPLE IDENTIFICATION: CLVC #5788 CUSTOMER: #2

Sample Collection: 06/06/91 time not given
Sample Relinquished: date and time not given
Sample Received: 06/07/91 1000 hours

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	20

SAMPLE IDENTIFICATION: CLVC #5789 CUSTOMER: #3

Sample Collection: 06/06/91 time not given
Sample Relinquished: date and time not given
Sample Received: 06/07/91 1000 hours

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	<10

*Reference Method: METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA-600/4-79-020 (Revised March 1983 Method 418.1 (Modified for soil)

CENTRAL VIRGINIA
LABORATORIES & CONSULTANTS

SAMPLE IDENTIFICATION: CLVC #5790 CUSTOMER: #4

Sample Collection: 06/06/91 time not given
Sample Relinquished: date and time not given
Sample Received: 06/07/91 1000 hours

ANALYSIS	RESULTS(mg/kg)
Total Petroleum Hydrocarbons*	60

SAMPLE IDENTIFICATION: CLVC #5791 CUSTOMER: #5

Sample Collection: 06/06/91 time not given
Sample Relinquished: date and time not given
Sample Received: 06/07/91 1000 hours

ANALYSIS	RESULTS(mg/kg)
Total Halides	10
Lead, Total	3200

SW-846 Method 1311 Toxicity Characteristic Leachate Procedure

METALS : Sample Weight 45.53 grams
Extraction Solution #1

CONTAMINANT	CONCENTRATION (mg/l)	REGULATORY LEVEL (mg/l)
Antimony	0.5	NA
Chromium	<0.05	5.0
Lead	2300	5.0

*Reference Method: METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA-600/4-79-020 (Revised March 1983 Method 418.1 (Modified for soil)

NA = Not Applicable

CENTRAL VIRGINIA
LABORATORIES & CONSULTANTS
P.O. Box 10758 Lynchburg, Virginia 24506
OFFICE: 3418 Langhorne Road • 804-847-2853

SAMPLE IDENTIFICATION: CLVC #5792 CUSTOMER: #6

Sample Collection: 06/06/91 time not given
Sample Relinquished: date and time not given
Sample Received: 06/07/91 1000 hours

ANALYSIS	RESULTS(mg/kg)
Total Halides	<10
Lead, Total	63000

SW-846 Method 1311 Toxicity Characteristic Leachate Procedure

METALS : Sample Weight 43.18 grams
Extraction Solution #1

CONTAMINANT	CONCENTRATION (mg/l)	REGULATORY LEVEL (mg/l)
Antimony	0.5	NA
Chromium	<0.05	5.0
Lead	2900	5.0

NA = Not Applicable

Sincerely,

Janet M. Kredlitz
Laboratory Manager

JMZ/kbm

HERCULES

Hercules Aerospace Company
Radford Army Ammunition Plant
Caller Service 1
Radford, VA 24141-0299

July 17, 1991

91-815-151

bc: Administrative File
D. W. Ratcliff
J. A. Morris
H. L. Stull

Administrative Contracting Officer
Radford Army Ammunition Plant
Radford, Virginia 24141

Attention SMCRA-EN

Dear Sir:

Removal of Underground Storage Tanks 7219-1 and -2

In compliance with State Water Control Board Regulation VR680-13-02, Underground Storage Tanks 7219 Number 1 and 2 have been removed.

Attached is EPA Form 7530 to be filed with the State Water Control Board along with soil analysis and a history associated with this work.

A copy of this document should also be filed with the local county building official, County of Montgomery, Mr. Wayne E. Mannon, Courthouse Room 408, Christiansburg, Virginia 24073.

