REVISED FINAL COMPLIANCE STATUS REPORT FOR FORMER FIRE TRAINING AREA HUNTER ARMY AIRFIELD SAVANNAH, GEORGIA

HSI SITE NUMBER 10395

Volume I of II

PREPARED FOR

U.S. ARMY CORPS OF ENGINEERS
SAVANNAH DISTRICT

PROJECT NO.12001-9-3411
CONTRACT NO. DAVA21-97-D-0034-0011

MAY 24, 2002

LAW
RESOURCES CREATING SOLUTIONS

DOCUMENT 24

CERTIFICATION OF COMPLIANCE WITH RISK REDUCTION STANDARDS

I certify under penalty of law that this report and all attachments were prepared under my direction in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Based on my review of the findings of this report with respect to the risk reduction standards of the Rules for Hazardous Site Response, Rule 391-3-19.07, I have determined that the following former FTA (Figure 6.1) is not in compliance with Types 1 through 4 risk reduction standards.

Certified by: Date:

____________________________________ _______________

Thomas C. Fry
Chief – ENRD Environmental Branch
Fort Stewart Directorate of Public Works

PROFESSIONAL GEOLOGIST CERTIFICATION

I certify that I am a qualified groundwater scientist who has received a baccalaureate or post-graduate 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, that 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 by a subordinate working under my direction.

Certified by: David B. Goershel

David B. Goershel, P.G.
Registered Professional Geologist
Georgia Registration # 1061

Date: May 23, 2002

PROJECT REVIEW COMMENTS	Date: February, 2001 Update May 2002	Page 1 of 17

Project Name, & Location: CSR for the Former FTA Hunter AAF, GA	To: Wes Smith LeAnn Taylor	From: *(Section)* *(Reviewer)*

Cmt. No.	**Page No./ Section No.**	**Georgia EPD Comments :**	**Response to comment.**	**COE Review Action & Date**
1		**Public Participation** EPD did not receive documentation showing that a notice was published that announced the CSR is available for inspection by the general public for a 30-day public comment period. This notice must be published in both a major paper of general circulation and the legal organ of the local governments in whose jurisdiction the site is located. As required by Rule 391-3-19-.06-(5)(d), an exact copy of the public notice, as it appeared in the paper, must be provided to EPD within 15 days after publishing the notice. Also, as required by Rule 391-3-19-06(5)(e), the responsible party must provide to the county and city governments in which the site is located a written notice providing the same information as required in the published notice. Please ensure that those requirements are met for the revised CSR.	Public Notices announcing the CSR is available for review were published in the April 3, 2000 edition of the Savannah Morning News and the April 4, 2000 edition of the Atlanta Journal-Constitution. Letters were also sent to Dr. Billy B. Hair, Chairman of the Board of Commissioners for Chatham County and to Mr. Floyd Adams, Mayor of City of Savannah. **Update** **Copies of the documentation of publication are provided in Appendix H of the Revised Final CSR. This documentation fulfills the Public Notice requirements of the HSRA Rules. Public notices for a Revised CSR is not required by HSRA**	
2			Acetone, methylene chloride, bis(2-ethylhexyl)phthalate, and trichlorofluoromethane were detected in soils at the site. Per GAEPD, additional soil samples will be collected to define the extent of acetone at the north end of the site. The detected concentrations do comply with the Type I RRS of 400 mg/kg for acetone. In addition, soil samples will also be collected in the north end of the site to define the extent of bis(2-ethylhexyl) phthalate. The maximum detected concentration of 1.7 mg/kg complies with the Type 1 RRS of 50 mg/kg for bis(2-ethylhexyl) phthalate. Proposed sample locations and analysis are shown on Figure 1.	

PROJECT REVIEW COMMENTS	Date: February, 2001 Update May 2002	Page 2 of 17
Project Name, & Location: CSR for the Former FTA Hunter AAF, GA	To: Wes Smith LeAnn Taylor	From: *(Section)* *(Reviewer)*

Cmt. No.	**Page No./ Section No.**	**Georgia EPD Comments :**	**Response to comment.**	**COE Review Action & Date**
2 - Cont.		Rule 391-3-19-.06(3)(a) requires that the CSR document the current status of the site with the regard to the risk reduction standards for all regulated substances associated with each release at the site. Since quality control data did not indicate the occurrence of laboratory contamination as stated in the CSR, all detected organic regulated substances must be investigated to meet the requirements of the Rules.	The extent of methylene chloride detected in soils has been delineated. The maximum detected concentration of 0.0067 mg/kg complies with the Type 1 RRS of 0.5 mg/kg for methylene chloride. The extent of trichlorofluoromethane detected in soils has been delineated. The detected concentrations of 0.007 to 0.012 mg/kg comply with Type 1 RRS of 200 mg/kg for trichlorofluoromethane. Risk Reduction Standards for acetone and toluene concentrations in ground water will be calculated in the revised CSR. The maximum detected concentration of acetone in ground water (0.021 mg/L) complies with the Type 1 RRS for acetone of 4 mg/L. The maximum detected concentration of toluene in ground water (0.005 mg/L) complies with the Type 1 RRS for toluene of 1 mg/L. **Update** **The extent of acetone and bis(2-ethylhexyl) phthalate in soil has been delineated in the Revised Final CSR as indicated on Figures 4.8A and 4.9A, Tables 4.3 and 4.4, and described in Sections 4.3.2 and 4.3.3. The RRS for acetone and toluene in groundwater were calculated and provided on Table 6.2 and described in Section 6.4.1. The maximum detected concentrations of acetone and toluene comply with the Type 1 RRS for both substances as indicated on Table 6.2.**	

PROJECT REVIEW COMMENTS	Date: February, 2001 Update May 2002	Page 3 of 17
Project Name, & Location: CSR for the Former FTA Hunter AAF, GA	To: Wes Smith LeAnn Taylor	From: *(Section)* *(Reviewer)*

Cmt. No.	**Page No./ Section No.**	**Georgia EPD Comments :**	**Response to comment.**	**COE Review Action & Date**
3		Arsenic, barium, chromium and lead have been found in groundwater and are very likely to be associated with releases at the site. They should be accessed for their occurrence in soil. The CSR must properly select analytical parameters as required by Rule 391-3-19-06(3)(b)(2)(ii). The selection should accommodate the analysis of all the regulated substances associated with each release for each of the environmental media involved.	Soil samples were collected and analyzed for the 8 RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) from borings that were advanced within the area that was excavated and the area surrounding the excavation during previous investigations. A statistical evaluation was performed on the available soils metals data to calculate a background concentration and to evaluate the delineation of metals in soil based on this statistical background concentration. The statistical evaluation indicated that the extent of metals in soil was not completely delineated to the north and west of the excavated area. Additional soil samples will be collected and analyzed in these locations to complete the delineation of the metals in soils. __Update__ **Site-specific background concentrations were calculated for the 8 RCRA metals in soils at the former FTA. The statistical calculations for the background concentrations are provided in Appendix H and in Section 4.3.1 of the text of the Revised Final CSR. Georgia EPD approved the site-specific background concentrations in a letter dated May 8, 2001 (Appendix H). The site metals data were evaluated to determine where delineation was incomplete. Additional soil samples were collected and analyzed for barium and chromium, Section 3.1.3. Figure 4.11 illustratess the extent of metals in soil.**	

Project Name, & Location:
CSR for the Former FTA
Hunter AAF, GA

To: Wes Smith
LeAnn Taylor

From: *(Section)*
(Reviewer)

Cmt. No.	Page No./ Section No.	Georgia EPD Comments :	Response to comment.	COE Review Action & Date
4		**Site Characterization – Soil** Appropriately, determined background concentrations are critical in the definition of the extent of soil contamination. The concentrations in Appendix III, Table 2 of the Rules cannot be used for background soil concentrations. HAAF must explicitly determine background soil concentrations for the metals released at the site using analytical data from samples taken from locations that are representative of soil conditions not affected by a release of a regulated substance as required by Rule 391-3-19-06(3)(b)2. Their extent of contamination must be determined accordingly.	During the course of the CSR investigation, 63 soil samples were obtained and analyzed for RCRA metals (arsenic, barium, cadmium, lead, mercury, nickel, selenium and silver). Since there was no known release of metals at the Site, it could not be determined which, if any, of the samples were representative of a release, and which were representative of background conditions. Therefore, a statistical evaluation which initially considered all of the available soil metals data was performed. The soils data was first evaluated for identification of statistical outliers. Seven samples which displayed statistical outliers for any metal were removed from the data sets for all metals. A statistical evaluation was then performed on the remaining data after the outliers had been removed. Statistical methods were selected based on the distribution of the data and the number of non-detects. The data were evaluated for normality using the Filliben, Shapiro-Francia, and Shapiro-Wilk tests. Log-normal data sets (arsenic, barium, chromium, lead, and selenium) were logarithmically transformed. Upper background concentrations (UBCs) were then selected on the transformed data using the mean plus 1.645 standard deviations. A non-parametric analysis was then performed on the remaining data sets that did not normalize by log transform (cadmium, mercury, and silver) and were assigned a UBC equal to the maximum observed value. In the case of mercury, the maximum observed value (0.40 mg/kg in sample BH-12) exceeded the UBC for arsenic, lead, selenium, and silver. Therefore, the next highest maximum observed value (0.39 mg/kg in sample BH-13) was selected as the mercury UBC. The statistical evaluation yielded UBCs for each of the eight metals analyzed and are listed below. The statistical plots used to select UBCs for each of the eight metals are included in **Appendix H**.	

PROJECT REVIEW COMMENTS	Date: February, 2001 Update May 2002	Page 5 of 17
Project Name, & Location: CSR for the Former FTA Hunter AAF, GA	To: Wes Smith LeAnn Taylor	From: *(Section)* *(Reviewer)*

<table>
<tr><th>Cmt. No.</th><th>Page No./ Section No.</th><th>Georgia EPD Comments :</th><th>Response to comment.</th><th>COE Review Action & Date</th></tr>
<tr><td>4 – Cont.</td><td></td><td>**Site Characterization – Soil**</td><td>
<table>
<tr><th>Metal</th><th>UBC (mg/kg)</th><th>Table 2, Statistical Method</th><th>Appendix III Values</th></tr>
<tr><td>Arsenic</td><td>2.6</td><td>Log-normal data Mean + 1.645 std. Dev</td><td>20</td></tr>
<tr><td>Barium</td><td>28</td><td>Log-normal data Mean + 1.645 std. Dev</td><td>1000</td></tr>
<tr><td>Cadmium</td><td>2.6</td><td>Non-Parametric, Max observed value</td><td>2</td></tr>
<tr><td>Chromium</td><td>7.7</td><td>Log-normal data Mean + 1.645 std. Dev</td><td>100</td></tr>
<tr><td>Lead</td><td>53</td><td>Log-normal data Mean + 1.645 std. Dev</td><td>75</td></tr>
<tr><td>Mercury</td><td>0.39</td><td>Non-Parametric, Max observed value</td><td>0.5</td></tr>
<tr><td>Selenium</td><td>1.9</td><td>Log-normal data Mean + 1.645 std. Dev</td><td>2</td></tr>
<tr><td>Silver</td><td>2.6</td><td>Non-Parametric, Max observed value</td><td>2</td></tr>
</table>
As indicated above, the UBC for arsenic, barium, chromium, lead, mercury, and selenium are below the Table 2, Appendix III values (which are based on GAEPD’s estimate of statewide background).
The UBCs were then used to evaluate where metals concentrations exceeded background and if the extent of metals could be delineated using the existing data. The results of the evaluation indicated that most of the exceedences of the background
</td><td></td></tr>
</table>

Project Name, & Location:
CSR for the Former FTA
Hunter AAF, GA

To: Wes Smith
LeAnn Taylor

From: *(Section)*
(Reviewer)

Cmt. No.	Page No./ Section No.	Georgia EPD Comments :	Response to comment.	COE Review Action & Date
4 – Cont.		Site Characterization – Soil	concentration (i.e., UBCs) were within the excavated area and areas immediately adjacent to the excavated area. The evaluation also indicated that the extent of the metals in soils was not completely delineated to the north and west of the excavated area. Additional delineation will be needed to the north of HMW-13 for chromium, to the west of SB-13 and HMW-11 for barium and chromium. Additional soil samples will be collected and analyzed for these metals in these locations to complete the delineation. Proposed sample locations and analysis are shown on Figure 1 (Appendix H). Update **Georgia EPD approved the site-specific upper background concentrations (UBCs) in a letter dated May 8, 2001. Additional soil samples were collected and analyzed for barium and chromium from soil borings SB-43, SB-44, SB-46, SB-47, and SB-48 (Table 4.3 and 4.4). The barium and chromium concentrations from these soil samples were less than the barium and chromium UBCs. Figure 4.11 shows the delineation of metals in soil at the former FTA. The data used in the statistical calculations and distribution plots are provided in Appendix H.**	

PROJECT REVIEW COMMENTS	Date: February, 2001 Update May 2002	Page 7 of 17
Project Name, & Location: CSR for the Former FTA Hunter AAF, GA	To: Wes Smith LeAnn Taylor	From: *(Section)* *(Reviewer)*

Cmt. No.	**Page No./ Section No.**	**Georgia EPD Comments :**	**Response to comment.**	**COE Review Action & Date**
5		The definition of the horizontal extent of soil contamination for volatile organic compounds (VOCs) and semi-VOCs is inadequate. The horizontal extent of contamination should be depicted using contour lines at the locations of samples with contaminent levels below the detection limits to demonstrate the complete definition described in Rule 391-3-19-06(3)(b)2. Additional samples must be collected to address the uncertainty of delineations as shown in Figures 4.7 and 4.8. Likewise, in Figure 6.1., areas of noncompliance should be drawn to actual data points meeting appropriate risk reduction criteria.	Additional soil samples will be collected at the north end of the site and at the south end of the site. These soil samples will be analyzed for VOCs and SVOCs. Proposed sample locations and analysis are shown on Figure 1. Using the existing and new soils data, an attempt will be made to contour the total concentrations of the VOCs and the total concentrations of SVOC concentrations. The information obtained from the contouring will be used to re-draw the areas of non-compliance on Figure 6.1. **Update** **Figure 4.7 (Distribution and Extent of VOCs in Soil) and Figure 4.8 (Distribution and Extent of SVOCs in Soil) are now Figures 4.8A (VOCs) and 4.9A (SVOCs) in the Revised Final CSR.** **Soil samples were collected and analyzed from soil borings SB-43 to SB-50 and analyzed for VOCs and SVOCS (Tables 4.3 and 4.4). The horizontal and vertical extent of VOCs and SVOCs in soils have been completed and are shown on Figures 4.2 through 4.6, and 4.8A and 4.9A. Contour maps (Figures 4.8B, 4.8C, 4.9B, and 4.9C) have been prepared for total VOCs and total SVOCs concentrations in surface soils and subsurface soils. Figure 6.1 was revised, the areas of non-compliance with RRS have been drawn to sample locations that have substance concentrations that meet RRS.**	

PROJECT REVIEW COMMENTS

Date: February, 2001
Update May 2002

Page 8 of 17

Project Name, & Location:
CSR for the Former FTA
Hunter AAF, GA

To: Wes Smith
LeAnn Taylor

From: *(Section)*
(Reviewer)

Cmt. No.	**Page No./ Section No.**	**Georgia EPD Comments :**	**Response to comment.**	**COE Review Action & Date**
6		**Site Characterization – Ground Water** The CSR must also determine the vertical groundwater gradient, flow direction, and flow rate for the aquifer as required by Rule 391-3-19-06(3)(b)3. The procedure used to determine the hydraulic parameters should be included in the CSR.	The flow direction and flow rate for the upper surficial aquifer were provided in the CSR on Page 4-4. Additional ground water levels will be measured and the data will be used to calculate the vertical ground water gradient for the site. The flow direction and flow rate for the upper surficial aquifer will be updated using the additional ground water levels. The procedures used to calculate the hydraulic parameters will again be included in the CSR. **<u>Update</u>** **Groundwater elevations were measured in all of the site monitoring wells in November 2001 (Table 4.1). The horizontal and vertical groundwater gradients are described in Section 4.2.1 of the Revised Final CSR. The November 2001 data indicated the site had a downward vertical gradient. The procedures used to calculate the hydraulic parameters are presented in Sections 4.2.1 through 4.2.3 and in Appendix E.**	
7		The horizontal extent of groundwater contamination was not determined to meet requirements of Rule 391-3-19-06-(3)(b)3. It appears that there not an appropriate number of data points at sufficient locations to the north of the site with concentrations at background levels to define the plumes horizontally. Additional data must be collected.	One to two monitoring wells will be installed at the north end of the site in an attempt to complete the delineation of the horizontal extent of VOCs in groundwater. Proposed sample locations and analysis are shown on Figure 1. **<u>Update</u>** **Monitoring wells HMW-21 and HMW-22 were installed to the north of the site. As shown on Figure 4.12 the horizontal extent of groundwater contamination has not been completed. The detection of chlorinated VOCs north and sidegradient of the former FTA storage tanks and fire training pad sources may not be associated with the former FTA.**	

PROJECT REVIEW COMMENTS	Date: February, 2001 Update May 2002	Page 9 of 17

Project Name, & Location: CSR for the Former FTA Hunter AAF, GA	To: Wes Smith LeAnn Taylor	From: *(Section)* *(Reviewer)*

Cmt. No.	Page No./ Section No.	Georgia EPD Comments :	Response to comment.	COE Review Action & Date
8		Figure 4.6 indicates that monitoring well HMW-5 is located side gradient to the sources. This suggests that the well may not be placed at the best location to provide convincing data to define the vertical extent of groundwater contamination. Please install and analyze an additional deep well as more appropriate location to meet the requirements of Rule 391-3-19-06(3)(b)3.	Monitoring well HMW-3 was installed to 50 feet bgs and is located downgradient of the former fire training area. Analytical results for the ground water sample from HMW-3 indicates that VOCs and SVOC were not detected and that the barium concentration was less than background concentrations. This data indicates that the regulated substances are not present at a depth of 50 feet and downgradient of the former fire training area. An additional ground water sample will be collected from monitoring well HMW-3 to confirm the results presented in the CSR rather than installing an additional deep well downgradient of the former fire training area. <u>Update</u> **Figure 4.6 (Potentiometric Map) has become Figure 4.7 in the Revised Final CSR. The potentiometric surface map from November 2001 (Figure 4.7) indicates that groundwater flow direction is from east to west across the site to the western and southern drainage ditches. Based on this data, monitoring well HMW-3 is downgradient of the former FTA. Monitoring well HMW-3 was sampled and analyzed for VOCs, SVOCs and 8 RCRA metals. (Table 4.5) None of these substances were detected in the groundwater sample from HMW-3 (Figure 4.12). The vertical extent of contamination in groundwater has been delineated.**	
9		**Risk Reduction Standards** In Appendix G (p. G-3), the inhalation rate of air exposure (IR_{air}) should be 15 m^3/day not 20m^3/day.	In accordance with GAEPD's question-and-answer form RAU-96-2, "Site-Specific Exposure Factors", 15 cubic meters per day (m^3/day) is used as the daily inhalation rate for Type 2 residential children and 20 m^3/day is used for Type 2 residential adults. These values were used in our calculations.	

PROJECT REVIEW COMMENTS	Date: February, 2001 Update May 2002	Page 10 of 17

Project Name, & Location: CSR for the Former FTA Hunter AAF, GA	To: Wes Smith LeAnn Taylor	From: *(Section)* *(Reviewer)*

Cmt. No.	**Page No./ Section No.**	**Georgia EPD Comments :**	**Response to comment.**	**COE Review Action & Date**
10		In Appendix G, the site-specific soil-to-air volatization factors (VF) cannot be validated since there are no references to the soil/air partition coefficient (K) as the soil-water partition coefficient (K_d) the organic carbon partition coefficient (K_{oc}) molecular diffusity, and Henry's law constant. Differences in the VF will produce different results for RAGS PRG equations 6 and 7.	Based on the GAEPD comments, Law reviewed the calculated volatilization factors (VFs). As a consequence, the VFs have been updated using more current U.S. Environmental Protection Agency sources for physical and chemical characteristics. The primary source used for physical and chemical characteristics is the "Soil Screening Guidance (SSG): Technical Background Document" (USEPA, 1996). Values from the SSG include the organic carbon partition coefficient (K_{oc}), Henry's Law Constant, and air diffusivity. When not available in the SSG, the Superfund Chemical Data Matrix (SCDM) database (USEPA, 1997) and/or Table A-1 from "Technical Support Document for the Hazardous Waste Identification Rule: Risk Assessment for Human and Ecological Receptors, Volume II" (USEPA, 1995) were used as sources for chemical and physical characteristics. The SCDM database lists K_d values which are based on a fraction organic carbon (f_{OC}) value of 0.002. Table 3, Appendix III of the HSRA Rule specifies a f_{OC} equal to 0.02. Therefore, Law's K_d values reflect the use of a f_{OC} of 0.02. The recalculated VFs are attached for reference in Appendix H of this document. As a consequence, the soil risk reduction standards were either unchanged or higher. The RRS for the volatile organic compounds are now generally one order of magnitude greater than the values listed in the CSR. __Update__ **The revised soil RRSs are presented on Tables 6.1a and 6.1b and Appendix G.**	

PROJECT REVIEW COMMENTS	Date: February, 2001 Update May 2002	Page 11 of 17
Project Name, & Location: CSR for the Former FTA Hunter AAF, GA	To: Wes Smith LeAnn Taylor	From: *(Section)* *(Reviewer)*

Cmt. No.	**Page No./ Section No.**	**Georgia EPD Comments :**	**Response to comment.**	**COE Review Action & Date**
11		The following comments are related to RAGS Equations: a) Appendix G should include RAGS equations 6 and 7. b) The soil Type 2 criteria for benzene should be the lesser of the calculated values using the RAGS equation 6 for carcinogens and RAGS equation 7 for the noncarcinogens. c) The soil Type 1 criteria for naphthalene should be the notification concentration (100 mg/kg) as opposed to the value derived from RAGS equation 7. Please see the following Table* for the correct risk reduction criteria. * Revised Table is provided in Appendix H.	Response to comment a): The equations from RAGS, Part B will be added to Appendix G. Response to comment b): The Type 2 value for benzene was the lesser of the two. The noncarcinogenic value (14 mg/kg) is less than the carcinogenic value (39 mg/kg). Response to comment c): If the VF is revised to a higher value, the Type 1 RRS does, in fact, revert to 100 mg/kg, the notification concentration for naphthalene. The values for soil RRS that are shown on the Table in the GAEPD comments (Comparison of Type 1,2, and 4 RRS Values for Ground Water and Soil) appear to have been shifted out of position. We have included a revision of this table in Appendix H showing the updated RRSs under the Hunter criteria; however, we can not determine how the RRS listed under the column labeled GAEPD Criteria were derived. For example, the soil RRS for 2,4-dinitrotoluene that was shown by GAEPD (100 mg/kg) could not be re-created for the following reasons. The notification concentration for 2,4-dinitrotoluene is 0.66 mg/kg. The GW Type 1 value x 100 is 0.005. Leaching was not tested. Therefore, 0.66 mg/kg would be selected as Decision Point 1. The risk-based values were both larger (Decision Points 2 and 3). Under HSRA Type 1, the lowest of the three Decision Points is selected. Therefore, the Type 1 soil criteria for 2,4-dinitrotoluene is equal to 0.66 mg/kg.	

PROJECT REVIEW COMMENTS	Date: February, 2001 Update May 2002	Page 12 of 17
Project Name, & Location: CSR for the Former FTA Hunter AAF, GA	To: Wes Smith LeAnn Taylor	From: *(Section)* *(Reviewer)*

Cmt. No.	**Page No./ Section No.**	**Georgia EPD Comments :**	**Response to comment.**	**COE Review Action & Date**
11 – Cont.		**Risk Reduction Standards - Continued**	In response to GAEPD comments regarding ground water RRS for benzene and lead, these are discussed as follows: Benzene Type 4 Ground water value: In accordance with verbal communication with the Superfund Hotline and Dr. Cliff Obdyke, the mid-range value of the benzene oral cancer slope factor has been used to calculate RRS for benzene. Lead RRS for Ground Water: Types 1 through 4 RRS are based on the Type 1 RRS value of 0.015 milligrams per liter (mg/L). **Update** **The equations from RAGS, Part B are in Appendix G of Revised Final CSR. Tables 6.1a, 6.1b, 6.2 have been revised to reflect the revision fo RRS. Sections 6.1, 6.2, and 6.4 have been revised to reflect these changes also.**	

PROJECT REVIEW COMMENTS	Date: February, 2001 Update May 2002	Page 13 of 17

Project Name, & Location: CSR for the Former FTA Hunter AAF, GA	To: Wes Smith LeAnn Taylor	From: *(Section)* *(Reviewer)*

Cmt. No.	**Page No./ Section No.**	**Georgia EPD Comments :**	**Response to comment.**	**COE Review Action & Date**
12		Section 5.3 (p. 5-4) identifies ecological receptors. The following Table lists screening values for soil in order to determine the need for an ecological risk assessment. Detected soil concentrations that are above these levels are listed. Since the data documents the need for ecological risk assessment the revised CSR must include such an assessment.	<u>Ecological Screening Values:</u> Quantitative ecological risk assessments are usually not part of Compliance Status Reports. Numerous CSRs have been submitted to GAEPD and have been approved which document soil concentrations in excess of the listed screening values without an ecological risk assessment. The HSRA rule does not provide a specific framework for the performance of ecological risk assessment, and we do not agree that detected soil concentrations in excess of screening values alone should determine the need for an ecological risk assessment. It appears that soil concentrations from the CSR have been compared to the Region IV Recommended Ecological Screening Values of Soil. The Region IV Screening Values are the most conservative value for each chemical obtained from several sources. For example: ▪ The values listed for the polycyclic aromatic hydrocarbons are detection limits as listed by the U.S. Fish and Wildlife Service (Beyer, 1990); and ▪ The value listed for dieldrin is the Dutch Ministry Standards target value. These values are extremely conservative and are not representative of values that are protective of species present at the site. Therefore, we do not agree that the mere presence of contaminant concentrations above the very conservative screening values is the appropriate trigger for an ecological risk assessment. In addition, many of the soil-sample results listed on GAEPD's table are not positively detected concentrations, but are sample quantitation limits. In accordance with the HSRA Rules, the soil samples were analyzed using accepted SW-846 methods.	

PROJECT REVIEW COMMENTS	Date: February, 2001 Update May 2002	Page 14 of 17

Project Name, & Location: CSR for the Former FTA Hunter AAF, GA	To: Wes Smith LeAnn Taylor	From: *(Section)* *(Reviewer)*

Cmt. No.	**Page No./ Section No.**	**Georgia EPD Comments :**	**Response to comment.**	**COE Review Action & Date**
12 – Cont.		**Ecological Risk Assessment - Continued**	The screening values are less than the detection limits, and, in accordance with Region IV ecological risk assessment guidance, the detection limit for the compound becomes the screening value. It is agreed that several compounds were detected at maximum concentrations exceeding their method detection limits. Therefore, despite our concern and reservations about the appropriateness of the method used to determine the need for ecological risk assessment, we propose to complete a Preliminary Risk Evaluation (PRE) at the site in the following manner: ▪ The site will be surveyed for supporting habitats and potential ecological receptor species will be identified; ▪ Risks for representative species will be addressed in the PRE which will compare modeled receptor intakes to No Observed Adverse Effect Level (NOAEL) and Low Observed Adverse Effect Level (LOAEL) Reference Threshold Values; ▪ The chemical-specific exposure point concentrations used in the risk calculations will be based on the 95 percent upper confidence limit of the arithmetic mean or the maximum detected concentration, whichever is smaller; and ▪ The approach of the PRE will be consistent with PREs already completed for RCRA Program sites at Hunter AAF.	

PROJECT REVIEW COMMENTS	Date: February, 2001 Update May 2002	Page 15 of 17

Project Name, & Location: CSR for the Former FTA Hunter AAF, GA	To: Wes Smith LeAnn Taylor	From: *(Section)* *(Reviewer)*

Cmt. No.	Page No./ Section No.	Georgia EPD Comments :	Response to comment.	COE Review Action & Date
12 – Cont.		Ecological Risk Assessment - Continued	**Update** **At the request of EPD, an Ecological Preliminary Risk Evaluation (EPRE) was conducted at the FTA. The EPRE compares measured concentrations of detected substances to conservative ecological screening values to identify substances detected at the FTA that pose a potential hazard to ecological receptors. Both terrestrial and aquatic habitats are present at the FTA. Ecological receptors potentially present at the FTA include earthworms and other soil-dwelling invertebrates, birds, shrews, rabbits, and raccoons. Surface water and surface soil are media of concern to ecological receptors at the Site. Groundwater is not a medium of exposure for ecological receptors; however it can potentially discharge to surface water and was evaluated along with surface water and surface soil during the EPRE. Substances detected in surface water samples were evaluated and were concluded to not pose a risk to wildlife receptors. Substances in groundwater were also evaluated because groundwater could discharge to surface water and were determined to not pose a risk to wildlife receptors. Substances detected in soil were evaluated and were determined to not pose a risk to wildlife receptors. Based on the results of the EPRE, no further action is recommended for an ecological risk assessment. The EPRE is described in Section 5.4 of the Revised CSR. Tables 5.3 to 5.15 present the calculations demonstrating that the detected substances do not pose a risk to ecological receptors at the FTA.**	

PROJECT REVIEW COMMENTS

Date: February, 2001
Update May 2002

Project Name, & Location:
CSR for the Former FTA
Hunter AAF, GA

To: Wes Smith
LeAnn Taylor

From: *(Section)*
(Reviewer)

Cmt. No.	**Page No./ Section No.**	**Georgia EPD Comments :**	**Response to comment.**	**COE Review Action & Date**
13		In Section 5.2.1 (Physical Site Characteristics, p. 5-2), please revisit the discussion of the two drainage ditches located north and south of the site. Include in the discussion the potential of the ditches to provide a habitat for aquatic species. Include any previous investigative work or site history that would provide information regarding the impact that the drainage ditches may have on the environment.	In preparation for the PRE discussed in the previous response, supporting habitats will be surveyed. The survey will include the drainage ditches located north and south of the site. However, these drainage features collect drainage from multiple sites. Therefore, surface water and sediment sampling is not proposed. Instead, groundwater concentrations will be modeled to the surface drainage features to discern whether the site is potentially impacting surface water features that are supportive of aquatic habitat. In other words, modeled concentrations will be compared to ambient water quality criteria. The choice of the model is dependent on the type of contaminants that are of interest. The lateral transport of groundwater from the source area to the point of discharge will probably be modeled using the Domenico analytical solute transport model as incorporated into the RBCA Tool Kit for Chemical Releases (Groundwater Services, Inc., 1998). For chlorinated solvents, BIOCHLOR, a model which also uses Domenico's scheme but has been updated as a natural attenuation decision support system, may be used. **Update** **A total of six surface water samples were collected from the two drainage ditches and analyzed for VOCs, SVOCs and 8 RCRA metals (Figure 4.12). Those analytical results are presented on Table 4.6. The surface water analytical data indicates that surface water is not being impacted by discharging groundwater. An ecological PRE was conducted at the FTA and is described in Section 5.4 and Figure 3.1 of the**	

PROJECT REVIEW COMMENTS	Date: February, 2001 Update May 2002	Page 17 of 17
Project Name, & Location: CSR for the Former FTA Hunter AAF, GA	To: Wes Smith LeAnn Taylor	From: *(Section)* *(Reviewer)*

Cmt. No.	**Page No./ Section No.**	**Georgia EPD Comments :**	**Response to comment.**	**COE Review Action & Date**
13 – Cont.			**Revised CSR. The ecological PRE evaluated the surface water analytical results along with the analytical results of the surface soil and groundwater. The ecological PRE determined that the substances detected in the surface water, groundwater and surface soil do not pose a risk to ecological receptors (Tables 5.3 to 5.15). On the basis that analytical data and risk evaluation indicate there is no impact to surface water or risk to ecological receptors, modeling of the groundwater concentrations to surface water is not warranted and was therefore not performed.**	

☐ Continued on Next Page ☒ End of Comments

TABLE OF CONTENTS

Page

EXECUTIVE SUMMARY ES-1
1.0 INTRODUCTION 1-1
2.0 SITE BACKGROUND 2-1
  2.1 SITE HISTORY 2-1
  2.2 PREVIOUS ACTIVITIES 2-2
  2.3 CURRENT SITE DESCRIPTION 2-2
  2.4 PREVIOUS SITE INVESTIGATIONS 2-3
    2.4.1 Preliminary Contamination Assessment (1987) 2-3
    2.4.2 Extent Assessment and Closure Plan (1990-1992) 2-4
    2.4.3 Source Removal Design (1995) 2-4
    2.4.4 Soil Remediation Activities (November 1997-March 1998) 2-5
    2.4.5 Separate Phase Hydrocarbon (SPH) Removal Activities (1999-Current) 2-5
    2.4.6 1999-2000 CSR Investigation 2-6
  2.5 DESCRIPTION OF EACH KNOWN SOURCE 2-7
  2.6 POTENTIALLY RESPONSIBLE PARTIES 2-7
3.0 ASSESSMENT ACTIVITIES 3-1
  3.1 SOIL INVESTIGATION 3-1
    3.1.1 Geoprobe® Sampling Activities 3-3
    3.1.2 Concrete Coring Activities 3-4
    3.1.3 Hand Auger Sampling Activities 3-4
    3.1.4 Hollow-Stem Augers and Split-spoon Sampling Activities 3-4
  3.2 GROUNDWATER INVESTIGATION 3-5
    3.2.1 Temporary Piezometer Installation and Sampling 3-6
    3.2.2 Monitoring Well Installation and Development 3-7
    3.2.3 Sampling of New and Existing Monitoring Wells 3-8
    3.2.4 Well Abandonment 3-9
  3.3 SURFACE WATER SAMPLING 3-10
  3.4 SITE SURVEY 3-10
  3.5 EXPOSURE ASSESSMENT 3-11
4.0 RESULTS OF THE INVESTIGATION 4-1
  4.1 REGIONAL GEOLOGY AND HYDROGEOLOGY 4-1
  4.2 SITE GEOLOGY AND HYDROGEOLOGY 4-2
    4.2.1 Groundwater Gradients 4-3
    4.2.2 Hydraulic Conductivity Measurements 4-4
    4.2.3 Groundwater Flow Rates 4-4
    4.2.4 Summary of Groundwater Flow Movement Across the Site 4-5

TABLE OF CONTENTS
(Continued)

Page

4.3 NATURE AND EXTENT OF REGULATED SUBSTANCES 4-5
4.3.1 Background Concentrations 4-7
4.3.2 Surface Soil Sampling and Analyses 4-9
4.3.3 Subsurface Soil (>2 feet bgs) Sampling and Analyses 4-13
4.3.4 Groundwater Sampling and Analyses 4-17
4.3.5 Surface Water Sampling and Analysis 4-20

5.0 RESULTS OF THE RECEPTOR STUDY 5-1

5.1 PURPOSE AND OBJECTIVES 5-1
5.2 SITE DESCRIPTION 5-1
5.2.1 Physical Site Characteristics 5-2
5.2.2 Land Use 5-2
5.2.3 Demographics 5-2
5.3 POTENTIAL RECEPTORS AND PATHWAYS OF EXPOSURE 5-3
5.3.1 Human Receptor Evaluation 5-3
5.3.2 Ecological Receptor Evaluation 5-4
5.4 ECOLOGICAL PRELIMINARY RISK EVALUATION 5-4
5.4.1 Ecological Screening Value Comparison 5-5
5.4.2 Preliminary Problem Formulation 5-6
5.4.3 Preliminary Ecological Effects Evaluation 5-10
5.4.4 Preliminary Exposure Estimate 5-11
EXPOSURE PARAMETERS FOR SURROGATE SPECIES 5-12
5.4.5 Preliminary Risk Calculation 5-13
5.4.6 Uncertainties 5-15
5.4.7 Conclusions 5-17
5.4.8 Risk Management and Site Recommendations 5-17

6.0 RISK REDUCTION STANDARDS 6-1

6.1 RISK REDUCTION STANDARDS FOR SOIL 6-1
6.2 RISK REDUCTION STANDARDS FOR GROUNDWATER 6-2
6.3 TOXICITY ASSESSMENT 6-3
6.4 COMPARISON OF RISK REDUCTION STANDARDS WITH DETECTED CONCENTRATIONS 6-3
6.4.1 Soil 6-3
6.4.2 Groundwater 6-4

7.0 REFERENCES 7-1

LIST OF APPENDICES

APPENDIX A	SUMMARY OF CHEMICAL ANALYSES FROM PREVIOUS INVESTIGATIONS
APPENDIX B	SUMMARY OF SOURCE REMOVAL ACTIVITIES
APPENDIX C	CSR FIELD PROCEDURES
APPENDIX D	SOIL BORING LOGS AND MONITORING WELL DIAGRAMS
APPENDIX E	HYDRAULIC CONDUCTIVITY CALCULATIONS
APPENDIX F	LABORATORY ANALYTICAL REPORTS FOR CSR ASSESSMENTS
APPENDIX G	CALCULATIONS FOR RISK REDUCTION STANDARDS
APPENDIX H	RESPONSE TO COMMENTS SUPPORTING DOCUMENTATION

LIST OF TABLES

Table

3.1 Summary of Soil Boring Data
3.2 Summary of Soil and Groundwater Samples Collected
3.3 Summary of Monitoring Well Construction Data
4.1 Summary of Groundwater Elevations (November 6, 2001)
4.2 Summary of Hydraulic Conductivity Testing
4.3 Summary of Regulated Substances Detected in Surface Soil Samples
4.4 Summary of Regulated Substances Detected in Subsurface Soil Samples
4.5 Summary of Regulated Substances Detected in Groundwater Samples
4.6 Summary of Regulated Substances Detected in Surface Water Samples
5.1 Results of Groundwater Usage Survey in a 3-mile Radius
5.2 Protected Animal and Plant Species Occurring in Vicinity of Hunter Army Airfield, Georgia
5.3 Ecological Screening Criteria for Surface Water, Groundwater and Surface Soil
5.4 Surface Water Concentrations for HAAF Former Fire Training Area
5.5 Groundwater Concentrations for HAAF Former Fire Training Area
5.6 Surface Soil Concentrations for HAAF Former Fire Training Area
5.7 Derivation of NOAELs for Mammal Test Species
5.8 Derivation of NOAELs for Bird Test Species
5.9 Derivation of Screening Toxicity Reference Values for Mammal Receptors
5.10 Derivation of Screening Toxicity Reference Values for Bird Receptors
5.11 Maximum Hazard Quotient Calculations for Raccoon from Surface Water
5.12 Maximum Hazard Quotient Calculations for Raccoon from Groundwater
5.13 Average Hazard Quotient Calculations for Raccoon from Groundwater
5.14 Maximum Hazard Quotient Calculations for Short-Tailed Shrew and American Robin
5.15 Average Hazard Quotient Calculations for Short-Tailed Shrew
6.1a Risk Reduction Standard for Soil – Types 1 and 2
6.1b Risk Reduction Standard for Soil – Types 3 and 4
6.2 Risk Reduction Standard for Groundwater – Types 1, 3 and 4

LIST OF FIGURES

Figure

2.1 Site Location Map
2.2 Map of Former Fire Training Area and Surrounding Area
2.3 Site Sampling Locations
3.1 General Process for Assessing Risk and Selecting Remedial Levels for Ecological Receptors
4.1 Hydrogeologic Profile Location Map
4.2 Hydrogeologic Profile A-A'
4.3 Hydrogeologic Profile B-B'
4.4 Hydrogeologic Profile C-C'
4.5 Hydrogeologic Profile D-D'
4.6 Hydrogeologic Profile E-E'
4.7 Potentiometric Surface Map on November 6, 2001
4.8A Distribution and Extent of Volatile Organic Compounds in Soil
4.8B Distribution and Extent of Total Volatile Organic Compounds Concentrations in Surface Soil
4.8C Distribution and Extent of Total Volatile Organic Compounds Concentrations in Subsurface Soil
4.9A Distribution and Extent of Semi-Volatile Organic Compounds in Soil
4.9B Distribution and Extent of Total Semi-Volatile Organic Compounds Concentrations in Surface Soil
4.9C Distribution and Extent of Total Semi-Volatile Organic Compounds Concentrations in Subsurface Soil
4.10 Distribution and Extent of Pesticides/PCBs in Soil
4.11 Distribution and Extent of Metals in Soil
4.12 Distribution and Extent of Regulated Substances in Groundwater
6.1 Risk Reduction Standards Compliance Map

LIST OF ACRONYMS AND ABBREVIATIONS

ADD	average daily dose
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
CESAS	Corps of Engineers – Savannah District
CSR	Compliance Status Report
DNR	Department of Natural Resources
ECOPC	Ecological Constituents of Potential Concern
ESE	Environmental Science and Engineering
EPRE	Ecological Preliminary Risk Evaluation
ERA	Ecological Risk Assessment
ESV	Ecological Screening Values
FTA	Fire Training Area
GA EPD	Georgia Environmental Protection Division
GIWQC	Georgia Instream Water Quality Criteria
GNHP	Georgia Natural Heritage Program Database System
HAAF	Hunter Army Airfield
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HQ	hazard quotient
HSI	Hazardous Site Inventory
HSP	Health and Safety Plan
HSRA	Hazardous Site Response Act
IRIS	Integrated Risk Information System
LOAEL	observed adverse effect level
mg/kg	milligram per kilogram
mg/L	milligram per liter
mL/min	milliliters per minute
msl	mean sea level
mV	milliVolts
NAD	North American Datum
NOAEL	no observed adverse effect level

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

NTU	nephelometric turbidity unit
O.D.	outside diameter
PAHs	polynuclear aromatic hydrocarbons
PCB	polychlorinated biphenyl
PID	photoionization detector
ppm	parts per million
QA/QC	quality assurance/quality control
RCRA	Resource Conservation and Recovery Act
RRS	Risk Reduction Standards
SAIC	Science Applications International Corporation
SCS	Soil Conservation Service
SPH	separate phase hydrocarbon
SVOC	semi-volatile organic compound
SWMU	Solid Waste Management Unit
TPH	total petroleum hydrocarbons
TRV	toxic reference values
USACE	United States Army Corps of Engineers
USAEHA	United States Environmental Hygiene Agency
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	underground storage tank
VOC	volatile organic compound

EXECUTIVE SUMMARY

This Revised Final Compliance Status Report (CSR) documents the site assessment and development of Risk Reduction Standards (RRS) for the former Fire Training Area (FTA) at Hunter Army Airfield (HAAF) in Savannah, Georgia [Hazardous Site Inventory (HSI) Number 10395]. The purpose of this CSR is to satisfy the requirements of the Georgia Hazardous Site Response Act (HSRA). (In this report "site" is used to denote the property that was occupied by the former FTA, while "Site" denotes the HSRA site definition.)

