

REVISED FINAL

PHASE II RCRA FACILITY INVESTIGATION  
REPORT FOR 16 SOLID WASTE MANAGEMENT UNITS

AT

FORT STEWART, GEORGIA  
VOLUME I OF III

REGULATORY AUTHORITY  
RESOURCE CONSERVATION AND RECOVERY ACT  
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The undersigned certifies that I am a qualified groundwater scientist who has received a baccalaureate or postgraduate degree in the natural sciences or engineering and have sufficient training and experience in groundwater hydrology and related fields, as demonstrated by state registration and completion of accredited university courses, to enable me to make sound professional judgments regarding groundwater monitoring and contaminant fate and transport. I further certify that this report was prepared by myself or a subordinate working under my direction.

  
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## ACRONYMS

ADA	Air Defense Artillery
ADD	average daily dose
amsl	above mean sea level
ARAR	applicable or relevant and appropriate requirement
Army	U.S. Army
AST	aboveground storage tank
ASTM	American Society for Testing and Materials
AT123D	Analytical Transient 1-, 2-, 3-Dimensional
AUF	area use factor
AWQC	Ambient Water Quality Criteria
BAF	bioaccumulation factor
BCF	bioconcentration factor
bgs	below ground surface
BHC	benzene hexachloride
BN	battalion
BTEX	benzene, toluene, ethylbenzene, and xylenes
CAP	Corrective Action Plan
CB	chemical/biological
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMCOC	contaminant migration chemical of concern
CMCOPC	contaminant migration constituent of potential concern
COC	contaminant of concern
COPC	contaminant of potential concern
CSM	Conceptual Site Model
DAF	dilution attenuation factor
DEH	Directorate of Engineering and Housing
DF	dilution factor
DO	dissolved oxygen
DOL	Directorate of Logistics
DPT	direct-push technology
DPW	Directorate of Public Works
DQO	data quality objective
DRMO	Defense Reutilization and Marketing Organization
ECOPC	ecological contaminant of potential concern
EOD	Explosive Ordnance Disposal
EPA	U.S. Environmental Protection Agency
EPRE	ecological preliminary risk evaluation
EP Tox	Extraction Procedure Toxicity
ERA	Ecological Risk Assessment
ESV	ecological screening value
FR	<u>Federal Register</u>
FSMR	Fort Stewart Military Reservation
GAF	gastrointestinal absorption factor
GEPD	Georgia Environmental Protection Division
GSSL	generic soil screening level
HAZWRAP	Hazardous Waste Remedial Actions Program
HELP	Hydrologic Evaluation of Landfill Performance

## ACRONYMS (continued)

HHCOC	human health chemical of concern
HHCOPC	human health contaminant of potential concern
HHPRE	human health preliminary risk evaluation
HI	hazard index
HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HQ	hazard quotient
IDW	investigation-derived waste
IEUBK	Integrated Exposure Uptake Biokinetic
ILCR	incremental lifetime cancer risk
IRA	Interim Removal Action
IWTP	Industrial Wastewater Treatment Plant
LAS	Land Application System
LOAEL	lowest observed adverse effect level
MCL	maximum contaminant level
MOGAS	motor gasoline
NFA	no further action
NGTC	National Guard Training Center
NGVD	National Geodetic Vertical Datum
NOAEL	no observed adverse effect level
NPDES	National Pollutant Discharge Elimination System
NTU	nephelometric turbidity unit
OB	open burn
OD	open detonation
ODAST	One-dimensional Analytical Solute Transport
OWS	oil/water separator
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PETN	pentaerythrite tetranitrate
PID	photoionization detector
POL	petroleum, oil, and lubricants
POTW	publicly owned treatment works
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
QCSR	Quality Control Summary Report
RBC	risk-based concentration
RBCA	Risk-based Corrective Action
RCRA	Resource Conservation and Recovery Act
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
Redox	oxidation-reduction
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
SAIC	Science Applications International Corporation
SAP	Sampling and Analysis Plan
SDWA	Safe Drinking Water Act
SESOIL	Seasonal Soil Compartment Model
SMCL	secondary maximum contaminant level

## ACRONYMS (continued)

SPT BN	Support Battalion
SRC	site-related contaminant
SSL	soil screening level
SQB	sediment quality benchmark
SVOC	semivolatile organic compound
SWMU	Solid Waste Management Unit
TAC	Tactical Air Command
TC	toxicity characteristic
TCLP	Toxicity Characteristic Leaching Procedure
TDS	total dissolved solids
TEF	toxicity equivalence factor
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TRPH	total recoverable petroleum hydrocarbons
TRV	toxicity reference value
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
UST	underground storage tank
UXO	unexploded ordnance
VOC	volatile organic compound
WQS	water quality standard

