SITE: HAA-13 Ph1 R1, HAAF, GEORGIA

(Folder #2)

FSGA CAP-Part B submission to GA EPD -	29 Aug 2000
GA EPD CAP-Part B approval -	18 Dec 2000
FSGA CAP-Part B response with required Milestone Schedule -	30 Jan 2001
FSGA CAP-Part B Addendum #1 sent to GA EPD -	9 Oct 2001
GA EPD CAP-Part B Addendum #1 Review Comments -	20 Nov 2001
FSGA CAP-Part B Addendum #1 response to GA EPD review comments -	20 Dec 2001
GA EPD Response to FSGA Comments via Conference Call during 2nd week -	Jan 2002
FSGA Revised CAP-Part B Addendum #1 sent to GA EPD (trans letter missing) –	(Jul/ Aug 2002)
GA EPD CAP-Part B Addendum #1 approval (trans letter missing) -	(????????)
FSGA CAP-Part B Addendum #2 sent to GA EPD -	24 Aug 2006
GA EPD CAP-Part B Addendum #2 approval -	28 Sep 2006

Contractor Change

FSGA Revised CAP-Part B sent to GA EPD -	24 July 2009
GA EPD CAP-Part B approval (for further investigation) -	3 Feb 2010
FSGA Revised CAP-Part B Addendum #1 sent to GA EPD -	5 Nov 2009
GA EPD CAP-Part B Addendum #1 approval -	5 Feb 2010
FSGA Revised CAP-Part B final implementation sent to GA EPD -	29 Jul 2010
GA EPD Revised CAP-Part B approval -	30 Aug 2010

Georgia Department of Natural Resources
Environmental Protection Division
Underground Storage Tank Management Program
4244 International Parkway, Suite 104, Atlanta, Georgia 30354
Chris Clark, Commissioner
F. Allen Barnes, Director
(404) 362-2687

August 30, 2010

Rec'd
10 Sept. 2010

Mr. Thomas C. Fry
U.S. Army/HQ 3d,Inf. Div (Mech)
Directorate of Public Works
1550 Frank Cochran Drive
Building 1137
Fort Stewart, Georgia 31314-4927

SUBJECT: Notice to Implement Corrective Action Plan (CAP)-Part B:
Hunter AAF, Former Fuel Pit #1
Former Building 8060
Savannah, Chatham County, GA
Facility ID: 9025085*1

Dear Mr. Thomas C. Fry:

The Georgia Underground Storage Tank Management Program (USTMP) has received your consultant's letter, dated July 29, 2010, that forwarded a properly certified CAP -Part B Progress Report. The report was prepared by ARCADIS.

The technical proposal contained in the Revised CAP-Part B for further investigation, monitoring and/or remediation of the current release is hereby approved by the USTMP. As a result of your CAP-Part B being technically approved, you are authorized to begin implementation of this plan.

Please submit a progress report concerning the June and September 2010 sampling events by November 30, 2010. If you have any technical questions, please contact me at (404) 362-4529.

Sincerely,

William E. Logan
Advanced Geologist
Corrective Action Unit II

WEL:
S: land/landdocs/williaml/Pend10/9025085R1B. 120
cc: Curtis Scott Bostian, P.E., ARCADIS
Lisa L. Lewis, GA EPD
File (CA): CHATHAM; 9025085

DEPARTMENT OF THE ARMY
US ARMY INSTALLATION MANAGEMENT COMMAND
HEADQUARTERS, US ARMY GARRISON, FORT STEWART / HUNTER ARMY AIRFIELD
1587 FRANK COCHRAN DRIVE
FORT STEWART, GEORGIA 31314

REPLY TO
ATTENTION OF

Office of the Directorate

JUL 29 2010

CERTIFIED MAIL
7008 3230 0000 7027 6436

Georgia Environmental Protection Division
Underground Storage Tank Management Program
Attention: Mr. William Logan
4244 International Parkway, Suite 104
Atlanta, Georgia 30354

Dear Mr. Logan:

Fort Stewart is pleased to submit to the Georgia Environmental Protection Division one copy of the Final Corrective Action Implementation Report for Former Pumphouse # 1 (Release #1), Facility ID #9-025085*1, Former Building 8060, Hunter Army Airfield, Georgia, dated July 2010, for your review.

The enclosed report summarizes the corrective action implementation activities performed from April – May 2010. Twelve injection wells and two monitoring wells were installed. Calcium peroxide injections occurred from April 6 through April 30, 2010.

Fort Stewart appreciates your consideration of these recommendations. If you have any questions or comments regarding the enclosed report, please contact Ms. Algeana Stevenson at (912) 315-5144 or Ms. Tressa Rutland, Directorate of Public Works, Prevention and Compliance Branch, at (912) 767-2010.

Sincerely,

Tressa M Rutland

for Robert R. Baumgardt
Director, Public Works

Enclosure

ARCADIS
Infrastructure, environment, buildings

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3d Inf Div (Mech)

Army Environmental Command
and
Fort Stewart Directorate of Public Works
Under Contract Number W91ZLK-05-D-0015 D.O. 0003

Final Corrective Action Implementation Report
Former Pumphouse #1 (Release #1)
Former Building 8060
Hunter Army Airfield
Savannah, GA
Facility ID No. 9-025085*1

July 15, 2010

ARCADIS

C. Scott Bostian, PE
Senior Engineer

Charles A. Bertz, PE
Senior Project Manager

Final Corrective Action Implementation Report Pumphouse #1 (Release #1)

Hunter Army Airfield

Prepared for:
U.S. Army Environmental Command

Prepared by:
ARCADIS
801 Corporate Center Drive, Suite 300
Raleigh, North Carolina 27607
Tel 919.854.1282
Fax 919.854.5448

Our Ref.:
GP08HAFS.H13B.NB1R1

Date:
July 15, 2010

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Acronyms

ACL	alternate concentration limit
BTEX	benzene, toluene, ethylbenzene, and xylene
CAP	Corrective Action Plan
COPCs	Constituents of Potential Concern
DAACG	Departure/Arrival Air Control Group
ft	feet
ft bls	feet below land surface
g/L	grams per liter
GA EPD	Georgia Environmental Protection Division
HAAF	Hunter Army Air Field
IW	Injection Well
lbs	pounds
lbs/gal	pounds per gallon
MNA	monitored natural attenuation
MW	monitor well
PVC	polyvinyl chloride
SAIC	Science Applications International Corporation
UIC	Underground Injection Control
UST	underground storage tank
USTMP	Underground Storage Tank Management Program

CORRECTIVE ACTION IMPLEMENTATION REPORT

Submittal Date: July 2010 Report Title/Number: Corrective Action Implementation Report

For Period Covering: March 2010 to May 2010

Facility Name: Former Pumphouse #1 (Release #1) Street Address: Former Building 8060, near Taxiway 3

Facility ID: 9-025085*1 City: Hunter Army Airfield County: Chatham Zip Code: 31409

Latitude: 32° 00′ 54″ Longitude: 81° 08′ 26″

Submitted by UST Owner/Operator:		Prepared by Consultant/Contractor:	
Name:	Thomas C. Fry/ Environmental Branch	Name:	Charles A. Bertz
Company:	U. S. Army/HQ 3d, Inf. Div. (Mech)	Company:	ARCADIS, U.S., Inc.
Address:	DPW ENRD ENV. Building 1137	Address:	801 Corporate Center Drive
	1550 Frank Cochran Drive		Suite 300
City:	Fort Stewart State: GA	City:	Raleigh State: NC
Zip Code:	31314-4927	Zip Code:	27607
Telephone:	(912) 767-2010	Telephone:	(919) 854-1282

1. Registered Professional Engineer or Professional Geologist Certification

I hereby certify that I have directed and supervised the fieldwork and preparation of this plan in accordance with State Rules and Regulations. As a registered professional geologist and/or professional engineer, I certify that I am a qualified groundwater professional as defined by the Georgia State Board of Professional Geologists. All of the information and laboratory data in this plan and in all of the attachments are true, accurate, complete, and in accordance with applicable State Rules and Regulations.

Name: Curtis S. Bostian

Signature: [signature]

Date: 7/15/10

GEORGIA REGISTERED PE025133 PROFESSIONAL ENGINEER CURTIS SCOTT BOSTIAN

[signature] 7/15/10

Georgia Stamp or Seal

2. Introduction

Former Pumphouse #1 was an aviation-fuel island located along the east-west taxiway of Hunter Army Airfield (HAAF) (Figure 2-1) that was used from about 1953 until the early 1970s. It consisted of ten 25,000-gallon underground storage tanks (USTs) and a 50,000-gallon underground defueling tank. The pumphouse was inactive from the 1970s to 1995, when eight of the 25,000-gallon USTs were removed. The 50,000-gallon defueling tank and two of the 25,000-gallon tanks remained in-place, partially under the pumphouse structure. In 1998, the pumphouse structure was removed, along with the two remaining 25,000-gallon USTs. The 50,000-gallon defueling tank was closed in-place. The piping from the boundary of the pumphouse facility to the bulk fuel farm was also drained, pigged, and grouted in-place.

The horizontal and vertical extent of petroleum-related impacts in soil and groundwater was delineated by activities performed during the previous investigations at the former Pumphouse #1 site and the Departure/Arrival Air Control Group (DAACG) facility. The investigations are documented in the Corrective Action Plan (CAP)–Part B Report (Science Applications International Corporation [SAIC] 2000), the CAP–Part B Addendum #1 Report (SAIC 2002) and the CAP–Part B Addendum #2 Report (SAIC 2006). As indicated in the former Pumphouse #1 CAP–Part B Report, two distinct and separate plumes are located within the vicinity of the former Pumphouse #1 site. Release #1 is an area of soil and groundwater contamination located near the DAACG facility that is in the vicinity of former Fuel Pits 1A and 1B, located approximately 900 feet (ft) west of former Building 8060 (i.e., Pumphouse #1). Release #2 is an area of soil and groundwater contamination located near the former Pumphouse #1 facility and former Fuel Pits 1C and 1D, located approximately 200 ft north of the former Tank Pits. The Release 1 and Release 2 areas are presented in Figure 2-1. The corrective actions at Release #2 are addressed in separate documents.

Benzene, toluene, ethylbenzene, and xylenes (BTEX) were among the chemicals of potential concern (COPCs) for site groundwater. The recommended remedial strategy for groundwater in the previous CAPs was free product removal followed by monitored natural attenuation (MNA). The first phase of the corrective action has been completed as free product is no longer present at recoverable quantities and has been consistently less than 1/8 inch in thickness in monitor wells. The second phase of the corrective action is remediation of groundwater to below Georgia Environmental Protection Department (GA EPD) approved alternate concentration limits (ACLs). To reduce the estimated timeframe for groundwater to reach ACLs, an active corrective action addressing the remaining smear zone and groundwater impacts was recommended in the Revised CAP – Part B (ARCADIS 2009b) and the Revised CAP – Part B Addendum #1 (ARCADIS 2009a). The proposed corrective action included using calcium peroxide to increase oxygen concentrations in the aquifer and stimulate biodegradation of the BTEX compounds.

The proposed remedy in the Revised CAP – Part B Addendum #1 (ARCADIS 2009a) was approved by GA EPD Underground Storage Tank Management Program (USTMP) on February 5, 2010. A copy of the Underground Injection Control (UIC) permit for the injection of calcium peroxide, which was approved by GA EPD on April 5, 2010, is included in Appendix C. Calcium peroxide injections occurred from April 6 through

April 30, 2010. The calcium peroxide will provide a sustained source of oxygen to enhance aerobic biodegradation of the residual BTEX present in this area. This report includes a summary of the corrective action implementation activities performed through May 2010.

3. Remedial Activities

3.1 Injection Permit

A UIC permit was obtained from the GA EPD Watershed Protection Branch to inject calcium peroxide for the purpose of remediating petroleum hydrocarbon impacts. The UIC permit application was approved by GA EPD on March 31, 2010, and is included as Appendix C. All injection activities were in compliance with permit requirements. The mass of calcium peroxide injected was below the permitted maximum amount and the injection pressures were at or below levels stipulated in the permit. As described below, smaller diameter injection wells were installed than described in the permit to mitigate potential geotechnical risks.

3.2 Well Installation

Twelve injection wells (IW), P1R1-IW-01 through P1R2-IW-12, were installed south of the DAACG from March 10 to 15, 2010. The injection wells were constructed using 2-inch diameter polyvinyl chloride (PVC) casing and screened from 5 to 20 feet below land surface (ft bls) with 0.010-inch slotted PVC screen. The injection well screen intervals were selected to ensure the ability to inject across the full vertical extent of aquifer impacts. All wells were installed through paved areas potentially subject to aircraft traffic and were installed using 2-inch instead of 4-inch diameter materials to lessen the chance of structural damage. Each well was completed in an 8-inch diameter flush-mounted, traffic-bearing vault. The row of injection wells closest to the DAACG building was moved about 30 ft southeast to avoid the concrete vehicle loading structure. Injection well drilling logs can be found in Appendix D.

In addition to the injection wells, two monitor wells (MW), P1R2-MW-01 and P1R2-MW-02, were installed south of the DAACG building, as directed by the GA EPD USTMP, to better delineate the BTEX impacts in groundwater. The monitor wells consisted of 2-inch diameter PVC casing, screened from 5 to 15 ft bls with 0.010-inch slotted PVC screen. The monitor well screen intervals were selected to bracket the water table. Each well was completed in an 8-inch diameter flush-mounted, traffic-bearing vault. Monitor well logs can be found in Appendix D. The locations of the newly installed injection and monitor wells can be found on Figure 3-1.

3.3 Pre-Injection Monitoring

Prior to calcium peroxide injections, groundwater samples were collected from injection well P1R1-IW-02 and monitoring wells P1R1-MW-01 and P1R1-MW-02 on March 29, 2010. Monitor well D-MW-02, the most proximal monitor well to the injection wells, was sampled in December 2009 and those results will also be used as a baseline for evaluation of the effects of the injection. The results from this sampling event can be found in Table 3-1. The pre-injection monitor well sample results from March 2009 are included on Figure 3-2. The laboratory analytical report for the samples collected on March 29, 2010 can be found in Appendix E.

3.4 Injections

As described in the Revised CAP – Part B Addendum #1, calcium peroxide was selected to stimulate biodegradation of BTEX in groundwater. Calcium peroxide was selected because it provides more sustained oxygen and is more soluble than other oxygen releasing materials. The slower release of oxygen provides for a more efficient use of the released oxygen.

Calcium peroxide was injected into each well as slurry at an average concentration of 0.233 pounds per gallon (lbs/gal) [28 grams per liter (g/L)]. Calcium peroxide injections occurred from April 6, 2010 until April 30, 2010. During this time, a total of 4,510 pounds (lbs) of calcium peroxide were injected into the twelve injection wells. The amount of calcium peroxide injected into each well varied from 254 lbs in P1R1-IW-06 to 626 lbs in P1R1-IW-02. Potable water was injected after the calcium peroxide solution to better distribute the calcium peroxide as well as to flush the area immediately adjacent to the injection wells. The amount of chase water injected into each well varied from 503 gallons in P1R1-IW-05 to 789 gallons in P1R1-IW-07. The mass and volumes injected into each injection well are included in Table 3-2 and presented on Figure 3-3. For reference on groundwater flow direction, a groundwater potentiometric surface map presenting the December 2009 data is included as Figure 3-4.

4. Conclusions and Recommendations

4.1 Conclusions

The following conclusions are presented:

- Twelve injection wells were successfully installed at the Pumphouse 1, Release #1 site. Injection rates indicate that the twelve injection wells are hydraulically connected to the surficial aquifer and are adequately constructed for this and future injections.

- The total of 4,510 lbs of calcium peroxide was injected into the twelve injection wells. This mass will provide approximately 766 lbs of slow release oxygen in order to stimulate aerobic biodegradation of the BTEX targets. Because of the lag in response that is typical for biostimulation remedies, sampling of area wells was not conducted immediately after the injections.

- The injection rate decreased as injections proceeded due to obstruction of mobile porosity by the low solubility calcium peroxide. The use of chase water helped distribute the calcium peroxide. Injection rates for future events will likely increase as the calcium peroxide previously injected dissolves.

- The sampling results from the 2 monitor wells installed at the site conformed to previous estimates of the impacted area.

4.2 Recommendations

The following recommendations are presented:

- ARCADIS will conduct quarterly performance monitoring at the site. The performance monitoring will include measurement of field parameters, including temperature, pH, dissolved oxygen, conductivity, and turbidity. Groundwater samples will also be collected for laboratory analysis of BTEX constituents and total suspended solids. The following wells are recommended to be sampled as part of the June 2010 performance monitoring: P1R1-IW-02, P1R1-MW-01, P1R1-MW-02, D-MW-01, D-MW-02, D-MW-34, D-MW-35, D-MW-36, D-MW-37, and D-MW-43.

- The first two quarterly events will be conducted in June 2010 and September 2010. The need for additional or more frequent sampling will be evaluated based on the data from these two events.

- During the June sampling event, groundwater elevations should be taken in all injection wells and select monitor wells in the target plume. The groundwater gauging results will be used to evaluate the groundwater flow directions within the targeted treatment area. This information would be used in preparation of a future injection strategy.

- After the second performance monitoring event in September, ARCADIS will evaluate all post-injection data to determine the dosing, schedule and overall strategy for the next round of calcium peroxide injections.

The proposed modified post-injection monitoring program is presented in Table 4-1.

Scanned datafolders, Admin todays date notified Ashenson + Dwerff By email

Georgia Department of Natural Resources

Environmental Protection Division
Underground Storage Tank Management Program
4244 International Parkway, Suite 104, Atlanta, Georgia 30354
Chris Clark, Commissioner
F. Allen Barnes, Director
(404) 362-2687

FEB
BY

RECEIVED
FEB 17 REC'D
BY

February 5, 2010

Mr. Thomas C. Fry
U.S. Army/HQ 3d,Inf. Div (Mech)
Directorate of Public Works
1550 Frank Cochran Drive
Building 1137
Fort Stewart, Georgia 31314-4927

SUBJECT: Notice to Implement Corrective Action Plan (CAP)-Part B:
Hunter AAF, Former Fuel Pit #1
Former Building 8060
Savannah, Chatham County, GA
Facility ID: 9025085*1

Dear Mr. Thomas C. Fry:

The Georgia Underground Storage Tank Management Program (USTMP) has received your consultant's letter, dated November 5, 2009, that forwarded a properly certified Revised CAP-Part B Addendum #1. The report was prepared by ARCADIS.

The technical proposal contained in the Revised CAP-Part B for further investigation, monitoring and/or remediation of the current release is hereby approved by the USTMP. As a result of your CAP-Part B being technically approved, you are authorized to begin implementation of this plan.

Note: EPD recommends that an additional line of injection wells be located downgradient of D-MW-34 to reduce the "Leading Edge" of the dissolved plume. Also, additional monitoring wells will be necessary to monitor site conditions downgradient of D-MW-34.

Please submit an updated milestone schedule by **March 8, 2010**, listing specific dates, events and a timetable to complete the proposed activities. If you have any technical questions, please contact me at (404) 362-4529.

Sincerely,

William E. Logan
Geologist III
Corrective Action Unit II

WEL:
S: land/landdocs/williaml/Pend10/9025085R1A. 120
cc: Curtis Scott Bostian, P.E., ARCADIS
Lisa L. Lewis, GA EPD
File (CA): CHATHAM; 9025085

DEPARTMENT OF THE ARMY
US ARMY INSTALLATION MANAGEMENT COMMAND
HEADQUARTERS, US ARMY GARRISON, FORT STEWART / HUNTER ARMY AIRFIELD
1587 FRANK COCHRAN DRIVE
FORT STEWART, GEORGIA 31314

REPLY TO
ATTENTION OF

NOV 05 2009

Office of the Directorate

CERTIFIED MAIL

7008 2810 0000 7784 0640

Georgia Environmental Protection Division
UST Management Program
Attention: Mr. William Logan
4244 International Parkway, Suite 104
Atlanta, GA 30354

Dear Mr. Logan:

Fort Stewart is pleased to submit to the Georgia Environmental Protection Division one copy of the Revised Corrective Action Plan (CAP)-Part B Addendum #1 Report for Former Pumphouse # 1 (Release #1), Facility ID #9-025085*1, Former Building 8060, Hunter Army Airfield, Georgia, dated October 2009, for your review.

The enclosed report documents additional details to the proposed remedial action, the basis for selection, conceptual design of the remedy, and implementation logistics. Free product is no longer present at recoverable quantities and has consistently been less than one-eighth of an inch in thickness in monitoring wells. The corrective action is remediation of groundwater to below the approved alternate concentration limit (ACL) of 285 ug/L. To reduce the estimated timeframe for groundwater to reach ACLs, an active corrective action addressing the remaining smear zone and groundwater contamination is recommended.

If you have any questions or comments regarding the enclosed report, please contact Ms. Algeana Stevenson at (912)315-5144 or Ms. Tressa Rutland, Directorate of Public Works, Prevention and Compliance Branch, at (912)767-2010.

Sincerely,

Thomas C. Frey
for Robert R. Baumgardt
Director, Public Works

Enclosure

CORRECTIVE ACTION PLAN-PART B

Facility Name:	Former Pumphouse #1 (Release #1)			Street Address:	Former Building 8060, near Taxiway 3		
Facility ID:	9-025085*1	City:	Hunter Army Airfield	County:	Chatham	Zip Code:	31409
Latitude:	32° 00′ 54″	Longitude:	81° 08′ 26″				

Submitted by UST Owner/Operator:				Prepared by Consultant/Contractor:			
Name:	Tom Fry/ Environmental Branch			Name:	Charles Bertz		
Company:	U. S. Army/HQ 3d, Inf. Div. (Mech)			Company:	ARCADIS		
Address:	DPW ENRD ENV. Br.			Address:	801 Corporate Center Dr.		
	1550 Frank Cochran Drive, Bldg. 1137				Suite 300		
City:	Fort Stewart	State:	GA	City:	Raleigh	State:	NC
Zip Code:	31314-4927			Zip Code:	27607		
Telephone:	(912) 767-2010			Telephone:	(919) 854-1282		

I. PLAN CERTIFICATION:

A. UST OWNER/OPERATOR

I hereby certify that the information contained in this plan and in all the attachments is true, accurate, and the plan satisfies all criteria and requirements of rule 391-3-15-09 of the Georgia Rules for Underground Storage tank Management.

Name: Tom Fry

Signature:_____ Date:_____

B. REGISTERED PROFESSIONAL ENGINEER OR PROFESSIONAL GEOLOGIST CERTIFICATION

I hereby certify that I have directed and supervised the fieldwork and preparation of this plan in accordance with State Rules and Regulations. As a registered professional geologist and/or professional engineer, I certify that I am a qualified groundwater professional, as defined by the Georgia State Board of Professional Geologists. All of the information and laboratory data in this plan and in all of the attachments are true, accurate, complete, and in accordance with applicable State Rules and Regulations.

Name: Scott Bostian, PE

Signature:

Date: 10/1/09

GEORGIA REGISTERED PROFESSIONAL ENGINEER CURTIS SCOTT BOSTIAN

Georgia Stamp or Seal

Check all boxes that apply. Attach supporting documentation, i.e. narrative, figures, tables, maps, boring/well logs, etc., for all items checked. Supporting documentation should be three-hole punched and prepared in conformity with the guidance document "Underground Storage Tank (UST) Release: Corrective Action Plan-Part B (CAP-B) Content", GUST 7B.

II. SITE INVESTIGATION REPORT

[X] Not Applicable The extent of contamination, and the local & site hydrogeology requirements have been fulfilled under the CAP Part A, therefore additional SIR reporting is not necessary.

[ ] **Extent of Contamination:**

[ ] Soil [ ] Groundwater [ ] Free Product [ ] Surface water

[ ] **Local and Site Hydrogeology:**

[ ] Documentation of Local Groundwater Conditions

[ ] Stratigraphic Boring Logs

[ ] Stratigraphic Cross Sections

[ ] Referenced or Documented Calculations of Relevant Aquifer Parameters

[ ] Direction of Groundwater Flow

[ ] Table of Monitoring Well Data

[ ] Potentiometric Map

[ ] Flow Net Superimposed on a Base Map

III. REMEDIAL ACTION PLAN

A. **Corrective Action Completed or In-Progress:**

[ ] Not Applicable

[X] Recovery/Removal of Free Product (Non-Aqueous Phase Hydrocarbons)

[ ] Remediation/Treatment of Contaminated Soils

[ ] Other (specify)

B. **Objectives of Corrective Action:**

[ ] No Further Action

[X] Remove Free Product That Exceeds One-Eighth Inch

[ ] Remediate Groundwater Contamination That Exceeds:

[ ] Maximum Contaminant Levels (MCLs)

OR

[ ] In-stream Water Quality Standards

B. **Objectives of Corrective Action (CONTINUED):**

[ ] Remediate Soil Contamination That Exceeds:

[ ] Threshold Values Listed In Table A

OR

☐ Threshold Values Listed In Table B

OR

☐ Alternate Threshold Levels (ATLs) (Reference CAP A App. I)

☒ Provide Risk-Based Corrective Action (Reference CAP B App. I):

☒ Remediate Soil and/or Groundwater Contamination That Exceeds Alternate Concentration Limits (ACLs) and Monitor Residual Contaminants

OR

☐ Monitor Soil and/or Groundwater Contamination That Exceeds Levels In Rule–391-3-15-.09(3).