HAAF is located in the southwestern portion of Savannah and covers approximately 5,400 acres. The mission of the facility is to provide command, control, training, administration, logistical and civilian-military support to non-divisional units stationed at Fort Stewart and HAAF. Aircraft based at HAAF currently include combat, transport, and training helicopters. The airfield is also used for overseas mobilization of troops and weapons.

The former FTA site is located on the northwestern portion of HAAF, west of the parking apron and runway, and 800 feet northwest of the air control tower. The site has not been used for fire training or any other purpose since 1991. The site formerly included a diked, gravel-covered concrete pad which was used for fire training. During training exercises, fuel was pumped from a nearby 10,000-gallon aboveground storage tank through an underground line to the pad where it was sprayed upon a simulated aircraft frame and ignited. Reportedly, water-contaminated JP-4 and diesel fuels were used for these training exercises. The pad and tank areas were the source areas for the contamination detected in soil and groundwater. These source areas underwent extensive remediation in 1998 which included removal of the fuel storage tank, fire training pad and contaminated soils. Based on past soil and groundwater sampling results, metals, semi-volatile organic compounds (SVOCs), and volatile organic compounds (VOCs) are present at the site.

As a part of the CSR assessment, a total of 133 soil samples were analyzed along with 31 groundwater samples from 22 monitoring wells. The results of these analyses, along with those from previous investigations at the site, have been used to define the horizontal and vertical extent of the HSRA-regulated substances associated with the Site. The studies have shown that the concentrations of detected regulated substances associated with the site are limited to the former FTA. The horizontal and vertical extent of VOCs, SVOCs, pesticides, PCBs and metals in surface and subsurface soils have been delineated at the Site. The extent of SVOCs, and metals in groundwater has been delineated. The horizontal and vertical extent of VOCs in groundwater is not delineated to the north of the former fire training pad. However, based upon groundwater flow directions and the substances detected, the groundwater contamination north of the former FTA may be originating from a source other than the former FTA site.

The current and future use of the HAAF former FTA property is non-residential. Forty-three HSRA-regulated substances including VOCs, SVOCs, pesticides and metals were detected in soil samples collected from the Site at concentrations above their respective detection limits. A study of the background metals concentrations in soil was performed during the 2001 CSR assessment to determine the upper background concentration for the Site. Georgia EPD approved the calculated upper background concentrations in soils for use at the former FTA. Types 1 through 4 RRS were calculated for these constituents detected based on the criteria provided in Section 391-3-19-.07(6)(c) of the HSRA rules. Twenty-nine of the 43 detected constituents comply with their Type 1 RRS. The maximum detected concentrations of 5 of the 14 remaining constituents complied with their respective Type 2 RRS. Type 3 RRS were calculated for the nine remaining constituents. Seven compounds in surface soil and seven compounds in subsurface soil did not comply with their respective Type 3 RRS for soils. Type 4 RRS were calculated for the eight constituents that exceeded the Type 3 RRS. The maximum detected concentrations of benzene, chloromethane, benzo(a)pyrene, and lead in soil did not comply with default Type 4 RRS for soil.

Fifteen HSRA-regulated substances were detected at concentrations exceeding detection limits in groundwater samples collected from the Site. Concentrations of five constituents exceeded the Types 1 and 3 RRS for groundwater. The maximum detected concentration of four constituents, lead, benzene, vinyl chloride, and naphthalene did not comply with default Type 4 RRS for groundwater.

Based on the above data, soil and groundwater at the HAAF former FTA are not in compliance with Types 1 through 4 RRS.

The most likely human receptor groups are maintenance workers that periodically mow or bush-hog the site or utility workers who install or repair underground utilities. Both of these groups may have direct contact with surface and near surface soil. Potentially complete pathways of exposure to soil include incidental ingestion, dermal absorption, and inhalation of fugitive dust and volatile emissions. Because the ditch banks are heavily vegetated, contact with ditch surface water and sediments is not expected to be a notable source of exposure for humans.

At the request of EPD, an Ecological Preliminary Risk Evaluation (EPRE) was conducted at the former FTA. The EPRE compares measured concentrations of detected substances to conservative ecological screening values to identify substances detected at the former FTA that pose a potential hazard to ecological receptors. Both terrestrial and aquatic habitats are present at the former FTA. Ecological receptors potentially present at the former FTA include earthworms and other soil-dwelling invertebrates, birds, shrews, rabbits, and raccoons. Surface water and surface soil are media of concern to ecological receptors at the Site. Groundwater is not a medium of exposure for ecological receptors; however it can potentially discharge to surface water and was evaluated along with surface water and surface soil during the EPRE. Substances detected in surface water samples were evaluated and were concluded to not pose a risk to wildlife receptors. Substances in groundwater were also evaluated because groundwater could discharge to surface water and were determined to not pose a risk to wildlife receptors. Substances detected in soil were evaluated and were determined to not pose a risk to wildlife receptors. Based on the results of the EPRE, no further ecological assessment is recommended.

1.0 INTRODUCTION

Law Engineering and Environmental Services, Inc., (LAW) was retained by the United States Corps of Engineers, Savannah District (CESAS) to prepare a Compliance Status Report (CSR) for the former Fire Training Area (FTA) at HAAF in Savannah, Georgia. A Pre-Final CSR was submitted to the Georgia Environmental Protection Division (GA EPD) on May 14, 1996. During 1998, removal activities (i.e., site structures and soil removal) were conducted at the former FTA with the objective to remove soils contaminated in excess of Georgia's Hazardous Site Response Act (HSRA) Risk Reduction Standards (RRS). In November 1998, Mr. Xaiobing Chen of the Georgia EPD, Hazardous Waste Management Branch contacted Ms. Melanie Little of the Fort Stewart Environmental Branch and recommended that the Installation withdraw the Pre-Final CSR and resubmit the CSR, incorporating the information on the removal activities and confirmatory soil sampling. The official request for withdrawal of the Pre-Final CSR was submitted to the GA EPD Hazardous Waste Management Branch in correspondence dated February 3, 1999 (Perez to Hendricks).

Additional assessment was performed from August 1999 to January 2000 to delineate the extent of soil and groundwater contamination previously detected at the former FTA for the CSR. A CSR for the former FTA was submitted to the GA EPD on March 31, 2000. On January 5, 2001, GA EPD issued a Notice of Deficiency letter on the CSR and requested a revised CSR for the former FTA. On February 26, 2001, LAW and CESAS responded to the comments, in the GA EPD Notice of Deficiency with the submittal of Response to Georgia EPD Comments, Compliance Status Report document. The Response to Comments document is attached. CESAS and LAW later met with the GA EPD on March 19, 2001 to discuss the response to comments. On May 8, 2001 GA EPD issued a letter titled Response to March 19, 2001 Meeting Letter which approved the background soil statistical study presented in the February 26, 2001 Response to Comments and the proposed additional soil and groundwater sampling locations. From October 31 to November 6, 2001, additional investigation of the soil and groundwater was conducted to complete delineation of contamination for the revision of the CSR. This Revised Final CSR includes the previous information from the March 31, 2000 CSR and the new data obtained in 2001.

In this report "site" is used to denote the property that was occupied by the former HAAF FTA, while "Site" denotes Georgia's HSRA site definition. The methodology and approach used to establish the project objectives and the overall CSR scope of work were conducted in a manner consistent with Section 391-3-19-.06 of the corrective action rules under Georgia's HSRA Rules.

The purpose of the Revised Final CSR is to document the compliance status of the Site with regard to the HSRA RRS. To provide the information required for this documentation, data were obtained to define the compliance status of the soil and groundwater at and adjacent to the site. The scope of the recently concluded revised CSR investigation was designed to build on the existing data developed during previous assessment activities conducted by U.S. Army Environmental Hygiene Agency and Environmental Science and Engineering (USAEHA 1987 and ESE 1993).

2.0 SITE BACKGROUND

HAAF is located in Chatham County, Georgia, within the southwest portion of the city of Savannah (Figure 2.1). The Installation is bounded to the north by the city of Savannah, to the east and south by residential and light commercial areas, and to the west by the Little Ogeechee River. Currently, HAAF serves as an aircraft support base for the U.S. Coast Guard and Fort Stewart, located 50 miles to the southwest.

The site is the former FTA, located in the northwest portion of the HAAF (Figure 2.2) and is approximately 800 feet northwest of the control tower, on a grassy cleared area measuring approximately 400 feet by 200 feet. The former FTA consisted of a 6,400-square-foot concrete fire training pad, which was covered with sand and gravel and surrounded by a concrete curb. In the center of the pad was a steel storage tank, which served as a mock aircraft during training activities. Fuel used in training exercises at the former FTA was stored in an approximately 17,000-gallon aboveground steel storage tank, located approximately 112 feet north of the fire training pad. The tank was surrounded on all sides by a 2.5-foot high earthen berm. The fuel was pumped from the tank to the fire training pad via an underground line. A second aboveground storage tank with a 1,100-gallon capacity was located northeast of the 17,000-gallon tank and was reported to have been used to contain water-contaminated fuel, solvents, or antifreeze (Figure 2.3). The former FTA has been inactive since 1991.

2.1 SITE HISTORY

HAAF was acquired by Fort Stewart from the U.S. Air Force (USAF) in 1967 following the designation of Fort Stewart as a flight training center. The facility served in support of the increased need for helicopter pilot training during the Vietnam Conflict. Aviation training was discontinued at Fort Stewart in 1973. Fort Stewart became a training and maneuver area upon activation of the 1st Battalion, 75th Infantry on January 21, 1974. Support and training for weapons systems, including tank, field artillery, helicopter gunnery, and small arms was carried out for regular Army and National Guard units. The 24th Infantry Division was permanently stationed at Fort Stewart in 1975 and was reflagged the 3rd Infantry Division (Mechanized) in May 1996. Aircraft based at HAAF currently include a variety of combat and transport helicopters. Additionally, the airfield was used for mobilization of troops and weapons during U.S. military operations in the Persian Gulf and Somalia.

2.2 PREVIOUS ACTIVITIES

The information presented in this section was obtained from reports prepared during previous investigations conducted by the U.S. Army Environmental Hygiene Agency (USAEHA), Environmental Science & Engineering (ESE), LAW, Geosciences, Inc., Omega Environmental Services, Metcalf and Eddy, and Science Applications International Corporation (SAIC).

The former FTA was used from the time of its construction (early 1980s) to 1991 for training of fire fighters based at HAAF. Fuel utilized for training exercises included mostly water-contaminated jet fuel (JP-4) and diesel fuels. Although solvents also were reported to have been used at the site (personal communication, USAEHA, 1993), no evidence or documentation exists that confirms solvents were used. During the training exercises, the fuel was pumped on the surfaces of the simulated aircraft and ignited. The fire was extinguished with water or foam (ESE, 1993). The pad was constructed with concrete curbs to contain the water and foam generated during fire fighting exercises. These curbs were not entirely effective in containing the fluids, which would occasionally spill over the curbs and flow onto the surrounding soil (ESE, 1993).

There is no documentation of the activities conducted by the USAF within the area now designated as the former FTA prior to acquisition of HAAF by the U.S. Army in 1967.

2.3 CURRENT SITE DESCRIPTION

The former FTA is located at HAAF in Savannah, Chatham County, Georgia. HAAF is geographically separated from the main Fort Stewart complex by a distance of approximately 50 miles. HAAF is located on 5,400 acres of land just southwest of Savannah. Figure 2.2 presents the HAAF property boundary. As the former FTA is part of a Federal Installation, a legal description of the boundary was not available. The airfield is bounded on the north by lightly populated areas, on the east and south by residential and light commercial areas, and on the west by the Little Ogeechee River. The site occupies a grassy cleared area approximately 400 feet by 200 feet and is inactive. The geographic coordinates of the former FTA are 32° 01' 10" North latitude and 81° 08' 36" West longitude [United States Geological Survey (USGS) Topographic Quadrangle, Garden City, Georgia, 1980]. The site location and surrounding area is shown on Figures 2.1 and 2.2.

The former FTA is bounded on the northwest and south by drainage ditches, by the airfield pavement on the east, and by wooded land on the southwest (see Figure 2.3). The topography of the former FTA averages approximately 30 feet above mean sea level (msl) and slopes gently west toward the Springfield Canal. The canal flows southwest before emptying into the Little Ogeechee River floodplain. Topographic relief in the vicinity of the site is approximately 21 feet. Elevations at the site range from 35 feet above msl at the fire training pad to 14 feet above msl in the northern drainage ditch (ESE, 1993). The former fire training pad, aboveground storage tanks and associated structures were removed in 1998. At this time, contaminated soils were also excavated and disposed off-site. The site is currently inactive, and is covered with grass, scrub brush and mature trees. Some piles of construction rubble are visible in the areas covered with trees. This rubble includes concrete and asphalt debris from past construction and fill activities (i.e., prior to 1980), and are not associated with the activities conducted at the former FTA. The asphalt debris contains polynuclear aromatic hydrocarbons (PAHs). PAHs are also present in the fuels used for training activities conducted at the former FTA. Therefore, the presence of PAHs may not be entirely associated with fire training activities.

2.4 PREVIOUS SITE INVESTIGATIONS

Several investigations have been conducted at the site beginning in 1987. Numerous soil borings and monitoring wells were installed and soil, sediment, and groundwater samples collected. Figure 2.3 shows the locations of the sampling points from the previous investigations. Appendix A provides a summary of the chemical analytical results for the investigations conducted up to the CSR assessment activities. Descriptions of the previous investigations conducted at the site are presented in the following sections.

2.4.1 Preliminary Contamination Assessment (1987)

A preliminary contamination assessment was performed by U.S. Army Environmental Hygiene Agency (USAEHA) in March 1987. The study was performed to evaluate the existence of contamination in the soils surrounding the curbed concrete pad on which training activities were conducted. The USAEHA performed drilling and sampling of four exploratory borings (BH-10, BH-11, BH-12, and BH-13). Arsenic, barium, chromium, cadmium, lead, mercury, selenium, and silver were detected in the shallow soil samples collected near the fire training pad. Two soil samples contained PAHs and phthalates on the north and south sides of the pad.

2.4.2 Extent Assessment and Closure Plan (1990-1992)

From 1990 to 1992 Environmental Science and Engineering (ESE) installed nine monitoring wells (HMW-1 through HMW-9) and six soil borings (HSB-1 through HSB-6) and collected seven sediment samples (PSS-1 through PSS-4 [1990] and HSD-1 through HSD-3 [1992]) to further define soil and groundwater contamination. Soil samples were not collected for laboratory analysis from the borings for monitoring wells HMW-1 through HMW-9. The ESE investigations also included soil gas analyses. The data from the 1990 to 1992 investigations indicated that the surface soils and drainage ditch sediment were impacted by volatile and semi-volatile organic compounds, while surficial groundwater was impacted by volatile organic compounds. The ESE investigations did not fully define the horizontal and vertical extent of contamination in the soils. The results of ESE assessment investigations are provided in *Final Significance of Contamination Report,* dated June 1993. Due to the presence of contaminants, ESE developed a closure plan to remediate the release of hazardous constituents in the soils (ESE 1994).

2.4.3 Source Removal Design (1995)

In December 1995, LAW conducted Source Removal Design Investigations at the former FTA. The objectives of the investigation were to acquire data to support a Source Removal Action Remedial Design for the fuel tanks, piping, concrete pad and contaminated soils and to further define the horizontal and vertical extent of soil and groundwater impacts. LAW installed four monitoring wells (HMW-10 through HMW-13) and seventeen soil borings (SB-01 through SB-17) to meet the objectives of the investigation.

The results of the investigation indicated soils contaminated with VOCs and SVOCs that exceeded Risk Reduction Standards (RRS) were present in the immediate area of the curbed concrete pad. The horizontal extent of the soils impacted by the concrete pad and fuel tanks had been delineated. Groundwater containing VOCs and SVOCs which exceeded RRS were present in the shallow groundwater to a depth of less than 35 feet below ground surface (bgs) in the surficial aquifer. The horizontal extent of groundwater contamination was not defined; however, the vertical extent of groundwater contamination was delineated. Measurable free-phase product was present in one monitoring well on-site (i.e., HMW-7). As previously stated (Section 1.0), a Pre-Final CSR was initially submitted to GA EPD to present the results of investigations conducted to date at the former FTA.

However, the GA EPD requested the Pre-Final CSR be withdrawn and be resubmitted to incorporate the 1998 removal activities that had been conducted.

2.4.4 Soil Remediation Activities (November 1997-March 1998)

Based upon the results of LAW's Source Removal Design investigation, Omega Environmental Services and its subcontractor, Geosciences, Inc., conducted soil remediation activities at the former FTA from November 1997 to March 1998. The soil remediation activities included the decontamination and removal of the simulated aircraft structure (i.e., steel tank), two aboveground storage tanks, underground fuel transmission lines, concrete pad, and sump pit structure. Soils, free-phase product, and wastewater were removed from the area and transported to off-site disposal facilities. The horizontal limits of the excavation are shown on Figure 2.3 and the depth of the excavation ranged from 5 to approximately 8 feet below ground surface. The remediation generated 9,430 tons of contaminated soils, 233 tons of demolished concrete debris, and 81,906 gallons of wastewater. A total of 27 confirmation soil samples were collected from the side walls and floor of the excavation and analyzed for RCRA metals; benzene, toluene, ethylbenzene, xylenes (BTEX); organochlorine pesticides; polychlorinated biphenyls (PCBs); and total petroleum hydrocarbons (TPH). Contaminated soils were excavated to a depth and lateral extent where the constituent concentrations were less than the HSRA Notification Concentrations. The confirmation soil samples indicated that constituents were still present in the soils beneath the excavation. The *Soil Remedial Action Report*, dated December 1998 presents the soil remediation activities in detail. Maps of the excavation and confirmation soil sampling locations, along with a summary of the laboratory analytical data of the confirmation samples is provided in Appendix B of this Revised Final CSR.

2.4.5 Separate Phase Hydrocarbon (SPH) Removal Activities (1999-Current)

The Installation began free product recovery with activation of a belt-skimmer at monitoring well HMW-7 in February 1999. Approximately 3 gallons of free product was removed by the belt-skimmer between February 1999 and October 1999. In October 1999, the Installation turned off the belt skimmer for a period of one week and measured free product levels in HMW-7. On October 7, 1999, 2.40 feet of free product was present in HMW-7. The system was initially running with a 45-minute rest/15-minute run cycle. In October 1999, the system was adjusted to a 15-minute run per 12-hour rest cycle and is currently operating at these standards. To monitor the effectiveness of the recovery system, six product delineation points were installed around HMW-7 on December 8, 1999 (Figure 2.3). Each point consisted of a 10-foot section of 0.01-inch slotted screen installed to a depth of approximately 8 feet below ground surface (bgs). The points were measured for the presence of product on December 15, 1999, February 24, 2000, March 3, 2000, and March 11, 2000. Free product was not encountered in any of the points.

2.4.6 1999-2000 CSR Investigation

From July 1999 to January 2000, LAW conducted additional CSR investigation of the soil and groundwater contamination at the former FTA. The CSR investigation was conducted to delineate the extent of previously detected HSRA- regulated substances in the soil and groundwater at the former FTA. The 1999-2000 CSR investigation included the advancement of 31 soil borings (SB-18 to SB-42 and HMW-14, HMW-14R to HMW-18) for soil sampling and installation of 8 monitoring wells (HMW-14, HMW-14R to HMW-20). A human and ecological exposure assessment was also conducted. The CSR investigation indicated that the extent of VOCs and SVOCs in soils was not complete on the north and/or south sides of the Site. The extent of pesticides, and PCB in soils was identified. The extent of VOCs in groundwater was not delineated on the north side of the Site. The extent of SVOCs and metals in groundwater was completed during the 1999-2000 CSR investigation. The soil and groundwater at the former FTA was evaluated not to be in compliance with Types 1 through 4 Risk Reduction Standards. The 1999-2000 data was presented in the CSR, dated March 31, 2000.

In response to the GA EPD comments on the CSR, additional soil and groundwater investigation was conducted to complete delineation of VOCs, SVOCs and metals in Site soils and VOCs in Site groundwater. The Revised Final CSR investigation included the advancement of nine soil borings (SB-43, SB-43A, SB-44 through SB-50) with soil sampling, the installation and sampling of two new monitoring wells (HMW-21 and HMW-22) and sampling of existing monitoring wells HMW-3 and HMW-14R. A soil background study was also conducted to calculate the upper background concentrations of metals in soils at the Site. A total of six surface water samples were collected and analyzed from the two ditches adjacent to the former FTA. The surface water sampling and a preliminary risk evaluation were conducted to demonstrate that contaminated groundwater was not impacting surface water in the two drainage ditches and impacting ecological receptors. The Revised Final CSR includes all of the data presented in the original CSR and the new data obtained in 2001.

2.5 DESCRIPTION OF EACH KNOWN SOURCE

Several regulated substances have been detected in the soil and groundwater at the former FTA. The majority of these regulated substances are associated with the fire-fighting training activities conducted within the former FTA. These activities included the storage and transmission of petroleum fuels at the site in aboveground storage tanks and in underground pipelines and the application of these fuels to the simulated aircraft structure as a fuel for the fire training activities. These components of the fire training area fuel application system may not have been structurally sound, and may have resulted in releases of fuels to soil and/or surficial groundwater (i.e., spillage during filling of aboveground storage tanks, leaking aboveground storage tanks, leaking underground pipelines, and/or leaking valves). In addition, the fire training pad was constructed with concrete curbs to contain the water and foam generated during fire fighting exercises. However, these curbs were not entirely effective in containing the fluids, which would occasionally spill over the curbs and flow onto the surrounding soil. As a result of the fluids (fuel and water) being released onto soils adjacent to the curbed concrete pad, it is probable that the impacted soils leached petroleum-related constituents into the surficial groundwater beneath the site. Thus, the site structures and/or the actual training activities have acted as a source of petroleum contamination to site soils and the surficial aquifer.

2.6 POTENTIALLY RESPONSIBLE PARTIES

The HSRA Rules require the name, address, and telephone number of any person(s) who may be a responsible party for the Site, and a description of the type and amount of regulated substances each party may have contributed to a release. The phrase "responsible party" is defined only as "a person who has contributed or who is contributing to a release." That phrase, as defined in O.C.G.A. § 12-8-92 and implemented through the application of principles of liability in O.C.G.A. § 12-8-96.1, implies a number of legal principles, defenses, and related definitions. The following entity is responsible for Site conditions:

U.S. ARMY
HQS 3D Infantry Division (Mechanized) and Fort Stewart
ENRD Environmental Branch (ATTN: Mr. Thomas C. Fry, Chief, ENRD)
Directorate of Public Works Bldg. 1137
1550 Frank Cochran Drive
Fort Stewart, Georgia 31314-4927
Phone: 912-767-2010

Based on the fact that only the U.S. Army used the Former FTA at HAAF, it is assumed that all identified contamination within the boundaries of the Site are related to activities conducted at the former FTA. Therefore, the U.S. Army assumes all (i.e., 100%) responsibility for the identified soil and groundwater contamination within the Site boundaries; however, it is noted that any activities conducted by the U.S. Air Force in this area prior to 1967 are not known, and if activities are identified in the future which can be shown to have resulted in site contamination within the boundaries of the Site, the U.S. Air Force may be pursued as a potentially responsible party.

3.0 ASSESSMENT ACTIVITIES

The field investigation and assessment activities for the Compliance Status Report (CSR) at the former FTA at HAAF were performed from July 1999 through February 2000. The field investigation and assessment activities for the Revised Final CSR were performed from October to November 2001. The assessment activities were conducted in accordance with the Final Work Plan Addendum for the Compliance Status Report, dated June 29, 1999, the Letter Work Plan-Modification No. 1, dated December 6, 1999 and the associated Revised Site Safety and Health Plan (SSHP) (LAW, 1999), Work Plan for Modification No. 4, dated October 2, 2001, and Addendum No. 1 to Final Site Safety and Health Plan, dated October 2001. Assessment activities consisted of field investigations, laboratory analyses, and data evaluation. The samples were analyzed following USEPA SW-846 procedures, and adherence to appropriate quality assurance/quality control (QA/QC) requirements. The activities conducted as part of the field investigations are listed below and are described in the following subsections:

- Soil investigation
- Groundwater investigation
- Surface water investigation
- Human and ecological exposure assessment and ecological preliminary risk evaluation

The field investigation activities consisted of advancing and sampling 40 borings, installing and developing 10 new monitoring wells, installing and sampling 8 temporary wells, and sampling 4 existing wells. The samples described in the following sections were collected and handled as described in Appendix C, CSR Field Procedures. Figure 2.3 presents the locations sampled during the CSR assessment activities.

3.1 SOIL INVESTIGATION

Due to the fact that analyses of soil samples obtained during previous investigations (see Section 2.4) indicated the presence of site-specific regulated substances in the soil and groundwater at the former FTA, additional assessment activities were conducted to define the horizontal and vertical extent of HSRA-regulated substances at the former FTA.

Soil investigation activities included the advancement and sampling of soil borings in four field events. The first field event consisted of the advancement of twelve soil borings (SB-18 through SB-29) and four monitoring well borings (HMW-14 through HMW-17) in July 1999. Two soil samples were collected from each location and analyzed for volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs). Additionally, soil samples collected from soil borings SB-22 through SB-27 were analyzed for pesticides and polychlorinated biphenyls (PCBs). Soil samples were collected from 0-2 feet below ground surface (bgs) to characterize surface soil contamination and from 2 feet above the water table to define the vertical extent of soil contamination.

Based on the HSRA-regulated constituents detected in samples collected during the July 1999 field event, eleven additional soil borings (SB-30 through SB-40) and four monitoring well borings (HMW-14R and HMW-18 through HMW-20) were advanced in January 2000. Soil borings SB-31, SB-32, and SB-33 required concrete coring prior to advancement. Two samples were collected from each boring and analyzed for various parameters based on defining the extent of previously detected constituents. Again, soil samples were collected from 0-2 feet bgs to define surface soil contamination and at least 2 feet above the water table to define vertical extent of soil contamination. Samples collected from within and to the east of the suspected former FTA boundary, (SB-31 through SB-34, SB-38 through SB-40) were submitted to the laboratory with a 48-hour notification of results to evaluate whether additional soil borings were required to define extent of contamination. Those borings located in the mature woodlands surrounding the site (SB-30, SB-35 through SB-37, HMW-14R, and HMW-18) were not anticipated to be contaminated due to site related activities and therefore, samples were submitted for standard data notification requirements.

After review of the 48-hour sample results, a third sampling event was required to define the extent of soil contamination. The third field event consisted of the advancement of two additional soil borings (SB-41 and SB-42) to define extent of SVOCs detected in the surface soil sample collected from SB-38. Two samples were collected from 0-2 and 2-3/3-5 feet bgs from each boring. The 0-2 foot bgs samples were analyzed initially for SVOCs and the deeper samples were held until results could be reviewed. Both surface soil samples did not contain SVOCs; therefore, extent of surface soil SVOC contamination had been defined and the deeper samples did not require analysis.

The fourth soil sampling event was conducted in October 2001 and was based on the analytical results of the 1999-2000 soil investigations and in response to the Georgia EPD comments on the CSR. Nine soil borings (SB-43, SB-43A, SB-44 through SB-50) were advanced for soil sampling and analysis to complete the delineation of previously detected VOCs, SVOCs, barium, and chromium in soils. Soil samples from borings SB-43, SB-44 and SB-46 were advanced on the north side of the Site to delineate VOCs and SVOCs in the subsurface soils. Two soil samples were collected from each boring, and were collected based upon being the soil sample with the highest photoionization detector response and the sample 2 feet above the water table. Soil boring SB-43A was advanced for the collection of a surface sample to confirm the detection of acetone previously detected in the surface soil at SB-43. A subsurface soil sample (2 to 4 feet) was collected from soil boring SB-47 to complete delineation of previously detected barium at soil boring SB-13. A subsurface soil sample (2 to 4 feet) was collected from soil boring SB-48 to complete delineation of previously detected chromium at soil boring HMW-11. Soil borings SB-45, SB-49, and SB-50 were advanced from 0 to 2 feet to complete delineation of previously detected SVOCs in the surface soils on the south side of the Site.

Soil samples were obtained as part of the CSR assessment activities using Geoprobe,® auger and/or hollow-stem augers with split-spoon sampler techniques. Tables 3.1 and 3.2 summarize the soil boring and soil sample data collected to date for the former FTA while the Soil Boring Logs for the CSR assessment activities are provided in Appendix D. The following sections provide a discussion of the soil sampling methodologies used during the CSR assessment activities.

3.1.1 Geoprobe® Sampling Activities

Twenty-nine surface and twenty-nine subsurface soil samples were collected using a Geoprobe® sampling device at the locations shown on Figure 2.3 (SB-18 through SB-40, HMW-14R, and HMW-14 through HMW-18). Soil samples were collected in four-foot intervals beginning at the ground surface, as shown on Tables 3.1 and 3.2 and discussed in Appendix C. Sampling continued until groundwater was encountered. The soil samples were logged in the field in accordance with the Unified Soil Classification System and were field-screened using a photoionization detector. To delineate the extent of potential contamination, soil samples were selected for laboratory chemical analysis based on depth of previously detected contaminants and depth of groundwater. Soil borings were filled with a bentonite/cement grout upon completion of soil sampling.

3.1.2 Concrete Coring Activities

Soil borings SB-31, SB-32, and SB-33 required concrete coring prior to advancement. The concrete coring was completed on January 3, 2000, two days prior to advancement of the soil borings. The concrete core was placed back in each hole and covered with an orange traffic cone until sampling. Once sampling began, the discarded cores (6" x 4") were contained in a 55-gallon drum and were disposed of at an appropriate storage facility, along with other general hardfill (concrete pad and steel posts from abandoned HMW-14) generated during the CSR investigation. Once the soil borings were complete, the coreholes were backfilled with minimum 4,000 psi concrete. The borings were advanced using a Geoprobe® sampling device as described in Section 3.1.1 and Appendix C.

3.1.3 Hand Auger Sampling Activities

Six surface soil sample and four subsurface soil samples from eight soil borings were collected using a hand auger at locations SB-41, SB-42, SB-43A, SB-45, SB-47 through SB-50 (Figure 2.3). Each hand auger boring was advanced to two to five feet bgs. Samples were obtained in the interval of 0 to 2 feet bgs and 2-3/3-5 feet bgs, as discussed in Appendix C. Hand auger borings were backfilled with native soil upon completion of soil sampling. As previously stated, the 0-2 foot bgs and 2-4 foot samples were analyzed.

3.1.4 Hollow-Stem Augers and Split-spoon Sampling Activities

One surface soil sample and five subsurface soil samples were collected using a split-spoon sampler from each of three soil borings (SB-43, SB-44, and SB-46) at locations shown on Figure 2.3. Each soil boring drilled with hollow-stem augers was advanced to the water table, approximately 12 feet bgs. Soil samples were collected in a split-spoon sampler on a continuous basis from the ground surface to groundwater. Samples were obtained for laboratory analysis at 0-2 feet bgs and in the vadose zone above the water table, as discussed in Appendix C. The soil samples were logged in the field in accordance with the Unified Soil Classification System and were field-screened using a photoionization detector. Soil samples were selected for laboratory analysis based on the depth of previously detected contaminants and field screening results. Soil boring SB-43 was completed as monitoring well HMW-21 and soil boring SB-46 was completed as monitoring well HMW-22. Soil boring SB-44 was filled with a cement/bentonite grout upon completion of soil sampling.

3.2 GROUNDWATER INVESTIGATION

The groundwater investigation at the former FTA consisted of an assessment of groundwater quality at and in the vicinity of the site, and measurement of existing hydraulic gradients. During previous investigations, groundwater data obtained from existing groundwater monitoring wells, located on and near the site, indicated the presence of VOCs, SVOCs, and arsenic, barium and lead. To further evaluate the vertical and horizontal extent of site-specific regulated substances in groundwater, nine single-cased (Type II) monitoring wells and eight temporary piezometers were installed as part of the CSR groundwater investigation.

The groundwater investigation activities occurred in three field events. In July 1999, six temporary piezometers (HMW-14, HMW-15, HMW-16A, HMW-16B, HMW-16C and HMW-17) were installed and sampled to determine monitoring well placement. Three of the six temporary piezometers (HMW-16A, HMW-16B, and HMW-16C) were used to determine the placement of monitoring well HMW-16 (Figure 2.3). The piezometers were sampled for BTEX on a 48-hour analytical turn-around time. Based on the results (located in Appendix F), monitoring wells were installed and developed. However, monitoring well HMW-14 did not contain sufficient water for development. It was later determined that HMW-14 was not representative of groundwater conditions and the well was abandoned and reinstalled as HMW-14R in the second field event, January 2000. In addition, monitoring wells HMW-15 and HMW-16 could not meet the development criteria of turbidity and were subsequently not sampled.

In order to fill data gaps encountered in the first groundwater field event (July 1999), two temporary piezometers (SB-38 and SB-40) were installed and sampled for VOCs and SVOCs on a 48-hour analytical turn-around time. Based on the analytical results from the piezometers (located in Appendix F), it was determined that the Site background "boundary" had been achieved; therefore, monitoring well HMW-19 was installed via overdrilling at SB-38 and HMW-20 was installed via overdrilling at SB-40. In addition, monitoring well HMW-18 was installed to determine Site boundaries to the south. The five newly installed wells (HMW-14R, HMW-17, HMW-18, HMW-19 and HMW-20), and two existing wells (HMW-2 and HMW-12) were sampled in January 2000 using low-flow sampling techniques. Existing well HMW-2 represents background and was sampled for lead, while the other wells (HMW-12, HMW-14R, HMW-17, HMW-18, HM2-19, and HMW-20) were sampled and analyzed for VOCs, SVOCs and specific metals (arsenic, barium and lead).

The third ground water field event was conducted in October and November 2001 and was performed to complete the delineation of VOCs previously detected in the groundwater on the north side of the Site. Monitoring wells HMW-21 and HMW-22 were installed to the northwest and northeast, respectively of existing monitoring well HMW-14R, where dichloroethenes had been detected in the groundwater. The newly installed wells (HMW-21 and HMW-22) were sampled in November 2001 using low-flow sampling techniques and analyzed for VOCs. Existing monitoring well HMW-14R was also sampled and analyzed for VOCs to confirm the analytical results from January 2000. Existing monitoring well HMW-3 was also sampled and analyzed for VOCs, SVOCs and eight RCRA metals in November 2001. This well is downgradient of the former FTA and screens a deeper portion of the uppermost aquifer. The analytical results for this groundwater sample were used to delineate vertical extent in groundwater.

Groundwater sampling and monitoring well construction data for the former FTA are summarized on Tables 3.2 and 3.3, respectively. Soil boring logs and monitoring well construction diagrams for the monitoring wells installed as part of the CSR assessment activities are provided in Appendix D. The following sections describe the activities conducted during the CSR assessment.