## EXECUTIVE SUMMARY

This report summarizes the results of the Phase II Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) for the 16 Solid Waste Management Units (SWMUs) at Fort Stewart, Georgia. The 16 SWMUs include: Camp Oliver Landfill, SWMU 2; TAC-X Landfill, SWMU 3; Inactive EOD Area in Red Cloud Range, Hotel Area, SWMU 9; Inactive EOD Area North of Garrison Area, SWMU 10; Inactive EOD Area Located Approximately Three Miles Northeast of Garrison Area, SWMU 11; Active EOD Containing Open Detonation Unit and Open Burn Unit, SWMU 12A; Old Fire Training Area, SWMU 14; DRMO Hazardous Waste Storage Area, SWMU 17; Industrial Wastewater Treatment Plant, SWMU 18; Old Sludge Drying Beds, SWMU 19; Old Radiator Shop/Paint Booth, SWMU 24B; Motorpools, SWMUs 27A through 27V; Evans Army Helicopter POL Storage Facility, SWMU 29; DEH Asphalt Tanks, SWMU 31; Supply Diesel Tank, SWMU 32; DEH Equipment Wash Rack, SWMU 34; and NGTC Equalization Basin, SWMU 37. Four of the 16 sites—Old Sludge Drying Beds, SWMU 19; Old Radiator Shop/Paint Booth, SWMU 24B; Motorpools, SWMUs 27A through 27V; and NGTC Equalization Basin, SWMU 37—had not been investigated previously and were investigated as Phase I RFIs. This report has been prepared by Science Applications International Corporation (SAIC) for the U.S. Army Corps of Engineers (USACE), Savannah District, under Contract DACA21-95-D-0022, Delivery Order No. 0009. The RFI was conducted in accordance with USACE Guidance EM 200-1-3 and the Georgia Environmental Protection Division (GEPD)-approved Sampling and Analysis Plan (SAP) (SAIC 1997).

The 16 SWMUs investigation consisted of 38 SWMU sites (including 22 motorpool sites) as designated under Hazardous Waste Permit HW-045. The sites were divided into 45 distinct geographic areas for investigation. Seven (SWMUs 2, 3, 9, 10, 11, 12A, and 29) of the 38 SWMUs are located outside the garrison area. The remaining 31 (SWMUs 14, 17, 18, 19, 24B, 27A through 27V, 31, 32, 34, and 37) are located within the garrison area.

### OBJECTIVES AND SCOPE OF THE INVESTIGATION

The specific objectives of the Phase I and Phase II RFIs for the 16 SWMUs at Fort Stewart, Georgia, as defined in the Phase II RFI SAP (SAIC 1997) (approved by the GEPD in October 1997) are listed below.

#### *Phase I RFI*

- Determine if contamination of the environment has occurred.
- Determine whether contaminants, if present, constitute a threat to human health or the environment.
- Determine the need for future action and/or no further action (NFA).

#### *Phase II RFI*

- Determine the horizontal and vertical extent of contamination.
- Determine whether contaminants present a threat to human health or the environment.

- Determine the need for future action and/or NFA.
- Gather data necessary to support a Corrective Action Plan (CAP), if warranted.

The information provided in this report is based upon data collected previously during the Phase I RFI (if available) and data collected as part of the Phase II field sampling and analysis. At some of the sites, the Phase II sampling program incorporated an observational approach to sampling, as defined in the Phase II RFI SAP (SAIC 1997). This observational approach used field screening techniques to determine the horizontal and vertical extent of contamination at the SWMU and to identify suitable locations for installation of permanent monitoring wells. The scope of the fieldwork for the Phase I and Phase II sites included the activities listed below.

### ***Phase I Sites***

- Collection of direct-push soil samples using a push probe.
- Collection of direct-push groundwater samples using a push probe.
- Installation of permanent groundwater monitoring points or monitoring wells to confirm the nature of potential contamination at a specific push-probe location.
- Collection of surface water and sediment samples at SWMUs at which surface water and sediment were available.
- Surveying of the positions of all sample locations.

### ***Phase II Sites***

- Collection of direct-push soil samples using a push probe.
- Collection of direct-push groundwater samples using a push probe, including vertical-profile probes.
- Installation of permanent groundwater monitoring wells both upgradient and downgradient of the site.
- Groundwater sampling at existing monitoring wells (if available) and sampling of newly installed wells around the SWMUs.
- Collection of surface water and sediment samples at SWMUs at which surface water and sediment were available.
- Surveying of the positions of all sample locations.

### **Nature and Extent of Contamination**

Site-related contaminants (SRCs) were identified for each site by comparing the analytical results obtained from soil, groundwater, surface water, and sediment against the reference background criteria. Contaminants with concentrations above the reference background criteria were identified as SRCs. The results of the chemical analyses on surface soil, subsurface soil, and groundwater were screened against the reference

background criteria for the Fort Stewart Military Reservation. Surface water and sediment were screened against site-specific background criteria.

In general, reference background samples were collected from each medium at locations upgradient or upstream of each site so as to be representative of naturally occurring conditions at sites under investigation. Upgradient or upstream samples were not collected at sites under a Phase I RFI (i.e., SWMUs 19, 24B, 27A through 27V and 37). The reference background concentrations for surface soil, subsurface soil, and groundwater were calculated as two times the average concentration of all of the locations selected to be in the background data set. If a chemical was not detected at a site, then one-half the detection limit was used as the concentration when calculating the reference mean background concentration. Surface water and sediment background samples were collected during the Phase II RFI and applied to the SWMUs on a site-specific basis.

Inorganics were considered to be SRCs if their concentrations were above the reference background concentrations, while organics were considered SRCs if they were simply detected because organic constituents are considered to potentially be man-made. SRCs from the nature and extent of contamination evaluation were further evaluated as potential concerns based upon fate and transport characteristics and upon their potential risk to human health and ecological receptors. A summary of SRCs by medium for each SWMU is presented in Table ES-1.

