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ADDENDUM FOR SWMU 27L: NGTC BLOCK 10200

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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TABLES

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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
CMCOPC	contaminant migration contaminant of potential concern
COC	constituent of concern
COPC	contaminant of potential concern
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
LOAEL	lowest observed adverse effect level
MCL	maximum contaminant level
NFA	no further action
NGTC	National Guard Training Center
NOAEL	no observed adverse effect level
NTU	nephelometric turbidity unit
OWS	oil/water separator
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
SPRE	supplemental preliminary risk evaluation
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

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 National Guard Training Center (NGTC) Block 10200 (SWMU 27L) performed in October 1999. A Phase I RFI was performed at SWMU 27L in January 1998, and the results are presented in Section 10.13 of the revised final Phase II Report for 16 SWMUs (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 27L, Block 10200 at Fort Stewart, Georgia, as defined in the conclusions and recommendations in Section 10.13.8 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 (GEPD 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 both upstream and downstream of the oil/water separator (OWS).
- 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. The contents of each volume are described below.

Chapter 1.0 describes the purpose of this 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 investigation 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 was not required. Chapter 10.0, in which SWMU 27L, Block 10200 is addressed (Section 10.13), designates, in sequential order, the SWMUs that are recommended for additional investigation or a CAP. Chapter 11.0 presents general conclusions and recommendations related to the SWMUs being recommended for NFA or SWMUs that indicate risk to human health or the 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. The analytical data are also provided in electronic format (i.e., on CDs). 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 the fate and transport input data and model descriptions. Appendix L presents the revised responses to GEPD comments received on the final 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 27L, Block 10200 are presented in Section 10.13 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 for 16 SWMUs.

2.0 HISTORY AND DESCRIPTION OF SWMU 27L, BLOCK 10200

This OWS is one of eight located in the NGTC along Troupe Avenue 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 southwestern corner of Block 10200 and receives wastewater from an adjacent vehicle wash rack (Figures 1 and 2). Troughs from the wash rack are piped to the OWS. The effluent discharges into a drainage ditch located southeast of the OWS along Troupe Avenue. The wash rack is not presently in use and is scheduled for removal during 2000. Units rarely use the motorpool, and when assigned to the facility, they are strictly forbidden from using the wash rack. All equipment and vehicles are washed at a centralized location in the National Guard area; therefore, only rainwater currently collects in the OWS, which is an open unit.

SWMU 27L, Block 10200 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 27L, Block 10200 in January 1998, and the results are discussed in the following section.

2.1 SUMMARY OF PHASE I RCRA FACILITY INVESTIGATION

A Phase I RFI was performed in January 1998. DPT techniques were used to collect four soil and groundwater samples at the site. The locations of the soil and groundwater sampling are presented in Figure 2. The four soil samples were collected based on field headspace screening for volatile organic compounds (VOCs). The soil and groundwater samples were analyzed for VOCs, semivolatile organic compounds (SVOCs), and lead.

One surface water and one sediment sample were collected in the drainage ditch at approximately the point at which the effluent pipe from the OWS discharges into the ditch. The surface water and sediment samples were analyzed for VOCs, SVOCs, and lead.

2.1.1 Surface Soil

Two surface soil samples were collected during the Phase I RFI because the field headspace screening for VOCs indicated that the surface soil interval had the most elevated level of these constituents. The results of the surface soil analyses are presented in Figure 3 and Table 1.

VOCs. No VOCs were detected in surface soil during the Phase I RFI.

SVOCs. No SVOCs were detected in surface soil during the Phase I RFI.

Lead. Lead was detected in the samples taken from GP2 and GP3 at concentrations of 5.2 mg/kg and 5.4 mg/kg, respectively, both of which are below the reference background criterion; therefore, lead is not considered to be a site-related contaminant (SRC) for surface soil based on the Phase I RFI.

2.1.2 Subsurface Soil

Two subsurface soil samples were collected during the Phase I RFI based on field headspace screening for VOCs. The results of the subsurface soil analysis are presented in Figure 3 and Table 2.

VOCs. Toluene was detected in the sample collected at GP4 at a concentration of 0.0253 mg/kg; therefore, toluene is considered to be an SRC for subsurface soil based on the Phase I RFI.

SVOCs. The sample collected at GP4 indicated the presence of bis(2-ethylhexyl)phthalate at a concentration of 0.23 mg/kg; therefore, bis(2-ethylhexyl)phthalate is considered to be an SRC for subsurface soil based on the Phase I RFI.

Lead. Lead was detected in the samples taken from GP1 and GP4 at concentrations of 9.1 mg/kg and 4.9 mg/kg, respectively, both of which are below the reference background criterion; therefore, lead is not considered to be an SRC based on the Phase I RFI.

2.1.3 Groundwater

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

VOCs. The samples taken at GP1, GP2, and GP4 indicated the presence of 1,1,2-trichloroethane at concentrations of 16.2 µg/L, 5.5 µg/L, and 6.2 µg/L, respectively. In addition, these concentration levels exceeded the maximum contaminant level (MCL) for this constituent. In addition, the samples collected from GP1, GP2, and GP4 indicated the presence of 4-methyl-2-pentanone at concentrations of 17.7 µg/L, 11.3 µg/L, and 7.4 µg/L, respectively. Bromodichloromethane and toluene were detected in the samples collected from GP1 at concentrations of 53.6 µg/L and 24.6 µg/L, respectively. 2-Butanone was detected at GP1 and GP4 at concentrations of 89.2 µg/L and 14.8 µg/L, respectively. The samples collected from GP2 and GP4 indicated the presence of 2-hexanone at concentrations of 8.6 µg/L and 7 µg/L, respectively. Ethylbenzene was detected in the samples collected from GP1 and GP4 at concentrations of 198 µg/L and 2.2 µg/L, respectively. Total xylenes were detected at a concentration of 810 µg/L at GP1.

All of these analytes—1,1,2-trichloroethane; 2-butanone; 2-hexanone; 4-methyl-2-pentanone; bromodichloromethane; ethylbenzene; toluene; and total xylenes—are considered to be SRCs for groundwater based on the Phase I RFI.

SVOCs. The sample collected from GP1 indicated the presence of 2-methylnaphthalene and naphthalene at concentrations of 22.6 µg/L and 54.1 µg/L, respectively. Both constituents are considered to be SRCs for 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 for groundwater.

2.1.4 Surface Water

One surface water sample was collected during the Phase I RFI. The results of the surface water analysis are presented in Table 4 and Figure 3.

VOCs. Acetone was detected in the sample collected at SWS1 at a concentration of 73.8 µg/L; therefore, acetone is considered to be an SRC for surface water according to the Phase I RFI.

SVOCs. No SVOCs were detected in surface water during the Phase I RFI.

Lead. Lead was not detected in surface water during the Phase I RFI.

2.1.5 Sediment

One sediment sample was collected during the Phase I RFI. The results of the sediment analysis are presented in Table 4 and Figure 3.

VOCs. No VOCs were detected in sediment.

SVOCs. No SVOCs were detected in sediment.

Lead. Lead was detected in the sediment sample taken from SWS1 at a concentration of 2.2 mg/kg, which does not exceed the reference background criterion; therefore, lead is not considered to be an SRC in sediment.

2.1.6 Conclusions and Recommendations of the Phase I RFI

No contamination was indicated in surface soil. Toluene and bis(2-ethylhexyl)phthalate were identified as SRCs in subsurface soil; however, neither of these constituents was identified as a contaminant migration contaminant of potential concern (CMCOPC) or a human health contaminant of potential concern (HHCOPC). 1,1,2-Trichloroethane; 2-butanone; 2-hexanone; 4-methyl-2-pentanone; bromodichloromethane; ethylbenzene; toluene; total xylenes; 2-methylnapthalene; and naphthalene were identified as SRCs in groundwater. 1,1,2-Trichloroethane; 4-methyl-2-pentanone; bromodichloromethane; ethylbenzene; 2-methylnapthalene; and naphthalene were identified as HHCOPCs in groundwater. 1,1,2-Trichloroethane was detected above its MCL in three of four groundwater samples. Bromodichloromethane, total xylenes, and 2-methylnaphthalene were identified as ecological contaminants of potential concern (ECOPCs) based on the potential hazards to aquatic biota if groundwater discharges to a nearby surface water bodies; therefore, the Phase I RFI [see Section 10.13.8.2, page 10.13-8 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) at the site.

3.0 SUMMARY OF PHASE II RCRA FACILITY INVESTIGATION

Four DPT groundwater samples were collected in October 1999 and analyzed for VOCs at an off-site analytical laboratory. The results of the groundwater screening were used to locate three monitoring wells (one upgradient and two downgradient) at SWMU 27L 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 ditch, two sediment samples (one upstream and one downstream of the OWS) were collected. No surface water was present in the drainage ditch during the Phase II RFI; therefore, no surface water samples were collected. The Phase II RFI sampling locations are presented in Figure 4. Monitoring well construction details are shown in Table 5. Boring logs and monitoring well diagrams are presented in Appendices A (page A.28-1) and B (page B.14-1) of the revised final Phase II RFI Report (SAIC 2000).

Geotechnical samples were collected from the three monitoring wells, and the results are presented in Table 6. All three of the monitoring wells were developed until the turbidity was less than or equal to 10 nephelometric turbidity units (NTUs) (Table 7). Monitoring well development data are presented in Table 7. The monitoring wells were sampled using low-flow techniques following the procedures outlined in the revised final version of the SAP for Phase II RFIs of the 16 SWMUs (SAIC 1997). The groundwater samples were analyzed for VOCs, 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 8.

4.0 PHYSICAL CHARACTERISTICS OF THE SITE

4.1 TOPOGRAPHY

The topography of the site is essentially flat, with a gravel vehicle parking area adjacent to the north and a grass border between the OWS and wash rack and the fence to the southeast. The surface elevation ranges from 72.02 feet to 72.92 feet above mean sea level (amsl).

4.2 SURFACE DRAINAGE

A drainage ditch is located approximately 25 feet southeast of the OWS. The effluent from the OWS discharges to the drainage ditch. Surface water is present in the drainage ditches only during rainfall events or when the OWS discharges to it. Water flow in the drainage ditch is toward the northeast. Potential surface water drainage from this site discharges to the drainage ditch/swale along Troupe Avenue, which ultimately discharges to a low area southeast of the site, where it is allowed to percolate into the soil [see Section 3.3 of the revised final Phase II RFI Report (SAIC 2000)].

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 7 feet below ground surface (bgs) in the monitoring wells. The shallow groundwater flow direction across the site is to the southeast (Figure 7), and the hydraulic gradient is 0.003 foot/foot.

4.5 ECOLOGY

As stated in Section 8.2 of the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000), SWMU 27L is classified as an "industrialized area with managed grasslands." The site lies along the southeastern portion of the garrison area and comprises approximately 0.01 acre (see Figure 2). The only ecological habitat at this SWMU consists of a small grassy area and a storm water ditch that parallel the road. The drainage ditch contains water only after rainfall events. There is no aquatic habitat at SWMU 27L. Water flow in the drainage ditch is toward the northeast. Industrial facilities exist across the road from the SWMU.

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

Four DPT samples were collected and analyzed for VOCs and SVOCs in October 1999. Each of the three monitoring wells was sampled and analyzed for VOCs, SVOCs, and RCRA metals. The results of the groundwater analyses are presented in Table 9 and Figure 8. Chain-of-custody forms and complete analytical results are presented in Appendix G (page G-175) and Appendix H (page H.29-1), respectively, of the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000).

VOCs. Carbon disulfide was detected at a concentration of 4.3 µg/L in GP8. Carbon disulfide is considered to be an SRC based on the Phase II RFI.

SVOCs. No SVOCs were detected in groundwater during the Phase II RFI.

RCRA Metals. Barium was detected in all three monitoring wells at concentrations below the background criterion; therefore, there are no RCRA metal SRCs for groundwater at this site.

5.4 SURFACE WATER

No surface water was present in the drainage ditch at the time of the field activities; therefore, no surface water samples were collected during the Phase II RFI. As discussed in Section 4.2 of this addendum, water is present in the drainage ditch only after rainfall events.

5.5 SEDIMENT

Two sediment samples [upstream (SWS3) and downstream (SWS2) of the OWS] were collected at SWMU 27L and analyzed for VOCs, SVOCs, and RCRA metals. The results of the sediment analyses are presented in Table 10 and Figure 8. Chain-of-custody forms and complete analytical results are presented in Appendix G (page G-175) and Appendix H (page H.29-1), respectively, of the revised final Phase II RFI Report for 16 SWMUs (SAIC 2000).

VOCs. 2-Butanone and acetone were detected in SWS2 at concentrations of 0.0165 mg/kg and 0.0746 mg/kg, respectively. 2-Butanone and acetone were also detected at SWS3 (site-specific background location) at concentrations of 0.0154 mg/kg and 0.0934 mg/kg, respectively, indicating that there is potentially an off-site source of these constituents. 2-Butanone and acetone are considered to be SRCs in sediment; however, it should be noted that 2-butanone was detected a concentration less than twice the concentration indicated in the background sample, and acetone was detected at a concentration below the concentration indicated in the background sample (SWS3).

SVOCs. Pyrene was detected at a concentration of 0.0242 mg/kg in SWS2, which is below the concentration (0.0457 mg/kg) indicated in the site-specific background location (SWS3). The detection of pyrene at SWS3, collected upstream of the SWMU, as well as detections of seven other SVOCs, further indicates that there is potentially an off-site source of contaminants impacting the sediment at SWMU 27L. Pyrene is considered to be an SRC in sediment based on the Phase II RFI.

RCRA Metals. Barium, cadmium, chromium, lead, mercury, and selenium were detected in SWS2 at concentrations of 105 mg/kg, 8.6 mg/kg, 23.8 mg/kg, 27.6 mg/kg, 0.094 mg/kg, and 1.1 mg/kg, respectively. All these concentrations are above site-specific background criteria, so barium, cadmium, chromium, lead, mercury, and selenium are considered to be SRCs in sediment at SWMU 27L.

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 by the Phase I RFI. SRCs for groundwater were determined using only the most current groundwater characterization data (Phase II RFI data collected from DPT locations and monitoring wells). Surface water (rainfall dependent) was not available during the Phase II RFI; therefore, the SRCs for surface water were determined from only the Phase I RFI. SRCs for sediment were determined from sediment collected during the Phase I and Phase II RFIs. 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 contaminants to migrate (i.e., their leachability) to groundwater was evaluated by comparing the maximum concentrations of subsurface soil and sediment SRCs to their respective generic soil screening levels (GSSLs).

Of the SRCs identified in soil and sediment, none of the analytes exceeded their respective GSSLs (Table 12); therefore, there are no CMCOPCs in soil or sediment at SWMU 27L based on leaching to groundwater.