3.2.1 Temporary Piezometer Installation and Sampling

A total of eight temporary piezometers (SB-38, SB-40, HMW-14, HMW-15, HMW-16A, HMW-16B, HMW-16C, and HMW-17) were installed to assist in placement of permanent monitoring wells. The piezometers were constructed of a 1.0-inch diameter PVC screen and casing and were installed after each soil boring was advanced using a Geoprobe®. The temporary piezometer screen was 10 feet in length with a slot size of 0.010-inch. The temporary piezometers were sampled within 24 hours after installation using a peristaltic pump. The temporary piezometers were not immediately sampled in order to allow settlement of fines within the water column. The settlement of fines from the water sample would reduce the impact of turbidity on sample results. Locations SB-38, SB-40, HMW-14, HMW-15, HMW-16A, and HMW-17 were converted into monitoring wells by removing the temporary piezometer, overdrilling the soil boring and installing a monitoring well using procedures discussed in Section 3.2.2. As previously mentioned (in Section 3.2), placement of HMW-16 was based on the results of three piezometers (HMW-16A, B, and C). Location HMW-16A was selected because the analytical results from HMW-16A were non-detect and the location was believed to be the most representative of Site boundaries at the time. The remaining temporary piezometer locations (i.e., HMW-16B and HMW-16C) were abandoned using a cement/bentonite grout to ground surface after the casing and screen were removed.

3.2.2 Monitoring Well Installation and Development

Nine Type II monitoring wells were installed to define the horizontal and vertical extent of site-specific regulated substances in groundwater. The monitoring wells were installed via the hollow stem auger method using 6.25-inch inside diameter hollow stem augers. Based upon the current depth to groundwater and review of historical groundwater data, monitoring wells were installed to a depth of approximately 16 to 20 feet bgs. In general, the monitoring wells were installed such that approximately 7 feet of water would be available in the well.

The monitoring well screen interface was designed to enable ample groundwater for development and sampling and to accommodate increase in water level elevation consistent with seasonal fluctuations observed at the former FTA. In addition, the placement of the well screen (i.e., intercept the water table) will allow for detection of separate phase hydrocarbons in the monitoring wells, if present.

The monitoring wells were constructed of 2-inch diameter schedule 40 PVC screen and riser. Monitoring wells HMW-14 (later abandoned), HMW-15, HMW-16, and HMW-17 were constructed with a 10-foot length of 0.010-inch slotted screen and a 20/40-grain size sand pack. Due to the development problems encountered in July 1999 with these wells and based upon sand pack and screen size calculations, a 10-foot length of 0.006-inch slotted screen and 30/60-grain size sand pack was used to construct monitoring wells HMW-14R, HMW-18, HMW-19, HMW-20, HMW-21, and HMW-22. The remainder of each of the monitoring wells were installed in accordance with guidance set forth in U.S. Army Corps of Engineers document EM1110-1-4000, *Monitor Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites*. Each well was completed with a protective cover aboveground completion, a concrete surface seal, and bollards. Detailed installation techniques are described in Appendix C.

The monitoring wells were developed using the pump and surge technique by using a purge pump equipped with surge rings or a submersible pump with a surge block. Well development was completed at least 48 hours before sampling of each new monitoring well. The monitoring wells were developed until a minimum of five well volumes had been removed, less than 0.1 ft. of sediment remained at the bottom of the monitoring well, and pH, specific conductance, turbidity, and temperature measurements were stabilized. In addition, the monitoring wells were to be developed to below 5 nephelometric turbidity units (NTUs). Only HMW-18, HMW-19, and HMW-22 were developed to below 5 NTUs. Development was conducted on monitoring wells HMW-14R (7.5 hrs), HMW-15 (7.0 hrs), HMW-16 (13.5 hrs), HMW-20 (12 hrs) and HMW-21 (12 hrs) in an attempt to obtain 5 NTUs. Although the remaining development criteria were met, the 5 NTUs criteria could not be met for these wells. The final NTUs obtained in each well were:

- HMW-14R (15.8)
- HMW-15 (452)
- HMW-16 (19.1)
- HMW-17 (23.1)
- HMW-18 (3.57)
- HMW-19 (4.4)
- HMW-20 (45.5)
- HMW-21 (100.2)
- HMW-22 (0.34)

Based upon these results, monitoring well HMW-15 was not sampled. However, because the groundwater samples were to be collected via low-flow methodology, impacts to water quality due to turbidity in excess of 5 NTUs in the remaining wells would be minimized. Therefore, these monitoring wells could be sampled. Detailed development procedures are described in Appendix C.

3.2.3 Sampling of New and Existing Monitoring Wells

Groundwater samples were obtained from two existing (HMW-2 and HMW-12) and five new (HMW-14R, HMW-17, HMW-18, HMW-19, and HMW-20) monitoring wells in 2000. Monitoring well

HMW-16, which was placed based upon the analytical results from temporary piezometers HMW-16A, HMW-16B, and HMW-16C (see Section 3.2.1), was not sampled because elevated photoionization (PID) readings measured during development indicated that this location was not representative of Site boundaries as originally evaluated. Groundwater samples were obtained from two new monitoring wells (HMW-21 and HMW-22) and two existing monitoring wells (HMW-3 and HMW-14R) in 2001. After installation of the new monitoring wells and following well development, the groundwater levels in the wells were allowed to stabilize. Groundwater levels were then measured in each of the new and existing monitoring wells. The wells were then purged and sampled using the low-flow sampling techniques detailed in Appendix C and briefly described below.

Prior to sampling, the monitoring wells were purged until a minimum of 3 well volumes had been removed, and until pH, specific conductance, and temperature had stabilized. In addition, the wells were to be purged to 5 NTUs. Monitoring wells HMW-2, HMW-3, HMW-14R, HMW-18, HMW-19, and HMW-22 were purged to below 5 NTUs. However, these criteria could not be obtained for the remaining wells. The NTUs for the remaining wells were: HMW-12 (7.49), HMW-17 (9.56), HMW-20 (9.30) and HMW-21 (100.2). Based upon the turbidity results for these monitoring wells during purging, groundwater sampling continued because samples collected via low-flow methodology have shown that impacts to water quality (primarily metals) are minimal at turbidity values similar to those observed. Once the remaining parameters had stabilized, the monitoring wells were sampled using low flow sampling techniques with a stainless steel and Teflon bladder pump or a peristaltic pump and Teflon tubing, per U.S. Army Corps of Engineers guidance (EM200-1-3) and USEPA Region IV guidance.

Decontamination of the equipment was conducted in accordance with procedures set forth in U.S. Army Corps of Engineers guidance document EM200-1-3, *Requirements for the Preparation of Sampling and Analysis Plans* and are presented in Appendix C.

3.2.4 Well Abandonment

As previously discussed, HMW-14 was abandoned because the well was determined to not be representative of groundwater conditions at the site. HMW-14 was abandoned by removing the bottom well plug and filling the annular space with grout (injected through a tremie pipe) while removing the PVC well screen and risers. Well abandonment procedures were conducted in accordance with guidance set forth in U.S. Army Corps of Engineers document EM1110-1-4000, *Monitor Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites* and Georgia Water Well Standards. The well abandonment logs are provided in Appendix D.

3.3 SURFACE WATER SAMPLING

Six surface water samples (HSW-1 to HSW-6) were collected from the two drainage ditches that bound the former FTA (Figure 2.3). The surface water samples were collected to evaluate the impact of groundwater contamination on the drainage ditches and to provide data for the ecological preliminary risk evaluation. Samples were collected at the headwall of each ditch, at the midpoint of each ditch and near the confluence of the ditches. The surface water samples were collected by CESAS personnel on October 31, 2001 and submitted to Accura Analytical Laboratory in Norcross, Georgia for analysis for VOCs, SVOCs, and the eight RCRA metals. The surface water samples were collected by directly filling the sample container from the stream flow at each sample location.

3.4 SITE SURVEY

Following completion of CSR assessment activities, the monitoring wells, soil, and surface water sampling locations were surveyed for horizontal location and elevation. The horizontal locations of monitoring wells and sampling locations were surveyed to a horizontal accuracy of 1.0 foot. The top-of-casing elevations were surveyed to the nearest 0.01-foot. Coordinate values used were Georgia State Plane, East Zone, North American Datum of 1983 (NAD). Ground surface elevations for monitoring wells and soil sampling locations were surveyed to the nearest 0.1-foot. The National Geodetic Vertical Datum (NGVD) of 1929 was used as the reference datum for elevations. Existing monitoring wells that were sampled were surveyed for horizontal location and top-of-casing elevation. Previous survey data (LAW, 1995) were used for existing monitoring wells that were not sampled during the 2000 field event. The survey was conducted by Donaldson, Garrett & Associates, Inc., a state of Georgia licensed land surveyor. For soil borings SB-23 through SB-26, the location is approximate. Soil boring location stakes were not present at the time of the survey. However, field personnel indicated that soil borings SB-24 through SB-26 were advanced in the approximate planned locations, as shown on Figure 2.3. Soil boring location SB-23 was located (as shown on Figure 2.3) using tape and compass methods by incorporating existing surveyed monitoring wells (HMW-8 and HMW-3) as reference points.

3.5 EXPOSURE ASSESSMENT

An exposure assessment was conducted to collect data that identifies the human populations and ecological systems that are susceptible to contaminant exposure from the former FTA site. Information obtained during the exposure assessment was used to identify exposure scenarios for determination of the appropriate risk reduction standards. Activities completed to develop the exposure assessment include the following:

- Review of reports from previous investigations
- Review of photographs and topographic maps
- Electronic search for local climate and census data
- Literature and database search to identify protected species
- Interviews with facility personnel
- Literature and electronic search for background information for the facility

In addition, site reconnaissance visits of the Site and surrounding areas that may be potentially affected by releases occurring at the site were performed by LAW personnel.

An ecological preliminary risk evaluation was conducted at the former FTA. Under HSRA, potential impacts to natural resources such as surface water are to be considered when determining if corrective action is indicated. The HSRA Rules do not specify the scope of the resource evaluation. However, a facility-wide approach at Hunter AAF has been developed for RCRA sites. In order to maintain consistency with other sites at the Hunter AAF facility the approach used for the RCRA site has been applied to the former FTA. This approach is based on USEPA guidance for ecological risk assessment and follows the process outlined on Figure 3.1.

The Hunter AAF approach to ecological risk assessments (ERAs) is based on the guidance contained in the USEPA Region IV Bulletins: <u>Supplemental Guidance to RAGS, Ecological Risk Assessment</u> (USEPA, 2001) and USEPA's <u>Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments</u> (USEPA, 1997a).

Risk is the likelihood of experiencing adverse effects. The assessment of risk for ecological receptors at the former FTA at HAAF focuses on identifying and evaluating the potential for harmful effects on ecological receptors as a result of exposure to chemicals released to the environment.

The assessment of risk for ecological receptors at the former FTA is being conducted under a phased approach in accordance with ecological risk assessment guidance. The two phases are the:

- Ecological Preliminary Risk Evaluation (EPRE)
- Ecological Risk Assessment (ERA)

The EPRE compares measured concentrations of detected substances to conservative ecological screening values to identify substances detected at the former FTA that pose a potential hazard to ecological receptors.

According to EPD's SWMU Guidance (EPD, 1996), the risk assessment process terminates with the EPRE if there is no potential hazard or risk to ecological receptors. If contaminants are found to be potential hazards in the EPRE, then additional work may be required. Only those substances that are indicated to be potential hazards in the EPRE are evaluated as ecological constituents of potential concern (ECOPCs) in an ERA, if one is required.

The need for an ERA is a risk-management decision based on the nature and magnitude of risk to ecological receptors in the environmental setting of the former FTA. If risk managers decide an ERA is not required, then no further data are collected and the site is certified in accordance with information presented in the EPRE. Should an ERA be required for the former FTA, additional site-specific data collection should be considered to quantify exposure and evaluate effects (EPD, 1996). Appropriate site-specific data for ERAs include concentrations of contaminants in animals and plants (tissue residues) and toxicity testing (USEPA, 1997a). Remedial levels for protection of ecological resources are developed and proposed in the ERA for only those substances identified as environmental contaminants of concern in the ERA (EPD, 1996).

This section presents the methodology for conducting the EPRE for the former FTA at HAAF.

1. The ecological risk evaluation process consists of five steps:
2. Ecological screening value comparison,
3. Preliminary problem formulation,
4. Preliminary ecological effects evaluation,
5. Preliminary exposure estimate, and
6. Preliminary risk calculation.

These five steps correspond to the five steps of the USEPA Region IV EPRE (USEPA, 2001).

As shown in Figure 3.1, the first step of the EPRE (Step1) is to screen substances as ECOPCs by comparing the maximum detected concentration to appropriate ecological screening criteria. Those substances detected in surface water and groundwater are compared to the Georgia Instream Water Quality Criteria (DNR, 1999). Those substances detected in surface soil are compared to the surface soil ecological screening values (ESVs) from USEPA Region IV (USEPA, 2001). If no constituent criteria or ESV can be located for comparison, then that constituent is selected as an ECOPC. If no ECOPCs are identified based on these comparisons (Step 1), then no further evaluation of risk is required. If ECOPCs are identified based on the screening, then these constituents are evaluated further (Steps 2 through 5). These four steps of the EPRE represent a preliminary evaluation of the risk to ecological receptors from exposure to ECOPCs.

The preliminary problem formulation (Step 2) identifies categories of potential ecological receptors that occur at the former FTA and the categories of ECOPCs—the substances in surface water, groundwater, and surface soil (i.e., soil samples with a beginning depth of less than one foot below ground surface) that might pose a risk to ecological receptors in the environmental setting. Preliminary assessment endpoints, ecological receptors, and surrogate species that represent the ecological receptors are selected for evaluation in the preliminary risk calculations (USEPA, 2001).

The preliminary ecological effects evaluation (Step 3) identifies toxicity reference values (TRVs) for use in the preliminary risk calculation (USEPA, 2001). TRVs are average daily doses (ADDs) (milligram per kilogram [kg] of body weight per day) for the surrogate species that are derived from published laboratory toxicity studies.

The preliminary exposure estimate (Step 4) quantifies the potential exposure pathways for ecological receptors according to the preliminary assessment endpoints identified in Step 2. The exposure parameters and equations used to calculate ADDs are presented in Step 4. In addition, the exposure point concentrations for surface water, ground water, and surface soil are identified.

In Step 5, the preliminary risk calculation, a Hazard Quotient (HQ) is calculated for each constituent, receptor and exposure medium. The HQ is the ratio of the estimated ADD and the chemical-specific

TRV for the surrogate species. HQs are used to evaluate the risk to ecological receptors and to support risk management decisions about the need for further evaluation of the former FTA in an ERA.

Both terrestrial and aquatic habitats are present at the former FTA. Media of concern to ecological receptors are surface water and surface soil. Surface water and surface soil can be contacted or ingested directly by ecological receptors or through the ingestion of biota which have bioaccumulated site-related contaminants. Although not a medium of exposure for ecological receptors, groundwater is also evaluated because it can potentially discharge to surface water in the northern ditch line.

4.0 RESULTS OF THE INVESTIGATION

The investigations conducted by ESE and the CSR assessment activities conducted by LAW have provided information on the geology and hydrogeology of the Site and the nature and extent of soil and groundwater contamination of site-specific HSRA-regulated substances, which resulted from activities conducted at the former FTA. Results of the analytical data for samples collected and analyzed during the previous investigations are provided in Appendix A of this document. The following sections present the results of the CSR assessment activities.

4.1 REGIONAL GEOLOGY AND HYDROGEOLOGY

The Savannah area lies within the Atlantic Coastal Plain which consists of a thick wedge of variably consolidated sediments ranging in age from recent to Cretaceous. The sedimentary wedge thickens and slopes eastward at a dip angle of less than 1 degree. Basement rocks underlying the coastal plain in the Savannah area consist of consolidated metamorphic and sedimentary rocks of Triassic to Precambrian age, and crystalline igneous rocks of the Precambrian Piedmont Formation. The depth to the Precambrian basement rocks in the Savannah area is approximately 4,200 feet (Cramer and Arden, 1980). Sediments comprising the principal artisan and surficial aquifers at the site extend to a depth of approximately 850 feet. The units consist principally of sands and limestones of Eocene to Recent age.

The two principal aquifer systems of the Georgia Coastal Plain are the surficial (or water table) aquifer and the Floridian aquifer. The Floridian aquifer system is comprised of Middle to Upper Eocene limestones of the Ocala Group, and possibly undifferentiated Oligocene sandy clay units. The upper confining unit of the Floridian aquifer is comprised of the Middle and Upper Miocene Hawthorn Group and Duplin Marl. These units are comprised of clay with occasional limestone beds and provide hydraulic separation between the Floridian aquifer system and the overlying surficial aquifer. In the Savannah area, the top of the Floridian aquifer system occurs at approximately 200 feet bgs (ESE, 1993).

The Pleistocene to Recent deposits overlying the Miocene units consists of beds of sand, silt and clay. Development of the surficial aquifer occurs in beds and lenses of sand within these deposits. The typical water table depth in the Savannah area is approximately 3 to 10 feet bgs.

The Floridian aquifer system is the major groundwater source for the coastal plain of Georgia and adjacent states. The Floridian aquifer in Georgia provides the majority of water for industrial and domestic use (500 million gallons per day statewide in 1978). No usage of the surficial aquifer has occurred in the study area.

4.2 SITE GEOLOGY AND HYDROGEOLOGY

The topography of the former FTA averages approximately 30 feet above mean sea level (msl) and slopes gently west toward the Springfield canal. The canal flows southwest before emptying into the Little Ogeechee River floodplain.

A review of the United States Soil Conservation Service (SCS) Soil Map for Chatham County (Wiles, Johnson, et. al 1974) shows the soil at the site to be Chipley-Urban Land Complex and Ellabelle Loamy Sand. The Chipley complex occurs on broad ridges located in upland areas and is usually gently sloping. Chipley soils are dark grayish-brown fine sand with some silt and clay, very friable, with low organic material and a rapid permeability. The Ellabelle loam sand occurs in depressions and drainage ways and in poorly drained areas. The Ellabelle soils are light grayish-brown to gray to black clayey fine sand loam, very friable, with high organic material and moderate permeability.

Previous investigations conducted at or near the former FTA (ESE, 1993a; USAEHA, 1987) indicate that the geologic section consists predominantly of sand, silty sand, and lesser clayey sand deposits to a depth of at least 100 feet below ground surface (bgs). Shallow borings performed during the CSR and previous investigations indicated the surficial deposits at the former FTA consist predominantly of fine-grained sand to depths of at least 10 feet (USAEHA, 1987 and ESE, 1993).

The subsurface soil conditions encountered during this investigation and the previous investigations may be categorized into two general strata based on geologic and engineering characteristics. Figures 4.1 through 4.6 present the hydrogeologic profile locations and profiles for the former FTA. The upper zone soils extend from the surface to approximately 35 feet bgs and consist of gray to brown, medium to coarse-grained, loose to medium-dense silty sand, with interbedded layers of clayey sand and poorly graded sand. The sand contains approximately 6 to 13 weight-percent particles finer than No. 200 mesh.

The fines are generally nonplastic, and the soil is classified as silty sand (SM) according to Unified Soil Classification System (USCS). Moisture contents in the upper zone soils ranged from 36 to 40 percent.

For a typical clean, poorly graded sand as found in the upper zone, the estimated conductivity is between 2 x 10^{-2} and 2 x 10^{-4} ft/min (Peck, Hanson, and Thornburn, 1974). Slug testing results indicated a site-specific hydraulic conductivity of 1.8 x 10^{-3} ft/min as discussed in Section 4.2.2.

Lower zone soils begin at approximately 35 feet bgs and continue to approximately 100 feet bgs; the soils consist of gray, fine to medium-grained, loose to medium-dense, poorly graded sand. The sand contains approximately 2 to 3 weight-percent particles finer than No. 200 mesh. The soil is classified as poorly graded sand (SP) according to the USCS. Moisture contents in the lower zone soils ranged from 32 to 44 percent. For a typical loose to medium-dense, poorly graded sand as found in the lower zone, the estimated conductivity is between 2 x 10^{-2} and 2 x 10^{-4} ft/min (Peck, Hanson, and Thornburn, 1974). Slug testing results indicated a conductivity of 1.8 x 10^{-3} ft/min as discussed in Section 4.2.2.

Borings performed at the former FTA encountered the surficial aquifer water table at 8 feet bgs. The surficial aquifer's vertical extent has yet to be determined; however, Kundell (1978) reports that the surficial aquifer may be up to 120 feet thick in the study area.

4.2.1 Groundwater Gradients

Groundwater elevations were measured in the existing and newly installed monitoring wells on November 6, 2001. Table 4.1 summarizes the water level measurements and calculated groundwater surface elevations (potentiometric surface).

An evaluation of the horizontal and vertical groundwater gradients at the Site was performed using the November 2001 groundwater elevation data (Table 4.1) and the resulting potentiometric surface map depicted on Figure 4.7. Based on the potentiometric surface map for November 6, 2001, the horizontal gradient in the groundwater in the uppermost soil ranges from 0.01 to 0.05 feet per foot across the Site.

Groundwater elevations (Table 4.1) in the three Site monitoring well clusters HMW-1/ HMW-2, HMW-3/ HMW-4, and HMW-5/ HMW-6 were used to calculate the vertical groundwater gradients at the Site. The vertical groundwater gradients were calculated by dividing the difference in groundwater elevations in each well cluster by the distance between the bottoms of each well screen in the cluster (Table 3.3). The calculated vertical gradients ranged from 0.026 feet/foot (HMW-3/HMW-4) to 0.048 feet/foot (HMW-1/HMW-2). The shallow well in each cluster had a higher groundwater elevation than the deep well; thus indicating a downward gradient in each of the three well clusters.

4.2.2 Hydraulic Conductivity Measurements

The horizontal hydraulic conductivity was calculated for six wells located at the site. Table 4.2 summarizes the hydraulic conductivity values and the hydraulic conductivity calculations are provided in Appendix E. The hydraulic conductivity was measured using the "slug-test" method. The field data were analyzed using the method of Bouwer and Rice (1976 and 1989). The hydraulic conductivity ranged from 8 x 10^{-4} to 1.8 x 10^{-3} ft/min. There was very little differentiation in hydraulic conductivity between the fine to medium silty sand and the fine to medium sand. The highest hydraulic conductivity (1.8 x 10^{-3} ft/min.) was measured in well HMW-03 which is screened from 39 to 49 feet bgs (i.e., deep well). The hydraulic conductivity in the uppermost soil ranged from 8 x 10^{-4} to 1.5 x 10^{-3} ft/min. These hydraulic conductivity values fall within the range expected of silty to clean sands (Freeze and Cherry, 1979).

4.2.3 Groundwater Flow Rates

The minimum and maximum hydraulic conductivity values and the minimum and maximum horizontal hydraulic gradients were used to calculate an estimated velocity of horizontal groundwater flow beneath the site. An effective porosity for the saturated soil was assumed to be 20 percent (a reasonable estimate for sand) (Walton, 1970). The horizontal groundwater flow velocity was calculated using the Darcy velocity equation:

$$V = \frac{KI}{n_e}$$

Where:

K = Hydraulic Conductivity (feet/min)
I = Hydraulic Gradient (feet/foot)
n_e = Effective Porosity

	Minimum	Maximum
Hydraulic Conductivity (feet/min)	8×10^{-4}	1.5×10^{-3}
Hydraulic Gradient (feet/foot)	0.01	0.05
Effective Porosity: 0.20		

Using the stated assumptions and estimations, an approximate horizontal flow velocity of from 21 to 197 feet per year was calculated.

4.2.4 Summary of Groundwater Flow Movement Across the Site

The groundwater elevations (Table 4.1 and Figure 4.7) indicate that the flow of groundwater in the upper surficial aquifer across the Site is to the west. Consistent with the surface features, the two ditches that bound the site area are likely groundwater discharges along the southern and northern boundaries of the Site. Presently, due to the extended drought conditions in the region, only the southern drainage ditch and a portion of the northern drainage ditch appear to be creating a groundwater discharge. Groundwater appears to be flowing beneath the western end of the northern drainage ditch.

4.3 NATURE AND EXTENT OF REGULATED SUBSTANCES

The nature and extent of soil and groundwater contamination of site-specific HSRA-regulated substances at the former FTA were characterized by obtaining surface soil (0 to 2 feet bgs), subsurface soil (greater than 2 feet bgs), and groundwater samples. Groundwater samples were collected from monitoring wells that screen the uppermost aquifer. Based on historical site operations (Section 2.2), the presence of fuel constituents (lead, TPH, BTEX, and PAHs) can be attributed to former site activities. The presence of chlorinated solvents was reported as possible based on conversations with Installation personnel (personal communication, USAEHA, 1993), although their use on-site is not supported by available documentation. The presence of other organic and inorganic constituents in the mature woodland areas north and south of the site is likely related to the concrete and asphalt fill material used to build up the area around the former FTA rather than an impact from actual fire-fighting training activities. It should be noted that PAHs are the primary constituents of asphaltic materials as well as fuel constituents. It is because of this condition that PAHs detected in sample locations in the mature woodlands are not considered related to the former fire training activities. Constituents previously analyzed for, but not detected, or determined not to be related to past site activities were not analyzed during the 1999/2000 CSR investigation.

Acetone, methylene chloride, phthalates and trichlorofluoromethane were detected in soil samples collected from the Site. These constituents are common laboratory artifacts and may have been introduced during laboratory preparation and analysis. However, review of available quality control data did not indicate laboratory contamination. Acetone is found in paints and thinners, used as a cleaning solvent or can be produced upon the acidification (with sodium bisulfate) of soil (USACE, 1999). Methylene chloride is a commonly used extraction solvent. Phthalates are components of plastics and may be introduced into environmental media via leaching with solvents. Trichlorofluoromethane is used as a coolant for air conditioners and refrigerators and may have been introduced into the soil samples during storage in laboratory refrigerators. Because trichlorofluoromethane was only detected in soil samples by ESE in 1992, and is not indicative of fire training activities, possible contamination of samples during storage is likely. The presence of these compounds detected in samples is believed to be laboratory artifact or indicative of the concrete/asphalt construction debris fill materials present at the Site. Therefore, the focus of the 1999/2000 CSR assessment activities was the complete delineation of arsenic, barium, lead, VOCs and PAHs in groundwater, and VOCs, PAHs, barium, chromium, organochlorine pesticides, and PCBs in soils. As required by the Georgia EPD January 2001 comments, the 2001 CSR assessment activities for soils included the delineation of the previously detected acetone, methylene chloride, and phthalates along with VOCs, SVOCs, barium, and chromium. The 2001 CSR assessment activities for ground water were focused on VOCs.

Concentrations of regulated substances detected in surface and subsurface soil samples collected during the CSR assessment activities conducted in 1999 to 2001 are summarized in Tables 4.3 and 4.4. Concentrations of regulated substances detected in groundwater samples collected during the CSR activities and previous investigations are summarized in Table 4.5. Figures 4.8A, 4.8B, 4.8C, 4.9A, 4.9B, 4.9C, 4.10, and 4.11 present the distribution and extent of site-specific regulated substances detected in surface and subsurface soil. Figure 4.12 presents the distribution and extent of site-specific regulated substances detected in groundwater.

4.3.1 Background Concentrations

Soil

During the course of the investigation of the former FTA, 63 soil samples were obtained and analyzed for RCRA metals (arsenic, barium, cadmium, lead, mercury, nickel, selenium and silver). Since there was no known release of metals at the Site, it could not be determined which, if any, of the samples were representative of a release, and which were representative of background conditions. Therefore, a statistical evaluation which initially considered all of the available soil metals data was performed.

The soils data was first evaluated for identification of statistical outliers. The Grubbs Outlier test referenced in USEPA Statistical Analysis of Ground Water Monitoring Data at RCRA Facilities, dated April 1989 and ASTM E178-75 was used to determine the outliers. Normally, outlier data points are left in the data set and are statistically evaluated with the other data points. To be conservative in the evaluation of the metals in soil at the HAAF former FTA site, the outliers were removed from the data set prior to the statistical analysis. If a data point was an outlier for one metal, it was removed from all of the metals data sets. Six samples which displayed statistical outliers for any metal were removed from the data sets for all metals. The outliers removed from the data set are listed below.

BH-10 (0-1 ft)	Barium concentration outlier
BH-11 (0-1 ft)	Arsenic and Lead concentration outliers
BH-13	Arsenic, Lead, and Mercury concentration outliers
BH-13 (0-1 ft)	Lead concentration outlier
FTASB-11 (SB-11) (0.5-1)	Barium concentration outlier
HMW-13 (8-10 ft)	Chromium concentration outlier

Sample locations BH-10, BH-11, BH-13, and SB-11 are located within the area where fuels were used in fire training exercises which is considered to be a source area.

A statistical evaluation was then performed on the remaining data after the outliers had been removed. Statistical methods were selected based on the distribution of the data and the number of non-detects. The data were evaluated for normality using the Filliben, Shapiro-Francia, and Shapiro-Wilk tests. Log-normal data sets (arsenic, barium, chromium, lead, and selenium) were logarithmically transformed. Upper background concentrations (UBCs) were then selected on the transformed data using the mean plus 1.645 standard deviations. A non-parametric analysis was then performed on the remaining data sets that did not normalize by log transform (cadmium, mercury, and silver) and were assigned a UBC equal to the maximum observed value. In the case of mercury, the maximum observed value (0.40 mg/kg in sample BH-12) exceeded the UBC for arsenic, lead, selenium, and silver. Therefore, the next highest maximum observed value (0.39 mg/kg in sample BH-13) was selected as the mercury UBC. The statistical evaluation yielded UBCs for each of the eight metals analyzed and are listed below. The statistical plots and statistical calculations used to select UBCs for each of the eight metals are included in Appendix H.

Metal	UBC (mg/kg)	Statistical Method	HSRA Table 2, Appendix III Values
Arsenic	2.6	Log-normal data Mean + 1.645 std. Dev	20
Barium	28	Log-normal data Mean + 1.645 std. Dev	1000
Cadmium	2.6	Non-Parametric, Max observed value	2
Chromium	7.7	Log-normal data Mean + 1.645 std. Dev	100
Lead	53	Log-normal data Mean + 1.645 std. Dev	75
Mercury	0.39	Non-Parametric, Max observed value	0.5
Selenium	1.9	Log-normal data Mean + 1.645 std. Dev	2
Silver	2.6	Non-Parametric, Max observed value	2

As indicated above, the UBC for arsenic, barium, chromium, lead, mercury, and selenium are below the HSRA Table 2, Appendix III values (which are based on GAEPD's estimate of statewide background). The UBCs were then used to evaluate where metals concentrations exceeded background and if the extent of metals could be delineated using the existing data. The results of the evaluation indicated that most of the exceedences of the background concentration (i.e., UBCs) were within the excavated area and areas immediately adjacent to the excavated area. The evaluation also indicated that the extent of the metals in soils was not completely delineated to the north and west of the excavated area. Additional delineation for chromium was conducted to the north of HMW-13 and to the west of HMW-11, for barium to the west of SB-13 (Figure 4.11).

Groundwater

Background groundwater samples from off-site locations were not collected during the 1999/2000 CSR assessment activities. However, review of previous groundwater analytical data collected during 1995 indicated that VOCs, PAHs, and metals (except barium) were not detected in groundwater samples collected from wells HMW-1 (deep) and HMW-2 (shallow). Barium was detected at 0.042 mg/L in well HMW-1 and 0.095 mg/L in well HMW-2 during the 1995 sampling event; however, it should be noted that sampling was performed using a Teflon® bailer and not low-flow sampling devices. Since these wells were located hydraulically upgradient from the former FTA, wells HMW-1 and HMW-2 are considered representative of background conditions for groundwater at the Site.

4.3.2 Surface Soil Sampling and Analyses

A summary of the laboratory analyses of surface soil samples collected during previous investigations is provided in Appendix A. The laboratory analytical reports for the surface soil samples collected during the CSR assessment activities are provided in Appendix F. A summary of HSRA-regulated substances detected in surface soil samples collected during the CSR assessment is provided in Table 4.3. The following text summarizes the results from both the previous investigations and the CSR assessment. Please refer to Section 4.3 for an explanation of the potential sources of these substances.

Laboratory analyses of the surface soil samples indicated the presence of four VOCs (acetone, tetrachloroethene, toluene, and trichlorofluoromethane) at concentrations greater than their respective practical quantitation limits (PQLs). The number of detections, the maximum concentrations detected, and the location in which the maximum concentration was detected for site-specific VOC regulated substances in surface soil samples are presented below:

Constituent	**No. of Detections**	**Maximum Concentration Detected (mg/kg)**	**Location**
Acetone	8	0.17	HMW-16
Tetrachloroethene	1	0.0061	SB-18
Toluene	1	0.021	SB-06
Trichlorofluoromethane	3	0.014	PSB-1

Laboratory analyses of the surface soil samples also indicated the presence of 17 SVOCs reported at concentrations greater than their respective PQLs. Included are the following regulated substances: acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, bis(2-Ethylhexyl)phthalate, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene. The number of detections, the maximum concentrations detected, and the location in which the maximum concentration was detected for site-specific SVOC regulated substances in surface soil samples are presented below:

Constituent	**No. of Detections**	**Maximum Concentration Detected (mg/kg)**	**Location**
Acenaphthene	1	1.7	SB-38
Acenaphthylene	7	3.6	HMW-16
Anthracene	8	7.5	HMW-16
Benzo(a)anthracene	15	34	HMW-16
Benzo(a)pyrene	15	26	HMW-16
Benzo(b)fluoranthene	17	28	HMW-16
Benzo(g,h,i)perylene	12	14	HMW-16
Benzo(k)fluoranthene	10	27	HMW-16
bis(2-Ethylhexyl)phthalate	1	0.39	HMW-12
Chrysene	16	33	HMW-16
Dibenzo(a,h)anthracene	4	3.9	SB-27
Fluoranthene	17	72	HMW-16
Fluorene	2	3.9	SB-38
Indeno(1,2,3-cd)pyrene	11	16	HMW-16
Naphthalene	1	0.53	SB-38
Phenanthrene	8	39	SB-38
Pyrene	16	49	HMW-16

Laboratory analyses of the surface soil samples also indicated the presence of two pesticides (dieldrin and methoxychlor) reported at concentrations greater than their respective PQLs. The number of detections, the maximum concentrations detected, and the location in which the maximum concentration was detected for site-specific pesticide regulated substances in surface soil samples are presented below:

Constituent	No. of Detections	Maximum Concentration Detected (mg/kg)	Location
Dieldrin	3	0.043	SB-27
Methoxychlor	1	0.14	SB-26

PCBs were not detected in the surface soil. Metals were detected in the surface and subsurface soils. The metals detected at concentrations greater than background concentrations in surface soils were arsenic, barium, cadmium, chromium, lead, and mercury. The number of detections and detections greater than background, the maximum concentrations detected, and the location in which the maximum concentration was detected for site-specific metals in the surface soil samples are presented below:

Constituent	No. of Detections	No. of Detections Greater than Background	Maximum Concentration Detected (mg/kg)	Location
Arsenic	25	5	13.9	BH-11
Barium	25	5	69	SB-11
Cadmium	15	1	3.87	BH-13
Chromium	26	3	14.7	SB-10
Lead	23	6	1185	BH-13
Mercury	18	3	0.79	BH-13

As presented on Figure 4.8A, the extent of HSRA-regulated VOCs in surface soils is defined along the eastern, southern, western, and northern Site boundaries by surface soil samples collected from the following locations:

<u>Boundary</u>	<u>Monitoring Wells/Borings Comprising Boundary</u>
Eastern	SB-20, SB-31, SB-33, SB-34
Southern	SB-35, SB-36, HMW-18, SB-25
Western	SB-38/HMW-19, SB-39, SB-40/HMW-20
Northern	PSB-5, SB-21, HMW-14R, SB-30

Figure 4.8B shows the contoured concentrations of total VOCs concentrations in surface soils within the non-detect line for VOCs for surface soils at the site. The contoured map was requested by GA EPD.

As presented on Figure 4.9A, the extent of HSRA-regulated SVOCs in surface soils is defined along the eastern, western, southern, and northern Site boundaries by surface soil samples collected from the following locations:

Boundary	**Monitoring Wells/Borings Comprising Boundary**
Eastern	SB-20, SB-16, SB-18, HMW-17, SB-50
Southern	SB-45, SB-49, HMW-18, SB-37, SB-42
Western	SB-41, HMW-15
Northern	PSB-5, SB-21, HMW-14R, SB-30

Figure 4.9B shows the contoured concentrations of total SVOCs concentrations in surface soils within the non-detect line for SVOCs for surface soils at the site. The contoured map was requested by GA EPD.

As depicted on Figure 4.10, the extent of HSRA-regulated pesticides and PCBs in surface soil is defined within the eastern, southern, western, and northern Site boundaries by surface soil samples collected from the following locations:

Boundary	**Monitoring Wells/Borings Comprising Boundary**
Eastern	EB-H8, EB-I8, SB-32 (PCBs only), SB-33 (PCBs only), SB-34 (pesticides only)
Southern	SB-36, HMW-18
Western	SB-37, SB-24,
Northern	SB-23, EB-G6, EB-G8

Due to the sporadic presence of pesticides in the surface soil and the absence of PCBs in the surface soil, the combined Site boundary for pesticides and PCBs was selected using results that reflected the most conservative location (pesticide or PCB result) in each direction away from the former FTA.

As presented on Figure 4.11, the extent of RCRA metals in the surface soils is defined along the eastern, southern, western, and northern Site boundaries by surface soil samples collected from the following locations:

Boundary	**Monitoring Wells/Borings Comprising Boundary**
Eastern	SB-04, SB-16, SB-06, SB-17
Southern	HMW-12, HMW-10
Western	PSB-2, SB-14, PSB-3
Northern	PSB-5, SB-43/HMW-21

4.3.3 Subsurface Soil (>2 feet bgs) Sampling and Analyses

A summary of the laboratory analyses of subsurface soil samples collected during previous investigations is provided in Appendix A. The laboratory analytical reports for the subsurface soil samples collected during the CSR assessment activities are provided in Appendix F. A summary of HSRA-regulated substances detected in subsurface soil samples collected during the CSR assessment is provided in Table 4.4. The following text summarizes the results from both the previous investigations and the CSR assessment. Please refer to Section 4.3 for an explanation of the potential sources for these substances.