C. **Design and Operation of Corrective Action Systems:**

☒ Soil ☒ Groundwater ☒ Free Product ☐ Surface water ☐ Not Applicable

D. **Implementation (MUST INCLUDE THE FOLLOWING):**

NOTE: If No Further Action is proposed and none of the following apply, a brief explanation must be provided with the signed Certificate of Completion.

- Milestone schedule for proposed site activities

- Inspection and preventive maintenance schedule for all specialized remediation equipment

  AND / OR

  Monitoring/sampling and reporting plan for measuring interim progress and project completion

- Plan to decommission equipment/wells and close site

IV. PUBLIC NOTICE:

- [ ] Not Applicable The Corrective Action Objectives submitted and approved under the CAP-Part A have not changed.
- [ ] Certified Letters to Adjacent, Potentially Affected Property Owners and Local Officials
- [x] Legal Notice in Newspaper, as approved by EPD
- [ ] Other EPD-approved Method (specify) _____

V. CLAIM FOR REIMBURSEMENT (For GUST Trust Fund sites only)

- [x] Not Applicable (specify) _____

- [ ] GUST Trust Fund Application - (attach if applicable)

- [ ] Cost Proposal:
  - [ ] A Total of All Costs Incurred To Date (MUST INCLUDE THE FOLLOWING):
    - ▶ Invoices and Proofs-of-Payment For All Costs Incurred To Date
    - ▶ Invoices itemized on the GUST-4D
    - ▶ All Non-Eligible Costs Clearly Identified as such
    - ▶ Incurred Costs Itemized per GUST-92 fonn or EPD provided form/specifications
  - [ ] A Total of Estimated Costs To Complete Corrective Action
    - ▶ Estimated Costs Itemized per GUST-92 form or EPD provided form or specifications
  - [ ] Total Project Costs

- [ ] Proposed Schedule For Reimbursement
  - [ ] Lump Sum Payment Upon Completion Of Corrective Action

    OR
  - [ ] Interim Payments With Final Payment Upon Completion

    OR
  - [ ] EPD Established Payment Schedule

2. Introduction

Addendum #1 to the Revised Corrective Action Plan – Part B (Revised CAP – Part B Addendum) for Pumphouse #1 Release #1 has been prepared to provide additional detail to the proposed corrective action for groundwater. The proposed groundwater corrective action is explained in the Revised Corrective Action Plan – Part B with 2008 Annual Report (Revised CAP – Part B) (ARCADIS 2009). The former Pumphouse #1, Facility ID #9-025085 was located near former Building 8060 at Hunter Army Airfield (HAAF), in Savannah, Georgia (Figure 2-1).

The horizontal and vertical extent of petroleum-related impacts in soil and groundwater was delineated by activities performed during the previous investigations at the former Pumphouse #1 site and the Departure/Arrival Air Control Group (DAACG) facility. The investigations are documented in the CAP–Part B Report (SAIC 2000), the CAP–Part B Addendum #1 Report (SAIC 2002), and the CAP–Part B Addendum #2 Report (SAIC 2006). Benzene, ethylbenzene, toluene, benzo(*a*)pyrene, chrysene, and naphthalene were identified as chemicals of potential concern (COPCs) for groundwater.

The recommended remedial strategy for groundwater in the previous corrective action plans (CAPs) was free product removal followed by monitored natural attenuation (MNA). The first phase of the corrective action has been completed as free product is no longer present at recoverable quantities and has been consistently less than 1/8 inch in thickness in monitor wells. The second phase of the corrective action is remediation of groundwater to below approved alternate concentration limits (ACLs). To reduce the estimated timeframe for groundwater to reach ACLs, an active corrective action addressing the remaining smear zone and groundwater contamination is recommended. The proposed remedial action, the basis for selection, conceptual design of the remedy, and implementation logistics are presented in the following sections.

3. Pre-design Field Data Collection

Pumphouse #1 Release #1 is located adjacent to an active runway. Consequently, it is important that the remedial strategy selected minimizes impacts to military operations as much as possible. The proposed remedial strategy is enhanced bioremediation via electron acceptor amendment. Enhanced bioremediation will result in less impact to the military flight operations at the site relative to more intrusive technologies such as six-phase heating, air sparge/soil vapor extraction, and chemical oxidation. To better characterize the biogeochemical conditions of the groundwater and to select the most appropriate electron acceptor, a round of groundwater sampling from selected monitor wells was performed in June 2009. Groundwater samples were collected from monitor wells D-MW-1, D-MW-2, D-MW-11, D-MW-19, D-MW-34, D-MW-35, D-MW-37, D-MW-41 and D-MW-42. The samples were analyzed and measured for the following:

- Dissolved Organic Carbon (DOC)
- Alkalinity
- Total Phosphorus (from D-MW-34 and D-MW-41 only)
- Total Kjeldahl Nitrogen (from D-MW-34 and D-MW-41 only)
- Nitrogen as Nitrate
- Total and Dissolved Iron
- Sulfate
- Sulfide
- Methane
- Benzene, Toluene, Ethylbenzene and Xylenes (BTEX)
- Total Petroleum Hydrocarbons (TPH)
- Total/dissolved lead
- Lead speciation (organic and inorganic forms in D-MW-34 and D-MW-41 only)
- pH (field measured)
- Dissolved Oxygen (DO) (field measured)

The sample results are summarized in Tables 3-1 through 3-3 in Appendix B and are presented in Figures 3-1 through 3-3 in Appendix A. The laboratory results are included in Appendix C. In general, the average concentrations of electron acceptors (dissolved oxygen and sulfate) are lower in monitor wells within the petroleum hydrocarbon impacted areas (i.e., D-MW-1, D-MW-2, D-MW-34, D-MW-35, D-MW-37) relative to the background (i.e., D-MW-41 and D-MW-42). Similarly, the average concentrations of metabolic by-products (ferrous [dissolved] iron and methane) are higher within the impacted areas. These observations indicate that intrinsic bioremediation of petroleum hydrocarbons coupled with reduction of electron acceptors is ongoing at the site. However, the relatively low background concentrations of oxygen, nitrate, ferric iron (the difference of total iron and dissolved iron), and sulfate have likely limited biodegradation of the

petroleum hydrocarbons, as evidenced by the relatively stable concentrations of BTEX between 2001 and 2009 (Table 3-3).

In addition to electron acceptors, nutrients such as nitrogen and phosphorus were also analyzed. Nitrogen and phosphorus are essential for biodegradation of organic contaminants by bacteria. The results indicate that nutrient levels are generally low within the groundwater unit. It is not clear whether the low nutrient levels have limited the intrinsic biodegradation since the biogeochemical data strongly indicate that electron acceptor availability is a limiting factor.

Lead was previously detected in groundwater samples collected from DPT borings in January 2008 at levels above the in-stream water quality standard (IWQS) of 30 µg/L. However, the high turbidity of the DPT water samples may have contributed to the elevated concentration of lead. For example, lead concentrations exceeding the IWQS were detected in approximately 10 to 15 percent of the low-flow groundwater samples (3 of the 30 samples from the December 2007 sampling event, and 4 of 27 samples from the December 2008 event), whereas lead concentrations exceeding the IWQS were detected in more than 30 percent of the DPT water samples (15 of 44 samples) during the January 2008 supplemental investigation (ARCADIS 2009).

Lead in groundwater was also evaluated during the June 2009 sampling event to better understand its speciation. The results indicate that inorganic lead exists in both dissolved phase and solid phase as suspended solids in the groundwater. In addition, it appears that lead exists predominantly in the organic form, especially in the BTEX source area (D-MW-34). This may have been a result of microbial alkylation of inorganic lead in anaerobic environments (USEPA 2007).

4. Basis for Selection of Corrective Action

As mentioned in the Revised CAP – Part B report, either oxygen or sulfate will be selected as the electron acceptor to be amended into the impacted groundwater. The qualitative assessment in Section 3 suggests that neither electron acceptor is present at a background level high enough to provide sufficient biodegradation capacity for cleanup within a reasonable timeframe. As a result, the selection of electron acceptor will be based on the inherent characteristics of the electron acceptor processes and of the microbial populations.

As described by Wiedemeier *et. al.* (1999), biodegradation of BTEX occurs more rapidly under aerobic conditions than under sulfate-reducing process. The production of hydrogen sulfide and metal sulfide precipitates (e.g., iron sulfide) from sulfate-reducing processes may result in reduction of permeability and hence injection capacity of the soil matrix. Additionally, sulfate-reducing microorganisms are typically sensitive to environmental conditions, including temperature, inorganic nutrients, and pH (Wiedemeier *et. al.* 1999). An imbalance in suitable environmental conditions could limit BTEX degradation via sulfate reduction.

The background sulfate concentrations indicate the sulfate reducer population may not be adequate to respond to sulfate amendments. Consequently, biodegradation through sulfate reduction may lag significantly or stall entirely. Conversely, many bacteria can rapidly adapt to perform biodegradation under aerobic conditions. Based on these comparisons, oxygen amendment is preferred over sulfate additions. Aerobic conditions can be engineered via different methods, such as oxygen/air sparging coupled with soil vapor extraction, injection and extraction of oxygen-saturated water for a recirculation system, and injection of chemicals that slowly release oxygen (e.g., magnesium peroxide, calcium peroxide, sodium percarbonate). The first two methods are more intrusive and would require trenching for the construction of underground conveyance piping for substrate or air delivery and groundwater or vapor extraction. Due to the significant disruption the construction would have on military flight operations, the first two methods were not selected as part of the remedial strategy. The injection of oxygen releasing substrates involves less intrusive site activities such as well installation and periodic injection events with mobile equipment.

The most important physico-chemical properties of three possible oxygen release chemicals are listed in Table 4-1. The comparison shows that calcium peroxide releases the most oxygen. Calcium peroxide has a low solubility (in comparison with sodium percarbonate). As a result, calcium peroxide is less reactive and provides a slower release of oxygen occurring over the course of several months. Sodium percarbonate releases oxygen more rapidly because of its higher solubility. Consequently, there is a less efficient use of the released oxygen. Because of the higher oxygen content and slow release characteristics, calcium peroxide is chosen to stimulate the biodegradation.

Calcium peroxide (CaO_2) slowly releases oxygen when in contact with water according to the following reaction:

$$2\ CaO_2 + 2\ H_2O \rightarrow 2\ Ca(OH)_2 + O_2$$

The speed at which oxygen is released is determined by physical and chemical properties of the aquifer (e.g., pH and temperature). When CaO_2 is exposed to a lower pH, hydrogen peroxide (H_2O_2) can be generated according to the following reaction:

$$CaO_2 + 2\,H^+ \rightarrow Ca^{2+} + H_2O_2$$

H_2O_2 releases oxygen according to the following reaction:

$$2\,H_2O_2 \rightarrow 2\,H_2O + O_2$$

Hydrogen peroxide is not expected to be generated directly around the injection wells because of the higher pH associated with calcium hydroxide and calcium peroxide. This ensures an efficient release of oxygen. As a consequence of the low solubility of calcium peroxide in water (<0.1 gram per liter [g/L] @ 20 °C), an oxygen release period of more than 6 months is typical.

As mentioned previously, it is not clear whether the low nutrient levels in the groundwater have contributed to the slow biodegradation of BTEX. Therefore, nutrient amendment as a remedial strategy will not be considered at this point. However, this option will be re-evaluated if oxygen amendment appears to be inadequate for simulating an increase in biodegradation rates.

As mentioned in the Revised CAP – Part B (ARCADIS 2009), the mitigation of lead in groundwater was considered during the remedy evaluation for dissolved petroleum hydrocarbons. The engineering of an aerobic environment is not expected to affect the mobility of lead as the geochemical transport processes of lead are not directly affected by redox conditions (USEPA 2007). The aerobic environment resulting from calcium peroxide injection may limit the microbial alkylation of inorganic lead to organic lead, which is a more soluble form of lead.

5. Design and Operation of Corrective Action

5.1 Well Layout and Design

Calcium peroxide will be delivered to the target treatment zone via an array of injection wells. Two lines of injection wells will be installed perpendicular to the general direction of groundwater flow in the most impacted areas near monitoring wells D-MW-34 and D-MW-2 (Figure 5-1). The injection wells will be installed 20 feet apart, with a target radius of injection (ROI) of 10 feet. The wells will be constructed with 15-foot screens that extend approximately 5 feet into the vadose zone to address the smear zone.

5.2 Calcium Peroxide Dosing and Injection Volume Design

The dosing of calcium peroxide was calculated by considering three sources of oxygen demand in the subsurface:

- Oxygen required by aerobic bacteria to degrade BTEX compounds;
- Oxygen demand by natural organic matter (NOM) in the groundwater; and
- Oxygen demand by NOM in the soil.

The amount of oxygen required to aerobically biodegrade BTEX was calculated using the total BTEX concentration observed in D-MW-34 during the June 2009 semiannual sampling event and an oxygen utilization factor for BTEX as described in Wiedemeier, *et. al.* (1999). The stoichiometry of the oxidation reaction of individual BTEX compounds by oxygen was considered when calculating the oxygen utilization factor, which is 3 g oxygen/g BTEX. The oxygen demand by NOM in soil and groundwater was calculated based on a typical soil NOM content of 200 milligrams per kilogram (mg/kg) of soil and an average chemical oxygen demand (COD) in groundwater of 104 milligrams per liter (mg/L) from the Pumphouse 1 Release 2 area. In addition, the mass flux of BTEX and NOM in groundwater through the calcium peroxide barrier within the 6-month longevity of calcium peroxide was determined based on a groundwater seepage velocity of 0.52 foot/day and a barrier cross section of 15 feet (thickness) x 100 feet (length perpendicular to groundwater flow). The total oxygen demand was converted to calcium peroxide dosing using an oxygen content of 17 percent by weight and a safety factor of 1.5 to account for losses of oxygen. The estimated calcium peroxide dosing is approximately 34 g calcium peroxide/L of water. The calcium peroxide dosing calculations are included as Appendix D.

The injection volume of calcium peroxide solution was calculated using the following equation:

$$V_{inj} = ROI^2 \times \pi \times h \times n_m \times \left(\frac{7.481\ gal}{ft^3}\right)$$

where:

V_{inj} = volume of injection (gal)

ROI = radius of injection (e.g., 10 feet)

h = height of injected fluid column (15 feet)

n_m = mobile porosity

The estimated injection volumes per injection well and the corresponding amounts of calcium peroxide with different mobile porosity (n_m) values are shown in the following table:

	$n_m = 0.05$	$n_m = 0.1$	$n_m = 0.15$	$n_m = 0.20$
Injection volume (gallons)	1,763	3,525	5,288	7,050
Mass of calcium peroxide (lb)	497	995	1,492	1,989

5.3 Injection Implementation

After the injection wells have been installed, a startup injection event utilizing all injection wells will be implemented. The purpose of the startup injection is to quantify the injection volume required to reach the design ROI. The arrival of calcium peroxide at a dose-response well located at the design ROI from an injection well (e.g., D-MW-2) will be monitored through measurement of total suspended solids (TSS), dissolved oxygen and conductivity. The likely calcium peroxide injection frequency is expected to be semi-annual but will be adjusted and optimized based on DO and BTEX concentrations in performance monitor wells (described in the following section). Based on estimates from the current data set, the need for a minimum of two injection events is anticipated.

5.4 Performance Monitoring Plan

Quarterly monitoring of designated performance monitor wells is proposed to evaluate remediation progress. Performance monitoring will consist of sampling up to 20 wells. These wells may include, but are not limited to, D-MW-1, D-MW-2, D-MW-11, D-MW-18, D-MW-34, D-MW-35, D-MW-37, D-MW-19, D-MW-33, D-MW-38, D-MW-43, and P1-MW-42. Sufficient downgradient wells will be included in the monitoring plan to evaluate contaminant migration. The quarterly monitoring schedule will include analysis of water quality parameters including dissolved oxygen, TSS and VOCs.

Total and dissolved inorganic lead and organic lead will also be analyzed in monitor well samples within the source area (e.g., D-MW-34, D-MW-1, D-MW-35, and D-MW-2) to evaluate the effect of calcium peroxide injection on lead concentrations in the groundwater.

6. Underground Injection Permit Application

Upon approval of the Revised CAP-Part B and this addendum, a permit application will be submitted to the Underground Injection Control (UIC) Division of Georgia Environmental Protection Division (GA EPD). The permit will be obtained before the initial injection event is conducted.

7. Project Schedule

A project schedule for the proposed corrective action was provided in the Revised CAP (ARCADIS 2009). Fort Stewart will notify GA EPD of any significant changes to the schedule and will provide GA EPD with an updated Gantt chart, as necessary.

8. References

ARCADIS. 2009. Final Revised Corrective Action Plan – Part B with 2008 Annual Report for Former Pumphouse #1 (Release #1), Former Building 8060, Facility ID #9-025085*1, Hunter Army Airfield, Georgia. June.

U.S. Environmental Protection Agency (USEPA). 2007. Monitored Natural Attenuation of Inorganic Contaminants in Ground Water. Vol. 2. Assessment for Non-Radionuclides including Arsenic, Cadmium, Chromium, Copper, Lead, Nickel, Nitrate, Perchlorate, and Selenium. October.

Science Applications International Corporation. 2006. Corrective Action Plan–Part B Addendum #2 for Former Pumphouse #1, Facility ID #9-025085, Building 8060, Hunter Army Airfield, Georgia. July.

Science Applications International Corporation. 2002. Corrective Action Plan–Part B Addendum #1 for Former Pumphouse #1, Facility ID #9-025085, Building 8060, Hunter Army Airfield, Georgia. July.

Science Applications International Corporation. 2000. Corrective Action Plan–Part B for Former Pumphouse #1, Facility ID #9-025085, Building 8060, Hunter Army Airfield, Georgia. August.

Wiedemeier, T.H., H.S. Rifai, J.T. Wilson, and C. Newell. 1999. Natural Attenuation of Fuels and Chlorinated Solvents in the Subsurface. John Wiley and Sons.

Scanned 2/10/10
+ put on Sharepoint under Contractor's admin
I notified A. Stevenson

Georgia Department of Natural Resources

Environmental Protection Division
Underground Storage Tank Management Program
4244 International Parkway, Suite 104, Atlanta, Georgia 30354
Chris Clark, Commissioner
F. Allen Barnes, Director
(404) 362-2687

RECEIVED
FEB 09 REC'D
By

February 3, 2010

Mr. Thomas C. Fry
U.S. Army/HQ 3d,Inf. Div (Mech)
Directorate of Public Works
1550 Frank Cochran Drive
Building 1137
Fort Stewart, Georgia 31314-4927

SUBJECT: Notice to Implement Corrective Action Plan (CAP)-Part B:
Hunter AAF, Former Fuel Pit #1
Former Building 8060
Savannah, Chatham County, GA
Facility ID: 9025085*1

Dear Mr. Thomas C. Fry:

The Georgia Underground Storage Tank Management Program (USTMP) has received your consultant's letter, dated July 24, 2009, that forwarded a properly certified Revised CAP-Part B and with the 2008 Annual Monitoring Report. The report was prepared by ARCADIS.

The technical proposal contained in the Revised CAP-Part B for further investigation, monitoring and/or remediation of the current release is hereby approved by the USTMP. As a result of your CAP-Part B being technically approved, you are authorized to begin implementation of this plan.

Note: If free product is observed, EPD requests that free product be removed by use of Enhanced Fluid Recovery and submit a copy of the Contractor's report to EPD. Please, conduct semiannual sampling and submit the monitoring reports on a semiannual schedule. A "No Further Action" will be granted only when EPD determines that site conditions are acceptable.

Please submit an updated milestone schedule by **March 4, 2010**, listing specific dates, events and a timetable to complete the proposed activities. If you have any technical questions, please contact me at (404) 362-4529.

Sincerely,

William E. Logan
Geologist III
Corrective Action Unit II

WEL:
S: land/landdocs/williaml/Pend10/9025085R1. 120
cc: Curtis Scott Bostian, P.E., ARCADIS
Lisa L. Lewis, GA EPD
File (CA): CHATHAM; 9025085

DEPARTMENT OF THE ARMY
US ARMY INSTALLATION MANAGEMENT COMMAND
HEADQUARTERS, US ARMY GARRISON, FORT STEWART / HUNTER ARMY AIRFIELD
1587 FRANK COCHRAN DRIVE
FORT STEWART, GEORGIA 31314

REPLY TO
ATTENTION OF

Office of the Directorate

JUL 24 2009

CERTIFIED MAIL
7008 3230 0002 9207 00

Georgia Environmental Protection Division
UST Management Program
Attention: Mr. William Logan
4244 International Parkway, Suite 104
Atlanta, GA 30354

Dear Mr. Logan:

Fort Stewart is pleased to submit to the Georgia Environmental Protection Division one copy of the Revised Corrective Action Plan [CAP]-Part B With 2008 Annual Monitoring Report, Former Pumphouse #1 (Release #1), Former Building 8060, Hunter Army Airfield, Savannah, GA, Facility ID 9-025085*1 dated June 2009, for your review.

The enclosed report documents the delineation of soil and groundwater contamination conducted in 2008 and the third annual sampling event conducted in December 2008. Free product was not observed at this site during the third annual sampling event. Based on the results of the soil and groundwater delineation, the following conclusions were derived. Recent free product thickness measurements indicate that very little mobile free product remains. Soil sampling confirmed that the petroleum hydrocarbon concentrations are below their respective alternate concentration levels; therefore, remediation of soil petroleum hydrocarbon related contaminants is not necessary. The groundwater petroleum hydrocarbon concentrations indicate that the groundwater impacted above their alternate concentration levels are located in the area previously identified in the CAP-Part B as having the largest free product quantities. Lead concentrations in soil exceed the Hazardous Site Response Act (HSRA) Type I Relative Risk Standard (RRS) but not the Type III RRS; therefore, active remediation is not recommended to address the lead concentrations in the soil. Lead concentrations in groundwater exceeded the In-Stream Water Quality Standard in samples from three monitoring wells. The elevated concentrations of lead are likely attributable to turbid groundwater samples.

The corrective action selected to address the benzene concentrations in the groundwater is enhanced bioremediation followed by monitoring of natural attenuation. Groundwater samples will be sampled annually from up to 26 groundwater monitoring wells. Pumphouse #1 Release #1 has been incorporated into a Performance Based Acquisition Contract. A new contractor (Arcadis) will be responsible for continuing the annual monitoring and developing future remedial actions.

If you have any questions or comments regarding the enclosed report, please contact Ms. Algeana Stevenson at (912)315-5144 or Ms. Tressa Rutland, Directorate of Public Works, Prevention and Compliance Branch, at (912)767-2010.

Sincerely,

Thomas C. Fry 07/24/09

For Robert R. Baumgardt
Director, Public Works

Enclosure

ARCADIS

CORRECTIVE ACTION PLAN-PART B

Facility Name:	Former Pumphouse #1 Site (Release #1)			Street Address:	Former Building 8060, near Taxiway 3
Facility ID:	9-025085*1	City:	Hunter Army Airfield	County:	Chatham	Zip Code: 31409
Latitude:	32°00'54"	Longitude:	81°08'26"		

Submitted by UST Owner/Operator:		Prepared by Consultant/Contractor:	
Name:	Tressa Rutland/ Environmental Branch	Name:	Charles Bertz
Company:	U. S. Army/HQ 3d, Inf. Div. (Mech)	Company:	ARCADIS
Address:	DPW ENRD ENV. Br. (Fry)	Address:	801 Corporate Center Dr.
	1550 Frank Cochran Drive, Bldg. 1137		Suite 300
City:	Port Stewart State: GA	City:	Raleigh State: NC
Zip Code:	31314-4927	Zip Code:	27607
Telephone:	(912) 767-2010	Telephone:	(919) 854-1282

I. PLAN CERTIFICATION:

A. UST OWNER/OPERATOR

I hereby certify that the information contained in this plan and in all the attachments is true, accurate, and the plan satisfies all criteria and requirements of rule 391-3-15-09 of the Georgia Rules for Underground Storage tank Management.

Name: Tressa Rutland

Signature:_____ Date:_____

B. REGISTERED PROFESSIONAL ENGINEER OR PROFESSIONAL GEOLOGIST CERTIFICATION

I hereby certify that I have directed and supervised the fieldwork and preparation of this plan in accordance with State Rules and Regulations. As a registered professional geologist and/or professional engineer, I certify that I am a qualified groundwater professional, as defined by the Georgia State Board of Professional Geologists. All of the information and laboratory data in this plan and in all of the attachments are true, accurate, complete and in accordance with applicable State Rules and Regulations.

