FINAL

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ADDENDUM FOR SWMU 27J: GANG MATES, BUILDING 10531

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TO THE

REVISED FINAL PHASE II RCRA FACILITY INVESTIGATION REPORT FOR 16 SOLID WASTE MANAGEMENT UNITS AT FORT STEWART, GEORGIA

Prepared for

U.S. ARMY CORPS OF ENGINEERS
SAVANNAH DISTRICT

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July 2000

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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contributed to the preparation of this document and should not be considered an eligible contractor for its review.

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ACRONYMS

ADD	average daily dose
amsl	above mean sea level
AT123D	Analytical Transient 1-,2-,3-Dimensional
AUF	area use factor
AWQC	Ambient Water Quality Criterion
bgs	below ground surface
CAP	Corrective Action Plan
CMCOC	contaminant migration constituent of concern
CMCOPC	contaminant migration contaminant of potential concern
COC	constituent of concern
COPC	contaminant of potential concern
DF	dilution factor

DO	dissolved oxygen
DPT	direct-push technology
ECOPC	ecological contaminant of potential concern
EPA	U.S. Environmental Protection Agency
EPRE	ecological preliminary risk evaluation
ERA	Ecological Risk Assessment
ESV	ecological screening value
FSMR	Fort Stewart Military Reservation
GEPD	Georgia Environmental Protection Division
GSSL	generic soil screening level
HHBRA	human health baseline risk assessment
HHCOPC	human health contaminant of potential concern
HHPRE	human health preliminary risk evaluation
HI	hazard index
HQ	hazard quotient
ILCR	incremental lifetime cancer risk
LOAEL	lowest observed adverse effect level
MCL	maximum contaminant level
NFA	no further action
NOAEL	no observed adverse effect level
NTU	nephelometric turbidity unit
ODAST	One-dimensional Analytical Solute Transport
OWS	oil/water separator
PID	photoionization detector
RBC	risk-based concentration
RBCA	Risk-based Corrective Action
RCRA	Resource Conservation and Recovery Act
Redox	oxidation-reduction potential
RfD	reference dose
RFI	RCRA Facility Investigation
SAIC	Science Applications International Corporation
SAP	Sampling and Analysis Plan
SDWA	Safe Drinking Water Act
SESOIL	Seasonal Soil Compartment
SRC	site-related contaminant
SVOC	semivolatile organic compound
SWMU	solid waste management unit
TRV	toxicity reference value
USACE	U.S. Army Corps of Engineers
VOC	volatile organic compound

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1.0 INTRODUCTION

This addendum to the revised final Phase II Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Report for 16 Solid Waste Management Units (SWMUs) at Fort Stewart, Georgia, (dated April 2000) presents the results for the Phase II RFI for the GANG MATES, Building 10531 (SWMU 27J) performed in October 1999. A Phase I RFI was performed at SWMU 27J in January 1998, and the results are presented in Section 10.12 of the revised final Phase II RFI Report (SAIC 2000). The results of the Phase I RFI indicated that additional investigation of the site was required to evaluate the nature and extent of potential groundwater contamination.

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.

1.1 OBJECTIVES AND SCOPE OF THE INVESTIGATION

The specific objectives of this Phase II RFI for SWMU 27J, Building 10531 at Fort Stewart, Georgia, as defined in the conclusions and recommendations in Section 10.12.8 of the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000) and the Phase II RFI Sampling and Analysis Plan (SAP) (SAIC 1997) [approved by the Georgia Environmental Protection Division (GEPD) in October 1997], are listed below.

- Determine the horizontal and vertical extent of groundwater contamination.
- Determine whether groundwater contaminants present a threat to human health or the environment.
- Determine the need for future action and/or no further action (NFA).
- Gather data necessary to support a Corrective Action Plan (CAP), if warranted.

The information provided in this addendum report is based upon data collected previously during the Phase I RFI (January 1998) and data collected as part of the Phase II field sampling and analysis (October 1999). The scope of the fieldwork for the Phase II sites included the activities listed below.

- Collection of direct-push groundwater samples using a push probe.
- Installation of permanent groundwater monitoring wells both upgradient and downgradient of the site.
- Groundwater sampling at newly installed monitoring wells around the SWMU.
- Collection of surface water (if available) and sediment samples.
- Surveying of the positions of all sample locations.

1.2 ADDENDUM REPORT ORGANIZATION

This report is an addendum to the revised final Phase II RFI Report for 16 SWMUs that was issued in April 2000. General procedures and/or methodology for field investigation, fate and transport analysis, human health risk assessment, and ecological risk assessment (ERA) are presented in the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000) and are referenced in the appropriate addendum sections. The revised final Phase II RFI Report for 16 SWMUs consists of three volumes: 12 chapters of text in Volume I, seven appendices in Volume II, and five appendices in Volume III. Chapter 1.0 describes the purpose of the investigation, summarizes the scope of work performed, and presents the organization of the report. General information is presented in Chapters 2.0 through 8.0. Chapter 2.0 describes the Fort Stewart Military Reservation (FSMR) Installation and discusses the history of the FSMR and the FSMR's regulator history. Chapter 3.0 presents the regional setting of the FSMR, including the demographics, topography, regional geology and hydrogeology, surface drainage, soils, and ecology. Chapter 4.0 summarizes the investigative activities and methodologies used in completing the Phase II RFI fieldwork. Chapter 5.0 describes the results of the background interpretation for surface soil, subsurface soil, groundwater, surface water, and sediment and their relationship to each site. Chapter 6.0 identifies general considerations affecting contaminant fate and transport. Chapter 7.0 presents the general methodology for the human health preliminary risk evaluation (HHPRE), and Chapter 8.0 presents the general methodology for the ecological preliminary risk evaluation (EPRE).

Chapter 9.0 designates in sequential order the SWMUs that are recommended for NFA and for which, therefore, additional investigation and/or evaluation is not required. Chapter 10.0, in which SWMU 27J, Building 10531 is addressed (Section 10.12), designates in sequential order the SWMUs that are recommended for additional investigation or a CAP. Chapter 11.0 presents general conclusions and recommendations identifying the SWMUs that are recommended for NFA or SWMUs that indicated risk to human health or environment and are recommended for additional investigation or a CAP. References are presented in Chapter 12.0.

Volume II of the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000) contains seven appendices. Appendix A contains the direct-push technology (DPT) and boring logs. Appendix B contains monitoring well construction diagrams. Appendix C is the Quality Control Summary Report. Appendix D provides a comparison of metal data from the Phase I and Phase II RFIs. Appendix E contains the geotechnical laboratory test results. Appendix F is the background data summary. Appendix G contains the chain-of-custody forms.

Volume III of the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000) contains five appendices. Appendix H provides the analytical data results. In addition, the analytical data are provided in electronic format (i.e., on a CD). Appendix I presents the methodology for the human health baseline risk assessment (HHBRA). Appendix J contains the toxicity profiles for contaminants of potential concern (COPCs). Appendix K presents fate and transport input data and model descriptions. Appendix L presents the revised responses to GEPD comments received on the final version of the Phase II RFI Report for 16 SWMUs submitted in February 1999 and the meeting minutes for the comment response meeting with GEPD held on September 14, 1999.

The results of the Phase I RFI for SWMU 27J, Building 10531 are presented in Section 10.12 of the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000). This addendum follows the same organization as that of the revised final Phase II RFI Report.

2.0 HISTORY AND DESCRIPTION OF SWMU 27J, GANG MATES, BUILDING 10531

SWMU 27J is one of two oil/water separators (OWSs) that support vehicle maintenance activities under GANG MATES and one of 32 OWSs distributed across 29 sites that support vehicle maintenance facilities within the garrison area (Figure 1). The OWS is located in the southeastern corner of the armor vehicle parking area, southeast of Building 10531 (Figure 2). The OWS receives wastewater from floor drains located in Building 10531. The site has visually stained soil and stressed vegetation, potentially due to numerous overflows of the OWS. No previous investigations have been performed at the site. The OWS discharges into the sanitary sewer system.

SWMU 27J, Building 10531 is regulated under a RCRA Permit [HW-045 (S&T)] issued to Fort Stewart in August 1987 for storage and treatment of hazardous waste. Detailed regulatory history of Fort Stewart is presented in Section 2.2 of the revised final Phase II RFI Report (SAIC 2000). A Phase I RFI was conducted at SWMU 27J, Building 10531 in January 1998, and the results are discussed in the following section.

2.1 PHASE I RCRA FACILITY INVESTIGATION

A Phase I RFI was performed at SWMU 27J, Building 10531 in January 1998, and the results were presented in Section 10.12 of the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000). DPT techniques were used to collect four soil and groundwater samples at the site. The Phase I soil and groundwater sampling locations are presented in Figure 2.

2.1.1 Surface Soil

Four surface soil samples were collected during the Phase I RFI based on field screening for volatile organic compounds (VOCs). The Phase I RFI results of the soil analysis are presented in Table 1 and Figure 3.

VOCs. Total xylenes were detected in the samples from GP1 and GP2 at concentrations of 0.0034 mg/kg and 0.0027 mg/kg, respectively; therefore, total xylenes are considered to be site-related contaminants (SRCs) in surface soil based on the Phase I RFI.

SVOCs. Di-*N*-octyl phthalate was detected in the sample taken from GP2 at a concentration of 0.433 mg/kg. Di-*N*-octyl phthalate is considered to be an SRC based on the Phase I RFI.

Lead. Lead was detected in the surface soil samples taken from all four sampling locations at concentrations ranging from 0.95 mg/kg at GP3 to 7.9 mg/kg at GP1. None of these concentrations exceeded the reference background criterion; therefore, lead is not considered to be an SRC based on the Phase I RFI.

2.1.2 Groundwater

Four groundwater samples were collected during the Phase I RFI from the four Geoprobe locations at the site. The Phase I RFI results of the groundwater analysis are presented in Table 2 and Figure 3.

VOCs. No VOCs were detected in groundwater during the Phase I RFI.

SVOCs. Benzo(*a*)pyrene was detected in the samples taken from GP2, GP3, and GP4 at concentrations of 6.1 µg/L, 5.7 µg/L, and 9.4 µg/L, respectively. In addition, the concentration levels for benzo(*a*)pyrene exceeded its maximum contaminant level (MCL) (0.2 µg/L). The sample taken from GP4 indicated di-*N*-octyl phthalate at a concentration of 13.2 µg/L. Both benzo(*a*)pyrene and di-*N*-octyl phthalate are considered to be SRCs in groundwater based on the Phase I RFI.

Lead. Lead was not detected at any of the four sampling locations; therefore, lead is not considered to be an SRC in groundwater based on the Phase I RFI.

2.1.3 Conclusions and Recommendations of the Phase I RFI

Total xylenes and di-*N*-octyl phthalate were identified as SRCs in surface soil; however, neither was determined to be a contaminant migration contaminant of potential concern (CMCOPC), human health contaminant of potential concern (HHCOPC), or ecological contaminant of potential concern (ECOPC). Benzo(*a*)pyrene and di-*N*-octyl phthalate were identified as SRCs in groundwater. However, only benzo(*a*)pyrene was identified as an HHCOPC in groundwater. Benzo(*a*)pyrene exceeded its MCL in three of the four groundwater samples. Benzo(*a*)pyrene and di-*N*-octyl phthalate were identified as ECOPCs in groundwater based on the potential hazards to aquatic biota if groundwater discharges to a nearby surface water body. Therefore, the Phase I RFI [see Section 10.12.8.2, page 10.12-6 of the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000)] concluded that the vertical and horizontal extent of potential groundwater contamination had not been determined and recommended that three shallow groundwater monitoring wells be installed (one upgradient and two downgradient). In addition, surface water and sediment samples were to be collected in a depression area downgradient of the site that receives surface water runoff from an adjacent parking area and potentially from the OWS.

3.0 SUMMARY OF PHASE II RCRA FACILITY INVESTIGATION

Four DPT groundwater samples were collected and analyzed for VOCs at an off-site analytical laboratory in October 1999. The results of the groundwater screening were used to locate three monitoring wells (one upgradient and two downgradient) at SWMU 27J at which to collect groundwater samples. With the concurrence of GEPD (Attachment A), no soil samples were collected during the installation of the monitoring wells for chemical analysis. In addition, because overland flow from the OWS may reach the adjacent drainage area, two surface water and sediment samples were collected downstream of the point at which the surface water runoff discharges from the adjacent parking area and potentially from the grassy area around the OWS to a downgradient depression area (see Section 4.2 of this addendum). The Phase II RFI sampling locations are presented in Figure 4. Boring logs and monitoring well diagrams are presented in Appendices A (page A.26-1) and B (page B.13-1) of the revised final Phase II RFI Report (SAIC 2000), respectively. Monitoring well construction details are shown in Table 3.

Geotechnical samples were collected from the three monitoring wells, and the results are presented in Table 4. All three of the monitoring wells were developed until the turbidity was less than or equal to 10 nephelometric turbidity units (NTUs) (Table 5). Monitoring well development data are presented in Table 5. The monitoring wells were sampled using low-flow techniques following the procedures outlined in the revised final SAP for Phase II RFIs for 16 SWMUs (SAIC 1997). The groundwater samples were analyzed for VOCs, semivolatile organic compounds (SVOCs) and RCRA metals. Conductivity, temperature, pH, dissolved oxygen (DO), oxidation-reduction potential (Redox), and turbidity were measured in the field during sampling, and the results are presented in Table 6.

4.0 PHYSICAL CHARACTERISTICS OF THE SITE

4.1 TOPOGRAPHY

The topography of the OWS site is essentially level. The OWS area is located in the grass border between the vehicle parking area and the boundary fence (Figure 2). The area to the west consists of a concrete vehicle parking area and a road. The surface elevation is approximately 57.5 feet above mean sea level (amsl).

4.2 SURFACE DRAINAGE

Surface water that contacts potentially contaminated surface soil at the OWS could migrate by overland flow to a low area located east of the site. However, the most significant contributor of surface water to the low area is surface runoff from the approximately 2.5-acre armor vehicle parking area located adjacent to the site (Figure 2). A concrete wall is located alongside the OWS to the south/southwest that prevents surface water runoff from the adjacent approximate 2.5-acre vehicle parking area from migrating to the area around the OWS. The surface water runoff from the vehicle parking area discharges through an opening between the concrete walls across a concrete erosion pad. The concrete erosion pad prevents surface runoff from the vehicle parking area from washing out a dirt road east of the site. The surface water from the vehicle parking area discharges to the same low area east of the site, where the runoff percolates into the soil (Figure 2). Surface water is present in the low area only after a rainfall event. The OWS discharges to the sanitary sewer system.

4.3 SOILS

The soils across the site consist of alternating layers of sand and silty to clayey sands, as indicated in cross sections A-A' and B-B' (Figures 5 and 6, respectively).

4.4 HYDROGEOLOGY

Groundwater was encountered at approximately 5 feet to 10 feet below ground surface (bgs) in the monitoring wells. The shallow groundwater flow direction across the site is to the east to slight southeast, and the hydraulic gradient is 0.0125 foot/foot (Figure 7).

4.5 ECOLOGY

As stated in Section 8.2 of the revised final Phase II RFI Report (SAIC 2000), SWMU 27J (Building 10531) is classified as an "industrialized area with managed grasslands" (Figure 2). The site is comprised of approximately 0.02 acre and is located in the southeastern corner of the garrison area. The area is comprised mainly of concrete surface, fence, and man-made structures. This SWMU contains a small section of managed grasses, and a forest borders the SWMU toward the east. There is no aquatic habitat at SWMU 27J.

5.0 NATURE AND EXTENT OF CONTAMINATION

5.1 SURFACE SOIL

With the concurrence of GEPD (Attachment A), no surface soil samples were collected during the Phase II RFI.

5.2 SUBSURFACE SOIL

With the concurrence of GEPD (Attachment A), no subsurface soil samples were collected during the Phase II RFI.

5.3 GROUNDWATER

Seven groundwater samples were taken from three monitoring wells and four DPT locations. The results of the groundwater analyses are presented in Table 7 for the Geoprobes and Table 8 for the monitoring wells as well as Figure 8. Chain-of-custody forms and complete analytical results are presented in Appendix G (page G-175) and Appendix H (page H.21-1), respectively, of the revised final Phase II RFI Report (SAIC 2000). Monitoring well MW1 is the background monitoring well (upgradient) for the site.

VOCs. 2-Hexanone was detected in MW3 at a concentration of 3.4 μg/L. Carbon disulfide was detected in groundwater samples from GP5 and GP6 at concentrations of 5.1 μg/L and 4.9 μg/L, respectively. Carbon disulfide and 2-hexanone are considered to be SRCs in groundwater based on the Phase II RFI.

SVOCs. Benzoic acid was detected in the sample taken from MW3 at a concentration of 14.4 μg/L. Bis(2-ethylhexyl)phthalate was detected in only background well MW1 at a concentration of 139 μg/L, which exceeds the MCL. Bis(2-ethylhexyl)phthalate was believed to be the result of field or laboratory contamination; therefore, the groundwater at MW1 was resampled on June 23, 2000. Bis(2-ethylhexyl)phthalate was not detected in MW1 during the resampling. The elevated concentration of bis(2-ethylhexyl)phthalate initially detected was considered to be the result of field or laboratory contamination; therefore, bis(2-ethylhexyl)phthalate is not an SRC at SWMU 27J, Building 10531. The chain-of-custody and analytical data sheets for the resampling data are presented in Attachment B of this addendum. Benzoic acid is considered to be an SRC in groundwater based on the Phase II RFI.

RCRA Metals. Barium, chromium, and lead were detected in the groundwater; however, they were detected at levels below the reference background criteria. Chromium was detected in only upgradient well MW1. Therefore, there are no RCRA metal SRCs in groundwater at SWMU 27J, Building 10531.

5.4 SURFACE WATER

Two surface water samples were collected during the Phase II RFI downgradient of the point at which runoff from the parking area discharges into a depression area east of the OWS. Because both SWS1 and SWS2 are downgradient sampling locations and no upgradient location was available, the site reference background criteria for surface water were taken from the Phase II RFI for the 724th Tanker Purging Station (SWMU 26) (SAIC 1998). Although the background surface water sample (SWS1) from SWMU 26 is upgradient of the garrison area in Mill Creek, it is an appropriate background sample for the surface water in the depression area for the following reasons: (1) the regional proximity of Mill Creek to the depression area and (2) the fact that the depression area and creeks in this area (i.e., Mill, Taylors, and Horse) are chemically similar due to climate, vegetation, underlying geology, etc. The results of the analysis of the surface water samples are presented in Table 9 and Figure 9. Complete analytical results are presented in Appendix H (page H.21-1) of the revised final Phase II RFI Report (SAIC 2000).

VOCs. No VOCs were detected in the surface water samples.

SVOCs. No SVOCs were detected in the surface water samples.

RCRA Metals. Barium, cadmium, and lead were detected in both surface water samples. Cadmium and lead were present at concentrations exceeding the reference background criteria. Cadmium and lead are considered to be SRCs in surface water based on the Phase II RFI.

5.5 SEDIMENT

During the Phase II RFI, two sediment samples were collected from the point at which runoff from the parking area discharges into a low area located east of the site. Because surface water is present in the low area only after rainfall events, the sediment data were evaluated against surface soil reference background criteria. The results of the sediment analysis are presented in Table 10 and Figure 9. Chain-of-custody forms and complete analytical results are presented in Appendix G (page G-175) and Appendix H (page H.21-1), respectively, of the revised final Phase II RFI Report (SAIC 2000).

VOCs. Acetone was detected in SWS1 at a concentration of 0.035 mg/kg. Acetone is considered to be an SRC in sediment based on the Phase II RFI.

SVOCs. Benzo(*g,h,i*)perylene (0.038 mg/kg and 0.0344 mg/kg), bis(2-ethylhexyl)phthalate (0.924 mg/kg and 0.502 mg/kg), and pyrene (0.0764 mg/kg and 0.0651 mg/kg) were all found in both sediment samples. Benzo(*g,h,i*)perylene, bis(2-ethylhexyl)phthalate, and pyrene are considered to be SRCs in sediment based on the Phase II RFI.

RCRA Metals. Arsenic, barium, cadmium, chromium, lead, and selenium were detected in both sediment samples (SWS1 and SWS2). Silver was detected in SWS1, but not in SWS2. Barium (29.2 mg/kg), cadmium (12.4 mg/kg), chromium (22.2 mg/kg), lead (19 mg/kg), selenium (0.42 mg/kg), and silver (0.55 mg/kg) had maximum detected concentrations greater than the surface soil reference background criteria; therefore, they are considered to be SRCs in sediment based on the Phase II RFI.

5.6 SITE-RELATED CONTAMINANT SUMMARY

No soil samples were collected during the Phase II RFI; therefore, the SRCs in surface and subsurface soil were the same as those indicated in the Phase I RFI. SRCs for groundwater were determined using only the most current groundwater characterization data (data collected during the Phase II RFI). The SRCs by medium and the corresponding maximum concentrations are presented in Table 11.

6.0 FATE AND TRANSPORT CONSIDERATIONS

The potential for soil and sediment constituents to migrate (i.e., their leachability) to groundwater was evaluated by comparing the maximum concentrations of soil SRCs to the respective generic soil screening levels (GSSLs).

Of the SRCs identified in soil, none of the analytes exceeded their GSSLs (Table 12). Cadmium exceeded the GSSL of 8 mg/kg in the sediment sample SWS1; therefore, cadmium is a CMCOPC in sediment at SWMU 27J based on leaching to groundwater.

7.0 HUMAN HEALTH PRELIMINARY RISK EVALUATION, SWMU 27J, BUILDING 10531

SRCs were identified for surface soil, groundwater, surface water, and sediment. Evaluation of the potential risks resulting from exposure to these constituents and the identification of HHCOPCs are addressed in this section.

7.1 EXPOSURE EVALUATION

The exposure evaluation addresses what human receptor populations, both on-site and off-site, might be exposed to contaminants present at the site. The exposure evaluation also addresses how contaminants might migrate and the potential exposure pathways for the various receptors. This is a preliminary evaluation that is used to evaluate and select the appropriate screening values used in this HHPRE.

7.1.1 Receptor Assessment

This is an active, secured site within the garrison area. However, surface soil contaminants may migrate off-site to a nearby ditch via runoff and/or discharge of groundwater. Therefore, off-site receptors (i.e., juveniles) may be exposed as a result of playing in the ditch. The potential receptor populations include:

- occupational populations (individuals working on the site),
- juvenile trespassers,
- construction workers, and
- off-site occupational receptors.

Land use at this site is not likely to change; therefore, future receptor populations are likely to be the same as the current ones.

7.1.2 Migration and Exposure Pathway Analysis

Potential migration pathways for soils include leaching into groundwater, surface soil runoff, release of volatile compounds into the air, and groundwater discharge. The site is comprised mainly of concrete surface, fence, and man-made structures. SWMU 27J contains a small section of managed grasses, and a forest borders the site toward the east. However, there is a low depression area located east of the site that potentially may receive some runoff from the site.

The on-site resident scenario is not considered to be a viable scenario for the site. However, in accordance with Risk-based Corrective Action (RBCA) guidance, it is used to derive screening values. The exposure pathways associated with this scenario are presented to show what pathways are taken into consideration when deriving the screening values.

7.2 RISK EVALUATION

The results of the human health risk screening are given below.

The SRCs for surface soil included total xylenes and di-*N*-octyl phthalate. The concentrations of these contaminants were below their respective screening values (Table 13); therefore, there are no HHCOPCs in surface soil.

The SRCs for groundwater consisted of two VOCs (2-hexanone and carbon disulfide) and one SVOC (benzoic acid). All the maximum concentrations of these constituents were below their respective screening values (Table 13); therefore, there are no HHCOPCs in groundwater at SWMU 27J.

The SRCs for surface water consisted of two metals, cadmium and lead. No Ambient Water Quality Criteria (AWQCs) are available for these constituents; therefore, they were compared with the U.S. Environmental Protection Agency (EPA) Region III tap water risk-based concentrations (RBCs) (EPA 2000a). Cadmium exceeded its screening value (Table 13), while lead was below its screening value.

Cadmium had a maximum detected concentration in the surface water of 47.4 μg/L as compared to a risk-based screening value of 1.825 μg/L. Cadmium is considered to be an HHCOPC in surface water.

The SRCs for sediment consisted of acetone (a VOC), three SVOCs [benzo(*g,h,i*)perylene, bis(2-ethylhexyl)phthalate, and pyrene], and six RCRA metals (barium, cadmium, chromium, lead, selenium, and silver). The maximum concentration of cadmium exceeded its screening value (Table 13). The remaining constituents were below their screening values.

The maximum concentration of cadmium (12.4 mg/kg) was only slightly above its screening value of 7.821 mg/kg. Cadmium is considered to be an HHCOPC in sediment.

7.3 UNCERTAINTIES

The human health uncertainties were addressed in Section 7.5 of the HHPRE (Chapter 7.0) of the revised final Phase II RFI Report (SAIC 2000).

8.0 ECOLOGICAL PRELIMINARY RISK EVALUATION, SWMU 27J, BUILDING 10531

The EPRE was conducted in accordance with GEPD (1996) guidance [see Chapter 8.0 of the revised final Phase II RFI Report (SAIC 2000)]. At sites where surface water, sediment, or groundwater was collected, an ecological screening value (ESV) comparison was conducted. If ECOPCs for aquatic biota were identified in surface water, sediment, or groundwater based on the ESV comparison (Step i), then further evaluation was required for those media. If no ECOPCs were identified based on the Step i screening of those media, then those ECOPCs were not considered further. At sites where surface soil was collected, substances detected in surface soil were evaluated in EPRE Steps ii through v because there are no ESVs for surface soil. The results of the five steps of the EPRE are presented below.

8.1 ECOLOGICAL SCREENING VALUE COMPARISON (STEP i)

There is no aquatic habitat at SWMU 27J, so analytes in surface water runoff and drainage area sediment were not screened against EPA Region IV ESVs (EPA 1996a).

Two VOCs and one SVOC were detected in groundwater. The results of the ESV comparison for groundwater are presented in Table 14. The ECOPC identified by the ESV comparison for groundwater was carbon disulfide, which was detected at a concentration exceeding the ESV.