Laboratory analyses of the subsurface soil samples indicated the presence of 12 VOCs at concentrations greater than their respective PQLs. Included are the following regulated substances: acetone, benzene, 2-butanone, chlorobenzene, chloromethane, cis-1,2-dichloroethene, trans-1,2-dichloroethene, ethylbenzene, methylene chloride, toluene, trichlorofluoromethane, and xylenes (total). The number of detections, the maximum concentrations detected, and the location in which the maximum concentration was detected for site-specific VOC regulated substances in subsurface soil samples are presented below:

Constituent	No. of Detections	Maximum Concentration Detected (mg/kg)	Location
Acetone	16	27	HSB-5
Benzene	8	18	SB-10
2-Butanone	3	15.1	HSB-5
Chlorobenzene	1	0.007	SB-11
Chloromethane	1	39	HSB-5
cis-1,2-Dichloroethene	1	0.27	HMW-14R
trans-1,2-Dichloroethene	1	0.013	HMW-14R
Ethylbenzene	11	120	SB-10
Methylene chloride	1	0.0067	HSB-6
Toluene	8	16	SB-12
Trichlorofluoromethane	3	0.012	PSB-2
Xylenes (total)	10	310	HMW-13

Laboratory analyses of the subsurface soil samples also indicated the presence of 20 SVOCs at concentrations greater than their respective PQLs. Included are the following regulated substances: acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, dibenzo(a,h)anthracene, diethyl phthalate, di-n-butylphthalate, 2,4-dinitrotoluene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene. The number of detections, the maximum concentrations detected, and the location in which the maximum concentration was detected for site-specific SVOC regulated substances in subsurface soil samples are presented below:

Constituent	**No. of Detections**	**Maximum Concentration Detected (mg/kg)**	**Location**
Acenaphthene	2	2.3	SB-30
Acenaphthylene	5	6.6	SB-30
Anthracene	3	5.7	SB-30
Benzo(a)anthracene	6	18	SB-30
Benzo(a)pyrene	6	20	SB-30
Benzo(b)fluoranthene	6	13	SB-30
Benzo(g,h,i)perylene	6	12	SB-30
Benzo(k)fluoranthene	3	13	HMW-16
Bis(2-Ethylhexyl)phthalate	9	2.0	SB-10
Chrysene	7	20	SB-30
Dibenzo(a,h)anthracene	3	4.2	SB-30
Diethyl phthalate	1	0.2	BH-12
Di-n-butylphthalate	3	2.4	BH-12
2,4-Dinitrotoluene	1	0.65	SB-14
Fluoranthene	12	24	HMW-16
Fluorene	8	3.7	SB-30
Indeno(1,2,3-cd)pyrene	6	11	SB-30
Naphthalene	12	79	SB-10
Phenanthrene	11	19	SB-30
Pyrene	12	26	SB-30

Laboratory analysis of the subsurface soil samples indicated the presence of three pesticides and one PCB at concentrations greater than their respective PQLs. These pesticides and PCBs were detected in the confirmatory soil samples collected during the source removal investigation and include dieldrin, 4,4-DDD, 4,4-DDE, and PCB-1254. The number of detections, the maximum concentrations detected, and the location in which the maximum concentration was detected for site-specific pesticide/PCB regulated substances in subsurface soil samples are presented below:

Constituent	No. of Detections	Maximum Concentration Detected (mg/kg)	Location
Dieldrin	1	0.01	EW-L5A
4,4'-DDD	8	0.015	EB-L5
4,4'-DDE	7	0.024	EB-L5
PCB-1254	2	0.081	EW-L8B

Laboratory analysis of the subsurface soil indicated the detection of six metals of which only four metals were detected at concentrations greater than background. The metals detected at concentrations greater than background include arsenic, barium, chromium, and lead. The number of detections and detections greater than background, the maximum concentrations detected, and the location in which the maximum concentration was detected for site-specific metals in the sub surface soil samples are presented below:

Constituent	No. of Detections	No. of Detections Greater than Background	Maximum Concentration Detected (mg/kg)	Location
Arsenic	31	2	3.94	BH-13
Barium	36	2	38.4	PSB-7
Chromium	37	1	31.7	HMW-13
Lead	21	2	107	PSB-7

As presented on Figure 4.8A, the extent of HSRA-regulated VOCs in subsurface soils is defined along the eastern, southern, western, and northern Site boundaries by subsurface soil samples collected from the following locations:

Boundary	**Monitoring Wells/Borings Comprising Boundary**
Eastern	SB-20, HSB-1, SB-31, SB-33, SB-34
Southern	SB-35, SB-36, HMW-18, SB-25
Western	SB-38/HMW-19, SB-39, SB-40/HMW-20, PSB-5, SB-21
Northern	SB-43/HMW-21, SB-44, SB-46/HMW-22

Figures 4.8C shows the contoured concentrations of total VOCs concentrations in subsurface soil within the non-detect line for VOCs for subsurface soils at the site. The contoured map was requested by GA EPD.

As presented on Figure 4.9A, the extent of HSRA-regulated SVOCs in subsurface soils is defined along the eastern, southern, western, and northern Site boundaries by subsurface soil samples collected from the following locations:

Boundary	**Monitoring Wells/Borings Comprising Boundary**
Eastern	SB-20, HSB-1, SB-16, SB-18, HMW-17
Southern	SB-35, SB-36, HMW-18, SB-37
Western	SB-38/HMW-19, SB-24, HMW-15
Northern	PSB-5, SB-21, SB-43/HMW-21, SB-44, SB-46/HMW-22

Figure 4.9C shows the contoured concentrations of total SVOCs concentrations in subsurface soil within the non-detect line for SVOCs for subsurface soils at the site. The contoured map was requested by GA EPD.

As presented in Figure 4.10, the extent of HSRA-regulated pesticides and PCBs in subsurface soils is defined along the eastern, western, northern, and southern site boundaries by subsurface soil samples collected from the following locations:

Boundary	**Monitoring Wells/Borings Comprising Boundary**
Eastern	EB-H8, EB-I8, SB-32 (PCBs only), SB-33 (PCBs only)
Southern	SB-34 (pesticides only), SB-27, SB-26
Western	SB-25, SB-24
Northern	SB-23, EB-G6, EB-G8

Due to the sporadic presence of pesticides and PCBs in the subsurface soil, the combined Site boundary for pesticides and PCBs was selected using results that reflected the most conservative location (pesticide or PCB result) in each direction away from the former FTA.

As presented on Figure 4.11, the extent of RCRA metals in the subsurface soils is defined along the eastern, southern, western, and northern Site boundaries by subsurface soil samples collected from the following locations:

Boundary	**Monitoring Wells/Borings Comprising Boundary**
Eastern	SB-04, HSB-1, SB-16, SB-06, HSB-5
Southern	SB-17, HMW-12, SB-48, SB-47
Western	PSB-2, SB-14, PSB-3
Northern	PSB-5, SB-46/HMW-22

Subsurface soil contamination was detected at depths ranging from 2 to 10 feet bgs across the Site. The vertical profile of soil contamination is shown on hydrogeologic profiles A-A' through E-E' (Figures 4.2 through 4.6). At a majority of locations with contamination present in the subsurface soil, the groundwater surface was encountered prior to collection of a non-detect subsurface soil sample. Therefore, the vertical extent of soil contamination at the Site is generally defined by the depth to the groundwater surface.

4.3.4 Groundwater Sampling and Analyses

A summary of the groundwater quality data obtained during previous investigations conducted at the Site is provided in Appendix A. The laboratory analytical reports for the groundwater samples collected during the CSR assessment activities are provided in Appendix F. Several of the groundwater monitoring wells installed during the previous investigations have been sampled on several occasions since their installation in the mid-1980s. It should be noted that the validity of some of the historical analytical data reported by the laboratories is questionable due to the lack of available quality control data. In addition, groundwater samples collected from previous investigations (prior to 2000 sampling) did not utilize low-flow sampling techniques.

Therefore, the historical data was used qualitatively to identify the regulated substances assessed in the CSR. However, only the most recent sampling results were considered in determining the distribution and extent of regulated substances present in the groundwater at the Site. Laboratory analyses of the groundwater samples indicated the presence of 15 HSRA-regulated substances at concentrations greater than their respective PQLs. A summary of regulated substances detected in groundwater samples collected at the Site is provided on Table 4.5.

Horizontal Delineation

The distribution and extent of HSRA-regulated substances present in the groundwater at the Site are shown on Figure 4.12 based on the presence of arsenic, barium, chromium, lead, naphthalene, and VOCs. As shown on Figure 4.12, the highest concentrations of benzene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, ethylbenzene, vinyl chloride, 1,1-dichlorethene, naphthalene, arsenic, barium, and chromium were detected north of the area of the removed storage tanks and fire test pad in monitoring wells HMW-13, HMW-14R, and HMW-21. These wells are located in a side-gradient flow direction from the storage tanks and fire test pad. Vinyl chloride and lead were detected at the highest concentrations in well HMW-6. Monitoring well HMW-6 is located south of the fire training pad and in a side-gradient flow direction from the fire test pad. Vinyl chloride has been detected once in HMW-6 in 1995. The groundwater flow direction from the area where the aboveground storage tanks, underground pipelines and the fire test pad containing the simulated aircraft structure (source areas) is from the east to the west toward the western drainage ditch. The monitoring wells (HMW-6, HMW-14R, and HMW-21) containing the chlorinated VOCs (cis-1,2-dichloroethene, trans-1,2-dichloroethene, vinyl chloride, and 1,1-dichlorethene) are located to the north (HMW-14R and HMW-21) and south (HMW-6) of the source areas and are sidegradient to the groundwater flow direction from the source areas (Figure 4.7). Monitoring wells HMW-9 and HMW-13 which are located between the source area and monitoring wells HMW-14R and HMW-21 do not contain chlorinated VOCs (Figure 4.12) which may indicate that the chlorinated VOCs in the groundwater may not be originating from the former FTA source area. Furthermore, chlorinated VOCs have not been detected in soil samples collected from the source area. Cis-1,2-dichloroethene and trans-1,2-dichloroethene have only been detected in soils immediately above the groundwater at the HMW-14R location where chlorinated VOCs were present in the groundwater. Vinyl chloride has not been detected in Site soils. Based on this data, the chlorinated VOCs in the groundwater may be associated with another source to the north and not associated with the former FTA Site.

The number of detections, the maximum concentrations detected, and the location in which the maximum concentration was detected for site-specific regulated substances in groundwater samples are presented below:

Constituent	No. of Detections	Maximum Concentration Detected (mg/l)	Location
Acetone	1	0.021	HMW-13
Benzene	5	0.322	HMW-13
1,1-Dichloroethene	1	0.0016	HMW-21
cis-1,2-Dichloroethene	2	0.95	HMW-14R
Trans-1,2-Dichloroethene	2	0.033	HMW-14R
Ethylbenzene	3	0.0864	HMW-13
Vinyl chloride	3	0.011	HMW-6
Xylenes (total)	3	0.378	HMW-11
Napthalene	3	0.121	HMW-13
2,4-Dimethylphenol	1	0.01	HMW-13
Arsenic	3	0.031	HMW-6
Barium	2	0.131	HMW-13
Chromium	1	0.046	HMW-13
Lead	1	0.0188	HMW-13

As depicted on Figure 4.12, the horizontal extent of site-specific regulated substances in groundwater is defined along the eastern, southern, and western Site boundaries by groundwater samples from the following monitoring wells:

Boundary	Monitoring Wells/Borings Comprising Boundary
Eastern	HMW-2, HMW-17
Southern	HMW-12, HMW-18
Western	HMW-19, HMW-20

The extent of groundwater contamination is partially defined along the northern Site boundary by groundwater samples collected from monitoring wells HMW-21 and HMW-22. The extent has been defined for each analyzed compound except cis- and trans-1,2-dichloroethene, 1,1-dichloroethene and vinyl chloride, which were detected in wells HMW-14R and HMW-21 during the CSR assessment. Cisand trans-1,2-dichloroethene were previously detected in monitoring well HMW-14R during the 1999/2000 CSR assessment. 1,1-Dichloroethene (HMW-21) and vinyl chloride (HMW-14R and HMW-21) were detected for the first time along the northern boundary during the 2001 CSR assessment. These four chlorinated solvents have not been historically detected at the Site, except vinyl chloride, which was detected once in monitoring well HMW-6 during a 1995 sampling event. Although a possible source for solvents at the former FTA has been indicated, it has not been deemed verifiable through documentation. The information from each of these sampling locations, along with groundwater flow direction and site topography, was used to establish the horizontal extent of groundwater contamination (Figure 4.12).

Vertical Delineation

The distribution and extent of site-specific-regulated substances present in the groundwater at depth are shown on Figures 4.2 to 4.6. Deeper monitoring wells HMW-1, HMW-3, and HMW-5, screened at 40 to 50 feet bgs and located to the east, south and west of the fire training pad were non-detect for regulated substances. Monitoring well HMW-3 was sampled for VOCs, SVOCs and RCRA metals during the 2001 CSR assessment. VOCs and SVOCs were not detected above the PQL nor were the RCRA metals detected at concentrations greater than background in this well. Monitoring well HMW-3 is downgradient of the former FTA. Therefore, Therefore, although the presence of downward vertical gradients suggest migration could occur, the type of substances detected and the absence of substances at depth in the groundwater suggest the groundwater contamination is limited to the uppermost aquifer.

4.3.5 Surface Water Sampling and Analysis

A summary of the water quality data from six surface water samples obtained from the two drainage ditches that bound the south and west sides of the former FTA is provided in Appendix F. The analytical results are summarized on Table 4.6 and the sampling locations are shown on Figure 4.12. The surface water samples were analyzed for VOCs, SVOCs and RCRA metals. Surface water sample HSW-1, located at the headwall of the western drainage ditch contained benzene, ethylbenzene, toluene, total xylenes and naphthalene at concentrations above the laboratory reporting limit. The detected concentrations are below the Georgia In-Stream Water Criteria. Other SVOCs and RCRA metals were not detected above the laboratory reporting limits in sample HSW-1. This surface water sample was collected from a drain pipe that collects surface water runoff from the runway to the north of the former FTA and is likely not representative of runoff and groundwater discharge from the former FTA. VOCs, SVOC, and RCRA metals were not detected above the laboratory reporting limits in the remaining five surface water samples (HSW-2, HSW-3, HSW-4, HSW-5 and HMW-6). The surface water quality data indicates that the surface water in the drainage ditches bounding the former FTA is not being impacted by the contaminated groundwater at the former FTA.

5.0 RESULTS OF THE RECEPTOR STUDY

An exposure assessment has been performed for the former FTA site at HAAF, Georgia. The exposure assessment was performed in a manner consistent with the U.S. Environmental Protection Agency's Guidelines for Exposure Assessment (57 Federal Register 104:22888-22938) and Risk Assessment Guidance for Superfund (USEPA, 1989) and is designed to fulfill requirements specified in Section 391-3-19.06(3)(b)4 of the HSRA Rule.

5.1 PURPOSE AND OBJECTIVES

The purpose of this exposure assessment is to briefly present a description of the former source area and provide an evaluation of the potential human health and environmental exposures at the former FTA site. The exposure assessment identifies potential receptors and pathways of exposure.

5.2 SITE DESCRIPTION

HAAF is located in the southwestern portion of Savannah and covers approximately 5,400 acres. The mission of the facility is to provide command, control, training, administration, logistical and civilian-military support to non-divisional units stationed at Fort Stewart. HAAF is the home of the Army's longest runway at 11,000 feet and is able to accommodate even large aircraft such as the C-5 Galaxy. Aircraft based at HAAF currently include combat, transport, and training helicopters. The airfield is also used for overseas mobilization of troops and weapons.

The former FTA site is located on the northwestern portion of HAAF, west of the parking apron and runway and 800 feet northwest of the air control tower. The site has not been used for fire training or any other purpose since 1991. The site formerly included a cubed concrete pad covered with gravel and sand, which was used for fire training activities. Fuels used for fire training were stored in a 17,000-gallon aboveground storage tank that was located 112 feet due north of the fire training pad. During training exercises, fuel was pumped through an underground line to the pad. Reportedly, water-contaminated JP-4 and diesel fuels were used for training exercises (Law, 1995). The pad and tank areas were the source areas for the contamination detected in soil and groundwater. However, these source areas underwent extensive remediation in 1998.

5.2.1 Physical Site Characteristics

The former FTA site is a mixture of evergreen and deciduous plant species, typical to the marshy woodlands of the Coastal Plains. The eastern portion of the site (i.e., the former FTA) is a maintained grassy meadow. The western portion consists of mounds containing asphalt and construction debris. Dense shrubs and a mixture of immature and mature trees cover this mounded area. Two densely vegetated man-made drainage ditches lie to the north and south of the site and contain free-flowing water. These ditches receive drainage both from the parking apron and the site itself. The two ditches join on the western edge of the site and discharge to the Springfield Canal (Figures 2.2 and 2.3). Areas of mature hardwood and evergreen forest are located north and south of the two drainage ditches.

Topography at the site gently slopes toward the Springfield Canal that is located 3,600 feet to the west. The Springfield Canal flows southwest before emptying to the Little Ogeechee River. Five and a half miles downstream of HAAF, the Little Ogeechee River is classified, according to the Georgia Water Use Classifications and Water Quality Standards, as a water "generally supporting shellfish" (GA EPD, 1999). Because of the distance between the former FTA and the Little Ogeechee River, the compounds detected in the soil and groundwater at the site are not expected to have an adverse impact on shellfish resources.

5.2.2 Land Use

HAAF is expected to continue in its current role as an adjunct military facility to Fort Stewart. The facility, as a whole, is gated and fenced. Therefore, it is, primarily, military personnel or military contractors who have access to the former FTA site. According to sources at HAAF, there are no future development plans for the former FTA area (Personal communication, 2000).

5.2.3 Demographics

The city of Savannah, with a total population of 137,560, is the closest population center (U.S Bureau of the Census, 1990). HAAF has a daytime population of approximately 12,500 which reportedly includes 4,283 active duty officers and enlisted personnel, 7,485 family members, and 736 civilian employees (Army Allotment, 2000).

On-post, there are 488 family housing units and 1,928 unaccompanied enlisted units. The majority of base housing is located 1.3 to 1.8 miles northeast of the site (Figure 2.2). Many HAAF families live off-post in nearby communities including Savannah, Garden City, and Richmond Hill.

HAAF has a medical clinic (i.e., Tuttle Clinic) with limited services, so most family members of active and retired military personnel utilize Winn Army Community Hospital at Fort Stewart or municipal hospitals in the Savannah area. There is an on-post day care center that serves up to 200 children. Schools are located off-post. Recreational facilities include bowling, golf, gymnasiums, swimming pools, fishing, and a campground, the Lotts Island Army Air Field Travel Camp, which is located on the Little Ogeechee River (Famnet, 2000; Army Allotment, 2000).

5.3 POTENTIAL RECEPTORS AND PATHWAYS OF EXPOSURE

The following section describes the current and future human and ecological receptors present at the site and potential pathways for exposure to site constituents.

5.3.1 Human Receptor Evaluation

The most likely receptor groups are maintenance workers that periodically mow or bush-hog the site or utility workers who install or repair underground utilities. Both of these groups may have direct contact with surface and near surface soil. Potentially complete pathways of exposure to soil include incidental ingestion, dermal absorption, and inhalation of fugitive dust and volatile emissions. Because the ditch banks are heavily vegetated, contact with ditch surface water and sediments is not expected to be a notable source of exposure for humans.

A review of available water-supply well data from the United States Geological Survey for the HAAF area shows 27 water-supply wells are within a three-mile radius of the former FTA. HAAF is listed as having nine wells with usage including agricultural, public and military. A total of three wells are less than one mile from the former FTA area, one well is at SCL Railroad Shops, and two wells are on HAAF. All 27 wells have depths greater than 150 feet bgs. Table 5.1 summarizes the water-well survey data with distances and directions.

Hunting of deer, turkey, and small game is allowable at HAAF, but is subject to post regulations and access is restricted during training activities (GA DNR, 2000). Hunters or fishermen are not expected to be present at the former FTA because of its proximity to the airfield and because other more favorable areas are readily available.

5.3.2 Ecological Receptor Evaluation

Ecological receptors may include a variety of small to medium-sized mammals including mice, rats, rabbits, foxes, skunks, raccoons, squirrels, bats, shrews and opossums. Avian species may include bluejays, crows, wrens, cowbirds, cardinals, swifts, doves, and other species typical to the Coastal Plains. Reptilian and amphibian species may include a variety of frogs, toads, salamanders, newts, sirens, lizards, skinks, turtles, and snakes (The Audubon Society, 1977, 1979, 1980; Burt and Grossenheider, 1976; Conant and Collins, 1991). Terrestrial species may have contact with shallow soil during feeding and burrowing activities. Terrestrial species may also ingest surface water. Riparian and aquatic species may come into dermal contact with or ingest surface water and sediment. Predator species may be exposed via accumulation of site constituents within the food chain.

A list of protected animal and plant species occurring in the vicinity of HAAF is provided on Table 5.2. Known rare species and natural community locations are available to the quarter- quadrangle level from the Georgia Natural Heritage Program Database System (GNHP, 1999). Table 5.2 includes data for the following quadrangles:

- Garden City, GA
- Burroughs, GA
- Savannah, GA – SC

In the vicinity of HAAF, five animal and three plant species were identified as threatened or endangered.

5.4 ECOLOGICAL PRELIMINARY RISK EVALUATION

At the request of EPD, an ecological preliminary risk evaluation (EPRE) was conducted at the former FTA. The EPRE was performed to demonstrate that the detected substances in the soil, groundwater and surface water were not posing a potential hazard to ecological receptors potentially present at the site.

The following sections describe the findings and results of the EPRE. Figure 3.1 presents the steps followed in conducting the EPRE. Tables 5.3 through 5.15 present the comparison of detected substances to ecological screening criteria.

5.4.1 Ecological Screening Value Comparison

To identify ECOPCs in water, concentrations in surface water or groundwater were compared to the Georgia Instream Water Quality Criteria. If the maximum detected concentration of a surface water or groundwater constituent exceeded Instream Water Quality Criteria, then the constituent was selected as an ECOPC and further evaluated. If no ECOPCs were identified during the screening process, then the media was not considered further during the EPRE.

Detected surface soil concentrations were compared to the USEPA Region IV Soil ESVs. When maximum detected concentrations of constituents exceeded the screening criteria, these constituents were selected as ECOPCs and evaluated in the EPRE, Steps 2 through 5. The results of the five steps of the EPRE are presented below.

Ecological screening criteria are provided in Table 5.3 for the substances detected in surface water, groundwater, and surface soil at the former FTA. For analytes without criteria, screening values are proposed based on surrogate analytes with similar properties, structures, and toxicity. Screening values are conservative to prevent elimination of any contaminant that might pose ecological risk. If no data are available to support the development of criteria or an ESV for an analyte, the analyte is an ECPOC by default (USEPA, 1997a).

The results of the screening value comparisons for surface water, groundwater, and surface soil are presented in Tables 5.4, 5.5, and 5.6, respectively. The maximum detected concentrations in samples from the former FTA are used to select for ECOPCs for potential receptors.

The results of the Georgia Instream Water Quality Criteria (GIWQC) comparison for surface water are presented in Table 5.4. The ECOPCs identified by the criteria comparison for surface water were total xylene and naphthalene. There are no surface water criteria for either of these constituents, thus the constituents are ECOPCs by default (USEPA, 1997a).

The results of the GIWQC comparison for groundwater are presented in Table 5.5. The ECOPCs identified by exceedences of the criteria for groundwater were benzene, chromium, and lead. No criteria are available for acetone, cis-1,2-dichloroethene, trans-1,2-dichloroethene, total xylenes, 2,4-dimethylphenol, naphthalene, and barium; these constituents are ECOPCs by default (USEPA, 1997a).

The results of the ESV comparison for surface soils are presented in Table 5.6. Chromium was the only metal detected in surface soils and did not exceed the HAAF facility background concentration for the former FTA at HAAF. The ECOPCs identified by exceedences of the ESVs for surface soil were acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene, indeno(123-cd)pyrene, naphthalene, phenanthrene, pyrene, and dieldrin. There are no ESVs for acetone and methoxychlor; therefore, these constituents are ECOPCs by default (USEPA, 1997a).

5.4.2 Preliminary Problem Formulation

The preliminary problem formulation identifies categories of potential ecological receptors and the substances that may pose a risk to those receptors in the environmental setting of the former FTA. Preliminary assessment endpoints, ecological receptors, and the surrogate species representative of ecological receptors are selected for evaluation in the preliminary risk calculation.

GAEPD (1996) specifies that the EPRE develop "risk characterization for a model ecological receptor." Development of risk characterization for multiple ecological receptors, such as mammals and birds, is allowable for sites at which more than one type of potentially hazardous chemical is detected (USEPA, 1997a). Characterizing the risk to multiple receptors can make the EPRE more protective of ecological resources because one receptor type may be more sensitive to one or more chemical contaminants than another receptor. The risk characterization for surface water, ground water, and surface soil at the former FTA considers representative species of both mammals and birds as ecological receptors.

5.4.2.1 Environmental Setting

The principal habitat types present at the former FTA are managed grassland and neighboring forestland. Managed grasslands are found at the former location of fire training activities and extend north and south to the drainage ditch in either direction. Managed grasslands are typified by planted grass of one or more species maintained by mowing, application of fertilizers, etc. Common fauna includes earthworms and other soil-dwelling invertebrates, birds such as robins, and mammals, such as shrews, rabbits, and raccoons. The former FTA beyond the ditchlines and within the isolated tree island between the northern and southern ditchlines consists mainly of mixed hardwood bottomland forest with a few interspersed pines. Characteristic flora of this habitat type includes long-leaf pine (*Pinus palustris*), loblolly pine (*P. taeda*), sweetgum (*Liquidambar styraciflua*), blackgum (*Nyssa sylvatica*), live oak (*Quercus virginiana*), Southern red oak (*Q. falcata*), white oak (*Q. alba*), water oak (*Q. nigra*), and magnolia (*Magnolia sp.*). Saw-palmetto (*Serrenoa repens*) and honeysuckle (*lonicera sp.*) are commonly found as two of several understory plants. Fauna includes a wide variety of birds, mammals, and reptiles. Common species include white-tailed deer (*Odocoileus virginianus*), wild turkey (*Meleagris gallopavo*), and gray squirrels (*Scurius carolinensis*). These descriptions are based on observations made by LAW personnel during a site visit conducted in January 2002.

The principal surface water body receiving drainage from the former FTA are the drainage ditches to the north and south which flow to the west toward Springfield Canal located 3,600 feet to the west. Aquatic environments are found along the northern and southern drainage ditches at the former FTA. At HAAF, these aquatic environments characteristically contain aquatic plants, water cresses and pondweed. These water plants were observed along the southern drainage ditch, but no aquatic plants were noted along the northern drainage ditch. Observed fauna consist of amphibians, reptiles, and birds. Fauna could include fish and aquatic invertebrates, although none were noted during the January 2002 site visit. Both sets of ditchline banks are maintained by "bush hog" and are comprised predominantly of emergent grasses.

These drainage ditches may serve as drinking holes for terrestrial animals and potentially as breeding locations for insects and amphibians. These ditches have a shallow water flow of 2 to 6 inches under normal conditions but swell during rain events as they assist in draining the northern and southern end of the runways which are located just across Lightning Road. These drainage ditches, especially the southern ditchline, have had concrete and asphalt waste placed on both sides of the banks to prevent erosion. These ditches are generally vegetated with grasses and are periodically mowed. In the ecological preliminary risk evaluation for the former FTA, surface water and groundwater samples were evaluated as a source of drinking water and aquatic biota for terrestrial mammals.

5.4.2.2 Surface Water and Ground Water

The EPRE for the former FTA evaluated the potential for risk to ecological receptors from exposure to surface water or ground water (e.g., which potentially emerges as surface water in the northern drainage ditch). For surface water and ground water, the identical ecological receptor and surrogate species are used to evaluate the potential risk over the identical exposure pathways.

The ecological receptors that are potentially exposed to substances in surface water or groundwater after it has discharged to surface water are aquatic plants and animals, terrestrial animals that come in direct contact with or ingest surface water, and those animals ingesting aquatic biota that live in the ditchlines or potentially drink from ditchlines. Terrestrial predators of aquatic biota, such as fish-eating birds and mammals, are not likely to be exposed to contaminants in surface water or groundwater, through ingestion of aquatic prey because no minnows, small fish, or invertebrates were noted during the January 2002 site visit. The ditchlines start on the former FTA site and are fed by underground culverts from the flightline area.

Based on the ECOPCs, the habitat, and the potential exposure pathways at the former FTA, the proposed ecological receptors for surface water and groundwater are aquatic biota, such as fish and amphibians, and terrestrial animals. Terrestrial animals are potentially exposed via ingestion of surface water or discharged groundwater and of aquatic biota that have bioaccumulated substances in their tissues.

The preliminary assessment endpoints for surface water and groundwater at the former FTA are protection of the long-term health and reproductive success of:

- Aquatic biota,
- Terrestrial mammal populations, and
- Benthic-eating mammals

No additional evaluation of the aquatic biota assessment endpoint was included because the Georgia Instream Water Quality Criteria and USEPA Region IV ESVs for surface water are the only reasonable published values that might serve as surface water TRVs, and there are no additional adjustments to exposure (i.e., body weight) for aquatic biota. The results of the ESV comparison for surface water and groundwater, adequately, identify the ECOPCs for aquatic biota at the former FTA.

The surrogate species to represent the terrestrial ecological receptors exposed to sediment is the short-tailed shrew (*Blarina blevicauda).* The surrogate species to represent the benthic-eating ecological receptors exposed to surface water and groundwater is the raccoon (*Procyon lotor*). Raccoons are found at the HAAF and potentially obtain food from drainage ditches and other aquatic habitats. The raccoon is common to the coastal plain of Georgia. Raccoons drink water from shallow surface water bodies and ingest more water per unit body weight than do larger mammals such as the white-tailed deer (*Odocoileus virginianus*): 0.082 gram per gram per day (USEPA, 1993) versus 0.065 gram per gram per day (Sample and Suter, 1994). Raccoons are opportunistic feeders, which will ingest aquatic biota, like benthic macroinvertebrates, clams, mollusk, etc. Thus, the life history and behavior of this species ensures a conservative estimate of risk in accordance with current ecological guidance.

5.4.2.3 Surface Soil

The EPRE for surface soil (0 foot to 1 foot) at the former FTA evaluates the potential for risk to ecological receptors from ECOPCs. The categories of ecological receptors that are potentially directly exposed to substances in surface soil at the former FTA are soil bacteria and fungi, vegetation, and animals that come in direct contact with or ingest soil (e.g., soil-dwelling invertebrates). Herbivorous invertebrates (e.g., insects) and vertebrates (e.g., birds and mammals) are potentially indirectly exposed when they ingest vegetation growing in contaminated soil. Carnivorous animals are potentially exposed when they ingest animals directly or they are exposed indirectly to contaminated soil due to dermal contact or incidental ingestion.

The proposed ecological receptors for the surface soil at the former FTA are carnivorous small mammals and birds that prey upon soil-dwelling invertebrates. These receptors are proposed because many of the substances detected in soil samples potentially biomagnify in soil-dwelling invertebrates (e.g., lead and pesticides). In general, there are also greater amounts of published data on the effects of these substances on mammals and birds than there are for other vertebrate wildlife such as reptiles and amphibians.

The preliminary assessment endpoint for surface soil at the former FTA is protection of long term health and reproductive success of small mammals and bird populations. The surrogate species to represent the generic small mammal and bird receptors are the short-tailed shrew (*Blarina brevicauda*) and the American robin (*Turdus migratorius*), respectively. The home range of the shrew is small, and robins are territorial during the spring-mating season. Earthworms and other soil-dwelling invertebrates represent a large percentage of both species' diets. The life history and behavior of these two surrogate species ensure a conservative estimate of risk.

5.4.3 Preliminary Ecological Effects Evaluation

The preliminary ecological effects evaluation identifies TRVs for use in the preliminary risk calculation. As described below, TRVs are derived from no observed adverse effects levels (NOAELs) observed during laboratory toxicity studies on test species. In the former FTA EPRE, TRVs were required for raccoons ingesting contaminated water and contaminated biota from drainage ditches and shrews and robins ingesting contaminated biota exposed to surface soil at the former FTA. The derivation of TRVs for the surrogate species is described below.

First, chronic NOAELs for test species were derived from published chronic or subchronic NOAEL or lowest observed adverse effects level (LOAEL) benchmarks for the test species exposed to the substance in controlled laboratory studies. The derivations of NOAELs for mammals and birds are shown in Tables 5.7 and 5.8, respectively. If a chronic NOAEL was not available for a contaminant, a chronic NOAEL was estimated from a subchronic NOAEL by dividing by an uncertainty factor of 10 (Sample, Opresko, and Suter, 1996). Published LOAELs might be used to derive a NOAEL by dividing the LOAEL by a conservative uncertainty factor of 10 (USEPA, 2001). Subchronic LOAELs were divided by an uncertainty factor of 100 to estimate a chronic NOAEL.

Most NOAELs and LOAELs for test species were those reported in Sample, Opresko, and Suter (1996). Some NOAELs were found in published toxicity studies or other risk assessments. In some cases, if neither a NOAEL or LOAEL was available for a contaminant, the benchmark for a related compound was used as a surrogate. The chronic NOAELs for PAHs for birds were derived from Shortelle et al. (1997), as cited in QST (1997).

The estimated bird NOAEL for pyrene reported in QST (1997) was used as the chronic NOAEL for the test species. Shortelle et al. (1997), as cited in QST (1997), used linear regression of NOAELs for chemicals for which there are benchmark values for both mammals and birds published in Opresko, Sample, and Suter (1995) to predict the bird NOAEL for SVOCs for which there were mammal data but no bird data. These predicted NOAELs are for a "composite" bird with a body weight equal to the average of all bird test species for the NOAELs used in the regression.

Once the published and estimated NOAELs for test species were identified or derived as described above, they were used to derive NOAELs for the former FTA surrogate species, as described below, and these derived NOAELs were used as the TRVs in the EPRE.

Chronic NOAELs for test species of the same taxonomic class as the surrogate species were adjusted for the body weight of the surrogate species to derive TRVs for the surrogate species. That is, mammal test species data were used for mammal surrogate species, and bird test species data were used for bird surrogate species. NOAELs for test species based on ADDs (milligrams per kg per day) were adjusted to the surrogate species based on body weight, according to the following equation:

$$\text{surrogate species NOAEL} = \text{test species NOAEL} \times (\text{BWt/BW})^{\text{CONV}},$$

where BWt and BW are the body weights (kg) of the test species and surrogate species, respectively, and where conv = 0.25 for mammals and conv = 0 for birds (Sample, Opresko, and Suter, 1996). For example, the published NOAEL for a chemical might be based on data for a 0.35-kg rat. The NOAEL for a 0.022-kg field mouse would be nearly two times larger than the rat NOAEL. The calculated NOAELs for the surrogate species were the TRVs used in the EPRE. The TRVs for the short-tailed shrew and the raccoon are presented on Table 5.9 and the TRVs for the American robin are presented on Table 5.10

5.4.4 Preliminary Exposure Estimate

For shrews and robins, which are indirectly exposed by ingestion of biota, the maximum detected concentration of each analyte in the 0-foot to 1-foot interval of surface soil samples from the former FTA were used as exposure point concentrations to calculate the maximum ADDs.

The ADD to shrews and robins from substances in surface soil was calculated as the product of the maximum detected concentration, the unitless soil-to-invertebrate bioaccumulation factor (BAF_i), and the daily specific food ingestion rate (IR) of the receptor. That is,

$$\text{ADD (mg/kg/d)} = \text{max. soil concentration (mg/kg)} \times \text{BAF}_i \times \text{IR (kg/kg/d)}.$$

For raccoons, which are directly exposed by ingestion of surface water and are indirectly exposed by ingestion of aquatic biota (i.e., such as benthos), the maximum detected concentration of each analyte in surface water samples was used as the exposure point concentration to calculate the maximum ADDs. The maximum detected concentration of each analyte in samples from the former FTA monitoring wells were used as the exposure point concentration to calculate the maximum ADDs for raccoons, directly or indirectly exposed to groundwater potentially discharging to surface water. This is a very conservative approach as no mixing or dilution is assumed.

The ADD to raccoons by ingestion of substances in surface water and groundwater was calculated as the product of the maximum detected concentration for water, the unit conversion factor (0.001 microgram per milligram), and the daily specific water ingestion rate (IR_{RW}) of the receptor, together with the product of the maximum detected concentration for food, the unitless bioconcentration factor (BCF) for the contaminant in fish tissue, and the daily specific food ingestion rate (IR_{RF}) of the receptor.

$$\text{ADD (mg/kg/d)} = \text{max. water concentration (mg/L)} \times IR_{RW} \text{ (L/kg/d)} + \text{max. water concentration (mg/L)} \text{ x } \text{BCF x } IR_{RF} \text{ (kg/kg/d)}$$

The exposure parameters for raccoons exposed to ECOPCs in surface water or groundwater and shrews and robins exposed to substances in surface soil are presented below:

Exposure Parameters for Surrogate Species

	Surrogate Species		
Parameter	**Shrew**	**Robin**	**Raccoon**
Body weight (kg)	0.015[a]	0.077[a]	3.99[b]
Food ingestion rate (kg/kg/d)	0.53[c]	0.21[c]	0.053
Water ingestion rate (L/kg/d)	–	–	0.08[b]
Area use factor	1	1	1
Home Range	3 acres	1 acre	385 acres
Relative bioavailability	100 percent	100 percent	100 percent
Diet	100 percent earthworm	100 percent earthworm	100 percent aquatic biota

Exposure Parameters for Surrogate Species

Parameter	Surrogate Species		
	Shrew	**Robin**	**Raccoon**
Source medium	Surface soil	Surface soil	Surface water; groundwater

[a] Sample, Opresko, and Suter (1996), Table B.1.

[b] USEPA 1993

[c] Converted from values reported as kg per day in Sample, Opresko, and Suter (1996) by dividing by body weight (kg)

– Not required for preliminary risk calculations

The exposures of surrogate species were estimated using conservative assumptions. It was assumed that the receptors spend their entire lives and obtain 100 percent of their diet or drinking water at the former FTA [i.e., the area use factor equals one]. Shrews and robins were assumed to eat only soil-dwelling invertebrates such as worms that bioaccumulate contaminants from soil, in accordance with USEPA Region IV requirements that the screening be based on exposure through two trophic transfers (USEPA, 1997a). Raccoons were assumed to drink only water from the ditchlines at the former FTA and to eat only aquatic biota from the drainage ditches. Chemicals in surface soil were assumed to bioaccumulate in the soil-dwelling invertebrate prey of ecological receptors at levels equal to published bioaccumulation factors (BAFs) for earthworms and other invertebrates as reported in Hazardous Waste Remedial Actions Program (HAZWRAP, 1994). Chemicals in surface water and groundwater were assumed to bioaccumulate in aquatic biota at levels equal to published BCFs for fish (HAZWRAP, 1994).

5.4.5 Preliminary Risk Calculation

The preliminary risk calculation uses HQs, the ratio of the maximum ADD to the TRV, to evaluate the potential for risk. The HQs of ECOPCs with consistent modes of toxicity and effects endpoints are added to produce an HI. An HI greater than one for a category of ECOPCs is a useful indicator of potential risk when no individual ECOPC in that category has an HQ greater than one. An HI assumes that the effects of the individual ECOPCs in the category are additive. Metals are assumed to have distinct modes of toxicity and effects endpoints. Therefore, HIs are calculated only for VOCs, SVOCs, and pesticides/PCBs when no individual ECOPC has an HQ greater than one and when HQs are calculated for more than one chemical.

Because of the uncertainties in quantifying exposure and effects, the exposure and effects assessments were designed to produce HQs that minimized the probability of falsely concluding that there was no risk when in fact there was. Therefore, ECOPCs with HQs less than one indicated little to no likelihood of risk to the ecological receptors. To minimize the probability of falsely concluding there was risk when there was none, HQs were also generated using average concentrations. If the average concentration HQ exceeded one, then an ERA using site-specific data for those ECOPCs with calculated HQs exceeding one was recommended (EPD, 1996).

Surface Water. The preliminary risk calculations for raccoons exposed to ECOPCs detected in surface water are presented in Table 5.11. This table shows the maximum detected concentrations, ADDs, TRVs, and HQs for the raccoon.