Very truly yours,

E. M. SOUCEK, DIRECTOR
ENGINEERING, MAINTENANCE AND UTILITIES

HLStull:gps
5348b

Coordination:

H. M. Harvey, Jr.

Attachment

BUILDING PERMIT

1159 "ID

Montgomery County Department of Planning and Inspections
P.O. Box 806 Christiansburg, Va. 24073 Phone: 382-5750

: ermit is VOID if work is not commenced within six (6) months from the date of issuance.
A k must comply with the Code of Ordinances of Montgomery County, Virginia

PAID

ling Permit No. 1159 Date May 28, 1991
e of Owner Radford Army Ammunition Plant Address P.O. Box 1 Ph 639-8619
e of Contractor Self Address Radford, VA 24141 Ph
ate of Contrs. Regist. No.
ıe of SubContractor Address Ph
ate Contrs. Regist. No.
ıe of Architect Address Ph

LOCATION OF CONSTRUCTION:

: (2) Underground Tank Removals
S W side of St. Rd. No. 114 about miles from

ivision Section Lot No.
of lot or Acreage of land 3500 acres Magist. Dist. Prices Fork
t street foundation setback ft. Side street setback ft.
side yard ft. Right side yard ft. Rear yard ft.

l Sq. Ft. Estimated Cost: $ -
Group Classification: PERMIT FEE: $ 40.00
of Construction: Dept. Approval:
Date: 5-28-91

REQUIRED INSPECTION - STRUCTURES

FOOTERS: Inspection to be made after footers are dug, grade stakes in place, all forms and bulkheads in place and reinforcement steel in footers.

NDATION & FRAMING: Inspection to be made on Forms and Reinforcement steel in place (poured concrete foundations) Inspect Block Walls, inspect all drain tile around foundations. Framing to be inspected after the roof, all framing, fire blocking and bracing are in place.

OUGH-IN-PLUMBING: Inspection after all plumbing is installed before insulation is put in walls. All underground plumbing to be inspected before covered with concrete slab.

UGH-IN-ELECTRICAL: All wiring to be inspected before insulating walls or covering in any manner. All underground wiring (conduit etc.) to be inspected before covering.

MECHANICAL: All mechanical work (heat systems duct work etc. to be inspected before covering in any manner.

SLAB INSPECTION: All concrete slabs basement, floors, garage floors, carport floors, patios etc. Inspections will be made when all base stone is in place, reinforcement wire, and grade stakes are in place.

FINAL INSPECTION: Inspection to be made after the building is complete and before being occupied. An occupancy permit will be issued after the final inspection of the building is made.

REQUIRED INSPECTIONS - MOBILE HOMES

MOBILE HOMES: One inspection covers footers for piers, tie downs, water and sewer connections and the electrical service for the home.

DOUBLE-WIDE MOBILE HOMES: Footer Inspection - This is made on footers before moving the two halves of the home to the site. Second Inspection - This covers the Water and Sewer connections, tie downs, set-up of the home, and the electrical service for the home.

ICE. .he Owner of this Permit shall be responsible for notifying this Department for ALL inspections as required above.
A **MINIMUM** of 24 HOURS NOTICE IS REQUIRED FOR ALL INSPECTION REQUESTS.

WHITE: APPLICANTS COPY; PINK: INSPECTORS COPY; YELLOW: COMMISSIONER OF REVENUE'S COPY; GREEN: TREASURER'S COPY

i Commonwealth Press, Inc.

APPENDIX I to §280.3

Notification for Underground Storage Tanks

FORM APPROVED
OMB NO. 2050-0068
APPROVAL EXPIRES 8-30-88

I.D. Number	STATE USE ONLY
Date Received	

GENERAL INFORMATION

Notification is required by Federal law for all underground tanks that have been used to store regulated substances since January 1, 1974, that are in the ground as of May 8, 1986, or that are brought into use after May 8, 1986. The information requested is required by Section 9002 of the Resource Conservation and Recovery Act (RCRA), as amended.

The primary purpose of this notification program is to locate and evaluate underground tanks that store or have stored petroleum or hazardous substances. It is expected that the information you provide will be based on reasonably available records, or, in the absence of such records, your knowledge, belief, or recollection.

Who Must Notify? Section 9002 of RCRA, as amended, requires that, unless exempted, owners of underground tanks that store regulated substances must notify designated State or local agencies of the existence of their tanks. Owner means

(a) in the case of an underground storage tank in use on November 8, 1984, or brought into use after that date, any person who owns an underground storage tank used for the storage, use, or dispensing of regulated substances; and

(b) in the case of any underground storage tank in use before November 8, 1984, but no longer in use on that date, any person who owned such tank immediately before the discontinuation of its use.