7.0 HUMAN HEALTH PRELIMINARY RISK EVALUATION, SWMU 27L, BLOCK 10200

SRCs were identified for the following media: subsurface 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, the OWS discharges to an open ditch outside the fence, but water is present only during rain events. The potential receptor populations include the following:

- construction workers,
- juvenile trespassers, and
- off-site occupational receptors.

On-site soil contamination at this site is limited to subsurface soil; therefore, only a construction worker or other individuals working within an excavation are likely to be exposed to contaminants. Juvenile trespassers playing in the drainage ditch might be exposed to contaminants present in sediment. It is unlikely that other receptors would come in contact with these contaminants.

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

The site is relatively flat and consists primarily of concrete structures; however, a small grassy area and a storm water ditch parallel the road. Potential migration pathways for soil include leaching into groundwater. Soil contamination at the site is limited to subsurface soil; therefore, air migration pathways (e.g., volatilization, fugitive dust) and surface water runoff are not viable migration pathways.

As previously discussed, the OWS discharges to a ditch adjacent to the site. Contaminants in the water may become adsorbed to soil particles within the ditch. Potential migration pathways for sediment include leaching into subsurface soil and volatilization into the air. The drainage ditch is vegetated, so releases via fugitive dust are not likely.

Because groundwater is lower than the adjacent drainage ditch and no other surface water bodies are nearby, groundwater at the site does not discharge into any nearby surface waters; therefore, migration via discharge of groundwater is not a viable migration pathway.

The on-site resident scenario is not considered to be a viable scenario for this 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 would be associated with an on-site resident exposure scenario.

Given that water is present only during rain events, exposure, if any, to contaminants in surface water would be sporadic; therefore, potential exposure to contaminants in surface water is not considered to be a chronic exposure and is generally not addressed. Surface water samples were taken at this site during a storm event only during the Phase I RFI. For the purposes of completeness, the risk characterization addressed potential risks associated with contaminants in the surface water.

7.2 RISK EVALUATION

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

Toluene and bis(2-ethylhexyl)phthalate were identified as SRCs for subsurface soil. The concentrations of these contaminants were below their respective screening values (Table 13); therefore, there are no HHCOPCs in subsurface soil.

The only SRC for groundwater based on the Phase II RFI data is carbon disulfide. The U.S. Environmental Protection Agency (EPA) Region III risk-based concentration (RBC) for carbon disulfide is 104.3 µg/L (EPA 2000a). The only detection of carbon disulfide during Phase II was at a concentration of 4.3 µg/L; therefore, there are no HHCOPCs for groundwater at this SWMU (Table 13).

Acetone was identified as an SRC in surface water based on the Phase I RFI data. There is no Ambient Water Quality Criterion (AWQC) for acetone; however, the maximum concentration of acetone (73.8 µg/L) was above the risk-based screening level for tap water (61 µg/L) (Table 13) (EPA 2000a). Given that incidental ingestion is the only potential pathway, the RBC for tap water is the most representative screening value; therefore, acetone is considered to be an HHCOPC in surface water.

Two VOCs (2-butanone and acetone), one SVOC (pyrene), and six RCRA metals were indicated as SRCs in sediment. The concentrations of the organics were below their respective screening values (Table 13); therefore, there are no organic HHCOPCs in sediment.

Of the six metals, cadmium and chromium were detected above their respective screening values (Table 13). The maximum concentrations of cadmium and chromium detected in sediment were 8.6 mg/kg and 23.8 g/kg, respectively, as compared to their screening values of 7.821 mg/kg and 23.46 mg/kg, respectively. Cadmium and chromium are considered to be HHCOPCs in sediment.

7.3 UNCERTAINTIES

The absence of groundwater contaminants in Phase II RFI samples that had been detected in Phase I RFI samples results in uncertainty because of the inconsistency in SRCs between sampling events. There are several possible explanations, including a one-time plug of contamination flowing through at the time of sampling or potential seasonal variations in groundwater flow direction. In either case, if the source of groundwater contaminants was on-site, it probably would have appeared in both groundwater sampling events.

The presence of acetone in the surface water sample is perplexing. Acetone is a highly volatile ketone that does not persist in the environment for long periods of time. On the other hand, it is a common laboratory contaminant (i.e., frequently inadvertently introduced into a sample during the analytical process). If the sample blank had been found to contain acetone at a level at least 10 percent as high as that in the actual sample, the results would have been rejected during the data validation process.

8.0 ECOLOGICAL PRELIMINARY RISK EVALUATION, SWMU 27L, BLOCK 10200

The EPRE was conducted in accordance with GEPD (1996) guidance [see Chapter 8.0 of the revised final Phase II RFI (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 27L (see Section 4.5 of this addendum), so analytes in surface water runoff and drainage ditch sediment were not screened against EPA Region IV ESVs (EPA 1996a). However, drainage ditch sediment was evaluated as surface soil.

One VOC, carbon disulfide, was detected in groundwater. The results of the ESV comparison for groundwater are presented in Table 14. Carbon disulfide was detected at a concentration exceeding the ESV, so it is an ECOPC.

Because there are no ESVs for soil, all analytes detected in drainage ditch sediment were evaluated further as surface soil 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 and is classified as an "industrialized area with managed grassland." The preliminary assessment endpoints, ecological receptors, and surrogate 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 robins and shrews ingesting contaminated biota and raccoons ingesting water. 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 shrews, raccoons, and mink and in Table 18 for robins and green herons.

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 drainage ditch sediment or of biota exposed to contaminated sediment and by ingestion of drinking water or aquatic biota exposed to groundwater if it discharges to 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 (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. A supplemental preliminary risk evaluation (SPRE) 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 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 ditch sediment are presented in Table 24. This table shows the maximum detected concentrations, ADDs, TRVs, and HQs for the receptors. HQs exceeding one are shown bordered by a double line. The ECOPCs present in drainage ditch sediment at concentrations resulting in ADDs exceeding the TRVs for the surrogate species are cadmium, chromium, lead, and selenium. The cadmium HQs are 25 for shrews and 78.9 for robins. The chromium HQ for robins is 4.6, while the lead HQ is 11.8. The selenium HQs are 1.07 for shrews and 2.02 for robins. The HI calculated for VOCs does not exceed one, nor does the HI for pyrene.

Groundwater. The preliminary risk calculations for raccoons, mink, and herons 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 UNCERTAINTY

The risks to ecological receptors from ECOPCs in drainage ditch sediment and groundwater at SWMU 27L are overestimated by the preliminary risk calculations; therefore, fate and transport modeling was performed to estimate the future concentration at the receptor location for carbon disulfide in groundwater. The nearest surface water receptor is a tributary to Peacock Creek, which is located approximately 1,400 feet from the site. Analytical Transient 1-,2-,3-Dimensional (AT123D) modeling (Attachment B) 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 for SWMU 27L, Block 10200 are presented in Table B-1, Attachment B. AT123D models were calibrated to the maximum observed groundwater concentration (4.3 μg/L) of the ECOPC at the source. AT123D modeling assumed a steady-state constant concentration at the source. AT123D modeling results are presented in Table B-2, Attachment B; the modeling results predicted the concentration of carbon disulfide at the surface water receptor to be 0.44 μg/L.

This concentration does not exceed the EPA Region IV surface water ESV for carbon disulfide (0.92 μg/L) (EPA 1996a); therefore, the ECOPC in groundwater at SWMU 27L does not pose a risk to aquatic biota.

The supplemental risk calculations for shrews and robins exposed to cadmium, chromium, lead, and selenium in drainage ditch 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 ditch sediment concentrations of ECOPCs do not exceed LOAEL–based TRVs (Tables 21 and 22); that is, they have HQs of less than one. Therefore, ECOPCs in drainage ditch sediment at SWMU 27L do not pose a risk to wildlife receptors.

9.0 HUMAN HEALTH BASELINE RISK ASSESSMENT, SWMU 27L, BLOCK 10200

The purpose of the 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 values, constituents of concern (COCs) will be selected based on the risk values for those constituents. 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 concluded that there are no CMCOPCs (i.e., constituents that may leach into groundwater at concentrations that could present a significant risk to human health as a result of use of 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 given below quantifies the potential risks associated with constituents identified in the HHPRE as presenting a potential risk to human health. The potential risks for site-specific human receptor populations are 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 27L, NGTC Block 10200. 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 Phase II RFI Report (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. There are no CMCOPCs in soil or sediment, and there are no HHCOPCs in soil or groundwater. Cadmium and chromium were identified as HHCOPCs in sediment collected during the Phase II RFI. Acetone was identified as an HHCOPC in surface water collected during the Phase I RFI.

9.2 EXPOSURE ASSESSMENT

The exposure assessment quantifies the amount of a COPC an individual may come in contact with at each site. The exposure 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.

SWMU 27L is one of eight OWSs located in the NGTC along Troupe Avenue. The OWS is located within a fenced area adjacent to a formerly used wash rack and consists of an area of approximately 0.01 acre, covered primarily by concrete and gravel. The OWS area is surrounded by grass, with the exception of a gravel parking area to the north (see Figure 2). The effluent from the OWS discharges into a drainage ditch located southeast of the OWS along Troupe Avenue. The drainage ditch is not within a secured area and can be accessed from Troupe Avenue.

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.

The COPCs at this site are limited to sediment and surface water located in the adjacent drainage ditch. This area is accessible to a juvenile who may play in the drainage ditch. The juvenile wader may be exposed to COPCs in sediment via inadvertent ingestion and to COPCs in surface water via ingestion and dermal contact.

Changes in land use are likely to result in the drainage ditch being converted to a closed storm water drainage line; therefore, the future receptor population would be the same as the current one, a juvenile wader.

The potential migration and exposure pathways for the various receptors are presented in Figure 9.

9.2.3 Estimation of Exposure Concentrations

The estimation of exposure concentrations for on-site receptors to HHCOPCs in sediment and surface water is discussed in Appendix I, Section I.2.3 of the revised final Phase II RFI Report (SAIC 2000). Given that only one sediment sample and one surface water sample were collected and/or analyzed for the HHCOPCs, the measured concentrations from the respective samples were used as the exposure concentrations.

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 (SAIC 2000). The exposure parameter values used to estimate potential exposure are given in Table 28. The analytical sampling results for both sediment and surface water were used to estimate the exposure concentrations.

There are no oral carcinogenic slope factors for acetone, cadmium, or chromium; therefore, carcinogenic intake values were not calculated for exposure of the juvenile wader. The estimated intakes for the juvenile wader are given in Table 29.

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 27L, NGTC Block 10200 was carried out as described in Appendix I, Section I.3 of the revised final Phase II RFI Report (SAIC 2000). The toxicity values are summarized in Table 30 and are discussed below.

The oral reference doses (RfDs) for acetone, cadmium, and chromium are 0.1 mg/kg/day, 0.001 mg/kg/day, and 0.003 mg/kg/day, respectively (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. Oral RfD values are given for hexavalent and trivalent chromium. As a conservative measure, the oral RfD value for hexavalent chromium was used because hexavalent chromium is more toxic than trivalent chromium.

The dermal RfD for cadmium is 2.5×10^{-5} mg/kg/day (EPA 2000b). The calculated dermal RfDs for acetone and chromium are 8.30×10^{-2} mg/kg/d and 6.00×10^{-5} mg/kg/d, respectively.

Toxicity profiles for each of these constituents are provided in Attachment C to this report.

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 (SAIC 2000). Quantitative estimates of noncarcinogenic risks were calculated for acetone, cadmium, and chromium for the oral exposure pathway and, if applicable, the dermal exposure pathway. None of these constituents have carcinogenic slope factors for the oral or dermal exposure pathways; therefore, carcinogenic risks were not calculated.

GEPD has defined target risk levels, which are used to determine if COCs should be identified for the site. COCs are those constituents that contribute significantly to the total risk associated with a site.

The noncarcinogenic target value for the total site HI is 1.0 (GEPD 1996). Any constituent that contributes significantly to the total risk associated with a site (i.e., a total HI for all pathways that is equal to or greater than 0.1) is identified as a COC.

Potential exposure of the current and future receptor populations would be the same. Exposure to COPCs in a drainage ditch is likely to be limited to a juvenile wader; therefore, only the current receptor populations are discussed.

9.4.1 Current Land-use Scenarios

COPCs associated with this site are limited to the off-site drainage ditch. These constituents are not likely to migrate on-site; therefore, current land-use receptors are not at risk from exposure to acetone in surface water and cadmium and chromium in sediment.

An off-site juvenile playing in the drainage ditch might be exposed to COPCs in sediment and surface soil. The potential risk to this receptor population is discussed below.

Juvenile Wader. The total HI for the juvenile wader is 0.00074, which is more than three orders of magnitude below the target value of 1.0 (Table 31); therefore, adverse systemic health risks are not expected for this receptor population.

9.5 UNCERTAINTY ASSESSMENT

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

9.6 RISK SUMMARY

The total HI for the potential exposure of the juvenile wader is 0.00074. This value is below the target value of 1.0; therefore, COPCs in sediment and surface water within the drainage ditch are not likely to present a significant risk to potential receptors at this site.

10.0 CONCLUSIONS AND SITE RECOMMENDATIONS, SWMU 27L, BLOCK 10200

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 27L, Block 10200. The data were derived from a series of screening and primary samples collected from surface soil, subsurface soil, groundwater, surface water, and sediment 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 RFI (October 1999) sampling and analysis activities.

10.1.1 Surface and Subsurface Soil

- No contaminants were indicated in surface soil.

- Toluene and bis(2-ethylhexyl)phthalate were detected in subsurface soil and are considered to be SRCs for subsurface soil.

10.1.2 Groundwater

Groundwater was encountered at approximately 5 feet to 7 feet bgs in the monitoring wells. The shallow groundwater flow direction across the site is to the southeast, and the hydraulic gradient is 0.003 foot/foot.

- Groundwater samples indicated the presence of carbon disulfide. Carbon disulfide is considered to be an SRC in groundwater.

- No RCRA metals were detected in groundwater at concentrations exceeding the respective reference background criteria.

10.1.3 Surface Water and Sediment

A drainage ditch is located approximately 25 feet southeast of the OWS. The effluent from the OWS discharges to the drainage ditch. Surface water is present in the drainage ditch only during rainfall events or when the OWS discharges to it. Water flow in the drainage ditch is toward the northeast. Potential surface water drainage from this site discharges to the drainage ditch/swale along Troupe Avenue, which ultimately discharges to a low area southeast of the site, where it is allowed to percolate into the soil.

- Acetone was detected in the surface water sample during the Phase I RFI. Acetone is considered to be an SRC for surface water. Surface water only occurs in the drainage ditch after rainfall events. No surface water was present in the drainage ditch during the Phase II RFI. The surface water is a transient medium, and acetone most likely originated from an off-site source or is the result of laboratory contamination.