The only two ECOPCs present in surface water were naphthalene and total xylenes. Neither of these compounds resulted in ADDs exceeding the TRVs for the surrogate species. No HIs were calculated since one compound is a VOC and the other an SVOC.

Groundwater. The preliminary risk calculations for raccoons exposed to ECOPCs detected in groundwater are presented in Table 5.12. This table shows the maximum detected concentrations, ADDs, TRVs, and HQs for the raccoon.

One ECOPC, xylene, at a maximum ground-water concentration resulted in an ADD that exceeded the TRV for the surrogate species. The HQ for the raccoon associated with xylene in groundwater is 2.5. The cumulative HIs calculated for raccoons do not exceed one, except the HI for VOCs which equals 2.6. An HI was not calculated for RCRA metals in groundwater because they are assumed to have dissimilar mechanisms of toxicity.

The supplemental risk evaluations for raccoons exposed to xylene and other VOCs in groundwater are presented in Table 5.13. The ADDs calculated using the average groundwater concentration do not exceed TRVs (HQs less than 1 and the HI for VOCs is less than one). Xylene in groundwater is, therefore, unlikely to pose a risk to wildlife receptors.

Surface Soil. The preliminary risk calculations for shrews and robins exposed to ECOPCs detected in surface soil are presented in Table 5.14. This table shows the maximum detected concentrations, ADDs, TRVs, and HQs for the short-tailed shrew and American robin.

No ECOPCs present in surface soil at maximum concentrations resulted in ADDs exceeding their respective TRVs. The cumulative HIs calculated for VOCs and pesticides did not exceed one. However, the SVOC cumulative HI for the short-tailed shrew was equal to 2.7.

The supplemental risk evaluations for short-tailed shrews exposed to SVOCs in surface soils are presented in Table 5.15. The ADDs calculated using the average surface soil concentrations do not exceed TRVs (HQs less than 1 and the cumulative SVOC HI is less than 1). Therefore, SVOCs are unlikely to pose a risk to wildlife receptors.

Based upon the above information, the ECOPCs in surface water, groundwater, and surface soil at the former FTA are unlikely to pose a risk to wildlife receptors.

5.4.6 Uncertainties

In accordance with state and federal risk assessment guidance, the former FTA EPRE was designed to minimize the probability of falsely concluding that there was no risk when in fact there was potential risk. The USEPA Region IV ESV and Georgia Instream Water Quality Criteria comparison was designed to be conservative and to screen out only those substances which pose minimal potential risk to ecological receptors. The preliminary ecological effects and exposure assessments were designed to produce preliminary risk calculations that tend to overestimate risk. Using conservative exposure and effects assumptions (e.g., an area use factor of one, maximum detected concentrations, and TRVs based on NOAELs), generally overestimates risk to ecological receptors. Therefore, contaminants with HQs or HIs less than or equal to one indicate little to no likelihood of hazard to the ecological receptors.

Because of the conservatism of the TRVs and exposure estimates, HQs exceeding one do not necessarily mean that the ecological receptors are at risk of ecologically significant adverse effect. ECOPCs with small HQs may not be potential hazards unless the receptors obtain all of their food from the former FTA and the TRVs closely approximate the actual toxicity threshold. ECOPCs with large HQs may not be potential hazards if the TRVs for those contaminants greatly overestimate the toxicity to the receptors at the former FTA. TRVs can overestimate toxicity because of differences in the form of the chemical tested, the means by which the chemical was administered to the test species, or if the test endpoint is not expected to cause a significant ecological effect. Some ECOPCs at the former FTA have small HQs, but are judged not to be potential hazards because the ecological receptors are unlikely to obtain 100 percent of their food from the former FTA, such as the raccoon which has a home range of approximately 385 acres and the entire study area of the former FTA is only approximately 8 acres.

In addition to conservative exposure and effects parameters used in the preliminary risk calculations, groundwater was treated as surface water in the EPRE in accordance with USEPA Region IV guidance (USEPA, 2001), which is a conservative treatment of groundwater. Groundwater is not expected to rapidly migrate away from the former FTA because of soil characteristics and hydraulic gradients. The concentration of ECOPCs in groundwater might, therefore, decline to safe levels by adsorption or biodegradation before the groundwater discharges to the nearest aquatic habitat with biota.

The risks to ecological receptors from ECOPCs in groundwater at the former FTA are overestimated by the preliminary risk calculations. Although groundwater potentially discharges to the nearest surface water body (northern drainage ditch), the maximum concentration of xylenes is predicted to occur at the discharge point without degradation or dilution. This is an overestimation of risk to groundwater discharge to surface water. A more realistic supplemental risk calculation was utilized to illustrate the minimal risk concerns of xylenes and VOCs in groundwater.

To evaluate the uncertainty associated with ECOPCs, supplemental risk calculations are made using a more realistic exposure point concentration, the average concentration. Supplemental risk calculations are made for short-tailed shrews exposed to SVOCs in surface soil and raccoons exposed to VOCs in groundwater that potentially discharges to surface water. Supplemental risk estimates are calculated for only those ECOPCs that are present at maximum concentrations resulting in exposures to a wildlife receptor that exceed the NOAEL–based TRVs (HQ of greater than 1).

5.4.7 Conclusions

Xylenes and naphthalene in surface water were selected as ECOPCs by default because there were no Georgia Instream Water Quality Criteria for these two substances. Neither of these two constituents' ADDs exceed their respective TRVs. Constituents in surface water; therefore, do not pose a risk to wildlife receptors.

Five VOCs, two SVOCs, and three metals were selected as ECOPCs in groundwater. Receptors would be exposed to ground water ECOPCs only if groundwater discharges to surface water. Benzene, chromium, and lead were selected as ECOPCs because their maximum concentration exceeded the Georgia Instream Water Quality Criteria. The remainder of the ECOPCs were selected by default because no water quality criteria were available for comparison. Only one of these constituents' maximum ADDs exceeded their respective TRVs. The maximum ADD for xylene exceeded its TRV for the raccoon. However, the generation of an ADD using the average xylenes concentration in groundwater does not exceed the raccoon TRV. Therefore, constituents in groundwater that may discharge to surface water do not appear to pose a risk to wildlife receptors.

Acetone, dieldrin, methoxychlor, and fourteen SVOCs were selected as ECOPCs in surface soil. Only acetone and methoxychlor were selected by default due to the lack of soil ESVs for these compounds. The remainder were selected due to an exceedence of the USEPA Region IV Soil ESV (USEPA, 2001). None of these constituents' maximum ADDs exceed their respective TRVs. However, the cumulative hazard index for SVOCs exceeded one. The generation of an ADD using the average SVOC concentrations does not exceed the TRV. Therefore, constituents in surface soils do not appear to pose a risk to wildlife receptors.

5.4.8 Risk Management and Site Recommendations

Based on information presented in this report, minimal risk to ecological receptors is posed by the ECOPCs in surface water, ground water and surface soil. Therefore, no further ecological evaluation is required at the former FTA based upon minimal risk to ecological receptors.

6.0 RISK REDUCTION STANDARDS

To certify compliance under HSRA, a Site listed on the Hazardous Site Inventory (HSI) must meet an applicable soil and/or groundwater RRS specified under the HSRA Rules. The RRS are based on property use (i.e., residential or non-residential) and, when applicable, site-specific conditions. Types 1 and 2 RRS are appropriate for residential sites; Types 3 and 4 RRS are appropriate for non-residential sites, with Type 4 standards incorporating site-specific parameters.

The current and future use of the HAAF former FTA property is non-residential. The properties surrounding HAAF are residential and industrial. The closest residential property is located greater than 1 mile away from the former FTA. For these reasons, Type 3 (default, non-residential) and Type 4 (site-specific, non-residential) RRS are appropriate for the Site. However, since a more restrictive RRS may be applied to a site (i.e., a non-residential property may be shown to comply with a residential standard), Type 1 (default, residential) and Type 2 (site-specific, residential) RRS were also evaluated for soils at the Site. The exposure parameters used in the RRS equations are discussed in the following two sections. The toxicity values used to calculate the RRS are provided in Appendix G and discussed in Section 6.3. The RRS for soils are summarized in Tables 6.1a and 6.1b, the RRS for groundwater are summarized in Table 6.2, and the supporting calculations are presented in Appendix G.

6.1 RISK REDUCTION STANDARDS FOR SOIL

Forty-three HSRA-regulated substances including VOCs, SVOCs, pesticides, and metals were detected in soil samples collected from the Site at concentrations above their respective detection limits. Six of the eight analyzed metals (arsenic, barium, chromium, cadmium, lead, and mercury) were detected at concentrations above site-specific background concentrations while selenium and silver were detected at concentrations below site-specific background concentrations. Type 1 RRS were calculated for these constituents based on the criteria provided in Section 391-3-19-.07(6)(c) of the HSRA rules. The maximum detected concentration of each constituent was then compared to its respective Type 1 RRS to determine which constituents required further evaluation (Table 6.1a). Twenty-nine of the detected constituents comply with their respective Type 1 RRS. Type 2 RRS were calculated for the 14 remaining constituents using default residential exposure parameters provided in Georgia EPD's Question and

Answer Form, RAU-96-2. As shown in Table 6.1a, the maximum detected concentrations of 5 of the 14 remaining constituents complied with their respective Type 2 RRS.

Type 3 RRS were then calculated for the nine constituents detected in soils at concentrations greater than Types 1 or 2 RRS (i.e., benzene, chloromethane, ethylbenzene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene) and lead. Type 3 RRS were determined using the default, non-residential exposure parameters provided in Appendix III, Table 3 of HSRA. Seven compounds in surface soil (i.e., chloromethane, ethylbenzene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd) pyrene and lead) and seven compounds in subsurface soil (i.e., benzene, chloromethane, ethylbenzene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, and indeno(1,2,3-cd)pyrene) did not comply with their respective Type 3 RRS for soils (Table 6.1b).

Using the default assumptions for an industrial site worker as published in the EPD's Question and Answer Form, Type 4 RRS were calculated for the eight constituents that exceeded the Type 3 RRS. The maximum detected concentrations of benzene, chloromethane, lead, and benzo(a)pyrene did not comply with default Type 4 RRS for soil (Table 6.1b).

6.2 RISK REDUCTION STANDARDS FOR GROUNDWATER

Fifteen HSRA-regulated substances were detected at concentrations exceeding detection limits in groundwater samples collected from the Site. The highest concentrations of constituents detected were compared to the Types 1 and 3 RRS presented in Table 1, Appendix III of the HSRA Rules to determine which constituents required further evaluation. Concentrations of five constituents exceeded the Types 1 and 3 RRS for groundwater. Using Georgia EPD's Question and Answer Form RAU-96-2, Type 4 RRS were then calculated for the five remaining constituents. As shown in Table 6.2, the maximum detected concentration of four constituents, lead, benzene, vinyl chloride, and naphthalene, did not comply with default Type 4 RRS for groundwater.

6.3 TOXICITY ASSESSMENT

For the constituents detected at the Site, the reference doses and carcinogenic slope factors used to quantify risk are provided in Appendix G. The toxicity values were derived first from the USEPA's Integrated Risk Information System (IRIS) database (IRIS, 2000), secondly, from the Health Effects Assessment Summary Tables (HEAST, 1997), and thirdly, from provisional values accepted by the EPD (EPD Question and Answer Form RAU-96-3).

6.4 COMPARISON OF RISK REDUCTION STANDARDS WITH DETECTED CONCENTRATIONS

6.4.1 Soil

As previously discussed, the Site meets Type 1, Type 2, or Type 3 RRS criteria for 35 of the 43 constituents detected in soil. Type 4 RRS for default industrial site workers were calculated for the remaining 8 soil constituents.

The detected concentrations of each constituent were compared on a point-by-point basis to the Type 4 RRS calculated for the Site. Based on this point-by-point comparison, four constituents [ethylbenzene, benzo(a)anthracene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene] comply with the Type 4 RRS. Of the remaining constituents, chloromethane, benzene, lead and benzo(a)pyrene exceed the Type 4 RRS.

Three soil samples in three locations had concentrations of benzene at concentrations exceeding Type 4 RRS. The location and sample identifications for these samples included the following:

HMW-13/2-4 feet
SB-10/9-10.4 feet
SB-12/8-10 FEET

One soil sample in one location had concentrations of chloromethane at concentrations exceeding Type 4 RRS. The location and sample identifications for these samples included the following:

HSB-5/5-8 FEET

Six soil samples in five locations had concentrations of benzo(a)pyrene at concentrations exceeding Type 4 RRS. Exceedences for benzo(a)pyrene were noted only for samples collected in 1999 and 2000.

The location and sample identifications for these samples included the following:

SB-27/1.5 feet
SB-30/6-8 feet
SB-36/0-2 feet
SB-38/0-2 feet
HMW-16/1.5 feet
HMW-16/7.0 feet

The outlying areas sampled in 1999 and 2000 are also associated with the presence of asphalt debris, which is the probable source of the PAHs detected in the outlying areas of the site.

Three soil samples in three locations had concentrations of lead that exceeded Type 4 RRS. The location and sample identifications for these samples included the following:

BH-10 (0-1feet)
BH-11 (0-1feet)
BH-13 (0-1feet)

Based on the information contained in this report, there are areas of the former FTA (HSI Number 10395) which are not in compliance with Type 4 RRS for soil. These specific areas are depicted on Figure 6.1 and include the areas in the vicinity of: HSB-5, SB-10, BH-10, BH-11, BH-13, SB-27, SB-30, SB-36, SB-38, HMW-13, and HMW-16.

6.4.2 Groundwater

As previously discussed, Type 4 RRS were determined for five regulated substances (i.e., lead, benzene, cis-1,2-dichloroethene, vinyl chloride, and naphthalene) detected in groundwater at the Site. One regulated substance (cis-1,2-dichloroethene) detected in groundwater complied with the Type 4 RRS for groundwater (Table 6.2). Concentrations exceeding Type 4 RRS were noted at locations HMW-13 (lead, benzene, and naphthalene), HMW-6 (benzene, vinyl chloride, and naphthalene), HMW-10 (benzene) and HWM-11 (benzene and naphthalene), HMW-14R (vinyl chloride), and HMW-21 (vinyl chloride). HMW-13, HMW-14R, and HMW-21 are located in the northern portion of the site. HMW-6 and HMW-11 are in the southeast portion and HMW-10 is in the central area of the triangular site. Additionally, light non-aqueous phase liquid was noted to be present in well HMW-7 (see Section 2.4.5).

Based on the information contained in this report, there are areas at the former FTA (HSI Number 10395) which are not in compliance with Type 4 RRS for groundwater. These specific areas are depicted on Figure 6.1 and include sample locations HMW-13, HMW-6, HMW-7, HMW-10, HMW-11, HMW-14R and HMW-21.

7.0 REFERENCES

Armyallotment, 2000, Internet Site: http://www.armyallotment.com/hunter.html, January 20, 2000.

ATSDR, 1999, Toxicological Profiles on CD-ROM, Agency for Toxic Substances and Disease Registry.

Bouwer, H., and R.C. Rice, 1976, "A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells"; Water Resources Research, V. 12, p. 423-428.

Bouwer, H., 1989, "The Bouwer and Rice Slug Test - An Update"; Ground Water, V. 27, p. 304-309.

Burt, W.H. and R.P. Grossenheider, 1976, A Field Guide to the Mammals, Houghton Mifflin Co., Boston.

Clarke, John S., Charles M. Hacke, and Michael F. Peck, 1990. Geology and Ground-Water Resources of the Coastal Area of Georgia. Department of Natural Resources Environmental Protection Division, Georgia Geologic Survey Bulletin 113. 106 pages.

Conant, R. and J.T. Collins, 1991, A Field Guide to Reptiles and Amphibians of Eastern/Central North America, Second Edition, Houghton Mifflin Co., Boston.

Cramer, Howard R., and Daniel D. Arden, 1980. Subsurface Cretaceous and Paleocene Geology of the Coastal Plain of Georgia.

DNR, 1999. Rules and Regulations for Water Quality Control, Chapter 391-3-6, Georgia Department of Natural Resources, Environmental Protection Division, Revised July 1999.

Environmental Science & Engineering, 1993, Final Significance of Contamination Report: Hunter Army Airfield Fire Training Area, Fort Stewart, Savannah, Georgia, June 1993.

Environmental Science & Engineering, Inc., 1994, Closure Plan for Hunter Army Airfield Fire Training Area (AAFTA), May 1994.

EPA 1993, Wildlife Exposure Factors Handbook, Vol. I, EPA/600/R-93/187A, Office of Research and Development, Washington, D.C.

EPD, 1996. Guidance for Selecting Media Remediation Levels at RCRA Solid Waste Management Units, Georgia Environmental Protection Division, Hazardous Waste Management Branch, November 1996

Famnet, 2000, Internet Site: http//www.famnet.com/usa/hunter_a/sites/instal.htm, January 20, 2000.

Freeze, A. and J.A. Cherry, 1979, Groundwater, Prentice –Hall, Inc, Englewood Cliff, New Jersey.

Georgia Department of Natural Resources, 2000, Federal Areas Open for Hunting, Internet Site: http://www.ganet.org/dnr/wild/huntingregs/federal.htm, January 20, 2000.

Georgia Department of Natural Resources, Environmental Protection Division, 1999, Hazardous Site Response, Chapter 391-3-19.

Georgia Environmental Protection Division, Hazardous Waste Management Branch, 1996, Question and Answer Form Number RAU-96-2.

Georgia Environmental Protection Division Hazardous Waste Management Branch, 1996, Question and Answer Form Number RAU-96-3.

Georgia Environmental Protection Division, 1999, Water Use Classifications and Water Quality Standards, Chapter 391-3-6-.03, July 1999.

Georgia Natural Heritage Program, 1999, The Georgia Natural Heritage Program Database System, October 1999.

HAZWRAP (Hazardous Waste Remedial Actions Program) 1994. Loring Air Force Base Risk Assessment Methodology (Final), Lockheed Martin Energy System, Inc., Oak Ridge, Tennessee.

Herrick, Stephen M., Robert C. Vorhis, 1963. Subsurface Geology of the Georgia Coastal Plain, Georgia State Division of Conservation, Geological Survey Circular 25, 79 pages.

Kundell, James E., 1978. Ground Water Resources of Georgia, Published by Institute of Government, University of Georgia.

Metcalf & Eddy, Inc., 1999, Final First Semi-Annual Monitoring Progress Report: Former Fire Training Area, Hunter Army Airfield, Savannah, Georgia, February 1999.

Metcalf & Eddy, Inc., 1999, Second Semi-Annual Monitoring Only Report for Former Fire Fighter Training Area, Hunter Army Airfield, Georgia, July 1999.

National Climatic Data Center, 2000, Climate-Radar Data Inventories, Savannah International Airport, January 2000.

Omega Environmental Services and Geosciences, Inc, 1998, Soil Remedial Action Report for Hunter Army Airfield Fire Training Area, Hunter Army Airfield, Georgia, Volumes I through VI, December 1998.

Opresko, D. M., B. E. Sample, and G. W. Suter, II 1995. Toxicological Benchmarks for Wildlife, 1995 Revision, ES/ER/TM-86/R3. Lockheed Martin Energy System, Inc., Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Peck, Hanson, and Thornburn, 1974. <u>Foundation Engineering</u>, John Wiley & Sons, New York, NY

Personal communication, 2000, Personal communication from Carl W. Smith, SASCOE, to David Goershel, LAW, Inc., January 28, 2000.

QST (QST Environmental, Inc.) 1997. Draft Final Remedial Investigation/Baseline Risk Assessment for the Landfills 3 and 4 Operable Unit, Fort Sheridan, Illinois, June.

Sample, B. E., D. M. Opresko, and G. W. Suter, II 1996. Toxicological Benchmarks for Wildlife: 1996 Revision, ES/ER/TM-86/R3, Lockheed Martin Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Science Applications International Corporation (SAIC) October, 1999, Third Semi-annual Monitoring Only Report Former Fire Training Area Hunter Army Airfield, Georgia. October, 1999.

The Audubon Society, 1977, Field Guide to North American Birds, Eastern Region, Alfred A. Knopf, Inc., New York.

The Audubon Society, 1979, Field Guide to North American Reptiles and Amphibians, Alfred A. Knopf, Inc., New York.

The Audubon Society, 1980, Field Guide to North American Mammals, Alfred A. Knopf, Inc., New York.

U.S. Bureau of the Census, 1990, Census of Population and Housing, Summary Tape File 1.

U.S. Army Corps of Engineers, Document EM1110-1-4000, Monitoring Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites, November 1, 1998.

U.S. Army Corps of Engineers, Document EM200-1-3, Requirements for the Preparation of Sampling and Analysis Plans, September 1, 1994.

U.S. Army Corps of Engineers, Storage and Preservation of Soil Samples for Volatile Compound Analysis, Alan D. Hewitt, Cold Regions Research & Engineering Laboratory, May 1999.

U.S. Army Environmental Hygiene Agency, 1987, Hazardous Waste Study No. 37-26-0127-88, Investigation of Soil Contamination, Fort Stewart, Georgia

USEPA, 1989, Risk Assessment Guidance for Superfund, Volume 1, Part A, US Environmental Protection Agency.

USEPA, 1989. Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities: Interim Final Guidance.

USEPA, 1992. Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities: Addendum to Interim Final Guidance.

USEPA, 1995. Determination of Background Concentrations of Inorganics in Soils and Sediments at Hazardous Waste Sites. December 1995.

USEPA, 1997a. "Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessment", Interim Final, June 1997.

USEPA, 2001. "Supplemental Guidance to RAGS: Human Health and Ecological Risk Assessment Bulletins, USEPA Region IV, April 2001.

Wilkes, Robert L., J.H. Johnson, H.T. Stoner, and D.D. Bacon, March 1974, Soil Survey of Bryan and Chatham Counties, Georgia, United States Department of Agriculture Soil Conservation Services.

TABLE 3.1

SUMMARY OF SOIL BORING DATA

Boring Number	Date Installed	Installed By	Total Depth (ft,bgs)	Ground Surface Elevation (ft. NGVD)	Bottom of Boring Elevation (ft. NGVD)	Purpose of Boring
HSB-1	2/12/90	ESE	10.0	NA	NA	Source Evaluation
HSB-2	2/13/90	ESE	10.0	NA	NA	Source Evaluation
HSB-3	2/13/90	ESE	10.0	NA	NA	Source Evaluation
HSB-4	2/13/90	ESE	10.0	NA	NA	Source Evaluation
HSB-5	2/13/90	ESE	10.0	NA	NA	Source Evaluation
HSB-6	2/13/90	ESE	10.0	NA	NA	Source Evaluation
FTASB-01(SB-01)	8/21/95	LAW	9.0	NA	NA	Source Delineation
FTASB-02 (SB-02)	8/21/95	LAW	3.0	NA	NA	Source Delineation
FTASB-03 (SB-03)	8/21/95	LAW	3.0	NA	NA	Source Delineation
FTASB-04(SB-04)	8/22/95	LAW	10.5	NA	NA	Source Delineation
FTASB-05 (SB-05)	8/22/95	LAW	9.0	NA	NA	Source Delineation
FTASB-06 (SB-06)	8/22/95	LAW	9.0	NA	NA	Source Delineation
FTASB-07 (SB-07)	8/22/95	LAW	9.0	NA	NA	Source Delineation
FTASB-08 (SB-08)	8/22/95	LAW	5.0	NA	NA	Source Delineation
FTASB-09 (SB-09)	8/22/95	LAW	7.0	NA	NA	Source Delineation
FTASB-10 (SB-10)	8/22/95	LAW	10.4	NA	NA	Source Delineation
FTASB-11 (SB-11)	8/23/95	LAW	10.0	NA	NA	Source Delineation
FTASB-12 (SB-12)	8/23/95	LAW	9.0	NA	NA	Source Delineation
FTASB-13 (SB-13)	10/3/95	LAW	4.5	NA	NA	Source Delineation
FTASB-14 (SB-14)	10/4/95	LAW	5.5	NA	NA	Source Delineation
FTASB-15 (SB-15)	10/4/95	LAW	6.5	NA	NA	Source Delineation
FTASB-16 (SB-16)	10/4/95	LAW	8.5	NA	NA	Source Delineation
FTASB-17 (SB-17)	10/4/95	LAW	6.5	NA	NA	Source Delineation
SB-18	7/22/99	LAW	8.0	31.8	23.8	Plume Delineation
SB-19	7/22/99	LAW	6.0	34.7	28.7	Plume Delineation
SB-20	7/22/99	LAW	6.0	35.6	29.6	Plume Delineation
SB-21	7/22/99	LAW	6.0	26.3	20.3	Plume Delineation
SB-22	7/22/99	LAW	6.0	22.3	16.3	Plume Delineation
SB-23	7/29/99	LAW	6.5	22.5	16.0	Plume Delineation
SB-24	7/29/99	LAW	6.5	24.1	17.6	Plume Delineation
SB-25	7/22/99	LAW	6.0	27.6	21.6	Plume Delineation
SB-26	7/22/99	LAW	6.0	33.5	27.5	Plume Delineation
SB-27	7/22/99	LAW	6.0	31.8	25.8	Plume Delineation

TABLE 3.1

SUMMARY OF SOIL BORING DATA

Boring Number	Date Installed	Installed By	Total Depth (ft,bgs)	Ground Surface Elevation (ft. NGVD)	Bottom of Boring Elevation (ft. NGVD)	Purpose of Boring
SB-28	7/22/99	LAW	6.0	33.5	27.5	Plume Delineation
SB-29	7/22/99	LAW	6.0	31.2	25.2	Plume Delineation
SB-30	1/5/00	LAW	10.0	31.6	21.6	Plume Delineation
SB-31	1/3/00	LAW	10.0	34.2	24.2	Plume Delineation
SB-32	1/5/00	LAW	10.0	33.7	23.7	Plume Delineation
SB-33	1/5/00	LAW	10.0	33.2	23.2	Plume Delineation
SB-34	1/5/00	LAW	10.0	32.5	22.5	Plume Delineation
SB-35	1/6/00	LAW	10.0	32.1	22.1	Plume Delineation
SB-36	1/6/00	LAW	6.0	28.9	22.9	Plume Delineation
SB-37	1/6/00	LAW	6.0	26.0	20.0	Plume Delineation
SB-38/HMW-19	1/4/00	LAW	14.0	22.3	8.3	Plume Delineation
SB-39	1/4/00	LAW	10.0	19.8	9.8	Plume Delineation
SB-40/HMW-20	1/4/00	LAW	14.0	21.0	7.0	Plume Delineation
SB-41	1/31/00	LAW	2.0	20.5	18.5	Plume Delineation
SB-42	1/31/00	LAW	2.0	20.0	18.0	Plume Delineation
SB-43/HMW-21	11/1/01	LAW	14.0	19.4	5.4	Plume Delineation
SB-43A	11/5/01	LAW	2.0	19.4*	17.4*	Plume Delineation
SB-44	11/1/01	LAW	10.0	30.9	20.9	Plume Delineation
SB-45	10/31/01	LAW	2.0	32.4	30.4	Plume Delineation
SB-46/HMW-22	10/31/01	LAW	23.0	35.5	12.5	Plume Delineation
SB-47	10/31/01	LAW	4.0	23.7	19.7	Plume Delineation
SB-48	10/31/01	LAW	5.0	26.6	21.6	Plume Delineation
SB-49	10/31/01	LAW	2.0	34.3	32.3	Plume Delineation
SB-50	10/31/01	LAW	2.0	33.0	31.0	Plume Delineation
BH-10	1987	USA EHA	8.5	NA	NA	Source Evaluation
BH-11	1987	USA EHA	8.5	NA	NA	Source Evaluation
BH-12	1987	USA EHA	7.5	NA	NA	Source Evaluation
BH-13	1987	USA EHA	7.5	NA	NA	Source Evaluation
PSB-1	3/3/92	ESE	4.0	NA	NA	Source Delineation
PSB-2	3/3/92	ESE	4.0	NA	NA	Source Delineation
PSB-3	3/4/92	ESE	4.5	NA	NA	Source Delineation
PSB-4	3/4/92	ESE	6.5	NA	NA	Source Delineation
PSB-5	3/4/92	ESE	4.0	NA	NA	Source Delineation
PSB-6	3/3/92	ESE	8.5	NA	NA	Source Delineation

TABLE 3.1

SUMMARY OF SOIL BORING DATA

Boring Number	Date Installed	Installed By	Total Depth (ft,bgs)	Ground Surface Elevation (ft. NGVD)	Bottom of Boring Elevation (ft. NGVD)	Purpose of Boring
PSB-7	3/4/92	ESE	7.0	NA	NA	Source Delineation
HMW-1	2/7/90	ESE	50.0	35.1	-14.9	Source Delineation
HMW-2	2/9/90	ESE	15.0	34.6	19.6	Source Delineation
HMW-3	2/9/90	ESE	50.0	26.6	-23.4	Source Delineation
HMW-4	2/12/90	ESE	15.0	27.2	12.2	Source Delineation
HMW-5	2/11/90	ESE	50.0	28.8	-21.2	Source Delineation
HMW-6	2/12/90	ESE	15.0	28.3	13.3	Source Delineation
HMW-7	3/4/90	ESE	14.0	NA	NA	Source Delineation
HMW-8	3/3/90	ESE	15.0	NA	NA	Source Delineation
HMW-9	3/2/90	ESE	15.0	NA	NA	Source Delineation
HMW-10	10/3/95	LAW	14.0	NA	NA	Source Delineation
HMW-11	10/3/95	LAW	16.0	NA	NA	Source Delineation
HMW-12	10/2/95	LAW	17.0	NA	NA	Source Delineation
HMW-13	10/3/95	LAW	20.0	NA	NA	Source Delineation
HMW-14	7/28/99	LAW	16.0	NA	NA	Source Delineation
HMW-14R	1/5/00	LAW	18.0	NA	NA	Source Delineation
HMW-15	7/28/99	LAW	16.0	NA	NA	Source Delineation
HMW-16	7/29/99	LAW	16.0	NA	NA	Source Delineation
HMW-17	7/28/99	LAW	16.0	NA	NA	Source Delineation
HMW-18	1/16/00	LAW	14.0	NA	NA	Source Delineation

<u>Notes:</u>

bgs	below ground surface
NGVD	National Geodetic Vertical Datum of 1929
ESE	Environmental Science & Engineering
LAW	Law Engineering and Environmental Services, Inc.
NA	Data not available
USAEHA	United States Army Environmental Hygiene Agency
SB	Soil Boring
HMW	Monitoring Well
HSB	Hand Auger Soil Boring
*	Estimated from SB-43 ground surface elevation

PREPARED BY: J. Martin 11/5/01
CHECKED BY: R. Quinn 11/16/01

TABLE 3.2

SUMMARY OF SOIL AND GROUND-WATER SAMPLES COLLECTED

Boring/ Well		Sample Depth	Date	Organic Vapor	Laboratory	
BH-10	Soil	0-1 7.5-8.5	1987	--	RCRA Metals, SVOC RCRA Metals, SVOC	Excavated during soil remediation activities
BH-11	Soil	0-1 7.5-8.5	1987	--	RCRA Metals, SVOC RCRA Metals, SVOC	Excavated during soil remediation activities
BH-12	Soil	0-1 6.5-7.5	1987	-- --	RCRA Metals, SVOC RCRA Metals, SVOC	Excavated during soil remediation activities
BH-13	Soil	0-1 6.0-7.5	1987	-- --	RCRA Metals, SVOC RCRA Metals, SVOC	Excavated during soil remediation activities
HSB-1	Soil	8-10	2/12/90	--	VOCs, SVOCs,RCRA Metals	
HSB-2	Soil	3-5	2/13/90	--	VOCs, SVOCs,RCRA Metals	Excavated during soil remediation activities
HSB-3	Soil	6-8	2/13/90	--	VOCs, SVOCs,RCRA Metals	
HSB-4	Soil	2-4	2/13/90	--	VOCs, SVOCs,RCRA Metals	
HSB-5	Soil	5-8	2/13/90	--	VOCs, SVOCs,RCRA Metals	
HSB-6	Soil	8-10	2/13/90	--	VOCs, SVOCs,RCRA Metals	
PSB-1	Soil	0-1 3-4	3/3/92	-- --	VOCs, SVOCs,RCRA Metals VOCs, SVOCs,RCRA Metals	
PSB-2	Soil	0-1 3-4	3/3/92	-- --	VOCs, SVOCs,RCRA Metals VOCs, SVOCs,RCRA Metals	
PSB-3	Soil	0-1 3.5-4.5	3/4/92	-- --	VOCs, SVOCs,RCRA Metals VOCs, SVOCs,RCRA Metals	
PSB-4	Soil	0-1 3.5-4 5.5-6.5	3/4/92	-- -- --	VOCs, SVOCs,RCRA Metals VOCs, SVOCs,RCRA Metals VOCs, SVOCs,RCRA Metals	Excavated during soil remedial action Excavated during soil remedial action Excavated during soil remedial action
PSB-5	Soil	0-1 3.5-4	3/4/92	-- --	VOCs, SVOCs,RCRA Metals VOCs, SVOCs,RCRA Metals	

TABLE 3.2

SUMMARY OF SOIL AND GROUND-WATER SAMPLES COLLECTED

Boring/ Well		Sample Depth	Date	Organic Vapor	Laboratory	
PSB-6	Soil	0-1	3/3/92	--	VOCs, SVOCs,RCRA Metals	Excavated during soil remediation activities
		3-4		--	VOCs, SVOCs,RCRA Metals	Excavated during soil remediation activities
		7.5-8.5		--	VOCs, SVOCs,RCRA Metals	
PSB-7	Soil	0-1	3/4/92	--	VOCs, SVOCs,RCRA Metals	Excavated during soil remediation activities
		3-4		--	VOCs, SVOCs,RCRA Metals	Excavated during soil remediation activities
		6-7		--	VOCs, SVOCs,RCRA Metals	
FTASB-01 (SB-01)	Soil	0.5-1.0	8/21/95	0	NA	Excavated during soil remediation activities
		2.5-3.0		70	NA	Excavated during soil remediation activities
		4.5-5.0		100	NA	Excavated during soil remediation activities
		6.5-7.0		50	NA	
		8.5-9.0		60	NA	
FTASB-02 (SB-02)	Soil	0.5-1.0	8/21/95	0	NA	Excavated during soil remediation activities
		2.5-3.0		60		Excavated during soil remediation activities
FTASB-03 (SB-03)	Soil	0.5-1.0	8/21/95	0	NA	Excavated during soil remediation activities
		2.5-3.0		60		Excavated during soil remediation activities
FTASB-04 (SB-04)	Soil	0.5-1.0	8/22/95	0	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
		2.5-3.0		0	NA	
		4.5-5.0		0	NA	
		6.5-7.0		0	NA	
		8.5-9.0		0	NA	
		9.0-10.5		0	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
FTASB-05 (SB-05)	Soil	0.5-1.0	8/22/95	0	NA	Excavated during soil remediation activities
		2.5-3.0		20	NA	Excavated during soil remediation activities
		4.5-5.0		20	NA	Excavated during soil remediation activities
		6.5-7.0		70	NA	
		8.5-9.0		60	NA	
FTASB-06 (SB-06)	Soil	0.5-1.0	8/22/95	0	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
		2.5-3.0		0	NA	
		4.5-5.0		0	NA	
		6.5-7.0		0	NA	
		8.5-10.8		>1	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
FTASB-07 (SB-07)	Soil	0.5-1.0	8/22/95	0	NA	Excavated during soil remediation activities
		2.5-3.0		16	NA	Excavated during soil remediation activities
		4.5-5.0		50	NA	Excavated during soil remediation activities
		6.5-7.0		80	NA	
		8.5-9.0		70	NA	
FTASB-08 (SB-08)	Soil	0.5-1.0	8/22/95	0	NA	Excavated during soil remediation activities
		2.5-3.0		5	NA	Excavated during soil remediation activities
		4.5-5.0		60	NA	Excavated during soil remediation activities

TABLE 3.2

SUMMARY OF SOIL AND GROUND-WATER SAMPLES COLLECTED

Boring/ Well		Sample Depth	Date	Organic Vapor	Laboratory	
FTASB-09 (SB-09)	Soil	0.5-1.0	8/22/95	0	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
		2.5-3.0		0	NA	
		4.5-5.0		0	NA	
		6.0-7.0		0	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
FTASB-10 (SB-10)	Soil	0.5-1.0	8/22/95	60	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	Excavated during soil remediation activities
		2.5-3.0		50	NA	Excavated during soil remediation activities
		4.5-5.0		35	NA	Excavated during soil remediation activities
		6.5-7.0		60	NA	
		8.5-9.0		40	NA	
		9.5-10.0		70	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
FTASB-11 (SB-11)	Soil	0.5-1.0	8/23/95	0	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	Excavated during soil remediation activities
		2.5-3.0		0	NA	Excavated during soil remediation activities
		4.5-5.0		5	NA	Excavated during soil remediation activities
		6.5-7.0		2	NA	
		8.5-9.0		10	NA	
		9.5-10.0		20	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
FTASB-12 (SB-12)	Soil	0.5-1.0	8/23/95	15	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	Excavated during soil remediation activities
		2.5-3.0		10	NA	Excavated during soil remediation activities
		4.5-5.0		10	NA	Excavated during soil remediation activities
		6.5-7.0		12	NA	
		8.0-10.0		11	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
FTASB-13 (SB-13)	Soil	0.5-2.5	10/3/95	0	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
		2.5-4.5		0	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
FTASB-14 (SB-14)	Soil	0.5-2.5	10/4/95	20	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
		2.5-4.5		50	NA	
		4.5-6.5		162	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
FTASB-15 (SB-15)	Soil	0.5-2.5	10/4/95	>1	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
		2.5-4.5		0	NA	
		4.5-6.5		0	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
FTASB-16 (SB-16)	Soil	0.5-2.5	10/4/95	30	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
		2.5-4.5		40	NA	
		4.5-6.5		40	NA	
		6.5-8.1		30	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
FTASB-17 (SB-17)	Soil	0.5-2.5	10/4/95	0	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
		2.5-4.5		2	NA	
		4.5-6.5		0	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
SB-18	Soil	1.5	7/22/99	NA	VOCs, SVOCs	
		6.0		NA	VOCs, SVOCs	