#### **Fate and Transport Analysis**

Fate and transport analysis was performed on each SWMU. This analysis included developing a site-specific Conceptual Site Model (CSM) identifying potential contaminant release and migration pathways and determining the potential for SRCs in surface soil, subsurface soil, and/or sediment to migrate to groundwater.

The maximum concentrations of the SRCs determined from nature and extent analysis were compared to U.S. Environmental Protection Agency (EPA) Generic Soil Screening Levels (GSSLs). Generally, if contaminant concentrations in soil fall below the GSSLs and there are no significant ecological receptors of concern, then no further study or action is warranted. SRCs were identified as contaminant migration constituents of potential concern (CMCOPCs) if they were detected at concentrations that exceeded their respective GSSLs. To evaluate leaching of CMCOPCs from soil to groundwater at the 16 SWMUs, groundwater concentrations of CMCOPCs were compared to maximum contaminant levels (MCLs). If an MCL for a chemical was not available, the groundwater concentration was compared to the risk-based concentration, as established by EPA Region III (EPA 1999b). A summary of the results of the fate and transport analysis (CMCOPCs) is presented in Table ES-2.

A weight-of-evidence approach was used to evaluate each CMCOPC identified based on leaching to groundwater. In some instances, the potential impact of CMCOPCs to groundwater, and possibly to surface water, was evaluated (modeled concentrations were compared to risk-based criteria) in a human health baseline risk assessment. CMCOPCs that indicated a potential risk to human health (i.e., that exceeded risk-based screening criteria) from modeling were identified as contaminant migration chemicals of concern, and remedial levels were developed based on protection of groundwater. SWMUs for which a human health baseline risk assessment was performed are identified in Table ES-2.

#### **Human Health Preliminary Risk Evaluation**

A human health preliminary risk evaluation (HHPRE) using a Step i risk evaluation approach based on guidance from GEPA was performed for each SWMU to determine the potential human health risks associated with the maximum concentrations of identified SRCs. The Step i risk evaluation involves the components listed below.

- For inorganics, compare detected concentrations to naturally occurring background levels to determine if detected inorganics are naturally occurring or are associated with past activities at the site.
- Identify potential migration and exposure pathways associated with the site and identify potential exposure scenarios to determine appropriate action levels.
- Identify available risk-based action levels for each contaminant detected above background levels or develop levels if they do not exist.
- Compare sample concentrations to action levels to determine if site conditions warrant further evaluation.

Chemicals that exceeded action levels were identified as human health contaminants of potential concern (HHCOPCs). A summary of the HHPRE results (HHCOPCs) is presented in Table ES-2.

A weight-of-evidence approach was used to evaluate each HHCOPC identified in the preliminary risk assessment. In some instances, HHCOPCs were evaluated further in a human health baseline risk assessment. HHCOPCs and/or CMCOPCs (see previous section) that either had hazard indices of 0.1 or incremental lifetime cancer risks of  $1 \times 10^{-6}$  were identified as human health contaminants of concern. Remedial levels were developed that were protective of the most sensitive receptor population, based on a minimum risk level of 3.0 for the total hazard index and  $1 \times 10^{-4}$  for the total incremental lifetime cancer risk. SWMUs for which a human health baseline risk assessment was performed are identified in Table ES-2.

### Ecological Preliminary Risk Evaluation

An ecological preliminary risk evaluation (EPRE) based on guidance from GEPD was performed to determine the potential risk to ecological receptors associated with the maximum concentrations of the identified SRCs. The EPRE compared measured concentrations of detected substances to conservative ecological screening values to identify substances detected at the facility that pose a potential hazard to ecological receptors and that are identified as ecological contaminants of potential concern (ECOPCs). A summary of the results of the EPRE (ECOPCs) is presented in Table ES-2.

A weight-of-evidence approach was used to evaluate each ECOPC identified in the preliminary risk evaluation. In some instances, ECOPCs were evaluated further in a supplemental preliminary risk evaluation (SPRE). The SPRE presented a comparison of more realistic exposure estimates to toxicity reference values based on the lowest observed adverse effects levels. The exposure estimates were calculated using measured concentrations and more realistic exposure assumptions such as diets, absorption efficiencies, and area use factors. SWMUs for which an SPRE was performed are identified in Table ES-2.

### Conclusions and Recommendations

A weight-of-evidence approach was used with the results from the fate and transport evaluation, HHPRE, human health baseline risk assessment (if performed), EPRE, and SPRE (if performed) to determine the recommendation for each SWMU. The recommendations fell into the following three categories:

- **No Further Action:** NFA was recommended for a SWMU if: (1) the contaminant levels in soil, groundwater, surface water, and sediment were below the reference background criteria, fate and transport values (GSSLs), and/or human health or ecological screening criteria or (2) significant uncertainty was evident, indicating minimal potential risk of migration to groundwater and/or a surface water body and/or to human health and ecological receptors.