- The organics 2-butanone, acetone, and pyrene and six RCRA metals (barium, cadmium, chromium, lead, mercury, and selenium) were detected in sediment collected downstream of the OWS and are considered SRCs in sediment. All three of these organic constituents (2-butanone, acetone, and pyrene) were also indicated in the site-specific background location (SWS3) indicating the presence of an off-site source, not related to the OWS.

10.2 CONCLUSIONS

Several assessments were conducted to determine the significance of the contaminant concentrations found at SWMU 27L 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), resulting in a potential risk to human health and the environment.

- An HHPRE (Chapter 7.0), which used a Step 1 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 HHCOPCs identified in the HHPRE.

10.2.1 Fate and Transport

- SRCs identified in subsurface soil and sediment did not exceed their respective GSSLs; therefore, there are no CMCOPCs in soil 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 in subsurface soil or groundwater for SWMU 27L.
- Acetone was identified as an SRC in surface water in the Phase I RFI and is considered to be an HHCOPC in surface water.
- There are no organic HHCOPCs in sediment. Cadmium and chromium were detected at concentrations slightly above their respective screening values and are considered to be HHCOPCs in sediment.

10.2.3 Ecological Preliminary Risk Evaluation

Based on the results of the EPRE screening analysis, ECOPCs were identified in groundwater and surface soil. Those constituents identified as ECOPCs were further analyzed using species-specific exposure factors and more realistic LOAEL–based TRVs, as compared to NOAEL–based TRVs. The results of the EPRE are summarized below.

- There are no SRCs in surface soil at SWMU 27L.
- There are no ECOPCs for wildlife receptors in surface water runoff and groundwater at SWMU 27L.
- Carbon disulfide in groundwater at SWMU 27L is an ECOPC for aquatic biota because it exceeds the EPA Region IV surface water ESV (EPA 1996a). Carbon disulfide in groundwater is unlikely to be a potential hazard to aquatic biota living in downgradient surface water bodies because the predicted maximum discharge concentration from modeling does not exceed the ESV. Therefore, carbon disulfide is unlikely to pose a hazard to aquatic biota.
- Cadmium, chromium, lead, and selenium in drainage ditch sediment at SWMU 27L are ECOPCs for terrestrial wildlife receptors because the preliminary HQs for shrews or robins exceed one; however, supplemental risk calculations (see Tables 26 and 27) result in HQs less than one. Therefore, cadmium, chromium, lead, and selenium in drainage ditch sediment at SWMU 27L are unlikely to pose a risk to shrews and robins, and further investigation and/or evaluation of these constituents in sediment is not warranted.

10.2.4 Human Health Baseline Risk Assessment

An HHBRA was performed to assess HHCOPCs identified in surface water and sediment identified in the HHPRE. Acetone was identified as an HHCOPC in surface water. Cadmium and chromium were detected slightly above their respective screening values and are considered to be HHCOPCs in sediment. The following bullet presents the conclusions of the HHBRA.

- The COPCs (acetone, cadmium, and chromium) at this site are limited to sediment and surface water located in the adjacent drainage ditch. This area is accessible to a juvenile that may play in the drainage ditch. The juvenile wader may be exposed to COPCs in sediment via inadvertent ingestion and to COPCs in surface water via ingestion and dermal contact. None of COPCs have carcinogenic slope factors for the oral or dermal exposure pathways; therefore, carcinogenic risks were not applicable. The total HI for the potential exposure of the juvenile wader is 0.00074. This value is below the target value of 1.0; therefore, COPCs in sediment and surface water within the drainage ditch are not likely to present a significant risk to potential receptors at this site. No further investigation and/or evaluation is required for surface water and/or sediment at SWMU 27L, Block 10200.

10.3 RISK MANAGEMENT AND SITE RECOMMENDATIONS

- Based on the information provided in this section, Fort Stewart respectfully requests that SWMU 27L, Block 10200 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 27L

Station	Reference Background Criteria	7XGP2	7XGP3
Sample ID		7X1211	7X1311
Date		01/27/98	01/27/98
Depth (feet)		0 to 2	0 to 2
Sample Type		Grab	Grab
Metals (mg/kg)			
Lead	8.81	5.2	5.4

Table 2. Summary of Phase I RFI Analytes Detected in Subsurface Soil, SWMU 27L

Station	Reference Background Criteria	7XGP1	7XGP4
Sample ID		7X1111	7X1411
Date		01/27/98	01/27/98
Depth (feet)		2 to 5	2 to 5
Sample Type		Grab	Grab
Volatile Organic Compounds (mg/kg)			
Toluene	0.00		**0.0253**
Semivolatile Organic Compounds (mg/kg)			
Bis(2-ethylhexyl)phthalate	0.00		**0.23**
Metals (mg/kg)			
Lead	11.10	9.1	4.9

Bold indicates concentrations above reference background criteria.

Table 3. Summary of Phase I RFI Analytes Detected in Groundwater, SWMU 27L

Station	Reference Background Criteria	Maximum Contaminant Level	7XGP1	7XGP2	7XGP3	7XGP4
Sample ID			7X4111	7X4211	7X4311	7X4411
Date			01/27/98	01/27/98	01/27/98	01/27/98
Sample Type			Grab	Grab	Grab	Grab
Volatile Organic Compounds (μg/L)						
1,1,2-Trichloroethane	0.00	5	***16.2***	***5.5***		***6.2***
2-Butanone	0.00		**89.2**			**14.8**
2-Hexanone	0.00			**8.6**		**7**
4-Methyl-2-pentanone	0.00		**17.7**	**11.3**		**7.4**
Bromodichloromethane	0.00	100	**53.6**			
Ethylbenzene	0.00	700	**198**			**2.2**
Toluene	0.00	1,000	**24.6**			
Xylenes, total	0.00	10,000	**810**			
Semivolatile Organic Compounds (μg/L)						
2-Methylnaphthalene	0.00		**22.6**			
Naphthalene	0.00		**54.1**			

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

Table 4. Summary of Phase I RFI Analytes Detected in Surface Water and Sediment, SWMU 27L

SURFACE WATER		
Station	**Reference Background Criteria**	**7XSWS1**
Sample ID		**7X3111**
Date		**02/01/98**
Sample Type		**Grab**
Volatile Organic Compounds ($\mu g/L$)		
Acetone	0.00	**73.8**

SEDIMENT		
Station	**Reference Background Criteria**	**7XSWS1**
Sample ID		**7X2111**
Date		**02/01/98**
Sample Type		**Grab**
Metals (mg/kg)		
Lead	8.81	2.2

Bold indicates concentrations above reference background criteria.

Table 5. Monitoring Well Construction Summary, SWMU 27L

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)
27L-MW1	10/07/99	2-inch PVC	N 681877.80 E 836075.52	15.0	3.6 to 13.6	2.6	72.54
27L-MW2	10/10/99	2-inch PVC	N 681816.97 E 836058.75	14.0	3.0 to 13.0	2.0	73.22
27L-MW3	10/06/99	2-inch PVC	N 681801.84 E 836076.84	15.0	4.0 to 14.0	2.3	72.79

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

Table 6. Summary of Geotechnical Analyses, SWMU 27L

Station	27L-MW1	27L-MW2	27L-MW3
Sample ID	**7X1173**	**7X1273**	**7X1373**
Depth (feet)	**10 to 12**	**3 to 13**	**7 to 8**
Moisture content (%)	24.02	19.76	26.40
Liquid limit (%)	NP	NP	NP
Plastic limit (%)	NP	NP	NP
Plasticity index (%)	NP	NP	NP
Class	NP	NP	NP
Gravel (%)	0.0	0.31	0.0
Sand (%)	98.27	89.61	90.43
Fines (%)	1.73	10.08	9.57
Specific gravity	2.66	NA	NA
Soil porosity	0.41	NA	NA
Bulk density (pcf)	102.84	NA	NA
Permeability (cm/sec)	4.20E-03	NA	NA
Total organic carbon (mg/kg)	6,170		

NA = Not analyzed.
NP = Non-plastic.
pcf = Pounds per cubic foot.

Table 7. Well Development Summary, SWMU 27L

Well No.	Date	Total Development Time (hours)	Total Volume Removed (gallons)	Final Turbidity Reading (NTUs)	Total Well Depth (feet)
27L-MW1	10/09/99	5 hours	275	5.2	13.96
27L-MW2	10/13/99	2 hours, 46 minutes	200	5.3	12.82
27L-MW3	10/09/99	6 hours, 25 minutes	420	7.0	14.07

Table 8. Field Parameter Measurements during Groundwater Sampling, SWMU 27L

Well No.	Date	pH (su)	Conductivity (mS/cm)	Temperature (°C)	Turbidity (NTUs)	DO (mg/L)	Redox (mV)
27L-MW1	10/28/99	4.53	77.0	26.15	2.91	-0.99	7.21
27L-MW2	10/28/99	4.85	82.0	25.70	2.53	-0.81	182.0
27L-MW3	10/28/99	5.16	47.0	24.80	3.5	-0.34	72.5
Average		5.01					

Table 9. Summary of Phase II RFI Analytes Detected in Groundwater, SWMU 27L

Station	Reference Background Criteria	27L-GP5	27L-GP6	27L-GP7	27L-GP8
Sample ID		7X4551	7X4651	7X4751	7X4851
Date		9/22/99	9/22/99	9/22/99	9/22/99
Sample Type		Grab	Grab	Grab	Grab
Volatile Organic Compounds (μg/L)					
Carbon disulfide	0.00				**4.3**

Station	Reference Background Criteria	27L-MW1[a]	27L-MW2	27L-MW3
Sample ID		7X4171	7X4271	7X4371
Date		10/28/99	10/28/99	10/28/99
Sample Type		Grab	Grab	Grab
Metals (μg/L)				
Barium	71.72	42.8	27.6	18.3

[a] Site-specific background location.

Bold indicates concentrations above reference background criteria.

Table 10. Summary of Phase II RFI Analytes Detected in Sediment, SWMU 27L

Station	Reference Background Criteria	7X-SWS2	7X-SWS3[a]
Sample ID		7X2211	7X2311
Date		02/23/00	02/24/00
Sample Type		Grab	Grab
Volatile Organic Compounds (mg/kg)			
2-Butanone	0.00	**0.0165**	**0.0154**
Acetone	0.00	**0.0746**	**0.0934**
Semivolatile Organic Compounds (mg/kg)			
Benzo(*a*)pyrene	0.00		**0.0199**
Benzo(*b*)fluoranthene	0.00		**0.0214**
Benzo(*k*)fluoranthene	0.00		**0.0195**
Benzoic acid	0.00		**0.511**
Chrysene	0.00		**0.0318**
Fluoranthene	0.00		**0.0472**
Phenanthrene	0.00		**0.0187**
Pyrene	0.00	**0.0242**	**0.0457**
Metals (mg/kg)			
Arsenic	2.8	1.9	1.4
Barium	49.8	**105**	24.9
Cadmium	5	**8.6**	2.5
Chromium	16.8	**23.8**	8.4
Lead	25	**27.6**	12.5
Mercury	0.048	**0.094**	0.024
Selenium	1.06	**1.1**	0.53

[a] Site-specific background location.

Bold indicates concentrations above reference background criteria.

Table 11. Summary of Site-related Contaminants, SWMU 27L

Analyte	Maximum Concentration (mg/kg) Surface Soil	Subsurface Soil	Sediment[a]	Maximum Concentration (µg/L) Groundwater	Surface Water
Volatile Organic Compounds					
2-Butanone	ND	ND	0.0165	ND	ND
Acetone	ND	ND	0.0746	ND	73.8
Carbon disulfide	ND	ND	ND	4.3	ND
Toluene	ND	0.0253[b]	ND	ND	ND
Semivolatile Organic Compounds					
Bis(2-ethylhexyl)phthalate	ND	0.23[b]	ND	ND	ND
Pyrene	ND	ND	0.0242	ND	ND
Metals					
Arsenic	NA	NA	BRBC	ND	NA
Barium	NA	NA	105	BRBC	NA
Cadmium	NA	NA	8.6	ND	NA
Chromium	NA	NA	23.8	ND	NA
Lead	BRBC	BRBC	27.6	ND	ND
Mercury	NA	NA	0.094	ND	NA
Selenium	NA	NA	1.1	ND	NA

[a] Constituents detected at the background location (SWS3) are not considered to be SRCs.
[b] Phase I RFI data.
BRBC = Below reference background criteria.
NA = Not analyzed.
ND = Not detected.

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

SOIL			
Site-related Contaminant	**Maximum Concentration**	**GSSL[a]**	**CMCOPC?**
Volatile Organic Compounds (mg/kg)			
Toluene	0.0253	12	No
Semivolatile Organic Compounds (mg/kg)			
Bis(2-ethylhexyl)phthalate	0.23	3,600	No

SEDIMENT			
Site-related Contaminant	**Maximum Concentration**	**GSSL[a]**	**CMCOPC?**
Volatile Organic Compounds (mg/kg)			
2-Butanone	0.0165	8	No
Acetone	0.0746	16	No
Semivolatile Organic Compounds (mg/kg)			
Pyrene	0.0242	4,200	No
Metals (mg/kg)			
Barium	105	1,600	No
Cadmium	8.6	8	No
Chromium	23.8	38	No
Lead[b]	27.6	400	No
Mercury	0.094	2	No
Selenium	1.1	5	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] A screening level of 400 mg/kg is used for lead based on Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities (EPA 1994).

Table 13. Human Health Risk Screening for Subsurface Soil, Groundwater, Surface Water, and Sediment, SWMU 27L

SUBSURFACE SOIL						
Analyte	Results > Detection Limit	Minimum Detect	Maximum Detect	EPA Region III Residential	HHCOPC?	Justification
Volatile Organic Compounds (mg/kg)						
Toluene	1/2	0.0253	0.0253	1,600	No	Max Detect < Risk Criteria
Semivolatile Organic Compounds (mg/kg)						
Bis(2-ethylhexyl)phthalate	1/2	0.23	0.23	46	No	Max Detect < Risk Criteria

GROUNDWATER						
Analyte	Freq. of Detection	Minimum Detect	Maximum Detect	Human Health Criteria	HHCOPC?	Justification
Volatile Organic Compounds (µg/L)						
Carbon disulfide	1/6	4.3	4.3	104.3	No	Max Detect < Risk Criteria

SURFACE WATER						
Analyte	Freq. of Detection	Minimum Detect	Maximum Detect	Human Health Criteria	HHCOPC?	Justification
Volatile Organic Compounds (µg/L)						
Acetone	1/1	73.8	73.8	61	Yes	Max Detect > Risk Criteria

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

SEDIMENT						
Analyte	Results > Detection Limit	Minimum Detect	Maximum Detect	EPA Region III Residential	HHCOPC?	Justification
Volatile Organic Compounds (mg/kg)						
2-Butanone	1/1	0.0165	0.0165	4,693	No	Max Detect < Risk Criteria
Acetone	1/1	0.0746	0.0746	782.1	No	Max Detect < Risk Criteria
Semivolatile Organic Compounds (mg/kg)						
Pyrene	1/2	0.0242	0.0242	234.6	No	Max Detect < Risk Criteria
Metals (mg/kg)						
Barium	1/1	105	105	547.5	No	Max Detect < Risk Criteria
Cadmium	1/1	8.6	8.6	7.821	Yes	Max Detect > Risk Criteria
Chromium	1/1	23.8	23.8	23.46	Yes	Max Detect > Risk Criteria
Lead	2/2	2.2	27.6	400	No	Max Detect < Risk Criteria
Mercury	1/1	0.094	0.094	2.346	No	Max Detect < Risk Criteria
Selenium	1/1	1.1	1.1	39.11	No	Max Detect < Risk Criteria

Table 14. Ecological Screening Value Comparison for Analytes Detected in Groundwater, SWMU 27L

Analyte	SWMU 27L Maximum	ESV	ECOPC Aquatic Biota?	Justification
Volatile Organic Compounds (µg/L)				
Carbon disulfide	4.3	0.92[a]	Yes	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 ESVs or, when there is no ESV, concentrations that become ECOPCs by default.