TABLE 3.2

SUMMARY OF SOIL AND GROUND-WATER SAMPLES COLLECTED

Boring/ Well		Sample Depth	Date	Organic Vapor	Laboratory	
SB-19	Soil	1.5 5.5	7/22/99	NA NA	VOCs, SVOCs VOCs, SVOCs	
SB-20	Soil	1.5 5.5	7/22/99	NA NA	VOCs, SVOCs VOCs, SVOCs	
SB-21	Soil	1.5 5.5	7/22/99	NA NA	VOCs, SVOCs VOCs, SVOCs	
SB-22	Soil	1.5 5.5	7/22/99	NA NA	VOCs, SVOCs, PCBs, Pest. VOCs, SVOCs, PCBs, Pest.	
SB-23	Soil	1.5 6.5	7/29/99	NA NA	VOCs, SVOCs, PCBs, Pest. VOCs, SVOCs, PCBs, Pest.	
SB-24	Soil	1.5 6.5	7/29/99	NA NA	VOCs, SVOCs, PCBs, Pest. VOCs, SVOCs, PCBs, Pest.	
SB-25	Soil	1.5 5.5	7/22/99	NA NA	VOCs, SVOCs, PCBs, Pest. VOCs, SVOCs, PCBs, Pest.	
SB-26	Soil	1.5 5.5	7/22/99	NA NA	VOCs, SVOCs, PCBs, Pest. VOCs, SVOCs, PCBs, Pest.	
SB-27	Soil	1.5 5.5	7/22/99	NA NA	VOCs, SVOCs, PCBs, Pest. VOCs, SVOCs, PCBs, Pest.	
SB-28	Soil	1.5 5.5	7/22/99	NA NA	VOCs, SVOCs VOCs, SVOCs	
SB-29	Soil	1.5 5.5	7/22/99	NA NA	VOCs, SVOCs VOCs, SVOCs	
SB-30	Soil	0-2 6-8	1/5/00	0.5 0.5	VOCs, SVOCs VOCs, SVOCs	
SB-31	Soil	0.5-2 5-7	1/5/00	0.3 0.3	VOCs VOCs	
SB-32	Soil	0.5-2 4-6	1/5/00	0.3 0.0	PCBs PCBs	
SB-33	Soil	0.5-2 3-5	1/5/00	0.1 0.4	VOCs, PCBs VOCs, PCBs	
SB-34	Soil	0-2 2.5-4.5	1/5/00	0.7 0.1	VOCs, Pesticides VOCs, Pesticides	

TABLE 3.2

SUMMARY OF SOIL AND GROUND-WATER SAMPLES COLLECTED

Boring/ Well		Sample Depth	Date	Organic Vapor	Laboratory	
SB-35	Soil	0-2	1/6/00	1.7	VOCs, SVOCs, Pesticides	
		4-6		0.5	VOCs, SVOCs, Pesticides	
SB-36	Soil	0-2	1/6/00	0.3	VOCs, SVOCs, Pesticides	
		2-3		0.3	VOCs, SVOCs	
SB-37	Soil	0-2	1/6/00	0.0	VOCs, SVOCs, Pesticides	
		2-3		0.0	VOCs, SVOCs	
SB-38	Soil	0-2	1/4/00	0.6	VOCs, SVOCs	
		3.5-5.5		0.1	VOCs, SVOCs	
SB-39	Soil	0-2	1/4/00	0.0	VOCs	
		2-4		0.0	VOCs	
SB-40	Soil	0-2	1/4/00	11.7	VOCs	
		2-4		3.2	VOCs	
SB-41	Soil	0-2	1/31/00	NA	SVOCs	
		2-4		NA	NA	
SB-42	Soil	0-2	1/31/00	NA	SVOCs	
		2-4		NA	NA	
SB-43	Soil	0-2	11/1/01	0.0	VOCs, SVOCs and Chromium	
		2-4		0.0	VOCs, SVOCs and Chromium	
		4-6		0.0		
		6-8		0.0		
		8-10		0.0		
		10-12		0.0		
SB-43A	Soil	0-2	11/5/01	0.0	Acetone	Confirmation sample of SB-43 (0-2)
SB-44	Soil	0-2	11/1/01		NA	
		2-4		0.0	VOCs, SVOCs and Chromium	
		4-6		0.0	NA	
		6-8		94.0	VOCs, SVOCs and Chromium	
		8-10		NM	NA	
SB-45	Soil	0-2	10/31/01	0.0	SVOCs	
SB-46	Soil	0-2	10/31/01	0.0		
		2-4		0.0		
		4-6		0.0	VOCs, SVOCs and Chromium	
		12-14		0.0	VOCs, SVOCs and Chromium	
		14-16		0.0		
		16-18		0.0		
		18-20		0.0		
		20-22		0.0		

TABLE 3.2

SUMMARY OF SOIL AND GROUND-WATER SAMPLES COLLECTED

Boring/ Well		Sample Depth	Date	Organic Vapor	Laboratory	
SB-47	Soil	0-2	10/31/01	0.0		
		2-4		0.0	Barium	
SB-48	Soil	0-2	10/31/01	0.0		
		2-5		0.0	Chromium	
SB-49	Soil	0-2	10/31/01	0.0	SVOCs	
SB-50	Soil	0-2	10/31/01	0.0	SVOCs	
HMW-10	Soil	0.0-2.0	10/3/95	0	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
		2.0-4.0		0	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
		4.0-6.0		0	NA	
		6.0-8.0		0	NA	
		8.0-10.0		<1	NA	
		10.0-12.0		<1	NA	
		12.0-14.0		<1	NA	
HMW-11	Soil	0.0-2.0	10/3/95	0	NA	
		2.0-4.0		<1	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
		4.0-6.0		9	NA	
		6.0-8.0		9	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
		8.0-10.0		2	NA	
		10.0-12.0		<1	NA	
		12.0-14.0		3	NA	
		14.0-16.0		0	NA	
HMW-12	Soil	0.0-1.5	10/2/95	0	NA	
		1.5-3.0		<1	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
		3.0-4.5		1	NA	
		4.5-6.0		2	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
		6.0-7.5		<1	NA	
		7.5-9.0		<1	NA	
		9.0-10.5		<1	NA	
		10.5-12.0		<1	NA	
		12.0-14.0		<1	NA	
		14.0-15.5		<1	NA	
		15.5-17.0		<1	NA	

TABLE 3.2

SUMMARY OF SOIL AND GROUND-WATER SAMPLES COLLECTED

Boring/ Well		Sample Depth	Date	Organic Vapor	Laboratory	
HMW-13	Soil	0.0-2.0	10/3/95	16	NA	
		2.0-4.0		30	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
		4.0-6.0		90	NA	
		6.0-8.0		130	NA	
		8.0-10.0		90	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
		10.0-12.0		100	NA	
		12.0-14.0		1	NA	
		14.0-16.0		2	NA	
		16.0-18.0		0	NA	
		18.0-20.0		2	NA	
HMW-14	Soil	1.5-3.0	7/28/99	NA	VOCs, SVOCs	
		6.0-7.0		NA	VOCs, SVOCs	
HMW-14R	Soil	0.0-2.0	1/5/00	0.7	VOCs, SVOCs	
		7.0-9.0		0.3	VOCs, SVOCs	
HMW-15	Soil	1.5-3.0	7/28/99	NA	VOCs, SVOCs	
		7.5-9.0		NA	VOCs, SVOCs	
HMW-16	Soil	1.5-3.0	7/29/99	NA	VOCs, SVOCs	
		7.0-8.5		NA	VOCs, SVOCs	
HMW-17	Soil	1.5-3.0	7/28/99	NA	VOCs, SVOCs	
		6.5-8.0		NA	VOCs, SVOCs	
HMW-18	Soil	0-2	1/6/00	0.0	VOCs, SVOCs, Pesticides	
		2-3		0.0	VOCs, SVOCs	
SD-1	Sediment	0-.5	2/12/90	NA	VOCs, SVOCs,RCRA Metals	
SD-2	Sediment	0-.5	2/12/90	NA	VOCs, SVOCs,RCRA Metals	
SD-3	Sediment	0-.5	2/12/90	NA	VOCs, SVOCs,RCRA Metals	
PSS-1	Sediment	0-.5	3/3/92	NA	VOCs, SVOCs,RCRA Metals	
PSS-2	Sediment	0-.5	3/3/92	NA	VOCs, SVOCs,RCRA Metals	
PSS-3	Sediment	0-.5	3/3/92	NA	VOCs, SVOCs,RCRA Metals	
PSS-4	Sediment	0-.5	3/4/92	NA	VOCs, SVOCs,RCRA Metals	
HMW-01	Groundwater	Screened Interval 38-48'	3/7/90	NA	VOCs, SVOCs,RCRA Metals	
			3/12/92		VOCs, SVOCs,RCRA Metals	
			10/7/95		VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	

TABLE 3.2

SUMMARY OF SOIL AND GROUND-WATER SAMPLES COLLECTED

Boring/ Well		Sample Depth	Date	Organic Vapor	Laboratory	
HMW-02	Groundwater	Screened Interval 4.6-14.6'	3/7/90	NA	VOCs, SVOCs,RCRA Metals	
			3/12/92		VOCs, SVOCs,RCRA Metals	
			10/7/95		VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
			11/5/98		BTEX,PAHs	Long-Term Semi-Annual Monitoring
			5/16/99		BTEX,PAHs	Long-Term Semi-Annual Monitoring
			7/12/99		BTEX, PAHs	Long-Term Semi-Annual Monitoring
			1/16/00		Total lead	
HMW-03	Groundwater	Screened Interval 39'-49'	3/8/90	NA	VOCs, SVOCs,RCRA Metals	
			3/12/92		VOCs, SVOCs,RCRA Metals	
			10/6/95		VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
			10/06/01		VOCs,SVOCs, RCRA Metals	
HMW-04	Groundwater	Screened Interval 3-13'	3/8/90	NA	VOCs, SVOCs,RCRA Metals	
			3/12/92		VOCs, SVOCs,RCRA Metals	
			10/6/95		VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
			11/5/98		BTEX, PAHs	Long-Term Semi-Annual Monitoring
			5/6/99		BTEX, PAHs	Long-Term Semi-Annual Monitoring
			7/12/99		BTEX, PAHs	Long-Term Semi-Annual Monitoring
HMW-05	Groundwater	Screened Interval 39-49'	3/8/90	NA	VOCs, SVOCs,RCRA Metals	
			3/12/92		VOCs, SVOCs,RCRA Metals	
			10/6/95		VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
HMW-06	Groundwater	Screened Interval 3-13'	3/8/90	NA	VOCs, SVOCs,RCRA Metals	
			3/12/92		VOCs, SVOCs,RCRA Metals	
			10/6/95		VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
			11/15/98		BTEX, PAHs	Long-Term Semi-Annual Monitoring
			5/6/99		BTEX, PAHs	Long-Term Semi-Annual Monitoring
			7/12/99		BTEX, PAHs	Long-Term Semi-Annual Monitoring
HMW-07	Groundwater	Screened Interval 3-13'	3/12/92	NA	VOCs, SVOCs,RCRA Metals	
HMW-08	Groundwater	Screened Interval 3-13'	3/12/92	NA	VOCs, SVOCs,RCRA Metals	
			10/8/95		VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
			11/5/98		BTEX, PAHs	Long-Term Semi-Annual Monitoring
			5/6/99		BTEX, PAHs	Long-Term Semi-Annual Monitoring
			7/12/99		BTEX, PAHs	Long-Term Semi-Annual Monitoring
HMW-09	Groundwater	Screened Interval 5-15'	3/12/92	NA	VOCs, SVOCs,RCRA Metals	
			10/8/95		VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO	
			11/5/98		BTEX, PAHs	Long-Term Semi-Annual Monitoring
			5/6/99		BTEX, PAHs	Long-Term Semi-Annual Monitoring
			7/12/99		BTEX, PAHs	Long-Term Semi-Annual Monitoring

93411.04 (Footnotes appear on page 10 of 10)

TABLE 3.2

SUMMARY OF SOIL AND GROUND-WATER SAMPLES COLLECTED

Boring/ Well		Sample Depth	Date	Organic Vapor	Laboratory	
HMW-10	Groundwater	Screened Interval 2.7-12.8'	10/9/95 11/5/98 5/6/99 7/12/99	NA	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO BTEX, PAHs BTEX, PAHs BTEX, PAHs	Long-Term Semi-Annual Monitoring Long-Term Semi-Annual Monitoring Long-Term Semi-Annual Monitoring
HMW-11	Groundwater	Screened Interval 4.7-14.8'	10/8/95 11/5/98 5/6/99 7/12/99	NA	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO BTEX, PAHs BTEX, PAHs BTEX, PAHs	Long-Term Semi-Annual Monitoring Long-Term Semi-Annual Monitoring Long-Term Semi-Annual Monitoring
HMW-12	Groundwater	Screened Interval 5.1-15.2'	10/8/95 1/19/00	NA	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO VOCs, SVOCs, Total Arsenic, Barium, and Lead	
HMW-13	Groundwater	Screened Interval 7.5-17.6'	10/9/95 11/5/98 5/6/99 7/12/99	NA	VOCs, SVOCs,RCRA Metals, TPH-GRO/DRO BTEX, PAHs BTEX, PAHs BTEX, PAHs	Long-Term Semi-Annual Monitoring Long-Term Semi-Annual Monitoring Long-Term Semi-Annual Monitoring
HMW-14	Groundwater	Screened Interval 4.9-14.9'	NA	NA	Not Sampled	Monitoring well abandoned
HMW-14R	Groundwater	Screened Interval 9.2-18.9'	1/5/00 1/17/00 11/6/01	NA NA	VOCs, SVOCs VOCs, SVOCs, Total Arsenic, Barium, and Lead VOCs	
HMW-15	Groundwater	Screened Interval 4.7-14.7'		NA	Not Sampled	
HMW-16	Groundwater	Screened Interval 4.3-14.3'		NA	Not Sampled	
HMW-17	Groundwater	Screened Interval 4.3-14.3'	7/21/99	NA	VOCs, SVOCs, Total Arsenic, Barium, and Lead	
HMW-18	Groundwater	Screened Interval 3.7-13.5'	1/20/00	NA	VOCs, SVOCs, Total Arsenic, Barium, and Lead	
HMW-19	Groundwater	Screened Interval 4.2-14.0'	1/20/00	NA	VOCs, SVOCs, Total Arsenic, Barium, and Lead	
HMW-20	Groundwater	Screened Interval 3.7-13.4'	1/18/00	NA	VOCs, SVOCs, Total Arsenic, Barium, and Lead	

TABLE 3.2

SUMMARY OF SOIL AND GROUND-WATER SAMPLES COLLECTED

Boring/ Well		Sample Depth	Date	Organic Vapor	Laboratory	
HMW-21	Groundwater	Screened Interval 2-11.5	11/6/01	NA	VOCs	
HMW-22	Groundwater	Screened Interval 11-25	11/6/01	NA	VOCs	
SB-38	Groundwater	4.0-14.0'	1/4/00	NA	VOCs, SVOCs	Temporary piezometer water sample
SB-40	Groundwater	4.0-14.0'	1/4/00	NA	VOCs, SVOCs	Temporary piezometer water sample
HMW-14	Groundwater	4.0-14.0'	7/21/99	NA	BTEX	Temporary piezometer water sample
HMW-15	Groundwater	4.0-14.0'	7/21/99	NA	BTEX	Temporary piezometer water sample
HMW-16A	Groundwater	4.0-14.0'	7/21/99	NA	BTEX	Temporary piezometer water sample
HMW-16B	Groundwater	4.0-14.0'	7/21/99	NA	BTEX	Temporary piezometer water sample
HMW-16C	Groundwater	4.0-14.0'	7/21/99	NA	BTEX	Temporary piezometer water sample
HMW-17	Groundwater	4.0-14.0'	7/21/99	NA	BTEX	Temporary piezometer water sample
HSW-1	Surface Water	NA	10/31/01	NA	VOCs, SVOCs, RCRA Metals	Surface water from FTA ditches collected by CESAS
HSW-2	Surface Water	NA	10/31/01	NA	VOCs, SVOCs, RCRA Metals	Surface water from FTA ditches collected by CESAS
HSW-3	Surface Water	NA	10/31/01	NA	VOCs, SVOCs, RCRA Metals	Surface water from FTA ditches collected by CESAS
HSW-4	Surface Water	NA	10/31/01	NA	VOCs, SVOCs, RCRA Metals	Surface water from FTA ditches collected by CESAS
HSW-5	Surface Water	NA	10/31/01	NA	VOCs, SVOCs, RCRA Metals	Surface water from FTA ditches collected by CESAS
HSW-6	Surface Water	NA	10/31/01	NA	VOCs, SVOCs, RCRA Metals	Surface water from FTA ditches collected by CESAS

Notes:

bgs	Below Ground Surface
RCRA Metals	arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver analyzed by USEPA Methods 6010, 7060, 7421, 7471, and 7740
SVOCs	Semi-volatile organic compounds analyzed by USEPA Method 8270
VOCs	Volatile organic compounds analyzed by USEPA Method 8240 or 8260
TPH-GRO/DRO	Total petroleum hydrocarbons for gasoline range organics and diesel range organics analyzed by USEPA Method 8015B
USAEHA	United States Army Environmental Hygiene Agency
CESAS	United States Army Corps of Engineers, Savannah District
ESE	Environmental Science & Engineering
LAW	Law Engineering and Environmental Services, Inc.
NA	Not Analyzed

PREPARED BY: R Quinn 2/3/00/S Durden 11/12/01
CHECKED BY: J Hartness 3/2/00/R Quinn 11/13/01

TABLE 3.3

SUMMARY OF MONITORING WELL CONSTRUCTION DATA

Well ID	Date Installed	Northing	Easting	Boring Diameter (inches)	TOC Elevation (NGVD)	Ground Surface Elevation (NGVD)	Boring Depth (bgs)	Screened Interval (ft, bgs)	Sandpack Interval (ft,bgs)	Bentonite Seal (ft,bgs)	Grout Interval (ft,bgs)	Well Diameter (inches)
HMW-1 (1)	2/7/90	734794.34	816370.12	10.3	38.42	36.7	50.0	38.0-48.0	35.0-50.0	33.0-35.0	0.0-33.0	2.0
HMW-2 (1)	2/9/90	734786.58	816363.02	10.3	37.93	36.8	15.0	4.6-14.6	3.1-15.0	2.1-3.1	0.0-2.1	2.0
HMW-3 (1)	2/9/90	734719.25	816011.95	10.3	29.75	28.1	50.0	39.0-49.0	37.0-50.0	35.0-37.0	0.0-35.0	2.0
HMW-4 (1)	2/12/90	734718.68	816018.22	10.3	30.42	28.4	15.0	3.0-13.0	2.0-15.0	1.0-2.0	0.0-1.0	2.0
HMW-5 (1)	2/11/90	734494.62	816074.63	10.3	31.94	30.0	50.0	39.0-49.0	35.0-50.0	33.0-35.0	0.0-33.0	2.0
HMW-6 (1)	2/12/90	734497.34	816067.77	10.3	31.53	29.9	15.0	3.0-13.0	2.0-15.0	1.0-2.0	0.0-1.0	2.0
HMW-7 (1)	3/4/92	734579.79	816022.48	8	28.88	28.3	14.0	3.0-13.0	1.5-14.0	0.0-1.5	None	2.0
HMW-8 (1)	3/3/92	734779.81	816009.36	8	27.50	26.0	15.0	3.0-13.0	1.5-15.0	0.0-1.5	None	2.0
HMW-9 (1)	3/2/92	734790.68	816129.62	8	34.39	32.4	15.0	5.0-15.0	3.0-14.0	0.5-3.0	None	2.0
HMW-10 (2)	10/3/95	734614.87	815936.60	8.5	27.41	NA	14.0	2.7-12.8	1.5-14.0	0.0-1.5	None	2.0
HMW-11(2)	10/3/95	734491.04	815971.75	8.5	31.05	NA	15.0	4.7-14.8	2.0-15.0	0.0-2.0	None	2.0
HMW-12 (2)	10/2/95	734465.67	816061.45	8.5	31.78	NA	16.0	5.1-15.2	3.0-16.0	1.0-3.0	0.0-1.0	2.0
HMW-13 (2)	10/3/95	734858.99	816186.45	8.5	34.88	NA	18.0	7.5-17.6	4.7-18.0	1.5-4.7	0.0-1.5	2.0
HMW-14 (2)(3)	7/28/99	734981.6	816256.64	8	36.59	34.55	15.4	4.9-14.9	2.0-14.9	0.5-2.0	0.0-0.5	2.0
HMW-14R (2)	1/7/00	735029.26	816249.07	9.5	34.67	32.7	19.5	9.2-18.9	5.5-19.5	3.0-5.5	0.0-3.0	2.0
HMW-15 (2)	7/28/99	734854.2	815958.13	8	23.84	22.08	14.7	4.7-14.7	2.0-14.7	0.5-2.0	0.0-0.5	2.0
HMW-16 (2)	7/28/99	734556.55	815860.75	8	29.06	27.14	14.3	4.3-14.3	2.0-14.3	0.5-2.0	0.0-0.5	2.0
HMW-17 (2)	7/29/99	734447.33	816145.38	8	33.29	31.25	14.3	4.3-14.3	2.0-14.3	0.5-2.0	0.0-0.5	2.0
HMW-18 (2)	36533	734404.99	815795.89	9.5	29.87	27.4	14.0	3.7-13.5	1.5-14.0	1.0-1.5	0.0-1.0	2.0
HMW-19 (2)	36533	734561.58	815545.08	9.5	24.5	22.3	14.5	4.2-14.0	3.0-14.5	2.0-3.0	0.0-2.0	2.0
HMW-20 (2)	1/9/00	734890.64	815912.74	9.5	23.19	21	14.0	3.7-13.4	1.5-14.0	1.0-1.5	0.0-1.0	2.0
HMW-21 (2)	11/1/01	735133.03	816083.64	12	22.28	19.38	14.0	2.0-11.5	1.5-14.0	1.0-1.5	0.0-1.0	2.0
HMW-22 (2)	11/1/01	735003.13	816410.66	12	38.19	35.45	23.0	11.0-20.5	8.5-23.0	5.5-8.5	0.0-5.5	2.0

Sources:

Well Installation Diagrams
Survey Data: LAW Eng. & Env. Svcs., Inc.
ESE, 1993a
NA Not Available
NGVD National Geodetic Vertical Datum of 1929
bgs below ground surface

Notes:

(1) Well installed by ESE
(2) Well installed by LAW
(3) HMW - 14 was abandoned 1/9/00 and replaced by HMW-14R

PREPARED BY: J Martin 11/15/01
CHECKED BY: R Quinn 11/16/01

TABLE 4.1

SUMMARY OF GROUNDWATER ELEVATIONS (November 6, 2001)

Monitoring Well	Top of Casing Elevation (ft, NGVD)	Depth to Groundwater (ft, bTOC)	Groundwater Elevation (ft, NGVD)
HMW-1	38.42	16.57	21.85
HMW-2	37.93	14.47	23.46
HMW-3	29.75	10.98	18.77
HMW-4	30.42	10.71	19.71
HMW-5	31.94	11.24	20.70
HMW-6	31.53	9.61	21.92
HMW-7	28.88	Water level was not measured due to presence of product	
HMW-8	27.50	10.60	16.90
HMW-9	34.39	13.06	21.33
HMW-10	27.41	11.29	16.12
HMW-11	31.05	14.22	16.83
HMW-12	31.78	13.3	18.48
HMW-13	34.88	14.36	20.52
HMW-14	36.59	Well was abandoned on 1/9/00	
HMW-14R	34.67	13.97	20.70
HMW-15	23.84	9.74	14.10
HMW-16	29.06	14.25	14.81
HMW-17	33.29	10.45	22.84
HMW-18	29.87	10.96	18.91
HMW-19	24.50	13.09	11.41
HMW-20	23.19	10.42	12.77
HMW-21	22.28	10.54	11.74
HMW-22	38.19	16.82	21.37

NGVD	National Geodetic Vertical Datum of 1929
bTOC	below top of casing

PREPARED BY: J Martin 11/15/01
CHECKED BY: R Quinn 11/16/01

TABLE 4.2

SUMMARY OF HYDRAULIC CONDUCTIVITY TESTING

Well Number	Date	Screened Interval (ft, bgs)	Lithology Screened	Aquifer Screened	IN (ft/min)	OUT (ft/min)	Hydraulic Conductivity (ft/min)	Hydraulic Conductivity (ft/day)	Source of Data
HMW-03	8/6/92	39.0-49.0	Poorly graded fine to medium sand	Deeper	0.00184	0.001691	0.0018	2.5	ESE
HMW-04	8/6/92	3.0-13.0	Fine to medium silty sand	Shallow	0.00111	0.001546	0.0013	1.9	ESE
HMW-10	10/10/95	5.5-15.71	Fine to medium sand	Shallow	0.0019	0.001334	0.0013	1.9	LAW
HMW-11	10/9/95	7.8-17.6	Fine to medium silty sand	Shallow	NA	0.0008195	0.0008	1.2	LAW
HMW-12	10/9/95	7.9-18.1	Fine to medium slightly silty sand	Shallow	0.001848	0.001241	0.0015	2.2	LAW
HMW-13	10/10/95	10.0-20.2	Fine to medium sand	Shallow	NA	0.0007968	0.0008	1.1	LAW

Notes:

bgs	below ground surface
ft/min	feet per minute
ft/daty	feet per day
ESE	Environmental Science & Engineering, Inc.
LAW	Law Engineering and Environmental Services, Inc.
NA	Not analyzed; screen not fully saturated.

PREPARED BY: R Quinn 1/20/00
CHECKED BY: E Rust 2/4/00

TABLE 4.3

SUMMARY OF REGULATED SUBSTANCES DETECTED IN SURFACE SOIL SAMPLES

SAMPLE LOCATION:	**SB-18**	**SB-19**	**SB-20**	**SB-21**	**SB-22**	**SB-23**	**SB-24**	**SB-25**	**SB-26**	**SB-27**	**SB-28**	**SB-29**	**SB-30**	**SB-31**
SAMPLE DATE:	**7/22/99**	**7/22/99**	**7/22/99**	**7/22/99**	**7/22/99**	**7/29/99**	**7/29/99**	**7/22/99**	**7/22/99**	**7/22/99**	**7/22/99**	**7/22/99**	**1/5/00**	**1/5/00**
Depth (ft):	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**0-2**	**0.5-2**
Parameter - Method (units)														
Pesticides - SW8081A/3550C (mg/kg)														
Dieldrin	NA	NA	NA	NA	<0.004	<0.0073	<0.0048	**0.038 J**	**0.026 J**	**0.043**	NA	NA	NA	NA
Methoxychlor	NA	NA	NA	NA	<0.02	<0.038	<0.025	<0.19	**0.140 J**	<0.18	NA	NA	NA	NA
ICP Metals - SW6010A/6010B (mg/kg)														
Chromium (UBC is 7.7 mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organics - SW8260B/5035 (mg/kg)														
Acetone	<0.0056	<0.064	<0.062	<0.064	<0.066	<0.064	**0.16**	<0.056	**0.079**	<0.065	<0.067	<0.064	<0.053	<0.053
cis-1,2-Dichloroethene	<0.0056	<0.0064	<0.0062	<0.0064	<0.0066	<0.0064	<0.011	<0.0056	<0.0069	<0.0065	<0.0067	<0.0064	<0.053	<0.053
Ethylbenzene	<0.0056	<0.0064	<0.0062	<0.0064	<0.0066	<0.0064	<0.011	<0.0056	<0.0069	<0.0065	<0.0067	<0.0064	<0.053	<0.053
Tetrachloroethene	**0.0061**	<0.0064	<0.0062	<0.0064	<0.0066	<0.0064	<0.011	<0.0056	<0.0069	<0.0065	<0.0067	<0.0064	<0.053	<0.053
Toluene	<0.0056	<0.0064	<0.0062	<0.0064	<0.0066	<0.0064	<0.011	<0.0056	<0.0069	<0.0065	<0.0067	<0.0064	<0.053	<0.053
trans-1,2-Dichloroethene	<0.0056	<0.0064	<0.0062	<0.0064	<0.0066	<0.0064	<0.011	<0.0056	<0.0069	<0.0065	<0.0067	<0.0064	<0.053	<0.053
Xylene (total)	<0.0056	<0.0064	<0.0062	<0.0064	<0.0066	<0.0064	<0.011	<0.0056	<0.0069	<0.0065	<0.0067	<0.0064	<0.053	<0.053
Semi-Volatile Organics - 8270C/3550C (mg/kg)														
Acenaphthene	<0.34	<0.37	<0.36	<0.34	<0.4	<0.36	<0.48	<0.37	<0.41	<1.4	<0.37	<0.36	<0.35	NA
Acenaphthylene	<0.34	<0.37	<0.36	<0.34	<0.4	<0.36	<0.48	**1.6**	**0.83**	**2.4**	<0.37	<0.36	<0.35	NA
Anthracene	<0.34	<0.37	<0.36	<0.34	<0.4	<0.36	<0.48	**1.5**	**2.2**	**2.8**	<0.37	<0.36	<0.35	NA
Benzo(a)anthracene	<0.34	<0.37	<0.36	<0.34	<0.4	**0.51**	<0.48	**7.4**	**6.8**	**17**	<0.37	<0.36	<0.35	NA
Benzo(a)pyrene	<0.34	<0.37	<0.36	<0.34	<0.4	**0.75**	<0.48	**6.2**	**5.2**	**16**	<0.37	<0.36	<0.35	NA
Benzo(b)fluoranthene	<0.34	<0.37	<0.36	<0.34	<0.4	**0.74**	<0.48	**7.0**	**5.8**	**17**	<0.37	<0.36	<0.35	NA
Benzo(g,h,i)perylene	<0.34	<0.37	<0.36	<0.34	<0.4	**0.56**	<0.48	**3.8**	**3.0**	**9.5**	<0.37	<0.36	<0.35	NA
Benzo(k)fluoranthene	<0.34	<0.37	<0.36	<0.34	<0.4	**0.63**	<0.48	**5.6**	**4.9**	**14**	<0.37	<0.36	<0.35	NA
bis (2-Ethylhexyl) phthalate	<0.34	<0.37	<0.36	<0.34	<0.4	<0.36	<0.48	<0.37	<0.41	<1.4	<0.37	<0.36	<0.35	NA
Chrysene	<0.34	<0.37	<0.36	<0.34	<0.4	**0.56**	<0.48	**7.2**	**6.4**	**16**	<0.37	<0.36	<0.35	NA
Dibenz (a,h) anthracene	<0.34	<0.37	<0.36	<0.34	<0.4	<0.36	<0.48	**1.8**	**0.47**	**3.9**	<0.37	<0.36	<0.35	NA
Fluoranthene	<0.34	<0.37	<0.36	<0.34	<0.4	**0.52**	<0.48	**11**	**13**	**22**	<0.37	<0.36	<0.35	NA
Fluorene	<0.34	<0.37	<0.36	<0.34	<0.4	<0.36	<0.48	<0.37	**0.45**	<1.4	<0.37	<0.36	<0.35	NA
Indeno(1,2,3-cd)pyrene	<0.34	<0.37	<0.36	<0.34	<0.4	**0.52**	<0.48	**4.6**	**3.5**	**11**	<0.37	<0.36	<0.35	NA
Naphthalene	<0.34	<0.37	<0.36	<0.34	<0.4	<0.36	<0.48	<0.37	<0.41	<1.4	<0.37	<0.36	<0.35	NA
Phenanthrene	<0.34	<0.37	<0.36	<0.34	<0.4	<0.36	<0.48	**2.0**	**7.3**	**7.1**	<0.37	<0.36	<0.35	NA
Pyrene	<0.34	<0.37	<0.36	<0.34	<0.4	**0.53**	<0.48	**8.5**	**8.7**	**18**	<0.37	<0.36	<0.35	NA

93411.04 (Footnotes appear on page 3 of 3)

TABLE 4.3

SUMMARY OF REGULATED SUBSTANCES DETECTED IN SURFACE SOIL SAMPLES

SAMPLE LOCATION: SAMPLE DATE: Depth (ft):	SB-32 1/5/00 0.5-2	SB-33 1/5/00 0.5-2	SB-34 1/5/00 0-2	SB-35 1/6/00 0-2	SB-36 1/6/00 0-2	SB-37 1/6/00 0-2	SB-38 1/4/00 0-2	SB-39 1/4/00 0-2	SB-40 1/4/00 0-2	SB-41 1/31/00 0-2	SB-42 1/31/00 0-2	SB-43 10/31/01 0-2	SB-43A 10/31/01 0-2
Parameter - Method (units)													
Pesticides - SW8081A/3550C (mg/kg)													
Dieldrin	NA	NA	<0.0036	<0.0035	<0.0036	<0.0037	NA	NA	NA	NA	NA	NA	NA
Methoxychlor	NA	NA	<0.018	<0.018	<0.019	<0.019	NA	NA	NA	NA	NA	NA	NA
ICP Metals - SW6010A/6010B (mg/kg)													
Chromium (UBC is 7.7 mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.4	NA
Volatile Organics - SW8260B/5035 (mg/kg)													
Acetone	NA	<0.053	<0.054	<0.055	<0.055	<0.056	<0.057	<0.059	<0.057	NA	NA	**0.088 JB**	<0.06
cis-1,2-Dichloroethene	NA	<0.0053	<0.0054	<0.0055	<0.0055	<0.0056	<0.0057	<0.0059	<0.0057	NA	NA	<0.0058	<0.006
Ethylbenzene	NA	<0.0053	<0.0054	<0.0055	<0.0055	<0.0056	<0.0057	<0.0059	<0.0057	NA	NA	<0.0058	<0.006
Tetrachloroethene	NA	<0.0053	<0.0054	<0.0055	<0.0055	<0.0056	<0.0057	<0.0059	<0.0057	NA	NA	<0.0058	<0.006
Toluene	NA	<0.0053J	<0.0054J	<0.0055J	<0.0055J	<0.0056J	<0.0057	<0.0059	<0.0057	NA	NA	<0.0058	<0.006
trans-1,2-Dichloroethene	NA	<0.0053	<0.0054	<0.0055	<0.0055	<0.0056	<0.0057	<0.0059	<0.0057	NA	NA	<0.0058	<0.006
Xylene (total)	NA	<0.0053	<0.0054	<0.0055	<0.0055	<0.0056	<0.0057	<0.0059	<0.0057	NA	NA	<0.012	<0.012
Semi-Volatile Organics - 8270C/3550C (mg/kg)													
Acenaphthene	NA	NA	NA	<0.36	<0.36	<0.37	**1.7**	NA	NA	<0.43	<0.44	<0.35	NA
Acenaphthylene	NA	NA	NA	<0.36	**0.97**	<0.37	**1.1**	NA	NA	<0.43	<0.44	<0.35	NA
Anthracene	NA	NA	NA	<0.36	**0.87**	<0.37	**7.4**	NA	NA	<0.43	<0.44	<0.35	NA
Benzo(a)anthracene	NA	NA	NA	<0.36	**8.7**	<0.37	**15**	NA	NA	<0.43	<0.44	<0.35	NA
Benzo(a)pyrene	NA	NA	NA	<0.36	**8.9**	<0.37	**9.9**	NA	NA	<0.43	<0.44	<0.35	NA
Benzo(b)fluoranthene	NA	NA	NA	<0.36	**8.7**	<0.37	**8.6**	NA	NA	<0.43	<0.44	<0.35	NA
Benzo(g,h,i)perylene	NA	NA	NA	<0.36	**5.7**	<0.37	**5.5**	NA	NA	<0.43	<0.44	<0.35	NA
Benzo(k)fluoranthene	NA	NA	NA	<0.36	**8.6**	<0.37	**9.4**	NA	NA	<0.43	<0.44	<0.35	NA
bis (2-Ethylhexyl) phthalate	NA	NA	NA	<0.36	<0.36	<0.37	<0.38	NA	NA	<0.43	<0.44	<0.35 J	NA
Chrysene	NA	NA	NA	<0.36	**8.9**	<0.37	**14**	NA	NA	<0.43	<0.44	<0.35	NA
Dibenz (a,h) anthracene	NA	NA	NA	<0.36	<0.36	<0.37	**3.1**	NA	NA	<0.43	<0.44	<0.35	NA
Fluoranthene	NA	NA	NA	**0.5**	**11**	<0.37	**33**	NA	NA	<0.43	<0.44	<0.35	NA
Fluorene	NA	NA	NA	<0.36	<0.36	<0.37	**3.9**	NA	NA	<0.43	<0.44	<0.35	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	<0.36	**5.7**	<0.37	**5.6J**	NA	NA	<0.43	<0.44	<0.35	NA
Naphthalene	NA	NA	NA	<0.36	<0.36	<0.37	**0.53**	NA	NA	<0.43	<0.44	<0.35	NA
Phenanthrene	NA	NA	NA	<0.36	**2.4J**	<0.37	**39**	NA	NA	<0.43	<0.44	<0.35	NA
Pyrene	NA	NA	NA	<0.36	**10J**	<0.37	**25J**	NA	NA	<0.43	<0.44	<0.35 J	NA

.notes appear on page 3 of 3)

TABLE 4.3

SUMMARY OF REGULATED SUBSTANCES DETECTED IN SURFACE SOIL SAMPLES

SAMPLE LOCATION:	SB-45	SB-49	SB-50	HMW-14	HMW-14R	HMW-15	HMW-16	HMW-17	HMW-18
SAMPLE DATE:	10/31/01	10/31/01	10/31/01	7/28/99	1/5/00	7/28/99	7/29/99	7/28/99	1/6/00
Depth (ft):	0-2	0-2	0-2	1.5	0-2	1.5	1.5	1.5	0-2
Parameter - Method (units)									
Pesticides - SW8081A/3550C (mg/kg)									
Dieldrin	NA	NA	NA	NA	NA	NA	NA	NA	<0.0042
Methoxychlor	NA	NA	NA	NA	NA	NA	NA	NA	<0.022
ICP Metals - SW6010A/6010B (mg/kg)									
Chromium (UBC is 7.7 mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organics - SW8260B/5035 (mg/kg)									
Acetone	NA	NA	NA	<0.057	<0.052	**0.075**	**0.17**	<0.06	<0.054
cis-1,2-Dichloroethene	NA	NA	NA	<0.0057	<0.0052	<0.007	<0.0062	<0.006	<0.0064
Ethylbenzene	NA	NA	NA	<0.0057	<0.0052	<0.007	<0.0062	<0.006	<0.0064
Tetrachloroethene	NA	NA	NA	<0.0057	<0.0052	<0.007	<0.0062	<0.006	<0.0064
Toluene	NA	NA	NA	<0.0057	<0.0052	<0.007	<0.0062	<0.006	<0.0064J
trans-1,2-Dichloroethene	NA	NA	NA	<0.0057	<0.0052	<0.007	<0.0062	<0.006	<0.0064
Xylene (total)	NA	NA	NA	<0.0057	<0.0052	<0.007	<0.0062	<0.006	<0.0064
Semi-Volatile Organics - 8270C/3550C (mg/kg)									
Acenaphthene	<0.34 JL	<0.33 JL	<0.34	<0.36	<0.34	<0.38	<3.5	<0.36	<0.42
Acenaphthylene	<0.34 JL	<0.33 JL	<0.34	<0.36	<0.34	<0.38	**3.6**	<0.36	<0.42
Anthracene	<0.34 JL	<0.33 JL	<0.34	<0.36	<0.34	<0.38	**7.5**	<0.36	<0.42
Benzo(a)anthracene	<0.34 JL	<0.33 JL	<0.34	<0.36	<0.34	<0.38	**34**	<0.36	<0.42
Benzo(a)pyrene	<0.34 JL	<0.33 JL	<0.34	<0.36	<0.34	<0.38	**26**	<0.36	<0.42
Benzo(b)fluoranthene	<0.34 JL	<0.33 JL	<0.34	<0.36	<0.34	<0.38	**28**	<0.36	<0.42
Benzo(g,h,i)perylene	<0.34 JL	<0.33 JL	<0.34	<0.36	<0.34	<0.38	**14**	<0.36	<0.42
Benzo(k)fluoranthene	<0.34 JL	<0.33 JL	<0.34	<0.36	<0.34	<0.38	**27**	<0.36	<0.42
bis (2-Ethylhexyl) phthalate	<0.34 JL	<0.33 JL	<0.34	<0.36	<0.34	<0.38	<3.5	<0.36	<0.42
Chrysene	<0.34 JL	<0.33 JL	<0.34	<0.36	<0.34	<0.38	**33**	<0.36	<0.42
Dibenz (a,h) anthracene	<0.34 JL	<0.33 JL	<0.34	<0.36	<0.34	<0.38	<3.5	<0.36	<0.42
Fluoranthene	<0.34 JL	<0.33 JL	<0.34	<0.36	<0.34	<0.38	**72**	<0.36	<0.42
Fluorene	<0.34 JL	<0.33 JL	<0.34	<0.36	<0.34	<0.38	<3.5	<0.36	<0.42
Indeno(1,2,3-cd)pyrene	<0.34 JL	<0.33 JL	<0.34	<0.36	<0.34	<0.38	**16**	<0.36	<0.42
Naphthalene	<0.34 JL	<0.33 JL	<0.34	<0.36	<0.34	<0.38	<3.5	<0.36	<0.42
Phenanthrene	<0.34 JL	<0.33 JL	<0.34	<0.36	<0.34	<0.38	**32**	<0.36	<0.42
Pyrene	<0.34 JL	<0.33 JL	<0.34	<0.36	<0.34	<0.38	**49**	<0.36	<0.42