Because there are no ESVs for soil, all analytes detected in soil were evaluated further in EPRE Steps ii through v.

8.2 PRELIMINARY PROBLEM FORMULATION (STEP ii)

The ecological habitat is described in Section 4.5 of this addendum. The preliminary assessment endpoints, ecological receptors, and species representative of those receptors selected for evaluation in the preliminary risk calculation are described in Section 8.2 of the revised final Phase II RFI Report (SAIC 2000).

8.3 PRELIMINARY EFFECTS (STEP iii)

In the EPRE, toxicity reference values (TRVs) were required for shrews and robins ingesting contaminated biota exposed to drainage area sediment at the site, for raccoons ingesting water, and for mink and heron ingesting aquatic biota. The derivation of TRVs is discussed in Section 8.3 of the revised final Phase II RFI Report (SAIC 2000). The derivation of no observed adverse effect levels (NOAELs) for test species is shown in Table 15 for mammals and Table 16 for birds. The derivation of TRVs for surrogate species from the test species NOAELs is shown in Table 17 for raccoons, shrews, and mink and in Table 18 for green herons and American robins.

For the uncertainty discussion, the derivation of lowest observed adverse effect levels (LOAELs) for test species is shown in Table 19 for mammals and Table 20 for birds. The derivation of TRVs for surrogate species from the test species LOAELs is shown in Table 21 for shrews, raccoons, and mink and in Table 22 for robins and green herons.

8.4 PRELIMINARY EXPOSURE (STEP iv)

Ecological receptors are probably exposed by ingestion of contaminated biota exposed to contaminated drainage area sediment, by ingestion of water, and by ingestion of aquatic biota if groundwater discharges to downgradient surface water. The exposure parameters for the surrogate species—shrews, raccoons, mink, green herons, and robins—are presented in Table 8-7 of the revised final Phase II RFI Report (SAIC 2000).

8.5 PRELIMINARY RISK CALCULATION (STEP v)

The preliminary risk calculation (Step v) uses hazard quotients (HQs), the ratios of the measured maximum concentrations and the TRVs, to evaluate the potential for risk. The HQs of ECOPCs with consistent modes of toxicity and effects endpoints are added to calculate a hazard index (HI). Metals are assumed to have distinct modes of toxicity and effects endpoints; therefore, HIs are calculated for only VOCs and SVOCs when no individual ECOPC has an HQ greater than one and HQs are calculated for more than one chemical. ECOPCs with HQs and HIs less than one indicate little to no likelihood of risk to the ecological receptors. An ERA using site-specific data is indicated for those ECOPCs with calculated HQs or HIs exceeding one (GEPD 1996).

Surface Water. The preliminary risk calculations for raccoons potentially exposed to ECOPCs detected in surface water runoff are presented in Table 23. This table shows the maximum detected concentrations, average daily doses (ADDs), TRVs, and HQs for the receptors. There are no ECOPCs present in surface water runoff at concentrations resulting in ADDs exceeding the TRVs for the surrogate species.

Sediment. The preliminary risk calculations for shrews and robins exposed to ECOPCs detected in drainage area sediment are presented in Table 24. This table shows the maximum detected concentrations, ADDs, TRVs, and HQs for shrews and robins. The ECOPCs present in drainage area sediment at concentrations resulting in ADDs exceeding the TRVs for the surrogate species are cadmium, chromium, and lead. The HIs calculated for SVOCs and acetone do not exceed one.

Groundwater. The preliminary risk calculations for raccoons exposed to ECOPCs detected in groundwater are presented in Table 25. This table shows the maximum detected concentrations, ADDs, TRVs, and HQs for the receptors. There are no ECOPCs present in groundwater at concentrations resulting in ADDs exceeding the TRVs for the surrogate species.

8.6 UNCERTAINTIES

The risks to ecological receptors from ECOPCs in drainage area sediment at SWMU 27J are overestimated by the preliminary risk calculations.

The supplemental risk calculations for shrews exposed to cadmium and robins exposed to cadmium, chromium, and lead in drainage area sediment are presented in Tables 26 and 27. The ADDs calculated using a realistic diet (EPA 1993), the site-specific area use factor (AUF), and mean drainage area sediment concentrations of ECOPCs do not exceed the LOAEL–based TRVs (see Tables 21 and 22) (i.e., HQs less than one). Therefore, ECOPCs in drainage area sediment at SWMU 27J do not pose a risk to wildlife receptors.

The risks to ecological receptors from ECOPCs in groundwater at SWMU 27J, Building 10531 are overestimated by the preliminary risk calculations; therefore, fate and transport modeling was performed to estimate future concentrations at the receptor location for carbon disulfide in groundwater. The nearest surface water receptor is a tributary to Peacock Creek, which is located approximately 1,200 feet from the site. Analytical Transient 1-,2-,3-Dimensional (AT123D) modeling (Attachment C) was performed to estimate the 100-year maximum exposure concentration of carbon disulfide (an ECOPC) in the surface water at the receptor location.

AT123D input parameters are presented in Table C-6, Attachment C. AT123D models were calibrated to the maximum observed concentration of carbon disulfide in groundwater (5.1 μg/L) at the source. AT123D modeling assumed a steady-state constant concentration at the source. AT123D modeling results are presented in Table C-7, Attachment C; the modeling results estimated the concentration of carbon disulfide at the surface water receptor to be 0.037 μg/L. This concentration does not exceed the EPA Region IV surface water ESV for carbon disulfide (0.92 μg/L) (EPA 1996a); therefore, carbon disulfide in groundwater at SWMU 27J, Building 10531 does not pose a risk to aquatic biota.

9.0 HUMAN HEALTH BASELINE RISK ASSESSMENT, SWMU 27J, BUILDING 10531

The purpose of this HHBRA is to quantify potential risk associated with COPCs identified in the previous screening assessments (i.e., fate and transport analysis and human health preliminary risk assessment). If the estimated risk value for a receptor exceeds the target risk value, constituents of concern (COCs) will be selected based on the risk value for each constituent. Remedial levels will be derived for each of the COCs identified.

The HHPRE has identified HHCOPCs in sediment and surface water that may present a potential risk to human health. The fate and transport analysis has identified CMCOPCs that may leach into groundwater at concentrations that could present a significant risk to human health as a result of using groundwater as a source of residential drinking water. Based on GEPD (1996) and EPA Region IV (EPA 1995) guidance, an HHBRA is required for those constituents identified as COPCs, which include both HHCOPCs and CMCOPCs.

The HHBRA presented below quantifies the potential risk associated with constituents identified in the fate and transport analysis and the HHPRE as presenting a potential risk to human health. The potential risk for site-specific human receptor populations is quantified for those potential exposure pathways identified for each receptor population.

The HHBRA consists of five elements: (1) identification of COPCs, (2) exposure assessment, (3) toxicity assessment, (4) risk characterization, and (5) assessment of uncertainty. The discussion in the following sections presents the information required to evaluate the human health risks associated with COPCs at SWMU 27J, Building 10531. A detailed discussion of each of the five elements, including methodology, selection of exposure parameters, and analysis of inherent uncertainties, is provided in Appendix I of the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000).

9.1 IDENTIFICATION OF COPCS

The CMCOPCs and HHCOPCs have been discussed in the sections on contaminant fate and transport (Chapter 6.0) and the HHPRE (Chapter 7.0), respectively.

Cadmium was identified as a CMCOPC in sediment. Cadmium was also identified as an HHCOPC in surface water and sediment. No HHCOPCs were identified in the remaining environmental media. Because water is present only after rainfall events, the sediment was evaluated as surface soil (see Section 9.2.2 of this addendum).

9.2 EXPOSURE ASSESSMENT

The exposure assessment quantifies the amount of a COPC an individual may come in contact with at each site. The assessment considers all pathways of potential human exposure, the magnitude of exposure, and the frequency and duration of exposure. The process for estimating exposure consists of the following elements: (1) characterization of the exposure setting in terms of the physical and demographic characteristics of the site, (2) identification of receptor populations, (3) identification of the exposure pathways by which an individual may come in contact with a COPC, (4) estimation of the exposure point concentration, and (5) quantification of the intake or dose to which an individual may be exposed.

9.2.1 Exposure Setting

The exposure setting describes the physical features at the site that are important when identifying the human populations that may be exposed to COPCs, either currently or in the future.

The OWS is located in the southeastern corner of an approximately 2.5-acre armor vehicle parking area southeast of Building 10531 within the garrison area. Surface water runoff from the vehicle parking area is directed through an opening between two concrete walls located south/southeast of the OWS, at which point it drains to a low, wooded area east of the site, where runoff percolates into the soil. Surface water is present only after a major rainfall event.

There are no permanent surface water features near this site. The nearest surface water body is a tributary to Peacock Creek located 1,200 feet from the SWMU. Analysis of potential groundwater migration concluded that cadmium, which has leached into groundwater, is not likely to migrate to this tributary (see Section 9.2.3 of this addendum).

9.2.2 Identification of Potential Receptor Populations and Exposure Pathways

A complete exposure pathway consists of four elements: (1) a source of contamination, (2) a transport or retention medium, (3) a point of contact with the chemical, and (4) a route of exposure (ingestion, dermal absorption, or inhalation) at the point of contact through which the chemical may be taken into the body. When all of these elements are present, the pathway is considered to be complete.

Impacted environmental media at this site include sediment and surface water. The sediment collected at this site was within a wooded area, where surface water runoff percolates into the ground. The sediment at this site is not located within a permanent surface water body and is better described as surface soil located within a wooded area. Sediment at this site was evaluated as surface soil, and the potential exposure to COPCs in sediment was addressed using surface soil scenarios.

Environmental media that are addressed under current land-use conditions include surface water and sediment, which are located outside the boundaries defining SWMU 27J. Cadmium was identified as a CMCOPC; however, this identification was based on the concentrations detected in sediment. Given that the source is off-site, no potentially impacted areas exist on-site. For the purposes of this risk assessment, it is assumed that off-site COPCs will migrate to on-site receptors in the future.

Current Land-use Populations. There are no current on-site receptor populations. A juvenile playing in the low area, where the surface water runoff percolates into soil, was used to evaluate exposure of an off-site receptor to sediment and surface water. This receptor is likely to be exposed to constituents in the surface water via incidental ingestion and dermal contact. The juvenile may also be exposed to COPCs in sediment via incidental ingestion and dermal contact. The site is currently vegetated; therefore, exposure via inhalation of fugitive dust is not considered to be a viable pathway.

Future Land-use Receptor Populations. Although no changes in land use are expected at this site, for the purposes of this risk assessment, it was assumed that the low lying area had been developed, surface water runoff to the site had been eliminated, groundwater drinking wells had been placed within this area, and the vegetative cover had been removed.

The potential on-site receptors for the future land-use scenario include an Installation worker and a resident. These receptors may be exposed via inhalation of fugitive dust.

The potential off-site receptor populations for the future land-use scenario include an off-site juvenile trespasser, off-site Installation worker, and off-site resident.

The off-site trespasser may be exposed to COPCs in sediment and surface water. The exposure pathways for sediment include incidental ingestion, dermal contact, and inhalation of fugitive dust. Exposure pathways for COPCs in surface water include incidental ingestion and dermal contact.

The off-site Installation worker may be exposed to COPCs in sediment and groundwater. Exposure pathways for sediment include incidental ingestion, dermal contact, and inhalation of fugitive dust. Exposure pathways for groundwater are limited to ingestion.

The off-site resident is presented for baseline purposes and is not considered to be a viable receptor population. It is assumed that the drainage from the parking area is diverted away from this area. The off-site resident may be exposed to COPCs in sediment and groundwater. Potential exposure pathways for the off-site resident include incidental ingestion of sediment, dermal contact with sediment, inhalation of fugitive dust, ingestion of groundwater, and dermal contact with groundwater. The absence of volatile COPCs in groundwater excludes inhalation as a potential exposure pathway. If the site was developed for residential purposes, it would be landscaped and vegetated; therefore, exposure via inhalation of fugitive dust is not a likely exposure pathway. However, as a conservative assumption, this pathway was evaluated.

9.2.3 Estimation of Exposure Concentrations

The estimation of exposure concentrations for on-site and off-site receptors to COPCs in surface soil, subsurface soil, groundwater, surface water, and fish is discussed in Appendix I, Section I.2.3 of the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000). Exposure concentrations in abiotic media were calculated using either analytical results or environmental fate and transport models. For the purposes of estimating direct exposure of current receptor populations to COPCs in sediment and surface water, the analytical results for the respective media were used to estimate exposure concentrations. The exposure point concentrations were equal to 95 percent of the upper confidence limit of the mean, unless this value was greater than the maximum detected concentration. In that case, the exposure concentration defaulted to the maximum concentration. The selected exposure concentrations based on the analytical data or the 95 percent upper confidence limits are given in Table 28.

The exposure concentration of fugitive dust in air was calculated using the formulas described in Appendix I, Section I.2.3 of the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000). The value was based on the exposure concentration for sediment. For the purposes of estimating exposure of an off-site receptor to fugitive dust, it was assumed that no dilution of the air concentrations occurred and that the exposure concentrations for both on-site and off-site receptors were the same.

Migration to Groundwater beneath the Source. The estimated groundwater concentration resulting from the leaching of cadmium from sediment was estimated using the Seasonal Soil Compartment (SESOIL) Model (Attachment C). The SESOIL model is used to estimate the concentrations of constituents leaching from soil as a result of rainwater percolating through it before it reaches the water table. The SESOIL results are then converted into the groundwater concentrations by using a site-specific dilution factor (DF). The DF is developed using the hydraulic analysis method (EPA 1996b), which uses the estimated rate of groundwater flow through the aquifer system and the estimated rate of rainwater percolating into the aquifer to calculate the rate of dilution. The fate and transport analysis discussion and the associated results are presented in Attachment A of this addendum.

Based on the SESOIL results, cadmium (0.143 mg/L) is likely to leach to groundwater (Attachment C, Table C-3 and Figure C-1). The estimated groundwater concentration (0.143 mg/L) was above the MCL of 0.005 mg/L (Table C-3, Attachment C); therefore, the potential risks associated with the leaching of cadmium to groundwater were assessed.

Migration of Groundwater to Surface Water. Cadmium in groundwater may migrate to surface water. The closest surface water body that may potentially be a point of deep surficial groundwater discharge is a tributary of Peacock Creek located approximately 1,200 feet away from the site. For the purposes of the groundwater modeling, it was assumed that the tributary is located downgradient of the SWMU.

The One-dimensional Analytical Solute Transport (ODAST) Model (Attachment C) was used to estimate the concentration of cadmium in groundwater adjacent to the tributary. The groundwater concentration of this constituent would be diluted upon discharge into the tributary; however, as a conservative measure, it was assumed that there is no dilution by the upstream surface water. The concentration of cadmium in the surface water was assumed to be equal to the modeled concentration present in groundwater adjacent to the tributary.

The physicochemical and modeling parameters for the ODAST modeling are presented in Table C-4, Attachment C of this addendum. The ODAST modeling of cadmium assumed a constant concentration at the source for a period of 70 years, and the modeling was simulated for a period of 1,000 years.

The modeling results indicate that cadmium will not migrate to the tributary of Peacock Creek (Table C-5, Attachment C); therefore, the risk associated with cadmium in groundwater migrating to surface water was not addressed further in this HHBRA.

9.2.4 Quantification of Exposure

The equations and exposure factors used to estimate exposures to receptor populations are discussed in Appendix I, Section I.2.4 of the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000). The exposure parameter values used to estimate potential exposures are given in Table 29. Potential noncarcinogenic and carcinogenic intakes were estimated, when appropriate, for each receptor population for all applicable pathways.

The HHCOPCs associated with this SWMU are limited to off-site areas. Current risks to receptor populations were addressed using an off-site juvenile trespasser scenario. The estimated intakes for this receptor are given in Table 30.

Future on-site receptor populations include an Installation worker and a resident. The estimated intakes for the Installation worker are given in Table 31. The resident population is divided into a resident child and a resident adult because the differences in behavior, exposure duration, and physiology between an adult and a child result in different doses of constituents in various environmental media. The child has a higher incidental soil ingestion rate because of the increased amount of hand-to-mouth behavior in children. This factor, coupled with the child's lower body weight, results in the child's receiving a higher dose of constituents in surface soil relative to the adult. The resident child is more sensitive to noncarcinogens than the resident adult. On the other hand, the increased exposure duration for the adult resident relative to the child resident results in a higher carcinogenic dose to the resident adult relative to the resident child; therefore, the resident adult is more sensitive to carcinogens in groundwater. However, the resident adult is not always more sensitive to exposure to carcinogens because this sensitivity changes with different environmental media. For the purposes of this risk assessment, the systemic and carcinogenic risks were estimated for both the resident child and the resident adult. The estimated intakes for the resident child and the resident adult are given in Tables 32 and 33, respectively.

Future off-site receptors include an Installation worker, a juvenile trespasser, a resident child, and a resident adult. The estimated intakes for the Installation worker and the juvenile trespasser are given in Tables 34 and 35, respectively. The estimated intakes for the off-site resident child and resident adult are given in Tables 36 and 37, respectively.

9.3 TOXICITY ASSESSMENT

The purpose of the toxicity assessment is to determine the increased likelihood and magnitude of adverse human health effects based on the extent of exposure to contamination. The toxicity assessment for SWMU 27J was carried out as described in Appendix I, Section I.3 of the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000). The toxicity values for cadmium are summarized in Table 38 and are discussed below.

The oral reference dose (RfD) for cadmium is 0.001 mg/kg/day (EPA 2000b). Cadmium has two oral RfDs, one based on food (0.001 mg/kg/d) and the other based on water (0.0005 mg/kg/d). These RfDs reflect the differences in the uptake gastrointestinal absorption rate for the different media. The oral RfD for food was used in this risk assessment because the absorption rate for sediment would be closer to that for food as compared to water.

The dermal RfD for cadmium is 2.5×10^{-5} mg/kg/day (EPA 2000b).

The toxicity profile for cadmium is provided in Attachment D of this addendum.

9.4 RISK CHARACTERIZATION RESULTS

The risk characterization followed the procedures outlined in Appendix I, Section I.4 of the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000). Quantitative estimates of noncarcinogenic and carcinogenic risks were calculated for the COPCs for each potentially complete exposure pathway.

The total HI and incremental lifetime cancer risk (ILCR) were calculated for each receptor, and these values were compared to a target risk value of 1.0 for the HI and 1×10^{-6} for the ILCR. If the risk values for a receptor exceeded these target risk values, then COCs were identified based on either the HI (HI greater than or equal to 0.1) or ILCR (ILCR greater than or equal to 1×10^{-6}).

9.4.1 Current Land-use Scenarios

There are no current on-site receptor populations. The potential risks associated with exposure of a current off-site receptor population are addressed using a juvenile trespasser scenario.

Off-site Juvenile Trespasser. The total HI for the juvenile trespasser is 0.118, which is below the target value of 1.0 (Table 39); therefore, adverse systemic health risks are not expected for this receptor population. An ILCR could not be calculated for this receptor because an oral cancer slope factor is not available for cadmium.

9.4.2 Future Land-use Scenarios

Future potential on-site receptors are the Installation worker and the resident. Future off-site receptors include an Installation worker, a juvenile trespasser, and a resident (child and adult). The potential risks to each of these receptor populations are discussed below.

On-site Installation Worker. The total HI for the Installation worker is 7.91×10^{-6}, which is more than five orders of magnitude less than the target value of 1.0 (Table 40); therefore, adverse systemic health risks are not expected for this receptor population.

The total ILCR is 1.01×10^{-9}, which is approximately three orders of magnitude below the target value of 1×10^{-6} (Table 40); therefore, carcinogenic risks are within an acceptable range for this receptor.

On-site Resident Child. The total HI for the resident child is 3.23×10^{-5}, which is more than four orders of magnitude less than the target value of 1.0 (Table 41); therefore, adverse systemic health risks are not expected for this receptor population.

The total ILCR is 9.95×10^{-10}, which is approximately three orders of magnitude below the target value of 1×10^{-6} (Table 41); therefore, carcinogenic risks are within an acceptable range for this receptor.

On-site Resident Adult. The total HI for the resident adult is 8.15×10^{-6}, which is more than four orders of magnitude less than the target value of 1.0 (Table 42); therefore, adverse systemic health risks are not expected for this receptor population.

The total ILCR is 1.25×10^{-9}, which is more than two orders of magnitude below the target value of 1×10^{-6} (Table 42); therefore, carcinogenic risks are within an acceptable range for this receptor.

Off-site Installation Worker. The total HI for the Installation worker is 3.05, which is greater than the target value of 1.0 (Table 43). Cadmium leaching to groundwater is the primary risk driver (HI = 2.80). Cadmium in sediment is also considered to be a COC (HI = 0.255).

The total ILCR is 1.01×10^{-9}, which is approximately three orders of magnitude below the target value of 1×10^{-6} (Table 43); therefore, carcinogenic risks are within an acceptable range for this receptor.

Off-site Juvenile Trespasser. The total HI for the juvenile trespasser is 0.118, which is below the target value of 1.0 (Table 44); therefore, adverse systemic health risks are not expected for this receptor population.

The total ILCR is 7.48×10^{-11}, which is more than four orders of magnitude below the target value of 1×10^{-6} (Table 44); therefore, carcinogenic risks are within an acceptable range for this receptor.

Off-site Resident Child. The total HI for the resident child is 19.8, which is more than an order of magnitude greater than the target value of 1.0 (Table 45). Cadmium leaching to groundwater is the primary risk driver (HI = 19.1). Cadmium in sediment is also considered to be a COC (HI = 0.698).

The total ILCR is 9.95×10^{-10}, which is approximately three orders of magnitude below the target value of 1×10^{-6} (Table 45); therefore, carcinogenic risks are within an acceptable range for this receptor.

Off-site Resident Adult. The total HI for the resident adult is 8.46, which is more than an order of magnitude greater than the target value of 1.0 (Table 46). Cadmium leaching to groundwater is the primary risk driver (HI = 8.10). Cadmium in sediment is also considered to be a COC (HI = 0.357).

The total ILCR is 1.25×10^{-9}, which is more than two orders of magnitude below the target value of 1×10^{-6} (Table 46); therefore, carcinogenic risks are within an acceptable range for this receptor.

9.5 UNCERTAINTY ASSESSMENT

A discussion of the general uncertainties associated with the analysis of risks at sites within the 16 SWMUs is provided in Appendix I, Section I.5 I of the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000).

9.6 RISK SUMMARY

The purpose of the risk summary is to provide an overview of the risk assessment results, including identification of the COPCs assessed, the receptor populations, and the risk characterization results.

The HHBRA addressed the risks associated with exposure to cadmium in sediment and surface water. Cadmium in sediment is also a CMCOPC.

Environmental media that were addressed under current land-use conditions include surface water and sediment, which are located outside the boundaries defining SWMU 27J. The sediment collected at this site from within a wooded area, where surface water runoff percolates into the ground. The sediment at this site is not located within a permanent surface water body and is better described as surface soil located within a wooded area. Sediment at this site was evaluated as surface soil, and the potential exposure to COPCs in sediment was addressed using surface soil scenarios.

A juvenile trespasser playing in the area of sediment contamination represents the current receptor population. This receptor will be exposed to COPCs in sediment and surface water.

Future land-use populations include an Installation worker, a juvenile trespasser, and a resident. The Installation worker and the resident represent both on-site and off-site receptors. The juvenile trespasser is an off-site receptor only. The residential receptor population was divided into an adult and a child because the adult receptor is at greater risk from exposure to carcinogens, while the child is at greater risk from exposure to noncarcinogens. The reader is referred to Appendix I, Section I.2.2 ("Identification of Potential Receptor Populations and Associated Exposure Pathways") of the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000) for a more detailed discussion on the potential exposure pathways and the differences between the exposure of the adult and child resident receptors.

The off-site Installation worker, off-site resident child, and off-site resident adult had total HIs that exceeded the target level of 1.0. The HIs for exposure to cadmium in sediment as a result of direct exposure and exposure to COPCs that have leached to groundwater exceeded the target level of 0.1. The HIs for exposure to COPCs that have leached into groundwater were more than an order of magnitude higher than the HIs for direct exposure to cadmium in sediment.

Cadmium was identified as a COC in sediment.

9.7 REMEDIAL LEVELS

Remedial levels were derived for cadmium in sediment that are protective of the on-site Installation worker and the on-site resident. The development of remedial levels followed the protocols given in Appendix I, Section I.6 of the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000).

The risk-based remedial levels should be based upon the most sensitive receptor population and the most significant exposure pathway. The resident child is the most sensitive receptor, with an HI of 0.698 for direct exposure to sediment and an HI of 19.1 for exposure to cadmium that has leached into groundwater. The risk-based remedial values were based on both direct exposure and the protection of groundwater.

The remedial level for contaminant migration constituents of concern (CMCOCs) represents that soil concentration that is unlikely to leach into groundwater in concentrations that present a significant threat to human health. The potential risk associated with CMCOCs is not direct exposure to soil, but exposure to the constituents in groundwater; therefore, the remedial levels in soil were based upon target groundwater concentrations. These values are the concentrations of a CMCOC in groundwater that present a defined risk to a receptor. For example, if the target groundwater concentration is based on an HI of 1.0, the risk value of 1.0 represents the potential risk to a receptor population exposed to the risk-based target concentration of the CMCOC in groundwater. The corresponding risk-based soil remedial value would represent the concentration of the CMCOC in soil that is likely to leach into groundwater, resulting in a CMCOC groundwater concentration equal to the target groundwater concentration.

The selection of a remedial level must take into consideration the target risk value for risk-based remedial levels and the regulatory standards for groundwater. The selection of a target risk value for remedial levels must take into account the total risk for that receptor population from all of the potential COCs present at the site. The total potential risks associated with the COCs should not result in a cumulative HI that exceeds 3.0 (GEPD 1996). The risk associated with exposure to cadmium in sediment includes direct exposure and exposure via leaching to groundwater. Taking into consideration that the risks associated with sediment involve two migration/exposure pathways, the recommended target risk value for the remedial value is 1.0. It should be noted that a risk-based remedial level for the protection of groundwater that is based on an HI of 1.0 would result in a cumulative risk of less than 2.0, given that the risks associated with direct exposure would be more than an order of magnitude less than 1.0. Remedial levels for both exposure pathways are presented; however, the recommended remedial level was selected based on protection both from direct exposure and protection of groundwater.