Table 15. Derivation of NOAELs for Mammal Test Species, SWMU 27L

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										
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
Mercury	Mink	1.00E-00	1.01E-00	Chronic	NOAEL	Reproduction	Aulerich et al. (1974) in [1]	1.0	1.0	1.01E-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
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
Methyl ethyl ketone	Rat	3.50E-01	1.77E+03	Chronic	NOAEL	Reproduction	Cox et al. (1975) in [1]	1.0	1.0	1.77E+03
Semivolatile Organic Compounds										
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).

IRIS = Integrated Risk Information System.

[1] = Sample, Opresko, and Suter (1996).

[2] = QST (1997); all values assumed to be chronic.

[3] = IRIS (EPA 1997).

Table 16. Derivation of NOAELs for Bird Test Species, SWMU 27L

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										
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
Mercury	Quail	1.50E-01	4.50E-01	Chronic	NOAEL	Reproduction	Hill and Schaffner (1976) in [1]	1.0	1.0	4.50E-01
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
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
Methyl ethyl ketone	None	None	None	None	None	None	None	None	None	No NOAEL
Semivolatile Organic Compounds										
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 27L

ECOPC	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									
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
Mercury	Mink	1.00E+00	1.01E+00	6.39E-01	6.46E-01	2.86E+00	2.89E+00	1.00E+00	1.01E+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
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
Methyl ethyl ketone	Rat	3.50E-01	1.77E+03	4.92E-01	8.71E+02	2.20E+00	3.89E+03	7.69E-01	1.36E+03
Semivolatile Organic Compounds									
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 27L

ECOPC	Test Species	Test Species Body Weight (kg) BW_t	Test Species $NOAEL_t$ (mg/kg/day)	American Robin		Green Heron	
				Body-weight Conversion Factor BW_{conv} $(BW_t / BW)^0$	NOAEL (mg/kg/day) $NOAEL_t \times BW_{conv}$	Body-weight Conversion Factor BW_{conv} $(BW_t / BW)^0$	NOAEL (mg/kg/day) $NOAEL_t \times BW_{conv}$
INORGANICS							
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
Mercury	Quail	1.50E-01	4.50E-01	1.00E+00	4.50E-01	1.00E+00	4.50E-01
Selenium	Mallard duck	1.00E+00	5.00E-01	1.00E+00	5.00E-01	1.00E+00	5.00E-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
Methyl ethyl ketone	None	None	No NOAEL	None	No NOAEL	None	No NOAEL
Semivolatile Organic Compounds							
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 27L

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
INORGANICS										
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
Selenium	Rat	3.50E-01	3.30E-01	Chronic	LOAEL	Reproduction	Rosenfeld and Beath (1954) in [1]	1.0	1.0	3.30E+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 27L

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
INORGANICS										
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
Selenium	Mallard duck	1.15E-00	1.00E+00	Chronic	LOAEL	Reproduction	Heinz et al. (1987) in [1]	1.0	1.0	1.00E+00

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 27L

ECOPC	Test Species	Test Species Body Weight BW_t (kg)	TRV_t (mg/kg/day)	Raccoon: Body-weight Conversion Factor BW_{conv} $(BW_t / BW)^{0.25}$	Raccoon: TRV (mg/kg/day) $TRV_t \times BW_{conv}$	Short-tailed Shrew: Body-weight Conversion Factor BW_{conv} $(BW_t / BW)^{0.25}$	Short-tailed Shrew: TRV (mg/kg/day) $TRV_t \times BW_{conv}$	Mink: Body-weight Conversion Factor BW_{conv} $(BW_t / BW)^{0.25}$	Mink: TRV (mg/kg/day) $TRV_t \times BW_{conv}$
INORGANICS									
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
Selenium	Rat	3.50E-01	3.30E-01	5.84E-01	1.93E-01	2.20E-00	7.25E-01	7.69E-01	2.54E-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 27L

ECOPC	Test Species	Test Species Body Weight BW_t (kg)	TRV_t (mg/kg/day)	American Robin: Body-weight Conversion Factor BW_{conv} $(BW_t / BW)^0$	American Robin: TRV (mg/kg/day) $TRV_t \times BW_{conv}$	Green Heron: Body-weight Conversion Factor BW_{conv} $(BW_t / BW)^0$	Green Heron: TRV (mg/kg/day) $TRV_t \times BW_{conv}$
INORGANICS							
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
Selenium	Mallard duck	1.15E-00	1.00E+00	1.00E-00	1.00E+00	1.00E-00	1.00E+00

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 Runoff, SWMU 27L

		Raccoon		
ECOPC	**C_{Max} (µg/L)**	**ADD (mg/kg/day) = C_{Max} × 0.001 × IR_w**	**TRV (mg/kg/day)**	**HQ = ADD/ TRV**
Volatile Organic Compounds				
Acetone	73.8	5.90E-03	4.92E+00	1.20E-03

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 = 0.08 (kg/kg/day).
TRV = Toxicity reference value= NOAEL (mg/kg/day); see Table 17.

Table 24. Preliminary Risk Calculations for ECOPCs in Drainage Ditch Sediment, SWMU 27L

			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	0.0746	5.00E-02	2.09E-03	2.20E+01	9.50E-05	4.51E-03	No TRV	No HQ
Methyl ethyl ketone	0.0165	5.00E-02	4.62E-04	3.89E+03	1.19E-07	9.98E-04	No TRV	No HQ
				HI =	9.51E-05		HI =	0.00E+00
Semivolatile Organic Compounds								
Pyrene	0.0242	5.00E-02	6.78E-04	1.19E+00	5.70E-04	1.46E-03	9.97E+00	1.47E-04
Metals								
Barium	105	7.50E-03	4.41E-01	1.17E+01	3.76E-02	9.53E-01	2.08E+01	4.58E-02
Cadmium	8.6	1.10E+01	5.30E+01	2.12E+00	2.50E+01	1.14E+02	1.45E+00	7.89E+01
Chromium	23.8	1.60E-01	2.13E+00	6.02E+03	3.54E-04	4.61E+00	1.00E+00	4.61E+00
Lead	27.6	4.00E-01	6.18E+00	1.76E+01	3.52E-01	1.34E+01	1.13E+00	1.18E+01
Mercury	0.094	3.40E-01	1.79E-02	2.89E+00	6.20E-03	3.87E-02	4.50E-01	8.59E-02
Selenium	1.1	7.60E-01	4.68E-01	4.40E-01	1.07E+00	1.01E+00	5.00E-01	2.02E+00

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) = 1.21.
IR_S = Shrew food ingestion rate (kg/kg/day) = 0.56.
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 27L

ECOPC	C_{Max} (µg/L)	BCF	Raccoon			Mink			Green Heron		
			ADD (mg/kg/day) $= C_{Max} \times 0.001 \times IR_w$	TRV (mg/kg/day)	HQ = ADD/TRV	ADD (mg/kg/day) $= C_{Max} \times 0.001 \times BCF \times IR_M$	TRV (mg/kg/day)	HQ = ADD/TRV	ADD (mg/kg/day) $= C_{Max} \times 0.001 \times BCF \times IR_H$	TRV (mg/kg/day)	HQ = ADD/TRV
Volatile Organic Compounds											
Carbon disulfide	4.3	1.00E+02	3.44E-04	5.41E+00	6.36E-05	5.89E-02	8.46E+00	6.96E-03	8.26E-02	No TRV	No HQ

0.001 (mg/µg) = Conversion from µg to mg.
ADD = Average daily dose (mg/kg/day).
BCF = Water-to-fish bioconcentration factor; default value for VOCs = 100.
C_{Max} = Maximum detected concentration (µg/L).
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.
HQ = Hazard quotient.
TRV = Toxicity reference value = NOAEL (mg/kg/day); see Tables 17 and 18.

Table 26. Supplemental Risk Calculations for ECOPCs in Drainage Ditch Sediment for Short-tailed Shrew, SWMU 27L

ECOPC	Site Concentration Mean (mg/kg)	SP_v	Short-tailed Shrew						
			ADD_P (mg/kg/day) $= Mean \times SP_r \times I_P \times AUF$	BAF_i	ADD_A (mg/kg/day) $= Mean \times BAF_i \times I_A \times AUF$	ADD_S (mg/kg/day) $= Mean \times I_S \times AUF$	ADD_{total} (mg/kg/day) $= ADD_P + ADD_A + ADD_S$	LOAEL TRV (mg/kg/day)	HQ $= ADD_{total}/TRV$
Metals									
Cadmium	8.60E+00	1.10E-01	7.60E-04	1.10E+01	5.09E-01	6.91E-03	5.16E-01	2.12E+01	2.44E-02
Selenium	1.10E+00	5.00E-03	4.42E-06	7.60E-01	4.49E-03	8.84E-04	5.38E-03	7.25E-01	7.42E-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 = 1.03E-02.
BAF_i = Soil-to-animal bioaccumulation factor; invertebrates.
HQ = Hazard quotient.
$I_A = TUF \times IR_f \times AF$.
I_A (kg/kg/day) = 5.22E-01.
$I_P = TUF \times IR_f \times PF$.
I_P (kg/kg/day) = 7.80E-02.
$I_S = TUF \times IR_f \times SF$.
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 parts.
TRV = Toxicity reference value = NOAEL (mg/kg/day); see Table 21.
TUF = Temporal use factor.

Table 27. Supplemental Risk Calculations for ECOPCs in Drainage Ditch Sediment for American Robin, SWMU 27L

			American Robin						
ECOPC	Site Concentration Mean (mg/kg)	SP_r	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	8.60E+00	3.00E-02	7.73E-04	1.10E+01	2.84E-01	5.36E-03	2.90E-01	2.00E+01	1.45E-02
Chromium	2.38E+01	9.00E-04	6.42E-05	1.60E-01	1.14E-02	1.48E-02	2.63E-02	5.00E+00	5.26E-03
Lead	1.49E+01	1.80E-03	8.04E-05	4.00E-01	1.79E-02	9.29E-03	2.72E-02	1.13E+01	2.41E-03
Selenium	1.10E+00	5.00E-03	1.65E-05	7.60E-01	2.51E-03	6.86E-04	3.21E-03	1.00E+00	3.21E-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 = 5.00E-03.
BAF_i = Soil-to-animal bioaccumulation factor; invertebrates.
HQ = Hazard quotient.
I_A = TUF × IR_f × AF.
I_A (kg/kg/day) = 6.00E-01.
I_P = TUF × IR_f × PF.
I_P (kg/kg/day) = 6.00E-01.
I_S = TUF × IR_f × SF.
I_S (kg/kg/day) = 1.25E-01.
IR_f = Food ingestion rate.
PF = Plant fraction.
SF = Soil fraction.
SP_r = Soil-to-plant bioaccumulation factor; reproductive parts.
TRV = Toxicity reference value = NOAEL (mg/kg/day); see Table 22.
TUF = Temporal use factor.

Table 28. Exposure Parameters for Potential Receptor Populations, SWMU 27L

Parameter	Units	Juvenile Wader
SEDIMENT		
Incidental Ingestion		
Sediment ingestion rate	g/day	0.1
Fraction ingested from area	unitless	0.13
Exposure frequency	days/year	52
Exposure duration	years	10
Body weight	kg	45
Carcinogen averaging time	days	25,550
Noncarcinogen averaging time	days	3,650
SURFACE WATER		
Incidental Ingestion		
Water ingestion rate	L/hour	0.01
Exposure time	hours/day	2
Exposure frequency	days/year	52
Exposure duration	years	10
Body weight	kg	45
Carcinogen averaging time	days	25,550
Noncarcinogen averaging time	days	3,650
Dermal Contact while Wading		
Skin area	m^2	0.4
Exposure time	hours/day	2
Exposure frequency	days/year	52
Exposure duration	years	10
Body weight	kg	45
Carcinogen averaging time	days	25,550
Noncarcinogen averaging time	days	3,650

Table 29. Estimated Intakes for Current Off-site Juvenile Wader, SWMU 27L

Environmental Medium	Chemical	Exposure Concentration	Units	Oral Exposure[a] Average Daily Dose for Noncarcinogens (mg/kg/day)	Dermal Exposure[a] Average Daily Dose for Noncarcinogens (mg/kg/day)
Sediment	Cadmium	8.6	mg/kg	3.5E-07	NA
Sediment	Chromium	23.8	mg/kg	9.8E-07	NA
Surface water	Acetone	73.8	µg/L	4.7E-06	1.1E-06

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

NA = Not applicable; this receptor is not exposed via this pathway.

Table 30. Toxicity Values for Constituents of Potential Concern, SWMU 27L

Chemical	Oral Reference Dose (mg/kg/day)	Ref[a]	Oral Cancer Slope Factor (mg/kg/day)$^{-1}$	Ref[a]	Gastrointestinal Absorption Factor[b]	Dermal Reference Dose[c] (mg/kg/day)	Dermal Cancer Slope Factor[d] (mg/kg/day)$^{-1}$	Inhalation Reference Dose (mg/kg/day)	Ref[a]	Inhalation Cancer Slope Factor (mg/kg/day)$^{-1}$	Ref[a]
Acetone	1.00E-01	I	ND		8.30E-01	8.30E-02	ND	ND		ND	
Cadmium	1.00E-03[e]	I	ND		NA	2.50E-05	ND	ND		6.30E+00	I
Chromium VI	3.00E-03	I	ND		0.02	6.00E-05	ND	3.00E-05	I	4.10E+01	H

[a] References:
I = Integrated Risk Information System (EPA 2000b).
H = Health Effects Assessment Summary Tables (EPA 1997).

[b] ORNL 1999.

[c] Dermal reference dose calculated by dividing the oral reference dose by the gastrointestinal absorption factor [see Section H.3.3 of the revised final Phase II RFI Report (SAIC 2000)].