- **Additional Investigation (Phase II RFI or additional monitoring):** A Phase II RFI or additional monitoring was recommended if the nature and extent of potential contaminants had not been determined, and further investigation or additional monitoring was required to evaluate extent or potential migration in the future.
- **Corrective Action Plan:** A CAP was recommended if the nature and extent of contamination at a SWMU was determined by the Phase II RFI, there was a potential risk of migration of contaminants to groundwater and/or surface water bodies or a potential risk to human health and ecological receptors, or institutional controls need to be applied to protect the health and safety of humans coming in contact with the site (i.e., inactive EOD areas). Such a site requires a CAP to evaluate appropriate remedial actions to eliminate or minimize these potential risks.

The recommendations for each SWMU are presented in Table ES-3.

Table ES-1. Summary of Site-related Contaminants

SWMU	Type of Investigation	Site-related Contaminants				
		Surface Soil	Subsurface Soil	Groundwater	Surface Water	Sediment
2	Phase II	2 VOCs, 14 pest., 1 SVOC, and 6 metals	1 VOC, 3 pest., 1 SVOC, and 3 metals	3 VOCs and 3 metals	None	alpha-Chlordane
3	Phase II	4 pest., BEHP, As, Cr, and Pb	2 VOCs, BEHP, 3 pest., Cr, and Cd	3 VOCs, 3 pest., Ba, Cd, Cr, Pb, and Hg	1 SVOC, As, Ba, Cr, and Pb	6 VOCs, As, Ba, Cr, Pb, Hg, and Se
9	Phase I <sup>c</sup>	As, Cr, and Ag	NC	NC	NP	NP
10	Phase II	As, Ba, Cr, and Pb	NC <sup>b</sup>	None	Cd, Cr, and Hg	As, Ba, and Pb
11	Phase II	As, Ba, Cr, Pb, and Ag	NC <sup>b</sup>	None	NP	NP
12A	Phase II	3 SVOCs, 4 exp., and 16 metals	Al, As, Ba, Cr, Fe, Pb, and V	BEHP, 1 exp., and 8 metals	RDX, Pb, Mn, and Hg	1 SVOC, 1 exp., and 9 metals
14	Phase I	2 VOCs, BEHP, and Hg	5 VOCs, Cr, and Hg	1 VOC, Pb, and Hg	NP	NP
17	Phase II	1 VOC	3 VOCs	3 VOCs and Pb	None	None
18	Phase II	1 VOC, Pb, and Hg	5 VOCs, 2 SVOCs, Ba, Cr, Pb, and Hg	9 VOCs, Ba, Cd, and Pb	1 SVOC and Ba	(6 VOCs, 4 SVOCs, As, Ba, Cd, Cr, Pb, Hg, Se, and Ag) <sup>f</sup>
19	Phase I	4 VOCs, 7 pest., and 5 metals	6 VOCs, 9 pest., and 5 metals	BEHP, 7 pest., and 3 metals	NP	NP
24B	Phase I	1 VOC, 10 SVOCs, and 6 metals	2 VOCs	1 VOC, 11 SVOCs, and Hg	NP	NP
27A (Bldg. 1339A)	Phase I	None	2 VOCs and 3 SVOCs	2 VOCs and BEHP	NP	NP
27A (Bldg. 1339B)	Phase I	BEHP and Pb	2 VOCs	1 VOC	NP	NP
27A (Bldg. 1322)	Phase I	3 VOCs and Pb	3 VOCs	Acetone	NP	NP
27B	Phase I	None	1 VOC	ND	NP	NP
27C	Phase I	1 VOC	2 VOCs and 1 SVOC	4 VOCs	NP	NP
27D	Phase I	3 VOCs	1 VOC	None	NP	NP
27E (Bldg. 1628)	Phase I	None	1 VOC	None	NP	NP

Note: Footnotes appear on page ES-8.