What Tanks Are Included? Underground storage tank is defined as any one or combination of tanks that (1) is used to contain an accumulation of "regulated substances," and (2) whose volume (including connected underground piping) is 10% or more beneath the ground. Some examples are underground tanks storing: 1. gasoline, used oil, or diesel fuel, and 2. industrial solvents, pesticides, herbicides or fumigants.

What Tanks Are Excluded? Tanks removed from the ground are not subject to notification. Other tanks excluded from notification are:
1. farm or residential tanks of 1,100 gallons or less capacity used for storing motor fuel for noncommercial purposes;
2. tanks used for storing heating oil for consumptive use on the premises where stored;
3. septic tanks;
4. pipeline facilities (including gathering lines) regulated under the Natural Gas Pipeline Safety Act of 1968, or the Hazardous Liquid Pipeline Safety Act of 1979, or which is an intrastate pipeline facility regulated under State laws;
5. surface impoundments, pits, ponds, or lagoons;
6. storm water or wastewater collection systems;
7. flow-through process tanks;
8. liquid traps or associated gathering lines directly related to oil or gas production and gathering operations;
9. storage tanks situated in an underground area (such as a basement, cellar, mineworking, drift, shaft, or tunnel) if the storage tank is situated upon or above the surface of the floor.

What Substances Are Covered? The notification requirements apply to underground storage tanks that contain regulated substances. This includes any substance defined as hazardous in section 101 (14) of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), with the exception of those substances regulated as hazardous waste under Subtitle C of RCRA. It also includes petroleum, e.g., crude oil or any fraction thereof which is liquid at standard conditions of temperature and pressure (60 degrees Fahrenheit and 14.7 pounds per square inch absolute).

Where To Notify? Completed notification forms should be sent to the address given at the top of this page.

When To Notify? 1. Owners of underground storage tanks in use or that have been taken out of operation after January 1, 1974, but still in the ground, must notify by May 8, 1986. 2. Owners who bring underground storage tanks into use after May 8, 1986, must notify within 30 days of bringing the tanks into use.

Penalties: Any owner who knowingly fails to notify or submits false information shall be subject to a civil penalty not to exceed $10,000 for each tank for which notification is not given or for which false information is submitted.

INSTRUCTIONS

Please type or print in ink all items except "signature" in Section V. This form must by completed for each location containing underground storage tanks. If more than 5 tanks are owned at this location, photocopy the reverse side, and staple continuation sheets to this form.

Indicate number of continuation sheets attached: 2

I. OWNERSHIP OF TANK(S)

Owner Name (Corporation, Individual, Public Agency, or Other Entity)
Radford Army Ammunition Plant (RAAP)

Street Address
Box 1

County
Montgomery/Pulaski

City: Radford, State: VA ZIP Code: 24141

Area Code: 703 Phone Number: 639-8482

Type of Owner (Mark all that apply ☒)

- ☐ Current
- ☐ Former
- ☐ State or Local Gov't
- ☒ Federal Gov't (GSA facility I.D. no. _____)
- ☐ Private or Corporate
- ☐ Ownership uncertain

II. LOCATION OF TANK(S)

(If same as Section 1, mark box here ☐)

Facility Name or Company Site Identifier, as applicable

Street Address or State Road, as applicable

County

City (nearest) State ZIP Code

Indicate number of tanks at this location: 28

Mark box here if tank(s) are located on land within an Indian reservation or on other Indian trust lands ☐

III. CONTACT PERSON AT TANK LOCATION

Name (If same as Section I, mark box here ☐): Shelley J. Barker

Job Title: Engineer

Area Code: 703 Phone Number: 639-8482

IV. TYPE OF NOTIFICATION

☐ Mark box here only if this is an amended or subsequent notification for this location.

V. CERTIFICATION (Read and sign after completing Section VI.)

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete.