[d] Dermal reference dose calculated by multiplying the oral RfD by the gastrointestinal absorption factor. Value for cadmium obtained from the literature [see Section H.3.3 of the revised final Phase II RFI Report (SAIC 2000)].

[e] Oral reference dose value for food.

ND = No data.

Table 31. Hazard Indices for Current Off-site Juvenile Wader, SWMU 27L

Chemical	Sediment[a]		Surface Water[a]			Total Hazard Index[a]
	Oral HQ	Total	Oral HQ	Dermal HQ	Total	
Acetone	NA	NA	4.7E-05	1.3E-05	6.0E-05	6.0E-05
Cadmium	3.5E-04	3.5E-04	NA	NA	NA	3.5E-04
Chromium	3.3E-04	3.3E-04	NA	NA	NA	3.3E-04
Pathway Total	**6.8E-04**	**6.8E-04**	**4.7E-05**	**1.3E-05**	**6.0E-05**	**7.40E-04**

[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).

NA = Not applicable; this constituent is not present in this environmental medium.

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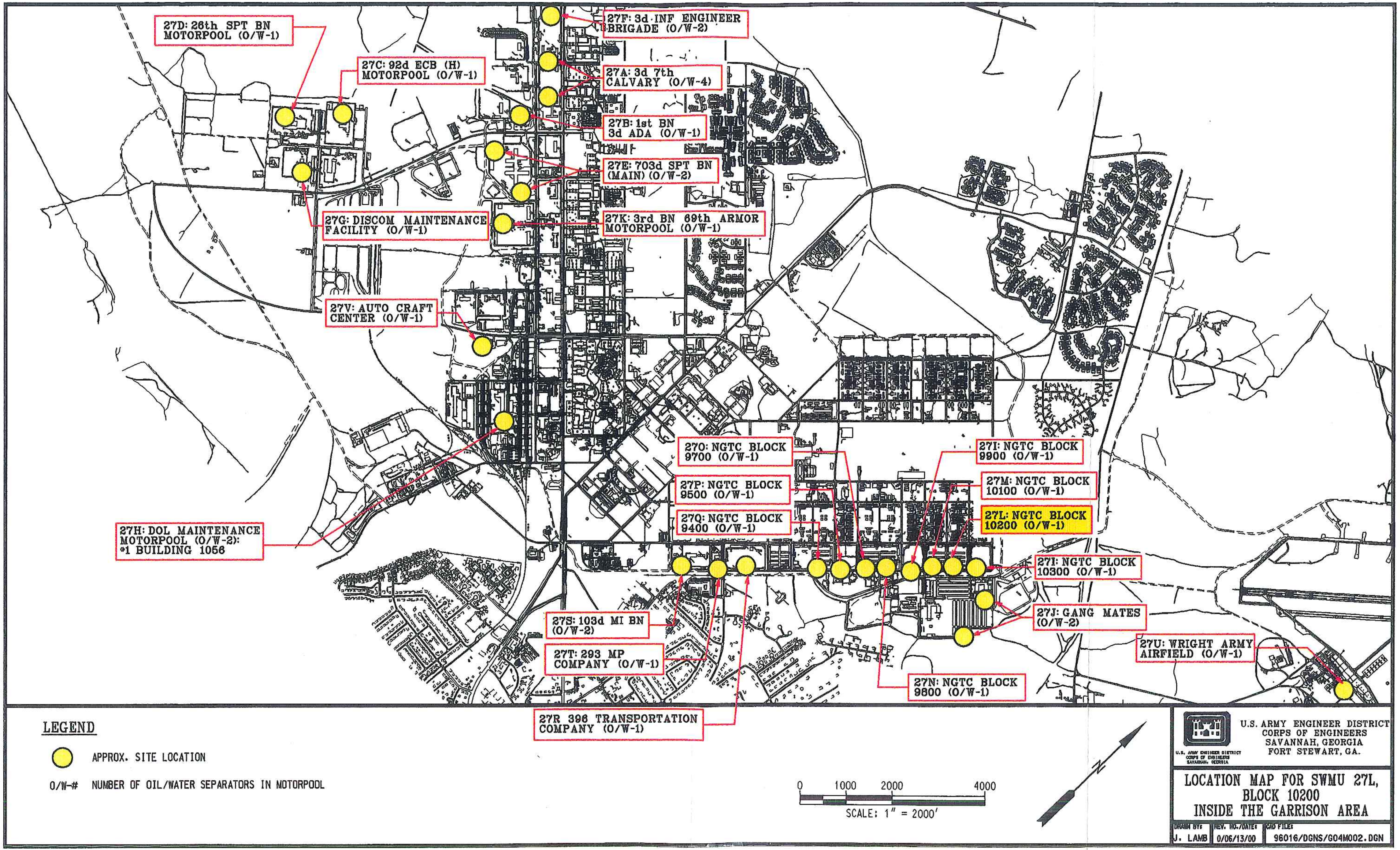


Figure 1. Location Map for SWMU 27L

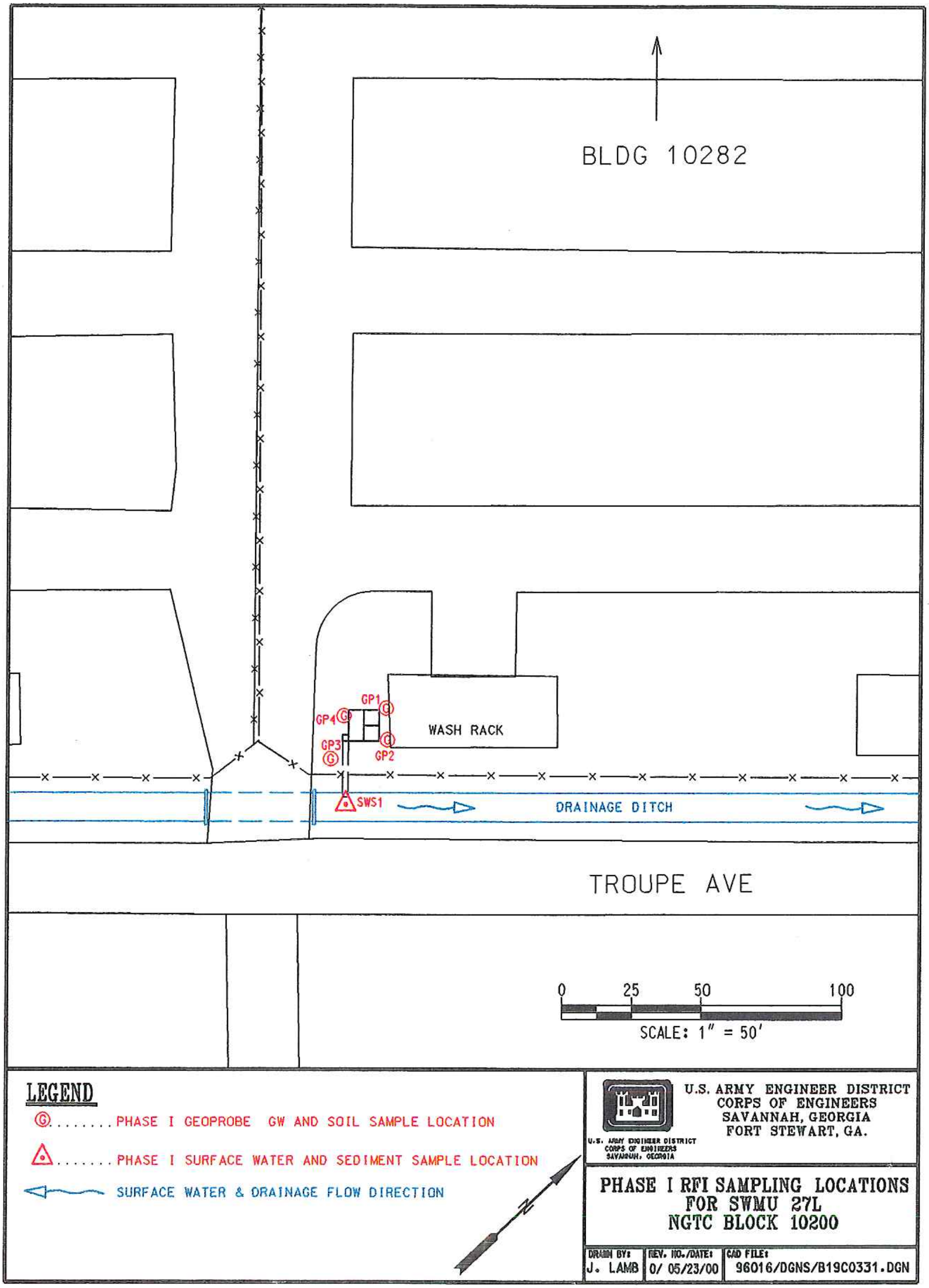


Figure 2. Phase I RFI Sampling Locations, SWMU 27L

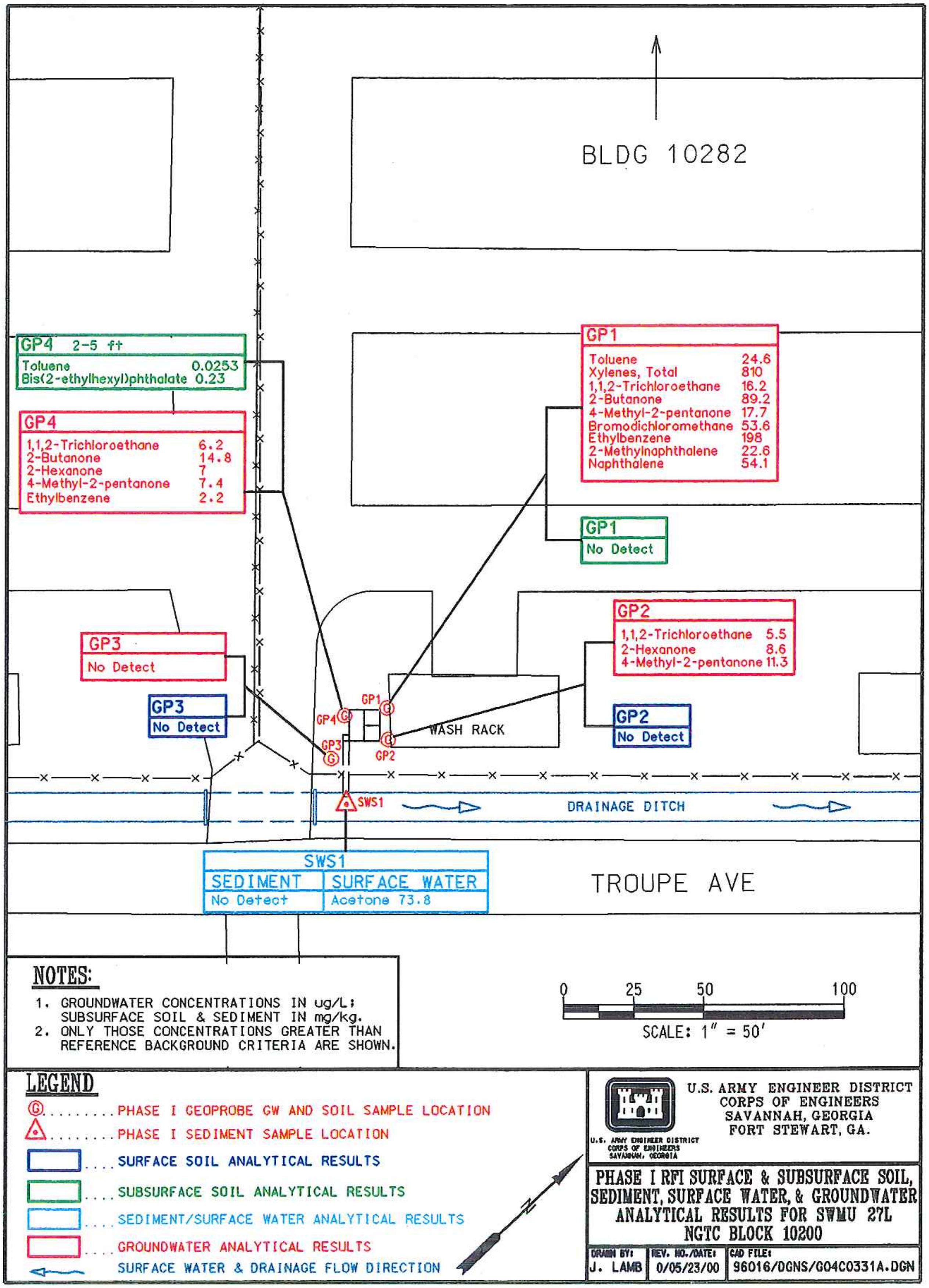


Figure 3. Summary of Phase I RFI Analytical Results in Surface Soil, Subsurface Soil, Groundwater, Surface Water, and Sediment, SWMU 27L