Remedial levels should take into account regulatory standards such as MCLs. The MCL takes into consideration both the potential human health risks associated with exposure to the contaminant in drinking water and the technological limitations in removing that contaminant from water. An MCL that is derived based on the acceptable human health risks as defined in the Safe Drinking Water Act (SDWA) may be more stringent than the possible target risk values allowed under the current GEPD RCRA guidance (GEPD 1996); therefore, the recommended target groundwater concentration will not exceed the MCL for cadmium, 5 µg/L.

The target groundwater concentrations are given in Table 47. The risk-based remedial level based on an HI of 1.0 is 7.5 µg/L as compared to the MCL for cadmium, 5 µg/L. The MCL was used as the target groundwater concentration.

The remedial level for soil is given in Table 48. The recommend remedial level is 0.43 mg/kg, based on a target groundwater concentration of 5 µg/L (the MCL for cadmium). This value (0.43 mg/kg) is significantly less than the risk-based remedial level for direct exposure to soil (17.77 mg/kg).

10.0 CONCLUSIONS AND RISK MANAGEMENT AND SITE RECOMMENDATIONS, SWMU 27J, BUILDING 10531

10.1 SUMMARY OF FINDINGS

The Phase II RFI presented in this addendum report was conducted to collect additional analytical data for determining the nature and extent of contamination in environmental media and the potential adverse effects to human health and the environment in the vicinity of SWMU 27J, Building 10531. The data were derived from a series of screening and primary samples collected from surface soil, surface water runoff, sediment, and groundwater in the study area during the Phase I and Phase II RFIs. The samples collected were analyzed for VOCs, SVOCs, and RCRA metals.

The following sections summarize the significant findings of the Phase I (January 1998) and Phase II (October 1999) RFI sampling and analysis activities.

10.1.1 Surface and Subsurface Soil

Low levels of organic constituents were detected in surface soil.

- Total xylenes and di-*N*-octyl phthalate were detected in the surface soil samples; therefore, they are considered to be SRCs.

- Subsurface soil did not indicate elevated of volatile organics, based on photoionization detector (PID) readings; therefore, no subsurface soil samples were collected in either phase if the investigation.

10.1.2 Groundwater

Groundwater was encountered at approximately 5 feet to 10 feet bgs in the monitoring wells. Groundwater flow at SWMU 27J is east to slightly southeast, with an hydraulic gradient of 0.0125 foot/foot. The closest perennial surface water body that may potentially intercept the shallow groundwater is approximately 1,200 feet to the east.

- 2-Hexanone, carbon disulfide, and benzoic acid were detected in groundwater and are considered to be SRCs in groundwater.

- Bis(2-ethylhexyl)phthalate was also initially detected (at 139 μg/L) in groundwater at MW1, the site background location. Bis(2-ethylhexyl)phthalate was not detected at MW1 during the resampling conducted in June 2000, indicating that the initial detection was the result of field or laboratory contamination. Bis(2-ethylhexyl)phthalate is not considered to be an SRC in groundwater for SWMU 27J, Building 10531.

- No RCRA metals were detected above reference background criteria; therefore, there are no RCRA metal SRCs.

10.1.3 Surface Water and Sediment

Surface water that contacts potentially contaminated surface soil at the OWS could migrate by overland flow to a low area located east of the site. However, the most significant contributor of surface water to the low area is surface runoff from the approximately 2.5-acre armor vehicle parking area located adjacent to the site. A concrete wall is located alongside the OWS to the south/southwest that prevents surface water runoff from the adjacent approximately 2.5-acre vehicle parking area from migrating to the area of the OWS. The surface water runoff from the vehicle parking area discharges through an opening between the concrete walls across a concrete erosion pad. The concrete erosion pad prevents surface runoff from the vehicle parking area from washing out a dirt road east of the site. The surface water from the vehicle parking area discharges to the same low area east of the site, where the runoff percolates into the soil. Surface water is present in the low area only after a rainfall event. The OWS discharges to the sanitary sewer system.

- Cadmium and lead were identified as SRCs in surface water.

- Acetone (a VOC) and three SVOCs [benzo(*g,h,i*)perylene, bis(2-ethylhexyl)phthalate, and pyrene] were identified as organic SRCs in sediment.

- The RCRA metals barium, cadmium, chromium, lead, selenium, and silver were indicated at levels above reference surface soil background criteria and are considered to be SRCs in sediment.

10.2 CONCLUSIONS

Several assessments were conducted to determine the significance of the contaminant concentrations found at SWMU 27J with respect to their impact on human health and the environment. The assessments included those listed below.

- An analysis of contaminant fate and transport (Chapter 6.0) evaluated the potential for SRCs to migrate from one environmental medium to another (e.g., leaching of constituents from soil into groundwater).

This section provides an assessment of that.potential for SRC migration from one medium to another, resulting in a potential risk to human health and the environment.

- An HHPRE (Chapter 7.0), which used a Step i risk screening, identified HHCOPCs.
- An EPRE (Chapter 8.0) was performed for terrestrial and aquatic receptors in the study area.
- An HHBRA (Chapter 9.0) was performed for CMCOPCs identified in the fate and transport analysis and HHCOPCs identified in the HHPRE.

10.2.1 Fate and Transport Analysis

Below are the conclusions regarding contaminant fate and transport.

- SRCs identified in soil did not exceed their respective GSSLs; therefore, there are no CMCOPCs in soil based on leaching to groundwater.
- Cadmium exceeded the GSSL in sediment; therefore, cadmium is a CMCOPC for sediment at the site based on leaching to groundwater.

10.2.2 Human Health Preliminary Risk Evaluation

Based on the results of the screening and the weight-of-evidence analysis, potential HHCOPCs have been identified for sediment and surface water runoff. The results of the HHPRE are summarized below.

- There are no HHCOPCs for surface soil.
- There are no HHCOPCs for groundwater.
- Cadmium is an HHCOPC for surface water.
- Cadmium is an HHCOPC for sediment.

10.2.3 Ecological Preliminary Risk Evaluation

Based on the results of the EPRE screening analysis, ECOPCs were identified in groundwater, surface water runoff, and sediment from the depression area. Sediment samples from the depression area were evaluated as surface soil, given the similarities in the type of habitat present within the depression and the surrounding area. Those constituents identified as ECOPCs were further evaluated using realistic exposure factors, mean site concentrations or predicted maximum groundwater discharge concentrations, and LOAEL–based TRVs, as compared to NOAEL–based TRVs. The results of the EPRE are summarized below.

- Carbon disulfide in groundwater is an ECOPC for aquatic biota because it exceeds the EPA Region IV ESV (EPA 1996a). Carbon disulfide in groundwater is unlikely to be a potential hazard to aquatic biota living in downgradient surface water because the predicted maximum discharge concentration does not exceed the ESV. Therefore, carbon disulfide is unlikely to pose hazard to aquatic biota.
- Cadmium, chromium, and lead collected from the sediment in the depression area are ECOPCs for terrestrial receptors because the preliminary HQs exceeded 1. The supplemental risk calculations for these

ECOPCs resulted in HQs less than 1 for shrews and robins. Therefore, cadmium, chromium, and lead are unlikely to pose a risk to terrestrial receptors.

- There are no ECOPCs in surface water runoff or groundwater for terrestrial receptors.

10.2.4 Human Health Baseline Risk Assessment

An HHBRA was performed to assess CMCOPCs identified in the fate and transport analysis and HHCOPCs identified in surface water and sediment in the HHPRE. Cadmium was identified as a CMCOPC under the fate and transport analysis. Cadmium was identified as an HHCOPC in surface water and sediment in the HHPRE. Because the sediment is not associated with a permanent surface water body but is located within a wooded area in which water is present only after rainfall events, the sediment at SWMU 27J was evaluated as surface soil. The potential exposure to COPCs in sediment was evaluated using surface soil scenarios.
The following bullets present the conclusions of the HHBRA.

- Cadmium in groundwater potentially may migrate to surface water, a tributary of Peacock Creek, located approximately 1,200 feet away from the site. Modeling results indicated, however, that cadmium will not migrate to this potential point of discharge (receptor point); therefore, the risk associated with cadmium migrating to surface water was not addressed.

- Modeling estimated that cadmium (a CMCOPC) would leach from sediment to groundwater at a concentration of 143 μg/L, which was above the MCL of 5 μg/L. A juvenile trespasser playing in the area of sediment and surface water contamination represents the current receptor population. Future land-use populations include an Installation worker, a juvenile trespasser, and a resident. The Installation worker and the resident represent both on-site and off-site receptors. The juvenile trespasser is an off-site receptor only. The residential receptor population was divided into an adult and a child because the adult receptor is at greater risk from exposure to carcinogens, while the child is at greater risk from exposure to noncarcinogens. The off-site Installation worker, off-site resident child, and off-site resident adult had total HIs that exceeded the target level of 1.0. The HIs for exposure to cadmium in sediment as a result of direct exposure and exposure via leaching to groundwater exceeded the target level of 0.1. The HIs for exposure via groundwater were more than an order of magnitude higher than the HIs for direct exposure to cadmium in sediment. Cadmium was identified as a COC in sediment. Remedial levels were derived for cadmium in sediment that are protective of the most sensitive receptor population and the most significant exposure pathway—the resident child with an HI of 0.698 for direct exposure to sediment and an HI of 19.1 for exposure to cadmium that has leached into groundwater. Given that the HI for exposure via groundwater (19.1) was more than an order of magnitude higher than the HI of 0.698 for direct exposure, the risk-based remedial values were based on the protection of groundwater. The remedial level for a CMCOC represents that soil concentration that is unlikely to leach into groundwater in concentrations that present a significant threat to human health. The selection of a remedial level must take into consideration the target risk value for risk-based remedial levels and the regulatory standards for groundwater (i.e., the MCL). The MCL for cadmium (5 μg/L) was selected as the target groundwater concentration because it was less than the risk-based remedial level (7 μg/L) based on an HI of 1.0. The recommended remedial level for cadmium in sediment/surface soil is 0.43 mg/kg based on a target groundwater concentration of 5 μg/L.

10.3 RISK MANAGEMENT AND SITE RECOMMENDATIONS

- Sediment/surface soil located off-site of SWMU 27J, Building 10531 was identified as a potential COC based on the potential to leach to groundwater at a concentration that may be a risk to human health and on direct exposure to the sediment/soil. Cadmium was not detected in any of the groundwater monitoring wells, and the results of the SESOIL modeling indicate that cadmium will take more than 200 years to reach the groundwater. The risk-based remedial level, based on an HI of 1.0 for direct exposure to soil, is 17.8 mg/kg, which is greater than the maximum detected concentration of 12.4 mg/kg. Given the conservatism of the leachate modeling, the extended period of time before any potential impact to groundwater may occur, and the fact that cadmium was not detected in groundwater, the potential threat to human health as a result of exposure via groundwater is likely to be minimal. Based on the risk-based remedial level for direct exposure to soil (17.8 mg/kg), which is greater than the maximum detected concentration (12.4 mg/kg), cadmium in sediment/surface soil does not require further investigation and/or evaluation.

- Based on the information provided in this section, Fort Stewart respectfully requests that SWMU 27J, Building 10531 be assigned an NFA status. If approved by GEPD, the Installation's Subpart B permit should be amended to annotate this change in investigative status.

- A CAP will not be required for this site. All permanent monitoring wells installed at the site will be properly abandoned within 90 days of approval of this report.

11.0 REFERENCES

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Table 1. Summary of Phase I RFI Analytes Detected in Surface Soil, SWMU 27J, Building 10531

Station	Reference Background Criteria	7UGP1	7UGP2	7UGP3	7UGP4
Sample ID		7U1111	7U1211	7U1311	7U1411
Date		01/29/98	01/29/98	01/29/98	01/30/98
Depth (feet)		0 to 2	0 to 2	1 to 2	1 to 2
Sample Type		Grab	Grab	Grab	Grab
Volatile Organic Compounds (mg/kg)					
Xylenes, total	0.00	**0.0034**	**0.0027**		
Semivolatile Organic Compounds (mg/kg)					
Di-*N*-octyl phthalate	0.00		**0.433**		
Metals (mg/kg)					
Lead	8.81	7.9	3.7	0.95	2

Bold indicates concentrations above reference background criteria.

Table 2. Summary of Phase I RFI Analytes Detected in Groundwater, SWMU 27J, Building 10531

Station	Reference Background Criteria	MCL	7UGP1	7UGP2	7UGP3	7UGP4
Sample ID			7U4111	7U4211	7U4311	7U4411
Date			01/29/98	01/28/98	01/29/98	01/30/98
Sample Type			Grab	Grab	Grab	Grab
Semivolatile Organic Compounds (μg/L)						
Benzo(*a*)pyrene	0.00	0.2		*6.1*	*5.7*	*9.4*
Di-*N*-octyl phthalate	0.00					13.2

Bold indicates concentrations above reference background criteria.
Boxed *italic* indicates concentrations above MCLs.

Table 3. Monitoring Well Construction Summary, SWMU 27J, Building 10531

Well No.	Date Installed	Size/Type	Coordinates	Total Depth (feet)	Screen Interval (feet bgs)	Top of Filter Pack Elevation (feet bgs)	Top of Casing Elevation (feet)
27J-MW1	10/08/99	2-inch PVC	N681027.76 E837276.71	15	2.20 to 12.20	1.2	51.92
27J-MW2	10/09/99	2-inch PVC	N681035.19 E837341.25	13	2.15 to 12.15	1.2	51.06
27J-MW3	10/09/99	2-inch PVC	N681067.40 E837351.97	14	2.10 to 12.10	1.2	51.11

Note: All elevations are National Geodetic Vertical Datum 1929.
PVC = Polyvinyl chloride.

Table 4. Summary of Geotechnical Analyses, SWMU 27J, Building 10531

Station	27J-MW1	27J-MW2	27J-MW3
Sample ID	7U1173	7U1273	7U1373
Depth (feet)	8 to 10	12 to 13	7 to 8
Moisture content (%)	16.78	15.99	12.18
Liquid limit (%)	24.8	22.2	13.8
Plastic limit (%)	18.7	17.2	13.3
Plasticity index (%)	6.1	5.0	0.5
Class	CL-ML	CL-ML	ML
Gravel (%)	0.0	1.37	2.19
Sand (%)	57.07	74.17	75.65
Fines (%)	42.93	24.46	22.06
Specific gravity	2.64	NA	NA
Soil porosity	0.34	NA	NA
Bulk density (pcf)	116.78	NA	NA
Permeability (cm/sec)	1.60E-7	NA	NA

NA = Not analyzed.
pcf = Pounds per cubic foot.

Table 5. Well Development Summary, SWMU 27J, Building 10531

Well No.	Date	Total Development Time (hours)	Total Volume Removed (gallons)	Final Turbidity Reading (NTUs)	Total Well Depth (feet)
27J-MW1	10/13/99	12 hours, 30 minutes	580	9.8	12.11
27J-MW2	10/13/99	11 hours	466	8.7	12.22
27J-MW3	10/13/99	10 hours, 23 minutes	485	9.9	12.06

Table 6. Field Parameter Measurements during Groundwater Sampling, SWMU 27J, Building 10531

Well No.	Date	pH (su)	Conductivity (mS/cm)	Temperature (°C)	Turbidity (NTUs)	DO (mg/L)	Redox (mV)
27J-MW1[a]	10/29/99	5.50	76.0	27.14	88.2	2.46	-13.9
27J-MW2	10/28/99	5.77	108.0	26.10	9.6	2.72	-147.9
27J-MW3	10/29/99	5.98	152.0	23.84	7.9	0.50	-32.9
Average[b]		5.88					

[a]Site-specific background location.
[b]Site-specific background location not included in calculation of average.

Table 7. Summary of Phase II RFI Analytes Detected in Groundwater in Geoprobes, SWMU 27J, Building 10531

Station	Reference Background Criteria	Maximum Contaminant Level	27J-GP5	27J-GP6	27J-GP7	27J-GP8
Sample ID			7U4551	7U4651	7U4751	7U4851
Date			09/23/99	09/23/99	09/22/99	09/22/99
Sample Type			Grab	Grab	Grab	Grab
Volatile Organic Compounds (µg/L)						
Carbon disulfide	0.00		**5.1**	**4.9**		

Bold indicates concentrations above reference background criteria.

Table 8. Summary of Phase II RFI Analytes Detected in Groundwater in Monitoring Wells, SWMU 27J, Building 10531

Station	Reference Background	Maximum Contaminant Level	27J-MW1[a]	27J-MW2	27J-MW3	27J-MW1
Sample ID			7U4171	7U4271	7U4371	7U1412
Date			10/29/99	10/28/99	10/29/99	6/23/00
Sample Type			Grab	Grab	Grab	Grab
Volatile Organic Compounds (µg/L)						
2-Hexanone	0.00				**3.4**	NA
Carbon disulfide	0.00					NA
Semivolatile Organic Compounds (µg/L)						
Benzoic acid	0.00				**14.4**	NA
Bis(2-ethylhexyl)phthalate	0.00	6	***139***[b]			
Metals (µg/L)						
Barium	71.72	2,000	64	13.9	36.3	NA
Chromium	3.56	100	**4.8**			NA
Lead	4.69	15	2.2		1.8	NA

[a]Site-specific background location.

[b]Bis(2-ethylhexyl)phthalate was believed to be the result of field or laboratory contamination. MW1 was resampled in June 2000. Bis(2-ethylhexyl)phthalate was not detected in the resampled groundwater; therefore, the initial bis(2-ethylhexyl)phthalate was considered to be due to field or laboratory contamination. Bis(2-ethylhexyl)phthalate is not considered to be an SRC in groundwater.

NA = Not analyzed.

Bold indicates concentrations above reference background criteria.

Boxed *italic* indicates concentrations above MCLs.

Table 9. Summary of Phase II RFI Analytes Detected in Surface Water, SWMU 27J, Building 10531

Station	**Reference Background Criteria**[a]	**27J-SWS1**	**27J-SWS2**
Sample ID		**7U3111**	**7U3211**
Date		**11/01/99**	**11/01/99**
Sample Type		**Grab**	**Grab**
	Metals (μg/L)		
Barium	44.8	30.6	29.1
Cadmium	0.2	**47.4**	**46.9**
Lead	5.2	**8.3**	**7.4**

[a]Site reference background location is SWS1 in Mill Creek from 724th Tanker Purging Station, SWMU 26.
Bold indicates concentrations above reference background criteria.

Table 10. Summary of Phase II RFI Analytes Detected in Sediment, SWMU 27J, Building 10531

Station	**Reference Background Criteria**[a]	**27J-SWS1**	**27J-SWS2**
Sample ID		**7U2111**	**7U2211**
Date		**11/01/99**	**11/01/99**
Sample Type		**Grab**	**Grab**
	Volatile Organic Compounds (mg/kg)		
Acetone	0.00	**0.035**	
	Semivolatile Organic Compounds (mg/kg)		
Benzo(*g*,*h*,*i*)perylene	0.00	**0.038**	**0.0344**
Bis(2-ethylhexyl)phthalate	0.00	**0.924**	**0.502**
Pyrene	0.00	**0.0764**	**0.0651**
	Metals (mg/kg)		
Arsenic	2.1	1.8	1
Barium	14.7	**24.8**	**29.2**
Cadmium	0.175	**12.4**	**6.1**
Chromium	6.21	**22.2**	**16.7**
Lead	8.81	**19**	8.4
Selenium	0.41	**0.42**	0.26
Silver	0.15	**0.55**	

[a]Site reference background criteria are surface soil reference criteria because surface water is present only after rainfall events.
Bold indicates concentrations above reference background criteria.

Table 11. Summary of Site-related Contaminants, SWMU 27J, Building 10531

Analyte	Maximum Concentration (mg/kg)			Maximum Concentration (µg/L)	
	Surface Soil	Subsurface Soil	Sediment	Groundwater	Surface Water
Volatile Organic Compounds					
Acetone	ND	NC	0.035	ND	ND
2-Hexanone	ND	NC	ND	3.4	ND
Carbon disulfide	ND	NC	ND	5.1	ND
Xylenes, total	0.0034[a]	NC	ND	ND	ND
Semivolatile Organic Compounds					
Benzoic acid	ND	NC	ND	14.4	ND
Benzo(*g,h,i*)perylene	ND	NC	0.038	ND	ND
Bis(2-ethylhexyl)phthalate	ND	NC	0.924	ND	ND
Di-*N*-octyl phthalate	0.433[a]	NC	ND	ND	ND
Pyrene	ND	NC	0.0764	ND	ND
Metals					
Arsenic	NA	NC	BRBC	ND	ND
Barium	NA	NC	29.2	BRBC	BRBC
Cadmium	NA	NC	12.4	ND	47.4
Chromium	NA	NC	22.2	4.8[b]	ND
Lead	BRBC	NC	19	BRBC	8.3
Selenium	NA	NC	0.42	ND	ND
Silver	NA	NC	0.55	ND	ND

[a]Phase I RFI data.
[b]Constituents detected at the background location (MW1) are not considered to be SRCs.
BRBC = Below reference background criterion.
NC = Soil samples not collected based on field headspace analysis.
ND = Not detected.

Table 12. GSSL Screening of Site-related Contaminants in Soil and Sediment, SWMU 27J, Building 10531

SOIL			
Site-related Contaminant	**Maximum Concentration**	**GSSL[a]**	**CMCOPC?**
Volatile Organic Compounds (mg/kg)			
Xylenes, total	0.0034	190	No
Semivolatile Organic Compounds (mg/kg)			
Di-*N*-octyl phthalate	0.433	10,000	No

SEDIMENT			
Site-related Contaminant	**Maximum Concentration**	**GSSL[a]**	**CMCOPC?**
Volatile Organic Compounds (mg/kg)			
Acetone	0.035	16	No
Semivolatile Organic Compounds (mg/kg)			
Benzo(*g,h,i*)perylene[b]	0.038	394	No
Bis(2-ethylhexyl)phthalate	0.924	3,600	No
Pyrene	0.0764	4,200	No
Metals (mg/kg)			
Barium	29.2	1,600	No
Cadmium	12.4	8	Yes
Chromium	22.2	38	No
Lead[c]	19	400	No
Selenium	0.42	5	No
Silver	0.55	34	No

[a]GSSL = EPA GSSL with a dilution attenuation factor (DAF) of 20 for inorganics and volatile and semivolatile organics. A DAF of 20 for inorganics was used because the area of potential contamination is less than 0.5 acre; unless otherwise indicated, GSSL is taken from Soil Screening Guidance: Technical Background Document (EPA 1996b).

[b]EPA–suggested GSSL is not available; GSSL is calculated following Soil Screening Guidance: Technical Background Document (EPA 1996b). GSSLs are back-calculated from MCL, if available; otherwise, GSSLs are back-calculated based on EPA Region III RBCs corresponding to 10^{-6} risk or HQ = 1 (SAIC 1999).

[c]EPA–suggested GSSL is not available; GSSL is calculated following Soil Screening Guidance: Technical Background Document (EPA 1996b).

Table 13. Human Health Risk Screening for Surface Soil, Groundwater, Surface Water, and Sediment, SWMU 27J, Building 10531

SURFACE SOIL						
Analyte	Results > Detection Limit	Minimum Detect	Maximum Detect	EPA Region III Residential	HHCOPC?	Justification
Volatile Organic Compounds (mg/kg)						
Xylenes, total	2/4	0.0027	0.0034	16,000	No	Max Detect < Risk Criteria
Semivolatile Organic Compounds (mg/kg)						
Di-*N*-octyl phthalate	1/4	0.433	0.433	160	No	Max Detect < Risk Criteria

GROUNDWATER						
Analyte	Freq. of Detection	Minimum Detect	Maximum Detect	Human Health Criteria	HHCOPC?	Justification
Volatile Organic Compounds (μg/L)						
2-Hexanone	1/6	3.4	3.4	146	No	Max Detect < Risk Criteria
Carbon disulfide	2/6	4.9	5.1	104.3	No	Max Detect < Risk Criteria
Semivolatile Organic Compounds (μg/L)						
Benzoic acid	1/2	14.4	14.4	14,600	No	Max Detect < Risk Criteria

SURFACE WATER								
Analyte	Freq. of Detection	Minimum Detect	Maximum Detect	Human Health Criteria	EPA Region III Tap Water (μg/L)	AWQC (μg/L)	HHCOPC?	Justification
Metals (μg/L)								
Cadmium	2/2	46.9	47.4	0.2	1.825	NA	Yes	Max Detect > Risk Criteria
Lead	2/2	7.4	8.3	5.2	15	NA	No	Max Detect < Risk Criteria

Note: Footnotes appear on page 33.

Table 13. Human Health Risk Screening for Surface Soil, Groundwater, Surface Water, and Sediment, SWMU 27J, Building 10531 (continued)

SEDIMENT						
Analyte	**Results > Detection Limit**	**Minimum Detect**	**Maximum Detect**	**EPA Region III Residential**	**HHCOPC?**	**Justification**
Volatile Organic Compounds (mg/kg)						
Acetone	1/2	0.035	0.035	782.1	No	Max Detect < Risk Criteria
Semivolatile Organic Compounds (mg/kg)						
Benzo(*g,h,i*)perylene	2/2	0.0344	0.038	8.75	No	Max Detect < Risk Criteria
Bis(2-ethylhexyl)phthalate	2/2	0.502	0.924	45.62	No	Max Detect < Risk Criteria
Pyrene	2/2	0.0651	0.0764	234.6	No	Max Detect < Risk Criteria
Metals (mg/kg)						
Barium	2/2	24.8	29.2	547.5	No	Max Detect < Risk Criteria
Cadmium	2/2	6.1	12.4	7.821	Yes	Max Detect > Risk Criteria
Chromium	2/2	16.7	22.2	23.46	No	Max Detect < Risk Criteria
Lead	2/2	8.4	19	400	No	Max Detect < Risk Criteria
Selenium	2/2	0.26	0.42	39.11	No	Max Detect < Risk Criteria
Silver	1/2	0.55	0.55	39.11	No	Max Detect < Risk Criteria

NA = AWQC not available.