Name and official title of owner or owner's authorized representative	Signature	Date Signed

CONTINUE ON REVERSE SIDE

Owner Name (from Section I) U. S. Army Location (from Section II) Bldg. 7219 - RAAP Page No. 2 of 2 Pages

VI. DESCRIPTION OF UNDERGROUND STORAGE TANKS (Complete for each tank at this location)

Tank Identification No. (e.g., ABC-123), or Clearly Assigned Sequential Number (e.g., 1,2,3...)		Tank No. 3332	Tank No. 3432	Tank No.	Tank No.	Tank No.
1. Status of Tank (Mark all that apply ☒)	Currently in Use	☐	☐	☐	☐	☐
	Temporarily Out of Use	☐	☐	☐	☐	☐
	Permanently Out of Use	XX	XX	☐	☐	☐
	Brought into Use after 5/8/86	☐	☐	☐	☐	☐
2. Estimated Age (Years)		15	15			
3. Estimated Total Capacity (Gallons)		5000	2650			
4. Material of Construction (Mark one ☒)	Steel	XX	XX	☐	☐	☐
	Concrete	☐	☐	☐	☐	☐
	Fiberglass Reinforced Plastic	☐	☐	☐	☐	☐
	Unknown	☐	☐	☐	☐	☐
	Other, Please Specify					
5. Internal Protection (Mark all that apply ☒)	Cathodic Protection	☐	☐	☐	☐	☐
	Interior Lining (e.g., epoxy resins)	☐	☐	☐	☐	☐
	None	XX	XX	☐	☐	☐
	Unknown	☐	☐	☐	☐	☐
	Other, Please Specify					
6. External Protection (Mark all that apply ☒)	Cathodic Protection	☐	☐	☐	☐	☐
	Painted (e.g., asphaltic)	☐	☐	☐	☐	☐
	Fiberglass Reinforced Plastic Coated	☐	☐	☐	☐	☐
	None	XX	XX	☐	☐	☐
	Unknown	☐	☐	☐	☐	☐
	Other, Please Specify					
7. Piping (Mark all that apply ☒)	Bare Steel	XX	XX	☐	☐	☐
	Galvanized Steel	☐	☐	☐	☐	☐
	Fiberglass Reinforced Plastic	☐	☐	☐	☐	☐
	Cathodically Protected	☐	☐	☐	☐	☐
	Unknown	☐	☐	☐	☐	☐
	Other, Please Specify					
8. Substance Currently or Last Stored in Greatest Quantity by Volume (Mark all that apply ☒)	a. Empty	☐	☐	☐	☐	☐
	b. Petroleum					
	Diesel	☐	☐	☐	☐	☐
	Kerosene	☐	☐	☐	☐	☐
	Gasoline (including alcohol blends)	☐	☐	☐	☐	☐
	Used Oil	☐	☐	☐	☐	☐
	Other, Please Specify	Waste Oil	Waste Oil			
	c. Hazardous Substance	XX	XX	☐	☐	☐
Please Indicate Name of Principal CERCLA Substance OR Chemical Abstract Service (CAS) No.						
Mark box ☒ if tank stores a mixture of substances		☐	☐	☐	☐	☐
	d. Unknown	☐	☐	☐	☐	☐
9. Additional Information (for tanks permanently taken out of service)	a. Estimated date last used (mo./yr)	5/91	5/91	/	/	/
	b. Estimated quantity of substance remaining (gal.)	0	0			
	c. Mark box ☒ if tank was filled with inert material (e.g., sand, concrete)	☐ Removed	☐ Removed	☐	☐	☐

AO	
SF	
SS	
QA	
TM	
EN	
OR	
CA	
XC	
XO	
CO	
CAF	
CAP	

July 29, 1991

Engineering Division

Mr. Mike Weaver
Virginia Water Control Board
2111 N. Hamilton Street
P. O. Box 11143
Richmond, Virginia 23230

Dear Mr. Weaver:

Enclosed please find notification of removal of two underground storage tanks by Building 7219 (in compliance with State Water Control Board Regulation VR 680-13-02). Accompanying the EPA Form 7530, you will find pertinent data involving said removals and the related spill.

If additional information is required, please contact Mr. Rou Tucker, AC 703 639-7628.