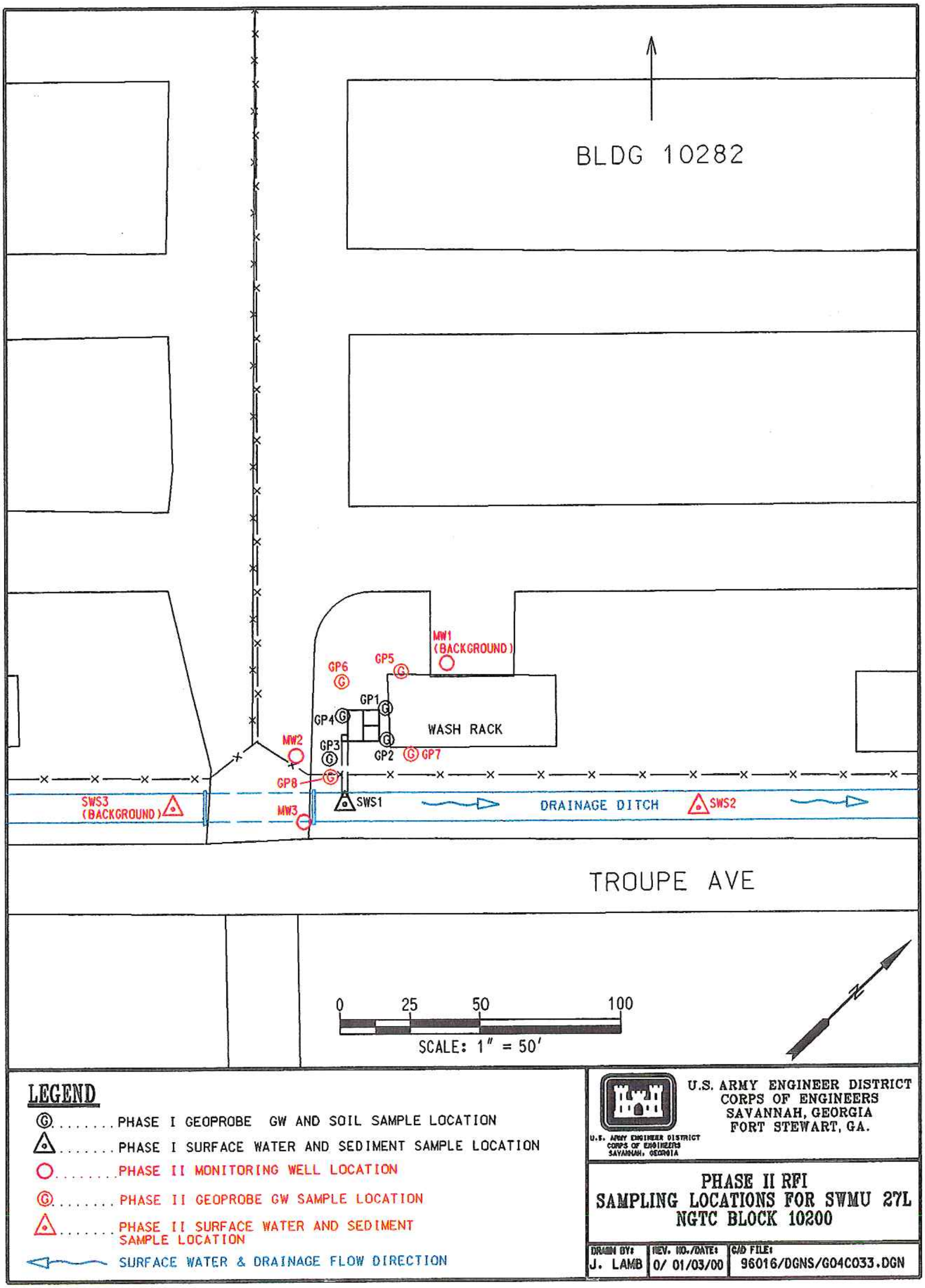
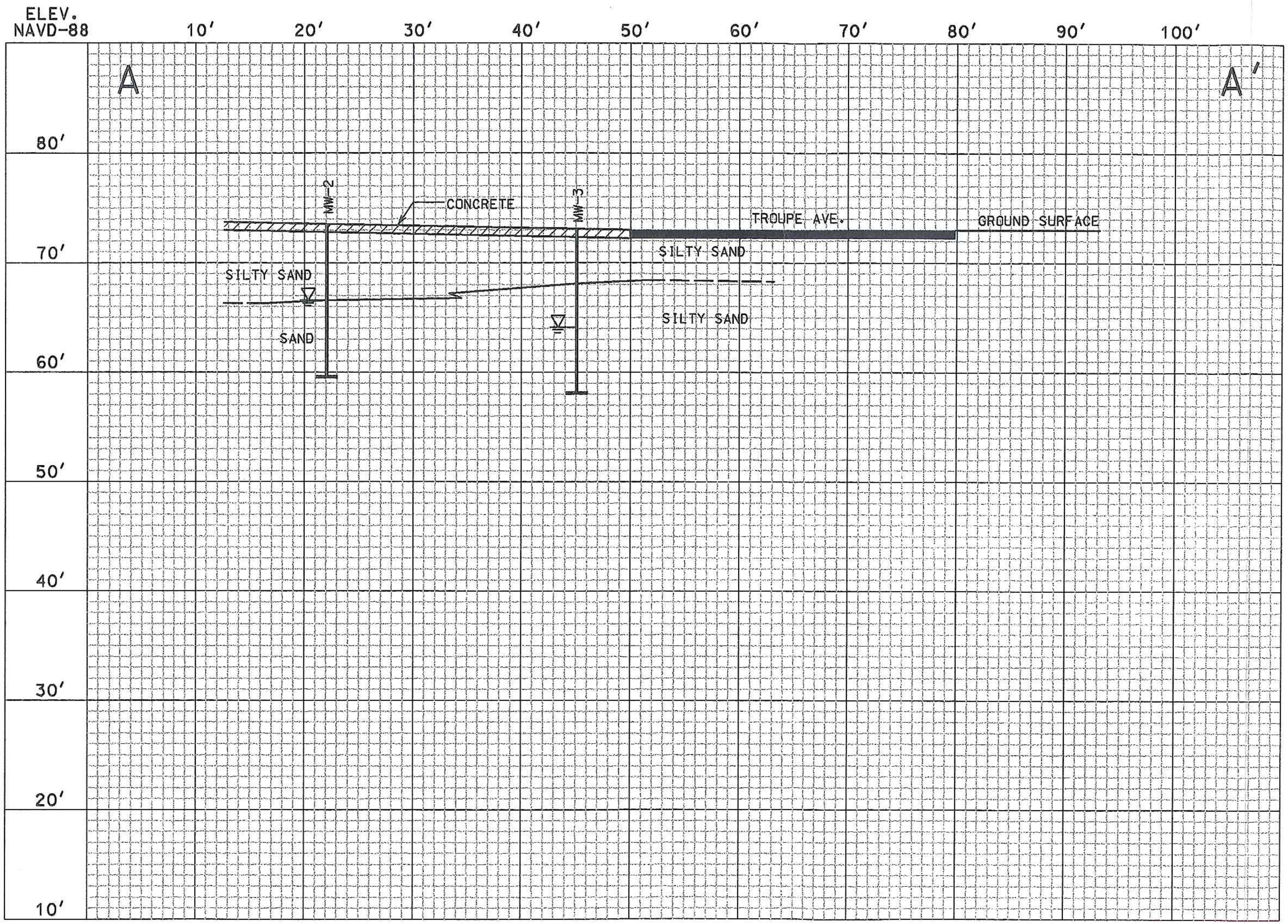


Figure 4. Phase II RFI Sampling Locations, SWMU 27L



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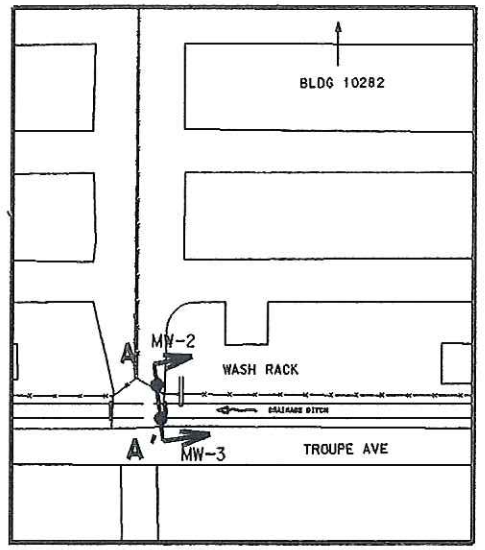
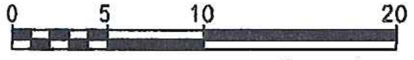
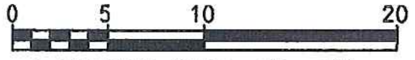


KEY PLAN
NTS



HORIZONTAL SCALE: 1" = 10'



VERTICAL SCALE: 1" = 10'

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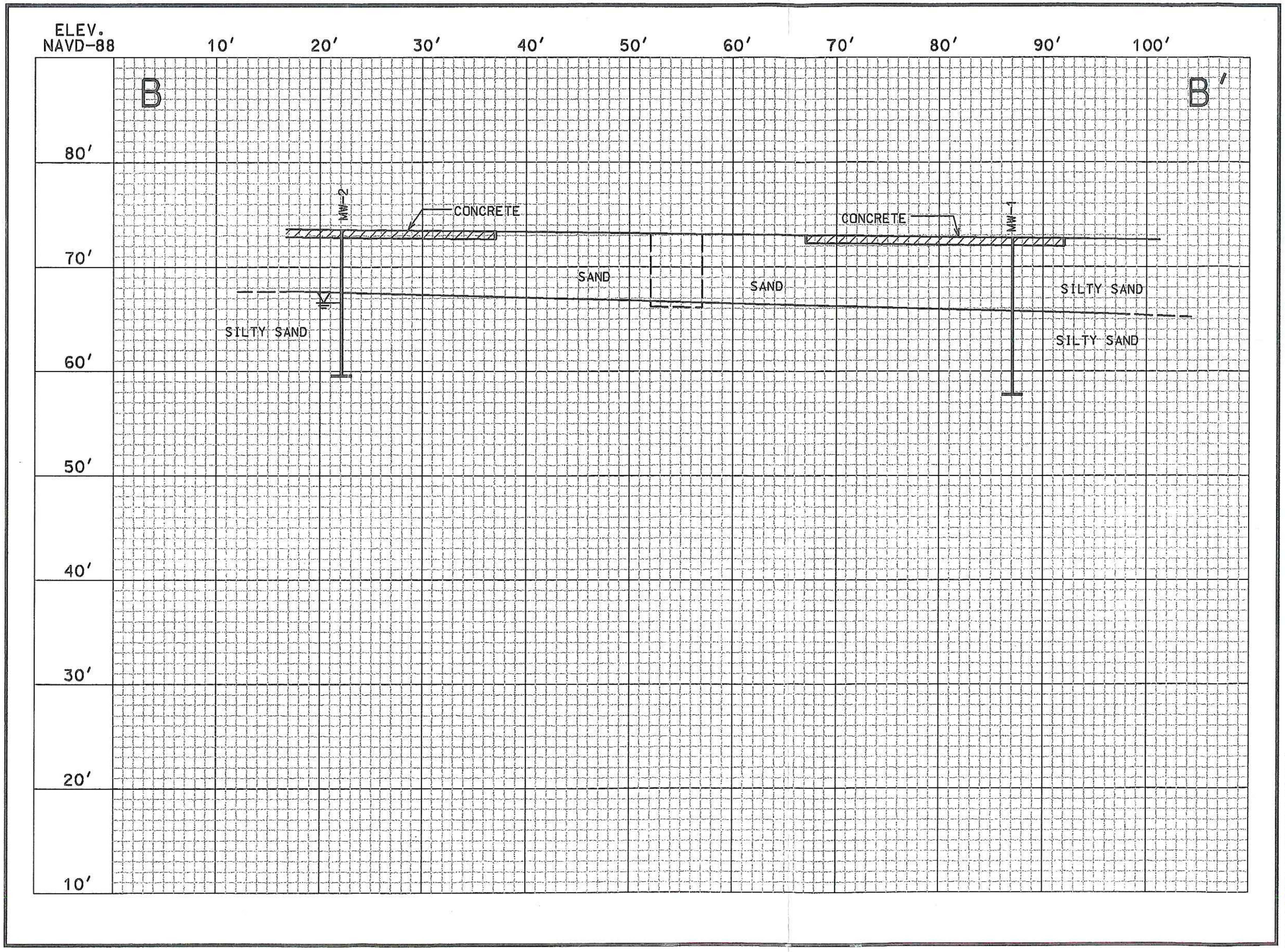
**CROSS SECTION A-A'
FOR SWMU 27L,
NGTC BLOCK 10200**

DRAWN BY:	REV. NO./DATE:	CAD FILE:
J. LAMB	0/03/09/00	96016/DGNS/G04CS033A.DGN

Figure 5. Phase II RFI Cross Section A-A', SWMU 27L



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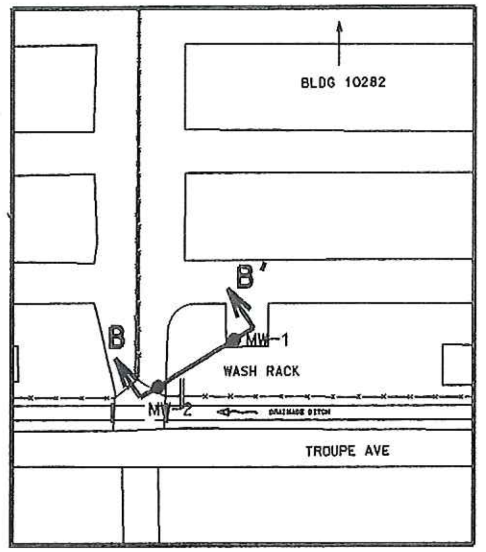

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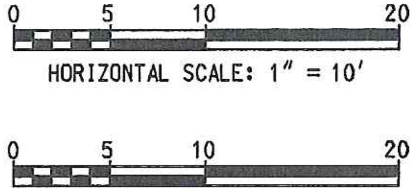

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CROSS SECTION B-B'
FOR SWMU 27L,
NGTC BLOCK 10200

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J. LAMB	0/03/09/00	96016/DGNS/G04CS033B.DGN