Table ES-2. Summary of CMCOPCs, HHCOPCs, and ECOPCs

SWMU	CMCOPCs			HHCOPCs					ECOPCs				HHBRA or SPRE Performed?
	Soil	Sediment	Surface Soil	Subsurface Soil	Groundwater	Surface Water	Sediment	Surface Soil	Groundwater	Surface Water	Sediment		
2	2 pest., Ar, Ca, and Hg	None	As and Cr	None	None	None	None	4,4'-DDE, Cd, Cr, and Pb	1 VOC, Pb, and Hg	None	None	HHBRA and SPRE	
3	None	As	As	None	1 pest. and Hg	1 SVOC, As, Cr, and Pb	As	Pb and Cr	2 pest., Ba, Cd, Pb, and Hg	1 SVOC, Ba, and Pb	2 VOCs, As, Ba, and Se	HHBRA and SPRE	
9 <sup>a</sup>	NA <sup>a</sup>	NA <sup>a</sup>	NA <sup>a</sup>	NC <sup>a</sup>	NC <sup>a</sup>	NP	NP	NA <sup>a</sup>	NC <sup>a</sup>	NP	NP		
10	NA <sup>b</sup>	NA <sup>b</sup>	NA <sup>b</sup>	NC	NA <sup>b</sup>	NA <sup>b</sup>	NA <sup>b</sup>	NA <sup>b</sup>	NA <sup>b</sup>	NA <sup>b</sup>	NA <sup>b</sup>		
11	NA <sup>b</sup>	NA <sup>b</sup>	NA <sup>b</sup>	NC	NA <sup>b</sup>	NA <sup>b</sup>	NA <sup>b</sup>	NA <sup>b</sup>	NA <sup>b</sup>	NP	NP		
12A	Ar, Cd, Cr, Pb, Ag, 1 SVOC, and 2 exp.	None	As and Pb	As	BEHP	Hg	None	1 SVOC, Cd, Cr, and Pb	BEHP	Pb and Hg	Ba	HHBRA and SPRE	
14	1 VOC	NA	None	None	None	NP	NP	None	Pb, Hg, and 1 VOC	NP	NP		
17	None	None	None	None	1 VOC	None	None	None	1 VOC and Pb	None	None	HHBRA	
18	Cr and Hg	(1 VOC, 1 SVOC, Ar, Ba, Cd, Cr, Hg, and Se) <sup>c</sup>	None	None	3 VOCs and Pb	1 SVOC	As	Pb	4 VOCs, Ba, and Pb	Ba and BEHP	None	HHBRA and SPRE	
19	2 pest.	NA	None	None	BEHP, 2 pest., and As	NP	NP	Cd, Pb, and 1 pest.	BEHP, 5 pest., Ba, and Hg	NP	NP	HHBRA and SPRE	
24B	1 VOC, 3 SVOCs, and Pb	NA	4 SVOCs, As, and Pb	None	1 VOC, 9 SVOCs, and Hg	NP	NP	NP	Hg and 9 SVOCs	NP	NP		
27A (Bldg. 1339A)	None	NA	None	None	BEHP	NP	NP	None	1 VOC and BEHP	NP	NP		
27A (Bldg. 1339B)	None	NA	None	None	Benzene	NP	NP	Pb	Xylenes	NP	NP		
27A (Bldg. 1322)	None	NA	None	None	Acetone	NA	NA	Pb	None	NP	NP	HHBRA	

Note: Footnotes appear on page ES-11.

Table ES-3. SWMU-specific Recommendations

SWMU	Recommendation
2	CAP
3	CAP
9	CAP
10	CAP
11	CAP
12A	Long-term compliance monitoring and CAP
14	NFA
17	NFA
18	Long-term monitoring and CAP
19	NFA
24B	Phase II RFI
27A (Building 1339A)	NFA
27A (Building 1339B)	NFA
27A (Building 1322)	NFA
27B	NFA
27C	NFA
27D	NFA
27E (Building 1628)	NFA
27E (Building 1720)	NFA
27F (NW Building 1340)	Phase II RFI
27F (NE Building 1340)	NFA
27G	NFA
27H (Building 1071)	Phase II RFI

SWMU	Recommendation
27H (Building 1056)	Phase II RFI
27I (Block 9900)	NFA
27I (Block 10300)	NFA
27J (Building 10535)	NFA
27J (Building 10531)	Phase II RFI
27K	NFA
27L (Block 10200)	Phase II RFI
27M (Block 10100)	NFA
27N (Block 9800)	NFA
27O (Block 9700)	NFA
27P (Block 9500)	NFA
27Q (Block 9400)	NFA
27R	NFA
27S	NFA
27T	Phase II RFI
27U	NFA
27V	NFA
29	CAP
31	NFA
34	NFA
32	NFA
37	NFA

## 10.4 SWMU 10: INACTIVE EOD AREA NORTH OF THE GARRISON AREA

### 10.4.1 History and Description of SWMU 10, Inactive EOD Area North of the Garrison Area

SWMU 10 is located 4 miles north of the garrison area and 1 mile east of State Road 119. This EOD site is located in an area designated as B-8 on the Fort Stewart Installation Map, near firing point 101. The EOD area operated from 1975 to 1980, with open detonation of UXO taking place (Geraghty and Miller 1992). There is one trench with a total area of 2 acres. The original RFA indicated that the craters in the ground contained no solid waste other than small bits of shrapnel, and there was no evidence of ashes or charred ground from explosions (USAEHA 1988). The site is located approximately 1,500 feet east of Taylors Creek. This EOD area is reported to be inactive.

Adjacent to the north of the site is an abandoned Methodist religious campground known as the Taylors Creek Campground. The campground encompasses approximately 10 acres and was used between 1820 and 1941. The property is eligible for the National Register of Historic Places.

The waste disposed of included excess artillery powder bags, small arms rounds, artillery and mortar rounds, illuminating projectiles, pyrotechnics, bulk explosives, rockets, propellant, and regular smoke grenades. There are no records or information indicating any disposal of CB agents, acids, solvents, or other hazardous or toxic substances in the EOD area (Environmental Science and Engineering 1982). Results of the previous investigations are presented below in sequential order.

#### 10.4.1.1 1987 RCRA Facility Assessment

In 1987, as part of the initial RFA investigation, 10 surface soil samples were collected at 40-foot intervals along a transect that was oriented so as to intersect as many blast craters as possible. Surface soil sample collection was limited to 0 inch to 1 inch bgs because of safety concerns related to UXO. The surface soil samples were analyzed for metals and EP Tox.

**Surface Soil.** The analyses for metals showed the existence of various levels of arsenic, barium, mercury, and lead in all the samples. Selenium, chromium, and cadmium were also detected in some of the samples. Lead was the only metal for which concentrations were significantly higher than background. None of the metals were leachable as defined by EP Tox. Because of the shallow collection depth, the data from the 1987 RFA were not used further in this interpretation.