Name: Scott Bostian, PE

Signature:

Date: 6/9/09

GEORGIA REGISTERED PROFESSIONAL ENGINEER CURTIS SCOTT BOSTIAN

6/9/09

Georgia Stamp or Seal

Check all boxes that apply. Attach supporting documentation, i.e. narrative, figures, tables, maps, boring/well logs, etc., for all items checked. Supporting documentation should be three-hole punched and prepared in conformity with the guidance document "Underground Storage Tank (UST) Release: Corrective Action Plan-Part B (CAP-B) Content", GUST 7B.

[X] Not Applicable The extent of contamination, and the local & site hydrogeology requirements have been fulfilled under the CAP Part A, therefore additional SIR reporting is not necessary.

[ ] **Extent of Contamination:**

[ ] Soil [ ] Groundwater [ ] Free Product [ ] Surface water

[ ] **Local and Site Hydrogeology:**

[ ] Documentation of Local Groundwater Conditions

[ ] Stratigraphic Boring Logs

[ ] Stratigraphic Cross Sections

[ ] Referenced or Documented Calculations of Relevant Aquifer Parameters

[ ] Direction of Groundwater Flow

[ ] Table of Monitoring Well Data

[ ] Potentiometric Map

[ ] Flow Net Superimposed on a Base Map

III. REMEDIAL ACTION PLAN

A. Corrective Action Completed or In-Progress:

[ ] Not Applicable

[X] Recovery/Removal of Free Product (Non-Aqueous Phase Hydrocarbons)

[ ] Remediation/Treatment of Contaminated Soils

[ ] Other (specify)

_____

_____

B. Objectives of Corrective Action:

[ ] No Further Action

[X] Remove Free Product That Exceeds One-Eighth Inch

[ ] Remediate Groundwater Contamination That Exceeds:

[ ] Maximum Contaminant Levels (MCLs)

OR

[ ] In-stream Water Quality Standards

B. Objectives of Corrective Action (CONTINUED):

[ ] Remediate Soil Contamination That Exceeds:

[ ] Threshold Values Listed In Table A

OR

☐ Threshold Values Listed In Table B

OR

☐ Alternate Threshold Levels (ATLs) (Reference CAP A App. I)

☒ Provide Risk-Based Corrective Action (Reference CAP B App. I):

☒ Remediate Soil and/or Groundwater Contamination That Exceeds Alternate Concentration Limits (ACLs) and Monitor Residual Contaminants

OR

☐ Monitor Soil and/or Groundwater Contamination That Exceeds Levels In Rule – 391-3-15-.09(3).

C. **Design and Operation of Corrective Action Systems:**

☒ Soil ☒ Groundwater ☒ Free Product ☐ Surface water ☐ Not Applicable

D. **Implementation (MUST INCLUDE THE FOLLOWING):**

NOTE: If No Further Action is proposed and none of the following apply, a brief explanation must be provided with the signed Certificate of Completion.

- Milestone schedule for proposed site activities

- Inspection and preventive maintenance schedule for all specialized remediation equipment

  AND / OR

  Monitoring/sampling and reporting plan for measuring interim progress and project completion

- Plan to decommission equipment/wells and close site

ARCADIS

IV. PUBLIC NOTICE:

☐ Not Applicable The Corrective Action Objectives submitted and approved under the CAP-Part A have not changed.

☐ Certified Letters to Adjacent, Potentially Affected Property Owners and Local Officials

☒ Legal Notice in Newspaper, as approved by EPD

☐ Other EPD-approved Method (specify) _____

V. CLAIM FOR REIMBURSEMENT (For GUST Trust Fund sites only)

☒ Not Applicable (specify) _____

☐ GUST Trust Fund Application - (attach if applicable)

☐ Cost Proposal:

☐ A Total of All Costs Incurred To Date (MUST INCLUDE THE FOLLOWING):

- Invoices and Proofs-of-Payment For All Costs Incurred To Date
- Invoices itemized on the GUST-4D
- All Non-Eligible Costs Clearly Identified as such
- Incurred Costs Itemized per GUST-92 form or EPD provided form/specifications

☐ A Total of Estimated Costs To Complete Corrective Action

- Estimated Costs Itemized per GUST-92 form or EPD provided form or specifications

☐ Total Project Costs

☐ Proposed Schedule For Reimbursement

☐ Lump Sum Payment Upon Completion Of Corrective Action

OR

☐ Interim Payments With Final Payment Upon Completion

OR

☐ EPD Established Payment Schedule

2. Site Investigation Report

Former Pumphouse #1 was an aviation-gas fuel island located along the east-west taxiway of Hunter Army Airfield (HAAF) (Figure 2-1) that was used from about 1953 until the early 1970s. It consisted of ten 25,000-gallon underground storage tanks (USTs) and a 50,000-gallon underground defueling tank. Former USTs 30 through 39 and 50 at former Pumphouse #1, Facility ID #9-025085 were located near former Building 8060 at HAAF (Figure 2-1). The pumphouse was inactive from the 1970s to 1995. Eight of the 25,000-gal USTs were removed in 1995. The 50,000-gallon defueling tank and two of the 25,000-gallon tanks remained in-place, partially under the pumphouse structure. In 1998, the pumphouse structure was removed, along with the two remaining 25,000-gallon USTs, and the 50,000-gallon defueling tank was closed in-place. The piping from the boundary of the pumphouse facility to the bulk fuel farm was also drained, pigged, and grouted in-place.

Various closure activities and Corrective Action Plan (CAP)–Part A and CAP–Part B investigations were performed at the former Pumphouse #1 site between 1995 and 2000 (Figure 2-2). The former Pumphouse #1 investigations covered an area south of the active taxiway. CAP–Part A and CAP–Part B investigations were conducted at the Departure/Arrival Air Control Group (DAACG) facility in 1995 and 1996, respectively. These investigations covered the active tarmac north of the active taxiway. Review of the analytical data from all of the investigations indicated that it was necessary to combine the DAACG facility data and the former Pumphouse #1 data to document the nature and extent of contamination. As a result, the former Pumphouse #1 CAP–Part B Report (Science Applications International Corporation [SAIC] 2000) combined the results of all the investigations into a single report, which was submitted to the Georgia Environmental Protection Division (GA EPD) in August 2000 and subsequently approved.

As indicated in the former Pumphouse #1 CAP–Part B Report, two distinct and separate plumes are located within the vicinity of the former Pumphouse #1 site. Release #1 is an area of soil and groundwater contamination located near the DAACG facility that is in the vicinity of former Fuel Pits 1A and 1B, located approximately 900 feet (ft) west of former Building 8060 (i.e., Pumphouse #1). Release #2 is an area of soil and groundwater contamination located near the former Pumphouse #1 facility and former Fuel Pits 1C and 1D, located approximately 200 ft north of the former Tank Pits. The Release 1 and Release 2 areas are presented in Figure 2-2. The corrective actions at Release #1 and Release #2 are being addressed separately.

For the former Fuel Pit 1A/DAACG area (Release #1), the CAP–Part B Report recommended additional investigation activities to further delineate the extent of free product. In May 2000, an interim action to remove the free product through the use of

absorbent socks was implemented. Upon completion of the additional investigation, a CAP–Part B Addendum #1 Report (SAIC 2002) was prepared and subsequently approved by GA EPD that recommended groundwater extraction and free product removal in a manner to cause minimal impact to the active flight operations.

The use of absorbent socks for free product removal at Release #1 was continued until July 2003. An additional investigation was conducted in 2003 to further delineate the horizontal and vertical extent of the free product in the subsurface at Release #1 and Release #2 using cone-penetrometer-technology (CPT) equipment with fluorescence detection. The results of the investigation were presented in the *Data Summary Report for the 2003 Free Product CPT Investigation at Former Pumphouse #1* (SAIC 2004) and were also included as an appendix in the *Third Annual Monitoring Only Report for Former Pumphouse #1* (SAIC 2005).

Due to funding limitations, the corrective action described in the CAP–Part B Addendum #1 was not implemented. However, in an effort to address the free product, the interim action to remove free product through the use of absorbent socks was implemented again in 2004. In 2005, the free product removal method was changed to bi-monthly vacuum extraction (VE) from numerous wells located throughout Release #1. In 2006, a CAP-Part B Addendum #2 was prepared and subsequently approved by GA EPD that recommended quarterly VE of free product at four wells for at least 8 hours and annual monitoring of 30 wells. In 2007, enhanced fluid recovery (EFR) of free product was performed on a quarterly basis. Free product recovery was not performed in 2008. Annual sampling was conducted in December 2007 and December 2008. Additional soil and groundwater samples were collected in January 2008. The results of the 2008 investigation and monitoring activities are included within this report.

This Revised CAP–Part B Report is being submitted to the GA EPD Underground Storage Tank Management Program (USTMP) to present the 2008 investigation and sampling results and to change the remedial approach for the former Fuel Pit 1A/DAACG area (Release #1).

2.1 Regional, Local, and Site Hydrogeology

A discussion of the regional, local, and site hydrogeology was presented in previous CAP–Part B Reports and is summarized below.

2.1.1 Groundwater Usage

According to the *Groundwater Pollution Susceptibility Map of Georgia* (GA EPD 1992), the former Pumphouse #1 site, Facility ID #9-025085 is located within an average or higher groundwater pollution susceptibility area. Nine water supply wells are located within the confines of the HAAF area. These wells are installed in the

deeper Floridan limestone aquifer and have the potential to provide up to 3,890 gallons per minute (gpm) of water to occupants of the HAAF installation (SAIC 2006a). Impacts at Pumphouse #1 are confined to the shallow surficial aquifer, which is separated from the Floridan by a thick regional aquitard, the Hawthorne Group.

2.1.2 Aquifer Description

The hydrogeology in the vicinity of HAAF is mostly influenced by two aquifer systems, the Principal Artesian (Floridan) Aquifer and the surficial aquifer (Miller 1990). The Principal Artesian Aquifer is the lowermost hydrologic unit and is regionally extensive from South Carolina to Georgia, Alabama, and most of Florida. Known elsewhere as the Floridan, this aquifer, approximately 800 ft in total thickness, is composed primarily of Tertiary-age limestone, including the Bug Island Formation, the Ocala Group, and the Suwannee Limestone. Groundwater from the Floridan is used primarily for drinking water (Arora 1984).

The confining layer for the Floridan Aquifer is the phosphatic clay of the Hawthorn Group. The surficial aquifer overlies the Hawthorn confining unit.

The surficial aquifer consists of widely varying amounts of sand and clay, ranging from 55 to 150 ft in thickness. This aquifer is primarily used for domestic lawn and agricultural irrigation. The top of the water table ranges from approximately 2 to 10 ft below ground surface (bgs) (Miller 1990). Groundwater in the surficial aquifer system is under unconfined, or water table, conditions. Locally, however, thin clay beds create confined or semi-confined conditions. Groundwater encountered at HAAF Pumphouse #1 UST investigation sites is part of the surficial aquifer system.

2.1.3 Surface Water

The water resources survey conducted during the CAP–Part B site investigation was presented in the CAP– Part B Report (SAIC 2000) and CAP–Part B Addendum #1 Report (SAIC 2002). Surface water bodies at HAAF include Hallstrom Lake, Lamar Canal, Buckhalter Canal, Springfield Canal, Pond 29 located northwest of Buildings 336 and 232, and an unnamed pond located along the southeastern boundary of the HAAF installation. Several unnamed drainage canals and ditches exist throughout HAAF. Most of these canals drain southwest into the Little Ogeechee River, which is part of the Lower Ogeechee watershed. The remaining drainage canals located on the eastern side of the HAAF installation flow east and eventually drain into the Vernon River, which is located southeast of the HAAF installation. Surface water bodies at HAAF and adjacent areas are not used as public water supplies. The ponds and lakes, as well as Lamar Canal, are perennial, whereas most of the drainage canals and ditches are intermittent. Most of the drainage canals are at least partially enclosed in culverts (SAIC 2006a).

2.1.4 Site Stratigraphy

The lithology encountered at the site is predominantly a white, pale brown, or light gray, very fine to medium-grained sand, with variable silt and clay content. Generally, the samples with higher silt and clay content were within a few feet of the surface. Less silt and clay content was noted with depth. The boring log of deep well P1-MW40 indicates increasing clay content from approximately 26 to 30 ft bgs, becoming a clayey, coarse-grained sand/gravel at 30 ft bgs.

2.1.5 Referenced or Documented Calculations

The following referenced or documented calculations were performed to support the CAP-Part B Site Investigation and were included in the CAP-Part B (SAIC 2000).

Disturbed soil samples were collected from eight monitor wells for grain-size analysis. In addition, undisturbed soil samples were collected from four monitor wells and a soil boring to determine selected engineering properties of the unsaturated zone at the site. The engineering properties measured included moisture content, porosity, specific gravity, bulk density and permeability.

Slug tests were conducted on two shallow and one deep well. The slug test data were evaluated using AQTESOLVE software. The calculated hydraulic conductivity values were 1.31×10^{-2} feet per minute (ft/min) (6.7×10^{-3} centimeters per second (cm/s) and 1.76×10^{-2} ft/min (8.9×10^{-3} cm/s in the shallow wells and 4.6×10^{-3} ft/min (2.3×10^{-3} cm/s) in the deep well. The average hydraulic conductivity based on slug test data is 1.17×10^{-2} ft/min (6.0×10^{-3} cm/s).

Aquifer testing (8-hour step test) was performed to determine the optimum pumping rate for the well. Pumping data yielded a transmissivity of 0.4035 ft^2/min assuming a saturated aquifer thickness of 60 ft (K = 0.0067 ft/min). The recovery data produced a transmissitvity of 0.089 ft^2/min assuming a saturated thickness of 60 ft.

2.1.6 Direction of Groundwater Flow

Historical water level measurements (Table 2-1) were taken during monitoring events to evaluate the directional flow in groundwater. Groundwater in the vicinity of the former Fuel Pit 1A/DAACG area was determined to flow generally to the northwest. Groundwater potentiometric surface measurements taken in December 2006, December 2007, and December 2008 are presented on Figures 2-3, 2-4 and 2-5, respectively. These annual water level measurements have consistently confirmed groundwater flow to the northwest.

2.2 Horizontal and Vertical Extent of Contamination

The horizontal and vertical extent of petroleum-related contamination in soil and groundwater was delineated by activities performed during the previous investigations at the former Pumphouse #1 site and the DAACG facility, which were documented in the CAP–Part B Report (SAIC 2000), the CAP–Part B Addendum #1 Report (SAIC 2002), and the CAP–Part B Addendum #2 Report (SAIC 2006a). Since the CAP-Part B Addendum #2, additional data have been obtained through annual sampling of monitor wells and a supplemental investigation using direct-push technology (DPT) conducted in January 2008. A summary of the results from these investigations is presented below.

2.2.1 Delineation of Soil Contamination

In the vicinity of the former Fuel Pit 1A/DAACG area (Release #1), the horizontal extent of petroleum-related contamination in soil was determined during the CAP-Part B site investigation and was discussed in detail in the CAP–Part B Report (SAIC 2000). Concentrations of benzene, toluene, ethylbenzene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, chrysene, and indeno(1,2,3-*cd*)pyrene exceeded the applicable Georgia Underground Storage Tank (GUST) Soil Threshold Levels (STLs) (i.e., Table B, Column 1), and concentrations of benzene, benzo(*a*)pyrene, chrysene, and indeno(1,2,3-*cd*)pyrene exceeded their respective Alternate Threshold Levels (ATLs). Benzene was the only constituent in soil to exceed its ATL of 9.3 milligrams per kilogram (mg/kg) in six boring locations. Benzo(*a*)pyrene, chrysene, and indeno(1,2,3-*cd*)pyrene concentrations in one soil sample exceeded the ATLs of 1.4, 2.1, and 0.66 mg/kg, respectively. The referenced report included the conclusion that the soil samples with these concentrations exceeding the ATLs were collected from the capillary fringe above the soil/water interface in the area of free product, and the presence of free product may have contributed to the high concentrations. The report authors also noted that the soil contamination exceeding ATLs was determined to follow the area of free product and groundwater contamination.

In January 2008, 45 soil borings were advanced to the groundwater table using DPT within the area of soil contamination that was previously identified in the CAP–Part B Report (SAIC 2000). Borehole installation and boring logs are provided in Appendix A. One soil sample was collected from each boring at the depth interval with the highest photoionization detector (PID) field screening reading. The soil samples were analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX) using the U.S. Environmental Protection Agency (USEPA) Method 8021B/8260B, polynuclear aromatic hydrocarbons (PAHs) using USEPA Method 8270C, and lead using USEPA Method 6010B. The analytical results from the soil sampling are summarized in Tables 2-2 and 2-3 and Figures 2-6 and 2-7. The January 2008 supplemental soil investigation data did not include any detections of BTEX or PAHs that exceeded the

approved ATL.

Lead was detected in all 45 soil borings. Since there is no STL value under the GUST regulations, the data were compared against the Hazardous Site Response Act (HSRA) Type 1 and Type 3 Risk Reduction Standards (RRS) concentrations of 75 and 400 mg/kg, respectively. Results from two locations (DB-35 and DB-41) exceeded the Type 1 RRS for residential use scenarios at concentrations of 104 mg/kg and 127 mg/kg, respectively (SAIC, 2008a). However, no concentrations exceeded the Type 3 RRS for non-residential use.

The analytical results of the January 2008 supplemental investigation are summarized below (SAIC 2008a).

- Benzene was detected in 4 of 45 samples at concentrations ranging from 0.000609J to 0.259J mg/kg. There were seven samples with elevated detection limits greater than 0.1 mg/kg. The concentrations did not exceed the approved ATL of 9.3 mg/kg.

- Toluene was detected in 31 of 45 samples at concentrations ranging from 0.000454J to 52 mg/kg. The concentrations did not exceed the approved ATL of 479 mg/kg.

- Ethylbenzene was detected in 35 of 45 samples at concentrations ranging from 0.000313J to 16.2 mg/kg. The concentrations did not exceed the approved ATL of 187 mg/kg.

- Xylenes (total) were detected in 45 of 45 samples at concentrations ranging from 0.000302J to 74 mg/kg. The concentrations did not exceed the approved ATL of 893 mg/kg.

- 2-Methylnaphthalene was detected in 24 of 45 samples at concentrations ranging from 0.00796J to 0.273 mg/kg. There is no STL value for this constituent.

- Acenaphthene was detected in 6 of 45 samples at concentrations ranging from 0.0175J to 0.046 mg/kg. There is no STL for this constituent.

- Acenaphthylene was detected in 1 of 45 samples at a concentration of 0.201 mg/kg. Acenaphthylene is not listed in Table B, Column 1 of Chapter 391-3-15-.09; however, using acenaphthene as a surrogate chemical, there would be no STL.

- Anthracene was detected in 9 of 45 samples at concentrations ranging from 0.00718J to 0.0709 mg/kg. There is no STL for this constituent.

- Benzo(*a*)anthracene was detected in 7 of 45 samples at concentrations ranging from 0.0115J to 0.914 mg/kg. One of the concentrations exceeded the STL of 0.66 mg/kg. An ATL was not calculated for this constituent as part of the CAP–Part B Report. The same methodology used for the other constituents would give an ATL of 4.7 mg/kg (i.e., ATL = Koc × fcs ×Cstd × DAFw = 125,719 mL/g × 0.0117 × 4.9E-05 mg/L × 65.8 = 4.7 mg/kg). None of the concentrations exceeded this potential ATL.

- Benzo(*a*)pyrene was detected in 3 of 45 samples at concentrations ranging from 0.013J to 0.656 mg/kg. None of the concentrations exceeded the STL of 0.66 mg/kg or the approved ATL of 1.4 mg/kg.

- Benzo(*b*)fluoranthene was detected in 7 of 45 samples at concentrations ranging from 0.0129J to 0.965 mg/kg. One of the concentrations exceeded the STL of 0.66 mg/kg, but did not exceed the approved ATL of 5.8 mg/kg.

- Benzo(*g,h,i*)perylene was detected in 1 of 45 samples at a concentration of 0.0125J mg/kg. The concentration did not exceed the STL of 0.66 mg/kg.

- Benzo(*k*)fluoranthene was detected in 1 of 45 samples at a concentration of 0.431 mg/kg. The concentration did not exceed the STL of 0.66 mg/kg.

- Chrysene was detected in 6 of 45 samples at concentrations ranging from 0.0122J to 1.03 mg/kg. One of the concentrations exceeded the STL of 0.66 mg/kg, but did not exceed the approved ATL of 2.1 mg/kg.

- Dibenz(*a,h*)anthracene was detected in 1 of 45 samples at a concentration of 0.175 mg/kg. The concentration did not exceed the STL of 0.66 mg/kg.

- Fluoranthene was detected in 19 of 45 samples at concentrations ranging from 0.0152J to 0.946 mg/kg. There is no STL for this constituent.

- Fluorene was detected in 18 of 45 samples at concentrations ranging from 0.0108J to 0.115 mg/kg. There is no STL for this constituent.

- Indeno(1,2,3-*cd*)pyrene was detected in 1 of 45 samples at a concentration of 0.351 mg/kg. The concentration did not exceed the STL of 0.66 mg/kg or the approved ATL of 0.66 mg/kg.

- Naphthalene was detected in 9 of 45 samples at concentrations ranging from 0.0245J to 0.142 mg/kg. There is no STL for this constituent.

- Phenanthrene was detected in 20 of 45 samples at concentrations ranging from 0.0118J to 0.332 mg/kg. There is no STL for this constituent.

- Pyrene was detected in 16 of 45 samples at concentrations ranging from

0.0129J to 1.83 mg/kg. There is no STL for this constituent.

- Lead was detected in 45 of 45 samples at concentrations ranging from 0.987J to 127 mg/kg. Lead is not listed in Table B, Column 1 of Chapter 391-3-15-.09. The Type 1 or Type 3 RRS from Chapter 391-3-19-.07 HSRA were utilized as applicable regulatory concentrations due to the known historical presence of lead in aviation fuel. The concentrations in two samples exceed the Type 1 RRS (Table 2, Chapter 391-3-19, Appendix III) of 75 mg/kg. None of the concentrations exceeded the Type 3 RRS [Chapter 391-3-19-.07(8)(d)(iii)] of 400 mg/kg.

2.2.2 Delineation of Groundwater Contamination

In the vicinity of the former Fuel Pit 1A/DAACG area (Release #1), the horizontal and vertical extent of petroleum-related contamination in groundwater was determined during the site investigations and was discussed in detail in the CAP–Part B Report (SAIC 2000) and CAP–Part B Addendum #1 Report (SAIC 2002). Benzene, ethylbenzene, toluene, benzo(*a*)pyrene, chrysene, and naphthalene were identified as chemicals of potential concern (COPCs) for groundwater. Based on the results of fate and transport (F&T) modeling, alternate concentration limits (ACLs) were calculated for these constituents. Benzene was the only constituent at the former Fuel Pit 1A/DAACG area (Release #1) to exceed its In-Stream Water Quality Standard (IWQS) and ACL during the site investigations. An ACL of 285 micrograms per liter (µg/L) was proposed for benzene in groundwater and subsequently approved by GA EPD.

During the first annual sampling event in December 2006, benzene was detected in 18 of 30 groundwater samples at concentrations ranging from 1.42 to 399 µg/L. The benzene concentrations for nine samples exceeded the IWQS of 51 µg/L. The concentration in the sample from well D-MW02 exceeded the ACL of 285 µg/L. None of the other constituents exceeded their respective IWQSs or ACLs (SAIC 2007). The groundwater concentration data from December 2006 are presented on Figure 2-8.

During the second annual sampling event in December 2007, 30 monitor wells were sampled for analysis of BTEX using U.SEPA Method 8021B/8260B, PAHs using USEPA Method 8270C and lead using USEPA Method 6010B. Benzene was detected in 19 of 30 groundwater samples at concentrations ranging from 1.02 to 935 µg/L. The benzene concentrations for ten samples (D-MW02, D-MW08, D-MW11, D-MW17, D-MW19, D-MW33, D-MW34, D-MW35, D-MW36, and D-MW37) exceeded the IWQS of 51 µg/L. The benzene concentrations in wells D-MW34 and D-MW35 exceeded the ACL of 285 µg/L in (Figure 2-9). Lead exceeded the IWQS of 30 µg/L

in three samples (D-MW34, D-MW35, and D-MW38) (Figure 2-10). Toluene in D-MW17 was the only other constituent that exceeded the respective IWQSs or ACLs.