Figure 6. Phase II RFI Cross Section B-B', SWMU 27L

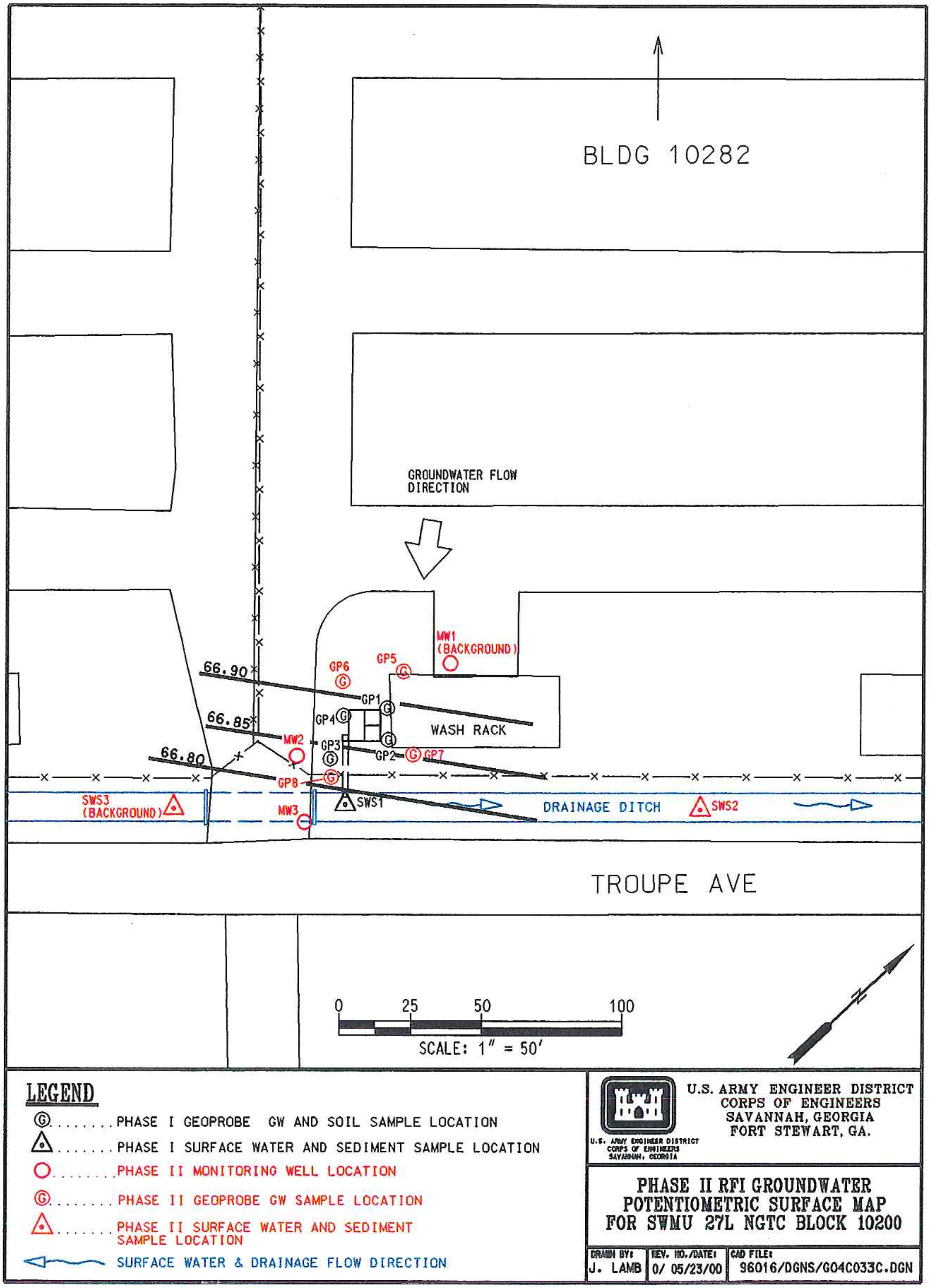

Figure 7. Phase II RFI Groundwater Potentiometric Surface Map, SWMU 27L

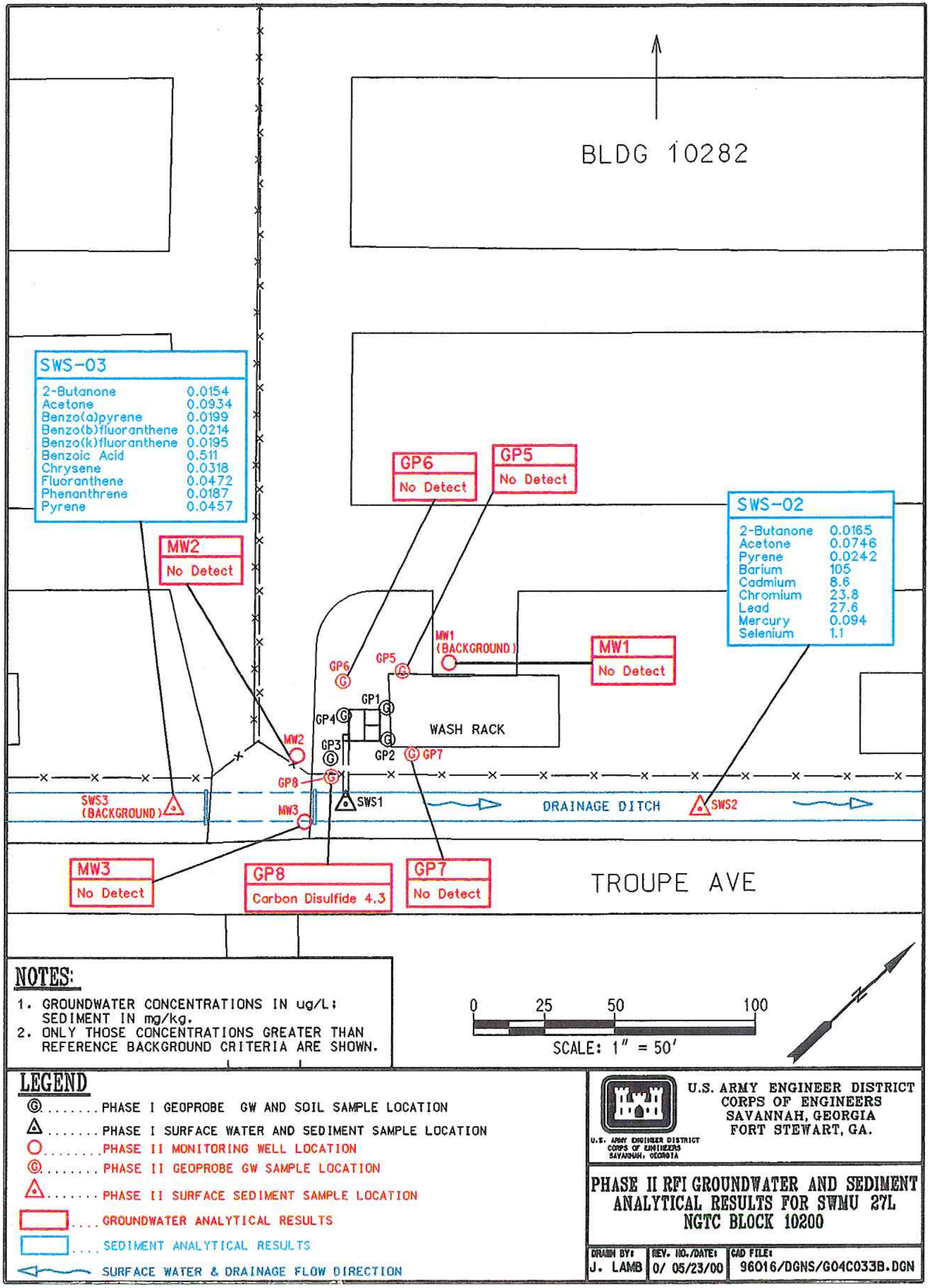

Figure 8. Summary of Phase II RFI Analytical Results in Groundwater and Sediment, SWMU 27L

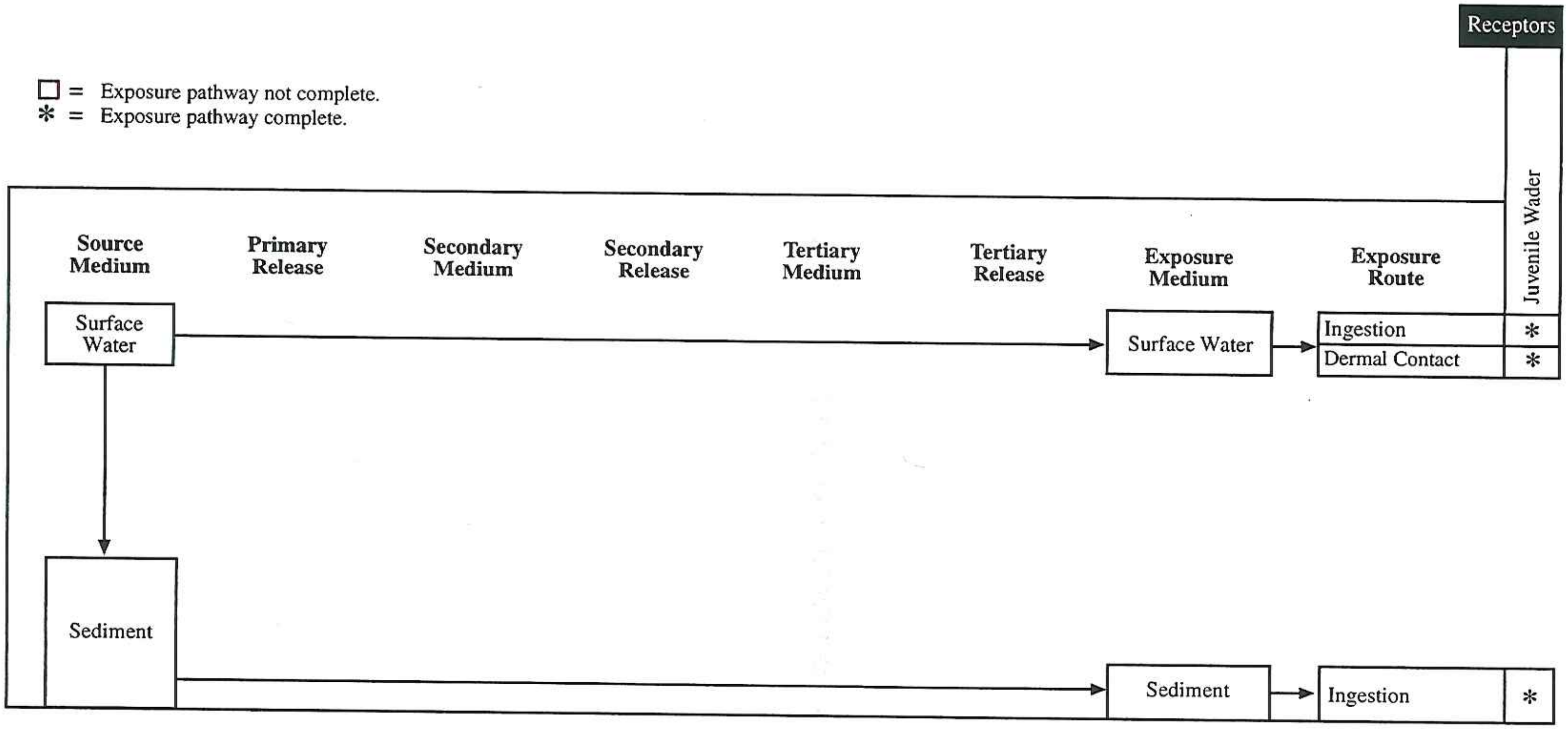

Figure 9. Phase II RFI Potential Migration and Exposure Pathways, SWMU 27L

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ATTACHMENT A
TO SWMU 27L: NGTC BLOCK 10200
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 27L: NGTC BLOCK 10200
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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The concentration of carbon disulfide, an ecological contaminant of potential concern in groundwater, was modeled to the tributary of Peacock Creek located approximately 1,400 feet to the northeast of the site. Analytical Transient 1-,2-,3-Dimensional (AT123D) modeling was performed to estimate the exposure concentrations of carbon disulfide in the surface water at the receptor location. A detailed discussion of the AT123D Model is presented in Chapter 6.0 and Appendix K of the revised final Phase II Resource Conservation and Recovery Act Facility Investigation Report for 16 Solid Waste Management Units (SWMUs) published by Science Applications International Corporation in April 2000.

The AT123D modeling parameters for SWMU 27L, Block 10200 are presented in Table B-1. The biodegradation rate of carbon disulfide was conservatively assumed to be zero because no biodegradation rate was available from the standard references. The AT123D Model was calibrated to the maximum observed groundwater concentration of carbon disulfide at the source. AT123D modeling assumed a steady-state, constant concentration at the source. The AT123D modeling results are presented in Table B-2. The AT123D output file is presented at the back of this attachment. The modeling results predicted the maximum groundwater concentration of carbon disulfide to be 0.00044 mg/L at the tributary of Peacock Creek.

Table B-1. Key Hydrogeological Parameters Used for AT123D Modeling, SWMU 27L

Parameter Type	Parameter Value	Source
Bulk density (kg/m^3)	1,570	Laboratory analysis
Effective porosity (%)	0.2	Mills et al. (1985) for silty sand type
Hydraulic conductivity (m/hour)	1.52E-01	Site specific
Hydraulic gradient	0.003	Site specific
Dispersivity (m)	42.67	Calculated assuming dispersivity = 0.1 × distance to receptor
Density of water (kg/m^3)	1,000	Assumed
Fraction of organic carbon (unitless)	0.0062	Laboratory analysis
Distance to receptor (feet)	1,400	Approximate distance to tributary of Peacock Creek
Source area length (m)	18.28	Conservative estimate
Source area width (m)	30.48	Conservative estimate

Source: 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.

Table B-2. AT123D Modeling Results, SWMU 27L

Contaminant of Potential Concern	Source Concentration[a] (mg/L)	Dilution Factor[b]	Receptor	Receptor Point Groundwater Concentration (mg/L)
Carbon disulfide[c]	0.0043	9.8	Tributary to Peacock Creek (1,400 feet)	4.4E-04

[a] Maximum observed groundwater concentrations.

[b] Dilution factor represents maximum concentration at the source ÷ maximum predicted concentration at the receptor.

[c] Ecological contaminant of potential concern.

AT123D OUTPUT FILE FOR SWMU 27L, BLOCK 10200

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SWMU 27L, Block 10200 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) ......... -0.1828E+02
END POINT OF X-SOURCE LOCATION (METERS) ........... 0.0000E+00
BEGIN POINT OF Y-SOURCE LOCATION (METERS) ......... -0.1524E+02
END POINT OF Y-SOURCE LOCATION (METERS) ........... 0.1524E+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) ............... 0.1520E+00
HYDRAULIC GRADIENT ................................ 0.3000E-02
LONGITUDINAL DISPERSIVITY (METER) ................. 0.4260E+02
LATERAL DISPERSIVITY (METER) ...................... 0.4260E+01
VERTICAL DISPERSIVITY (METER) ..................... 0.1000E+01
DISTRIBUTION COEFFICIENT, KD (M**3/KG) ............ 0.2820E-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) ................ 0.1570E+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) . 0.6110E-06


RETARDATION FACTOR ................................ 0.3214E+01
RETARDED DARCY VELOCITY (M/HR) .................... 0.7095E-03
RETARDED LONGITUDINAL DISPERSION COEF. (M**2/HR) .. 0.3023E-01
RETARDED LATERAL DISPERSION COEFFICIENT (M**2/HR) . 0.3028E-02
RETARDED VERTICAL DISPERSION COEFFICIENT (M**2/HR). 0.7151E-03
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DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.0000E+00 HRS
 (ADSORBED CHEMICAL CONC. =   0.2820E+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.         426.
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. =   0.2820E+00 * DISSOLVED CHEMICAL CONC.)

Z =  0.00
X
Y    0.          10.          20.          50.          75.          90.
0.   0.430E-02   0.331E-02    0.261E-02    0.165E-02    0.130E-02    0.116E-02
CONTINUE X
Y    100.        150.         200.         300.         350.         426.
0.   0.109E-02   0.853E-03    0.713E-03    0.515E-03    0.430E-03     0.312E-03



DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.6680E+06 HRS
(ADSORBED CHEMICAL CONC. =   0.2820E+00 * DISSOLVED CHEMICAL CONC.)

Z =  0.00
X
Y    0.          10.          20.          50.          75.          90.
0.   0.430E-02   0.331E-02    0.262E-02    0.166E-02    0.130E-02    0.116E-02
CONTINUE X
Y    100.        150.         200.         300.         350.         426.
0.   0.109E-02   0.856E-03    0.717E-03    0.521E-03    0.438E-03    0.321E-03



DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.6796E+06 HRS
(ADSORBED CHEMICAL CONC. =   0.2820E+00 * DISSOLVED CHEMICAL CONC.)

Z =  0.00
X
Y    0.          10.          20.          50.          75.          90.
0.   0.430E-02   0.331E-02    0.262E-02    0.166E-02    0.130E-02    0.116E-02
CONTINUE X
Y    100.        150.         200.         300.         350.         426.
0.   0.109E-02   0.859E-03    0.721E-03    0.528E-03    0.445E-03    0.330E-03
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DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.6913E+06 HRS
(ADSORBED CHEMICAL CONC. =   0.2820E+00 * DISSOLVED CHEMICAL CONC.)