Sincerely,

ORIGINAL SIGNED BY

Joe D. Wilson
Chief Engineer

Enclosure

Copies Furnished (w/encl):

Mr. David Miles, State Water Control Board, P. O. Box 7017, Roanoke, VA 24019
Mr. Wayne Mannon, Courthouse Room 408, Christiansburg, VA 24073

BUILDING PERMIT

1159

Montgomery County Department of Planning and Inspections
P.O. Box 806 Christiansburg, Va. 24073 Phone: 382-5750

le: This Permit is VOID if work is not commenced within six (6) months from the date of issuance.
ork must comply with the Code of Ordinances of Montgomery County, Virginia

PAID

lding Permit No. 1159 Date May 28, 1991
me of Owner Radford Army Ammunition Plant Address P.O. Box 1 Ph 639-8619
me of Contractor Self Address Radford, VA 24141 Ph
State of Contrs. Regist. No.
me of SubContractor Address Ph
State Contrs. Regist. No.
me of Architect Address Ph

LOCATION OF CONSTRUCTION:

E: (2) Underground Tank Removals
E S W side of St. Rd. No. 114 about miles from

odivision Section Lot No.
e of lot or Acreage of land 3500 acres Magist. Dist. Prices Fork
nt street foundation setback ft. Side street setback ft.
t side yard ft. Right side yard ft. Rear yard ft.

al Sq. Ft. Estimated Cost: $ -
e Group Classification: PERMIT FEE: $ 40.00
e of Construction: Dept. Approval:
Date: 5-28-91

REQUIRED INSPECTION - STRUCTURES

FOOTERS: Inspection to be made after footers are dug, grade stakes in place, all forms and bulkheads in place and reinforcement steel in footers.

OUNDATION & FRAMING: Inspection to be made on Forms and Reinforcement steel in place (poured concrete foundations) Inspect Block Walls, inspect all drain tile around foundations. Framing to be inspected after the roof, all framing, fire blocking and bracing are in place.

ROUGH-IN-PLUMBING: Inspection after all plumbing is installed before insulation is put in walls. All underground plumbing to be inspected before covered with concrete slab.

ROUGH-IN-ELECTRICAL: All wiring to be inspected before insulating walls or covering in any manner. All underground wiring (conduit etc.) to be inspected before covering.

MECHANICAL: All mechanical work (heat systems duct work etc. to be inspected before covering in any manner.

SLAB INSPECTION: All concrete slabs basement, floors, garage floors, carport floors, patios etc. Inspections will be made when all base stone is in place, reinforcement wire, and grade stakes are in place.

FINAL INSPECTION: Inspection to be made after the building is complete and before being occupied. An occupancy permit will be issued after the final inspection of the building is made.

REQUIRED INSPECTIONS - MOBILE HOMES

MOBILE HOMES: One inspection covers footers for piers, tie downs, water and sewer connections and the electrical service for the home.

DOUBLE-WIDE MOBILE HOMES: Footer Inspection - This is made on footers before moving the two halves of the home to the site.
Second Inspection - This covers the Water and Sewer connections, tie downs, set-up of the home, and the electrical service for the home.

OTI The Owner of this Permit shall be responsible for notifying this Department for ALL inspections as required above.
A **MINIMUM** of **24 HOURS NOTICE** IS REQUIRED FOR ALL INSPECTION REQUESTS.

WHITE: APPLICANTS COPY; PINK: INSPECTORS COPY; YELLOW: COMMISSIONER OF REVENUE'S COPY; GREEN: TREASURER'S COPY

1075 Commonwealth Press, Inc.

APPENDIX I to §280.3

Notification for Underground Storage Tanks

FORM APPROVED OMB NO. 2050-0068 APPROVAL EXPIRES 8-31-88

I.D. Number | STATE USE ONLY

Date Received

GENERAL INFORMATION

Notification is required by Federal law for all underground tanks that have been used to store regulated substances since January 1, 1974, that are in the ground as of May 8, 1986, or that are brought into use after May 8, 1986. The information requested is required by Section 9002 of the Resource Conservation and Recovery Act (RCRA), as amended.

The primary purpose of this notification program is to locate and evaluate underground tanks that store or have stored petroleum or hazardous substances. It is expected that the information you provide will be based on reasonably available records, or, in the absence of such records, your knowledge, belief, or recollection.

Who Must Notify? Section 9002 of RCRA, as amended, requires that, unless exempted, owners of underground tanks that store regulated substances must notify designated State or local agencies of the existence of their tanks. Owner means

(a) in the case of an underground storage tank in use on November 8, 1984, or brought into use after that date, any person who owns an underground storage tank used for the storage, use, or dispensing of regulated substances; and

(b) in the case of any underground storage tank in use before November 8, 1984, but no longer in use on that date, any person who owned such tank immediately before the discontinuation of its use.