Table 14. Ecological Screening Value Comparison for Analytes Detected in Groundwater, SWMU 27J, Building 10531

Analyte	SWMU 27J, Building 10531 Maximum	ESV	ECOPC Aquatic Biota?	Justification
Volatile Organic Compounds (µg/L)				
2-Hexanone	3.4	99[a]	No	Max Detect < ESV
Carbon disulfide	5.1	0.92[a]	Yes	Max Detect > ESV
Semivolatile Organic Compounds (µg/L)				
Benzoic acid	14.4	41.6[a]	No	Max Detect < ESV

[a]Chronic National Ambient Water Quality Criteria or Tier II values as reported in Suter and Tsao (1996), Table 1 or Table 3.

ESV = EPA Region IV ESVs (EPA 1996a) and, where indicated, alternative values for analytes without ESVs.

Cells with double borders indicate concentrations exceeding ESV or, when there is no ESV, compounds that become ECOPCs by default.

Table 15. Derivation of NOAELs for Mammal Test Species, SWMU 27J, Building 10531

ECOPC	Test Species	Test Species Body Weight (kg) BW_t	Benchmark (mg/kg/day)	Test Duration	Endpoint	Effect	Source	Duration Conversion Factor (DCF)	Endpoint Conversion Factor (ECF)	NOAEL (mg/kg/day) Benchmark × DCF × ECF
INORGANICS										
Metals										
Arsenic	Mouse	3.00E-02	1.26E-00	Chronic	LOAEL	Reproduction	Schroeder and Mitchner (1971) in [1]	1.0	0.1	1.26E-01
Barium	Rat	4.35E-01	5.06E-00	Chronic	NOAEL	Growth	Perry et al. (1983) in [1]	1.0	1.0	5.06E-00
Cadmium	Rat	3.03E-01	1.00E-00	Chronic	NOAEL	Reproduction	Sutou et al. (1980b) in [1]	1.0	1.0	1.00E-00
Chromium	Rat	3.50E-01	2.74E+03	Chronic	NOAEL	Reproduction	Ivankovic and Preussmann (1975) in [1]	1.0	1.0	2.74E+03
Lead[a]	Rat	3.50E-01	8.00E-00	Chronic	NOAEL	Reproduction	Azar et al. (1973) in [1]	1.0	1.0	8.00E-00
Selenium	Rat	3.50E-01	2.00E-01	Chronic	NOAEL	Reproduction	Rosenfeld and Beath (1954) in [1]	1.0	1.0	2.00E-01
Silver	Rat	3.50E-01	1.01E+02	Chronic	NOAEL	None	Walker (1971) in [2]	1.0	1.0	1.01E+02
ORGANICS										
Volatile Organic Compounds										
Acetone	Rat	3.50E-01	1.00E+02	Subchronic	NOAEL	Reproduction	EPA (1986c) in [1]	0.1	1.0	1.00E+01
Carbon disulfide	Rat	3.50E-01	1.10E+01	Chronic	NOAEL	Fetal toxicity	Hardin et al. (1981) in [3]	1.0	1.0	1.10E+01
Semivolatile Organic Compounds										
Benzo(*g,h,i*)perylene	Mouse	3.00E-02	1.33E+01	Chronic	NOAEL	None	Neal and Rigdon (1967) in [2]	1.0	1.0	1.33E+01
Bis(2-ethylhexyl)phthalate	Mouse	3.00E-02	1.83E+01	Chronic	NOAEL	Reproduction	Lamb et al. (1987) in [1]	1.0	1.0	1.83E+01
Pyrene	Mouse	3.00E-02	1.00E+01	Chronic	LOAEL	Reproduction	Opresko (1995) in [2]	1.0	0.1	1.00E-00

[a] = Lead acetate.
DCF = 1 if chronic, 0.1 if subchronic (Sample, Opresko, and Suter 1996).
ECF = 1 if NOAEL, 0.1 if LOAEL (Sample, Opresko, and Suter 1996).
[1] = Sample, Opresko, and Suter (1996).
[2] = QST (1997); all values assumed to be chronic.
[3] = Integrated Risk Information System (EPA 1997).

Table 16. Derivation of NOAELs for Bird Test Species, SWMU 27J, Building 10531

ECOPC	Test Species	Test Species Body Weight (kg) BW_t	Benchmark (mg/kg/day)	Test Duration	Endpoint	Effect	Source	Duration Conversion Factor (DCF)	Endpoint Conversion Factor (ECF)	NOAEL (mg/kg/day) Benchmark × DCF × ECF
INORGANICS										
Metals										
Arsenic	Mallard duck	1.00E+00	5.14E+00	Chronic	NOAEL	Mortality	USFWS (1979) in [1]	1.0	1.0	5.14E+00
Barium	Chick (14 days old)	1.21E-01	2.08E+02	Subchronic	NOAEL	Mortality	Johnson et al. (1960) in [1]	0.1	1.0	2.08E+01
Cadmium	Mallard duck	1.15E+00	1.45E+00	Chronic	NOAEL	Reproduction	White and Finley (1978) in [1]	1.0	1.0	1.45E+00
Chromium	Black duck	1.25E+00	1.00E+00	Chronic	NOAEL	Reproduction	Haseltine et al. (unpubl.) in [1]	1.0	1.0	1.00E+00
Lead[a]	Quail	1.50E-01	1.13E+00	Chronic	NOAEL	Reproduction	Edens et al. (1976) in [1]	1.0	1.0	1.13E+00
Selenium	Mallard duck	1.00E+00	5.00E-01	Chronic	NOAEL	Reproduction	Heinz et al. (1989) in [1]	1.0	1.0	5.00E-01
Silver	Composite bird	8.50E-01	5.79E+01	Chronic	NOAEL	None	Shortelle et al. (1997) in [2]	1.0	1.0	5.79E+01
ORGANICS										
Volatile Organic Compounds										
Acetone	None	None	None	None	None	None	None	None	None	No NOAEL
Carbon disulfide	None	None	None	None	None	None	None	None	None	No NOAEL
Semivolatile Organic Compounds										
Benzo(*g,h,i*)perylene	Composite bird	8.50E-01	1.24E+01	Chronic	NOAEL	None	Shortelle et al. (1997) in [2]	1.0	1.0	1.24E+01
Bis(2-ethylhexyl)phthalate	Ringed dove	1.55E-01	1.10E+00	Chronic	NOAEL	Reproduction	Peakall (1974) in [1]	1.0	1.0	1.10E+00
Pyrene	Composite bird	8.50E-01	9.97E+00	Chronic	NOAEL	None	Shortelle et al. (1997) in [2]	1.0	1.0	9.97E+00

[a] = Lead acetate.
DCF = 1 if chronic, 0.1 if subchronic (Sample, Opresko, and Suter 1996).
ECF = 1 if NOAEL, 0.1 if LOAEL (Sample, Opresko, and Suter 1996).
[1] = Sample, Opresko, and Suter 1996.
[2] = QST (1997).

Table 17. Derivation of NOAELs and Screening Toxicity Reference Values for Mammal Receptors, SWMU 27J, Building 10531

Analyte	Test Species	Test Species Body Weight (kg) BW_t	Test Species $NOAEL_t$ (mg/kg/day)	Raccoon		Short-tailed Shrew		Mink	
				Body-weight Conversion Factor BW_{conv} $(BW_t / BW)^{0.25}$	NOAEL (mg/kg/day) $NOAEL_t \times BW_{conv}$	Body-weight Conversion Factor BW_{conv} $(BW_t / BW)^{0.25}$	NOAEL (mg/kg/day) $NOAEL_t \times BW_{conv}$	Body-weight Conversion Factor BW_{conv} $(BW_t / BW)^{0.25}$	NOAEL (mg/kg/day) $NOAEL_t \times BW_{conv}$
INORGANICS									
Metals									
Arsenic	Mouse	3.00E-02	1.26E-01	2.66E-01	3.35E-02	1.19E+00	1.50E-01	4.16E-01	5.24E-02
Barium	Rat	4.35E-01	5.06E+00	5.19E-01	2.63E+00	2.32E+00	1.17E+01	8.12E-01	4.11E+00
Cadmium	Rat	3.03E-01	1.00E+00	4.74E-01	4.74E-01	2.12E+00	2.12E+00	7.42E-01	7.42E-01
Chromium	Rat	3.50E-01	2.74E+03	4.92E-01	1.35E+03	2.20E+00	6.02E+03	7.69E-01	2.11E+03
Lead	Rat	3.50E-01	8.00E+00	4.92E-01	3.93E+00	2.20E+00	1.76E+01	7.69E-01	6.15E+00
Selenium	Rat	3.50E-01	2.00E-01	4.92E-01	9.84E-02	2.20E+00	4.40E-01	7.69E-01	1.54E-01
Silver	Rat	3.50E-01	1.01E+02	4.92E-01	4.98E+01	2.20E+00	2.22E+02	7.69E-01	7.78E+01
ORGANICS									
Volatile Organic Compounds									
Acetone	Rat	3.50E-01	1.00E+01	4.92E-01	4.92E+00	2.20E+00	2.20E+01	7.69E-01	7.69E+00
Carbon disulfide	Rat	3.50E-01	1.10E+01	4.92E-01	5.41E+00	2.20E+00	2.42E+01	7.69E-01	8.46E+00
Semivolatile Organic Compounds									
Benzo(*g,h,i*)perylene	Mouse	3.00E-02	1.33E+01	2.66E-01	3.54E+00	1.19E+00	1.58E+01	4.16E-01	5.54E+00
Bis(2-ethylhexyl)phthalate	Mouse	3.00E-02	1.83E+01	2.66E-01	4.87E+00	1.19E+00	2.18E+01	4.16E-01	7.61E+00
Pyrene	Mouse	3.00E-02	1.00E+00	2.66E-01	2.66E-01	1.19E+00	1.19E+00	4.16E-01	4.16E-01

BW (kg) Raccoon = 5.98.
BW (kg) Shrew = 0.015.
BW (kg) Mink = 1.0.

Table 18. Derivation of NOAELs and Screening Toxicity Reference Values for Bird Receptors, SWMU 27J, Building 10531

Analyte	Test Species	Test Species Body Weight (kg) BW_t	Test Species $NOAEL_t$ (mg/kg/day)	American Robin: Body-weight Conversion Factor BW_{conv} $(BW_t / BW)^0$	American Robin: NOAEL (mg/kg/day) $NOAEL_t \times BW_{conv}$	Green Heron: Body-weight Conversion Factor BW_{conv} $(BW_t / BW)^0$	Green Heron: NOAEL (mg/kg/day) $NOAEL_t \times BW_{conv}$
INORGANICS							
Metals							
Arsenic	Mallard duck	1.00E+00	5.14E+00	1.00E+00	5.14E+00	1.00E+00	5.14E+00
Barium	Chick (14 days old)	1.21E-01	2.08E+01	1.00E+00	2.08E+01	1.00E+00	2.08E+01
Cadmium	Mallard duck	1.15E+00	1.45E+00	1.00E+00	1.45E+00	1.00E+00	1.45E+00
Chromium	Black duck	1.25E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Lead	Quail	1.50E-01	1.13E+00	1.00E+00	1.13E+00	1.00E+00	1.13E+00
Selenium	Mallard duck	1.00E+00	5.00E-01	1.00E+00	5.00E-01	1.00E+00	5.00E-01
Silver	Composite bird	8.50E-01	5.79E+01	1.00E+00	5.79E+01	1.00E+00	5.79E+01
ORGANICS							
Volatile Organic Compounds							
Acetone	None	None	No NOAEL	None	No NOAEL	None	No NOAEL
Carbon disulfide	None	None	No NOAEL	None	No NOAEL	None	No NOAEL
Semivolatile Organic Compounds							
Benzo(*g,h,i*)perylene	Composite bird	8.50E-01	1.24E+01	1.00E+00	1.24E+01	1.00E+00	1.24E+01
Bis(2-ethylhexyl)phthalate	Ringed dove	1.55E-01	1.10E+00	1.00E+00	1.10E+00	1.00E+00	1.10E+00
Pyrene	Composite bird	8.50E-01	9.97E+00	1.00E+00	9.97E+00	1.00E+00	9.97E+00

BW (kg) Robin = 0.08.
BW (kg) Green heron = 0.25.

Table 19. Derivation of LOAEL Toxicity Reference Values for Mammal Test Species, SWMU 27J, Building 10531

ECOPC	Test Species	Test Species Body Weight (kg) BW_t	Benchmark (mg/kg/day)	Test Duration	Endpoint	Effect	Source	Duration Conversion Factor (DCF)	Endpoint Conversion Factor (ECF)	TRV (mg/kg/day) Benchmark × DCF × ECF
						Metals				
Cadmium	Rat	3.03E-01	1.00E+01	Chronic	LOAEL	Reproduction	Sutou et al. (1980b) in [1]	1.0	1.0	1.00E+01
Chromium	Rat	3.50E-01	2.74E+03	Chronic	NOAEL	Reproduction	Ivankovic and Preussmann (1975) in [1]	1.0	10.0	2.74E+04
Lead	Rat	3.50E-01	8.00E+01	Chronic	LOAEL	Reproduction	Azar et al. (1973) in [1]	1.0	1.0	8.00E+01

DCF = 1 if chronic, 0.1 if subchronic (Sample, Opresko, and Suter 1996).
ECF = 10 if NOAEL, 1.0 if LOAEL (Sample, Opresko, and Suter 1996).
[1] = Sample, Opresko, and Suter (1996).

Table 20. Derivation of LOAEL Toxicity Reference Values for Bird Test Species, SWMU 27J, Building 10531

ECOPC	Test Species	Test Species Body Weight (kg) BW_t	Benchmark (mg/kg/day)	Test Duration	Endpoint	Effect	Source	Duration Conversion Factor (DCF)	Endpoint Conversion Factor (ECF)	TRV (mg/kg/day) Benchmark × DCF × ECF
						Metals				
Cadmium	Mallard duck	1.15E-00	2.00E+01	Chronic	LOAEL	Reproduction	White and Finley (1978) in [1]	1.0	1.0	2.00E+01
Chromium	Black duck	1.25E-00	5.00E-00	Chronic	LOAEL	Reproduction	Haseltine et al. (unpubl.) in [1]	1.0	1.0	5.00E-00
Lead	Quail	1.50E-01	1.13E+01	Chronic	LOAEL	Reproduction	Edens et al. (1976) in [1]	1.0	1.0	1.13E+01

DCF = Duration conversion factor; 1 if chronic, 0.1 if subchronic (Sample, Opresko, and Suter 1996).
ECF = Endpoint conversion factor; 10 if NOAEL, 1.0 if LOAEL (Sample, Opresko, and Suter 1996).
[1] = Sample, Opresko, and Suter (1996).

Table 21. Derivation of LOAEL Toxicity Reference Values for Mammal Receptors, SWMU 27J, Building 10531

				Raccoon		Short-tailed Shrew		Mink	
ECOPC	Test Species	Test Species Body Weight BW_t (kg)	TRV_t (mg/kg/day)	Body-weight Conversion Factor BW_{conv} $(BW_t / BW)^{0.25}$	TRV (mg/kg/day) $TRV_t \times BW_{conv}$	Body-weight Conversion Factor BWconv $(BW_t / BW)^{0.25}$	TRV (mg/kg/day) $TRV_t \times BW_{conv}$	Body-weight Conversion Factor BW_{conv} $(BW_t / BW)^{0.25}$	TRV (mg/kg/day) $TRV_t \times BW_{conv}$
Metals									
Cadmium	Rat	3.03E-01	1.00E+01	5.64E-01	5.64E-00	2.12E-00	2.12E+01	7.42E-01	7.42E-00
Chromium	Rat	3.50E-01	2.74E+04	5.84E-01	1.60E+04	2.20E-00	6.02E+04	7.69E-01	2.11E+04
Lead	Rat	3.50E-01	8.00E+01	5.84E-01	4.68E+01	2.20E-00	1.76E+02	7.69E-01	6.15E+01

BW (kg) Raccoon = 3 per Rod Stafford (GEPD), September 1999.
BW (kg) Short-tailed shrew = 0.015 per Sample, Opresko, and Suter (1996), Table B.1.
BW (kg) Mink = 1 per Sample, Opresko, and Suter (1996), Table B.1.

Table 22. Derivation of LOAEL Toxicity Reference Values for Bird Receptors, SWMU 27J, Building 10531

				American Robin		Green Heron	
ECOPC	Test Species	Test Species Body Weight BW_t (kg)	TRV_t (mg/kg/day)	Body-weight Conversion Factor BW_{conv} $(BW_t / BW)^0$	TRV (mg/kg/day) $TRV_t \times BW_{conv}$	Body-weight Conversion Factor BW_{conv} $(BW_t / BW)^0$	TRV (mg/kg/day) $TRV_t \times BW_{conv}$
Metals							
Cadmium	Mallard duck	1.15E-00	2.00E+01	1.00E-00	2.00E+01	1.00E-00	2.00E+01
Chromium	Black duck	1.25E-00	5.00E-00	1.00E-00	5.00E-00	1.00E-00	5.00E-00
Lead	Quail	1.50E-01	1.13E+01	1.00E-00	1.13E+01	1.00E-00	1.13E+01

BW (kg) American robin = 0.077 (Sample, Opresko, and Suter 1996; Table B.1).
BW (kg) Green heron = 0.241 (Birds of North America, No. 129, 1994).

Table 23. Preliminary Risk Calculations for ECOPCs in Surface Water, SWMU 27J, Building 10531

ECOPC	C_{Max} (µg/L)	Raccoon		
		ADD (mg/kg/day) = $C_{Max} \times 0.001 \times IR_W$	TRV (mg/kg/day)	HQ = ADD/TRV
Metals				
Cadmium	47.4	3.79E-03	4.74E-01	7.99E-03
Lead	8.3	6.64E-04	3.93E+00	1.69E-04

0.001 (mg/µg) = conversion from µg to mg.
ADD = Average daily dose (mg/kg/day).
C_{Max} = Maximum detected concentration (µg/L).
HQ = Hazard quotient.
IR_W = Raccoon water ingestion rate (L/kg/day) = 0.080.
TRV =Toxicity reference value = NOAEL (mg/kg/day); see Table 17.

Table 24. Preliminary Risk Calculations for ECOPCs in Drainage Area Sediment, SWMU 27J, Building 10531

			Short-tailed Shrew			American Robin		
ECOPC	C_{Max} (mg/kg)	BAF_i	ADD (mg/kg/day) = $C_{Max} \times BAF_i \times IR_S$	TRV (mg/kg/day)	HQ = ADD/TRV	ADD (mg/kg/day) = $C_{Max} \times BAF_i \times IR_R$	TRV (mg/kg/day)	HQ = ADD/TRV
Volatile Organic Compounds								
Acetone	0.035	5.00E-02	9.80E-04	2.20E+01	4.46E-05	2.12E-03	No TRV	No HQ
Semivolatile Organic Compounds								
Benzo(*g,h,i*)perylene	0.038	5.00E-02	1.06E-03	1.58E+01	6.73E-05	2.30E-03	1.24E+01	1.85E-04
Bis(2-ethylhexyl)phthalate	0.924	5.00E-02	2.59E-02	2.18E+01	1.19E-03	5.59E-02	1.10E+00	5.08E-02
Pyrene	0.0764	5.00E-02	2.14E-03	1.19E+00	1.80E-03	4.62E-03	9.97E+00	4.64E-04
				HI =	3.05E-03		**HI =**	5.15E-02
Metals								
Barium	29.2	7.50E-03	1.23E-01	1.17E+01	1.04E-02	2.65E-01	2.08E+01	1.27E-02
Cadmium	12.4	1.10E+01	7.64E+01	2.12E+00	3.60E+01	1.65E+02	1.45E+00	1.14E+02
Chromium	22.2	1.60E-01	1.99E+00	6.02E+03	3.31E-04	4.30E+00	1.00E+00	4.30E+00
Lead	19	4.00E-01	4.26E+00	1.76E+01	2.42E-01	9.20E+00	1.13E+00	8.14E+00
Selenium	0.42	7.60E-01	1.79E-01	4.40E-01	4.07E-01	3.86E-01	5.00E-01	7.72E-01
Silver	0.55	1.50E-01	4.62E-02	2.22E+02	2.08E-04	9.98E-02	5.79E+01	1.72E-03

0.001 (mg/µg) = Conversion from µg to mg.
ADD = Average daily dose (mg/kg/day).
BAF_i = Soil-to-invertebrate bioaccumulation factor (HAZWRAP 1994).
C_{Max} = Maximum detected surface soil concentration (mg/kg).
HQ = Hazard quotient; HI = hazard index = sum of HQs.
IR_R = Robin food ingestion rate (kg/kg/day) = 1.52.
IR_S = Shrew food ingestion rate (kg/kg/day) = 0.53.
TRV = Toxicity reference value = NOAEL (mg/kg/day); see Tables 17 and 18.
Cells with double borders indicate HQ > 1.

Table 25. Preliminary Risk Calculations for ECOPCs in Groundwater, SWMU 27J, Building 10531

ECOPC	C_{Max} (µg/L)	BCF	Raccoon: ADD (mg/kg/day) = C_{Max} × 0.001 × IR_w	Raccoon: TRV (mg/kg/day)	Raccoon: HQ = ADD/TRV	Mink: ADD (mg/kg/day) = C_{max} × 0.001 × BCF × IR_M	Mink: TRV (mg/kg/day)	Mink: HQ = ADD/TRV	Green Heron: ADD (mg/kg/day) = C_{Max} × 0.001 × BCF × IR_H	Green Heron: TRV (mg/kg/day)	Green Heron: HQ = ADD/TRV
Volatile Organic Compounds											
Carbon disulfide	5.1	1.00E+02	4.08E-04	5.41E+00	7.54E-05	6.99E-02	8.46E+00	8.26E-03	9.79E-02	No TRV	No HQ

0.001 (mg/µg) = conversion from µg to mg.
ADD = Average daily dose (mg/kg/day) = 0.600.
BCF = Water-to-tissue bioconcentration factor (HAZWRAP 1994); default value for VOCs = 100.
C_{Max} = Maximum detected concentration (µg/L).
HQ = Hazard quotient.
IR_H = Heron food ingestion rate (kg/kg/day) = 0.192.
IR_M = Mink food ingestion rate (kg/kg/day) = 0.137.
IR_w = Raccoon water ingestion rate (L/kg/day) = 0.08.
TRV = Toxicity reference value = NOAEL (mg/kg/day); see Tables 17 and 18.

Table 26. Supplemental Risk Calculations for ECOPCs in Drainage Area Sediment for Short-tailed Shrew, SWMU 27J, Building 10531

			Short-tailed Shrew						
ECOPC	Site Concentration Mean (mg/kg)	SP_v	ADD_P (mg/kg/day) = Mean × SP_r × I_P × AUF	BAF_i	ADD_A (mg/kg/day) = Mean × BAF_i × I_A × AUF	ADD_S (mg/kg/day) = Mean × I_S × AUF	ADD_{total} (mg/kg/day) = ADD_P + ADD_A + ADD_S	LOAEL TRV (mg/kg/day)	HQ = ADD_{total}/TRV
Metals									
Cadmium	9.25E+00	1.10E-01	1.65E-03	1.10E+01	1.10E+00	1.50E-02	1.12E+00	2.12E+01	5.27E-02

ADD_A = Average daily dose; animal.
ADD_P = Average daily dose; plant.
ADD_S = Average daily dose; soil.
ADD_{total} = Average daily dose; total.
AF = Animal fraction.
AUF = Area use factor = 2.07E-02.
BAF_i = Soil-to-animal bioaccumulation factor; invertebrates.
HQ = Hazard quotient.
I_A = TUF × IR_f × AF.
I_A (kg/kg/day) = 5.22E-01.
I_P = TUF × IR_f × PF.
I_P (kg/kg/day) = 7.80E-02.
I_S = TUF × IR_f × SF.
I_S (kg/kg/day) = 7.80E-02
IR_f = Food ingestion rate.
PF = Plant fraction.
SF = Soil fraction.
SP_v = Soil-to-plant bioaccumulation factor; vegetative.
TRV = Toxicity reference value = LOAEL (mg/kg/day); see Table 21.
TUF = Temporal use factor.

Table 27. Supplemental Risk Calculations for ECOPCs in Drainage Area Sediment for American Robin, SWMU 27J, Building 10531

ECOPC	Site Concentration Mean (mg/kg)	SP_r	American Robin						
			ADD_P (mg/kg/day) = Mean × SP_r × I_P × AUF	BAF_i	ADD_A (mg/kg/day) = Mean × BAF_i × I_A × AUF	ADD_S (mg/kg/day) = Mean × I_S × AUF	ADD_{total} (mg/kg/day) = ADD_P + ADD_A + ADD_S	LOAEL TRV (mg/kg/day)	HQ = ADD_{total}/TRV
Metals									
Cadmium	9.25E+00	3.00E-02	1.66E-03	1.10E+01	6.09E-01	1.15E-02	6.22E-01	2.00E+01	3.11E-02
Chromium	1.95E+01	9.00E-04	1.05E-04	1.60E-01	1.86E-02	2.42E-02	4.30E-02	5.00E+00	8.59E-03
Lead	1.37E+01	1.80E-03	1.48E-04	4.00E-01	3.28E-02	1.71E-02	5.00E-02	1.13E+01	4.43E-03

ADD_A = Average daily dose; animal.
ADD_P = Average daily dose; plant.
ADD_S = Average daily dose; soil.
ADD_{total} = Average daily dose; total.
AF = Animal fraction.
AUF = Area use factor = 0.01.
BAF_i = Soil-to-animal bioaccumulation factor; invertebrates.
HQ = Hazard quotient.
I_A (kg/kg/day) = 6.00E-01.
I_A = TUF × IR_f × AF.
I_P (kg/kg/day) = 6.00E-01.
I_P = TUF × IR_f × PF.
I_S (kg/kg/day) = 1.25E-01.
I_S = TUF × IR_f × SF.
IR_f = Food ingestion rate.
PF = Plant fraction.
SF = Soil fraction.
SP_r = Soil-to-plant bioaccumulation factor; reproductive.
TRV = Toxicity reference value = LOAEL (mg/kg/day); see Table 22.
TUF = Temporal use factor.