During the January 2008 supplemental investigation, the 45 soil borings that were discussed above for soil sampling were advanced with DPT to the groundwater table within the area of groundwater contamination that was identified in the CAP–Part B Report (SAIC 2000). One groundwater sample was collected from each boring from a 4-ft interval just below the soil/water interface. The groundwater samples were analyzed for BTEX using USEPA Method 8021B/8260B, PAHs using USEPA Method 8270C, and lead using USEPA Method 6010B (Appendix C). The analytical results from the soil sampling are summarized in Tables 2-4 and 2-5 and illustrated on Figure 2-11. Benzene was detected in groundwater from 12 borings at concentrations that exceeded the IWQS of 51 ug/L (Table 2-4). Benzene was detected in groundwater from eight soil borings at concentrations that exceeded the ACL of 285 ug/L. One sample (D-DB-45) had detected concentrations of benzo(a)anthracene and chrysene that exceeded their respective IWQSs (Table 2-5). Lead concentrations in groundwater exceeded the IWQS of 30 ug/L in samples from 15 of the 45 borings.

The analytical results of the January 2008 supplemental investigation are summarized as follows.

- Benzene was detected in 33 of 45 samples at concentrations ranging from 0.399J to 1,360 µg/L. The concentrations in 19 samples exceeded the IWQS of 51 µg/L, and the concentrations in 8 samples exceeded the ACL of 285 µg/L.

- Toluene was detected in 40 of 45 samples at concentrations ranging from 0.27J to 10,100 µg/L. Four of the concentrations exceeded the IWQS of 5,980 µg/L.

- Ethylbenzene was detected in 40 of 45 samples at concentrations ranging from 0.252J to 1,500 µg/L. None of the concentrations exceeded the IWQS of 2,100 µg/L.

- Total xylenes were detected in 41 of 45 samples at concentrations ranging from 0.264J to 5,670 µg/L. There is no ACL or IWQS for total xylenes. The concentrations did not exceed the maximum contaminant level (MCL) of 10,000 µg/L.

- 2-Methylnaphthalene was detected in 23 of 44 samples at concentrations ranging from 0.385J to 3.41 µg/L. There is no IWQS or ACL for 2-methylnaphthalene.

- Benzo(*a*)anthracene was detected in 1 of 44 samples at a concentration of 0.528J µg/L. The concentration exceeded the IWQS of 0.018 µg/L, but did not

exceed the ACL of 1.2 µg/L.

- Benzo(*b*)fluoranthene was detected in 1 of 44 samples at a concentration of 0.294J µg/L. There is no IWQS for benzo(*b*)fluoranthene. The concentration did not exceed the ACL of 3.6 µg/L.

- Chrysene was detected in 1 of 44 samples at a concentration of 0.386J µg/L. The concentration exceeded the IWQS of 0.018 µg/L, but did not exceed the ACL of 1.2 µg/L.

- Fluorene was detected in 1 of 44 samples at a concentration of 0.349J µg/L. The concentration did not exceed the IWQS of 5,300 µg/L.

- Naphthalene was detected in 28 of 44 samples at concentrations ranging from 0.441J to 14.2 µg/L. There is no IWQS for naphthalene. The concentrations did not exceed the ACL of 260 µg/L.

- Phenanthrene was detected in 2 of 44 samples at concentrations of 0.328J and 0.528J µg/L. There is no IWQS or ACL for phenanthrene.

- Pyrene was detected in 1 of 44 samples at a concentration of 0.668J µg/L. The concentration did not exceed the IWQS of 4,000 µg/L.

- Lead was detected in 43 of 44 samples at concentrations ranging from 0.27J to 204 µg/L. The concentrations in 15 samples exceeded the IWQS of 30 µg/L.

During the third annual sampling event in December 2008, 25 monitor wells were sampled for analysis of BTEX using U.SEPA Method 8260B and lead using USEPA Method 6010B. All groundwater and surface water samples collected were analyzed by a certified laboratory as listed in the Site-Wide Quality Assurance Project Plan (QAPP) (ARCADIS 2008). Field laboratory data included quality control samples, and all data were reviewed by the project chemistry team. All data reported by Shealy Laboratory were evaluated in accordance with the Level II validation protocols set forth in the Site-Wide QAPP (ARCADIS 2008). Field parameters from each well that were sampled are provided in Table 2-6. The analytical results are provided in Table 2-7a and Appendix D and illustrated in Figures 2-10 and 2-12. Historical groundwater analytical results are provided in Table 2-7b and Table 2-7c.

Analytical results from the sampling event are summarized below.

- Benzene was detected in 18 of 25 groundwater samples at concentrations ranging from 2.7 to 490J µg/L. The concentrations in eight samples exceeded the IWQS of 51 µg/L and in two samples exceeded the ACL of 285 µg/L.

- Toluene was detected in 18 of 25 groundwater samples at concentrations ranging from 1.7 to 4,900J µg/L. The concentrations did not exceed the IWQS or ACL.

- Ethylbenzene was detected in 21 of 25 groundwater samples at concentrations ranging from 1.4 to 2,500 µg/L. The concentrations did not exceed the IWQS or ACL.

- Total xylenes were detected in 20 of 25 groundwater samples at concentrations ranging from 1.9 to 2,700 µg/L. There is no ACL or IWQS for total xylenes.

- Lead was detected in 5 of 25 groundwater samples at concentrations ranging from 10 to 130 µg/L. The concentrations in two samples exceeded the IWQS of 30 µg/L.

2.2.3 Delineation of Free Product

Free product was identified at the former Fuel Pit 1A/DAACG area (Release #1) in February 2000. The free product was observed in wells D-MW1, D-MW2, D-MW8, D-MW11, D-MW13, and D-MW17 at thicknesses ranging from sheen to 0.88 ft. The horizontal extent of the free product was bounded by existing wells at the site.

In February 2001, 11 4-inch monitor wells (D-MW33 through D-MW43) were installed to supplement CAP–Part B investigation activities at this site. In March and July 2001, field bailout tests were conducted in wells D-MW2, D-MW34, and D-MW35 using the field bailout test method (Gruszczenski 1987). The results of the field bailout tests were presented in the CAP–Part B Addendum #1 Report (SAIC 2002). The thickest and most recoverable portion of the free product plume was located in the vicinity of wells D-MW2, D-MW34, and D-MW35.

In September/October 2003, additional activities were performed with CPT equipment with fluorescence detection to delineate the horizontal and vertical extent of the free product at both Release #1 and Release #2. The investigation concluded that the likely zones of nonaqueous-phase liquid (NAPL) contamination tend to occur between 6 and 13 ft bgs, which is in the vicinity of the water table and smear zone, and at a thickness ranging from 1 to 5 ft.

Absorbent socks were used in numerous wells associated with Release #1 between February 2000 and March 2005. Beginning in June 2005, bi-monthly VE activities were initiated on wells located throughout Release #1 area. The quantity of the water/product mixture varied from well to well. Subsequent report authors concluded

that the amount of free product removed from each well was very small (i.e., less than 0.5 gallon). In 2006, the free product removal method was changed to quarterly vacuum extraction at four wells for at least 8 hours. A summary of the free product thickness measured during the absorbent sock replacement or VE activities from June 2004 to January 2006 is provided in Table 2-8. In 2004, 2005 and 2006, the thickness ranged from sheen to 0.10 ft. In 2007, enhanced fluid recovery techniques were employed for free product removal on a quarterly basis in four wells across the site. The thickness ranged from sheen to 0.75 ft. The results of those activities are summarized in Table 2-9. Free product was not present in monitor wells measured in December 2007 or December 2008.

2.2.4 Delineation of Surface Water and Sediment Contamination

Results from the surface water and sediment samples collected during the CAP–Part B investigation were discussed in the CAP–Part B Report (SAIC 2000). BTEX constituents were collected in February 1999 from locations downgradient of the Release #1 area. The locations were approved in advance by GA EPD in January 1999. Some BTEX constituents were detected in the surface water samples but concentrations were below the IWQS. No PAH constituents were detected in the surface water samples. Low concentrations of total petroleum hydrocarbons and PAHs were detected in some of the sediment samples taken in December 1996. Additional sediment samples were not required by GA EPD.

3. Remedial Action Plan

3.1 Corrective Action Completed or in Progress

3.1.1 Recovery/Removal of Free Product

During sampling activities in February 2000, free product was measured in six wells at thicknesses from 0.01 to 0.74 ft. Absorbent socks were placed in each well following these measurements on February 24, 2000. As an interim action, the absorbent socks were removed and replaced in wells with free product on a bi-monthly basis from May 2000 through June 2003 and September 2004 through May 2005.

Beginning in June 2005, bi-monthly VE activities were initiated on approximately 50 wells located throughout the Release #1 and Release #2 areas. Reports on the VE events stated that the quantity of free product removed from each well was very small (i.e., less than 0.5 gallon). The results of these free product removal activities were presented in the CAP–Part B Addendum #1 Report (SAIC 2002) and the 2004-2005 Free Product Removal Report (SAIC 2006b).

In 2006, the free product removal method was changed to quarterly VE at four wells for a minimum of 8 hours. In 2007, EFR techniques were used for free product removal on a quarterly basis in the four wells with the greatest amount of free product (Table 2-9). The quantity of free product recovered continued to be small with most mass recovered in the vapor phase.

3.1.2 Remediation/Treatment of Contaminated Backfill Material and Native Soil

No contaminated backfill material or native soil associated with the former Fuel Pit 1A/DAACG area (Release #1) has been excavated, remediated, or treated.

3.2 Objectives of Corrective Action

3.2.1 Remove Free Product That Exceeds One-Eighth Inch at the Former Fuel Pit 1A/DAACG Area (Release #1)

The previously approved CAPs included the primary goal of removing free product in exceeding 1/8 inch thickness. Free product in excess of 1/8 inch has not been detected in monitor wells from June 2004 through December 2008. From June 2004

through 2006, free product was detected sporadically in CPT wells and all thickness measurements were less than 0.1 ft. During the quarterly measurements prior to VE events in 2007, four free product measurements (three in April and one in July) were reported above 0.01 ft. Recovery results indicated very little mobile (recoverable) mass. Liquid levels will be measured during future monitoring events to confirm the absence of free product at a thickness greater than 1/8 inch. EFR utilizing a vacuum truck will be invoked as the corrective action if free product is detected in recoverable quantities.

3.2.2 Remediate Groundwater Contamination at the Former Fuel Pit 1A/DAACG Area (Release #1)

As discussed in the CAP–Part B Report (SAIC 2000), previous investigations documented benzene contamination in groundwater at the former Fuel Pit 1A/DAACG area (Release #1) at concentrations that exceeded the IWQS of 51 µg/L and the ACL of 285 µg/L. The objectives of the corrective action for groundwater are to reduce the concentrations of the contaminants of concern to below ACLs approved in the CAP-Part B (SAIC 2000).

Three samples from monitor wells sampled in December 2007 contained lead concentrations above the IWQS of 30 µg/L. A total of four groundwater samples, including two sets of primary and duplicate samples collected from monitor wells in December 2008 contained lead concentrations above the IWQS. During the supplemental DPT investigation conducted in January 2008, lead was detected in 43 of 44 groundwater samples at concentrations ranging from 0.27J to 204 µg/L. The concentrations in 15 samples exceeded the IWQS of 30 µg/L. It should be noted that the samples from monitor wells were obtained utilizing low-flow purging techniques and all turbidity readings were less than 5 Nephelometric Turbidity Units (NTU). The samples obtained during the supplemental investigation were obtained with DPT and sample turbidity is not known. The samples taken with DPT were likely affected by higher turbidity and the monitor well samples are likely more indicative of the groundwater impacted by lead.

3.2.3 Remediate Soil Contamination at the Former Fuel Pit 1A/DAACG Area (Release #1)

The objective of the corrective action is to reduce concentrations of soil contaminants exceeding ATLs approved in the CAP-Part B (SAIC 2000). Data from the DPT soil sampling conducted in January 2008 demonstrated that concentrations of BTEX and PAHs are below their respective ATLs across the Release #1 area.

In data from DPT soil sampling conducted in January 2008, lead exceeded the Type 1 RRS of 75 mg/kg in two locations (D-DB-35 and D-DB-41), which are in the areas

impacted by petroleum hydrocarbons. There were not any soil lead concentrations that exceeded the Type 3 RRS of 400 mg/kg. Since the area is an active air field, the Type 3 RRS (Industrial) are likely to be most applicable.

3.2.4 Provide Risk-Based Corrective Action

A risk-based approach was used in the CAP–Part B Report (SAIC 2000) to identify COPCs for soil and groundwater and to develop ATLs and ACLs for various constituents. The results of the risk screening for Release #1 were presented in the CAP–Part B Report (SAIC 2000) and the results are summarized below.

Benzene, ethylbenzene, toluene, xylenes, benzo(*a*)pyrene, benzo(*b*)fluoranthene, chrysene, and indeno(1,2,3-*cd*)pyrene were identified as COPCs for soil. ATLs of 9.3 mg/kg for benzene, 187 mg/kg for ethylbenzene, 479 mg/kg for toluene, 893 mg/kg for xylenes, 1.4 mg/kg for benzo(*a*)pyrene, 5.8 mg/kg for benzo(*b*)fluoranthene, 2.1 mg/kg chrysene, and 0.66 mg/kg for indeno(1,2,3-*cd*)pyrene were proposed in the CAP–Part B Report (SAIC 2000).

Benzene, ethylbenzene, toluene, benzo(*a*)pyrene, chrysene, and naphthalene were identified as COPCs for groundwater. ACLs of 285 µg/L for benzene; 114,800 µg/L for ethylbenzene; 800,000 µg/L for toluene; 1.2 µg/L for benzo(*a*)pyrene; 1.2 µg/L for chrysene; and 260 µg/L for naphthalene were proposed in the CAP–Part B Report (SAIC 2000). The ATLs and ACLs were approved by GA EPD in correspondence dated December 18, 2000 (Logan 2000).

F&T modeling results were provided in the CAP–Part B Report (SAIC 2000). A storm drain located 230 ft northeast (downgradient) of the center of the plume was identified as the nearest possible location at which a receptor might encounter migrating groundwater contamination. Due to the proximity of Releases #1 and #2, the most conservative F&T modeling results were used for developing one set of ACLs and ATLs for both areas of contamination (SAIC 2000).

The CAP-Part B site investigation did not include analyses of soil or groundwater samples for lead. Lead was not identified as a COPC and risk based standards were not developed for lead in soil or groundwater. The proposed applicable standards for lead are the IWQS for groundwater and the HSRA Type III RRS for soil.

3.2.5 Conclusions and Recommendation

The following conclusions are based on the results discussed above:

- Recent thickness measurements indicate that very little mobile free product remains.
- Soil petroleum hydrocarbon concentrations are below ATLs.
- Groundwater petroleum hydrocarbon concentrations indicate that the groundwater impacted above ACLs is located in the area previously identified in the CAP-Part B as having the largest free product quantities.
- Lead concentrations in soil exceed the HSRA Type I RRS but not the Type III RRS.
- Lead concentrations in groundwater exceeded the IWQS in samples from three monitor wells. Lead concentrations detected in DPT groundwater samples were likely affected by turbidity and may not be representative.

3.3 Design and Operation of Corrective Action

3.3.1 Basis for Selection

The corrective action for the groundwater plume at the former Fuel Pit 1A/DAACG area should consist of alternatives that are protective of the environment, but can be implemented in a manner that causes minimal disruption of the active military flight operations. In previous CAPs, monitored natural attenuation (MNA) was selected as the most viable alternative once the free product had been removed because (1) the free product was continuing to act as a source for the groundwater contamination, and (2) the maximum benzene concentrations during the CAP–Part B and supplemental investigations were less than three times the ACL. The strategy was that MNA would provide for monitoring of the groundwater plume without impacting the military flight operations. The recommended corrective action for groundwater consisted of free product removal in conjunction with MNA of the groundwater plume until the free product was removed. At that point, the corrective action would be re-evaluated. After free product was reduced to less than 1/8 inch or agreed upon limits of recoverable mass, soil sampling of hot spots would be conducted to confirm soil contaminant concentrations were below ATLs.

Based on recent free product measurements, free product is no longer present at recoverable quantities and is less than 1/8 inch in thickness in monitor wells.

Soil sampling confirmed that all contaminants of concern previously identified in the CAP site investigation are below ATLs. Therefore, remediation of soil for petroleum hydrocarbon related contaminants is not necessary.

The groundwater areas identified as impacted with benzene concentrations above the ACL through data from monitor wells and the January 2008 DPT samples are similar and match the area noted in the CAP-Part B (MW-2, 34, 35) as containing the most free product (SAIC 2002) (Figure 3-1). This remedial target area for hydrocarbon remediation and the existing wells in the area are presented in Figure 3-2.

The lead concentrations in soil are below the HSRA Type III RRS and active remediation is not recommended. The groundwater areas impacted by lead above IWQS based on the monitor well sample data from December 2007 and December 2008 (MW34 and 35 and 38 [2007 only]) matches target area for benzene remediation. The DPT sampling results indicated that lead was present in groundwater samples at levels exceeding IWQS across a larger area. However, the elevated concentration of lead is likely attributable to turbid groundwater samples. Low-flow groundwater sampling conducted at the site before (December 2007) and after (December 2008) supported this hypothesis. The remedy for benzene will be selected with the goal of mitigating the lead concentration in groundwater.

In selecting the corrective action for the former Fuel Pit 1A/DAACG area, the following items were taken into consideration:

(1) A separate phase immobile residual is likely acting as a continuing source for groundwater contamination, and the fluctuations in concentrations are at least partially attributable to groundwater elevation changes. The variation of groundwater elevations with time is presented on Figure 3-3.

(2) For most monitor wells, the benzene concentrations in groundwater increased in December 2007 and decreased slightly in December 2008. Overall, benzene concentrations have decreased since the initial CAP site investigation. The variation of benzene concentrations with time is presented on Figure 3-4.

(3) There are active military flight operations in the area.

(4) Wells in the impacted area are oxygen depleted and biodegradation may be limited by terminal electron acceptor (TEA) availability.

(5) The remedy for dissolved benzene should be beneficial to mitigation of the dissolved lead.

The first phase of the corrective action strategy, consisting of removing the recoverable (mobile) free product, has been substantially completed, and no further free product recovery activities are recommended at this time. Free product has been detected periodically in some wells and appears to correlate with fluctuations in groundwater elevation. Free product thickness versus groundwater elevation is

presented for two wells most frequently manifesting free product in Figure 3-5 and Figure 3-6. Continued monitoring of CPT and monitor wells for free product should continue. Soil COPC concentrations were below ATLs and soil remediation is not necessary. The final phase of the corrective action is remediation of groundwater to below ACLs. Due to the oxygen limited conditions in groundwater, remediation through MNA may result in an extended timeframe. Therefore, an active corrective action addressing the remaining smear zone and groundwater contamination is recommended.

The primary focus of the alternative evaluation was to find a cost-effective method of remediating the site with minimal impact to the military flight operations. Therefore, more intrusive technologies such as six phase heating, pump and treat and air sparging with soil vapor extraction were eliminated from consideration. Mass transfer enhancements such as surfactant washing will be considered at a later date if concentration data indicate that a significant residual NAPL will result in an extended remediation timeframe. Because of the relatively low dissolved mass and contamination being located under the air field, aggressive chemical oxidation was not considered.

Therefore, enhanced bioremediation remedial alternatives were the focus of consideration. The first step in implementation of bioremediation is determination of biogeochemical characteristics of the aquifer. The proposed analyses are listed in Section 3.3.3. After these data are obtained, the bioremediation approach will be optimized. Either oxygen or sulfate will be selected as the most appropriate electron acceptor. Data indicate that oxygen is depleted in the plume area, but data are not available on other electron acceptors or sources of oxygen demand. There are no data on sulfate concentrations at the site but if sulfate depletion in the plume is determined, sulfate addition can be an effective remedy. If sulfate is determined to be the optimal TEA, a sulfate solution created by adding sulfate salts to potable water could be injected through existing or newly installed wells. If oxygen is selected as the optimal electron acceptor, a number of methods would be evaluated. An oxygen releasing substrate (calcium peroxide or other) could be slurried and injected with DPT into the target interval. Another alternative is injection of oxygenated groundwater through CPT points previously used for free product monitoring and recovery. Any gaps in coverage determined during the initial injection would be remedied by installation of additional injection wells. The groundwater could be oxygenated through gas diffusion technology, inline gas/liquid contactor or low concentrations of hydrogen peroxide. Nutrients would be added to the groundwater prior to injection if in-situ nutrient limits are determined to exist.

3.3.2 Theory and Feasibility

Dissolved-phase hydrocarbons above ACLs exist in the groundwater beneath the site. Water table elevation changes result in fluctuations in dissolved concentrations as the groundwater contacts residual source mass that is located in the smear zone. The dissolved BTEX compounds are potentially both aerobically and anaerobically biodegradable by bacteria, which already exist in the subsurface. The dissolved oxygen concentration in groundwater is less than 1 mg/L in impacted areas. Data are not available for other electron acceptors, but electron acceptor availability is likely a factor limiting biodegradation. Other encumbrances to bacterial metabolism, such as low nutrient concentrations, may also be minor factors limiting biodegradation. Therefore, as a first step, a data set will be collected to evaluate biogeochemical conditions within the affected shallow aquifer. Based on these data, an optimal electron acceptor will be selected for addition to the shallow groundwater with the goal of increasing the rate of biodegradation of benzene. Nutrients will be added to the water if determined to be beneficial. The electron acceptor will be added at a frequency determined from baseline biogeochemical data and subsequently from monitoring of the initial injection. The application can be through existing CPT wells formerly used to monitor and recover free product, through DPT points or through newly installed injection wells. The monitor wells currently used to monitor the plume will be utilized to obtain samples to evaluate remediation progress. The injection rate and total TEA mass will be determined based on the calculated TEA demand and the optimal injection rates determined during first injection activity.

3.3.3 Remediation System

The first task will be sampling of selected monitor wells for analysis of biogeochemical parameters. Samples will be taken from monitor wells D-MW1, D-MW2, D-MW11, D-MW34, D-MW35, D-MW37, D-MW19, D-MW41 and D-MW42. Samples from D-MW41 and D-MW42 will be used to establish background conditions. Samples will be analyzed for the following:

- Dissolved Organic Carbon (DOC)
- Alkalinity
- Total Phosphorus (two monitor wells)
- Total (Kjedahl) Nitrogen (two monitor wells)
- Nitrogen as Nitrate
- Total/Dissolved Fe
- Sulfate
- Sulfide

- Oxidation Reduction Potential (ORP)
- pH
- Dissolved Oxygen (DO)
- Methane
- Volatile Organic Compounds (VOCs)
- Total Petroleum Hydrocarbons (TPH)
- Total/dissolved lead
- Lead speciation (organic and inorganic forms in two monitor wells)

If sulfate is determined to be a significant TEA at the site based on the results of these analyses, Biotrap® samplers will be installed in two wells to confirm the presence of sulfate-reducing bacteria. These are passive sampling devices that can be installed in standard monitor wells to permit representative sampling of the bacterial community in the aquifer. The samplers would be left in place for approximately 45 days to collect time integrated bacterial samples. A Performance Report will be generated utilizing these data and submitted to GA EPD. The Performance Report will summarize the biogeochemical data and will describe the rationale for selection of the optimal electron acceptor (oxygen or sulfate). Initial estimates of TEA requirements and nutrient requirements will also be made.

The first injection of the TEA solution or slurry will be conducted in accordance with injection rates estimated from existing site hydrogeological data. Addition rates and distribution area and aquifer chemistry will be evaluated and subsequent injection strategy will be adjusted. For injection through existing wells, a tracer may be added and surrounding wells sampled for analysis of tracer concentration. The effects of the first bioremediation injection will be monitored for a time period appropriate to the selected technology (likely 4 to 6 months). After sufficient post-injection monitoring data are collected, a second Performance Report will be submitted for GA EPD review. The report will present the data set and recommended optimizations for the bioremediation approach.

The subsequent remediation approach will consist of periodic addition of TEA and possibly nutrients to enhance biodegradation. The specific frequency and volumes will be determined and explained in the report. In addition to the annual sampling described below, monitoring of each injection event will be conducted quarterly. GA EPD will be notified if a change to the frequency of monitoring activities is proposed. After evaluation of baseline biogeochemical data and determination of the strategy for the first injection, GA EPD Underground Injection Control (UIC) will be notified of the proposed injection in accordance with Procedure EPD-UIC-003. A UIC permit

application will be submitted after initial results are evaluated and injection design is complete.

The post-injection monitoring will consist of sampling of up to 20 wells. These wells may include, but are not limited to, D-MW1, D-MW2, D-MW11, D-MW18, D-MW34, D-MW35, D-MW37, D-MW19, D-MW33, D-MW38, D-MW43, and P1-MW42. CPT wells or newly installed wells may also be sampled. Wells sampled will include sufficient downgradient wells to evaluate contaminant migration. Any changes to the remediation strategy proposed in this document will be submitted to GA EPD.

3.4 Implementation

3.4.1 Milestone Schedule

A project schedule for the proposed corrective action has been prepared. A Gantt chart showing milestone activities and anticipated duration is provided in Figure 3-7. Fort Stewart will notify GA EPD of any significant changes to the schedule and will provide GA EPD with an updated Gantt chart, as necessary. The schedule will be updated after injection strategy and frequency are finalized.