What Tanks Are Included? Underground storage tank is defined as any one or combination of tanks that (1) is used to contain an accumulation of "regulated substances," and (2) whose volume (including connected underground piping) is 10% or more beneath the ground. Some examples are underground tanks storing: 1. gasoline, used oil, or diesel fuel; and 2. industrial solvents, pesticides, herbicides or fumigants.

What Tanks Are Excluded? Tanks removed from the ground are not subject to notification. Other tanks excluded from notification are:

1. farm or residential tanks of 1,100 gallons or less capacity used for storing motor fuel for noncommercial purposes;
2. tanks used for storing heating oil for consumptive use on the premises where stored;
3. septic tanks;
4. pipeline facilities (including gathering lines) regulated under the Natural Gas Pipeline Safety Act of 1968, or the Hazardous Liquid Pipeline Safety Act of 1979, or which is an intrastate pipeline facility regulated under State laws;
5. surface impoundments, pits, ponds, or lagoons;
6. storm water or wastewater collection systems;
7. flow-through process tanks;
8. liquid traps or associated gathering lines directly related to oil or gas production and gathering operations;
9. storage tanks situated in an underground area (such as a basement, cellar, mineworking, drift, shaft, or tunnel) if the storage tank is situated upon or above the surface of the floor.

What Substances Are Covered? The notification requirements apply to underground storage tanks that contain regulated substances. This includes any substance defined as hazardous in section 101 (14) of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), with the exception of those substances regulated as hazardous waste under Subtitle C of RCRA. It also includes petroleum, e.g., crude oil or any fraction thereof which is liquid at standard conditions of temperature and pressure (60 degrees Fahrenheit and 14.7 pounds per square inch absolute).

Where To Notify? Completed notification forms should be sent to the address given at the top of this page.

When To Notify? 1. Owners of underground storage tanks in use or that have been taken out of operation after January 1, 1974, but still in the ground, must notify by May 8, 1986. 2. Owners who bring underground storage tanks into use after May 8, 1986, must notify within 30 days of bringing the tanks into use.

Penalties: Any owner who knowingly fails to notify or submits false information shall be subject to a civil penalty not to exceed $10,000 for each tank for which notification is not given or for which false information is submitted.

INSTRUCTIONS

Please type or print in ink all items except "signature" in Section V. This form must by completed for each location containing underground storage tanks. If more than 5 tanks are owned at this location, photocopy the reverse side, and staple continuation sheets to this form.

Indicate number of continuation sheets attached: 2

I. OWNERSHIP OF TANK(S)

Owner Name (Corporation, Individual, Public Agency, or Other Entity)
Radford Army Ammunition Plant (RAAP)

Street Address
Box 1

County
Montgomery/Pulaski

City: Radford, | State: VA | ZIP Code: 24141

Area Code: 703 | Phone Number: 639-8482

Type of Owner (Mark all that apply ☒)

- ☐ Current
- ☐ Former
- ☐ State or Local Gov't
- ☒ Federal Gov't (GSA facility I.D. no. _____)
- ☐ Private or Corporate
- ☐ Ownership uncertain

II. LOCATION OF TANK(S)

(If same as Section 1, mark box here ☐)

Facility Name or Company Site Identifier, as applicable

Street Address or State Road, as applicable

County

City (nearest) | State | ZIP Code

Indicate number of tanks at this location: 28

Mark box here if tank(s) are located on land within an Indian reservation or on other Indian trust lands ☐

III. CONTACT PERSON AT TANK LOCATION

Name (If same as Section I, mark box here ☐) | Job Title | Area Code | Phone Number

Shelley J. Barker | Engineer | 703 | 639-8482

IV. TYPE OF NOTIFICATION

☐ Mark box here only if this is an amended or subsequent notification for this location.

V. CERTIFICATION (Read and sign after completing Section VI.)

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete.