Notes:

J	Estimated Quantitation based upon QC data
NA	Not analyzed
UBC	Upper Background Concentration

PREPARED BY: J Martin 11/15/01
CHECKED BY: R Quinn 11/16/01

93411.04 (Footnotes appear on page 3 of 3)

TABLE 4.4

SUMMARY OF REGULATED SUBSTANCES DETECTED IN SUBSURFACE SOIL SAMPLES

SAMPLE LOCATION:	SB-18	SB-19	SB-20	SB-21	SB-22	SB-23	SB-24	SB-25	SB-26	SB-27	SB-28	SB-29	SB-30	SB-31
SAMPLE DATE:	7/22/99	7/22/99	7/22/99	7/22/99	7/22/99	7/29/99	7/29/99	7/22/99	7/22/99	7/22/99	7/22/99	7/22/99	1/5/00	1/5/00
Depth (ft):	6.0	5.5	5.5	5.5	5.5	6.5	6.5	5.5	5.5	5.5	5.5	5.5	6-8	5-7
Parameter - Method (units)														
Pesticides - SW8081A/3550C (mg/kg)														
Dieldrin	NA	NA	NA	NA	<0.004	<0.0041	<0.0041	<0.004	<0.0041	<0.004	NA	NA	NA	NA
Methoxychlor	NA	NA	NA	NA	<0.021	<0.021	<0.021	<0.02	<0.021	<0.02	NA	NA	NA	NA
ICP Metals - SW6010A/6010B (mg/kg)														
Barium (UBC is 28 mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium (UBC is 7.7 mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organics - SW8260B/5035 (mg/kg)														
Acetone	<0.058	<0.064	<0.062	<0.067	<0.054	**0.11**	**0.14**	<0.06	<0.065	<0.056	<0.061	<0.062	<0.055	<0.053
cis-1,2-Dichloroethene	<0.0058	<0.0064	<0.0062	<0.0067	<0.0054	<0.0075	<0.0087	<0.006	<0.0065	<0.0056	<0.0061	<0.0062	<0.055	<0.0053
Ethylbenzene	<0.0058	<0.0064	<0.0062	<0.0067	<0.0054	<0.0075	<0.0087	<0.006	<0.0065	**0.02**	<0.0061	<0.0062	<0.055	<0.0053
Tetrachloroethene	<0.0058	<0.0064	<0.0062	<0.0067	<0.0054	<0.0075	<0.0087	<0.006	<0.0065	<0.0056	<0.0061	<0.0062	<0.055	<0.0053
Toluene	<0.0058	<0.0064	<0.0062	<0.0067	<0.0054	**0.02**	<0.0087	<0.006	<0.0065	<0.0056	<0.0061	<0.0062	<0.055	<0.0053
trans-1,2-Dichloroethene	<0.0058	<0.0064	<0.0062	<0.0067	<0.0054	<0.0075	<0.0087	<0.006	<0.0065	<0.0056	<0.0061	<0.0062	<0.055	<0.0053
Xylene (total)	<0.0058	<0.0064	<0.0062	<0.0067	<0.0054	<0.0075	<0.0087	<0.006	<0.0065	**0.028**	<0.0061	<0.0062	<0.055	<0.0053
Semi-Volatile Organics - 8270C/3550C (mg/kg)														
Acenaphthene	<0.36	<0.37	<0.35	<0.39	<0.4	<0.41	<0.41	<0.39	<0.41	<0.4	<0.38	<0.37	**2.3**	NA
Acenaphthylene	<0.36	<0.37	<0.35	<0.39	<0.4	<0.41	<0.41	<0.39	<0.41	<0.4	<0.38	<0.37	**6.6**	NA
Anthracene	<0.36	<0.37	<0.35	<0.39	<0.4	<0.41	<0.41	<0.39	<0.41	<0.4	<0.38	<0.37	**5.7**	NA
Benzo(a)anthracene	<0.36	<0.37	<0.35	<0.39	<0.4	<0.41	<0.41	<0.39	<0.41	<0.4	<0.38	<0.37	**18**	NA
Benzo(a)pyrene	<0.36	<0.37	<0.35	<0.39	<0.4	<0.41	<0.41	<0.39	<0.41	<0.4	<0.38	<0.37	**20**	NA
Benzo(b)fluoranthene	<0.36	<0.37	<0.35	<0.39	<0.4	<0.41	<0.41	<0.39	<0.41	<0.4	<0.38	<0.37	**13**	NA
Benzo(g,h,i)perylene	<0.36	<0.37	<0.35	<0.39	<0.4	<0.41	<0.41	<0.39	<0.41	<0.4	<0.38	<0.37	**12**	NA
Benzo(k)fluoranthene	<0.36	<0.37	<0.35	<0.39	<0.4	<0.41	<0.41	<0.39	<0.41	<0.4	<0.38	<0.37	**12**	NA
bis (2-Ethylhexyl) phthalate	<0.36	<0.37	<0.35	<0.39	<0.4	<0.41	<0.41	<0.39	<0.41	<0.4	<0.38	<0.37	< 1.9	NA
Chrysene	<0.36	<0.37	<0.35	<0.39	<0.4	<0.41	<0.41	<0.39	<0.41	<0.4	<0.38	<0.37	**20**	NA
Dibenz (a,h) anthracene	<0.36	<0.37	<0.35	<0.39	<0.4	<0.41	<0.41	<0.39	<0.41	<0.4	<0.38	<0.37	**4.2**	NA
Fluoranthene	<0.36	<0.37	<0.35	<0.39	<0.4	<0.41	<0.41	<0.39	<0.41	**0.43**	<0.38	<0.37	**22**	NA
Fluorene	<0.36	<0.37	<0.35	<0.39	<0.4	<0.41	<0.41	<0.39	<0.41	<0.4	<0.38	<0.37	**3.7**	NA
Indeno(1,2,3-cd)pyrene	<0.36	<0.37	<0.35	<0.39	<0.4	<0.41	<0.41	<0.39	<0.41	<0.4	<0.38	<0.37	**11**	NA
Naphthalene	<0.36	<0.37	<0.35	<0.39	<0.4	<0.41	<0.41	<0.39	<0.41	<0.4	<0.38	<0.37	<1.9	NA
Phenanthrene	<0.36	<0.37	<0.35	<0.39	<0.4	<0.41	<0.41	<0.39	<0.41	<0.4	<0.38	<0.37	**19**	NA
Pyrene	<0.36	<0.37	<0.35	<0.39	<0.4	<0.41	<0.41	<0.39	<0.41	**0.41**	<0.38	<0.37	**26J**	NA

93411.04 notes appear on page 3 of 3)

TABLE 4.4

SUMMARY OF REGULATED SUBSTANCES DETECTED IN SUBSURFACE SOIL SAMPLES

SAMPLE LOCATION:	SB-32	SB-33	SB-34	SB-35	SB-36	SB-37	SB-38	SB-39	SB-40	SB-43	SB-44	SB-44	SB-46	SB-46
SAMPLE DATE:	1/5/00	1/5/00	1/5/00	1/6/00	1/6/00	1/6/00	1/4/00	1/4/00	1/4/00	11/1/01	11/1/01	11/1/01	10/31/01	10/31/01
Depth (ft):	4-6	3-5	2.5-4.5	4-6	2-3	2-3	3.5-5.5	2-4	2-4	2-4	2-4	6-8	4-6	12-14
Parameter - Method (units)														
Pesticides - SW8081A/3550C (mg/kg)														
Dieldrin	NA	NA	<0.0037	<0.0035	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methoxychlor	NA	NA	<0.019	<0.018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ICP Metals - SW6010A/6010B (mg/kg)														
Barium (UBC is 28 mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium (UBC is 7.7 mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.6	2.7	4.3	1.9	3.9
Volatile Organics - SW8260B/5035 (mg/kg)														
Acetone	NA	<0.053	<0.056	<0.052	<0.06	<0.061	<0.066J	<0.3	<0.063	<0.06	<0.058	<0.059	<0.06	<0.058
cis-1,2-Dichloroethene	NA	<0.0053	<0.0056	<0.0052	<0.006	<0.0061	<0.0066J	<0.03	<0.0063	<0.006	<0.0058	<0.0059	<0.006	<0.0058
Ethylbenzene	NA	<0.0053	<0.0056	<0.0052	<0.006	<0.0061	<0.0066J	<0.03	<0.0063	<0.006	<0.0058	<0.0059	<0.006	<0.0058
Tetrachloroethene	NA	<0.0053	<0.0056	<0.0052	<0.006	<0.0061	<0.0066J	<0.03	<0.0063	<0.006	<0.0058	<0.0059	<0.006	<0.0058
Toluene	NA	<0.0053J	<0.0056J	<0.0052J	<0.006J	<0.0061J	<0.0066J	<0.03	<0.0063	<0.006	<0.0058	<0.0059	<0.006	<0.0058
trans-1,2-Dichloroethene	NA	<0.0053	<0.0056	<0.0052	<0.006	<0.0061	<0.0066J	<0.03	<0.0063	<0.006	<0.0058	<0.0059	<0.006	<0.0058
Xylene (total)	NA	<0.0053	<0.0056	<0.0052	<0.006	<0.0061	<0.0066J	<0.03	<0.0063	<0.012	<0.012	<0.012	<0.012	<0.012
Semi-Volatile Organics - 8270C/3550C (mg/kg)														
Acenaphthene	NA	NA	NA	<0.35	<0.39	<0.4	<0.43	NA	NA	<0.35	<0.35	<0.38	<0.34	<0.38
Acenaphthylene	NA	NA	NA	<0.35	<0.39	<0.4	<0.43	NA	NA	<0.35	<0.35	<0.38	<0.34	<0.38
Anthracene	NA	NA	NA	<0.35	<0.39	<0.4	<0.43	NA	NA	<0.35	<0.35	<0.38	<0.34	<0.38
Benzo(a)anthracene	NA	NA	NA	<0.35	<0.39	<0.4	<0.43	NA	NA	<0.35	<0.35	<0.38	<0.34	<0.38
Benzo(a)pyrene	NA	NA	NA	<0.35	<0.39	<0.4	<0.43	NA	NA	<0.35	<0.35	<0.38	<0.34	<0.38
Benzo(b)fluoranthene	NA	NA	NA	<0.35	<0.39	<0.4	<0.43	NA	NA	<0.35	<0.35	<0.38	<0.34	<0.38
Benzo(g,h,i)perylene	NA	NA	NA	<0.35	<0.39	<0.4	<0.43	NA	NA	<0.35	<0.35	<0.38	<0.34	<0.38
Benzo(k)fluoranthene	NA	NA	NA	<0.35	<0.39	<0.4	<0.43	NA	NA	<0.35	<0.35	<0.38	<0.34	<0.38
bis (2-Ethylhexyl) phthalate	NA	NA	NA	< 0.35	< 0.39	< 0.4	< 0.43	NA	NA	<0.35 J	<0.35 J	<0.38 J	<0.34 J	<0.38 J
Chrysene	NA	NA	NA	<0.35	<0.39	<0.4	<0.43	NA	NA	<0.35	<0.35	<0.38	<0.34	<0.38
Dibenz (a,h) anthracene	NA	NA	NA	<0.35	<0.39	<0.4	<0.43	NA	NA	<0.35	<0.35	<0.38	<0.34	<0.38
Fluoranthene	NA	NA	NA	<0.35	<0.39	<0.4	<0.43	NA	NA	<0.35	<0.35	<0.38	<0.34	<0.38
Fluorene	NA	NA	NA	<0.35	<0.39	<0.4	<0.43	NA	NA	<0.35	<0.35	<0.38	<0.34	<0.38
Indeno(1,2,3-cd)pyrene	NA	NA	NA	<0.35	<0.39	<0.4	<0.43	NA	NA	<0.35	<0.35	<0.38	<0.34	<0.38
Naphthalene	NA	NA	NA	<0.35	<0.39	<0.4	<0.43	NA	NA	<0.35	<0.35	<0.38	<0.34	<0.38
Phenanthrene	NA	NA	NA	<0.35	<0.39	<0.4	<0.43	NA	NA	<0.35	<0.35	<0.38	<0.34	<0.38
Pyrene	NA	NA	NA	<0.35	<0.39	<0.4	<0.43	NA	NA	<0.35 J	<0.35 J	<0.38 J	<0.34 J	<0.38 J

93411.04 (Footnotes appear on page 3 of 3)

TABLE 4.4

SUMMARY OF REGULATED SUBSTANCES DETECTED IN SUBSURFACE SOIL SAMPLES

SAMPLE LOCATION:	SB-47	SB-48	HMW-14	HMW-14R	HMW-15	HMW-16	HMW-17	HMW-18
SAMPLE DATE:	10/31/01	10/31/01	7/28/99	1/5/00	7/28/99	7/29/99	7/28/99	1/6/00
Depth (ft):	2-4	2-5	7.5	7-9	7.5	7.0	6.5	2-3
Parameter - Method (units)								
<u>Pesticides - SW8081A/3550C (mg/kg)</u>								
Dieldrin	NA	NA	NA	NA	NA	NA	NA	NA
Methoxychlor	NA	NA	NA	NA	NA	NA	NA	NA
<u>ICP Metals - SW6010A/6010B (mg/kg)</u>								
Barium (UBC is 28 mg/kg)	6.5	NA	NA	NA	NA	NA	NA	NA
Chromium (UBC is 7.7 mg/kg)	NA	3.9	NA	NA	NA	NA	NA	NA
<u>Volatile Organics - SW8260B/5035 (mg/kg)</u>								
Acetone	NA	NA	**0.095**	<0.054	**0.17**	<0.065	**0.095**	<0.064
cis-1,2-Dichloroethene	NA	NA	<0.006	**0.27**	<0.0062	<0.0065	<0.0063	<0.0058
Ethylbenzene	NA	NA	<0.006	<0.0054	<0.0062	<0.0065	<0.0063	<0.0058
Tetrachloroethene	NA	NA	<0.006	<0.0054	<0.0062	<0.0065	<0.0063	<0.0058
Toluene	NA	NA	<0.006	<0.0054	<0.0062	<0.0065	<0.0063	<0.0058J
trans-1,2-Dichloroethene	NA	NA	<0.006	**0.013**	<0.0062	<0.0065	<0.0063	<0.0058
Xylene (total)	NA	NA	<0.006	<0.0054	<0.0062	<0.0065	<0.0063	<0.0058
<u>Semi-Volatile Organics - 8270C/3550C (mg/kg)</u>								
Acenaphthene	NA	NA	<0.36	<0.36	<0.36	<0.79	<0.37	<0.38
Acenaphthylene	NA	NA	**0.47**	<0.36	<0.36	**1.5**	<0.37	<0.38
Anthracene	NA	NA	<0.36	<0.36	<0.36	**2.2**	<0.37	<0.38
Benzo(a)anthracene	NA	NA	**1.8**	<0.36	<0.36	**13**	<0.37	<0.38
Benzo(a)pyrene	NA	NA	**1.9**	<0.36	<0.36	**10**	<0.37	<0.38
Benzo(b)fluoranthene	NA	NA	**1.6**	<0.36	<0.36	**9.1**	<0.37	<0.38
Benzo(g,h,i)perylene	NA	NA	**1.2**	<0.36	<0.36	**5.7**	<0.37	<0.38
Benzo(k)fluoranthene	NA	NA	**2.0**	<0.36	<0.36	**13**	<0.37	<0.38
bis (2-Ethylhexyl) phthalate	NA	NA	<0.36	**0.43**	<0.36	<0.79	<0.37	< 0.38
Chrysene	NA	NA	**1.9**	<0.36	<0.36	**12**	<0.37	<0.38
Dibenz (a,h) anthracene	NA	NA	**0.43**	<0.36	<0.36	**0.86**	<0.37	<0.38
Fluoranthene	NA	NA	**2.4**	<0.36	<0.36	**24**	<0.37	<0.38
Fluorene	NA	NA	<0.36	<0.36	<0.36	<0.79	<0.37	<0.38
Indeno(1,2,3-cd)pyrene	NA	NA	**1.2**	<0.36	<0.36	**6.4**	<0.37	<0.38
Naphthalene	NA	NA	<0.36	<0.36	<0.36	<0.79	<0.37	<0.38
Phenanthrene	NA	NA	<0.36	<0.36	<0.36	**10**	<0.37	<0.38
Pyrene	NA	NA	**2.0**	<0.36	<0.36	**17**	<0.37	<0.38

<u>NOTES:</u>

J Estimated quantitation based upon QC data
NA Not analyzed
UBC Upper Background Concentration

PREPARED BY: <u>J Martin 11/15/01</u>
CHECKED BY: <u>R Quinn 11/16/01</u>

TABLE 4.5

SUMMARY OF REGULATED SUBSTANCES DETECTED IN GROUNDWATER SAMPLES

SAMPLE LOCATION: SAMPLE DATE: PARAMETER/METHOD (units)	HMW-1 10/7/95	HMW-2 1/16/00	HMW-2 7/12/99	HMW-2 10/7/95	HMW-3 11/6/01	HMW-3 10/6/95	HMW-4 7/12/99	HMW-4 10/6/95	HMW-5 10/6/95	HMW-6 7/12/99	HMW-6 10/6/95	HMW-8 7/12/99	HMW-8 10/8/95
Volatile Organics - SW8240B/SW8260B (mg/L)													
Acetone	<0.02	NA	NA	<0.02	<0.025	<0.02	NA	<0.02	<0.02	NA	<0.02	NA	<0.02
Benzene	<0.005	NA	<0.002	<0.005	<0.001	<0.005	<0.002	<0.005	<0.005	**0.0842**	**0.1**	<0.002	**0.11**
Ethylbenzene	<0.005	NA	<0.002	<0.005	<0.001	<0.005	<0.002	<0.005	<0.005	**0.0224**	**0.037**	<0.002	**0.011**
Toluene	<0.005	NA	<0.002	<0.005	<0.001	<0.005	<0.002	<0.005	<0.005	<0.002	<0.005	<0.002	<0.005
Vinyl chloride	<0.005	NA	NA	<0.005	<0.001	<0.005	NA	<0.005	<0.005	NA	**0.011**	NA	<0.005
Xylene (total)	<0.005	NA	<0.006	<0.005	<0.001	<0.005	<0.006	<0.005	<0.005	<0.006	<0.005	<0.006	<0.005
1,1-Dichloroethene	<0.005	NA	NA	<0.005	<0.001	<0.005	NA	<0.005	<0.005	NA	<0.005	NA	<0.005
cis-1,2-Dichloroethene	<0.005	NA	NA	<0.005	<0.001	<0.005	NA	<0.005	<0.005	NA	<0.005	NA	<0.005
trans-1,2-Dichloroethene	<0.005	NA	NA	<0.005	<0.001	<0.005	NA	<0.005	<0.005	NA	<0.005	NA	<0.005
Semi-Volatile Organics - SW8270B/SW8270C (mg/L)													
2,4-Dimethylphenol	<0.01	NA	NA	<0.01	NA	<0.01	NA	<0.01	<0.01	NA	<0.01	NA	<0.01
Naphthalene	<0.01	NA	<0.0106	<0.01	<0.010	<0.010	<0.0104	<0.010	<0.010	**0.0747**	**0.061**	<0.010	<0.010
ICP Metals SW6010A/SW6010B (mg/L)													
Barium	**0.042**	NA	NA	**0.095**	**0.019**	**0.048**	NA	**0.112**	**0.03**	NA	**0.045**	NA	**0.093**
Chromium	<0.02	NA	NA	<0.02	<0.01	<0.02	NA	<0.02	<0.02	NA	<0.02	NA	<0.02
Arsenic SW7060A (mg/L)													
Arsenic	<0.01	NA	NA	<0.01	<0.01	<0.01	NA	<0.01	<0.01	NA	**0.031**	NA	<0.01
Lead SW7421(mg/L)													
Lead	<0.003	<0.003	NA	**0.0173**	<0.005	<0.003	NA	**0.0118**	<0.003	NA	<0.003	NA	<0.003

93411.04 (Footnotes appear on page 3 of 3)

TABLE 4.5

SUMMARY OF REGULATED SUBSTANCES DETECTED IN GROUNDWATER SAMPLES

SAMPLE LOCATION: SAMPLE DATE: PARAMETER/METHOD (units)	HMW-9 7/12/99	HMW-9 10/8/95	HMW-10 7/12/99	HMW-10 10/9/95	HMW-11 7/12/99	HMW-11 10/8/95	HMW-12 1/19/00	HMW-12 10/8/95	HMW-13 7/12/99	HMW-13 10/9/95	HMW-14R 11/6/01	HMW-14R 1/17/00	HMW-17 1/19/00
<u>Volatile Organics - SW8240B/SW8260B (mg/L)</u>													
Acetone	NA	<0.02	NA	<0.02	NA	<0.02	<0.02	<0.02	NA	**0.021**	<0.025	<0.02	<0.02
Benzene	<0.002	**0.025**	**0.104**	**0.41**	**0.039**	**0.034**	<0.005	<0.005	**0.322**	**1.2**	**0.0011**	<0.005	<0.005
Ethylbenzene	<0.002	**0.012**	<0.002	**0.059**	**0.0057**	**0.022**	<0.005	<0.005	**0.0864**	**0.63**	<0.001	<0.005	<0.005
Toluene	<0.002	<0.005	<0.002	<0.005	<0.002	<0.005	<0.005	<0.005	<0.002	**0.005**	<0.001	<0.005	<0.005
Vinyl chloride	NA	<0.005	NA	<0.005	NA	<0.005	<0.005	<0.005	NA	<0.005	<0.001	<0.005	<0.005
Xylene (total)	<0.006	**0.31 JL**	**0.0462**	**0.18**	**0.378**	**0.81**	<0.005	<0.005	**0.276**	**0.52**	**0.0048**	<0.005	<0.005
1,1-Dichloroethene	NA	<0.005	NA	<0.005	NA	<0.005	<0.005	<0.005	NA	<0.005	<0.002	<0.005	<0.005
cis-1,2-Dichloroethene	NA	<0.005	NA	<0.005	NA	<0.005	<0.005	<0.005	NA	<0.005	<0.001	<0.005	<0.005
trans-1,2-Dichloroethene	NA	<0.005	NA	<0.005	NA	<0.005	<0.005	<0.005	NA	<0.005	**0.95**	**0.22**	<0.005
											0.033	**0.009**	
<u>Semi-Volatile Organics - SW8270B/SW8270C (mg/L)</u>													
2,4-Dimethylphenol	NA	<0.02	NA	<0.01	NA	<0.01	NA	<0.01	NA	**0.01**	NA	NA	NA
Naphthalene	<0.0108	**0.02**	<0.0103	<0.01	**0.0348**	**0.042**	<0.010	<0.010	**0.121**	**0.19**	NA	<0.010	<0.010
<u>ICP Metals SW6010A/SW6010B (mg/L)</u>													
Barium	NA	**0.068**	NA	**0.079**	NA	**0.047**	**0.026 J**	**0.058**	NA	**0.131**	NA	**0.048 J**	<0.02
Chromium	NA	<0.02	NA	0.02	NA	<0.02	NA	<0.02	NA	**0.046**	NA	NA	NA
<u>Arsenic SW7060A (mg/L)</u>													
Arsenic	NA	<0.01	NA	<0.01	NA	<0.01	<0.01	**0.013**	NA	**0.03**	NA	<0.01	<0.01
<u>Lead SW7421(mg/L)</u>													
Lead	NA	<0.003	NA	**0.0053**	NA	**0.0038**	<0.003	**0.0048**	NA	**0.0188**	NA	<0.003	<0.003

TABLE 4.5

SUMMARY OF REGULATED SUBSTANCES DETECTED IN GROUNDWATER SAMPLES

SAMPLE LOCATION:	HMW-18	HMW-19	HMW-20	HMW-21	HMW-22
SAMPLE DATE:	1/20/00	1/20/00	1/19/00	11/6/01	11/6/01
PARAMETER/METHOD (units)					
Volatile Organics - SW8240B/SW8260B (mg/L)					
Acetone	<0.02	<0.02	<0.02	<0.025	<0.025
Benzene	<0.005	<0.005	<0.005	<0.001	<0.001
Ethylbenzene	<0.005	<0.005	<0.005	<0.001	<0.001
Toluene	<0.005	<0.005	<0.005	<0.001	<0.001
Vinyl chloride	<0.005	<0.005	<0.005	**0.0054**	<0.001
Xylene (total)	<0.005	<0.005	<0.005	<0.002	<0.002
1,1-Dichloroethene	<0.005	<0.005	<0.005	**0.0016**	<0.001
cis-1,2-Dichloroethene	<0.005	<0.005	<0.005	**0.39**	<0.001
trans-1,2-Dichloroethene	<0.005	<0.005	<0.005	**0.0058**	<0.001
Semi-Volatile Organics - SW8270B/SW8270C (mg/L)					
2,4-Dimethylphenol	NA	NA	NA	NA	NA
Naphthalene	<0.010	<0.010	<0.010	NA	NA
ICP Metals SW6010A/SW6010B (mg/L)					
Barium	**0.037 J**	**0.056 J**	<0.02	NA	NA
Chromium	NA	NA	NA	NA	NA
Arsenic SW7060A (mg/L)					
Arsenic	<0.01	<0.01	<0.01	NA	NA
Lead SW7421(mg/L)					
Lead	<0.003	<0.003	<0.003	NA	NA

DATA QUALIFICATIONS/NOTES

J Estimated quantitation based upon QC data
JL Estimated quantitation : possible biased low or a false negative based upon QC data
NA Not Analyzed

PREPARED BY: J Martin 11/15/01
CHECKED BY: R Quinn 11/16/01

TABLE 4.6

SUMMARY OF REGULATED SUBSTANCES DETECTED IN SURFACE WATER SAMPLES

SAMPLE LOCATION: SAMPLE DATE: PARAMETER/METHOD (units)	Georgia In-Stream Water Criteria (1)	Maximum Contaminant Levels (2)	HSW-1 10/31/01	HSW-2 10/31/01	HSW-3 10/31/01	HSW-4 10/31/01	HSW-5 10/31/01	HSW-6 10/31/01
Volatile Organics - SW8260B (mg/L)								
Benzene	0.071	0.005	**0.013**	<0.005	<0.005	<0.005	<0.005	<0.005
Ethylbenzene	28.71	0.7	**0.0085**	<0.005	<0.005	<0.005	<0.005	<0.005
Toluene	200	1	**0.014 JB**	<0.005	<0.005	<0.005	<0.005	<0.005
Xylene (total)	not established	10	**0.067**	<0.005	<0.005	<0.005	<0.005	<0.005
Naphthalene	not established	0.0065 (3)	**0.0099**	<0.005	<0.005	<0.005	<0.005	<0.005
Semi-Volatile Organics - SW8270C (mg/L)			<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
RCRA Metals - SW6010B (mg/L)			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Notes:

(1) Georgia Rules and Regulations for Water Quality Control, Chapter 391-3-6, Revised October 2001
(2) USEPA Drinking Water Standards and Health Advisories, Summer 2000.
(3) Region 3 Risk Based Concentration for tap water.
JB Estimated quantitation: possibly biased high or false positive based upon blank data.

PREPARED BY: J Martin 11/15/01
CHECKED BY: R Quinn 11/16/01

TABLE 5.1

RESULTS OF GROUNDWATER USAGE SURVEY IN A 3-MILE RADIUS

OWNER or WELL NAME	USAGE	LATITUDE/LONGITUDE	DEPTH of WELL (ft) *	BOTTOM of CASING (ft) *	CASING DIAMETER (in)	DISTANCE and DIRECTION from SITE [miles]
Savannah, GA 36	P	315922/0810845	414	252.00	10.00	2.1/SSE
Howard Johnsons Mtl	C	320314/0810850	448	294.00	4.00	2.4/NNW
SCL RR, SAV Shops	C	320119/0810852	508	275.00	8.00	.3/NW
McCallan, Mrs.	P	320308/0810858	341	146.00	4.00	2.3/NNW
Rahn Dairy	A	320150/0811034	375	310.00	4.00	2.1/WNW
Biltmore Gardens MHP	P	320239/0811048	380	290.00	4.00	2.8/NW
U.S. Army, Hunter 09	F	320019/0811007	623	270.00	12.00	1.8/SW
U.S. Army, Hunter 01	A	320145/0810806	504	259.00	12.00	.8/NW
U.S. Army, Hunter 02	T	320115/0810745	555	260.00	16.00	.8/ENE
U.S. Army, Hunter 03	P	320002/0810910	370	324.00	4.00	1.4/SSW
U.S. Army, Hunter 05	P	320001/0811104	380	85.00	4.00	2.8/SW
U.S. Army, Hunter 04A	H	320103/0810958	360	267.00	4.00	1.3/WSW
U.S. Army, Hunter 04	T	320058/0810955	300	90.00	3.00	1.3/WSW
U.S. Army, Hunter 06	H	320017/0811034	180	60.00	3.00	2.2/SW
U.S. Army, Hunter 08	A	320003/0811023	375	255.00	8.00	2.2/SW
Savannah, GA 25	P	320227/0810853	540	287.00	10.00	1.5/NNW
Savannah, GA 13	U	315948/0810707	1000	270.00	12.00	2.1/SE
Grove Park Water Co.	P	315942/0810612	400	264.00	4.00	2.9/SE
Rivers End SubDiv 01	P	315921/0810659	440	200.00	4.00	2.6/SSE
Rivers End SubDiv 2	P	315924/0810646	400	227.00	4.00	2.7/SE
Savannah, GA 09	P	320219/0810614	710	267.00	16.00	2.6/ENE
Derst Baking Co.	N	320258/0810728	568	258.00	10.00	2.3/NNE
Benedictine School	U	320028/0810542	327	100.00	4.00	2.9/ESE
Savannah, GA 06	P	320040/0810549	750	240.00	12.00	2.8/ESE
Reynolds-Manley L1	U	320243/0810700	346	68.00	6.00	2.4/NE
Sav Elec & Pwr Co Op 2	N	320317/0810716	561	276.00	6.00	2.8/NNE
Candler Hospital	C	320146/0810557	600	50.00	24.00	2.6/ENE

Notes:

*	Below ground surface
P	Public
C	Commercial
A	Agriculture
U	Unused
F, T, H	Military

Sources:
Ground-water Site Inventory: U.S. Geological Survey, Georgia District, February 14, 2000.

PREPARED BY: R Quinn 3/17/00
CHECKED BY: J. Vickers 3/17/00

TABLE 5.2

PROTECTED ANIMAL AND PLANT SPECIES OCCURRING IN THE VICINITY OF HUNTER ARMY AIRFIELD, GEORGIA

Kingdom Subgroup	Scientific Name	Common Name	Federal Status	State Status	Global Rarity Rank	State Rarity Rank
Animals						
Reptile	*Clemmys guttata*	Spotted Turtle		U	G5	S3S4
Reptile	*Gopherus polyphemus*	Gopher Tortoise	LT/NL	T	G3	S3
Bird	*Sterna antillarum*	Least Tern	LE/NL	R	G4	S2S3
Bird	*Picoides borealis*	Red-cockaded Woodpecker	LE	E	G3	S2
Fish	*Petromyzon marinus*	Sea Lamprey			G5	S3
Plants						
Dicot	*Sarracenia minor*	Hooded Pitcherplant		U	G4	S4
Monocot	*Sporobolus pinetorum*	Pineland Dropseed				S2?
Monocot	*Pteroglossaspis ecristata*	Wild Coco			G2	S1

Federal Status (US Fish and Wildlife):

LE	Listed endangered
LT	Listed threatened
NL	Status varies for parts of range with some ranges not listed

State Status (Georgia Department of Natural Resources):

E	Listed as endangered
T	Listed as threatened
R	Listed as rare
U	Listed as unusual and deserving of special consideration

State[Global] Rank:

S1/G1	Critically imperiled because of extreme rarity
S2/G2	Imperiled because of rarity
S3/G3	Rare or uncommon
S4/G4	Apparently secure
S5/G5	Demonstrably secure
?	Denotes questionable rank

__Source:__

Georgia Natural Heritage Program, The Georgia Natural Heritage Program Database System, October 1999.

PREPARED BY: __L Smith 2/2/00__
CHECKED BY: __E Hustings 2/7/00__

TABLE 5.3

Ecological Screening Criteria for Surface Water, Groundwater, and Surface Soil.

Analyte	Surface Water and Groundwater (mg/L)[(a)]	Surface Soil (mg/Kg)[(b)]
Volatile Organic Compounds		
Acetone	NA	NA
Benzene	0.071	--
1,1-Dichloroethene	0.003	--
cis-1,2-Dichloroethene	NA	--
trans-1,2-Dichloroethene	NA	--
Ethylbenzene	28.72	--
Naphthalene	NA	--
Tetrachloroethene	--	0.01
Toluene	200	--
Vinyl Chloride	0.525	--
Xylene (total)	NA	--
Semi-Volatile Organic Compounds		
Acenaphthene	--	20
Acenaphthylene	--	0.1[(c)]
Anthracene	--	0.1
Benzo(a)anthracene	--	0.1[(c)]
Benzo(a)pyrene	--	0.1
Benzo(b)fluoranthene	--	0.1[(c)]
Benzo(g,h,i)perylene	--	0.1[(c)]
Benzo(k)fluoranthene	--	0.1[(c)]
Chrysene	--	0.1[(c)]
Dibenz(a,h)anthracene	--	0.1[(c)]
2,4-Dimethylphenol	NA	--
Fluoranthene	--	0.1
Fluorene	--	30
Indeno(1,2,3-cd)pyrene	--	0.1[(c)]
Naphthalene	NA	0.1
Phenanthrene	--	0.1
Pyrene	--	0.1
Pesticides		
Dieldrin	--	0.0005
Methoxychlor	--	NA
Metals		
Arsenic	0.05	--
Barium	NA	--
Chromium	0.011	0.4
Lead	0.0012	--

Notes:

(a)	Georgia Instream Water Quality Criteria, Revised July 1999.
(b)	Region IV Soil Ecological Screening Values, EPA 2001.
(c)	Value for Benzo(a)pyrene used as a surrogate.
--	Data not needed for Ecological Assessment.
NA	Not Available

PREPARED BY: CMB 2/3/02
CHECKED BY: EFC 2/4/02

TABLE 5.4

Surface Water Concentrations for HAAF Former Fire Training Area

Parameter	Frequency of Detection	Minimum Detected Concentration (mg/L)	Maximum Detected Concentration (mg/L)	Georgia Instream Water Quality Criteria (mg/L) [(a)]	Ecological Constituent of Potential Concern (Yes/No)
Volatile Organic Compounds					
Benzene	1/6	NA	0.013	0.071	No
Ethylbenzene	1/6	NA	0.0085	28.72	No
Toluene	1/6	NA	0.014	200	No
Xylene (total)	1/6	NA	$\boxed{0.067}$	NA	Yes
Naphthalene	1/6	NA	$\boxed{0.0099}$	NA	Yes

Notes:

☐	Boxed maximum detected concentrations exceed the Class I Groundwater Quality Standards.
[(a)]	Georgia Rules and Regulations for Water Quality Control, Chapter 391-3-6, Revised October 2001.
NA	Not Available

PREPARED BY: CMB 2/3/02
CHECKED BY: EFC 2/4/02

TABLE 5.5

Groundwater Concentrations for HAAF Former Fire Training Area

Parameter	Frequency of Detection	Minimum Detected Concentration (mg/L)	Maximum Detected Concentration (mg/L)	Georgia Instream Water Quality Criteria (mg/L)[a]	Ecological Constituent of Potential Concern (Yes/No)
Volatile Organic Compounds					
Acetone	1/19	NA	0.021	NA	Yes
Benzene	5/19	0.0011	0.322	0.071	Yes
1,1-Dichloroethene	1/19	NA	0.0016	0.003	No
cis-1,2-Dichloroethene	2/19	0.39	0.95	NA	Yes
trans-1,2-Dichloroethene	2/19	0.0058	0.033	NA	Yes
Ethylbenzene	3/19	0.0057	0.0864	28.72	No
Vinyl Chloride	3/19	0.0048	0.011	0.525	No
Xylene(Total)	3/19	0.0462	0.378	NA	Yes
Semi-Volatile Organic Compounds					
2;4-Dimethylphenol	1/12	NA	0.01	NA	Yes
Naphthalene	3/17	0.0348	0.121	NA	Yes
Metals					
Arsenic	2/17	0.03	0.031	0.05	No
Barium	15/17	0.019	0.131	NA	Yes
Chromium	1/12	NA	0.046	0.011	Yes
Lead	4/17	0.0038	0.018	0.0012	Yes

Notes:

Boxed maximum detected concentrations exceed the Class I Groundwater Quality Standards.

[a] Georgia Rules and Regulations for Water Quality Control, Chapter 391-3-6, Revised October 2001.