Table 28. Selected Exposure and Modeling Concentrations, SWMU 27J, Building 10531

Medium/Unit	Analyte	Maximum Detected Concentration	95 Percent Upper Confidence Limit
Sediment (mg/kg)	Cadmium	**12.4**	29.1
Surface water (μg/L)	Cadmium	**47.4**	48.7

Bold indicates exposure concentrations selected.

Table 29. Exposure Parameters for Potential Receptor Populations, SWMU 27J, Building 10531

Parameter	Units	Current Off-site Juvenile Trespasser	Future On-site Installation Worker	On-site Resident Adult	On-site Resident Child	Future Off-site Installation Worker	Future Off-site Juvenile Trespasser	Off-site Resident Adult	Off-site Resident Child
SEDIMENT									
Incidental Ingestion									
Soil ingestion rate	g/day	0.1	NA	NA	NA	0.1	0.1	0.1	0.2
Fraction ingested from area	unitless	0.25	NA	NA	NA	1	0.25	1	1
Exposure frequency	days/year	52	NA	NA	NA	250	52	350	350
Exposure duration	years	10	NA	NA	NA	25	10	30	6
Body weight	kg	45	NA	NA	NA	70	45	70	15
Carcinogen averaging time	days	25,550	NA	NA	NA	25,550	25,550	25,550	NA
Noncarcinogen averaging time	days	3,650	NA	NA	NA	9,125	3,650	NA	2,190
Dermal Contact									
Skin area	cm^2/event	3,700	NA	NA	NA	5,000	3,700	5,000	1,700
Adherence factor	mg/cm^2	1	NA	NA	NA	0.2	1	0.2	0.2
Exposure frequency	events/year	52	NA	NA	NA	250	52	350	350
Exposure duration	years	10	NA	NA	NA	25	10	30	6
Body weight	kg	45	NA	NA	NA	70	45	70	15
Carcinogen averaging time	days	25,550	NA	NA	NA	25,550	25,550	25,550	NA
Noncarcinogen averaging time	days	3,650	NA	NA	NA	9,125	3,650	NA	2,190
Inhalation of Dust									
Inhalation rate	m^3/hour	NA	2.5	0.80	0.68	2.5	1.90	0.80	0.68
Exposure time	hours/day	NA	8	18.4	18.4	8	6	18.4	18.4
Exposure frequency	days/year	NA	250	350	350	250	52	350	350
Exposure duration	years	NA	25	30	6	25	10	30	6
Body weight	kg	NA	70	70	15	70	45	70	15
Carcinogen averaging time	days	NA	25,550	25,550	25,550	25,550	25,550	25,550	25,550
Noncarcinogen averaging time	days	NA	9,125	10,950	2,190	9,125	3,650	10,950	2,190
SURFACE WATER									
Incidental Ingestion									
Water ingestion rate	mL/hour	10	NA	NA	NA	NA	10	NA	NA
Exposure time	hours/day	2	NA	NA	NA	NA	2	NA	NA
Exposure frequency	days/year	52	NA	NA	NA	NA	52	NA	NA
Exposure duration	years	10	NA	NA	NA	NA	10	NA	NA

Table 29. Exposure Parameters for Potential Receptor Populations, SWMU 27J, Building 10531 (continued)

Parameter	Units	Current Off-site Juvenile Trespasser	Future On-site Installation Worker	On-site Resident Adult	On-site Resident Child	Future Off-site Installation Worker	Future Off-site Juvenile Trespasser	Off-site Resident Adult	Off-site Resident Child
Body weight	kg	45	NA	NA	NA	NA	45	NA	NA
Carcinogen averaging time	days	25,550	NA	NA	NA	NA	25,550	NA	NA
Noncarcinogen averaging time	days	3,650	NA	NA	NA	NA	3,650	NA	NA
Dermal Contact while Wading									
Skin area	m^2	0.17	NA	NA	NA	NA	0.17	NA	NA
Exposure time	hours/day	2	NA	NA	NA	NA	2	NA	NA
Exposure frequency	days/year	52	NA	NA	NA	NA	52	NA	NA
Exposure duration	years	10	NA	NA	NA	NA	10	NA	NA
Body weight	kg	45	NA	NA	NA	NA	45	NA	NA
Carcinogen averaging time	days	25,550	NA	NA	NA	NA	25,550	NA	NA
Noncarcinogen averaging time	days	3,650	NA	NA	NA	NA	3,650	NA	NA
GROUNDWATER									
Drinking Water Ingestion									
Drinking water ingestion	L/day	NA	1	2	1	1	NA	2	1
Fraction ingested from area	unitless	NA	1	1	1	1	NA	1	1
Exposure frequency	days/year	NA	250	350	350	250	NA	350	350
Exposure duration	years	NA	25	30	6	25	NA	30	6
Body weight	kg	NA	70	70	15	70	NA	70	15
Carcinogen averaging time	days	NA	25,550	25,550	25,550	25,550	NA	25,550	25,550
Noncarcinogen averaging time	days	NA	9,125	10,950	2,190	9,125	NA	10,950	2,190
Dermal Contact while Bathing									
Skin area	m^2	NA	NA	2	0.700	NA	NA	2	0.700
Exposure time	hours/day	NA	NA	0.17	0.33	NA	NA	0.17	0.33
Exposure frequency	days/year	NA	NA	350	350	NA	NA	350	350
Exposure duration	years	NA	NA	30	6	NA	NA	30	6
Body weight	kg	NA	NA	70	15	NA	NA	70	15
Carcinogen averaging time	days	NA	NA	25,550	25,550	NA	NA	25,550	25,550
Noncarcinogen averaging time	days	NA	NA	10,950	2,190	NA	NA	10,950	2,190

Table 30. Estimated Intakes for Current Off-site Juvenile Trespasser, SWMU 27J, Building 10531

Environmental Medium	Chemical	Exposure Concentration	Units	Oral Exposure[a]		Dermal Exposure[a]	
				Average Daily Dose for Noncarcinogens (mg/kg/day)	Average Daily Dose for Carcinogens (mg/kg/day)	Average Daily Dose for Noncarcinogens (mg/kg/day)	Average Daily Dose for Carcinogens (mg/kg/day)
Surface water	Cadmium	4.74E-02	mg/L	3.00E-06	ND	1.20E-06	ND
Sediment	Cadmium	1.24E+01	mg/kg	1.49E-06	ND	1.57E-06	ND

[a]The equations used to calculate oral and dermal exposures in surface water and sediment are presented in Appendix I, Sections I.2.4.4 and I.2.4.5, respectively, of the revised final Phase II RFI Report (SAIC 2000).

ND = Toxicity data are not available.

Table 31. Estimated Intakes for Future On-site Installation Worker, SWMU 27J, Building 10531

Environmental Medium	Chemical	Exposure Concentration	Units	Inhalation Exposure[a] Average Daily Dose for Noncarcinogens (mg/kg/day)	Inhalation Exposure[a] Average Daily Dose for Carcinogens (mg/kg/day)
Sediment	Cadmium	1.24E+01	mg/kg	4.51E-10	1.61E-10

[a]The equation used to calculate inhalation exposure in sediment is presented in Appendix I, Section I.2.4.5 of the revised final Phase II RFI Report (SAIC 2000).

Table 32. Estimated Intakes for Future On-site Resident Child, SWMU 27J, Building 10531

Environmental Medium	Chemical	Exposure Concentration	Units	Inhalation Exposure[a] Average Daily Dose for Noncarcinogens (mg/kg/day)	Inhalation Exposure[a] Average Daily Dose for Carcinogens (mg/kg/day)
Sediment	Cadmium	1.24E+01	mg/kg	1.89E-09	1.58E-10

[a]The equation used to calculate inhalation exposure in sediment is presented in Appendix I, Section I.2.4.5 of the revised final Phase II RFI Report (SAIC 2000).

Table 33. Estimated Intakes for Future On-site Resident Adult, SWMU 27J, Building 10531

Environmental Medium	Chemical	Exposure Concentration	Units	Inhalation Exposure[a] Average Daily Dose for Noncarcinogens (mg/kg/day)	Inhalation Exposure[a] Average Daily Dose for Carcinogens (mg/kg/day)
Sediment	Cadmium	1.24E+01	mg/kg	4.6E-10	2.0E-10

[a]The equation used to calculate inhalation exposure in sediment is presented in Appendix I, Section I.2.4.5 of the revised final Phase II RFI Report (SAIC 2000).

Table 34. Estimated Intakes for Future Off-site Installation Worker, SWMU 27J, Building 10531

Environmental Medium	Chemical	Exposure Concentration	Units	Oral Exposure[a]		Dermal Exposure[a]		Inhalation Exposure[a]	
				Average Daily Dose for Noncarcinogens (mg/kg/day)	Average Daily Dose for Carcinogens (mg/kg/day)	Average Daily Dose for Noncarcinogens (mg/kg/day)	Average Daily Dose for Carcinogens (mg/kg/day)	Average Daily Dose for Noncarcinogens (mg/kg/day)	Average Daily Dose for Carcinogens (mg/kg/day)
Sediment	Cadmium	1.24E+01	mg/kg	1.21E-05	ND	6.07E-06	ND	4.51E-10	1.61E-10
Groundwater (modeled)	Cadmium	1.43E-01	mg/L	1.40E-03	ND	NA	NA	NA	NA

[a]The equations used to calculate oral, dermal, and inhalation exposures for groundwater and sediment are presented in Appendix I, Sections I.2.4.3 and I.2.4.5, respectively, of the revised final Phase II RFI Report (SAIC 2000).
NA = Not applicable; fish bioaccumulation factor is used to estimate the fish tissue concentrations.
ND = Toxicity data are not available.

Table 35. Estimated Intakes for Future Off-site Juvenile Trespasser, SWMU 27J, Building 10531

Environmental Medium	Chemical	Exposure Concentration	Units	Oral Exposure[a]		Dermal Exposure[a]		Inhalation Exposure[a]	
				Average Daily Dose for Noncarcinogens (mg/kg/day)	Average Daily Dose for Carcinogens (mg/kg/day)	Average Daily Dose for Noncarcinogens (mg/kg/day)	Average Daily Dose for Carcinogens (mg/kg/day)	Average Daily Dose for Noncarcinogens (mg/kg/day)	Average Daily Dose for Carcinogens (mg/kg/day)
Surface water	Cadmium	4.74E-02	mg/L	3.00E-06	ND	1.20E-06	ND	NA	NA
Sediment	Cadmium	1.24E+01	mg/kg	1.49E-06	ND	1.57E-06	ND	8.31E-11	1.19E-11

[a]The equations used to calculate oral, dermal, and inhalation exposures for surface water and sediment are presented in Appendix I, Sections I.2.4.4 and I.2.4.5, respectively, of the revised final Phase II RFI Report (SAIC 2000).
NA = Not applicable; this pathway was not assessed for this environmental medium.
ND = Toxicity data are not available.

Table 36. Estimated Intakes for Future Off-site Resident Child, SWMU 27J, Building 10531

Environmental Medium	Chemical	Exposure Concentration	Units	Oral Exposure[a]		Dermal Exposure[a]		Inhalation Exposure[a]	
				Average Daily Dose for Noncarcinogens (mg/kg/day)	Average Daily Dose for Carcinogens (mg/kg/day)	Average Daily Dose for Noncarcinogens (mg/kg/day)	Average Daily Dose for Carcinogens (mg/kg/day)	Average Daily Dose for Noncarcinogens (mg/kg/day)	Average Daily Dose for Carcinogens (mg/kg/day)
Sediment	Cadmium	1.24E+01	mg/kg	1.59E-04	ND	1.35E-05	ND	1.84E-09	1.58E-10
Groundwater (modeled)	Cadmium	1.43E-01	mg/L	9.14E-03	ND	2.11E-05	ND	NA	NA

[a]The equations used to calculate oral, dermal, and inhalation exposures for groundwater and sediment are presented in Appendix I, Sections I.2.4.3 and I.2.4.5, respectively, of the revised final Phase II RFI Report (SAIC 2000).
NA = Not applicable; lead is evaluated separately using a biokinetic uptake model.
ND = Toxicity data are not available.

Table 37. Estimated Intakes for Future Off-site Resident Adult, SWMU 27J, Building 10531

Environmental Medium	Chemical	Exposure Concentration	Units	Oral Exposure[a]		Dermal Exposure[a]		Inhalation Exposure[a]	
				Average Daily Dose for Noncarcinogens (mg/kg/day)	Average Daily Dose for Carcinogens (mg/kg/day)	Average Daily Dose for Noncarcinogens (mg/kg/day)	Average Daily Dose for Carcinogens (mg/kg/day)	Average Daily Dose for Noncarcinogens (mg/kg/day)	Average Daily Dose for Carcinogens (mg/kg/day)
Sediment	Cadmium	1.24E+01	mg/kg	1.70E-05	ND	8.49E-06	ND	4.64E-10	1.99E-10
Groundwater (modeled)	Cadmium	1.43E-01	mg/L	3.92E-03	ND	6.66E-06	ND	NA	NA

[a]The equations used to calculate oral, dermal, and inhalation exposures for groundwater and sediment are presented in Appendix I, Sections I.2.4.3 and I.2.4.5, respectively, of the revised final Phase II RFI Report (SAIC 2000).
NA = Not applicable; fish bioaccumulation factor is used to estimate the fish tissue concentrations.
ND = Toxicity data are not available.

Table 38. Toxicity Values for Constituents of Concern, SWMU 27J, Building 10531

Chemical	Oral Reference Dose (mg/kg/day)	Ref[a]	Oral Cancer Slope Factor $(mg/kg/day)^{-1}$	Ref[a]	Dermal Reference Dose (mg/kg/day)	Ref[a]	Inhalation Reference Dose (mg/kg/day)	Ref[a]	Inhalation Cancer Slope Factor $(mg/kg/day)^{-1}$	Ref[a]
Cadmium–water	5.00E-04	I	ND		2.50E-05	D	5.7E-05	E	6.30E+00	I
Cadmium–food	1.00E-03	I	ND		2.50E-05	D	5.7E-05	E	6.30E+00	I

[a]References:
D = Section I.3.4 (Dermal Evaluation of Constituents) (SAIC 2000).
E = EPA's National Center for Environmental Assessment (EPA 2000a).
I = Integrated Risk Information System (EPA 2000b).
ND = No data.

Table 39. Hazard Indices for Current Off-site Juvenile Trespasser, SWMU 27J, Building 10531

Chemical	Sediment[a] Ingestion HI	Sediment[a] Dermal HI	Sediment[a] Total	Surface Water[a] Ingestion HI	Surface Water[a] Dermal HI	Surface Water[a] Total	Total Hazard Index[a]
Cadmium	1.49E-03	6.28E-02	6.43E-02	6.00E-03	4.80E-02	5.40E-02	1.18E-01
Pathway Total	**1.49E-03**	**6.28E-02**	**6.43E-02**	**6.00E-03**	**4.80E-02**	**5.40E-02**	**1.18E-01**

[a]The equations used to calculate noncarcinogenic risk are presented in Appendix I, Section I.4.2 of the revised final Phase II RFI Report (SAIC 2000).

Table 40. Hazard Indices and Carcinogenic Risks for Future On-site Installation Worker, SWMU 27J, Building 10531

Chemical	Sediment[a] Inhalation HI	Sediment[a] Total	Total Hazard Index[a]
Cadmium	7.91E-06	7.91E-06	7.91E-06
Pathway Total	**7.91E-06**	**7.91E-06**	**7.91E-06**
Chemical	**Sediment[b] Inhalation ILCR**	**Sediment[b] Total**	**Total Cancer Risk[b]**
Cadmium	1.01E-09	1.01E-09	1.01E-09
Pathway Total	**1.01E-09**	**1.01E-09**	**1.01E-09**

[a]The equations used to calculate noncarcinogenic risk are presented in Appendix I, Section I.4.2 of the revised final Phase II RFI Report (SAIC 2000).

[b]The equations used to calculate carcinogenic risk are presented in Appendix I, Section I.4.1 of the revised final Phase II RFI Report (SAIC 2000).

Table 41. Hazard Indices and Carcinogenic Risks for Future On-site Resident Child, SWMU 27J, Building 10531

Chemical	Sediment[a]		Total Hazard Index[a]
	Inhalation HI	Total	
Cadmium	3.23E-05	3.23E-05	3.23E-05
Pathway Total	**3.23E-05**	**3.23E-05**	**3.23E-05**

Chemical	Sediment[b]		Total Cancer Risk[b]
	Inhalation ILCR	Total	
Cadmium	9.95E-10	9.95E-10	9.95E-10
Pathway Total	**9.95E-10**	**9.95E-10**	**9.95E-10**

[a]The equations used to calculate noncarcinogenic risk are presented in Appendix I, Section I.4.2 of the revised final Phase II RFI Report (SAIC 2000).

[b]The equations used to calculate carcinogenic risk are presented in Appendix I, Section I.4.1 of the revised final Phase II RFI Report (SAIC 2000).

Table 42. Hazard Indices and Carcinogenic Risks for Future On-site Resident Adult, SWMU 27J, Building 10531

Chemical	Sediment[a]		Total Hazard Index[a]
	Inhalation HI	Total	
Cadmium	8.15E-06	8.15E-06	8.15E-06
Pathway Total	**8.15E-06**	**8.15E-06**	**8.15E-06**

Chemical	Sediment[b]		Total Cancer Risk[b]
	Inhalation ILCR	Total	
Cadmium	1.25E-09	1.25E-09	1.25E-09
Pathway Total	**1.25E-09**	**1.25E-09**	**1.25E-09**

[a]The equations used to calculate noncarcinogenic risk are presented in Appendix I, Section I.4.2 of the revised final Phase II RFI Report (SAIC 2000).

[b]The equations used to calculate carcinogenic risk are presented in Appendix I, Section I.4.1 of the revised final Phase II RFI Report (SAIC 2000).

Table 43. Hazard Indices and Carcinogenic Risks for Future Off-site Installation Worker, SWMU 27J, Building 10531

Chemical	Groundwater Modeled Concentrations[a]		Sediment[a]				Total Hazard Index[a]
	Ingestion HI	Total	Ingestion HI	Dermal HI	Inhalation HI	Total	
Cadmium	2.80E+00	2.80E+00	1.21E-02	2.43E-01	7.9E-06	2.55E-01	3.05E+00
Pathway Total	**2.80E+00**	**2.80E+00**	**1.21E-02**	**2.43E-01**	**7.9E-06**	**2.55E-01**	**3.05E+00**

Chemical	Groundwater Modeled Concentrations[b]		Sediment[b]				Total Cancer Risk[b]
	Ingestion ILCR	Total	Ingestion ILCR	Dermal ILCR	Inhalation ILCR	Total	
Cadmium	ND	ND	ND	ND	1.01E-09	1.01E-09	1.01E-09
Pathway Total	—	—	—	—	**1.01E-09**	**1.01E-09**	**1.01E-09**

[a]The equations used to calculate noncarcinogenic risk are presented in Appendix I, Section I.4.2 of the revised final Phase II RFI Report (SAIC 2000).

[b]The equations used to calculate carcinogenic risk are presented in Appendix I, Section I.4.1 of the revised final Phase II RFI Report (SAIC 2000).

ND = The toxicity data required to quantify the risk are not available.

— = No sum value could be calculated.

Table 44. Hazard Indices and Carcinogenic Risks for Future Off-Site Juvenile Trespasser, SWMU 27H, Building 10531

Chemical	Sediment[a]				Surface Water[a]			Total Hazard Index[a]
	Ingestion HI	Dermal HI	Inhalation HI	Total	Ingestion HI	Dermal HI	Total	
Cadmium	1.49E-03	6.28E-02	1.46E-06	6.43E-02	6.00E-03	4.80E-02	5.40E-02	1.18E-01
Pathway Total	**1.49E-03**	**6.28E-02**	**1.46E-06**	**6.43E-02**	**6.00E-03**	**4.80E-02**	**5.40E-02**	**1.18E-01**

Chemical	Sediment[b]				Surface Water[b]			Total Cancer Risk[b]
	Ingestion ILCR	Dermal ILCR	Inhalation ILCR	Total	Ingestion ILCR	Dermal ILCR	Total	
Cadmium	ND	ND	7.48E-11	7.48E-11	ND	ND	ND	7.48E-11
Pathway Total	—	—	**7.48E-11**	**7.48E-11**	—	—	—	**7.48E-11**

[a]The equations used to calculate noncarcinogenic risk are presented in Appendix I, Section I.4.2 of the revised final Phase II RFI Report (SAIC 2000).

[b]The equations used to calculate carcinogenic risk are presented in Appendix I, Section I.4.1 of the revised final Phase II RFI Report (SAIC 2000).

ND = The toxicity data required to quantify the risk are not available.

— = No sum value could be calculated.

Table 45. Hazard Indices and Carcinogenic Risks for Future Off-site Resident Child, SWMU 27J, Building 10531

Chemical	Groundwater Modeled Concentrations[a]			Sediment[a]				Total Hazard Index[a]
	Ingestion HI	Dermal HI	Total	Ingestion HI	Dermal HI	Inhalation HI	Total	
Cadmium	1.83E+01	8.45E-01	1.91E+01	1.59E-01	5.39E-01	3.23E-05	6.98E-01	1.98E+01
Pathway Total	**1.83E+01**	**8.45E-01**	**1.91E+01**	**1.59E-01**	**5.39E-01**	**3.23E-05**	**6.98E-01**	**1.98E+01**

Chemical	Groundwater Modeled Concentrations[b]			Sediment[b]				Total Cancer Risk[b]
	Ingestion ILCR	Dermal ILCR	Total	Ingestion ILCR	Dermal ILCR	Inhalation ILCR	Total	
Cadmium	ND	ND	ND	ND	ND	9.95E-10	9.95E-10	9.95E-10
Pathway Total	—	—	—	—	—	**9.95E-10**	**9.95E-10**	**9.95E-10**

[a]The equations used to calculate noncarcinogenic risk are presented in Appendix I, Section I.4.2 of the revised final Phase II RFI Report (SAIC 2000).

[b]The equations used to calculate carcinogenic risk are presented in Appendix I, Section I.4.1 of the revised final Phase II RFI Report (SAIC 2000).

ND = The toxicity data required to quantify the risk are not available.

— = No sum value could be calculated.

Table 46. Hazard Indices and Carcinogenic Risks for Future Off-site Resident Adult, SWMU 27J, Building 10531

Chemical	Groundwater Modeled Concentrations[a]			Sediment[a]				Total Hazard Index[a]
	Ingestion HI	Dermal HI	Total	Ingestion HI	Dermal HI	Inhalation HI	Total	
Cadmium	7.84E+00	2.66E-01	8.10E+00	1.70E-02	3.40E-01	8.15E-06	3.57E-01	8.46E+00
Pathway Total	**7.84E+00**	**2.66E-01**	**8.10E+00**	**1.70E-02**	**3.40E-01**	**8.15E-06**	**3.57E-01**	**8.46E+00**

Chemical	Groundwater Modeled Concentrations[b]			Sediment[b]				Total Cancer Risk[b]
	Ingestion ILCR	Dermal ILCR	Total	Ingestion ILCR	Dermal ILCR	Inhalation ILCR	Total	
Cadmium	ND	ND	ND	ND	ND	1.25E-09	1.25E-09	1.25E-09
Pathway Total	—	—	—	—	—	**1.25E-09**	**1.25E-09**	**1.25E-09**

[a]The equations used to calculate noncarcinogenic risk are presented in Appendix I, Section I.4.2 of the revised final Phase II RFI Report (SAIC 2000).

[b]The equations used to calculate carcinogenic risk are presented in Appendix I, Section I.4.1 of the revised final Phase II RFI Report (SAIC 2000).

ND = The toxicity data required to quantify the risk are not available.

— = No sum value could be calculated.

Table 47. Target Groundwater Concentrations for Contaminant Migration Constituents of Concern, SWMU 27J, Building 10531

CMCOC	Estimated Groundwater Concentration (µg/L)	Maximum Contaminant Level (µg/L)	Target Groundwater Concentration (µg/L) Hazard Index 0.1	0.5	1
Cadmium	143	**5**	0.7	3.7	7.5

Bold indicates recommended target groundwater values.

Table 48. Remedial Levels for Sediment, SWMU 27J, Building 10531

COC	Units	Maximum Sediment Concentration	Remedial Levels Based on Direct Exposure – Hazard Index 0.1	0.5	1	Remedial Levels Based on Protection of Groundwater – Hazard Index 0.1	0.5	1	Sediment Remedial Level Based on MCL	Subsurface Background Concentration
Cadmium	mg/kg	12.40	1.78	8.88	17.77	0.06	0.32	0.65	**0.43**	0.23

Bold indicates recommended remedial levels.