#### 10.4.1.2 1993 Phase I RCRA Facility Investigation

In 1993, as part of the Phase I RFI, six surface soil samples were collected from various locations within each of two blast craters at depths of 1.0 foot to 1.5 feet bgs and analyzed for VOCs, RCRA total metals, and explosives residue (Figure 10.4-1). Analytical results for the Phase I RFI are presented in Table 10.4-1.

#### *Surface Soil*

**VOCs.** Concentrations of VOCs were not reported above the detection limits in the surface soil samples.

**Metals.** Arsenic, barium, chromium, and lead were detected above the reference background criteria in surface soil and are considered to be SRCs in surface soil from the Phase I RFI.

**Explosives.** No explosives residues were detected in the surface soil samples.

## **10.4.2 Summary of Phase II RCRA Facility Investigation Activities**

Initial screening consisted of using DPT techniques to collect groundwater samples from Geoprobe borings for explosives analysis. Eight Geoprobes were installed around the perimeter of the EOD area, as indicated in Figure 10.4-1. The results of the Geoprobe screening were used to determine the extent of potential contamination and the location of a vertical-profile boring. Due to the lack of contamination observed in the Geoprobe borings, a vertical-profile boring was not installed at the site. In addition, no monitoring wells were installed at the site during the Phase II RFI activities.

Three surface soil samples were collected from within the boundary of the SWMU and analyzed for explosives and RCRA metals. The Phase II RFI sampling locations are presented in Figure 10.4-1.

Two surface water and two sediment samples were collected from Taylors Creek and analyzed for explosives and RCRA metals. The upstream location was south-southwest of the site, and the downstream location was west of the site. Conductivity, temperature, pH, DO, Redox, and turbidity were measured in the field during sampling, and the results are presented in Table 10.4-2.

## **10.4.3 Physical Characteristics of the Site**

### **10.4.3.1 Topography**

There are approximately 3 feet of relief across the site. The elevation of the site is approximately 67 feet amsl along the eastern boundary and slopes gently downward to approximately 64 feet amsl along the western boundary.

### **10.4.3.2 Surface drainage**

Taylors Creek is located approximately 1,500 feet southwest of the EOD area. Based on topography, the surface water flow direction is to the west toward Taylors Creek. Drainage occurs as overland flow; there are no surface water features in the immediate vicinity of (fewer than 1,500 feet from) the former EOD area.

### **10.4.3.3 Soils**

Site-specific subsurface soil characterization was not performed at this site. There were no soil cuttings associated with the Geoprobe installation, so soil samples were not collected for classification. However, the soils present at the site are expected to be similar to those at other sites at Fort Stewart, which means they should be silty and clayey sands.

### **10.4.3.4 Hydrogeology**

Groundwater was encountered from approximately 5.5 feet bgs or 61.6 feet amsl at the southeastern corner of the site to approximately 7.4 feet bgs or 57.3 feet amsl at the northwestern corner of the site. The shallow groundwater flow direction across the site is estimated to be toward the southwest.

### **10.4.3.5 Ecology**

As stated in Section 8.2, the habitats at SWMU 10 are classified as "unmanaged grasslands" and "aquatic habitats." The aquatic habitats at the site consist of low-lying areas that form ephemeral bodies of water after rain events. Pine-oak forest surrounds all sides of the site. The boundary is marked mainly by hardwoods and

immature pine. Many shallow depressions are scattered throughout the site. Some of these areas are of substantial size and hold rainwater for an indefinite period.

Common terrestrial fauna are expected to exist at this location. In addition, amphibians might be using the ephemeral bodies of water collected in shallow depressions for breeding purposes. No evidence of aquatic life was present in the ephemeral bodies of water during the field investigation.

#### **10.4.4 Nature and Extent of Contamination**

##### **10.4.4.1 Surface soil**

Surface soil samples were collected from three surface soil locations within the boundary of the EOD area and were analyzed for explosives and RCRA metals. The results of the surface soil analyses are presented in Table 10.4-3 and Figure 10.4-2.

**Explosives.** No explosives were detected in the surface soil samples.

**RCRA Metals.** Lead was detected in the sample from SS8 at a concentration (51.6 mg/kg) that exceeded the reference background criterion (8.4 mg/kg); therefore, lead is considered to be an SRC in surface soil.

##### **10.4.4.2 Subsurface soil**

In accordance with the approved Work Plan (SAIC 1997), no subsurface soil samples were collected. Approval is required from the Department of the Army before subsurface drilling can be implemented at a former EOD site. In addition, potential contamination would primarily be associated with the surface soil at a former EOD site.

##### **10.4.4.3 Groundwater**

Groundwater samples were collected from eight Geoprobe locations and were screened for explosives. No explosives were detected in any of the eight groundwater samples. The horizontal and vertical extent of contamination was determined from the Geoprobe groundwater data; therefore, in accordance with the GEPD-approved Work Plan and with GEPD concurrence, the proposed vertical-profile and three monitoring wells were not installed.

##### **10.4.4.4 Surface water**

Two surface water samples were collected from Taylors Creek. The surface water samples were analyzed for explosives and RCRA metals. The results of the surface water analyses are presented in Table 10.4-4 and Figure 10.4-3.