Name and official title of owner or owner's authorized representative: Karl I. Gohlke, CPT, CO, Acting Commander | Signature: Karl I. Gohlke | Date Signed: July 29, 1991

CONTINUE ON REVERSE SIDE

Owner Name (from Section I) U. S. Army Location (from Section II) Bldg. 7219 - RAAP Page No. 2 of 2 Pages

VI. DESCRIPTION OF UNDERGROUND STORAGE TANKS (Complete for each tank at this location.)

Tank Identification No. (e.g., ABC-123), or Sequentially Assigned Sequential Number (e.g., 1,2,3...)	Tank No. 5332	Tank No. 5432	Tank No.	Tank No.	Tank No.
1. Status of Tank (Mark all that apply ☒) — Currently in Use	☐	☐	☐	☐	☐
Temporarily Out of Use	☐	☐	☐	☐	☐
Permanently Out of Use	XX	XX	☐	☐	☐
Brought into Use after 5/8/86	☐	☐	☐	☐	☐
2. Estimated Age (Years)	15	15			
3. Estimated Total Capacity (Gallons)	5000	2650			
4. Material of Construction (Mark one ☒) — Steel	XX	XX	☐	☐	☐
Concrete	☐	☐	☐	☐	☐
Fiberglass Reinforced Plastic	☐	☐	☐	☐	☐
Unknown	☐	☐	☐	☐	☐
Other, Please Specify					
5. Internal Protection (Mark all that apply ☒) — Cathodic Protection	☐	☐	☐	☐	☐
Interior Lining (e.g., epoxy resins)	☐	☐	☐	☐	☐
None	XX	XX	☐	☐	☐
Unknown	☐	☐	☐	☐	☐
Other, Please Specify					
6. External Protection (Mark all that apply ☒) — Cathodic Protection	☐	☐	☐	☐	☐
Painted (e.g., asphaltic)	☐	☐	☐	☐	☐
Fiberglass Reinforced Plastic Coated	☐	☐	☐	☐	☐
None	XX	XX	☐	☐	☐
Unknown	☐	☐	☐	☐	☐
Other, Please Specify					
7. Piping (Mark all that apply ☒) — Bare Steel	XX	XX	☐	☐	☐
Galvanized Steel	☐	☐	☐	☐	☐
Fiberglass Reinforced Plastic	☐	☐	☐	☐	☐
Cathodically Protected	☐	☐	☐	☐	☐
Unknown	☐	☐	☐	☐	☐
Other, Please Specify					
8. Substance Currently or Last Stored in Greatest Quantity by Volume (Mark all that apply ☒) — a. Empty	☐	☐	☐	☐	☐
b. Petroleum — Diesel	☐	☐	☐	☐	☐
Kerosene	☐	☐	☐	☐	☐
Gasoline (including alcohol blends)	☐	☐	☐	☐	☐
Used Oil	☐	☐	☐	☐	☐
Other, Please Specify	Waste Oil	Waste Oil			
c. Hazardous Substance	XX	XX	☐	☐	☐
Please Indicate Name of Principal CERCLA Substance OR Chemical Abstract Service (CAS) No.					
Mark box ☒ if tank stores a mixture of substances	☐	☐	☐	☐	☐
d. Unknown	☐	☐	☐	☐	☐
9. Additional Information (for tanks permanently taken out of service) — a. Estimated date last used (mo./yr)	5/91	5/91	/	/	/
b. Estimated quantity of substance remaining (gal.)	0	0			
c. Mark box ☒ if tank was filled with inert material (e.g., sand, concrete)	☐ Removed	☐ Removed	☐	☐	☐

HERCULES

Hercules Aerospace Company
Radford Army Ammunition Plant
P.O. Box 1
Radford, VA 24141-0100

January 23, 1992

92-815-18

bc: Administrative File
D. W. Ratcliff
J. A. Morris
C. A. Jake
H. L. Stull

Administrative Contracting Officer
Radford Army Ammunition Plant
Radford, Virginia 24141

Attention SMCRA-EN

Dear Sir:

Removal of Underground Storage Tank 7219-1 & -2
Site Closure

Reference: Closure Notice of July 17, 1991

Enclosed for your inspection and transmittal to the Virginia State Water Control Board, Roanoke, Virginia, attention Mr. Ray Wirt, you will find the Hazardous Waste Manifest covering the disposition of soil contaminated with lead and petroleum from the spill which occurred while removing the U.S.T. at Building 7219-1 and -2.