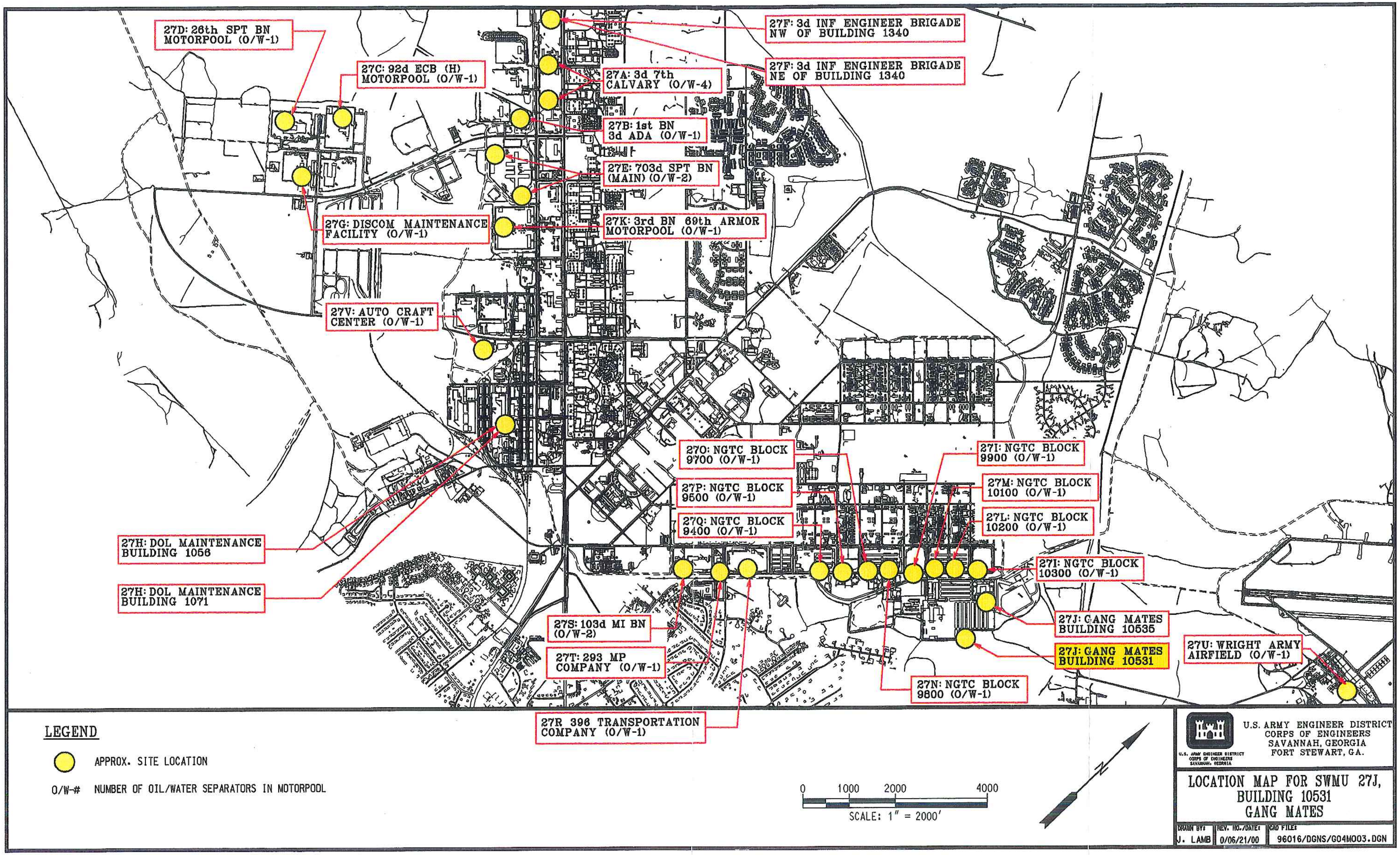


Figure 1. Location Map for SWMU 27J, Building 10531

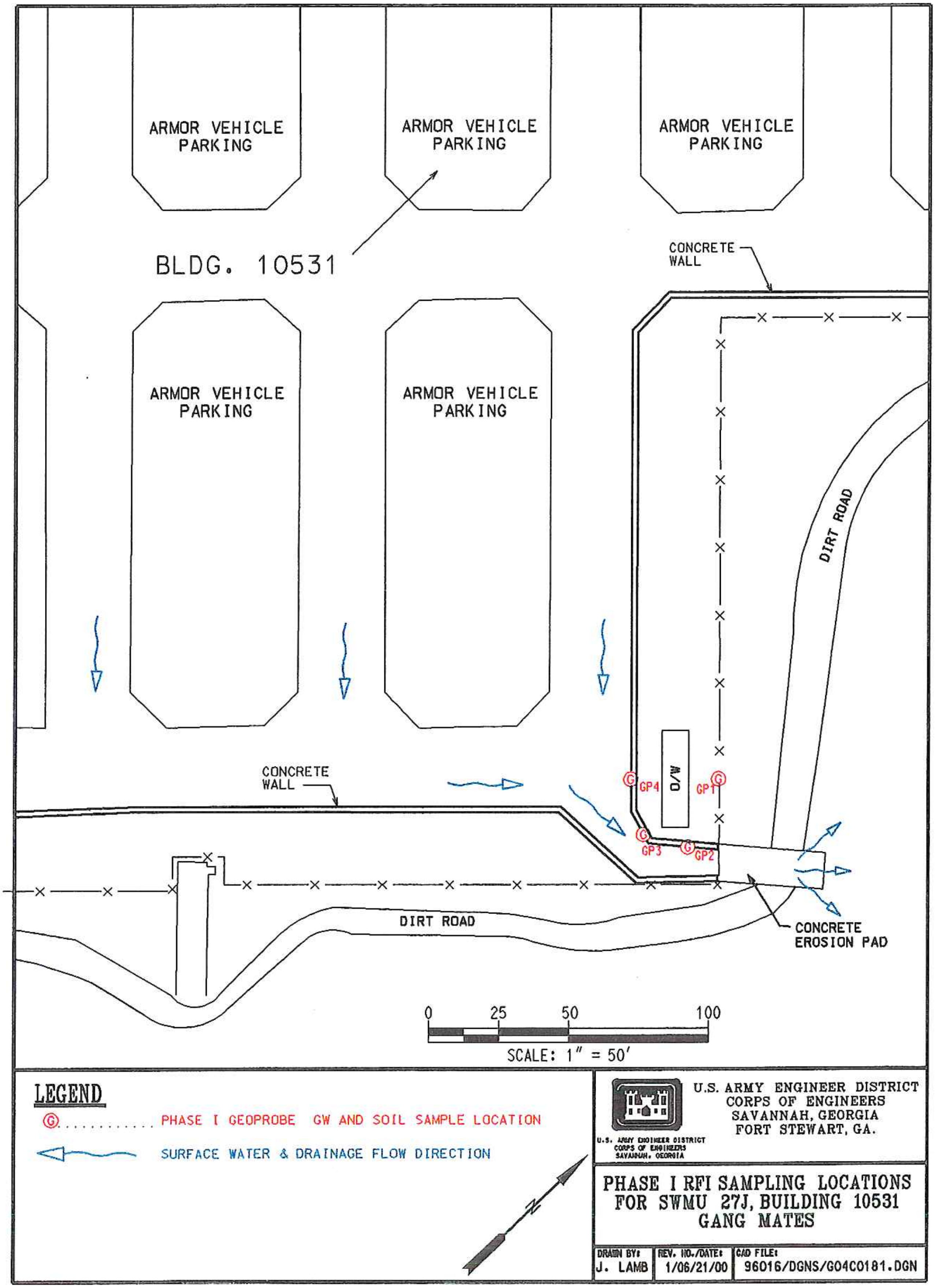


Figure 2. Phase I RFI Sampling Locations, SWMU 27J, Building 10531

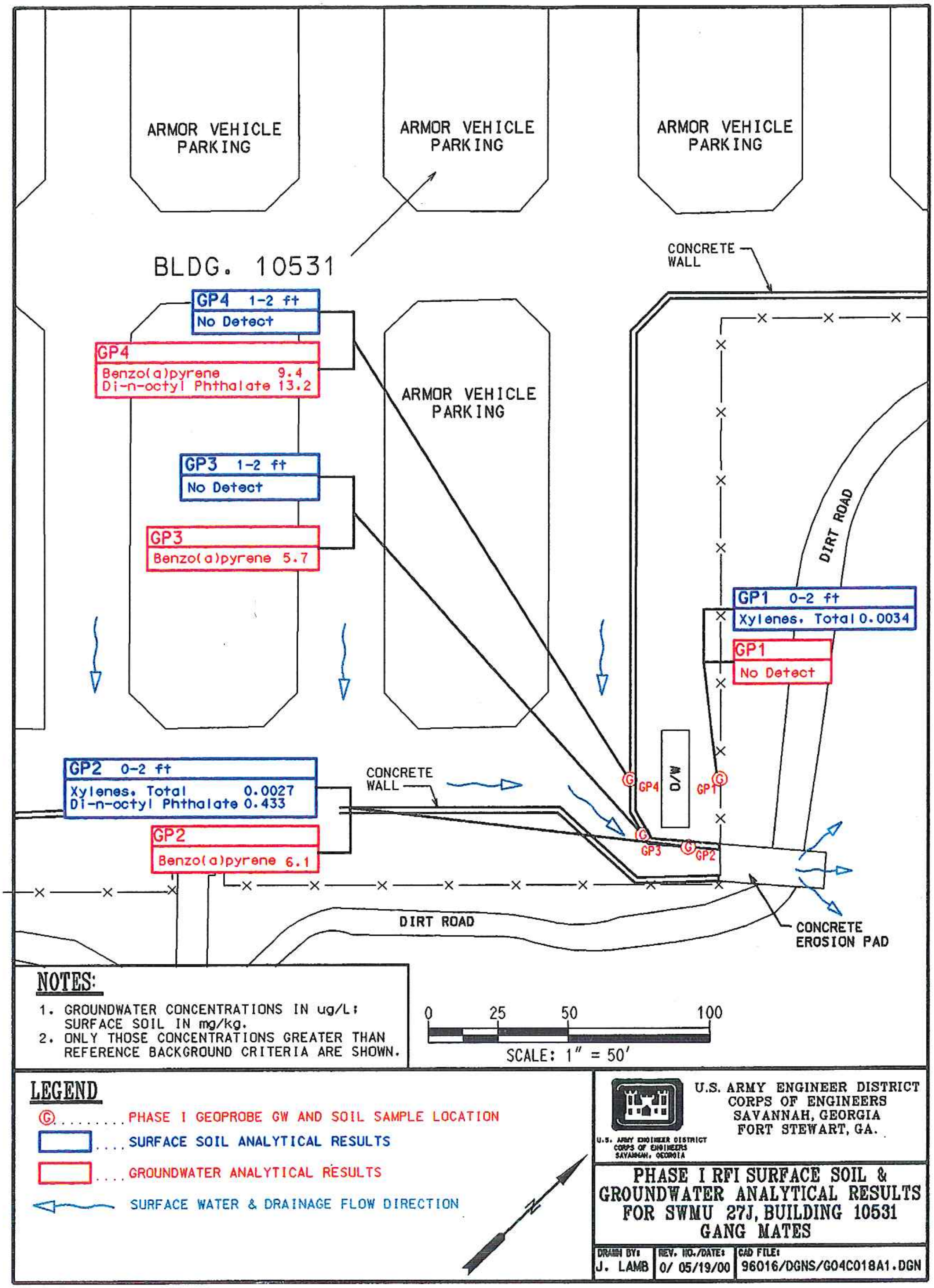


Figure 3. Summary of Phase I RFI Analytical Results in Surface Soil and Groundwater, SWMU 27J, Building 10531

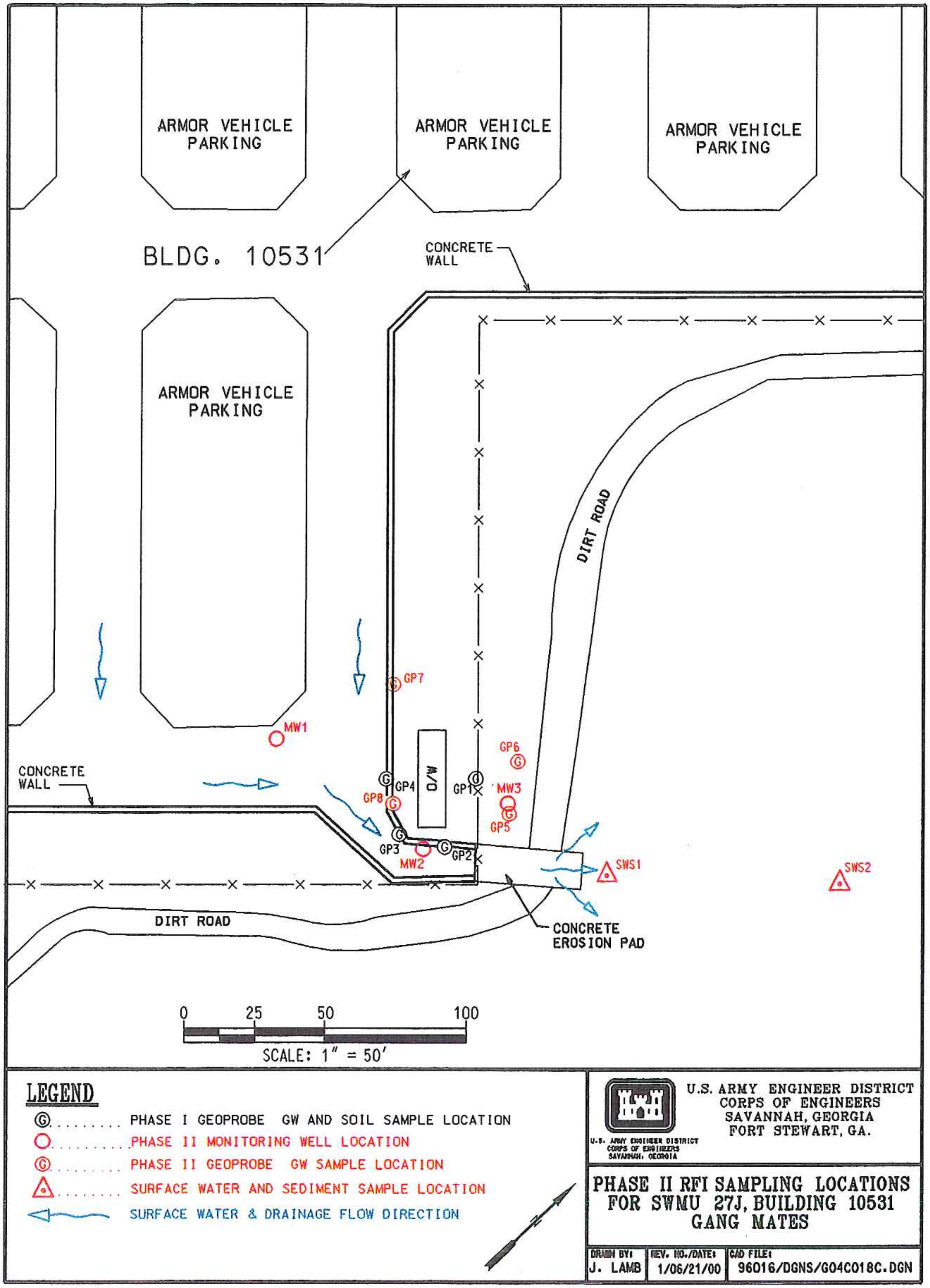


Figure 4. Phase II RFI Sampling Locations, SWMU 27J, Building 10531

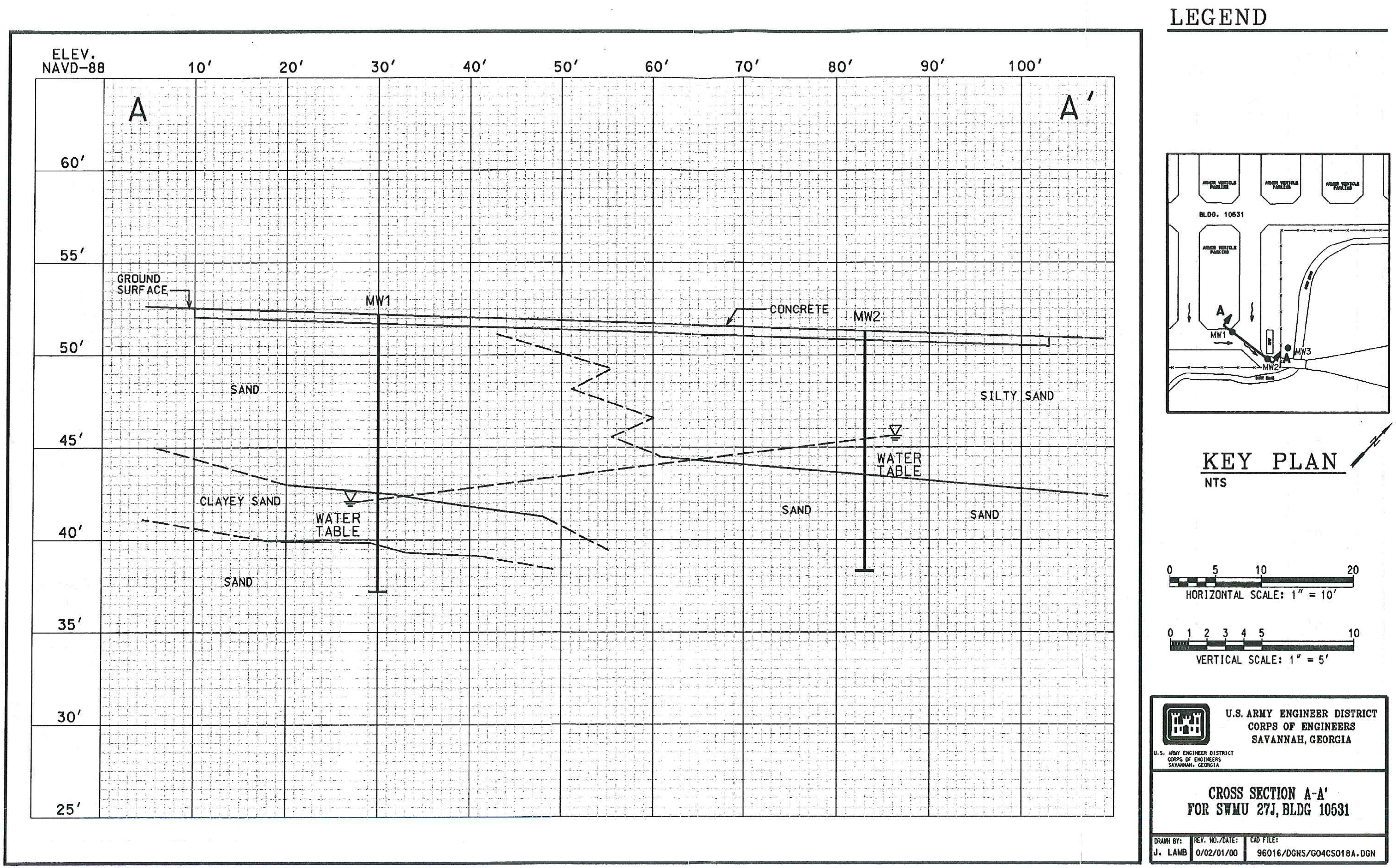
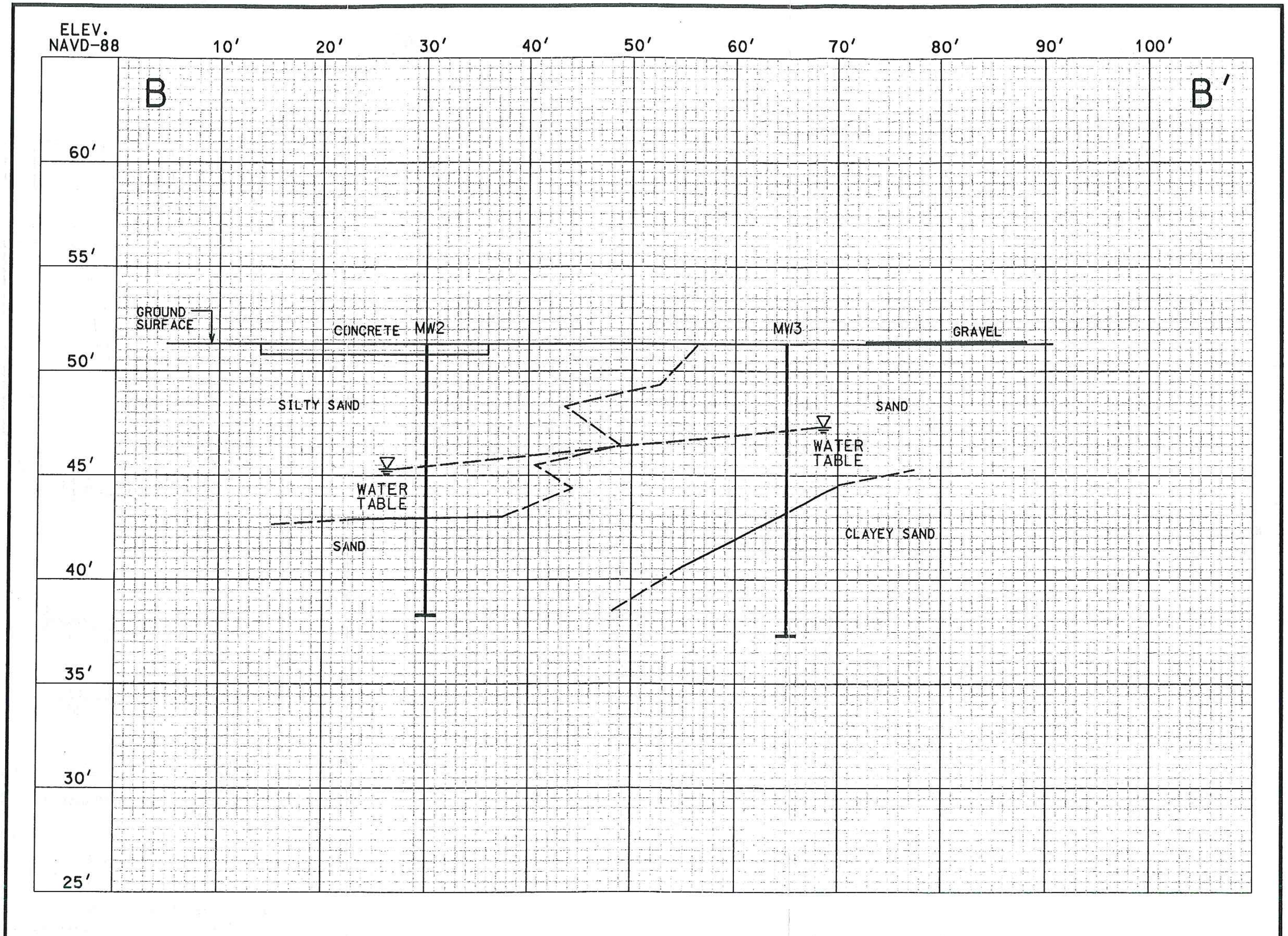
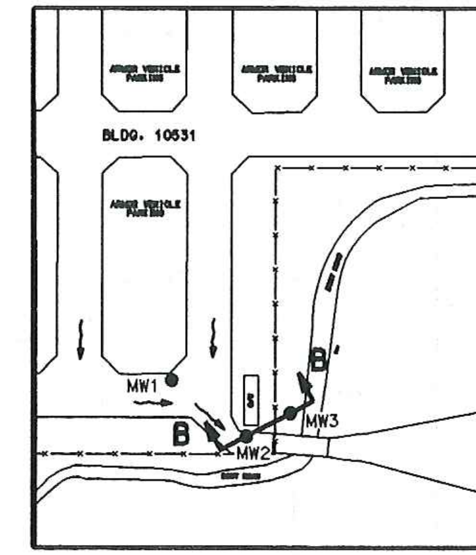


Figure 5. Phase II RFI Cross Section A-A', SWMU 27J, Building 10531



LEGEND



KEY PLAN
NTS

0 5 10 20
HORIZONTAL SCALE: 1" = 10'

0 1 2 3 4 5 10
VERTICAL SCALE: 1" = 5'

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

CROSS SECTION B-B'
FOR SWMU 27J, BLDG 10531

DRAWN BY:	REV. NO./DATE:	CAD FILE:
J. LAMB	0/02/01/00	96016/DGNS/G04CS018B.DGN

Figure 6. Phase II RFI Cross Section B-B', SWMU 27J, Building 10531

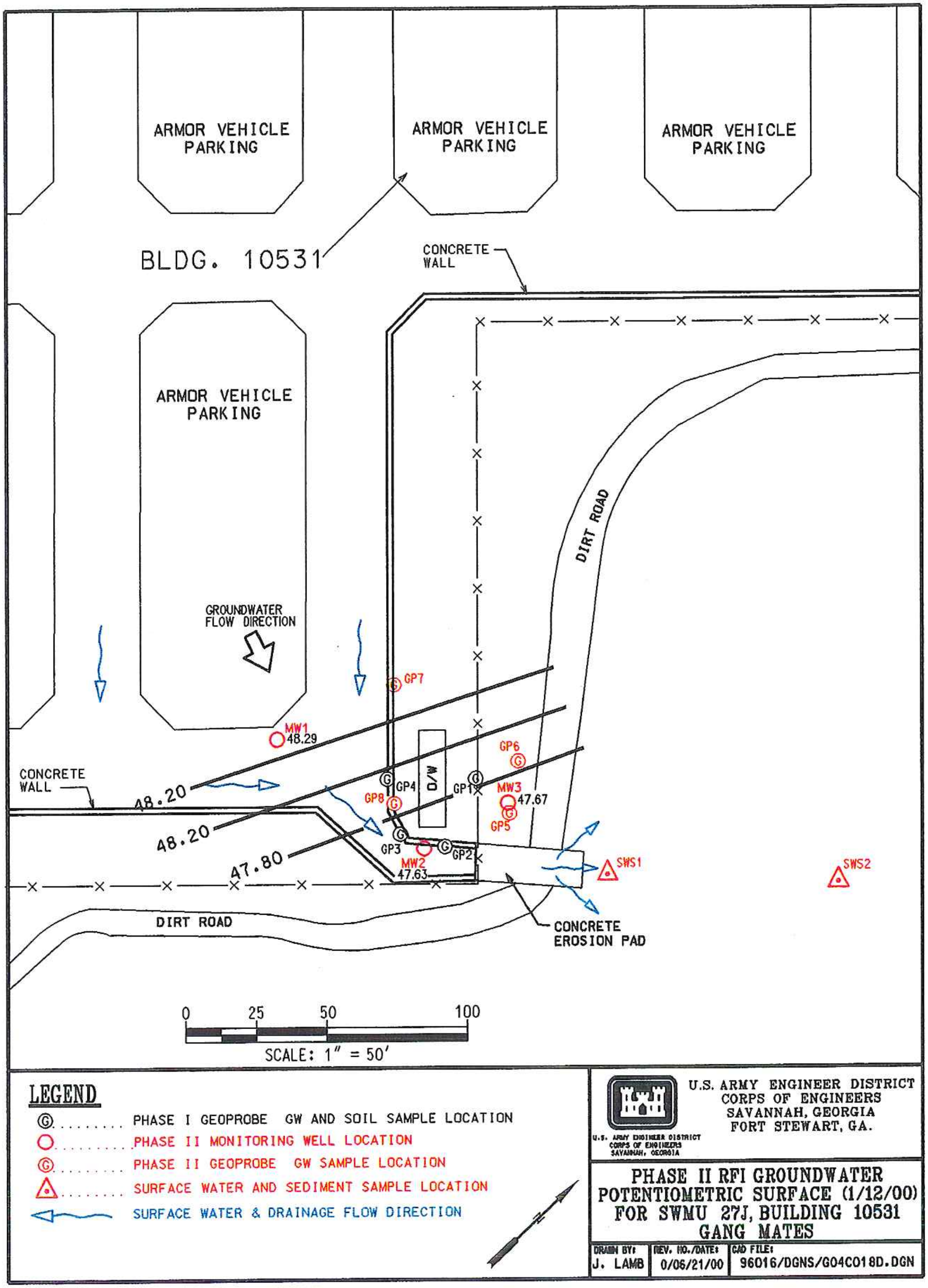


Figure 7. Phase II RFI Groundwater Potentiometric Surface Map, SWMU 27J, Building 10531