Z =  0.00
X
Y    0.          10.         20.         50.         75.         90.
0.   0.430E-02   0.331E-02   0.262E-02   0.166E-02   0.130E-02   0.117E-02
CONTINUE X
Y    100.        150.        200.        300.        350.        426.
0.   0.109E-02   0.861E-03   0.724E-03   0.534E-03   0.452E-03   0.338E-03


DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.7030E+06 HRS
(ADSORBED CHEMICAL CONC. =   0.2820E+00 * DISSOLVED CHEMICAL CONC.)

Z =  0.00
X
Y    0.          10.         20.         50.         75.         90.
0.   0.430E-02   0.331E-02   0.262E-02   0.166E-02   0.130E-02   0.117E-02
CONTINUE X
Y    100.        150.        200.        300.        350.        426.
0.   0.110E-02   0.863E-03   0.727E-03   0.539E-03   0.459E-03   0.346E-03


DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.7147E+06 HRS
(ADSORBED CHEMICAL CONC. =   0.2820E+00 * DISSOLVED CHEMICAL CONC.)

Z =  0.00
X
Y    0.          10.         20.         50.         75.         90.
0.   0.430E-02   0.331E-02   0.262E-02   0.166E-02   0.130E-02   0.117E-02
CONTINUE X
Y    100.        150.        200.        300.        350.        426.
0.   0.110E-02   0.866E-03   0.731E-03   0.545E-03   0.466E-03   0.354E-03


DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.7264E+06 HRS
(ADSORBED CHEMICAL CONC. =   0.2820E+00 * DISSOLVED CHEMICAL CONC.)

Z =  0.00
X
Y    0.          10.         20.         50.         75.         90.
0.   0.431E-02   0.331E-02   0.262E-02   0.166E-02   0.130E-02   0.117E-02
CONTINUE X
Y    100.        150.        200.        300.        350.        426.
0.   0.110E-02   0.868E-03   0.733E-03   0.550E-03   0.472E-03   0.362E-03
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DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.7380E+06 HRS
(ADSORBED CHEMICAL CONC. =   0.2820E+00 * DISSOLVED CHEMICAL CONC.)

Z =  0.00
X
Y    0.          10.          20.          50.          75.          90.
0.   0.431E-02   0.331E-02    0.262E-02    0.166E-02    0.131E-02    0.117E-02
CONTINUE X
Y    100.        150.         200.         300.         350.         426.
0.   0.110E-02   0.869E-03    0.736E-03    0.555E-03    0.479E-03    0.370E-03


DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.7497E+06 HRS
(ADSORBED CHEMICAL CONC. =   0.2820E+00 * DISSOLVED CHEMICAL CONC.)

Z =  0.00
X
Y    0.          10.          20.          50.          75.          90.
0.   0.431E-02   0.331E-02    0.262E-02    0.166E-02    0.131E-02    0.117E-02
CONTINUE X
Y    100.        150.         200.         300.         350.         426.
0.   0.110E-02   0.871E-03    0.739E-03    0.560E-03    0.485E-03    0.377E-03


DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.7614E+06 HRS
(ADSORBED CHEMICAL CONC. =   0.2820E+00 * DISSOLVED CHEMICAL CONC.)

Z =  0.00
X
Y    0.          10.          20.          50.          75.          90.
0.   0.431E-02   0.331E-02    0.262E-02    0.166E-02    0.131E-02    0.117E-02
CONTINUE X
Y    100.        150.         200.         300.         350.         426.
0.   0.110E-02   0.873E-03    0.741E-03    0.564E-03    0.490E-03    0.384E-03


DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.7731E+06 HRS
(ADSORBED CHEMICAL CONC. =   0.2820E+00 * DISSOLVED CHEMICAL CONC.)

Z =  0.00
X
Y    0.          10.          20.          50.          75.          90.
0.   0.431E-02   0.331E-02    0.262E-02    0.166E-02    0.131E-02    0.117E-02
CONTINUE X
Y    100.        150.         200.         300.         350.         426.
0.   0.110E-02   0.875E-03    0.744E-03    0.569E-03    0.496E-03    0.391E-03
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DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.7848E+06 HRS
(ADSORBED CHEMICAL CONC. =   0.2820E+00 * DISSOLVED CHEMICAL CONC.)

Z =  0.00
X
Y    0.           10.          20.          50.          75.          90.
0.   0.431E-02    0.331E-02    0.262E-02    0.166E-02    0.131E-02    0.117E-02
CONTINUE X
Y    100.         150.         200.         300.         350.         426.
0.   0.110E-02    0.876E-03    0.746E-03    0.573E-03    0501E-03     0.398E-03
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DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.7964E+06 HRS
(ADSORBED CHEMICAL CONC. =   0.2820E+00 * DISSOLVED CHEMICAL CONC.)

Z =  0.00
X
Y    0.           10.          20.          50.          75.          90.
0.   0.431E-02    0.331E-02    0.262E-02    0.166E-02    0.131E-02    0.118E-02
CONTINUE X
Y    100.         150.         200.         300.         350.         426.
0.   0.110E-02    0.877E-03    0.748E-03    0.577E-03    0.506E-03    0.404E-03
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DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.8081E+06 HRS
(ADSORBED CHEMICAL CONC. =   0.2820E+00 * DISSOLVED CHEMICAL CONC.)

Z =  0.00
X
Y    0.           10.          20.          50.          75.          90.
0.   0.431E-02    0.331E-02    0.262E-02    0.166E-02    0.131E-02    0.118E-02
CONTINUE X
Y    100.         150.         200.         300.         350.         426.
0.   0.111E-02    0.879E-03    0.750E-03    0.580E-03    0.510E-03    0.410E-03
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DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.8198E+06 HRS
(ADSORBED CHEMICAL CONC. =   0.2820E+00 * DISSOLVED CHEMICAL CONC.)

Z =  0.00
X
Y    0.           10.          20.          50.          75.          90.
0.   0.431E-02    0.331E-02    0.262E-02    0.167E-02    0.131E-02    0.118E-02
CONTINUE X
Y    100.         150.         200.         300.         350.         426.
0.   0.111E-02    0.880E-03    0.752E-03    0.584E-03    0.515E-03    0.416E-03
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```
DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.8315E+06 HRS
(ADSORBED CHEMICAL CONC. =   0.2820E+00 * DISSOLVED CHEMICAL CONC.)

Z =  0.00
X
Y    0.          10.         20.         50.         75.         90.
0.   0.431E-02   0.331E-02   0.262E-02   0.167E-02   0.131E-02   0.118E-02
CONTINUE X
Y    100.        150.        200.        300.        350.        426.
0.   0.111E-02   0.881E-03   0.754E-03   0.587E-03   0.519E-03   0.422E-03


DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.8432E+06 HRS
(ADSORBED CHEMICAL CONC. =   0.2820E+00 * DISSOLVED CHEMICAL CONC.)

Z =  0.00
X
Y    0.          10.         20.         50.         75.         90.
0.   0.431E-02   0.331E-02   0.262E-02   0.167E-02   0.131E-02   0.118E-02
CONTINUE X
Y    100.        150.        200.        300.        350.        426.
0.   0.111E-02   0.882E-03   0.755E-03   0.591E-03   0.524E-03   0.428E-03


DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.8548E+06 HRS
(ADSORBED CHEMICAL CONC. =   0.2820E+00 * DISSOLVED CHEMICAL CONC.)

Z =  0.00
X
Y    0.          10.         20.         50.         75.         90.
0.   0.431E-02   0.331E-02   0.262E-02   0.167E-02   0.131E-02   0.118E-02
CONTINUE X
Y    100.        150.        200.        300.        350.        426.
0.   0.111E-02   0.883E-03   0.757E-03   0.594E-03   0.528E-03   0.433E-03
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. =   0.2820E+00 * DISSOLVED CHEMICAL CONC.)

Z =      0.00
X
Y    0.          10.         20.         50.         75.         90.
0.   0.431E-02   0.331E-02   0.262E-02   0.167E-02   0.131E-02   0.118E-02
CONTINUE X
Y    100.        150.        200.        300.        350.        426.
0.   0.111E-02   0.884E-03   0.758E-03   0.597E-03   0.531E-03   0.438E-03
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ATTACHMENT C
TO SWMU 27L: NGTC BLOCK 10200
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 profiles for human health contaminants of potential concern (HHCOPCs). The toxicity profiles provide pertinent information concerning the uptake, mechanisms of toxicity, and toxicity values for the HHCOPCs. In addition to the toxicity profiles, a toxicity summary (Table C-1) is given for all of the site-related contaminants. 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)].

Acetone. Acetone is a clear, colorless, highly flammable liquid with a vapor pressure of 182 millimeters (7.28 inches) of mercury at 20°C (68°F). It is completely miscible in water and soluble in organics such as benzene and ethanol. Its log K_{ow} has been estimated to be -0.24. Acetone is used primarily as a solvent and chemical intermediate and is found in some consumer products such as nail polish remover (Opresko 1995).

Acetone may be released into the environment as stack and/or fugitive emissions and in wastewater effluents from facilities that produce and use acetone as a chemical intermediate and solvent. Acetone is also a natural metabolic by-product found in and released from plants and animals. Much of the acetone released into the environment will volatilize into the atmosphere, where it is subject to photooxidation (average half-life is 22 days). Volatilization from surface waters is moderately rapid (estimated half-life is about 20 hours based on a model river). If spilled onto the ground, acetone will both volatilize and leach into the soil, with relatively little adsorbed to soil particles. Acetone has been detected in groundwater and drinking water (Opresko 1995).

Acetone can be absorbed through the lungs, digestive tract, and skin. It is rapidly transported throughout the body and is not preferentially stored in any body tissue. The liver is the major organ of acetone metabolism, and excretion occurs mainly through the lungs and the urine (Opresko 1995).

Acute toxic effects after ingestion of 50 milliliters (39.5 grams) or more may include ataxia, sedation, and coma; respiratory depression; gastrointestinal disorders (vomiting and hematemesis); hyperglycemia and ketonemia; acidosis; and hepatic and renal lesions. Ingestion of 10 to 20 milliliters (7.9 to 15.8 grams) generally is not toxic, and consumption of 20 grams/day for several days resulted in only slight drowsiness. The minimum lethal dose for a 68-kilogram (150-pound) man is estimated to be 100 milliliters (79.1 grams). No information is available on the subchronic or chronic oral toxicity to humans. In animal studies, subchronic oral exposures were associated with kidney damage and hematological changes (Opresko 1995).

Information on the inhalation toxicity of acetone to humans is derived from occupational and laboratory studies. Typical symptoms of inhalation exposure are central nervous system depression and irritation of the mucous membranes of the eyes, nose, and throat. Central nervous system effects can range from subtle neurobehavioral changes to narcosis, depending on the magnitude and length of exposure (Opresko 1995).

There is an oral RfD for acetone of 0.1 mg/kg/day, based on a no observed adverse effect level (NOAEL) of 100 mg/kg/day in rats. The toxicity endpoints include increased liver and kidney weights and nephrotoxicity (EPA 2000). No evidence is available to suggest that acetone is carcinogenic in humans or animals. Negative results have been reported in occupational exposure studies and in rodent skin painting studies. Although acetone has not been tested in a 2-year rodent bioassay, in vitro tests for mutagenicity, chromosome damage, and deoxyribonucleic acid interaction indicate that acetone is not genotoxic except under severe conditions. Acetone is classified by EPA in weight-of-evidence Group D, not classifiable as to human carcinogenicity (EPA 2000).

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 1984a).

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 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).

Chromium. Chromium is a metal that occurs in nature primarily as the mineral chromite. Although chromium exists in several valence states, the trivalent (III) and hexavalent (VI) valence states are the only two of any biological significance (Amdur, Doull, and Klassan 1991). Trivalent chromium is considered an essential element in man and animals.

Acute animal studies indicate that chromium (III) compounds are consistently less toxic than chromium (VI) (Friberg, Nordberg, and Vouk 1986), but neither oxidation state is very toxic by the oral route (Daugherty 1992). No adverse effects were observed in long-term drinking water studies in rats.

Chromium compounds (and particularly hexavalent compounds) are very strong skin irritants and sensitizers in humans, producing dermatitis, dermatosis, eczema, erythema, and skin ulceration. Exposure to chromium has caused respiratory effects such as nasal irritation, nasal ulcers, nasal perforation, asthmatic attacks, pneumoconiosis, bronchitis, and chronic lung congestion in humans under various occupational conditions

(Daugherty 1992). Both hexavalent and trivalent chromium compounds are known to be nephrotoxic, with some reports indicating that they may also be hepatotoxic and neurotoxic (EPA 1984b).

Chromium compounds, both trivalent and hexavalent, have induced developmental effects in hamsters and mice (but only at maternally toxic doses) and testicular effects in rabbits after intraperitoneal, intravenous, or subcutaneous injections (EPA 1984b). Bacterial test systems have consistently demonstrated that chromium (VI) compounds are directly mutagenic, while chromium (III) compounds are not (EPA 1984b). An increased frequency of chromosome aberrations in lymphocytes from workers exposed to chromates during production of such compounds has been reported (EPA 1984b), and several occupational epidemiology studies have shown that occupational exposure to chromium is associated with an increase in lung cancer deaths for workers. Evidence also suggests increased risk of developing nasal, pharyngeal, and gastrointestinal cancers (IARC 1980; Daugherty 1992).

An oral RfD value of 0.003 mg/kg-day has been calculated for chromium (VI) (EPA 2000). The RfD is based on a chronic drinking water study with rats. No adverse effects were noted in the study (EPA 2000). The inhalation RfC for chromium (VI) is 8E-6 $\mu g/m^3$ based on nasal septum atrophy in exposed occupational populations (EPA 2000). EPA has placed chromium (VI) in weight-of-evidence group A, known human carcinogen, for its carcinogenicity via inhalation. The air unit risk is $0.012/(\mu g/m^3)$ (EPA 2000).

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Table C-1. Summary of Toxicity Data for Chemicals of Potential Concern, SWMU 27L

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
Acetone					D	1.00E-01	I	1,000	Liver, kidney				
Cadmium–food			6.30E+00	I	B1	1.00E-03	I	10	Kidney				
Chromium VI			4.10E+01	H	A[a]	3.00E-03	I	300	Clinical	3.00E-05	I	90	Resp

[a] Inhalation only.

CSF_i = Inhalation cancer slope factor.

CSFo = Oral cancer slope factor.

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.

Clinical = Endpoints included clinical effects such as change in body weight, enzyme levels, etc. Effects cannot be associated with any specific organ system.

Resp = Respiratory system.

WOE = Cancer weight-of-evidence classification.