3.4.2 Progress Reporting

Performance Reports will be submitted to GA EPD that will summarize the sampling, injection and/or monitoring activities. The period will be based on optimal monitoring or injection frequency. At a minimum, the Performance Report will consist of a table summarizing the TEA addition activities and biogeochemistry data and a proposal for subsequent activities. In addition, annual reports summarizing all remediation and monitoring activities for the preceding year will be submitted to GA EPD.

Petition for permanent closure (i.e., completion report) will be submitted upon approval of the final progress report when Release #1 reaches GA EPD-approved closure criteria. GA EPD will provide final approval for decommissioning the monitor wells. Decommissioning of the monitor wells will be completed in accordance with the United States Army Corps of Engineers (USACE) design manual for monitor wells. Decommissioning will comply with all applicable state and federal standards. The following certification will be submitted to GA EPD within 30 days of submittal of the final progress report:

I hereby certify that the Corrective Action Plan–Part B, dated , 20 , for Hunter Army Airfield, Former Pumphouse #1 site (Release #1), Facility ID 9-025085*1, including any and all certified amendments/addenda thereto, has been implemented in accordance with the schedules, specifications, sampling programs, and conditions

contained therein and that the plan's stated objectives have been met.

_____

Signature (Owner/Operator)

3.4.3 Inspection Schedule and Preventative Maintenance Program

There will not be a permanent system installed at HAAF; thus, on-site inspection and preventative maintenance will not be required.

3.4.4 Periodic Monitoring

Groundwater samples will be collected annually from up to 26 wells (D-MW1, D-MW2, D-MW8, D-MW11, D-MW12, D-MW13, D-MW17, D-MW18, D-MW19, D-MW22, D-MW33, D-MW34, D-MW35, D-MW36, D-MW37, D-MW38, D-MW39, D-MW40, D-MW41, D-MW42, D-MW43, P1-MW11, P1-MW12, P1-MW13, P1-MW42) and analyzed for BTEX and lead. The wells in the monitoring program may be adjusted based on the results of analytical data. PAH compounds observed during the CAP–Part A and Part B investigations and subsequent sampling were detected at concentrations below their respective ACLs. Therefore, it is recommended that PAH analysis not be performed during the annual sampling. Remedial action will continue at the site until the ACLs are achieved as agreed upon by GA EPD and HAAF. If required by GA EPD, one additional groundwater sampling event will be conducted for analysis of PAHs once ACLs have been achieved. The monitoring only portion of the corrective action will continue until the benzene concentrations in groundwater are below the ACL of 285 µg/L for two sampling events and lead concentrations in soil and groundwater meet appropriate standards as agreed upon by HAAF and GA EPD. Wells may be added or removed from the monitoring plan as the boundaries of the plume change. These changes will be documented in the monitoring only reports.

During each sampling event, water levels will be measured in all monitor wells. Specific conductivity, pH, and temperature analyses will be measured on each sample from the monitor wells from which analytical samples are collected. The samples will be shipped to a GA EPD certified laboratory for BTEX analysis in accordance with USEPA Methods 8021B/8260B and 6010B.

3.4.5 Effectiveness of Corrective Action

The corrective action (i.e., enhanced bioremediation followed by MNA) will be discontinued once the objectives of the monitoring only plan have been achieved. Two of the three goals approved in previous CAP have been achieved and will be

considered complete upon concurrence of GA EPD and HAAF.

The two goals completed are:

- The quantity of free product in monitor wells has reached reduction goals and recovery efforts will be terminated if agreed upon by GA EPD and HAAF. Continued monitoring for free product is warranted, however.
- The benzene, benzo(*a*)pyrene, chrysene, and indeno(1,2,3-*cd*)pyrene concentrations in soil are reduced to below their ATLs of 9.3 , 1.4, 2.1, and 0.66 mg/kg, respectively.

The remaining goal is reduction of the benzene concentrations in groundwater to below the ACL of 285 µg/L. In addition, the lead concentration in groundwater will be reduced below the IWQS (30 µg/L) or other appropriate standard.

3.4.6 Confirmatory Soil Sampling Program

No excavation of soil is planned. Therefore, confirmatory sampling associated with excavation of soil will not be performed. Confirmatory samples of soil contamination that previously exceeded the benzene ATL of 9.3 mg/kg, the benzo(*a*)pyrene ATL of 1.4 mg/kg, the chrysene ATL of 2.1 mg/kg, and the indeno(1,2,3-*cd*)pyrene ATL of 0.66 has been completed and all concentrations were below ATLs.

3.4.7 Stockpiled Bulk Soil Sampling

For the former Fuel Pit 1A/DAACG area (Release #1), no stockpiled soil will be generated by this corrective action. Therefore, no soil sampling will be conducted.

3.4.8 Monitoring Only Termination Conditions

As previously stated in the CAP Addendum 2, the following conditions are required prior to termination of monitoring only program:

- Concentrations of benzene in groundwater must be at or below the ACL.
- Concentrations of benzene, benzo(*a*)pyrene, chrysene, and indeno(1,2,3-*cd*)pyrene in soil must be at or below their respective ATLs prior to termination of the monitoring only program.
- Product removal activities must have reached a quantifiable goal agreed to by GA EPD and HAAF.

Once these conditions are met, the remedial system and monitoring may be terminated regardless of the site ranking score.

An additional goal is reduction of lead concentrations to below IWQS or other appropriate risk based standard.

3.4.9 Post-Completion Site Restoration Activities

As the remediation is currently planned, no modifications will be made to the Release #1 area because no permanent equipment or systems will be located at the site.

RECEIVED
OCT 11 2006
PAGE 1 OF 1

TRESSA

Georgia Department of Natural Resources

Environmental Protection Division
Underground Storage Tank Management Program
4244 International Parkway, Suite 104, Atlanta, Georgia 30354
Noel Holcomb, Commissioner
Carol A. Couch, Ph.D., Director
(404) 362-2687

September 28, 2006

Mr. Michael W. Biering
U.S. Army/HQ 3d,Inf. Div (Mech)
Directorate of Public Works
1550 Frank Cochran Drive
Fort Stewart, Georgia 31314-4927

SUBJECT: Notice to Implement Corrective Action Plan (CAP)-Part B:
Hunter AAF, Former Fuel Pit #1
Former Building 8060
Savannah, Chatham County, GA
Facility ID: 9025085*1

Dear Mr. Biering:

The Georgia Underground Storage Tank Management Program (USTMP) has received your consultant's letter, dated August 24, 2006, that forwarded a CAP-Part B Addendum #2.

The technical proposal contained in the CAP-Part B Addendum#2 for further investigation, monitoring and/or remediation of the current release is hereby approved by the USTMP. As a result of your CAP-Part B being technically approved, you are authorized to begin implementation of this plan.

Please submit an updated milestone schedule by **December 15, 2006**, listing specific dates, events and a timetable to complete the proposed activities. If you have any technical questions, please contact me at (404) 362-4529.

Sincerely,

William E. Logan
Senior Geologist
Corrective Action Unit II

WEL:
S:land/landdocs/williaml.pending04/9025085A.120
cc: Patricia Stoll, P.E., SAIC
Lisa L. Lewis, GA EPD
File (CA): CHATHAM; 9025085

DEPARTMENT OF THE ARMY
HEADQUARTERS, FORT STEWART
DIRECTORATE OF PUBLIC WORKS
1550 FRANK COCHRAN DRIVE
FORT STEWART, GEORGIA 31314-4927

REPLY TO
ATTENTION OF

AUG 2 4 2006

Office of the Directorate

CERTIFIED MAIL

Georgia Environmental Protection Division
UST Management Program
Attention: Mr. William Logan
4244 International Parkway, Suite 104
Atlanta, GA 30354

Dear Mr. Logan:

Fort Stewart is pleased to submit one copy of the Corrective Action Plan (CAP)-Part B Addendum #2 for Former Pumphouse # 1 (Release #1), Facility ID #9-025085, Former Building 8060, Hunter Army Airfield, Georgia, dated July 2006. Due to funding restraints the corrective actions described in the CAP-Part B Addendum #1 (SAIC 2002) were not implemented. This report is being submitted to the Georgia Environmental Protection Division Underground Storage Management Program (USTMP) to document the change of the remedial alternative for the former Fuel Pit 1A/DAACG area (Release #1).

In order to address free product more assertively, Fort Stewart implemented extraction of free product via vacuum truck versus absorbent socks in 2005. This approach was discussed and approved by GA EPD USTMP representative Mr. William Logan in a conference call on October 26, 2005 with installation personnel, Savannah District Corps of Engineers and representatives from Science Application International Corporation (SAIC). The enclosed report recommends that the free product removal activities utilizing a vacuum truck be continued. Monitoring of the natural attenuation (MNA) of groundwater in the vicinity of the former Fuel Pit 1A/DAACG area (Release #1) will take place in conjunction with free product removal activities. Upon completion of free product removal activities, recommendations for corrective actions addressing the groundwater and soil contamination will be re-evaluated. Additional justifications for these recommendations are provided in the enclosed report.

Fort Stewart appreciates your consideration of this recommendation. If you have any questions or comments regarding the

enclosed report, please contact Ms. Algeana Stevenson at (912)315-4226 or Ms. Tressa Rutland, Directorate of Public Works, Environmental Branch, at (912)767-2010.

Sincerely,

Michael W. Biering, P.E.
Director, Public Works

Enclosure

FINAL

CORRECTIVE ACTION PLAN–PART B
ADDENDUM #2
FORMER PUMPHOUSE #1 (RELEASE #1)
FACILITY ID #9-025085*1
FORMER BUILDING 8060
HUNTER ARMY AIRFIELD, GEORGIA

Prepared for
U. S. Army Corps of Engineers
Savannah District
Under Contract Number DACA21-02-D-0004
Delivery Order Number 0044

Prepared by
SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
151 Lafayette Drive
Oak Ridge, Tennessee 37830

July 2006

06-034(E)/071006

Georgia Department of Natural Resources

Environmental Protection Division
Land Protection Branch
Underground Storage Tank Management Program
4244 International Parkway, Suite 104
Atlanta, Georgia 30354
Phone (404) 362-2687
FAX (404) 362-2654

CORRECTIVE ACTION PLAN
PART B

Facility Name: Former Pumphouse #1 Site (Release #1)

Street Address: Former Building 8060, near Taxiway 3

City: Hunter Army Airfield **County:** Chatham

Facility ID #: 9-025085*1

Submitted by UST Owner/Operator:
Name: Thomas C. Fry/Environmental Branch
Company: US Army/HQ 3d Inf. Div (Mech)
Address: Directorate of Public Works, Bldg 1137
1550 Frank Cochran Drive
City: Fort Stewart State: GA
Zip Code: 31314-4927

Prepared by:
Name: Patricia Stoll
Company: Science Applications International Corp.
Address: P.O. Box 2501
City: Oak Ridge State: TN
Zip Code: 37831

I. PLAN CERTIFICATION

A. UST Owner/Operator

I hereby certify that the information contained in this plan and in all the attachments is true, accurate, and complete, and the plan satisfies all criteria and requirements of Rule 391-3-15-.09 of the Georgia Rules for Underground Storage Tank Management.

Name: Thomas C. Fry

Signature: _____ Date: _____

B. Professional Engineer or Professional Geologist

Name: Patricia Stoll

Signature: Patricia A. Stoll

Date: 7/11/06

GEORGIA REGISTERED 22851 PROFESSIONAL ENGINEER P. A. STOLL

P Stoll 7/11/06

Georgia Stamp or Seal

Check all boxes below that apply. Attach supporting documentation, i.e., narrative, figures, tables, maps, boring/well logs, etc., for all items checked. Supporting documentation should be three-hole punched and prepared in conformity with the guidance document "Underground Storage Tank (UST) Release: Corrective Action Plan – Part B (CAP-B) Content", GUST-7B.

II. SITE INVESTIGATION REPORT

☒ Note Applicable: The extent of contamination and the local and site hydrogeology requirements have been fulfilled under the Corrective Action Plan (CAP)–Part B Addendum #1 Report (SAIC 2002) and approved by GA EPD in correspondence dated February 25, 2004.

☐ Extent of Contamination

☐ Local and Site Hydrology

III. REMEDIAL ACTION PLAN:

A. Corrective Action Completed or In-Progress:

☒ Recovery/Removal of Free-Product (Non-aqueous Phase Hydrocarbons)

☐ Remediation/Treatment of Contaminated Backfill Material & Native Soils

☐ Other (specify) _____

B. Objective of Corrective Action:

☒ Remove Free Product That Exceeds One-Eighth Inch

☐ Remediate Groundwater Contamination That Exceeds:

- ☐ Maximum Contaminant Levels (MCLs)
  OR
- ☐ In-stream Water Quality Standards

☐ Remediate Soil Contamination That Exceeds:

- ☐ Threshold Values Listed in Table A
  OR
- ☐ Threshold Values Listed in Table B
  OR
- ☐ Alternate Threshold Levels (ATLs)

☒ Provide Risk Based Corrective Action (Reference CAP B App. VI) (Section III.B.4)

- ☒ Remediate Soil and/or Groundwater Contamination That Exceeds Alternate Concentration Limits (ACLs) and Monitor Residual Contaminants
  OR
- ☐ Monitor Soil and/or Groundwater Contamination That Exceeds Levels in Rule -.09 (3) But Is Less Than ACLs
  OR
- ☐ No Further Action Required - Soil and/or Groundwater Contamination is Below Levels in Rule -.09 (3)

C. **Design Operation of Corrective Action Systems**

☒ **Soil** ☒ **Groundwater** ☒ **Free Product** ☐ **Surface Water**

☐ **Not Applicable**

D. **Implementation (Section III.D)**

Includes, as a minimum, the following:

- Milestone schedule for site remediation
- Inspection and preventive maintenance schedule for all specialized remediation equipment
- Monitoring/sampling and reporting plan for measuring interim progress and project completion
- Plan to decommission equipment/wells and close site

IV. PUBLIC NOTICE

☐ Certified Letters to Adjacent, and Potentially Affected Property Owners and Local Officials

☒ Legal Notice in Newspaper, as approved by EPD (CAP-Part B Addendum #1 Report)

☐ Other EPD-approved Method (specify)_____

V. CLAIM FOR REIMBURSEMENT: (FOR GUST TRUST FUND SITES ONLY)

☐ GUST Trust Fund Application (GUST-36), must be attached if applicable

☐ Cost Proposal

- ☐ Non-Reimbursable Costs
  OR
- ☐ Reimbursable Costs
  - ☐ Total Project Costs
    - ☐ Costs incurred to date, per GUST-92
    - ☐ Estimated costs to complete corrective action, per GUST-92
  - ☐ Invoices and Proofs-of-Payment for Costs Incurred to Date

☐ Proposed Schedule For Reimbursement

- ☐ Lump Sum Payment Upon Completion Of Corrective Action
  OR
- ☐ Interim Payments With Final Payment Upon Completion

☒ Not Applicable

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II. SITE INVESTIGATION REPORT

II.A PROJECT HISTORY

Former Underground Storage Tanks (USTs) 30 through 39 and 50 at former Pumphouse #1, Facility ID #9-025085 were located near former Building 8060 at Hunter Army Airfield (HAAF), Georgia. Former Pumphouse #1 was an aviation-gas fuel island located along the east-west taxiway of HAAF (Figure 1) that was used from about 1953 until the early 1970s, and it consisted of ten 25,000-gal USTs and a 50,000-gal underground defueling tank. The pumphouse was inactive from the 1970s to 1995. Eight of the 25,000-gal USTs were removed in 1995. The 50,000-gal defueling tank and two of the 25,000-gal tanks remained in-place, partially under the pumphouse structure. In 1998, the pumphouse structure was removed, along with the two remaining 25,000-gal USTs, and the 50,000-gal defueling tank was closed in-place. The piping from the boundary of the pumphouse facility to the bulk fuel farm was also drained, pigged, and grouted in-place.

Various closure activities and Corrective Action Plan (CAP)–Part A and CAP–Part B investigations were performed at the former Pumphouse #1 site between 1995 and 2000. The former Pumphouse #1 investigations covered an area south of the active taxiway. CAP–Part A and CAP–Part B investigations were conducted at the Departure/Arrival Air Control Group (DAACG) facility in 1995 and 1996, respectively. These investigations covered the active tarmac north of the active taxiway. Review of the analytical data from all of the investigations indicated that it was necessary to combine the DAACG facility data and the former Pumphouse #1 data to document the nature and extent of contamination. As a result, the former Pumphouse #1 CAP–Part B Report (SAIC 2000) combined the results of all the investigations into a single report, which was submitted to the Georgia Environmental Protection Division (GA EPD) in August 2000 and approved by GA EPD in correspondence dated December 18, 2000 (Logan 2000).

As indicated in the former Pumphouse #1 CAP–Part B Report, two distinct and separate plumes are located within the vicinity of the former Pumphouse #1 site. Release #1 is an area of soil and groundwater contamination located near the DAACG facility that is in the vicinity of former Fuel Pits 1A and 1B, located approximately 900 ft west of former Building 8060 (i.e., Pumphouse #1). Release #2 is an area of soil and groundwater contamination located near the former Pumphouse #1 facility and former Fuel Pits 1C and 1D, located approximately 200 ft north of the former Tank Pits. The corrective actions at Release #1 and Release #2 are being addressed separately.

For the former Pumphouse #1 Tank Pit area (Release #2), the CAP–Part B Report recommended semiannual monitoring for benzene, toluene, ethylbenzene, and xylenes (BTEX). Release #2 has been under the monitoring only program since September 2001 and the results have been presented in annual monitoring only reports for the site.

For the former Fuel Pit 1A/DAACG area (Release #1), the CAP–Part B Report recommended additional investigation activities to further delineate the free product activities. In May 2000, an interim action to remove the free product through the use of absorbent socks was implemented. Upon completion of the additional investigation, a CAP–Part B Addendum #1 Report (SAIC 2002) was prepared that recommended groundwater extraction and free product removal in a manner to cause minimal impact to the active flight operations. GA EPD provided comments on the CAP–Part B Addendum #1 Report in correspondence dated November 20, 2001. Fort Stewart submitted a response to comments on December 20, 2001, and GA EPD approved the report in correspondence dated February 25, 2004.

The use of absorbent socks for free product removal at Release #1 was continued until July 2003. In addition, an additional investigation was conducted in 2003 to further delineate the horizontal and vertical extent of the free product in the subsurface at Release #1 and Release #2 using cone-penetrometer-technology (CPT) equipment with fluorescence detection. The results of this investigation were presented in the *Data Summary Report for the 2003 Free Product CPT Investigation at Former Pumphouse #1, Facility ID #9-025805, Former Building 8060, Hunter Army Airfield, Georgia* (SAIC 2004), which was also included as an appendix in the *Third Annual Monitoring Only Report for Former Pumphouse #1, Facility ID #9-025805, Former Building 8060, Hunter Army Airfield, Georgia* (SAIC 2005).

Due to funding limitations as a result of an increase in military obligations world-wide, the corrective action described in the CAP–Part B Addendum #1 has not been implemented. However, in an effort to address the free product, the interim action to remove free product through the use of absorbent socks was implemented again in 2004. In 2005, the free product removal method was changed to bi-monthly vacuum extraction (VE) from numerous wells located throughout Release #1.

This addendum to the former Pumphouse #1 CAP–Part B Report is being submitted to the GA EPD Underground Storage Tank Management Program (USTMP) to change the remedial alternative for the former Fuel Pit 1A/DAACG area (Release #1). Science Applications International Corporation prepared this report for the HAAF Directorate of Public Works (DPW) Environmental Branch through the U. S. Army Corps of Engineers (USACE), Savannah District under contract DACA21-02-D-0004, delivery order 0044.

II.B HORIZONTAL AND VERTICAL EXTENT OF CONTAMINATION

The horizontal and vertical extent of petroleum-related contamination in soil and groundwater was delineated by activities performed during the previous investigations at the former Pumphouse #1 site and the DAACG facility, which were documented in the CAP–Part B Report (SAIC 2000) and the CAP–Part B Addendum #1 Report (SAIC 2002). A summary of the results from these investigations is presented below.

II.B.1 Delineation of Soil Contamination

In the vicinity of the former Fuel Pit 1A/DAACG area (Release #1), the horizontal extent of petroleum-related contamination in soil was determined during the various investigations and was discussed in detail in the CAP–Part B Report (SAIC 2000). Concentrations of benzene, toluene, ethylbenzene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, chrysene, and indeno(1,2,3-*cd*)pyrene exceeded the applicable Georgia Underground Storage Tank (GUST) soil threshold levels (STLs) (i.e., Table B, Column 1), and concentrations of benzene, benzo(*a*)pyrene, chrysene, and indeno(1,2,3-*cd*)pyrene exceeded their respective alternate threshold levels (ATLs). The area of soil contamination, as determined in 2001, associated with Release #1 is presented in Figure 2. The analytical results for subsurface soil samples collected during the 2001 supplemental investigation are presented in Table 1.

In the vicinity of the former Pumphouse #1 Tank Pit area (Release #2), benzene, toluene, ethylbenzene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, and chrysene exceeded the applicable GUST STLs (i.e., Table B, Column 1), and benzene and chrysene exceeded their respective ATLs.

II.B.2 Delineation of Groundwater Contamination

In the vicinity of the former Fuel Pit 1A/DAACG area (Release #1), the horizontal extent of petroleum-related contamination in groundwater was determined during the various investigations and

was discussed in detail in the CAP–Part B Report (SAIC 2000) and CAP–Part B Addendum #1 Report (SAIC 2002). The vertical extent of groundwater contamination at the former Fuel Pit 1A/DAACG area (Release #1) was delineated through soil sampling during the CAP–Part B investigation and was discussed in the CAP–Part B Report (SAIC 2000). Benzene, ethylbenzene, toluene, benzo(*a*)pyrene, chrysene, and naphthalene were identified as chemicals of potential concern (COPCs) for groundwater. Based on the results of fate and transport (F&T) modeling, alternate concentration limits (ACLs) were calculated for these constituents. Benzene was the only constituent at the former Fuel Pit 1A/DAACG area (Release #1) to exceed its In-Stream Water Quality Standard (IWQS) and ACL during the various investigations. An ACL of 285 µg/L was proposed for benzene in groundwater and was approved by GA EPD in correspondence dated December 18, 2000 (Logan 2000). The area of benzene contamination, as determined in 2001, associated with Release #1 is presented in Figure 3. The analytical results for groundwater samples collected during the 2001 supplemental investigation are presented in Table 2.

In the vicinity of the former Pumphouse #1 Tank Pit area (Release #2), benzene, ethylbenzene, toluene, benzo(*a*)anthracene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, benzo(*k*)fluoranthene, chrysene, dibenzo(*a,h*)anthracene, indeno(1,2,3-*cd*)pyrene, and naphthalene were identified as COPCs for groundwater. Benzene was the only constituent at the former Pumphouse #1 Tank Pit area (Release #2) to exceed its IWQS and ACL during the various investigations. An ACL of 285 µg/L was proposed for benzene in groundwater and was approved by GA EPD in correspondence dated December 18, 2000 (Logan 2000). A monitoring only program for Release #2 was implemented in September 2001 and the results are being provided in annual monitoring only reports.

II.B.3 Delineation of Free Product

Free product was identified at the former Fuel Pit 1A/DAACG area (Release #1) in February 2000. The free product was observed in wells D-MW1, D-MW2, D-MW8, D-MW11, D-MW13, and D-MW17 at thicknesses ranging from a sheen to 0.88 ft. There horizontal extent of the free product was bounded by existing wells at the site. Following the CAP–Part B investigation, the interim corrective action consisted of free product recovery in the wells via absorbent socks, which were installed on February 22, 2000. The absorbent socks were removed and replaced on a bimonthly basis from May 2000 through July 2003.

In February 2001, 11 4-in. monitoring wells (D-MW33 through D-MW43) were installed to supplement CAP–Part B investigation activities at this site. In March and July 2001, field bailout tests were conducted in wells D-MW2, D-MW34, and D-MW35 using the field bailout test method (Gruszczenski 1987). The results of the field bailout tests were presented in the CAP–Part B Addendum #1 Report (SAIC 2002). From an aerial extent, the free product plume is located underneath an active tarmac that is associated with active military flight operations. However, the thickest and most recoverable portion of the free product plume is located in the vicinity of wells D-MW2, D-MW34, and D-MW35.

In September/October 2003, additional activities were performed with CPT equipment with fluorescence detection to delineate the horizontal and vertical extent of the free product at both Release #1 and Release #2. The investigation concluded that the likely zones of nonaqueous-phase liquid (NAPL) contamination tend to occur between 6 and 13 ft below ground surface (BGS), which is in the vicinity of the water table and smear zone, and at a thickness ranging from 1 to 5 ft. There are a few locations, however, in which pockets of NAPL exist below the water table at depths greater than 20 ft BGS. These locations are D-CPT-3 in the area associated with Release #1 and P1-CPT-1, P1-CPT-11, and P1-CPT-11 associated with Release #2.