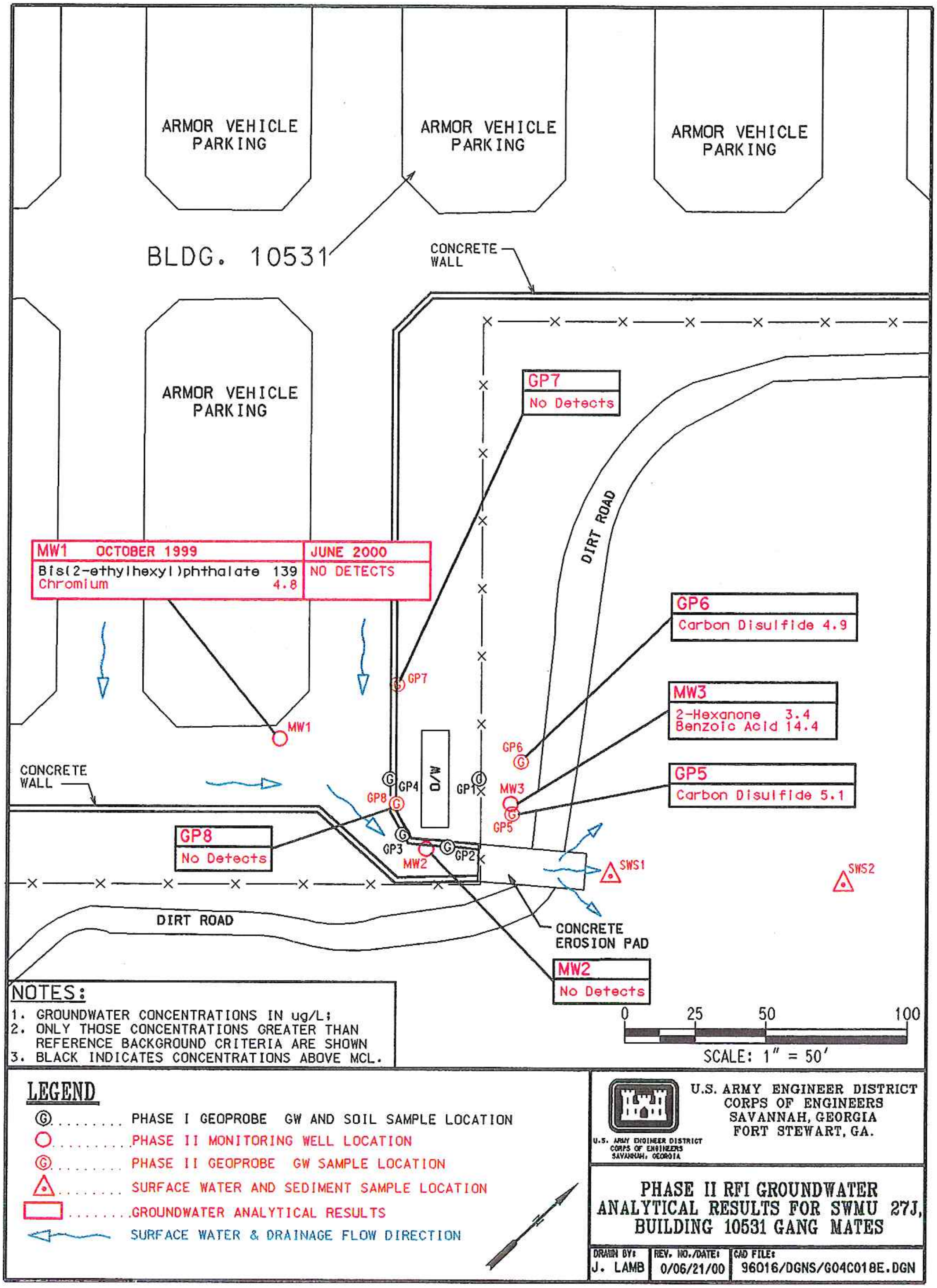


Figure 8. Summary of Phase II RFI Analytical Results in Groundwater, SWMU 27J, Building 10531

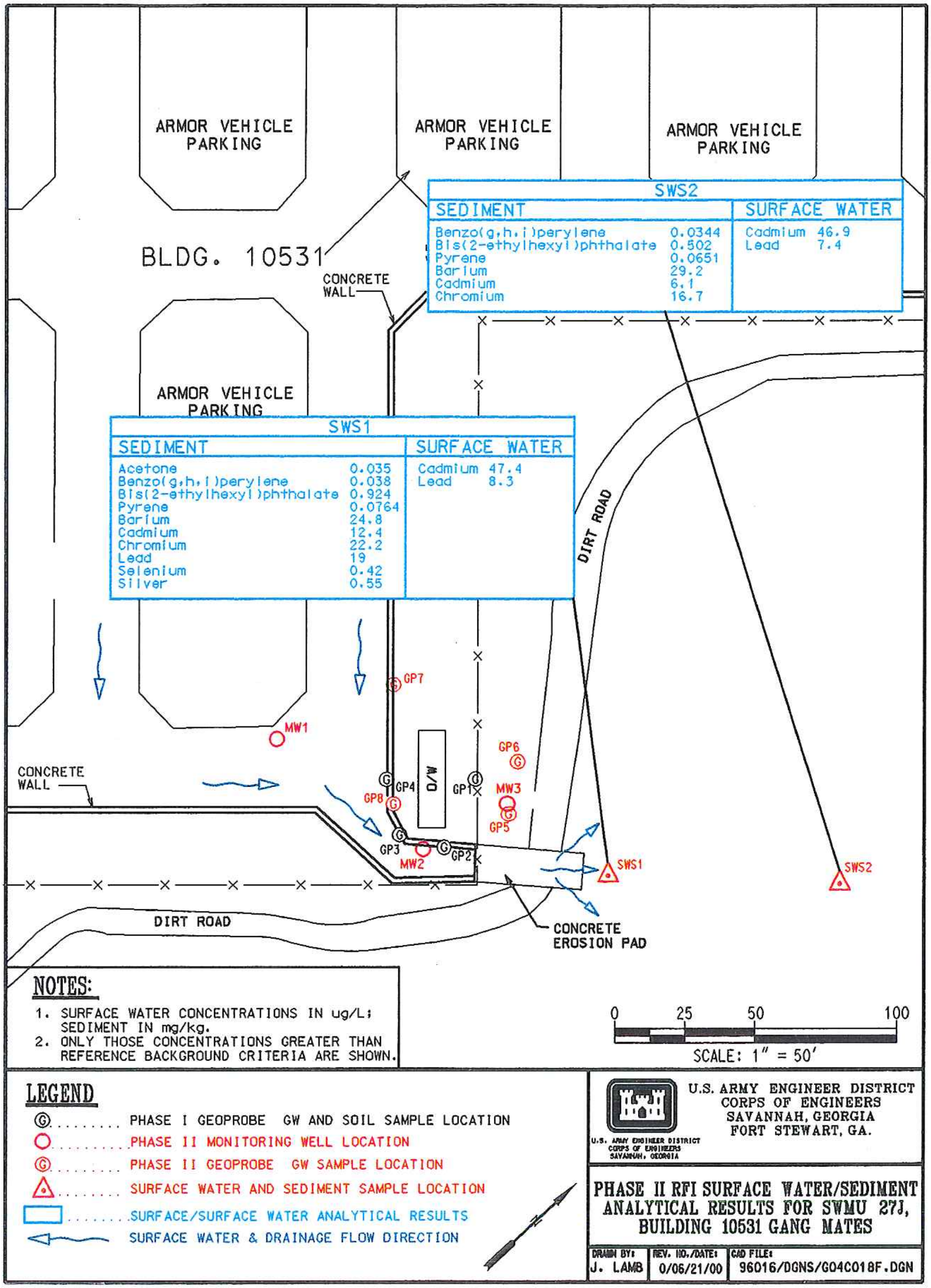


Figure 9. Summary of Phase II RFI Analytical Results in Surface Water and Sediment, SWMU 27J, Building 10531

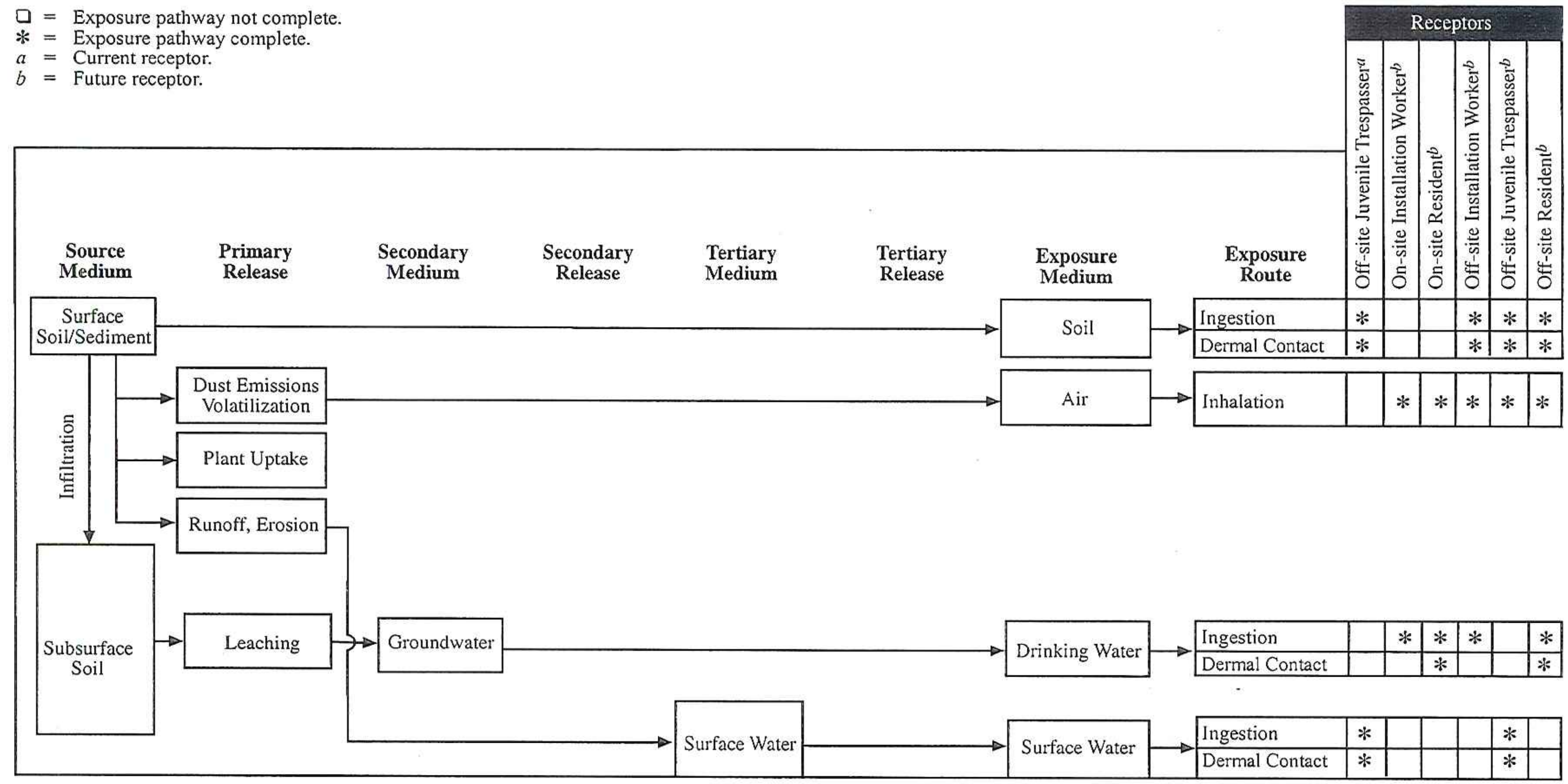


Figure 10. Phase II RFI Potential Migration and Exposure Pathways, SWMU 27J, Building 10531

ATTACHMENT A
TO SWMU 27J, BUILDING 10531
TO THE
REVISED FINAL PHASE II RCRA FACILITY INVESTIGATION REPORT
FOR
16 SOLID WASTE MANAGEMENT UNITS
AT
FORT STEWART, GEORGIA

E-MAIL FROM REGULATOR

(E-mail from Brent Rabon, Georgia Department of Natural Resources, Georgia Environmental Protection Division to Melanie Little, Directorate of Public Works, Fort Stewart, Georgia, October 5, 1999)

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Longaker, Jeff

From: Brent Rabon [Brent_Rabon@mail.dnr.state.ga.us]
Sent: Tuesday, October 05, 1999 4:59 PM
To: littledera@aol.com
Cc: Madeleine_Kellam@mail.dnr.state.ga.us
Subject: Proposed Monitoring Well Locations

Melanie, GA EPD is in receipt of your facsimiles (Little to Rabon) dated 4 October 99 identifying proposed monitoring well locations for a number of sites addressed in the 16 SWMUs RFI Report dated February 1999. Consistent with our conversations this afternoon, please note the following.

1. GA EPD concurs with the proposed monitoring well locations at SWMU 27F (Northeast of Building 1340), SWMU 27J (Building 10535), SWMU 27N, SWMU 27U, and SWMU 27S. Please note that, per your feedback, analytical results for Geoprobe Loction No. 8EGP2 were non-detect for bis(2-ethylhexyl)phthalate at SWMU 27S during the September 1999 sampling event.

2. GA EPD concurs with the proposed monitoring well locations at SWMU 27L. Per our discussions on SWMU 27L, (1) groundwater samples will be analyzed for VOCs, SVOCs and RCRA Metals, (2) sediment and surface water samples will be collected and analyzed for VOCs, SVOCs and RCRA Metals and (3) no soil samples will be collected.

3. GA EPD concurs with the proposed monitoring well locations at SWMU 27F (Northwest of Building 1340) as modified per our Conference Call this afternoon. Per our discussions on SWMU 27F (Northwest of Building 1340), (1) groundwater and soil samples will be collected (See page 10.7-7 of the 16 SWMUs RFI Report dated February 1999), (2) all environmental media will be analyzed for VOCs, SVOCs and RCRA Metals and (3) a modified map with new proposed monitoring well locations for MW-3, MW-4 and MW-5 will be faxed to my attention tomorrow for our review.

4. GA EPD concurs with the proposed monitoring well locations at SWMU 27J (Building 10531). Per our discussions on SWMU 27J (Building 10531), (1) groundwater samples will be analyzed for VOCs, SVOCs and RCRA Metals, (2) sediment and surface water samples will be collected and analyzed for VOCs, SVOCs and RCRA Metals (Fort Stewart will contact GA EPD with specific sampling locations at a later date) and (3) no soil samples will be collected.

5. GA EPD concurs with the proposed monitoring well locations at SWMU 27H (Building 1071). Per our discussions on SWMU 27H (Building 1071), (1) groundwater, soil, sediment and surface water samples will be collected and analyzed for VOCs, SVOCs and RCRA Metals (See page 10.8-7 of the 16 SWMUs RFI Report dated February 1999) and (2) Fort Stewart will add a sediment/surface water sampling location (i.e., Location No. SWS3) immediately west of Geoprobe Location No. GP8.

. GA EPD concurs with the proposed monitoring well locations at SWMU 24B. Per our discussions on SWMU 27B, (1) groundwater and soil samples will be collected (See page 10.6-9 of the 16 SWMUs RFI Report dated February 1999) and

(2) all environmental media will be analyzed for VOCs, SVOCs and RCRA Metals.

7. GA EPD concurs with the proposed monitoring well locations at SWMU 27H (Building 1056) which were provided on the figure for SWMU 24B. Per our discussions on SWMU 27H (Building 1056), (1) groundwater samples will collected at the two (2) monitoring well locations immediately north and south of the oil/water separator and analyzed for VOCs and SVOCs and (2) a monitoring well will be installed west of the Wash Rack in order to determine depth to groundwater only and create a potentiometric map for the site (i.e., no groundwater sample will be collected from this well for hazardous constituent analyses).

Should you have any questions or should the text above be inconsistent with our conversations earlier today, please do not hesitate to contact me. Thank you for your time and assistance in providing feedback to us today.

Brent Rabon

ATTACHMENT B
TO SWMU 27J, BUILDING 10531
TO THE
REVISED FINAL PHASE II RCRA FACILITY INVESTIGATION REPORT
FOR
16 SOLID WASTE MANAGEMENT UNITS
AT
FORT STEWART, GEORGIA

CHAIN-OF-CUSTODY FORM AND ANALYTICAL DATA

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CHAIN-OF-CUSTODY FORM

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SAIC An Employee-Owned Company
Science Applications International Corporation
800 Oak Ridge Turnpike, Oak Ridge, TN 37831 (423) 481-4600

CHAIN OF CUSTODY RECORD

COC NO.: G16Ø37

PROJECT NAME: ~~SWMU 12A~~ 16 SWMUs

PROJECT NUMBER: 01-1624-04-7328-~~710~~ 400

PROJECT MANAGER: Jeff Longaker

Sampler (Signature): [signature] (Printed Name): Laura

LABORATORY NAME: General Engineering Laboratory

LABORATORY ADDRESS: 2040 Savage Raod, Charleston, SC 29417

PHONE NO: (803) 556-8171

REQUESTED PARAMETERS

Sample ID	Date Collected	Time Collected	Matrix	EXPLOSIVES	SVOC	RCRA METALS	BIS	Cadmium	No. of Bottles/ Vials:	OVA SCREENING	OBSERVATIONS, COMMENTS, SPECIAL INSTRUCTIONS
7U1412	6/23/00	1430	water						2		7 day TAT
~~7A1412~~ 7P1412 not 7/10/00	6/22/00	1550	↓						2		↓
8FZ411	6/24/00	0820	soil					1	1	2750%	↓
8FZ511	6/24/00	0825	↓					1	1		↓
8FZ611	6/24/00	0835	↓					1	1		↓

SB 6/24/00

RELINQUISHED BY: [signature] COMPANY NAME: SAIC	Date/Time 6/24/00 0920	RECEIVED BY: [signature] COMPANY NAME: GEL	Date/Time. 6/24/00 1155
RECEIVED BY: Raymond Reed COMPANY NAME: GEL	Date/Time 6/24/00 0920	RELINQUISHED BY: COMPANY NAME:	Date/Time
RELINQUISHED BY: Raymond Reed COMPANY NAME: GEL	Date/Time 6/24/00 1155	RECEIVED BY: COMPANY NAME:	Date/Time

TOTAL NUMBER OF CONTAINERS: 7

Cooler ID: #406

Cooler Temperature: 3.7°C

FEDEX NUMBER:

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ANALYTICAL DATA

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1B
SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

7U1412

Lab Name: GENERAL ENGINEERING LABOR Contract: N/A

Lab Code: N/A Case No.: N/A SAS No.: N/A SDG No.: FS16A45W

Matrix: (soil/water) WATER Lab Sample ID: 27506001

Sample wt/vol: 1020 (g/mL) ML Lab File ID: 4A324

Level: (low/med) LOW Date Received: 06/24/00

% Moisture: ______ decanted: (Y/N)___ Date Extracted:06/27/00

Concentrated Extract Volume: 1.00(mL) Date Analyzed: 06/29/00

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
117-81-7	bis(2-Ethylhexyl)phthalate	9.8	U

FORM I SV-1 OLM03.0

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ATTACHMENT C
TO SWMU 27J, BUILDING 10531
TO THE
REVISED FINAL PHASE II RCRA FACILITY INVESTIGATION REPORT
FOR
16 SOLID WASTE MANAGEMENT UNITS
AT
FORT STEWART, GEORGIA

FATE AND TRANSPORT ANALYSIS

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Fate and transport modeling was performed for the preliminary contaminant migration contaminant of potential concern (CMCOPC) (cadmium) in sediment and the ecological contaminant of potential concern (ECOPC) (carbon disulfide) in groundwater. No preliminary CMCOPCs were identified in soil and no human health contaminants of potential concern in groundwater. The main purpose of the modeling was to estimate future groundwater concentrations in the leachate beneath Solid Waste Management Unit (SWMU) 27J, Building 10531 and future surface water concentrations at the receptor locations, a tributary of Peacock Creek located 1,200 feet from the site.

The modeled groundwater concentration of cadmium and the measured concentration of carbon disulfide were modeled to the tributary of Peacock Creek located approximately 1,200 feet from the site. The modeling procedures used to estimate groundwater and surface water concentrations are discussed below.

Migration to Groundwater Beneath the Source

The predicted groundwater concentration resulting from the leaching of the preliminary CMCOPC, cadmium, from the sediment above the water table was estimated using the Seasonal Soil Compartment (SESOIL) Model [see Section 6.4.2 and Appendix K of the revised final Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Report for 16 SWMUs (SAIC 2000)]. Chemical and climatic parameters used in SESOIL modeling are presented in Table 6-2 and Appendix K, Table K-1 of the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000), respectively. The hydrogeological parameters and application data used in SESOIL modeling for SWMU 27J, Building 10531 are presented in Tables C-1 and C-2, respectively. SESOIL modeling results are presented in Table C-3 and Figure C-1. The predicted groundwater concentration was calculated by dividing the SESOIL leachate concentration by a dilution factor (DF) of 1.41. The DF was developed by using the hydraulic analysis method (EPA 1996), which involves calculating the rate of flow through the aquifer system and the rate of rainwater percolation into the aquifer. The parameters used in the development of the DF are presented in Table C-1. The thickness of the zone of mixing in the groundwater aquifer was calculated to be 23.6 feet using the formula for depth of mixing presented in the U.S. Environmental Protection Agency's soil screening guidance (EPA 1996). The maximum groundwater concentration of cadmium was predicted to be 0.143 mg/L (maximum contaminant level = 0.005 mg/L) by the SESOIL modeling.

Migration of Groundwater to Surface Water

Cadmium. Groundwater migration modeling was used to evaluate the potential for cadmium (a CMCOPC) in groundwater, which is the result of leaching from sediment, to migrate to a tributary of Peacock Creek, located approximately 1,200 feet from the site. The One-dimensional Analytical Solute Transport (ODAST) Model [see Chapter 6.0 and Appendix K of the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000)] was used to estimate the surface water concentration of cadmium based on the SESOIL–modeled groundwater concentration (0.143 mg/L). As a conservative measure, it was assumed that there is no dilution of groundwater concentrations in the tributary and that the surface water concentration is equal to the groundwater concentration adjacent to the tributary. The groundwater migration modeling was used to evaluate the potential migration of cadmium that has leached from sediment. ODAST modeling parameters are presented in Table C-4. ODAST modeling of cadmium assumed a constant concentration at the source for a period of 70 years and was simulated for a period of 1,000 years. The ODAST modeling results are presented in Table C-5. ODAST modeling results indicate that cadmium from sediment leachate will not migrate to the tributary of Peacock Creek through the groundwater pathway.

Carbon Disulfide. Groundwater migration modeling was used to evaluate the potential for carbon disulfide (an ECOPC) in groundwater to migrate to a tributary of Peacock Creek, located approximately 1,200 feet from the site. The Analytical Transient 1-, 2-, 3-Dimensional (AT123D) Model [see

Chapter 6.0 and Appendix K of the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000)] was used to estimate the surface water concentration of carbon disulfide based on the maximum measured groundwater concentration. As a conservative measure, it was assumed that there is no dilution of groundwater concentrations in the tributary and that the surface water concentration is equal to the groundwater concentration adjacent to the tributary. The modeling parameters are presented in Table C-6. The biodegradation rate of carbon disulfide was conservatively assumed to be zero because no biodegradation rate was available from the references. The AT123D model was calibrated to the maximum observed groundwater concentration of carbon disulfide (0.0051 mg/L) at the source. AT123D modeling assumed a steady-state, constant concentration at the source. AT123D modeling results are presented in Table C-7. The AT123D model output file is presented at the back of this attachment. The modeled concentration of carbon disulfide in surface water is 0.000037 mg/L.

REFERENCES

EPA (U.S. Environmental Protection Agency) 1996. Soil Screening Guidance: Technical Background Document, EPA/540/R-95/128, Office of Solid Waste and Emergency Response, May.

Mills, W. B., D. B. Porcella, M. J. Ungs, S. A. Gherini, K. V. Summers, G. L. Rupp, and G. L. Bowie 1985. Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants: Parts 1, 2, and 3, EPA/600/6-85/002, EPA Environmental Research Laboratory, Office of Research and Development, Athens, Georgia.

SAIC (Science Applications International Corporation) 2000. Phase II RCRA Facility Investigation Report for 16 Solid Waste Management Units at Fort Stewart, Georgia (Revised Final), April.

Table C-1. Hydrogeological and Chemical Parameters Used for SESOIL Modeling, SWMU 27J, Building 10531

Parameter Type	Parameter Value	Source
Soil type	Silty sand	SWMU 27J, Building 10531 specific
Bulk density (gm/cm^3)	1.74	Laboratory analysis
Percolation rate (cm/year)	35.9	From HELP model
Intrinsic permeability (cm^2)	8.00E-10	Calibrated
Disconnectedness index	10	Calibrated
Porosity (%)	0.34	Laboratory analysis
Depth to water table (feet)	4	Site specific
Organic carbon content (%)	0.265	Laboratory analysis
Frendlich equation exponent	1	SESOIL default value
DAF	1.41	Calculated
Area of source (m^2)	2.23E+03	Estimated from soil contamination area
Distribution coefficient (L/kg)	75	pH 6.8 (EPA 1996)

DAF = Dilution attenuation factor.
HELP = Hydrologic Evaluation of Landfill Performance.