**Explosives.** No explosives were detected in the surface water samples.

**RCRA Metals.** Cadmium (0.97 µg/L), chromium (1.5 µg/L), and mercury (0.16 µg/L) were detected in the downstream surface water sample (SWS2) at concentrations exceeding site-specific reference background criteria and are, therefore, considered to be SRCs.

#### 10.4.4.5 Sediment

Two sediment samples were collected from Taylors Creek. The sediment samples were analyzed for explosives and RCRA metals. The results of the sediment analyses are presented in Table 10.4-4 and Figure 10.4-3.

**Explosives.** No explosives were detected in the sediment samples.

**RCRA Metals.** Arsenic (1.3 mg/kg), barium (22.3 mg/kg), and lead (15.5 mg/kg) were detected in the downgradient sediment sample (SWS2) at concentrations exceeding site-specific reference background criteria and are, therefore, considered to be SRCs.

#### 10.4.4.6 Site-related contaminant summary

SRCs by medium and the corresponding maximum concentrations from the Phase I and Phase II RFIs are presented in Table 10.4-5.

### 10.4.5 Conclusions and Risk Management and Site Recommendations for SWMU 10

#### 10.4.5.1 Conclusions

##### *Nature and Extent of Contamination*

- Groundwater is estimated to flow to the southwest toward Taylors Creek.
- Taylors Creek, the nearest downgradient receptor, is located approximately 1,500 feet southwest of the site and is separated from the site by forest and grass habitats.
- No explosive compounds were detected in groundwater, surface soil, surface water, or sediment samples.
- Concentrations of arsenic, barium, chromium, and lead exceeded reference background criteria in surface soil samples collected during the Phase I and/or Phase II RFIs and are considered to be SRCs.
- Cadmium, chromium, and mercury exceeded site-specific reference background criteria in the downstream surface water sample and are considered to be SRCs.
- Arsenic, barium, and lead exceeded site-specific reference background criteria in the downstream sediment sample and are considered to be SRCs.
- Arsenic, barium, chromium, and lead exceeded their respective reference background criteria in surface soil samples and are considered SRCs in surface soil. However, the maximum concentrations of the metal SRCs were within the range established by the USGS for element concentrations in soils of the eastern United States. The maximum concentration of arsenic (6.02 mg/kg) is within the observed range of arsenic soil concentrations of 0.1 mg/kg to 73 mg/kg (USGS 1984). Lead was detected above the reference background criterion (8.81 mg/kg) in three of eight surface soil samples. The concentrations in two of these soil samples (12.0 mg/kg and 9.56 mg/kg) were only slightly above the reference background criterion (8.81 mg/kg). All of the lead concentrations were within the range of less than 10 mg/kg to 300 mg/kg (USGS 1984). Chromium was detected above the reference background criterion in two of eight surface soil samples. The chromium concentrations (38.9 mg/kg and 6.98 mg/kg) were on the low end of the range (1 mg/kg to 1,000 mg/kg) observed in the eastern United States (USGS 1984). The maximum concentration (42 mg/kg) of barium was within the range (10 mg/kg to

1,500 mg/kg) observed in the eastern United States (USGS 1984). Given that the concentrations of these metals in surface soil were within the range of naturally occurring concentrations, the potential impacts to human health and the environment are likely to be minimal, and further investigation and/or evaluation of these metals in surface soil is not required.

- Cadmium, chromium, and mercury exceeded the site-specific reference background criteria in the downstream surface water sample from Taylors Creek and are considered to be SRCs in surface water. Taylors Creek is located approximately 1,500 feet from SWMU 10 and is separated from it by forest and grass habitat. Cadmium and mercury were not detected in surface soil above the reference background criteria. Chromium was detected above the reference background criterion in only two of eight surface soil samples. The chromium concentrations in surface soil (38.9 mg/kg and 6.98 mg/kg) were within (at the low end of) the concentration range (1 mg/kg to 1,000 mg/kg) of chromium observed in the eastern United States (USGS 1984). Thus, it is unlikely that the cadmium, chromium, and mercury observed in Taylors Creek surface water are associated with SWMU 10 and probably are the result of naturally occurring background concentrations. Therefore, the potential impacts to human health and the environment are likely to be minimal, and further investigation and/or evaluation of these metals in surface water is not required.
- Arsenic, barium, and lead were detected in sediment above the reference background criteria and are considered to be SRCs in sediment. Arsenic, barium, and lead were not detected in the associated surface water above the reference background criteria. The topography between the site and Taylors Creek is relatively flat, and the soils in the FSMR are typically sandy, with relatively high porosity; therefore, it is likely that runoff from precipitation events would percolate into the adjacent surface and subsurface soil. Potentially contaminated runoff would be unlikely to impact the distant stream (i.e., 1,500 feet from SWMU 10). Arsenic, barium, and lead were detected in surface soil above the reference background criteria. However, the observed arsenic, barium, and lead concentrations were all within the concentration range for the eastern United States (see bullet 7). In addition, Taylors Creek is located approximately 1,500 feet from SWMU 10 and is separated from it by forest and grass habitat. Migration of these metals in soil would be highly retarded by their physicochemical properties. Thus, it is unlikely that arsenic, barium, and lead in sediment in Taylors Creek are associated with SWMU 10 and probably are the result of naturally occurring background concentrations. Therefore, the potential impacts to human health and the environment are likely to be minimal, and these constituents in sediment do not warrant further investigation and/or evaluation.