Absorbent socks have been replaced in numerous wells associated with both Release #1 and Release #2 between February 2000 to July 2003 and June 2004 and March 2005. Absorbent socks remained in the wells between August 2003 and May 2004; however, there was no contract to changeout the socks during

this time. Beginning in June 2005, bi-monthly VE activities were initiated on approximately 50 wells located throughout Release #1 and Release #2. Prior to conducting VE, the depth to product and water were recorded. The well evacuation apparatus was installed and the drop tube was set approximately 1 ft below the groundwater level. A vacuum was applied to the well for approximately 45 min. The quantity of the water/product mixture varied from well to well; however, it appears that the amount of free product removed from each well was very small (i.e., less than 0.5 gal). A summary of the free product thickness measured during the absorbent sock replacement or VE activities from June 2004 to January 2006 for Release #1 is provided in Table 3. The aerial extent of the free product area for Release #1 is shown in Figure 4.

II.B.4 Delineation of Surface Water and Sediment Contamination

Results from the surface water and sediment samples collected during the CAP–Part B investigation were discussed in the CAP–Part B Report (SAIC 2000). BTEX constituents were detected in the surface water samples collected from the drainage ditch located south of the former Tank Pit area. No polyaromatic hydrocarbon (PAH) constituents were detected in the surface water samples. Total petroleum hydrocarbons and PAHs were detected in some of the sediment samples.

II.C REGIONAL, LOCAL, AND SITE HYDROGEOLOGY

A discussion of the regional, local, and site hydrogeology was presented in the CAP–Part B Report (SAIC 2000).

II.C.1 Groundwater Usage

According to the *Groundwater Pollution Susceptibility Map of Georgia* (GA EPD 1992), the former Pumphouse #1 site, Facility ID #9-025085 is located within an average or higher groundwater pollution susceptibility area. Nine water supply wells are located within the confines of the HAAF area. These wells have the potential to provide up to 3,890 gallons per minute (gpm) of water to occupants of the HAAF installation.

II.C.2 Aquifer Description

The hydrogeology in the vicinity of HAAF is mostly influenced by two aquifer systems. These are referred to as the Principal Artesian (Floridan) Aquifer and the surficial aquifer (Miller 1990). The Principal Artesian Aquifer is the lowermost hydrologic unit and is regionally extensive from South Carolina to Georgia, Alabama, and most of Florida. Known elsewhere as the Floridan, this aquifer, approximately 800 ft in total thickness, is composed primarily of Tertiary-age limestone, including the Bug Island Formation, the Ocala Group, and the Suwannee Limestone. Groundwater from the Floridan is used primarily for drinking water (Arora 1984).

The confining layer for the Floridan Aquifer is the phosphatic clay of the Hawthorn Group. There are minor occurrences of aquifer material within the Hawthorn Group; however, they have limited utilization (Miller 1990). The surficial aquifer overlies the Hawthorn confining unit.

The surficial aquifer consists of widely varying amounts of sand and clay, ranging from 55 to 150 ft in thickness. This aquifer is primarily used for domestic lawn and agricultural irrigation. The top of the water table ranges from approximately 2 to 10 ft BGS (Miller 1990). Groundwater in the surficial aquifer system is under unconfined, or water table, conditions. Locally, however, thin clay beds create confined or semiconfined conditions.

Groundwater encountered at HAAF UST investigation sites is part of the surficial aquifer system. Based on the facts that all public and non-public water supply wells draw water from the Floridan Aquifer and that the Hawthorn confining unit separates the Floridan Aquifer from the surficial aquifer, it is concluded that there is no hydraulic interconnection between HAAF UST sites (and associated plumes) and water supply withdrawal points.

II.C.3 Surface Water

The water resources survey conducted during the CAP–Part B site investigation is presented in the CAP–Part B Report (SAIC 2000) and CAP–Part B Addendum #1 Report (SAIC 2002). Surface water bodies at HAAF include Hallstrom Lake, Lamar Canal, Buckhalter Canal, Springfield Canal, Pond 29 located northwest of Buildings 336 and 232, and an unnamed pond located along the southeastern boundary of the HAAF installation. Several unnamed drainage canals and ditches exist throughout HAAF. Most of these canals drain southwest into the Little Ogeechee River, which is part of the Lower Ogeechee watershed. The remaining drainage canals located on the eastern side of the HAAF installation flow east and eventually drain into the Vernon River, which is located southeast of the HAAF installation. Surface water bodies at HAAF and adjacent areas are not used as public water supplies. The ponds and lakes, as well as Lamar Canal, are perennial, whereas most of the drainage canals and ditches are intermittent. Most of the drainage canals are at least partially enclosed in culverts.

II.C.4 Site Stratigraphy

The lithology encountered at the site is predominantly a white, pale brown, or light gray, very fine to medium-grained sand, with variable silt and clay content. Generally, the samples with higher silt and clay content were within a few feet of the surface. Less silt and clay content was noted with depth. The boring log of deep well P1-MW40 indicates an increasing clay content from approximately 26 to 30 ft BGS, becoming a clayey, coarse-grained sand/gravel at 30 ft BGS.

II.C.5 Direction of Groundwater Flow

Table 4 summarizes construction details for the monitoring wells associated with the former Fuel Pit 1A/DAACG area (Release #1). During the interim action free product removal activities in October 2005, groundwater elevations were measured in numerous monitoring wells associated with Release #1 to prior to free product removal. In October 2005, the groundwater flow in the vicinity of the former Fuel Pit 1A/DAACG area is to the northwest at a gradient of approximately 0.0083 ft/ft. Figure 5 shows the potentiometric surface at the site in October 2005.

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III. REMEDIAL ACTION PLAN

III.A CORRECTIVE ACTION COMPLETED OR IN PROGRESS

III.A.1 Recovery/Removal of Free Product

During sampling activities in February 2000, free product was measured in wells D-MW1, D-MW2, D-MW8, D-MW11, D-MW13, and D-MW17 at thicknesses of 0.01, 0.88, 0.15, 0.74, and 0.15 ft and a sheen, respectively. Absorbent socks were placed in each well following these measurements on February 24, 2000. The free product covered an area of approximately 400 by 500 ft at the former Fuel Pit 1A/DAACG area (Release #1) in February 2000. GA EPD was notified of the free product in correspondence dated March 8, 2000 (Stanley 2000). As an interim action until a corrective action could be implemented, the absorbent socks were removed and replaced in wells with free product on a bi-monthly basis from May 2000 through June 2003 and September 2004 through May 2005.

Beginning in June 2005, bi-monthly VE activities were initiated on approximately 50 wells located throughout Release #1 and Release #2. Prior to conducting VE, the depth to product and water were recorded. The well evacuation apparatus was installed and the drop tube was set approximately 1 ft below the groundwater level. A vacuum was applied to the well for approximately 45 min. The quantity of the water/product mixture varied from well to well; however, it appears that the amount of free product removed from each well was very small (i.e., less than 0.5 gal). The results of the free product removal activities were presented in the CAP–Part B Addendum #1 Report (SAIC 2002) and the 2004-2005 Free Product Removal Report (SAIC 2006).

III.A.2 Remediation/Treatment of Contaminated Backfill Material and Native Soil

No contaminated backfill material or native soil associated with the former Fuel Pit 1A/DAACG area (Release #1) have been excavated, remediated, or treated.

III.B OBJECTIVES OF CORRECTIVE ACTION

III.B.1 Remove Free Product That Exceeds One-Eighth Inch at the Former Fuel Pit 1A/DAACG Area (Release #1)

In February 2000, free product in excess of 1/8 in. in thickness was observed in wells D-MW1, D-MW2, D-MW8, D-MW11, D-MW13, and D-MW17. The free product plume is located underneath an active tarmac that is associated with military flight operations. In 2000, the thickest amount of free product was located near the southwestern boundary of the product plume in the vicinity of wells D-MW2, D-MW34, and D-MW35. Between February 2000 and May 2005, free product has been removed via absorbent socks, which were removed and replaced on a periodic basis. In June 2005, the free product removal method was changed to removal via a vacuum truck. In 2004 and 2005, the thickness underneath the active tarmac ranged from a sheen to 0.10 ft.

It is recommended that free product removal activities utilizing a vacuum truck be continued as the corrective action to address the free product.

III.B.2 Remediate Groundwater Contamination at the Former Fuel Pit 1A/DAACG Area (Release #1)

As discussed in the CAP–Part B Report (SAIC 2000), previous investigations documented benzene contamination in groundwater at the former Fuel Pit 1A/DAACG area (Release #1) at concentrations that exceeded the IWQS of 71.28 µg/L and the ACL of 285 µg/L.

The supplemental groundwater sampling conducted in March 2001 indicated that the benzene plume was similar to the plume that had been observed during the CAP–Part A and CAP–Part B investigations. The benzene concentrations in 12 wells exceeded the IWQS. The benzene concentrations in D-MW2 (400 µg/L), D-MW34 (388 µg/L), D-MW35 (765 µg/L), D-MW37 (601 µg/L), and D-MW40 (313 µg/L) exceeded the ACL of 285 µg/L in 2001. These wells are located in the southwestern portion of the groundwater plume where the free product was the thickest in 2000 and 2001.

The groundwater plume in 2001 covered an area of approximately 500 by 850 ft (i.e., ~9 acres) underneath an active tarmac that is associated with military flight operations. The corrective action for the groundwater plume at the former Fuel Pit 1A/DAACG area should consist of alternatives that are protective of the environment, but can be implemented in a manner that causes minimal disruption of the active military flight operations. Monitored natural attenuation (MNA) appears to be the most viable alternative once the free product has been removed because (1) the free product continues to act as a source for the groundwater contamination, but has been accumulating at a slower rate than in previous years and (2) the maximum benzene concentrations during the CAP–Part B and supplemental investigations were less than three times the ACL. MNA would provide for monitoring of the groundwater plume without impacting the military flight operations. It is recommended that the corrective action for groundwater consist of free product removal in conjunction with MNA of the groundwater plume in the vicinity of the former Fuel Pit 1A/DAACG area (Release #1) until the free product is removed. At that point, the corrective action will be re-evaluated.

III.B.3 Remediate Soil Contamination at the Former Fuel Pit 1A/DAACG Area (Release #1)

As discussed in the CAP–Part B Report (SAIC 2000), previous investigations documented that benzene, toluene, ethylbenzene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, chrysene, and indeno(1,2,3-*cd*)pyrene contamination in soil at the former Fuel Pit 1A/DAACG area (Release #1) exceeded the applicable GUST STLs. Benzene was the only constituent in soil to exceed its ATL of 9.3 mg/kg in six boring locations. Benzo(*a*)pyrene, chrysene, and indeno(1,2,3-*cd*)pyrene concentrations in one soil sample exceeded the ATLs of 1.4, 2.1, and 0.66 mg/kg, respectively. The soil samples with these concentrations exceeding the ATLs were collected from the capillary fringe above the soil/water interface in the area of free product, and the presence of free product may have contributed to the high concentrations. The soil contamination exceeding ATLs follows the area of free product and groundwater contamination, and is located underneath an active tarmac that is associated with military flight operations. Active remediation of the soil contamination underneath the tarmac will impact active military operations.

It is recommended that the corrective action for removal of the free product be implemented prior to recommendation of a corrective action for the soil contamination. Once the majority of the free product has been removed, additional soil borings should be installed in the vicinity of the boreholes that had constituents exceeding ATLs to determine if the soil concentrations have degraded to below the ATLs.

III.B.4 Provide Risk-Based Corrective Action

A risk-based approach was used in the CAP–Part B Report (SAIC 2000) to identify COPCs for soil and groundwater and to develop ATLs and ACLs for various constituents. The results of the risk screening for

both areas were presented in the CAP–Part B Report (SAIC 2000) and the results for the former Fuel Pit 1A/DAACG area are summarized below.

In summary, benzene, ethylbenzene, toluene, xylenes, benzo(*a*)pyrene, benzo(*b*)fluoranthene, chrysene, and indeno(1,2,3-*cd*)pyrene were identified as COPCs for soil. ATLs of 9.3 mg/kg for benzene, 187 mg/kg for ethylbenzene, 479 mg/kg for toluene, 893 mg/kg for xylenes, 1.4 mg/kg for benzo(*a*)pyrene, 5.8 mg/kg for benzo(*b*)fluoranthene, 2.1 mg/kg chrysene, and 0.66 mg/kg for indeno(1,2,3-*cd*)pyrene were proposed in the CAP–Part B Report (SAIC 2000) and approved by GA EPD in correspondence dated December 18, 2000 (Logan 2000). Benzene, benzo(*a*)pyrene, chrysene, and indeno(1,2,3-*cd*)pyrene were the constituents that exceeded their respective ATLs during the CAP–Part A and Part B investigations.

Benzene, ethylbenzene, toluene, benzo(*a*)pyrene, chrysene, and naphthalene were identified as COPCs for groundwater. ACLs of 285 µg/L for benzene; 114,800 µg/L for ethylbenzene; 800,000 µg/L for toluene; 1.2 µg/L for benzo(*a*)pyrene; 1.2 µg/L for chrysene; and 260 µg/L for naphthalene were proposed in the CAP–Part B Report (SAIC 2000) and approved by GA EPD in correspondence dated December 18, 2000 (Logan 2000). Benzene was the only compound to exceed its respective ACL during the CAP–Part B investigation.

The F&T modeling results were provided in the CAP–Part B Report (SAIC 2000). A storm drain located 230 ft northeast (downgradient) of the center of the plume is the nearest possible location at which a receptor might encounter migrating groundwater contamination due to a possible hydraulic connection between the groundwater and the potential receptor. Modeling of leaching to groundwater by percolating rainwater was performed using the Seasonal Soil Compartment Model to determine the predicted maximum concentration in the leachate at the water table interface. The predicted leachate concentration of 12,500 µg/L was above the maximum groundwater concentration of 700 µg/L at the source. The Analytical Transient 1-, 2-, 3-Dimensional Model was calibrated to the maximum predicted concentration of benzene (i.e., 12,000 µg/L) assuming a steady-state (continuous) concentration at the source.

Based on modeling results, the estimated dilution attenuation factor (DAF) for benzene at the storm drain was 4.0. The modeling results indicated that benzene should be reaching the storm drain at a concentration of 3,100 µg/L, which is above the state IWQS of 71.28 µg/L, thereby predicting that the potential receptor is impacted by the current site conditions. However, actual groundwater results indicated that groundwater contamination at concentrations near the IWQS reaches the storm drain. A similar model was run for the former Tank Pit area, which resulted in a DAF of 5.25. Due to the close proximity of both releases to each other, the most conservative F&T modeling results were used for developing one set of ACLs and ATLs for both areas of contamination.

ACLs for constituents in groundwater [i.e., benzene, toluene, ethylbenzene, benzo(*a*)anthracene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, benzo(*k*)fluoranthene, chrysene, dibenzo(*a,h*)anthracene, indeno(*1,2,3,-cd*)pyrene, and naphthalene] and ATLs for constituents in soil [i.e., benzene, toluene, ethylbenzene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, chrysene, and indeno(*1,2,3,-cd*)pyrene] were calculated in the CAP–Part B Report dated August 2000. The ACLs and ATLs were approved by the GA EPD in correspondence dated December 18, 2000. A summary of the approved ACLs and ATLs is provided in Table 5.

III.C DESIGN AND OPERATION OF CORRECTIVE ACTION SYSTEMS AT THE FORMER FUEL PIT 1A/DAACG AREA (RELEASE #1)

III.C.1 System Effectiveness/Basis for Selection

The presumed remedies evaluated for aromatic hydrocarbons in soil and groundwater at the former Fuel Pit 1A/DAACG area included free product removal, MNA, oxygen-injection-enhanced bioremediation, air-sparging with soil VE, six-phase heating, and PHOSter® II-enhanced bioremediation. The primary focus of the alternative evaluation was to find a cost-effective method of remediating the site with minimal impact to the military flight operations. Active remediation of the majority of the soil and groundwater contamination underneath the active tarmac would either impact military flight operations for a significant period of time or not be cost effective to implement because of the requirements that would be necessary to minimize the impact to flight operations.

In selecting the corrective action for the former Fuel Pit 1A/DAACG area, the following items were taken into consideration: (1) the free product is acting as a continuous source for soil and groundwater contamination, (2) the benzene concentrations in groundwater underneath the active tarmac are less than three times the ACL, and (3) the soil contamination is primarily associated with the interval above the soil/water interface where the free product is located. Based on these considerations and the active military flight operations, a phased approach to the corrective action is recommended for the former Fuel Pit 1A/DAACG area. The first phase will consist of removing the free product without impacting active military flight operations in conjunction with MNA of the groundwater plume until free product recovery activities are terminated. Once the removal of the free product reaches a quantity removed or well thickness that is agreed upon by GA EPD and HAAF, and the results of any MNA can be evaluated, HAAF will re-evaluate the need for an active corrective action addressing any remaining soil and groundwater contamination.

III.C.1.a Theory and feasibility

Data indicate that free product is tied up in the soil pores at the soil/water interface at the former Fuel Pit 1A/DAACG area (Release #1), dissolved-phase hydrocarbons exist in the groundwater beneath the site, and residual saturation of hydrocarbons exists in soil at the site. The seasonal water table fluctuations of approximately 2 ft have further transported and smeared free-phase petroleum product onto soil. The BTEX compounds are both volatile and aerobically degradable by bacteria, which already exist in the subsurface.

Since 2000, an interim action of free product removal via absorbent socks and VE has been implemented to address the free product. Both of these methods have been shown to reduce the quantity of free product accumulating in the wells.

During the 2001 investigation, the Georgia IWQS for benzene of 71.28 µg/L was exceeded in 12 monitoring wells. However, only five of the wells contained benzene concentrations that exceeded the GA EPD-approved benzene ACL of 285 µg/L. HAAF proposes to continue with quarterly VE to remove free product in conjunction with MNA of the groundwater plume.

III.C.1.b Remediation system

The former Fuel Pit 1A/DAACG area (Release #1) is located underneath a tarmac associated with active military flight operations. The proposed first phase of the corrective action is a remediation system consisting of periodic VE in various wells to remove the free product. Initially, "periodic" will be conducted on a quarterly basis; however, with the concurrence of GA EPD, the frequency of VE activities

may be changed. Prior to conducting VE, product level and water level measurements will be made in numerous wells located throughout Release #1 and Release #2 to determine which wells may be accumulating free product. These wells may include, but are not limited to, D-MW-02, D-MW-05, D-MW-06, D-MW-08, D-MW-11, D-MW-12, D-MW-13, D-MW-17, D-MW-34, D-MW-35, D-MW-36, D-MW-37, D-MW-38, D-MW-39, D-MW-40,D-MW-41, D-MW-42, D-MW-43, D-CPT-1, D-CPT-2, D-CPT-3, D-CPT-4, D-CPT-5, D-CPT-6, D-CPT-7, D-CPT-8, D-CPT-10, D-CPT-11, D-CPT-12, D-CPT-14, D-CPT-17, D-CPT-18, D-CPT-21, D-CPT-29, D-CPT-31, D-CPT-37, D-CPT-39, D-CPT-40, D-CPT-42, P1-MW-01, P1-MW-02, P1-MW-03, P1-MW-18, P1-MW-21, P1-MW-22, P1-CPT-2, P1-CPT-3, P1-CPT-7, P1-CPT-8, P1-CPT-11, P1-CPT-17, and P1-CPT-18.

Upon completion of the product and water level measurements, the VE activities will be conducted in the wells with the greatest amount of free product. The well evacuation apparatus was installed and the drop tube was set approximately 1 ft below the groundwater level. Depending on the number of wells to be vacuum extracted, the vacuum will applied a well for 4 to 8 hr. The purge water will be containerized in a tanker truck and transported off-site for disposal.

In conjunction with the VE activities for free product removal, a monitoring only program will be implemented for the former Fuel Pit 1A/DAACG area and will consist of annual sampling of up to 30 wells. Any changes to the remediation system proposed in this document will be submitted to GA EPD.

III.D IMPLEMENTATION

III.D.1 Milestone Schedule

A milestone schedule for the proposed corrective action has been prepared. A Gantt chart showing milestone activities and anticipated duration is provided in Figure 6. The actual time required to achieve free produce recovery may be greater, or less, than presented in Figure 6; therefore, Fort Stewart will notify GA EPD USTMP of any significant changes to the schedule and will provide GA EPD USTMP with an updated Gantt chart, as necessary.

III.D.2 Progress Reporting

For the former Fuel Pit 1A/DAACG area (Release #1), quarterly free product removal letter reports will be submitted to GA EPD that will summarize the free product removal activities for each quarter. At a minimum, the quarterly letter report will consist of an e-mail with a table summarizing the free product removal activities. In addition, annual free product removal reports will be submitted to GA EPD that will summarize free product removal activities for the preceding year. The annual free product removal report for the former Fuel Pit 1A/DAACG area (Release #1) will be a separate document from the annual monitoring only report for the former Pumphouse #1 Tank Pit area (Release #2).

III.D.3 Certificate of Completion Report

Petition for permanent closure will be submitted with the final progress report (i.e., completion report) for the first release to reach closure criteria. An addendum to the completion report will be submitted for the second release to reach the GA EPD-approved closure criteria. GA EPD will provide final approval for decommissioning the monitoring wells, which will be requested in the final completion addendum report. Decommissioning of the monitoring wells will be completed in accordance with the USACE design manual for monitoring wells. Decommissioning will comply with all applicable state and federal standards.

The following certification will be submitted to GA EPD within 30 days of submittal of the final progress report:

> I hereby certify that the Corrective Action Plan–Part B, dated ___, 20_, for Hunter Army Airfield, Former Pumphouse #1 site (Release #1 and Release #2), Facility ID 9-025085, including any and all certified amendments/addenda thereto, has been implemented in accordance with the schedules, specifications, sampling programs, and conditions contained therein and that the plan's stated objectives have been met.
>
> _____
> Signature (Owner/Operator)

III.D.4 Inspection Schedule and Preventative Maintenance Program

There will not be a permanent system installed at HAAF; thus, on-site inspection and preventative maintenance will not be required.

III.D.5 Periodic Monitoring

For the former Fuel Pit 1A/DAACG area (Release #1), groundwater samples will be collected annually from up to 26 wells (D-MW1, D-MW2, D-MW8, D-MW11, D-MW12, D-MW13, D-MW17, D-MW18, D-MW19, D-MW22, D-MW33, D-MW34, D-MW35, D-MW36, D-MW37, D-MW38, D-MW39, D-MW40, D-MW41, D-MW42, D-MW43, P1-MW11, P1-MW12, P1-MW13, P1-MW42, and one additional well to be installed along the storm drain) and analyzed for BTEX. The wells in the monitoring program may be adjusted based on the results of analytical data. PAH compounds observed during the CAP–Part A and Part B investigations were detected at concentrations below their respective ACLs; therefore, it is recommended that PAH analysis not be performed during the annual sampling. Monitoring will continue at the site until the recovery of free product reaches a quantity removed or well thickness that is agreed upon by GA EPD and HAAF. Recommendations regarding free product removal end points will be made in the quarterly and annual reports. Free product removal activities will not be discontinued until GA EPD grants approval to terminate them. Once free product removal activities have been terminated, HAAF will provide a recommendation to GA EPD on the next phase of the corrective action. The monitoring only portion of the corrective action will continue until the benzene concentrations in groundwater are below the ACL of 285 μg/L for two sampling events. Wells may be added or removed from the monitoring plan as the boundaries of the plume change. These changes will be documented in the monitoring only reports.

During each sampling event, water levels will be measured in all monitoring wells. Specific conductivity, pH, and temperature analyses will be measured on each sample from the monitoring wells from which analytical samples are collected. The samples will be shipped to an approved laboratory for BTEX analysis in accordance with U. S. Environmental Protection Agency Method 8021B/8260B and GA EPD laboratory certification requirements.

III.D.6 Effectiveness of Corrective Action

For the former Fuel Pit 1A/DAACG area (Release #1), the corrective action (i.e., product recovery followed by MNA) will be discontinued once the objectives of the monitoring only plan have been achieved—the recovery of free product has reached a quantifiable goal agreed upon by GA EPD and HAAF based on the quarterly free product removal reports; the benzene concentrations in groundwater

are below the ACL of 285 µg/L; and the benzene, benzo(*a*)pyrene, chrysene, and indeno(1,2,3-*cd*)pyrene concentrations in soil are reduced to below their ATLs of 9.3 , 1.4, 2.1, and 0.66 mg/kg, respectively.