Table C-2. SESOIL Application Data, SWMU 27J, Building 10531

COPCs	No. of Layers	Layer No.	Thickness of Layer (feet)	No. of Sublayers	Sublayer No.	Concentration (µg/g)
Cadmium	3	1	1	1	1	22.7
		2	2	3	1	0
					2	0
		3	1	10	1	0
					2	0
					3	0
					4	0
					5	0
					6	0
					7	0
					8	0
					9	0
					10	0

Table C-3. Summary of Leachate Modeling Results, SWMU 27J, Building 10531

Preliminary CMCOPCs[a]	Maximum Concentration (mg/kg)	Predicted $C_{leachate,max}$ beneath the Source (mg/L)	Predicted T_{max} (years)	Predicted $C_{gw,max}$ at the Source[b] (mg/L)	Maximum Observed Groundwater Concentration (mg/L)	Groundwater Target Concentration (mg/L)	Source[c]	CMCOPC?
				Metals				
Cadmium	22.7	0.202	214	0.143	ND	0.005	M	Yes

[a]These constituents were selected for SESOIL modeling from this site.
[b]The predicted maximum concentration in groundwater ($C_{gw,max}$) at the source was calculated by applying a dilution factor to the predicted maximum leachate concentration ($C_{leachate,max}$).
[c]M = Maximum contaminant level.
ND = Not detected.

Table C-4. Parameters Used for ODAST Modeling, SWMU 27J, Building 10531

Parameter Type	Parameter Value	Source
Bulk density (gm/cm^3)	1.74	Laboratory analysis
Effective porosity (%)	0.2	Mills et al. (1985) for sandy silt
Hydraulic conductivity (cm/s)	2.00E-04	Average from slug tests performed at Fort Stewart underground storage tank sites
Hydraulic gradient	0.0125	Site specific
Groundwater velocity (feet/day)	0.0354	Calculated
Dispersion coefficient (feet^2/day)	4.25	Calculated assuming dispersivity = 0.1 × distance to receptor
Distance to receptor (feet)	1,200	Approximate distance to a tributary to Mill Creek
Distribution coefficient for cadmium (L/kg)	35	Corresponding to pH = 5.9 (EPA 1996)

Table C-5. ODAST Modeling Results, SWMU 27J, Building 10531

COPC[a]	Source Concentration[b] (mg/L)	Dilution Factor[c]	Receptor	Receptor Point Groundwater Concentration (mg/L)
Cadmium	0.143	Infinite	Tributary to Peacock Creek (1,200 feet)	0

[a]CMCOPC modeled to groundwater.
[b]SESOIL–predicted groundwater concentration.
[c]Dilution factor represents (maximum concentration at the source) ÷ (maximum predicted concentration at the receptor in 1,000 year simulation).

Table C-6. Key Hydrogeological Parameters Used for AT123D Modeling, SWMU 27J, Building 10531

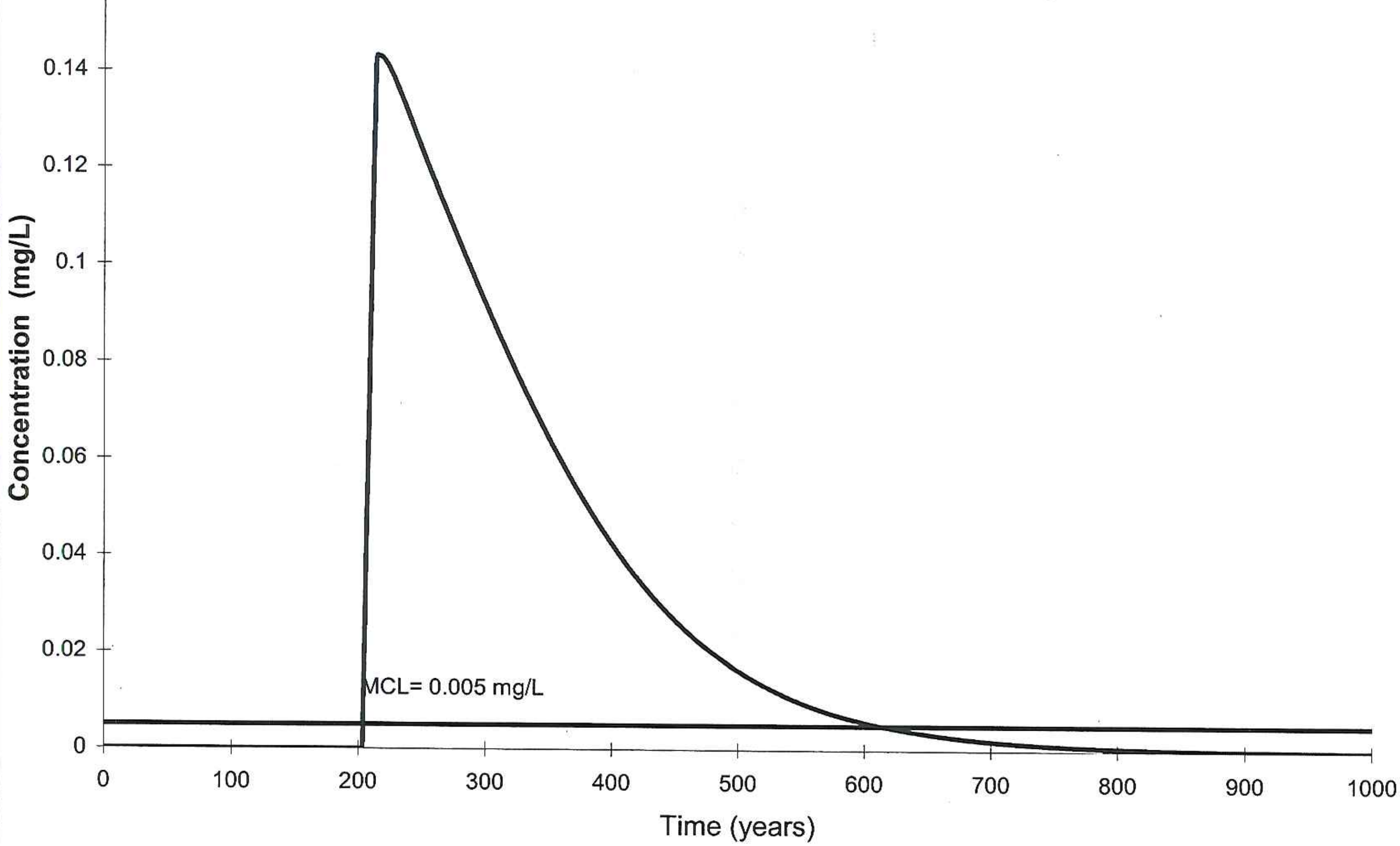
Parameter Type	Parameter Value	Source
Bulk density (kg/m^3)	1,740	Laboratory analysis
Effective porosity (%)	0.2	Mills et al. (1985) for sandy clay type
Hydraulic conductivity (m/hour)	7.20E-03	Site specific
Hydraulic gradient	0.0125	Site specific
Dispersivity (m)	36.58	Calculated assuming dispersivity = 0.1 × distance to receptor
Density of water (kg/m^3)	1,000	Assumed
Fraction of organic carbon (unitless)	0.0027	Laboratory analysis
Distance to receptor (feet)	1,200	Approximate distance to the tributary of Peacock Creek
Source area length (m)	27	Conservative estimate
Source area width (m)	27	Conservative estimate

Table C-7. AT123D Modeling Results, SWMU 27J, Building 10531

COPC	Source Concentration[a] (mg/L)	Dilution Factor[b]	Receptor	Receptor Point Groundwater Concentration (mg/L)
Carbon disulfide	0.0051	137	Tributary to Peacock Creek (1,200 feet)	3.7E-05

[a]Maximum observed groundwater concentration.
[b]Dilution factor represents (maximum concentration at the source) ÷ (maximum predicted concentration at the receptor).

Figure C-1. Predicted Concentration of Cadmium in Groundwater Based on Leachate Modeling Using SESOIL, SWMU 27J, Building 10531



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AT123D OUTPUT FILE FOR SWMU 27J, BUILDING 10531

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SWMU 27J, Building 10531 Carbon disulfide

NO. OF POINTS IN X-DIRECTION 12
NO. OF POINTS IN Y-DIRECTION 1
NO. OF POINTS IN Z-DIRECTION 1
NO. OF ROOTS: NO. OF SERIES TERMS 400
NO. OF BEGINNING TIME STEP 900
NO. OF ENDING TIME STEP 1198
NO. OF TIME INTERVALS FOR PRINTED OUT SOLUTION 16
INSTANTANEOUS SOURCE CONTROL = 0 FOR INSTANT SOURCE 1
SOURCE CONDITION CONTROL = 0 FOR STEADY SOURCE 0
INTERMITTENT OUTPUT CONTROL = 0 NO SUCH OUTPUT 1
CASE CONTROL =1 THERMAL, = 2 FOR CHEMICAL, = 3 RAD 2

AQUIFER DEPTH, = 0.0 FOR INFINITE DEEP (METERS) ... 0.1524E+02
AQUIFER WIDTH, = 0.0 FOR INFINITE WIDE (METERS) ... 0.0000E+00
BEGIN POINT OF X-SOURCE LOCATION (METERS) .... -0.2700E+02
END POINT OF X-SOURCE LOCATION (METERS) .... 0.0000E+00
BEGIN POINT OF Y-SOURCE LOCATION (METERS) .... -0.1350E+02
END POINT OF Y-SOURCE LOCATION (METERS) .... 0.1350E+02
BEGIN POINT OF Z-SOURCE LOCATION (METERS) .... -0.1000E+01
END POINT OF Z-SOURCE LOCATION (METERS) .... 0.0000E+00

POROSITY .... 0.2000E+00
HYDRAULIC CONDUCTIVITY (METER/HOUR) 0.7200E-02
HYDRAULIC GRADIENT 0.1250E-01
LONGITUDINAL DISPERSIVITY (METER) .... 0.3658E+02
LATERAL DISPERSIVITY (METER) .... 0.3658E+01
VERTICAL DISPERSIVITY (METER) .... 0.1000E+01
DISTRIBUTION COEFFICIENT, KD (M**3/KG) 0.1210E-03
HEAT EXCHANGE COEFFICIENT (KCAL/HR-M**2-DEGREE C).. 0.0000E+00

MOLECULAR DIFFUSION MULTIPLY BY POROSITY (M**2/HR) 0.3600E-05
DECAY CONSTANT (PER HOUR) .... 0.0000E+00
BULK DENSITY OF THE SOIL (KG/M**3) .... 0.1740E+04
ACCURACY TOLERANCE FOR REACHING STEADY STATE 0.1000E-02
DENSITY OF WATER (KG/M**3) .... 0.1000E+04
TIME INTERVAL SIZE FOR THE DESIRED SOLUTION (HR) .. 0.7300E+03
DISCHARGE TIME (HR) .... 0.8760E+06
WASTE RELEASE RATE (KCAL/HR), (KG/HR), OR (CI/HR) . 0.1372E-06

RETARDATION FACTOR .... 0.2053E+01
RETARDED DARCY VELOCITY (M/HR) 0.2192E-03
RETARDED LONGITUDINAL DISPERSION COEF. (M**2/HR) .. 0.8028E-02
RETARDED LATERAL DISPERSION COEFFICIENT (M**2/HR) . 0.8107E-03
RETARDED VERTICAL DISPERSION COEFFICIENT (M**2/HR). 0.2280E-03

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.0000E+00 HRS
(ADSORBED CHEMICAL CONC. = 0.1210E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

X						
Y	0.	10.	20.	50.	75.	90.
0.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CONTINUE X						
Y	100.	150.	200.	300.	350.	365.
0.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.6563E+06 HRS
(ADSORBED CHEMICAL CONC. = 0.1210E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

X						
Y	0.	10.	20.	50.	75.	90.
0.	0.503E-02	0.362E-02	0.282E-02	0.165E-02	0.117E-02	0.973E-03
CONTINUE X						
Y	100.	150.	200.	300.	350.	365.
0.	0.862E-03	0.467E-03	0.232E-03	0.361E-04	0.108E-04	0.725E-05

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.6680E+06 HRS
(ADSORBED CHEMICAL CONC. = 0.1210E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

X						
Y	0.	10.	20.	50.	75.	90.
0.	0.503E-02	0.363E-02	0.283E-02	0.166E-02	0.118E-02	0.984E-03
CONTINUE X						
Y	100.	150.	200.	300.	350.	365.
0.	0.873E-03	0.479E-03	0.241E-03	0.392E-04	0.121E-04	0.817E-05

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.6796E+06 HRS
(ADSORBED CHEMICAL CONC. = 0.1210E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

X						
Y	0.	10.	20.	50.	75.	90.
0.	0.504E-02	0.363E-02	0.284E-02	0.167E-02	0.119E-02	0.994E-03
CONTINUE X						
Y	100.	150.	200.	300.	350.	365.
0.	0.884E-03	0.490E-03	0.251E-03	0.425E-04	0.134E-04	0.916E-05

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.6913E+06 HRS
(ADSORBED CHEMICAL CONC. = 0.1210E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00
X

Y	0.	10.	20.	50.	75.	90.
0.	0.504E-02	0.364E-02	0.284E-02	0.168E-02	0.120E-02	0.100E-02

CONTINUE X

Y	100.	150.	200.	300.	350.	365.
0.	0.895E-03	0.502E-03	0.260E-03	0.459E-04	0.149E-04	0.102E-04

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.7030E+06 HRS
(ADSORBED CHEMICAL CONC. = 0.1210E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00
X

Y	0.	10.	20.	50.	75.	90.
0.	0.505E-02	0.365E-02	0.285E-02	0.168E-02	0.121E-02	0.101E-02

CONTINUE X

Y	100.	150.	200.	300.	350.	365.
0.	0.905E-03	0.513E-03	0.270E-03	0.495E-04	0.164E-04	0.114E-04

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.7147E+06 HRS
(ADSORBED CHEMICAL CONC. = 0.1210E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00
X

Y	0.	10.	20.	50.	75.	90.
0.	0.505E-02	0.365E-02	0.286E-02	0.169E-02	0.122E-02	0.102E-02

CONTINUE X

Y	100.	150.	200.	300.	350.	365.
0.	0.916E-03	0.524E-03	0.279E-03	0.531E-04	0.181E-04	0.126E-04

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.7264E+06 HRS
(ADSORBED CHEMICAL CONC. = 0.1210E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00
X

Y	0.	10.	20.	50.	75.	90.
0.	0.506E-02	0.366E-02	0.286E-02	0.170E-02	0.123E-02	0.103E-02

CONTINUE X

Y	100.	150.	200.	300.	350.	365.
0.	0.926E-03	0.534E-03	0.289E-03	0.569E-04	0.199E-04	0.140E-04

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.7380E+06 HRS
(ADSORBED CHEMICAL CONC. = 0.1210E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

X						
Y	0.	10.	20.	50.	75.	90.
0.	0.506E-02	0.366E-02	0.287E-02	0.171E-02	0.124E-02	0.104E-02
CONTINUE X						
Y	100.	150.	200.	300.	350.	365.
0.	0.935E-03	0.545E-03	0.298E-03	0.609E-04	0.217E-04	0.154E-04

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.7497E+06 HRS
(ADSORBED CHEMICAL CONC. = 0.1210E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

X						
Y	0.	10.	20.	50.	75.	90.
0.	0.507E-02	0.367E-02	0.287E-02	0.171E-02	0.125E-02	0.105E-02
CONTINUE X						
Y	100.	150.	200.	300.	350.	365.
0.	0.945E-03	0.556E-03	0.308E-03	0.650E-04	0.237E-04	0.169E-04

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.7614E+06 HRS
(ADSORBED CHEMICAL CONC. = 0.1210E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

X						
Y	0.	10.	20.	50.	75.	90.
0.	0.507E-02	0.367E-02	0.288E-02	0.172E-02	0.125E-02	0.106E-02
CONTINUE X						
Y	100.	150.	200.	300.	350.	365.
0.	0.954E-03	0.566E-03	0.317E-03	0.692E-04	0.257E-04	0.185E-04

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.7731E+06 HRS
(ADSORBED CHEMICAL CONC. = 0.1210E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

X						
Y	0.	10.	20.	50.	75.	90.
0.	0.507E-02	0.367E-02	0.288E-02	0.173E-02	0.126E-02	0.107E-02
CONTINUE X						
Y	100.	150.	200.	300.	350.	365.
0.	0.963E-03	0.576E-03	0.326E-03	0.735E-04	0.279E-04	0.202E-04

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.7848E+06 HRS
(ADSORBED CHEMICAL CONC. = 0.1210E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00
X

Y	0.	10.	20.	50.	75.	90.
0.	0.508E-02	0.368E-02	0.289E-02	0.173E-02	0.127E-02	0.108E-02

CONTINUE X

Y	100.	150.	200.	300.	350.	365.
0.	0.972E-03	0.586E-03	0.336E-03	0.780E-04	0.302E-04	0.220E-04

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.7964E+06 HRS
(ADSORBED CHEMICAL CONC. = 0.1210E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00
X

Y	0.	10.	20.	50.	75.	90.
0.	0.508E-02	0.368E-02	0.289E-02	0.174E-02	0.128E-02	0.109E-02

CONTINUE X

Y	100.	150.	200.	300.	350.	365.
0.	0.980E-03	0.596E-03	0.345E-03	0.825E-04	0.326E-04	0.239E-04

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.8081E+06 HRS
(ADSORBED CHEMICAL CONC. = 0.1210E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00
X

Y	0.	10.	20.	50.	75.	90.
0.	0.508E-02	0.369E-02	0.290E-02	0.174E-02	0.128E-02	0.109E-02

CONTINUE X

Y	100.	150.	200.	300.	350.	365.
0.	0.989E-03	0.605E-03	0.354E-03	0.872E-04	0.351E-04	0.259E-04

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.8198E+06 HRS
(ADSORBED CHEMICAL CONC. = 0.1210E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00
X

Y	0.	10.	20.	50.	75.	90.
0.	0.509E-02	0.369E-02	0.290E-02	0.175E-02	0.129E-02	0.110E-02

CONTINUE X

Y	100.	150.	200.	300.	350.	365.
0.	0.997E-03	0.615E-03	0.363E-03	0.920E-04	0.377E-04	0.280E-04

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.8315E+06 HRS
(ADSORBED CHEMICAL CONC. = 0.1210E+00 * DISSOLVED CHEMICAL CONC.)

Z= 0.00
X

Y	0.	10.	20.	50.	75.	90.
0.	0.509E-02	0.369E-02	0.290E-02	0.176E-02	0.130E-02	0.111E-02

CONTINUE X

Y	100.	150.	200.	300.	350.	365.
0.	0.100E-02	0.624E-03	0.372E-03	0.969E-04	0.404E-04	0.302E-04

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.8432E+06 HRS
(ADSORBED CHEMICAL CONC. = 0.1210E+00 * DISSOLVED CHEMICAL CONC.)

Z= 0.00
X

Y	0.	10.	20.	50.	75.	90.
0.	0.509E-02	0.370E-02	0.291E-02	0.176E-02	0.130E-02	0.112E-02

CONTINUE X

Y	100.	150.	200.	300.	350.	365.
0.	0.101E-02	0.633E-03	0.381E-03	0.102E-03	0.432E-04	0.325E-04

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.8548E+06 HRS
(ADSORBED CHEMICAL CONC. = 0.1210E+00 * DISSOLVED CHEMICAL CONC.)

Z= 0.00
X

Y	0.	10.	20.	50.	75.	90.
0.	0.510E-02	0.370E-02	0.291E-02	0.177E-02	0.131E-02	0.112E-02

CONTINUE X

Y	100.	150.	200.	300.	350.	365.
0.	0.102E-02	0.642E-03	0.390E-03	0.107E-03	0.461E-04	0.348E-04

STEADY STATE SOLUTION HAS NOT BEEN REACHED BEFORE FINAL SIMULATING TIME

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.8665E+06 HRS
(ADSORBED CHEMICAL CONC. = 0.1210E+00 * DISSOLVED CHEMICAL CONC.)

Z= 0.00
X

Y	0.	10.	20.	50.	75.	90.

CONTINUE X

Y	100.	150.	200.	300.	350.	365.
0.	0.510E-02	0.370E-02	0.292E-02	0.177E-02	0.132E-02	0.113E-02
0.	0.103E-02	0.651E-03	0.399E-03	0.112E-03	0.491E-04	0.373E-04

ATTACHMENT D
TO SWMU 27J, BUILDING 10531
TO THE
REVISED FINAL PHASE II RCRA FACILITY INVESTIGATION REPORT
FOR
16 SOLID WASTE MANAGEMENT UNITS
AT
FORT STEWART, GEORGIA

TOXICITY PROFILES FOR CONTAMINANTS OF POTENTIAL CONCERN

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This attachment contains the toxicity profile for the contaminant migration contaminant of potential concern (CMCOPC) and human health contaminant of potential concern (HHCOPC). The toxicity profile provides pertinent information concerning the uptake, mechanisms of toxicity, and toxicity values for the CMCOPC and HHCOPC. In addition to the toxicity profile, a toxicity summary (Table D-1) is given for the site-related contaminant. The toxicity summary consists of the essential data used to derive toxicity values [reference doses (RfDs) and cancer slope factors] obtained from U.S. Environmental Protection Agency (EPA) toxicity databases [Integrated Risk Information System (IRIS; EPA 2000) and Health Effects Assessment Summary Tables (HEAST; EPA 1997)].

Cadmium. Cadmium is a naturally occurring element found worldwide in soil and rocks. The primary sources of environmental cadmium contamination are smelters and the burning of fossil fuels in power plants.

Cadmium is absorbed more efficiently through the lungs than by the gastrointestinal tract. Acute oral exposures to cadmium can cause vomiting, diarrhea, and abdominal pain, while longer-term oral exposure to cadmium affects the kidneys and possibly the skeletal system (Young 1991). Inhalation exposure to cadmium may cause headache, chest pains, muscular weakness, pulmonary edema, and death (Young 1991), while longer-term inhalation exposure also results in kidney damage (ATSDR 1989; EPA 1980; EPA 1984).

Limited evidence shows possible adverse spermatogenic effects of cadmium in occupationally exposed workers (Barlow and Sullivan 1982). The results of genotoxicity and mutagenicity tests with cadmium are inconclusive. Some assays show positive results (certain mammalian cell culture assay systems), while other assays report negative findings (mouse bone marrow and mouse micronucleus assays) (ATSDR 1989).

EPA's IRIS database (EPA 2000) lists oral RfDs of 0.0005 mg/kg/day and 0.001 mg/kg/day for cadmium in water and in food, respectively. These RfDs were based on respective human no observed adverse effect levels (NOAELs) of 0.005 mg/kg/day and 0.01 mg/kg/day in water and food and an uncertainty factor of 10 to account for human variability. The NOAELs were calculated with a toxicokinetic model using a human renal cortex concentration of 200 μg cadmium per gram wet weight, the highest human renal cadmium concentration not associated with significant proteinuria in EPA's Drinking Water Criteria Document on Cadmium (EPA 1985). The model assumed that 0.01 percent of the cadmium body burden is eliminated daily, and that 5 percent and 2.5 percent of ingested cadmium are absorbed from water and food, respectively. A new RfD has been proposed in EPA's recent Toxicological Review: Cadmium and Compounds (EPA 1999), which is undergoing external review. The proposed RfD of 0.0007 mg/kg/day is an estimate of a daily oral intake (in excess of estimated dietary cadmium intake) that would be associated with a 10-percent occurrence of minimal proteinuria/enzymuria in an exposed population at the age of 70. The estimate is based on a toxicokinetic model and data for renal dysfunction in cross-sectional studies of human populations exposed to excess cadmium.

A reference concentration (RfC) assessment is not available in IRIS or HEAST, but an inhalation RfC has been proposed in EPA's recent Toxicological Review: Cadmium and Compounds (EPA 1999), which is undergoing external review. The proposed RfC of 0.00065 mg/m^3 is an estimate of an air concentration producing an inhaled intake (in excess of estimated dietary cadmium intake) that would be associated with a 10-percent occurrence of minimal proteinuria/enzymuria in an exposed population at the age of 70. The estimate is based on a toxicokinetic model and data for renal dysfunction in cross-sectional studies of human populations exposed to excess cadmium (EPA 1999).

EPA has placed cadmium in weight-of-evidence class B1, probable human carcinogen (EPA 2000). An inhalation unit risk of $1.8 \times 10^{-3}/(\mu g/m^3)$ was derived based on excess deaths from lung, trachea, and bronchus cancers in male workers exposed to airborne cadmium in the workplace (EPA 2000).

REFERENCES

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Young, R.A., 1991. Toxicity Summary for Cadmium, Biomedical and Environmental Information Analysis Section, Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee, available at <http://risk.lsd.ornl.gov/tox/profiles/cadmiu_c.htm>.

Table D-1. Summary of Toxicity Data for Chemicals of Potential Concern, SWMU 27J

Chemical	CSF_o (1/mg/kg/day)	Ref	CSF_i (1/mg/kg/day)	Ref	WOE	RfD_o (mg/kg/day)	Ref	UF-MF	Target Organs	RfD_i (mg/kg/day)	Ref	UF-MF	Target Organs
Cadmium–food	ND		6.30E+00	I	B1	1.00E-03	I	10	Kidney	ND			
Cadmium–water	ND		6.30E+00	I	B1	5.00E-03	I		Kidney	ND			

CSF_i = Inhalation cancer slope factor.
CSFo = Oral cancer slope factor.
ND = No data.
Ref = Source of information: E = EPA's National Center for Environmental Assessment; H = Health Effects Assessment Summary Tables, U.S. Environmental Protection Agency; I = Integrated Risk Information System, on-line database, <www.epa.gov/IRIS>.
RfD_i = Inhalation reference dose.
RfD_o = Oral reference dose.
UF-MF = Product of the uncertainty and modifying factors.
Target Organs = Primary organ systems affected by noncarcinogenic chemicals.
WOE = Cancer weight-of-evidence classification.