#### **10.4.5.2 Site Recommendations**

- Based on the information presented in this section and the potential health and safety risks associated with the site (i.e., a former EOD area), an NFA status is recommended for SWMU 10 regarding further investigation of the site. With the concurrence of GEPD, Fort Stewart recommends a CAP evaluating institutional controls be prepared for this site and SWMUs 8, 9, 11, and 12A that will provide/establish institutional controls to ensure the protection of human health and the continued safety of all personnel using the FSMR, specifically the former EOD areas. Institutional controls that are protective of human health against potential UXO risks will also be protective against potential risks from the potential SRCs identified for SWMU 10; therefore, further investigation and/or remediation of the identified SRCs is not warranted. It is anticipated that the CAP will be submitted to GEPD in the fourth fiscal quarter (July through September) of 2000.

Table 10.4-1. Summary of Phase I RFI Results, SWMU 10

SURFACE SOIL							
Analyte	Reference Background Criteria	Sample Location					
		SS1 <sup>a</sup>	SS2	SS3	SS4	SS5	SS6
<i>Metals (mg/kg)</i>							
Arsenic	2.10	<2.5	<2.5	<2.5	<b>6.02</b>	<2.5	<b>2.8</b>
Barium	14.70	9.21	<b>29.5</b>	<b>16.0</b>	<b>20.2</b>	9.2	<b>42.0</b>
Chromium	6.21	<2.5	<b>38.9</b>	2.66	5.14	<2.5	<b>6.98</b>
Lead	8.81	3.37	8.55	6.06	<b>12.0</b>	4.25	<b>9.56</b>
<i>Explosives (mg/kg)</i>							
Explosives	0.00	ND	ND	ND	ND	ND	ND

<sup>a</sup>Site-specific background location.

ND = Not detected.

**Bold** indicates concentrations above reference background criteria.

Table 10.4-2. Field Parameter Measurements during Surface Water Sampling, SWMU 10

Parameter	pH (su)	Conductivity (mS/cm)	Temperature (°C)	Turbidity (NTUs)	DO (mg/L)	Redox (mV)
10-SWS1	4.70	9	8.67	15.6	10.27	269.6
10-SWS2	4.36	8	9.08	NR	8.58	277.9

NR = Not reportable.

Table 10.4-3. Summary of Analytes Detected in Surface Soil, SWMU 10

Station	Reference Background Criteria	10-SS7	10-SS8	10-SS9
Sample ID		107711	107811	107911
Date		01/31/98	01/31/98	01/31/98
Depth (feet)		0 to 1	0 to 1	0 to 1
Sample Type		Grab	Grab	Grab
<i>Metals (mg/kg)</i>				
Arsenic	2.10	0.62	0.79	0.53
Barium	14.70	12.6	10.2	10
Cadmium	0.18	0.11	0.15	0.07
Chromium	6.21	2.4	2.4	2.5
Lead	8.81	8.1	<b>51.6</b>	3.7

**Bold** indicates concentrations above reference background criteria.

Table 10.4-4. Summary of Analytes Detected in Surface Water and Sediment, SWMU 10

SURFACE WATER					
Station	Reference Background Criteria	MCL	Ambient Water Quality Criteria	10-SWS1 <sup>a</sup>	10-SWS2
Sample ID				103111	103211
Date				02/01/98	02/01/98
Sample Type				Grab	Grab
<i>Metals (µg/L)</i>					
Barium	32.00	2,000		16	12
Cadmium	0.40	5			<b>0.97</b>
Chromium	1.38	100		0.69	<b>1.5</b>
Mercury	0.10	2	0.144		<b>0.16</b>

SEDIMENT				
Station	Reference Background Criteria	10-SWS1 <sup>a</sup>	10-SWS2	
Sample ID		102111	102211	
Date		02/01/98	02/01/98	
Filtered		Total	Total	
Sample Type		Grab	Grab	
<i>Metals (mg/kg)</i>				
Arsenic	0.98	0.49	<b>1.3</b>	
Barium	11.0	5.5	<b>22.3</b>	
Cadmium	0.18	0.09	0.15	
Chromium	6.6	3.3	5.2	
Lead	9.0	4.5	<b>15.5</b>	

<sup>a</sup>Site-specific background location.

**Bold** indicates concentrations above reference background criteria.

Table 10.4-5. Summary of Site-related Contaminants, SWMU 10

Analyte	Maximum Concentration (mg/kg)			Maximum Concentration (µg/L)	
	Surface Soil	Subsurface Soil	Sediment	Groundwater	Surface Water
Arsenic	6.02 <sup>a</sup>	NC	1.3	NA	ND
Barium	42.0 <sup>a</sup>	NC	22.3	NA	BRBC
Cadmium	ND	NC	BRBC	NA	0.97
Chromium	38.9 <sup>a</sup>	NC	BRBC	NA	1.5
Lead	51.6	NC	15.5	NA	ND
Mercury	ND	NC	ND	NA	0.16

<sup>a</sup>Phase I RFI data.

BRBC = Below reference background criteria.

NA = Not analyzed.

NC = Medium not collected based on screening results.

ND = Not detected.