NA Not Available

PREPARED BY: CMB 2/3/02
CHECKED BY: EFC 2/4/02

TABLE 5.6

Surface Soil Concentrations for HAAF Former Fire Training Area

Parameter	Frequency of Detection	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Background Concentration (mg/kg)	Recommended ESV for Soil (mg/kg)	Constituent of Potential Concern (Yes/No)
Volatile Organic Compounds						
Acetone	5/28	0.075	$\boxed{0.17}$	NA	NA	Yes
Tetrachloroethene	1/28	NA	0.0061	NA	0.01	No
Semi-Volatile Organic Compounds						
Acenaphthene	1/29	NA	1.7	NA	20	No
Acenaphthylene	6/29	0.83	$\boxed{3.6}$	NA	0.1	Yes
Anthracene	6/29	0.87	$\boxed{7.5}$	NA	0.1	Yes
Benzo(a)anthracene	7/29	0.51	$\boxed{34}$	NA	0.1	Yes
Benzo(a)pyrene	7/29	0.75	$\boxed{26}$	NA	0.1	Yes
Benzo(b)fluoranthene	7/29	0.74	$\boxed{28}$	NA	0.1	Yes
Benzo(g,h,i)perylene	7/29	0.56	$\boxed{14}$	NA	0.1	Yes
Benzo(k)fluoranthene	7/29	0.63	$\boxed{27}$	NA	0.1	Yes
Chrysene	7/29	0.56	$\boxed{33}$	NA	0.1	Yes
Dibenz(a,h)anthracene	4/29	0.47	$\boxed{3.9}$	NA	0.1	Yes
Fluoranthene	8/29	0.50	$\boxed{72}$	NA	0.1	Yes
Fluorene	2/29	0.45	3.9	NA	30	No
Indeno(123-cd)pyrene	7/29	0.52	$\boxed{16}$	NA	0.1	Yes
Naphthalene	1/29	NA	$\boxed{0.53}$	NA	0.1	Yes
Phenanthrene	6/29	2.0	$\boxed{39}$	NA	0.1	Yes
Pyrene	7/29	0.53	$\boxed{49}$	NA	0.1	Yes
Pesticides						
Dieldrin	3/11	0.026 J	$\boxed{0.043}$	NA	0.0005	Yes
Methoxychlor	1/11	NA	$\boxed{0.14\ J}$	NA	NA	Yes
Metals						
Chromium	1/1	NA	2.4	7.7	0.4	No[a]

Notes:

☐	Boxed concentrations exceed ecological screening values.
NA	Not Available
[a]	Chromium maximum detected concentration is below the facility's background concentration.

PREPARED BY: CMB 2/3/02
CHECKED BY: EFC 2/4/02

TABLE 5.7

Derivation of NOAELs for Mammal Test Species

ECOPC	Test Species	Test Species Body Weight	Benchmark (mg/kgBW/d)	Test Duration	Endpoint	Effect	Source	Duration Conversion Factor (DCF)	Endpoint Conversion Factor (ECF)	NOAEL (mg/kgBW/d) Benchmark x DCF x ECF
Volatile Organic Compounds										
Acetone	Rat	3.50E-01	1.00E+02	Subchronic	NOAEL	Reproduction	Perry et al. (1983) in [1]	0.1	1.0	1.00E+01
Benzene	Mouse	3.00E-02	2.64E+02	Chronic	LOAEL	Reproduction	Nawrot and Staples (1979) in [1]	1.0	0.1	2.64E+01
cis-1,2-Dichloroethene	Mouse	3.00E-02	4.52E+02	Subchronic	NOAEL	Blood Chemistry	Palmer et al. (1979) in [1]	0.1	1.0	4.52E+01
trans-1,2-Dichloroethene	Mouse	3.00E-02	4.52E+02	Subchronic	NOAEL	Blood Chemistry	Palmer et al. (1979) in [1]	0.1	1.0	4.52E+01
Xylene	Mouse	3.00E-02	2.06E+00	Chronic	NOAEL	Reproduction	Marks et al. (1982) in [1]	1.0	1.0	2.06E+00
Semivolatile Organic Compounds										
Acenaphthylene [(a)]	Mouse	3.00E-02	1.75E+02	Chronic	NOAEL	None	ATSDR (1997) in [2]	1.0	1.0	1.75E+02
Anthracene	Rodent	1.65E-02	3.30E+03	Chronic	LOAEL	Carcinogenicity	Eisler (1987) [3]	1.0	0.1	3.30E+02
Benzo(a)anthracene	Mouse	3.00E-02	1.33E+01	Chronic	NOAEL	None	Neal and Rigdon (1967) in [2]	1.0	1.0	1.33E+01
Benzo(a)pyrene	Mouse	3.00E-02	1.00E+01	Chronic	LOAEL	Reproduction	Mackenzie and Angevine (1981) in [1]	1.0	0.1	1.00E+00
Benzo(b)fluoranthene	Mouse	3.00E-02	1.33E+01	Chronic	NOAEL	None	Neal and Rigdon (1967) in [2]	1.0	1.0	1.33E+01
Benzo(g,h,i)perylene	Mouse	3.00E-02	1.33E+01	Chronic	NOAEL	None	Neal and Rigdon (1967) in [2]	1.0	1.0	1.33E+01
Benzo(k)fluoranthene	Mouse	3.00E-02	1.00E+01	Chronic	LOAEL	Reproduction	Opresko (1995) in [2]	1.0	0.1	1.00E+00
Chrysene	Mouse	3.00E-02	1.33E+01	Chronic	NOAEL	None	Neal and Rigdon (1967) in [2]	1.0	1.0	1.33E+01
Dibenz(a,h)anthracene[(b)]	Mouse	3.00E-02	1.00E+01	Chronic	LOAEL	Reproduction	Mackenzie and Angevine (1981) in [1]	1.0	0.1	1.00E+00
2,4-Dimethylphenol [(c)]	Rat	3.00E-01	2.40E+00	Chronic	LOAEL	Mortality	Sax (1984) [4]	1.0	0.1	2.40E-01
Fluoranthene	Mouse	3.00E-02	5.00E+02	Chronic	LOAEL	None	ATSDR (1997) in [2]	1.0	0.1	5.00E+01
Indeno(1,2,3-cd)pyrene	Mouse	3.00E-02	1.33E+01	Chronic	NOAEL	None	Neal and Rigdon (1967) in [2]	1.0	1.0	1.33E+01
Naphthalene	Rat	3.50E-01	5.00E+01	Chronic	LOAEL	None	ATSDR (1997) in [2]	1.0	0.1	5.00E+00
Phenanthrene	Mouse	3.00E-02	1.00E+01	Chronic	LOAEL	Reproduction	Opresko (1995) in [2]	1.0	0.1	1.00E+00
Pyrene	Mouse	3.00E-02	1.00E+01	Chronic	LOAEL	Reproduction	Opresko (1995) in [2]	1.0	0.1	1.00E+00
Pesticides										
Dieldrin	Rat	3.50E-01	2.00E-01	Chronic	LOAEL	Reproduction	Treon and Cleveland (1955) in [1]	1.0	0.1	2.00E-02
Methoxychlor	Rat	3.50E-01	4.00E+00	Chronic	NOAEL	Reproduction	Gray et al. (1988) in [1]	1.0	1.0	4.00E+00
Metals										
Barium	Rat	4.35E-01	5.06E+00	Chronic	NOAEL	Growth	Schroeder and Mitchner (1971) in [1]	1.0	1.0	5.06E+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	Rat	3.50E-01	8.00E+00	Chronic	NOAEL	Reproduction	Azar et al. (1973) in [1]	1.0	1.0	8.00E+00

Notes:

(1) Sample, Opresko, and Suter. "Toxicity Benchmarks for Wildlife": 1996 Revision.

(2) QST (1997): all values assumed to be chronic.

(3) Eisler 1987. "Polycyclic Aromatic Hydrocarbon Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review," U.S. Fish Wildlife Service Biol. Report 85 (1.11).

(4) Sax, N.I., 1984. "Dangerous Properties of Industrial Materials," Sixth Edition, Van Nostrand Co., New York.

[(a)] Values for Acenaphthene used when calculating Acenaphthylene due to insufficent Acenaphthylene studies.

[(b)] Values for Benzo(a)pyrene used when calculating Dibenz(a,h)anthracene due to insufficent Dibenz(a,h)anthracene studies.

[(c)] Values for 4-Methylphenol used when calculating 2,4-Dimethylphenol due to insufficient 2,4-Dimethylphenol studies.

ECOPC Ecological Constituent of Potential Concern
NOAEL No Observable Adverse Effects Level
LOAEL Lowest Observable Adverse Effects Level

PREPARED BY: CMB 2/3/02
CHECKED BY: EFC 2/4/02

TABLE 5.8

DERIVATION OF NOAELs FOR BIRD TEST SPECIES

ECOPC	Test Species	Test Species Body Weight	Benchmark (mg/kgBW/d)	Test Duration	Endpoint	Effect	Source	Duration Conversion Factor (DCF)	Endpoint Conversion Factor (ECF)	NOAEL (mg/kgBW/d) Benchmark x DCF x ECF
Volatile Organic Compounds										
Acetone	None	None	None	None	None	None	None	None	None	None
Semivolatile Organic Compounds										
Acenaphthylene	Composite bird	8.50E-01	8.78E+01	Chronic	NOAEL	None	Chortelle et al. (1997) in [2]	1.0	1.0	8.78E+01
Anthracene [a]	Composite bird	8.50E-01	9.97E+00	Chronic	NOAEL	None	Shortelle et al. (1997) in [2]	1.0	1.0	9.97E+00
Benzo(a)anthracene	Composite bird	8.50E-01	1.24E+01	Chronic	NOAEL	None	Shortelle et al. (1997) in [2]	1.0	1.0	1.24E+01
Benzo(a)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
Benzo(b)fluoranthene	Composite bird	8.50E-01	1.24E+01	Chronic	NOAEL	None	Shortelle et al. (1997) in [2]	1.0	1.0	1.24E+01
Benzo(g,h,i)perylene	Composite bird	8.50E-01	1.24E+01	Chronic	NOAEL	None	Shortelle et al. (1997) in [2]	1.0	1.0	1.24E+01
Benzo(k)fluoranthene	Composite bird	8.50E-01	9.97E+00	Chronic	NOAEL	None	Shortelle et al. (1997) in [2]	1.0	1.0	9.97E+00
Chrysene	Composite bird	8.50E-01	1.24E+01	Chronic	NOAEL	None	Shortelle et al. (1997) in [2]	1.0	1.0	1.24E+01
Dibenz(a,h)anthracene [b]	Composite bird	8.50E-01	9.97E+00	Chronic	NOAEL	None	Shortelle et al. (1997) in [2]	1.0	1.0	9.97E+00
Fluoranthene	Composite bird	8.50E-01	1.95E+02	Chronic	NOAEL	None	Shortelle et al. (1997) in [2]	1.0	1.0	1.95E+02
Indeno(1,2,3-cd)pyrene	Composite bird	8.50E-01	1.24E+01	Chronic	NOAEL	None	Shortelle et al. (1997) in [2]	1.0	1.0	1.24E+01
Naphthalene	Composite bird	8.50E-01	3.39E+01	Chronic	NOAEL	None	Shortelle et al. (1997) in [2]	1.0	1.0	3.39E+01
Phenanthrene	Composite bird	8.50E-01	9.97E+00	Chronic	NOAEL	None	Shortelle et al. (1997) in [2]	1.0	1.0	9.97E+00
Pyrene	Composite bird	8.50E-01	9.97E+00	Chronic	NOAEL	None	Shortelle et al. (1997) in [2]	1.0	1.0	9.97E+00
Pesticides										
Dieldrin	Barn Owl	4.66E-01	7.70E-02	Chronic	NOAEL	Reproduction	Mendenhall et al. (1983) in [1]	1.0	1.0	7.70E-02
Methoxychlor	Composite bird	8.50E-01	8.42E+00	Chronic	NOAEL	None	Shortelle et al. (1997) in [2]	1.0	1.0	8.42E+00

Notes:

[1]	Sample, Opresko, and Suter 1996.
[2]	QSY (1997).
[a]	Values for Phenanthrene used when calculating Anthracene due to insufficent Anthracene studies.
[b]	Values for Benzo(a)pyrene used when calculating Dibenz(a,h)anthracene due to insufficent Dibenz(a,h)anthracene studies.
ECOPC	Ecological Constituent of Potential Concern
BW	Body Weight
NOAEL	No Observable Adverse Effects Level

PREPARED BY: CMB 2/3/02
CHECKED BY: EFC 2/4/02

TABLE 5.9

Derivation of Screening Toxicity Reference Values for Mammal Receptors

				Raccoon		Short-tailed Shrew	
ECOPC	Test Species	Test Species Body Weight (kg) BW_t	Test Species $NOAEL_t$ (mg/kgBW/d)	Body-weight Conversion Factor BW_{conv} $(BW_t/BW)^{0.25}$	TRV (mg/kgBW/d) $NOAEL_t \times BW_{conv}$ BW_{conv}	Body-weight Conversion Factor BW_{conv} $(BW_t/BW)^{0.25}$	TRV (mg/kgBW/d) $NOAEL_t \times BW_{conv}$ BW_{conv}
Volatile Organic Compounds							
Acetone	Rat	3.50E-01	1.00E+01	5.44E-01	5.44E+00	2.20E+00	2.20E+01
Benzene	Mouse	3.00E-02	2.64E+01	2.94E-01	7.77E+00	1.19E+00	3.14E+01
cis-1,2-Dichloroethene	Mouse	3.00E-02	4.52E+01	2.94E-01	1.33E+01	1.19E+00	5.38E+01
trans-1,2-Dichloroethene	Mouse	3.00E-02	4.52E+01	2.94E-01	1.33E+01	1.19E+00	5.38E+01
Xylene	Mouse	3.00E-02	2.06E+00	2.94E-01	6.07E-01	1.19E+00	2.45E+00
Semivolatile Organic Compounds							
Acenaphthylene [(a)]	Mouse	3.00E-02	1.75E+02	2.94E-01	5.15E+01	1.19E+00	2.08E+02
Anthracene	Rodent	1.65E-02	3.30E+02	2.54E-01	8.37E+01	1.02E+00	3.38E+02
Benzo(a)anthracene	Mouse	3.00E-02	1.33E+01	2.94E-01	3.92E+00	1.19E+00	1.58E+01
Benzo(a)pyrene	Mouse	3.00E-02	1.00E+00	2.94E-01	2.94E-01	1.19E+00	1.19E+00
Benzo(b)fluoranthene	Mouse	3.00E-02	1.33E+01	2.94E-01	3.92E+00	1.19E+00	1.58E+01
Benzo(g,h,i)perylene	Mouse	3.00E-02	1.33E+01	2.94E-01	3.92E+00	1.19E+00	1.58E+01
Benzo(k)fluoranthene	Mouse	3.00E-02	1.00E+00	2.94E-01	2.94E-01	1.19E+00	1.19E+00
Chrysene	Mouse	3.00E-02	1.33E+01	2.94E-01	3.92E+00	1.19E+00	1.58E+01
Dibenz(a,h)anthracene[(b)]	Mouse	3.00E-02	1.00E+00	2.94E-01	2.94E-01	1.19E+00	1.19E+00
2,4-Dimethylphenol [(c)]	Rat	3.00E-01	2.40E-01	5.24E-01	1.26E-01	2.11E+00	5.08E-01
Fluoranthene	Mouse	3.00E-02	5.00E+01	2.94E-01	1.47E+01	1.19E+00	5.95E+01
Indeno(1,2,3-cd)pyrene	Mouse	3.00E-02	1.33E+01	2.94E-01	3.92E+00	1.19E+00	1.58E+01
Naphthalene	Rat	3.50E-01	5.00E+00	5.44E-01	2.72E+00	2.20E+00	1.10E+01
Phenanthrene	Mouse	3.00E-02	1.00E+00	2.94E-01	2.94E-01	1.19E+00	1.19E+00
Pyrene	Mouse	3.00E-02	1.00E+00	2.94E-01	2.94E-01	1.19E+00	1.19E+00
Pesticides							
Dieldrin	Rat	3.50E-01	2.00E-02	5.44E-01	1.09E-02	2.20E+00	4.40E-02
Methoxychlor	Rat	3.50E-01	4.00E+00	5.44E-01	2.18E+00	2.20E+00	8.79E+00
Metals							
Barium	Rat	4.35E-01	5.06E+00	5.75E-01	2.91E+00	2.32E+00	1.17E+01
Chromium	Rat	3.50E-01	2.74E+03	5.44E-01	1.49E+03	2.20E+00	6.02E+03
Lead	Rat	3.50E-01	8.00E+00	5.44E-01	4.35E+00	2.20E+00	1.76E+01

Notes:

[(a)] Values for Acenaphthene used when calculating Acenaphthylene due to insufficent Acenaphthylene studies.

[(b)] Values for Benzo(a)pyrene used when calculating Dibenz(a,h)anthracene due to insufficent Dibenz(a,h)anthracene studies.

[(c)] Values for 4-Methylphenol used when calculating 2,4-Dimethylphenol due to insufficient 2,4-Dimethylphenol studies.

ECOPC Ecological Constituent of Potential Concern
BW_T Body Weight of Test Species
BW Body Weight of Receptor
TRV Toxicity Reference Value
$NOAEL_T$ No Observable Adverse Effects Level for Test Species.

PREPARED BY: CMB 2/3/02
CHECKED BY: EFC 2/4/02

TABLE 5.10

Derivation of Screening Toxicity Reference Values for Bird Receptors

				American Robin	
Analyte	Test Species	Test Species Body Weight (kg) BW_t	Test Species $NOAEL_t$ (mg/kgBW/d)	Body-weight Conversion Factor BW_{conv} $(BW_t/BW)^0$	TRV (mg/kgBW/d) $NOAEL_t \times BW_{conv}$
Volatile Organic Compounds					
Acetone	None	None	None	None	None
Semivolatile Organic Compounds					
Acenaphthylene	Composite bird	8.50E-01	8.78E+01	1.00E+00	8.78E+01
Anthracene [a]	Composite bird	8.50E-01	9.97E+00	1.00E+00	9.97E+00
Benzo(a)anthracene	Composite bird	8.50E-01	1.24E+01	1.00E+00	1.24E+01
Benzo(a)pyrene	Composite bird	8.50E-01	9.97E+00	1.00E+00	9.97E+00
Benzo(b)fluoranthene	Composite bird	8.50E-01	1.24E+01	1.00E+00	1.24E+01
Benzo(g,h,i)perylene	Composite bird	8.50E-01	1.24E+01	1.00E+00	1.24E+01
Benzo(k)fluoranthene	Composite bird	8.50E-01	9.97E+00	1.00E+00	9.97E+00
Chrysene	Composite bird	8.50E-01	1.24E+01	1.00E+00	1.24E+01
Dibenz(a,h)anthracene[b]	Composite bird	8.50E-01	9.97E+00	1.00E+00	9.97E+00
Fluoranthene	Composite bird	8.50E-01	1.95E+02	1.00E+00	1.95E+02
Indeno(1,2,3-cd)pyrene	Composite bird	8.50E-01	1.24E+01	1.00E+00	1.24E+01
Naphthalene	Composite bird	8.50E-01	3.39E+01	1.00E+00	3.39E+01
Phenanthrene	Composite bird	8.50E-01	9.97E+00	1.00E+00	9.97E+00
Pyrene	Composite bird	8.50E-01	9.97E+00	1.00E+00	9.97E+00
Pesticides					
Dieldrin	Barn Owl	4.66E-01	7.70E-02	1.00E+00	7.70E-02
Methoxychlor	Composite bird	8.50E-01	8.42E+00	1.00E+00	8.42E+00

Notes:

[a] Values for Phenanthrene used when calculating Anthracene due to insufficent Anthracene studies.

[b] Values for Benzo(a)pyrene used when calculating Dibenz(a,h)anthracene due to insufficent Dibenz(a,h)anthracene studies.

BW_t	Body Weight of Test Species
BW	Body Weight of Receptor
TRV	Toxicity Reference Value
$NOAEL_t$	No Observable Adverse Effects Level for Test Species.

PREPARED BY: CMB 2/3/02
CHECKED BY: EFC 2/4/02

TABLE 5.11

Maximum Hazard Quotient Calculations for Raccoon from Surface Water

				Raccoon	
ECOPC	**Groundwater Maximum Concentration (mg/L)**	**BCF**	**ADD (mg/kg/d) = (C_{WATER} x BCF x IR_{RF}) + (C_{WATER} x IR_{RW})**	**TRV (mg/kg/d)**	**HQ = ADD/TRV**
Volatile Organic Compounds					
Xylene	0.378	7.50E+01	6.70E-02	6.07E-01	1.10E-01
Semi-Volatile Organic Compounds					
Naphthalene	0.121	7.40E+01	9.90E-03	2.72E+00	3.64E-03

<u>Notes:</u>

ADD	Average Daily dose (mg/kg/d).
HQ	Hazard Quotient
IR_{RF}	Racoon food ingestion rate (kg/kgBW/d) = 0.053.
IR_{RW}	Racoon water ingestion rate (L/kgBW/d) = 0.08.
ND	Not Detected
TRV	Toxicity Reference Value
ECOPC	Ecological Constituent of Potential Concern
BCF	Bioconcentration Factor
CWATER	Concentration in Groundwater

PREPARED BY: <u>CMB 2/3/02</u>
CHECKED BY: <u>EFC 2/4/02</u>

TABLE 5.12

Maximum Hazard Quotient Calculations for Raccoon from Groundwater

				Raccoon	
ECOPC	**Groundwater Maximum Concentration (mg/L)**	**BCF**	**ADD (mg/kg/d) = (C_{WATER} x BCF x IR_{RF}) + (C_{WATER} x IR_{RW})**	**TRV (mg/kg/d)**	**HQ = ADD/TRV**
Volatile Organic Compounds					
Acetone	0.021	1.70E-01	1.87E-03	5.44E+00	3.44E-04
Benzene	0.322	4.30E+00	9.91E-02	7.77E+00	1.28E-02
cis-1,2-Dichloroethene	0.95	5.70E+00	3.63E-01	1.33E+01	2.73E-02
trans-1,2-Dichloroethene	0.033	9.60E+00	1.94E-02	1.33E+01	1.46E-03
Xylene	0.378	7.50E+01	1.53E+00	6.07E-01	2.53E+00
				HI =	**2.57E+00**
Semi-Volatile Organic Compounds					
2,4-Dimethylphenol	0.01	3.10E+01	1.72E-02	1.26E-01	1.37E-01
Naphthalene	0.121	7.40E+01	4.84E-01	2.72E+00	1.78E-01
				HI =	**3.15E-01**
Metals					
Barium	0.131	3.00E+00	3.13E-02	2.91E+00	1.08E-02
Chromium	0.046	3.00E+00	1.10E-02	1.49E+03	7.38E-06
Lead	0.0188	3.00E+00	4.49E-03	4.35E+00	1.03E-03

Notes:

Barium	surrogate BCF of Chromium used due to lack of literature value
2,4-Dimethylphenol	surrogate TRV of 4-Methylphenol used due to lack of literature value
ADD	Average Daily dose (mg/kg/d).
HI	Hazard Index
HQ	Hazard Quotient
IR_{RF}	Racoon food ingestion rate (kg/kgBW/d) = 0.053.
IR_{RW}	Racoon water ingestion rate (L/kgBW/d) = 0.08.
NA	Not Analyzed
ND	Not Detected
TRV	Toxicity Reference Value
BCF	Bioconcentration Factor
CWATER	Concentration in Groundwater
ECOPC	Ecological Constituent of Potential Concern

PREPARED BY: CMB 2/3/02
CHECKED BY: EFC 2/4/02

TABLE 5.13

AVERAGE HAZARD QUOTIENT CALCULATIONS FOR RACCOON FROM GROUNDWATER

				Raccoon	
ECOPC	**Groundwater Average Concentration (mg/L)**	**BCF**	**ADD (mg/kg/d) = (C_{WATER} x BCF x IR_{RF}) + (C_{WATER} x IR_{RW})**	**TRV (mg/kg/d)**	**HQ = ADD/TRV**
Volatile Organic Compounds					
Acetone	0.011	1.70E-01	9.79E-04	5.44E+00	1.80E-04
Benzene	0.03	4.30E+00	9.24E-03	7.77E+00	1.19E-03
cis-1,2-Dichloroethene	0.073	5.70E+00	2.79E-02	1.33E+01	2.10E-03
trans-1,2-Dichloroethene	0.0041	9.60E+00	2.41E-03	1.33E+01	1.82E-04
Xylene	0.039	7.50E+01	1.58E-01	6.07E-01	2.61E-01
				HI =	**2.64E-01**

Notes:

ADD	Average Daily dose (mg/kg/d).
HI	Hazard Index
HQ	Hazard Quotient
IR_{RF}	Racoon food ingestion rate (kg/kgBW/d) = 0.053.
IR_{RW}	Racoon water ingestion rate (L/kgBW/d) = 0.08.
NA	Not Analyzed
ND	Not Detected
TRV	Toxicity Reference Value
ECOPC	Ecological Constituent of Potential Concern
BCF	Bioconcentration Factor
C_{WATER}	Concentration in Groundwater

PREPARED BY: CMB 2/3/02
CHECKED BY: EFC 2/4/02

TABLE 5.14

Maximum Hazard Quotient Calculations for Short-Tailed Shrew and American Robin

			Short-Tailed Shrew			American Robin		
ECOPC	Soil Maximum Concentration (mg/kg)	BAF_i	ADD (mg/kg/d) = C_{SOIL} X BAF_i x IRs	TRV (mg/kg/d)	HQ = ADD/TRV	ADD (mg/kg/d) = C_{SOIL} X BAF_i x IR_R	TRV (mg/kg/d)	HQ = ADD/TRV
Volatile Organic Compounds								
Acetone	0.17	5.00E-01	4.51E-02	2.20E+01	2.05E-03	1.79E-02	NV	NV
				HI =	**2.05E-03**		**HI =**	NV
Semi-Volatile Organic Compounds								
Acenaphthylene	3.6	5.00E-01	9.54E-01	2.08E+02	4.59E-03	3.78E-01	8.78E+01	4.31E-03
Anthracene	7.5	2.40E-02	9.54E-02	3.38E+02	2.82E-04	3.78E-02	9.97E+00	3.79E-03
Benzo(a)anthracene	34	2.50E-02	4.51E-01	1.58E+01	2.85E-02	1.79E-01	1.24E+01	1.44E-02
Benzo(a)pyrene	26	6.80E-02	9.37E-01	1.19E+00	7.87E-01	3.71E-01	9.97E+00	3.72E-02
Benzo(b)fluoranthene	28	6.40E-02	9.50E-01	1.58E+01	6.01E-02	3.76E-01	1.24E+01	3.03E-02
Benzo(g,h,i)perylene	14	4.90E-02	3.64E-01	1.58E+01	2.30E-02	1.44E-01	1.24E+01	1.16E-02
Benzo(k)fluoranthene	27	6.40E-02	9.16E-01	1.19E+00	7.70E-01	3.63E-01	9.97E+00	3.64E-02
Chrysene	33	3.50E-02	6.12E-01	1.58E+01	3.87E-02	2.43E-01	1.24E+01	1.96E-02
Dibenz(a,h)anthracene	3.9	6.80E-02	1.41E-01	1.19E+00	1.18E-01	5.57E-02	9.97E+00	5.59E-03
Fluoranthene	72	1.60E-02	6.11E-01	5.95E+01	1.03E-02	2.42E-01	1.95E+02	1.24E-03
Indeno(1,2,3-cd)pyrene	16	8.40E-02	7.12E-01	1.58E+01	4.51E-02	2.82E-01	1.24E+01	2.28E-02
Naphthalene	0.53	5.00E-01	1.40E-01	1.10E+01	1.28E-02	5.57E-02	3.39E+01	1.64E-03
Phenanthrene	39	2.40E-02	4.96E-01	1.19E+00	4.17E-01	1.97E-01	9.97E+00	1.97E-02
Pyrene	49	1.80E-02	4.67E-01	1.19E+00	3.93E-01	1.85E-01	9.97E+00	1.86E-02
				HI =	**2.71E+00**		**HI =**	**2.27E-01**
Pesticides								
Dieldrin	0.043	5.00E-01	1.14E-02	4.40E-02	2.59E-01	4.52E-03	7.70E-02	5.86E-02
Methoxychlor	0.14	5.00E-01	3.71E-02	8.79E+00	4.22E-03	1.47E-02	8.42E+00	1.75E-03
				HI =	**2.63E-01**		**HI =**	**6.04E-02**

<u>Notes:</u>

ADD	Average Daily dose (mg/kg/d).
BAF_i	Soil-to-invertebrate bioaccumulation factor (HAZWRAP 1994).
HI	Hazard Index
HQ	Hazard Quotient
IR_R	Robin food ingestion rate (kg/kgBW/d) = 0.21.
IR_S	Shrew food ingestion rate (kg/kgBW/d) = 0.53.
TRV	Toxicity Reference Value
ECOPC	Ecological Constituent of Potential Concern
NV	No Value
C_{SOIL}	Concentration in Soil

PREPARED BY: <u>CMB 2/3/02</u>
CHECKED BY: <u>EFC 2/4/02</u>

TABLE 5.15

AVERAGE HAZARD QUOTIENT CALCULATIONS FOR SHORT-TAILED SHREW

			Short-Tailed Shrew		
ECOPC	**Soil Average Concentration (mg/kg)**	**BAF_i**	**ADD (mg/kg/d) = C_{SOIL} X BAF_i x IRs**	**TRV (mg/kg/d)**	**HQ = ADD/TRV**
Semi-Volatile Organic Compounds					
Acenaphthylene	0.51	5.00E-01	1.35E-01	2.08E+02	6.50E-04
Anthracene	0.92	2.40E-02	1.17E-02	3.38E+02	3.46E-05
Benzo(a)anthracene	3.2	2.50E-02	4.24E-02	1.58E+01	2.68E-03
Benzo(a)pyrene	2.7	6.80E-02	9.73E-02	1.19E+00	8.18E-02
Benzo(b)fluoranthene	2.8	6.40E-02	9.50E-02	1.58E+01	6.01E-03
Benzo(g,h,i)perylene	1.6	4.90E-02	4.16E-02	1.58E+01	2.63E-03
Benzo(k)fluoranthene	2.6	6.40E-02	8.82E-02	1.19E+00	7.41E-02
Chrysene	3.1	3.50E-02	5.75E-02	1.58E+01	3.64E-03
Dibenz(a,h)anthracene	0.53	6.80E-02	1.91E-02	1.19E+00	1.61E-02
Fluoranthene	5.8	1.60E-02	4.92E-02	5.95E+01	8.27E-04
Indeno(1,2,3-cd)pyrene	1.76	8.40E-02	7.84E-02	1.58E+01	4.96E-03
Naphthalene	0.27	5.00E-01	7.16E-02	1.10E+01	6.50E-03
Phenanthrene	3.2	2.40E-02	4.07E-02	1.19E+00	3.42E-02
Pyrene	4.3	1.80E-02	4.10E-02	1.19E+00	3.45E-02
				HI =	**2.69E-01**

Notes:

ADD	Average Daily dose (mg/kg/d).
BAF_i	Soil-to-invertebrate bioaccumulation factor (HAZWRAP 1994).
HI	Hazard Index
HQ	Hazard Quotient
IR_S	Shrew food ingestion rate (kg/kgBW/d) = 0.53.
TRV	Toxicity Reference Value
ECOPC	Ecological Constituent of Potential Concern

PREPARED BY: CMB 2/3/02
CHECKED BY: EFC 2/4/02

TABLE 6.1A

RISK REDUCTION STANDARDS FOR SOILS - TYPES 1 AND 2

			Risk Reduction Standards (RRS)					
	Maximum Detected Concentrations (mg/kg)		Type 1			Type 2		
HSRA-Regulated Substance	**Surface (a)**	**Subsurface (b)**	**RRS**	**Reference**	**Status**	**RRS**	**Reference**	**Status**
Organo-chlorine Pesticides								
Dieldrin	0.043	ND	0.66	B	C	***	***	***
Methoxychlor	0.14J	ND	10	B	C	***	***	***
Volatile Organic Compounds								
Acetone	0.17	27	400	D	C	***	***	***
Benzene	ND	18	0.5	D	E	0.14	H	E
2-Butanone	ND	15.1	200	D	C	***	***	***
Chloromethane	ND	39	0.3	D	E	0.39	H	E
Chlorobenzene	ND	0.007	10	D	C	***	***	***
cis-1,2-dichloroethene	ND	0.27	0.53	B	C	***	***	***
	ND	120	70	D	E	100	H	E
Methylene Chloride	ND	0.0067	0.5	D	C	***	***	***
Tetrachloroethene	0.0061	ND	0.5	D	C	***	***	***
trans-1,2-dichloroethene	ND	0.013	10	D	C	***	***	***
Trichlorofluoromethane	0.014	0.012	200	D	C	***	***	***
Toluene	0.021	16	100	D	C	***	***	***
Xylene	ND	310	1000	D	C	***	***	***
Semi-Volatile Organic Compounds								
Anthracene	7.5	5.7	500	B	C	***	***	***
Acenaphthene	1.7	2.3	300	B	C	***	***	***
Acenaphthylene	3.6	6.6	130	B	C	***	***	***
Benzo(a)anthracene	34	18	5	B	E	12	F	E
Benzo(b)fluoranthene	28	13	5	B	E	12	F	E
Benzo(k)fluoranthene	27	13	5	B	E	120	F	C
Benzo(g,h,i) perylene	14	12	500	B	C	***	***	***
Benzo(a) pyrene	26	20	1.64	B	E	1.2	F	E
bis(2-ethylhexyl) phthalate	0.39	2.0	50	B	C	***	***	***
Chrysene	33	20	5	B	E	1200	F	C
Dibenzo(a,h) anthracene	3.9	4.2	2	F	E	1.2	F	E
Di-n-butyl phthalate	ND	2.4	400	D	C	***	***	***
Diethyl phthalate	ND	0.2	500	D	C	***	***	***
2,4-Dinitrotoluene	ND	0.65	0.66	B	C	***	***	***
Fluoranthene	72	24	500	B	C	***	***	***
Fluorene	3.9	3.7	360	B	C	***	***	***
Indeno(1,2,3-cd) pyrene	16	11	5	B	E	12	F	E
Naphthalene	0.53	79	100	B	C	***	***	***
Phenanthrene	39	19	110	B	C	***	***	***
Pyrene	49	26J	500	B	C	***	***	***
Metals								
Arsenic (background = 2.6)	13.9	3.94	20	A	C	***	***	***
Barium (background = 28)	69	38.4	1000	A	C	***	***	***
Cadmium (background = 2.6)	3.87	ND	2	A	E	12	H	C
Chromium (background = 7.7)	14.7	31.7	100	A	C	***	***	***
Lead (background = 53)	1185	107	75	A	E	270	H	E
Mercury (background = 0.39)	0.79	0.39	0.5	A	E	4.9	H	C
Selenium (background = 1.9)	1.1	1.2	2	A	C	***	***	***
Silver (background = 2.6)	2.5	ND	2	A	E	17	H	C

<u>Notes:</u>

mg/kg	mg/kg = milligram per kilogram
Reference	Reference for the RRS
ND	Substance not detected
(a)	Surface soil is defined under HSRA as 0 to 2 feet below ground surface
(b)	Subsurface soil is defined under HSRA as any point above the upper most groundwater zone; used here to mean other than surface soil.
***	Constituent complies with prior RRS
A	Table 2, Appendix III of the HSRA Regulations
B	Appendix I of the HSRA Regulations
C	Substance concentration meets the respective RRS
D	Type I HSRA groundwater criteria times 100
E	Substance concentration exceeds the respective RRS
F	Calculated using RAGS Equation 6 for carcinogens
G	Calculated using RAGS Equation 7 for non-carcinogens
H	Leaching to groundwater
J	Estimated concentration
NA	Not analyzed

PREPARED BY: <u>L. Smith 11/19/01</u>
CHECKED BY: <u>E. Curtis 11/19/01</u>
REVISED BY: <u>L. Smith 1/17/02</u>

TABLE 6.1B

RISK REDUCTION STANDARDS FOR SOILS - TYPES 3 AND 4

HSRA-Regulated Substance	Maximum Detected Concentrations (mg/kg)		Risk Reduction Standards (RRS)								
			Type 3 Surface			Type 3 Subsurface			Type 4		
	Surface (a)	Subsurface (b)	RRS	Reference	Status	RRS	Reference	Status	RRS	Reference	Status
Volatile Organic Compounds											
Benzene	ND	18	0.5	D	NA	0.5	D	E	0.13	H	E
Chloromethane	ND	39	0.3	D	E	0.3	D	E	2	H	E
Ethylbenzene	ND	120	70	D	E	70	D	E	340	H	C
Semi-Volatile Organic Compounds											
Benzo(a)anthracene	34	18	5	B	E	5	B	E	78.4	F	C
Benzo(b)fluoranthene	28	13	5	B	E	5	B	E	78	F	C
Benzo(a)pyrene	26	20	1.64	B	E	1.64	B	E	7.8	F	E
Dibenzo(a,h) anthracene	3.9	4.2	5	B	C	5	B	C	***	***	***
Indeno(1,2,3-cd) Pyrene	16	11	5	B	E	5	B	E	78.4	F	C
Metals											
Lead	1185	107	400	B	E	400	B	C	270	H	E

__Notes:__

mg/kg	milligram per kilogram
Reference	Reference for the RRS
ND	Substance not detected
NA	Substance not detected in surface soil
***	Constituent complies with prior RRS
(a)	Surface soil is defined under HSRA as 0 to 2 feet below ground surface
(b)	Subsurface soil is defined under HSRA as any point above the upper most groundwater zone; used here to mean other than surface soil.
A	Table 2, Appendix III of the HSRA Regulations
B	Appendix I of the HSRA Regulations
C	Substance concentration meets the respective RRS
D	Type I HSRA groundwater criteria times 100
E	Substance concentration exceeds the respective RRS
F	Calculated using RAGS Equation 6 for carcinogens
G	Calculated using RAGS Equation 7 for non-carcinogens
H	Leaching to groundwater

PREPARED BY: L. Smith 11/19/01
CHECKED BY: E. Curtis 11/19/01
REVISED BY: L. Smith 1/17/02

TABLE 6.2

RISK REDUCTION STANDARDS FOR GROUNDWATER - TYPES 1, 3 AND 4

HSRA-Regulated Substance	Maximum Detected Concentrations (mg/l)	Risk Reduction Standards (RRS)					
		Types 1 and 3			Type 4		
		RRS	Reference	Status	RRS	Reference	Status
Inorganic Constituents							
Arsenic	0.031	0.05	A	C	***	***	***
Barium	0.131	2	A	C	***	***	***
Chromium	0.046	0.1	A	C	***	***	***
Lead	0.0188	0.015	A	E	0.015	A	E
Volatile Organic Compounds							
Acetone	0.021	4	A	C	***	***	***
Benzene	0.322	0.005	A	E	0.005	D	E
cis-1,2-Dichloroethene	0.95	0.005	B	E	1	F	C
1,1-Dichloroethene	0.0016	0.007	A	C	***	***	***
Ethylbenzene	0.0864	0.7	A	C	***	***	***
Toluene	0.005	1	A	C	***	***	***
trans-1,2-Dichloroethene	0.033	0.1	A	C	***	***	***
Vinyl Chloride	0.011	0.002	A	E	0.0033	D	E
Xylenes	0.378	10	A	C	***	***	***
Semi-Volatile Organic Compounds							
2,4-Dimethylphenol	0.01	0.7	A	C	***	***	***
Naphthalene	0.121	0.02	A	E	0.0088	F	E

Notes:

mg/kg	milligram per kilogram
Reference	Reference for the RRS
***	Constituent complies with prior RRS
A	Table 1, Appendix III of the HSRA Regulations
B	Detection Limit
C	Substance concentration meets the respective RRS
D	Calculated using RAGS Equation 1 for carcinogens
E	Substance concentration exceeds the respective RRS
F	Calculated using RAGS Equation 2 for non-carcinogens

PREPARED BY: L. Smith 1/17/02
CHECKED BY: E. Curtis 1/17/02