III.D.7 Confirmatory Soil Sampling Plan

For the former Fuel Pit 1A/DAACG area (Release #1), no excavation of soil is planned under the free product removal and monitoring only plan; therefore, confirmatory sampling associated with excavation of soil will not be performed. However, because there is an area of soil contamination that exceeds the benzene ATL of 9.3 mg/kg, the benzo(*a*)pyrene ATL of 1.4 mg/kg, the chrysene ATL of 2.1 mg/kg, and the indeno(1,2,3-*cd*)pyrene ATL of 0.66, three confirmatory soil samples will be collected from the area of soil contamination. The soil samples will be collected once the free product has reached a quantifiable goal agreed to by GA EPD and HAAF and the benzene concentrations in groundwater are approaching the ACL. The soil samples will be analyzed for only benzene, benzo(*a*)pyrene, chrysene, and indeno(1,2,3-*cd*)pyrene only. The location of these samples will be determined during the monitoring only program and will be submitted to GA EPD in a letter or annual report for approval.

III.D.8 Stockpiled Bulk Soil Sampling

For the former Fuel Pit 1A/DAACG area (Release #1), no stockpiled soil will be generated by this corrective action; therefore, no soil sampling will be conducted.

III.D.9 Monitoring Only Termination Conditions

For the former Fuel Pit 1A/DAACG area (Release #1), concentrations of benzene in groundwater must be at or below the ACL, and concentrations of benzene, benzo(*a*)pyrene, chrysene, and indeno(1,2,3-*cd*)pyrene in soil must be at or below their respective ATLs prior to termination of the monitoring only program. Once the product removal activities have reached a quantifiable goal agreed to by GA EPD and HAAF based on the quarterly free product removal reports and the benzene ACL and the benzene, benzo(*a*)pyrene, chrysene, and indeno(1,2,3-*cd*)pyrene ATLs have been achieved, the remedial system and monitoring may be terminated regardless of the site ranking score.

III.D.10 Post-Completion Site Restoration Activities

No modifications will be made to the former Fuel Pit 1A/DAACG area (Release #1), because there is no permanent equipment or systems located at the site as part of this remediation.

III.E PUBLIC NOTIFICATION

The former Pumphouse #1 site is located entirely within the confines of HAAF, which is part of the Fort Stewart Military Reservation, a federal facility. The U. S. Government owns all of the property contiguous to the site. The Fort Stewart DPW has complied with the public notice requirements defined by GA EPD guidance by publishing an announcement in the *Savannah Morning News* on April 1 and 8, 2001. Because the corrective action still consists of free product removal with MNA, an updated public notice has not been made.

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IV. CLAIM FOR REIMBURSEMENT

HAAF is a federally owned facility and has funded the investigation for the former Pumphouse #1 site (Release #1 and Release #2), Facility ID #9-025085 using U. S. Department of Defense Environmental Restoration Funds. Application for GUST Trust Fund reimbursement is not being pursued at this time.

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CORRECTIVE ACTION PLAN–PART B
ADDENDUM #1
FORMER PUMPHOUSE #1
FACILITY IDENTIFICATION NUMBER #9-025085
FORMER BUILDING 8060
HUNTER ARMY AIRFIELD, GEORGIA

Prepared for
U.S. Army Corps of Engineers
Savannah District
Under Contract Numbers DACA21-95-D-0022 and DACA63-97-D-0041
Delivery Order Numbers 0061 and CV01

Prepared by
SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
151 Lafayette Drive
Oak Ridge, Tennessee 37830

July 2002

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LIST OF ACRONYMS

ACL	alternate concentration limit
ATL	alternate threshold level
BGS	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
CAP	Corrective Action Plan
COPC	chemical of potential concern
DAACG	Departure/Arrival Air Control Group
DPW	Directorate of Public Works
GA EPD	Georgia Environmental Protection Division
gpm	gallons per minute
GUST	Georgia Underground Storage Tank
HAAF	Hunter Army Airfield
hp	horsepower
IWQS	In-Stream Water Quality Standard
NPDES	National Pollutant Discharge Elimination System
PAH	polynuclear aromatic hydrocarbon
STL	soil threshold level
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
UST	underground storage tank
USTMP	Underground Storage Tank Management Program
VOC	volatile organic compound

I. CORRECTIVE ACTION PLAN CERTIFICATION – PART B

(Form and certification follow this page.)

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Georgia Department of Natural Resources
Environmental Protection Division
Land Protection Branch
Underground Storage Tank Management Program
4244 International Parkway, Suite 104
Atlanta, Georgia 30354
Phone (404) 362-2687
FAX (404) 362-2654

CORRECTIVE ACTION PLAN
PART B

Facility Name: Former Pumphouse #1 Site

Street Address: Former Building 8060, Near Taxiway 3

City: Hunter Army Airfield **County:** Chatham

Facility ID #: 9-025085

Submitted by UST Owner/Operator:
Name: Thomas C. Fry/Environmental Branch
Company: US Army/HQ 3d Inf. Div (Mech)
Address: Directorate of Public Works, Bldg 1137
1550 Frank Cochran Drive
City: Fort Stewart State: GA
Zip Code: 31314-4927

Prepared by:
Name: Patricia Stoll
Company: Science Applications International Corp.
Address: P.O. Box 2501
City: Oak Ridge State: TN
Zip Code: 37831

I. PLAN CERTIFICATION

A. UST Owner/Operator

I hereby certify that the information contained in this plan and in all the attachments is true, accurate, and complete, and the plan satisfies all criteria and requirements of Rule 391-3-15-.09 of the Georgia Rules for Underground Storage Tank Management.

Name: Thomas C. Fry

Signature: _____ Date: _____

B. Professional Engineer or Professional Geologist

Name: Patricia Stoll

Signature: Patricia A Stoll

Date: 7/16/02

GEORGIA REGISTERED 22851 PROFESSIONAL ENGINEER PATRICIA A. STOLL

Georgia Stamp or Seal

Check all boxes below that apply. Attach supporting documentation, i.e., narrative, figures, tables, maps, boring/well logs, etc., for all items checked. Supporting documentation should be three-hole punched and prepared in conformity with the guidance document "Underground Storage Tank (UST) Release: Corrective Action Plan – Part B (CAP-B) Content", GUST-7B.

II. SITE INVESTIGATION REPORT

A. Horizontal and Vertical Extent of Contamination:

- ☒ Soil (Section II.A.1)
- ☒ Groundwater (Section II.A.2)
- ☒ Free Product (Section II.A.3)
- ☒ Surface Water (Section II.A.4)

B. Local and Site Hydrogeology

- ☒ Documentation of Local Groundwater Conditions (Section II.B.1)
- ☒ Stratigraphic Boring Logs (Section II.B.2)
- ☒ Stratigraphic Cross Sections (Section II.B.3)
- ☒ Referenced or Documented Calculations of Relevant Aquifer Parameters (Section II.B.4)
- ☒ Direction of Groundwater Flow (Section II.B.5)
  - ☒ Table of Monitoring Well Data (Table 5)
  - ☒ Potentiometric Map (Figure 13)
  - ☒ Flow Net Superimposed on a Base Map (Figure 13)

III. REMEDIAL ACTION PLAN:

A. Corrective Action Completed or In-Progress:

- ☒ Recovery/Removal of Free-Product (Non-aqueous Phase Hydrocarbons)
- ☐ Remediation/Treatment of Contaminated Backfill Material & Native Soils
- ☐ Other (specify)_____

B. Objective of Corrective Action:

- ☒ Remove Free Product That Exceeds One-Eighth Inch
- ☐ Remediate Groundwater Contamination That Exceeds:
  - ☐ Maximum Contaminant Levels (MCLs)

    OR
  - ☐ In-Stream Water Quality Standards

B. Objective of Corrective Action (continued):

☐ Remediate Soil Contamination That Exceeds:

☐ Threshold Values Listed in Table A

OR

☐ Threshold Values Listed in Table B

OR

☐ Alternate Threshold Levels (ATLs)

☒ Provide Risk Based Corrective Action (Reference CAP B App. VI) (Section III.B.4)

☒ Remediate Soil and/or Groundwater Contamination That Exceeds Alternate Concentration Limits (ACLs) and Monitor Residual Contaminants

OR

☐ Monitor Soil and/or Groundwater Contamination That Exceeds Levels in Rule -.09 (3) But Is Less Than ACLs

OR

☐ No Further Action Required - Soil and/or Groundwater Contamination is Below Levels in Rule -.09 (3)

C. Design Operation of Corrective Action Systems

☒ Soil ☒ Groundwater ☒ Free Product ☐ Surface Water ☐ Not Applicable

D. Implementation (Section III.D)

Includes, as a minimum, the following:

- Milestone schedule for site remediation
- Inspection and preventive maintenance schedule for all specialized remediation equipment
- Monitoring/sampling and reporting plan for measuring interim progress and project completion
- Plan to decommission equipment/wells and close site

IV. PUBLIC NOTICE

☐ Certified Letters to Adjacent, and Potentially Affected Property Owners and Local Officials

☒ Legal Notice in Newspaper, as approved by EPD (Section III.E)

☐ Other EPD-approved Method (specify)_____

V. **CLAIM FOR REIMBURSEMENT:** (For GUST Trust Fund sites only)

- ☐ GUST Trust Fund Application (GUST-36), must be attached if applicable
- ☐ Cost Proposal
  - ☐ Non-Reimbursable Costs

    OR
  - ☐ Reimbursable Costs
    - ☐ Total Project Costs
      - ☐ Costs incurred to date, per GUST-92
      - ☐ Estimated costs to complete corrective action, per GUST-92
    - ☐ Invoices and Proofs-of-Payment for Costs Incurred to Date
- ☐ Proposed Schedule For Reimbursement
  - ☐ Lump Sum Payment Upon Completion Of Corrective Action

    OR
  - ☐ Interim Payments With Final Payment Upon Completion
- ☒ Not Applicable

II. SITE INVESTIGATION REPORT

The results of the Corrective Action Plan (CAP)–Part B investigation at the Former Pumphouse #1, Facility ID #9-025085, Former Building 8060, at Hunter Army Airfield (HAAF), Georgia, were presented in the CAP–Part B Report (SAIC 2000). This report documents the supplemental investigation activities conducted at the Former Fuel Pit 1A Departure/Arrival Air Control Group (DAACG) area of the Former Pumphouse #1 site as recommended and approved in the CAP–Part B Report.

The Former Pumphouse #1 site is located along the east–west taxiway of HAAF, as illustrated in Figure 1. The Former Pumphouse #1 site is located within an average or higher groundwater pollution susceptibility area, is more than 500 feet from a withdrawal point, and is fewer than 500 feet from a surface water body. As defined in Georgia Underground Storage Tank (GUST) Management Rule 391-5-15.09, the appropriate soil threshold levels (STLs) are presented in Table B, Column 1 of GUST Rules 391-5-15 because a surface water body is located fewer than 500 feet from the site.

According to the operational information provided by the Fort Stewart Directorate of Public Works (DPW), Former Pumphouse #1 was an aviation-gas fuel island used from about 1953 until the early 1970s that consisted of ten 25,000-gallon underground storage tanks (USTs) and a 50,000-gallon underground defueling tank. The pumphouse was inactive from the 1970s to 1995. Eight of the 25,000-gallon USTs were removed in 1995. The 8-inch cast iron piping internal to the Former Pumphouse #1 facility was removed prior to the tank removal exercise. The 50,000-gallon defueling tank and two of the 25,000-gallon tanks remained in place, partially under the pumphouse structure. In 1998 the pumphouse structure was removed along with the two remaining 25,000-gallon USTs, and the 50,000-gallon defueling tank was closed in place. The piping from the boundary of the pumphouse facility to the bulk fuel farm was also drained, pigged, and grouted in place.

Various closure activities as well as CAP–Part A and CAP–Part B investigations at the Former Pumphouse #1 site were performed between 1995 and 2000. The Former Pumphouse #1 investigations covered an area south of the active taxiway. CAP–Part A and CAP–Part B investigations were conducted at the DAACG facility in 1995 and 1996, respectively. These investigations covered the active tarmac north of the active taxiway. Review of the analytical data from all of the investigations indicated that it was necessary to combine the DAACG facility data and the Former Pumphouse #1 data to document the nature and extent of contamination. As a result, the Former Pumphouse #1 CAP–Part B Report (SAIC 2000) combined the results from all the investigations in a single report. It was submitted to the Georgia Environmental Protection Division (GA EPD) in August 2000 and approved by GA EPD in correspondence dated December 18, 2000 (Logan 2000).

As indicated in the Former Pumphouse #1 CAP–Part B Report, there are two distinct and separate plumes located within the vicinity of the Former Pumphouse #1 site. Release #1 is an area of soil and groundwater contamination near the DAACG facility in the vicinity of Former Fuel Pits 1A and 1B, approximately 900 feet west of former Building 8060 (i.e., Pumphouse #1). In February 2000, free product was identified in this area in six wells (i.e., D-MW1, D-MW2, D-MW8, D-MW11, D-MW13, and D-MW17) at thicknesses ranging from a sheen to 0.88 foot. Throughout this document Release #1 will be referred to as the Former Fuel Pit 1A/DAACG area. Release #2 is an area of soil and groundwater contamination located near the Former Pumphouse #1 facility and Former Fuel Pits 1C and 1D, approximately 200 feet north of the former tank pits. Throughout this document Release #2 will be referred to as the Former Pumphouse #1 tank pit area. Based on the proximity of the various former fuel pits to the areas of contamination, it appears that a release from Former Fuel Pit 1A is responsible for the contamination associated with Release #1 and that a release from Former Fuel Pit 1C is responsible for the contamination associated with Release #2. During the CAP–Part B investigation activities, the

horizontal and vertical extent of petroleum-related contamination in soil and groundwater was determined for both areas of contamination.

For the Former Fuel Pit 1A/DAACG area (Release #1), the CAP–Part B Report recommended additional investigation activities to further define the extent of the free product and to determine the amount of recoverable free product at the Former Fuel Pit 1A/DAACG area prior to proposing a remediation system for the site. As a result, eleven 4-inch wells were installed in February 2001 to delineate the free product area around the Former Fuel Pit 1A/DAACG area, 31 monitoring wells were sampled in March 2001, and field bailout tests were conducted in three wells to evaluate the thickness of the free-phase product. The locations of the monitoring wells installed as part of the CAP–Part B investigation and supplemental investigation activities are shown in Figure 2.

For the Former Pumphouse #1 tank pit area (Release #2), the CAP–Part B Report recommended semiannual monitoring of eight wells (i.e., D-MW5, D-MW6, P1-MW1, P1-MW2, P1-MW18, P1-MW19, P1-MW22, and P1-MW23) for benzene, toluene, ethylbenzene, and xylenes (BTEX). The CAP–Part B Report was approved by GA EPD in correspondence dated December 18, 2000 (Logan 2000). Semiannual monitoring is scheduled to begin in September 2001 and will continue at the site until the benzene concentrations in groundwater are below the alternate concentration limit (ACL) of 285 µg/L for two sampling events. Once the benzene ACL has been achieved at the Former Pumphouse #1 tank pit area, three confirmatory soil samples will be collected from the area of soil alternate threshold levels (ATLs) of 9.3 mg/kg and 2.1 mg/kg, respectively. The results of the monitoring program for the Former Pumphouse #1 tank pit area will be documented in future annual monitoring only reports. This release is not addressed in this addendum. However, the approved monitoring only program is being implemented in accordance with the GA EPD–approved CAP–Part B Report.

This addendum to the Former Pumphouse #1 CAP–Part B Report is being submitted to the GA EPD Underground Storage Tank Management Program (USTMP) to document the results of the supplemental investigation activities for the Former Fuel Pit 1A/DAACG area (Release #1) only. Science Applications International Corporation performed the supplemental investigation for the HAAF DPW Environmental Branch through the U.S. Army Corps of Engineers (USACE), Savannah District under contracts DACA21-95-D-0022, delivery order 0061 and DACA63-97-D-0041, delivery order CV01.

II.A. HORIZONTAL AND VERTICAL EXTENT OF CONTAMINATION

The horizontal and vertical extent of petroleum-related contamination in soil and groundwater was delineated by activities performed during the previous investigations at the Former Pumphouse #1 site and the DAACG facility, which were documented in the CAP–Part B Report (SAIC 2000). The supplemental investigation activities were performed in accordance with the technical approach described in the CAP–Part B Report and the requirements of the *Work Plan for Preliminary Groundwater and Corrective Action Plan–Part A Investigations at Former Underground Storage Tank Sites, Hunter Army Airfield, Georgia* (SAIC 1998) and the *Addendum #4 to Sampling and Analysis Plan for Preliminary Groundwater and Corrective Action Plan–Part A/Part B Investigations at Former Underground Storage Tank Sites, Hunter Army Airfield, Georgia* (SAIC 2001).

II.A.1. Delineation of Soil Contamination at the Former Fuel Pit 1A/DAACG Area (Release #1)

In the vicinity of the Former Fuel Pit 1A/DAACG area (Release #1), the horizontal extent of petroleum-related contamination was determined during the various investigations and was discussed in detail in the CAP–Part B Report (SAIC 2000). Concentrations of benzene, toluene, ethylbenzene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, chrysene, and indeno(*1,2,3-cd*)pyrene exceeded the applicable GUST STLs (i.e.,

Table B, Column 1), and concentrations of benzene, benzo(*a*)pyrene, chrysene, and indeno(*1,2,3-cd*)pyrene exceeded their respective ATLs.

During the installation of monitoring wells (D-MW33 through D-MW43) in February 2001, soil samples were collected for geochemical analyses. Field screening through volatile organic compound (VOC) headspace was performed on all soil samples collected from above the saturated zone during the monitoring well installations. For each 2-foot-length soil sample collected, VOC headspace readings were measured using an organic vapor analyzer. The field screening results are presented on each boring log included in Appendix IV. One soil sample was collected from each boring using field screening methods and analyzed for BTEX, polynuclear aromatic hydrocarbons (PAHs), and lead. Analytical results are summarized in Table 1 and presented Figure 3. The results from soil samples collected during the CAP–Part B supplemental investigation activities in February 2001 are summarized below.

- Benzene was detected in three of the 11 soil samples collected at concentrations ranging from 0.00048J mg/kg to 1.44J mg/kg. In addition, six samples had elevated detection limits ranging from 0.131 mg/kg to 11.3 mg/kg. Two of the concentrations and the elevated detection limits exceeded the benzene STL of 0.017 mg/kg. The elevated detection limit in well D-MW35 exceeded the GA EPD–approved benzene ATL of 9.3 mg/kg

- Toluene was detected in seven of the 11 soil samples collected at concentrations ranging from 0.0949J mg/kg to 2,550 mg/kg. The concentration in well D-MW35 exceeded the toluene STL of 115 mg/kg and the GA EPD–approved ATL of 479 mg/kg.

- Ethylbenzene was detected in nine of the 11 soil samples collected at concentrations ranging from 0.136J mg/kg to 355 mg/kg. The concentration in well D-MW35 exceeded the ethylbenzene STL of 18 mg/kg and the GA EPD–approved ATL of 187 mg/kg.

- Xylenes were detected in ten of the 11 soil samples collected at concentrations ranging from 0.0015J mg/kg to 1,860 mg/kg. The concentration in well D-MW35 exceeded the xylenes STL of 700 mg/kg and the GA EPD–approved ATL of 893 mg/kg.

- Acenaphthalene, anthracene, benzo(*a*)anthracene, chrysene, fluoranthene, fluorene, naphthalene, phenanthrene, or pyrene was detected in six of the 11 soil samples collected. The concentrations of benzo(*a*)anthracene and chrysene did not exceed the GUST STL of 0.66 mg/kg. None of the other constituents detected has a GUST STL.

II.A.2. Delineation of Groundwater Contamination at the Former Fuel Pit 1A/DAACG Area (Release #1)

BTEX and PAH compounds were detected in groundwater samples collected during the various investigations. This contamination was discussed in the CAP–Part B Report (SAIC 2000). Based on the results of fate and transport modeling, an ACL of 285 µg/L was proposed for benzene in groundwater and was approved by GA EPD in correspondence dated December 18, 2000 (Logan 2000). Benzene was the only constituent at the Former Fuel Pit 1A/DAACG area (Release #1) and the Former Pumphouse #1 tank pit area (Release #2) to exceed its In-Stream Water Quality Standard (IWQS) and ACL during the various investigations.

II.A.2.a. Horizontal extent of groundwater contamination

In the vicinity of the Former Fuel Pit 1A/DAACG area, the horizontal extent of this plume was defined during the CAP–Part B investigation. The groundwater is migrating toward the underground storm drain located to the northwest of the Former Fuel Pit 1A. The dissolved plume appears to migrate beyond the storm drain to the northwest. Several PAH compounds exceeded their respective IWQSs or risk-based screening criteria, but the concentrations did not exceed their respective ACLs. Benzene was the only contaminant to exceed its IWQS of 71.28 µg/L and ACL of 285 µg/L during the various investigations.

As a result of the recommendations presented in the CAP–Part B Report (SAIC 2000), 11 additional monitoring wells were installed in February 2001 to better delineate the extent of free product in the vicinity of the Former Fuel Pit 1A/DAACG area. In March 2001, groundwater samples were collected from selected wells within the Former Fuel Pit 1A/DAACG area and analyzed for BTEX. Thirty-one groundwater samples were collected for geochemical analysis, as presented in Table 2 and Figure 4. Monitoring well locations are shown in Figure 2.

Benzene was identified in 20 groundwater samples during the supplemental investigation. Benzene concentrations ranged from 0.2J µg/L to 765 µg/L, as illustrated in Figure 5. The concentrations in 12 samples exceed the Georgia IWQS of 71.28 µg/L. The concentrations in four samples were above the site ACL for benzene of 285 µg/L. With the exception of one sample, the analytical detection limit for benzene was 1 µg/L.

Toluene was identified in 24 groundwater samples during the supplemental investigation. Toluene concentrations ranged from 0.27J µg/L to 29,600 µg/L, as illustrated in Figure 6. The concentrations did not exceed the Georgia IWQS of 200,000 µg/L or the site ACL for toluene of 800,000 µg/L. With the exception of one sample, the analytical detection limit for toluene was 1 µg/L.

Ethylbenzene was identified in 25 groundwater samples during the supplemental investigation. Ethylbenzene concentrations ranged 0.20J µg/L to 1,280 µg/L, as illustrated in Figure 7. The concentrations did not exceed the Georgia IWQS of 28,718 µg/L or the site ACL for ethylbenzene of 114,800 µg/L .The analytical detection limit for ethylbenzene was 1 µg/L.

Total xylenes were identified in 28 groundwater samples during the supplemental investigation. Total xylenes concentrations ranged from 0.43J µg/L to 6,370 µg/L, as illustrated in Figure 8. There is no Georgia IWQS for xylenes, and the concentrations did not exceed the federal maximum contaminant level of 10,000 µg/L. An ACL was not calculated for xylenes as part of the CAP–Part B Report. The analytical detection limit for total xylenes was 3 µg/L.

II.A.2.b. Vertical extent of groundwater contamination

The vertical extent of groundwater contamination at the Former Fuel Pit 1A/DAACG area (Release #1) was delineated through soil sampling during the CAP–Part B investigation and was discussed in the CAP–Part B Report (SAIC 2000).

II.A.3. Delineation of Free Product Plume at the Former Fuel Pit 1A/DAACG Area (Release #1)

II.A.3.a CAP–Part B investigation, 2000

Free product was identified at the Former Fuel Pit 1A/DAACG area in February 2000. The free product was observed in wells D-MW1, D-MW2, D-MW8, D-MW11, D-MW13, and D-MW17 at thicknesses ranging from a sheen to 0.88 foot.

Following the CAP–Part B investigation, the interim corrective action consisted of free product recovery in the wells via absorbent socks, which were installed on February 22, 2000. The absorbent socks were removed and replaced on a bimonthly basis from May 2000 through July 2001, as indicated in Table 3. Absorbent sock removal and replacement was discontinued in several perimeter wells between December 2000 and May 2001 due to a lack of free product in these wells. During this time period, water/product level measurements were performed on a bimonthly basis.

II.A.3.b Supplemental investigation, 2001

As recommended in the CAP–Part B Report, eleven 4-inch monitoring wells (D-MW33 through D-MW43) were installed in February 2001 to supplement CAP–Part B investigation activities at this site. Water level measurements were collected from the wells in and around the product plume on March 7, 2001 (Table 3). The measured thicknesses of free product were 1.26 feet, 1.47 feet, 1.62 feet, and 0.04 foot in wells D-MW2, D-MW34, D-MW35, and D-MW38, respectively. Due to the free product recovery via absorbent socks, free product was not observed in perimeter wells D-MW1, D-MW8, D-MW11, D-MW13, and D-MW17. However, the absorbent socks were removed from the perimeter wells in December 2000 and were not reinstalled. As indicated in Table 3, the free product reappeared in the perimeter wells in May 2001, and absorbent socks were placed in the wells.