A copy of this document should also be filed with the local county building official, County of Montgomery, Mr. Wayne E. Mannon, Court House Room 408, Christiansburg, Virginia 24073.

Very truly yours,

E. M. SOUCEK, DIRECTOR
ENGINEERING, MAINTENANCE AND UTILITIES

HLS:gps
1600q

Coordination:

H. M. Harvey, Jr.

Attachment

OF NATURAL RESOURCES | ATT. ☐ DIS ☐ REJ. ☐ PR ☐

Please print or type

Form Approved OMB No 2050-0039 Expires 9-30-91

UNIFORM HAZARDOUS WASTE MANIFEST

1 Generator's US EPA ID No: V A 1 1 2 1 0 0 2 0 7 3 0 | Manifest Document No: 0 0 7 3 8 6

2 Page 1 of 1 | Information in the shaded areas is not required by Federal law.

3 Generator's Name and Mailing Address
HERCULES INCORPORATED
RADFORD ARMY AMMUNITION PLANT
P.O. BOX 1 (ROUTE 114)
RADFORD, VA 24141-0100
ATTN: MARK C. ALDERMAN

A State Manifest Document Number: MI 2235436

B. State Generator's ID: SAME

4 Generator's Phone: (703) 639-7529

5 Transporter 1 Company Name: DART TRUCKING COMPANY

6 US EPA ID Number: O H D 0 0 9 8 6 5 8 2 5

C. State Transporter's ID: OHD009865825

D. Transporter's Phone: (216) 533-9841

7 Transporter 2 Company Name:

8 US EPA ID Number:

E. State Transporter's ID:

F. Transporter's Phone:

9 Designated Facility Name and Site Address
MICHIGAN DISPOSAL, INC.
49350 N. I-94 SERVICE DRIVE
BELLEVILLE, MI 48111

10 US EPA ID Number: M I D 0 0 0 7 2 4 8 3 1

G. State Facility's ID: MID000724831

H. Facility's Phone: (313) 699-7120

	11 US DOT Description (including Proper Shipping Name, Hazard Class, and ID NUMBER) HM		12 Containers No	Type	13 Total Quantity	14 Unit Wt/Vol	I. Waste No.	NH
a	X	HAZARDOUS WASTE, SOLID, N.O.S. (SOIL CONTAMINATED WITH LEAD & PETROLIUM) ORM-E NA 9189	0 1 0 1 1	BOT	0 0 1 4 1/2	Y	D 0 0 8	H
b								
c								
d								

J. Additional Descriptions for Materials Listed Above
(A). S,T 100%
EMERGENCY RESPONSE CONTACT R.W. SWINEY (804) 539-0005
EMERGENCY RESPONSE GUIDEBOOK # 31

K. Handling Codes for Wastes Listed Above: a/ / b/ / c/ / d/ /

15. Special Handling Instructions and Additional Information
TRANSPORTERS VA STATE ID # OHD0098658257 a. 43,980 Lbs.

16. GENERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled and are in all respects in proper condition for transport by highway according to applicable international and national government regulations.

If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment; OR, if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.

Printed/Typed Name: HERCULES INCORPORATED BY: H. R. BLANKENSHIP | Signature | Date: Month Day Year 1 1 1 0 9 1

17 Transporter 1 Acknowledgement of Receipt of Materials

Printed/Typed Name: Rick Showers | Signature | Date: Month Day Year 1 1 1 1 9 1

18 Transporter 2 Acknowledgement of Receipt of Materials

Printed/Typed Name | Signature | Date: Month Day Year

19 Discrepancy Indication Space
6757

20. Facility Owner or Operator Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19

Printed/Typed Name: Thomas Box | Signature | Date: Month Day Year 1 1 2 0 9 1

EPA Form 8700-22 (Rev. 9/88) PR 5110 Rev. 4/90

GENERATOR — TRANSPORTER — FACILITY

MICHIGAN AT 1 800 292-4706 OR OUT OF STATE AT 517 373 7660 AND THE NATIONAL RES

ILLS MUST BE REPORTED TO THE MICHIGAN POLLUTION EMERGENCY ALERTING S
C. ZA AT 1 800 424 8802 24 HOURS PER DAY