II.A.3.c. Field bailout tests

On March 10, 2001, field bailout tests were conducted in wells D-MW2 and D-MW34 using the field bailout test method (Gruszczenski 1987). The apparent product thicknesses (i.e., the thicknesses measured in the wells) were 1.35 feet in D-MW2 and 1.50 feet in D-MW34. Once the static product level and static water level were measured, the free product was pumped from each well with a peristaltic pump. As the free product recovered in the well, the product and water levels were measured. The methodology and analytical results of the bailout tests are presented in Attachment A. The results indicate that the actual formation product thicknesses were approximately 0.15 foot and 0.09 foot in wells D-MW2 and D-MW34, respectively, in March 2001. The bimonthly absorbent sock activity had been effective in removing the free product along the outer boundary of the free product plume, resulting in a smaller product area in March 2001. After several months (i.e., December 2000 through May 2001) without absorbent socks in the perimeter wells, however, the free product began to accumulate in the perimeter wells again in May 2001; therefore, the May 2001 product plume was used to calculate the product volume instead of the March 2001 product plume. In May 2001, the area of the product plume covered approximately 120,750 ft^2; however, the thickest portion of the plume covered an area of approximately 49,000 ft^2 (Figure 9). Based on the actual formation product thicknesses calculations and the area of the product plume in May 2001, there are approximately 13,000 gallons of free product floating on the groundwater table southwest of the flight line barricades and approximately 3,000 gallons of this product are estimated to be recoverable.

To confirm the results of the field bailout tests conducted in March 2001, field bailout tests were conducted in wells D-MW2, D-MW34, and D-MW35 on July 26, 2001. The measured thicknesses of free product were 1.31 feet, 1.49 feet, and 1.89 feet in wells D-MW2, D-MW34, and D-MW35, respectively

(Table 3). The area of free product in July 2001 was 147,500 ft^2; however, the thickest portion of the plume covered an area of approximately 61,200 ft^2 (Figure 10). The results indicate that the actual product thicknesses were approximately 0.15 foot, 0.32 foot, and 0.21 foot in wells D-MW2, D-MW34, and D-MW35, respectively. Based on the actual product thickness calculations (Attachment A), there are approximately 21,000 gallons of free product floating on the groundwater table southwest of the flight line barricades and approximately 5,000 gallons of this product are estimated to be recoverable.

From an aerial extent, the majority of the free product plume is located north and east of the flight line barricades, underneath an active tarmac that is associated with active military flight operations, as shown in Figures 9 and 10. The actual formation thickness north and east of the flight line barricades typically ranges from 0.01 feet to 0.04 feet. The amount of recoverable free product under the active tarmac area is very limited. However, the thickest and most recoverable portion of the free product plume is located in the vicinity of wells D-MW2, D-MW34, and D-MW35, which are located southwest of the flight line barricades.

II.A.4. Delineation of Surface Water and Sediment Contamination

Results from the surface water and sediment samples collected during the CAP–Part B investigation were discussed in the CAP–Part B Report (SAIC 2000).

II.B. REGIONAL, LOCAL, AND SITE HYDROGEOLOGY

A discussion of the regional, local, and site hydrogeology was presented in the CAP–Part B Report (SAIC 2000) and is repeated in this document for convenience.

II.B.1. Documentation of Local Groundwater Conditions

II.B.1.a. Groundwater usage

According to the *Groundwater Pollution Susceptibility Map of Georgia* (GA EPD 1992), the Former Pumphouse #1 site, Facility ID #9-025085 is located within an average or higher groundwater pollution susceptibility area. Nine water supply wells are located within the confines of the HAAF area (Figures 11 and 12). These wells have the potential to provide up to 3,890 gallons per minute (gpm) of water to occupants of the HAAF installation. Fort Stewart DPW was unable to provide documentation listing the companies responsible for well installation and drillers' logs showing as-built information and subsurface geologic data. Information concerning such documentation was requested from several water well drilling companies in the Chatham County area; however, data procurement met with very limited success. Fort Stewart DPW provided well locations, pump rates, treatments, casing depths, and total depths for eight of the nine wells located at HAAF. Because of the lack of data, documentation of subsurface geology based on HAAF drilling logs remains extremely limited; therefore, other references containing deep-well information were used to document the subsurface geology and aquifer characteristics underlying HAAF and its vicinity.

Wells 1 and 2, both public water supply wells located in the cantonment area of HAAF, constitute the main water supply system at HAAF (Figure 12). Well 1, located at Building 711 on the corner of Moore Road and Douglas Street, is a 12-inch-diameter well with a 100-horsepower (hp) turbine pump serving a 100,000-gallon elevated storage tank (Tank 1) through 10-inch lines. Water from Well 1 is injected with hydrofluosilic acid and chlorine gas solution at the well house. Well 2, located at Building 1205 on the corner of Neal Street and Lightning Drive, is a 12-inch-diameter well with a 100-hp turbine pump serving a 200,000-gallon elevated tank (Tank 2) through 10-inch lines. Water from Well 2 is also injected with

hydrofluosilic acid and chlorine gas solution at the well house. Wells 1 and 2 provide water to a 500,000-gallon elevated storage tank (Tank 3) located on Middleground Road behind noncommissioned officer family housing. This tank provides potable water to 694 service connections, which are used by an average of at least 5,000 individuals year-round.

Wells 3, 4A, and 7 are public supply wells located outside the cantonment area of HAAF. Well 3, located at Building 8455, is a 4.0-inch-diameter well with a 1.0-hp electric submersible pump serving a 1,000-gallon hydropneumatic storage tank through 1.5-inch galvanized steel lines. Water from Well 3 is treated with calcium hypochlorite solution and is consumed by approximately 25 people during daytime hours year-round. Well 4A, located at Building 8581 at the 117th Air National Guard Facility, is a 4.0-inch-diameter well. Pumping is accomplished by a 0.75-hp turbine pump with an 80-gpm capacity. Well 4A provides water for approximately 50 people per day year-round. Well 7 is located at Building 8703 on the Forest River, west of Rio Road. Well 7 is a 4.0-inch-diameter well with a 3.0-hp submersible pump serving a 5,000-gallon hydropneumatic tank through 2.0-inch galvanized steel lines. Well 7 serves approximately 500 people on a part-time basis. Sanitary protection for Wells 3, 4A, and 7 is provided by a pump motor block, concrete slab, sealed well head, and screened casing vent.

Based on the GA EPD criteria of serving potable water to fewer than 25 occupants per day and having fewer than 15 service connections, Wells 5, 8, and 9 are classified as non-public supply wells.

Well 10 is a non-potable water source, and the water is used for cleaning military equipment at a wash-rack facility. Additional information, including capacity, borehole depth, and casing depth, is not available. The locations of supply wells found outside the boundary of HAAF are shown on Figure 17. These wells include numbers 1, 42, 13, 25, 15, 27, 14, 23, 6, and 9. The City of Savannah Bureau of Water Operations was unable to provide drilling logs or as-built well information related to these wells.

The Former Pumphouse #1 site is approximately 4,200 feet southwest (downgradient) of HAAF Well 2, which is located at Building 1205 on Lightning Road. Well 3, which is located at Building 8455, is approximately 6,700 feet southwest (downgradient) of the Former Pumphouse #1 site. Therefore, the Former Pumphouse #1 site, including both Release #1 and Release #2, is classified as being more than 500 feet from a withdrawal point. Well 2 is part of the main public water supply system at HAAF. This system supplies water to approximately 7,500 people through 525 service connections.

II.B.1.b. Aquifer description

The hydrogeology in the vicinity of HAAF is mostly influenced by two aquifer systems. These are referred to as the Principal Artesian (Floridan) Aquifer and the surficial aquifer (Miller 1990). The Principal Artesian Aquifer is the lowermost hydrologic unit and is regionally extensive from South Carolina to Georgia, Alabama, and most of Florida. Known elsewhere as the Floridan, this aquifer, approximately 800 feet in total thickness, is composed primarily of Tertiary-age limestone, including the Bug Island Formation, the Ocala Group, and the Suwannee Limestone. Groundwater from the Floridan is used primarily for drinking water (Arora 1984). According to Miller (1990), one of the largest cones of depression produced in the Floridan Aquifer exists directly beneath Savannah, Georgia. According to 1980 estimates, more than 500 million gallons of water per day were withdrawn from the Floridan Aquifer for public and industrial use in southeast Georgia, more than any other region (Miller 1990).

The confining layer for the Floridan Aquifer is the phosphatic clay of the Hawthorn Group. There are minor occurrences of aquifer material within the Hawthorn Group; however, they have limited utilization (Miller 1990). The surficial aquifer overlies the Hawthorn confining unit.

The surficial aquifer consists of widely varying amounts of sand and clay, ranging from 55 feet to 150 feet in thickness, and is composed primarily of the Satilla and Cypresshead Formations in the Savannah vicinity (Arora 1984). This aquifer is primarily used for domestic lawn and agricultural irrigation. The top of the water table ranges from approximately 2 feet to 10 feet below ground surface (BGS) (Miller 1990). Groundwater in the surficial aquifer system is under unconfined, or water table, conditions. Locally, however, thin clay beds create confined or semiconfined conditions.

Groundwater encountered at HAAF UST investigation sites is part of the surficial aquifer system. Based on the facts that all public and non-public water supply wells draw water from the Floridan Aquifer and that the Hawthorn confining unit separates the Floridan Aquifer from the surficial aquifer, it is concluded that there is no hydraulic interconnection between HAAF UST sites (and associated plumes) and water supply withdrawal points.

II.B.1.c. Surface water

The water resources survey conducted during the CAP–Part B site investigation is presented in Appendix III. Surface water bodies at HAAF include Hallstrom Lake, Lamar Canal, Buckhalter Canal, Springfield Canal, Pond 29 located northwest of Buildings 336 and 232, and an unnamed pond located along the southeastern boundary of the HAAF installation (Figure 11). Several unnamed drainage canals and ditches exist throughout HAAF. Most of these canals drain southwest into the Little Ogeechee River, which is part of the Lower Ogeechee watershed. The remaining drainage canals located on the eastern side of the HAAF installation flow east and eventually drain into the Vernon River, which is located southeast of the HAAF installation. Surface water bodies at HAAF and adjacent areas are not used as public water supplies. The ponds and lakes, as well as Lamar Canal, are perennial, whereas most of the drainage canals and ditches are intermittent. Most of the drainage canals are at least partially enclosed in culverts.

There is a groundwater divide at the Former Fuel Pit 1A/DAACG area with groundwater flowing to the south-southwest and to the northwest. To the southwest there is an underground storm drain located 510 feet south-southwest of D-MW2, which is connected to a drainage ditch located south of the former tank pit area. To the northwest there is an underground storm drain located 450 feet northwest of D-MW2 and a drainage ditch located 1,000 feet northwest of D-MW2. At the Former Pumphouse #1 tank pit area, a drainage ditch is located approximately 300 feet south of the former tank pits and may receive some of the groundwater from the site. Based on the surface water features discussed in Appendix III, the Former Pumphouse #1 site, Facility ID #9-025085 is classified as being located fewer than 500 feet from a surface water body.

There are numerous underground water, electrical, and abandoned fuel lines that connect the former fuel pits located at the edge of the taxiway north of the former tank pits. These underground lines are located upgradient of the area of contamination around the former tank pits and are within the area of contamination near the Former Fuel Pit 1A/DAACG area. The invert depth of the former fuel transfer line in the vicinity of Fuel Pit 1A is approximately 6.4 feet BGS. There are two monitoring wells that are located in the vicinity of Fuel Pit 1A, and in March 2001 the depths to groundwater in these wells were 10.49 feet in P1-MW11and 10.98 feet in P1-MW13. Therefore, the invert depth of the former fuel transfer line is located approximately 4.0 feet above the water table. During the CAP–Part B investigation in 1999, the invert depth was approximately 2.0 feet above the water table. The water and electrical lines run adjacent to the former fuel transfer line. It is estimated that the invert depths of these utilities are no more than 5 feet BGS.

II.B.2. Stratigraphic Boring Logs

The local stratigraphy of HAAF and its vicinity is presented in Section II.B.2.a, and the site stratigraphy from the CAP–Part A and CAP–Part B site investigations is presented in Section II.B.2.b.

II.B.2.a. Local stratigraphy

HAAF is located within the barrier island sequence district of the coastal plain physiographic province of the southeastern United States (Clark and Zisa 1976). The barrier island sequence district in Chatham and Bryan counties is characterized by the existence of several marine terraces (step-like topographic surfaces that decrease in elevation toward the coast). These marine terraces, and their associated deposits, are the result of sea level fluctuations that occurred during the Pleistocene epoch. The surficial (Quaternary) deposits in Chatham and Bryan counties, by decreasing elevation and age, are part of the Okefenokee, Wicomico, Penholoway, Pamlico, and Silver Bluff terrace complexes.

HAAF, as well as most of Chatham County, is underlain by the Pleistocene Pamlico Terrace. The Pleistocene Satilla Formation (formerly known as the Pamlico Formation) consists of deposits of the Pamlico Terrace complex and other terrace complexes in the region. The Satilla Formation is a lithologically heterogeneous unit that consists of variably bedded to non-bedded sand and variably bedded silty to sandy clay. During the Pleistocene, these sand and clay deposits were formed in offshore and inner continental shelf, barrier island, and marsh/lagoonal-type environments. According to the *Geologic Map of Georgia* (GA DNR 1976), clay beds of marsh origin, which were deposited on the northwestern side of the former Pamlico barrier island complex, exist in the western quarter of HAAF. Very fine- to coarse-grained sand deposits of barrier island origin are more common throughout the remaining areas of HAAF.

II.B.2.b. Site stratigraphy

As determined from soil borings drilled during the CAP–Part B site investigation, the lithologies present within 15 feet of the surface at the site appear to correlate with the regional stratigraphic section. Soil boring logs from the wells installed during the supplemental investigation are located in Appendix IV. The lithology encountered is predominantly a white, pale brown, or light gray, very fine to medium-grained sand, with variable silt and clay content. Generally, the samples with higher silt and clay content were within a few feet of the surface. Less silt and clay content was noted with depth. The boring log of deep well P1-MW40 indicates an increasing clay content from approximately 26 feet BGS to 30 feet BGS, becoming a clayey, coarse-grained sand/gravel at 30 feet BGS.

II.B.3. Stratigraphic Cross Sections

Stratigraphic cross sections have been developed and were presented in the CAP–Part B Report (SAIC 2000).

II.B.4. Geotechnical Analysis

Soil samples were collected for geotechnical analysis during the CAP–Part B investigation, and the results were presented in the CAP–Part B Report (SAIC 2000). In February 2001, soil samples were collected from wells D-MW37 and D-MW39 for various geotechnical analyses. The results are presented in Table 4 and Attachment B.

II.B.5. Direction of Groundwater Flow

II.B.5.a. Well construction details

During the supplemental investigation activities in 2001, each monitoring well casing consisted of 4-inch inside diameter, Schedule 40, flush-threaded polyvinyl chloride risers with a 10-foot screen set across the water table. The well screen slot size was 0.010 inch. Table 5 summarizes construction details for existing monitoring wells associated with the Former Fuel Pit 1A/DAACG area and the wells installed at the site during the supplemental investigation in February 2001. The existing wells were resurveyed in February 2001 so that the reference datum for all the wells was consistent. Well construction diagrams for wells D-MW33 through D-MW43 are presented in Appendix VII.

Following installation of the well casing, filter pack sand was poured while the augers were gradually removed to ensure a complete and even distribution of the filter pack. The filter pack extended to a measured level at least 2 feet above the top of the well screen. Well seals were composed of bentonite pellets and allowed to hydrate before filling of the annular space above the seal. The well seal extended to a measured level of at least 2.0 feet above the top of the filter pack. Above the well seal, the remaining annular space was completed with a 1.0-foot-long, flush-mounted, sheet-steel protective casing that was grouted in place with a concrete pad. Well casings were capped with expandable locking caps. Protective casings were covered with bolted cast-iron manhole covers. Inscribed monitoring well identification plates were placed inside each manhole cover.

II.B.5.b. Potentiometric mapping

During the supplemental investigation activities, water level measurements were collected from 18 existing monitoring wells and from the 11 newly installed monitoring wells in March 2001. Data obtained from these measurements are presented in Table 3. Groundwater in the study area is under water table conditions and is encountered between 8.12 feet and 12.81 feet BGS, at an average of 10.6 feet BGS. Figure 13 shows the potentiometric surface at the site in March 2001. Groundwater flow in the vicinity of the Former Fuel Pit 1A/DAACG area is to the northwest at a gradient of approximately 0.0086 foot/foot.

II.B.5.c. Equipotential flow net

Equipotential flow nets based on March 2001 water level measurements and the contoured potentiometric surfaces are presented in Figure 13 for the shallow and deep surficial portions of the aquifer.

III. REMEDIAL ACTION PLAN

III.A. CORRECTIVE ACTION COMPLETED OR IN PROGRESS

III.A.1. Recovery/Removal of Free Product

During sampling activities in February 2000, free product was measured in wells D-MW1, D-MW2, D-MW8, D-MW11, D-MW13, and D-MW17 at thicknesses of 0.01 foot, 0.88 foot, 0.15 foot, 0.74 foot, 0.15 foot, and a sheen, respectively. Absorbent socks were placed in each well following these measurements on February 24, 2000. The free product covered an area of approximately 400 feet by 500 feet at the Former Fuel Pit 1A/DAACG area (Release #1) in February 2000. GA EPD was notified of the free product in correspondence dated March 8, 2000 (Stanley 2000).

As an interim action until the CAP–Part B investigation was completed and this report approved, the absorbent socks were removed and replaced in wells with free product on a bimonthly basis from May 2000 through January 2002. Absorbent sock removal and replacement was discontinued in several perimeter wells between December 2000 and May 2001 due to a lack of free product. Field bailout tests were conducted in March 2001 and July 2001 to determine the amount of recoverable product. In July 2001, the dimensions of the free product plume were similar to those of February 2000. Bimonthly replacement of the absorbent socks will continue until a corrective action is implemented to remove the free product.

III.A.2. Remediation/Treatment of Contaminated Backfill Material and Native Soil

During UST closure activities in 1995, all contaminated soil removed during the project was tested in accordance with disposal facility requirements and transported to Kedesh, Inc., Highway 84, Ludowici, GA 31316. The closure report for Former Pumphouse #1 was not submitted to GA EPD in 1995 because review of the closure analytical data indicated that a CAP–Part A would be required (in accordance with requirements of GUST-9, Item 15, page 12, dated August 1995). However, the analytical data presented in the closure report were summarized in the CAP–Part B Report. Approximately 913 cubic yards of contaminated soil were excavated from the site.

During the UST closure activities in 1998, the excavated soil was returned to the tank pit with the concurrence of GA EPD. The 1998 closure report for Former Pumphouse #1 (Earth Tech 1998) was not submitted to GA EPD because the CAP–Part A Report, which incorporated the area of the removal activities, had already been submitted to GA EPD.

III.B. OBJECTIVES OF CORRECTIVE ACTION

III.B.1. Remove Free Product That Exceeds One-Eighth Inch at the Former Fuel Pit 1A/DAACG Area (Release #1)

In February 2000, free product in excess of 1/8 inch in thickness was observed in wells D-MW1, D-MW2, D-MW8, D-MW11, D-MW13, and D-MW17. Since February 2000, free product has been removed via absorbent socks replaced on a bimonthly basis. The thickest amount of free product is located near the southwestern boundary of the product plume in the vicinity of wells D-MW2, D-MW34, and D-MW35. Field bailout tests indicate that there are approximately 3,000 gallons to 5,000 gallons of recoverable free product at the Former Fuel Pit 1A/DAACG area. More than half of the free product plume is located north and east of the flight line barricades (summer 2001 location), underneath an active tarmac that is

associated with military flight operations. The thicknesses underneath the active tarmac range from 0.01 foot to 0.04 foot. However, the area in which the free product plume is the thickest (i.e., up to 0.32 foot actual thickness) is located southwest of the flight line barricades (summer 2001 location) and is accessible without being impacted by flight line operations or without impacting flight line operations during remedial activities. It is recommended that additional free product removal activities be implemented at the site in the area southwest of the flight line barricades (summer 2001 location).

III.B.2. Remediate Groundwater Contamination at the Former Fuel Pit 1A/DAACG Area (Release #1)

As discussed in the CAP–Part B Report (SAIC 2000), previous investigations documented benzene contamination in groundwater at the Former Fuel Pit 1A/DAACG area (Release #1) at concentrations that exceeded the IWQS of 71.28 μg/L and the ACL of 285 μg/L.

The supplemental groundwater sampling conducted in March 2001 indicated that the benzene plume was similar to the plume that had been observed during the CAP–Part A and CAP–Part B investigations. The benzene concentrations in 12 wells exceeded the IWQS. The benzene concentrations in D-MW2, D-MW34, D-MW35, D-MW37, and D-MW39 exceeded the ACL. These wells are located southwest of the flight line barricades where the free product is the thickest. The majority of the groundwater plume extends 400 feet north and 300 feet east of the flight line barricades, underneath an active tarmac that is associated with military flight operations; however, the benzene concentrations underneath the active tarmac do not exceed the benzene ACL. Active remediation of the entire groundwater plume will impact active military operations. However, the majority of the groundwater contamination north and east of the flight line barricades is less than the benzene ACL. Therefore, it is recommended that a groundwater corrective action be implemented at the site in the area located southwest of the flight line barricades where benzene concentrations exceed the ACLs.

A large area of the groundwater plume exists underneath an active tarmac; therefore, the corrective action for the groundwater plume at the Former Fuel Pit 1A/DAACG area should consist of alternatives that are protective of the environment but can be implemented in a manner that causes minimal disruption of the active military flight operations. Monitored natural attenuation appears to be the most viable alternative once the free product has been removed because (1) the free product continues to act as a source for the groundwater contamination, (2) the benzene concentrations underneath the active tarmac are below the ACL, and (3) the maximum benzene concentrations during the CAP–Part B and supplemental investigations were less than three times the ACL. Monitored natural attenuation would provide for monitoring of the groundwater plume without impacting the military flight operations. It is recommended that the corrective action for groundwater consist of free product removal in conjunction with monitored natural attenuation of the groundwater plume in the vicinity of the Former Fuel Pit 1A/DAACG area until the free product is removed. At that point, the corrective action will be reevaluated.

III.B.3. Remediate Soil Contamination at the Former Fuel Pit 1A/DAACG Area (Release #1)

As discussed in the CAP–Part B Report (SAIC 2000), previous investigations documented that benzene, toluene, ethylbenzene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, chrysene, and indeno(*1,2,3-cd*)pyrene contamination in soil at the Former Fuel Pit 1A/DAACG area (Release #1) exceeded the applicable GUST STLs. Benzene was the only constituent in soil to exceed its ATL of 9.3 mg/kg in six boring locations. Benzo(*a*)pyrene, chrysene, and indeno(*1,2,3-cd*)pyrene concentrations in one soil sample exceeded the ATLs of 1.4 mg/kg, 2.1 mg/kg, and 0.66 mg/kg, respectively. The soil samples with these concentrations exceeding the ATLs were collected from the capillary fringe above the soil/water interface in the area of free product, and the presence of free product may have contributed to the high concentrations. The soil contamination exceeding ATLs follows the area of free product and groundwater

contamination, and a large portion is located north and east of the flight line barricades, underneath an active tarmac that is associated with military flight operations. Active remediation of the soil contamination north and east of the flight line barricades will impact active military operations.

It is recommended that the corrective action for removal of the free product be implemented prior to recommendation of a corrective action for the soil contamination. Once the majority of the free product has been removed, additional soil borings should be installed north and east of the flight line barricades to determine if the soil concentrations have degraded to below the ATLs.

III.B.4. Provide Risk-Based Corrective Action

A risk-based approach was used in the CAP–Part B Report (SAIC 2000) to identify chemicals of potential concern (COPCs) for soil and groundwater and to develop ATLs and ACLs for various constituents. The results of the risk screening for both areas were presented in the CAP–Part B Report (SAIC 2000) and the results for the Former Fuel Pit 1A/DAACG area are summarized below.

In summary, benzene, ethylbenzene, toluene, xylenes, benzo(*a*)pyrene, benzo(*b*)fluoranthene, chrysene, and indeno(*1,2,3-cd*)pyrene were identified as COPCs for soil. ATLs of 9.3 mg/kg for benzene, 187 mg/kg for ethylbenzene, 479 mg/kg for toluene, 893 mg/kg for xylenes, 1.4 mg/kg for benzo(*a*)pyrene, 5.8 mg/kg for benzo(*b*)fluoranthene, 2.1 mg/kg chrysene, and 0.66 mg/kg for indeno(*1,2,3-cd*)pyrene were proposed in the CAP–Part B Report (SAIC 2000) and approved by GA EPD in correspondence dated December 18, 2000 (Logan 2000). Benzene, benzo(*a*)pyrene, chrysene, and indeno(*1,2,3-cd*)pyrene were the constituents that exceeded their respective ATLs during the CAP–Part A and Part B investigations.

Benzene, ethylbenzene, toluene, benzo(*a*)pyrene, chrysene, and naphthalene were identified as COPCs for groundwater. ACLs of 285 µg/L for benzene; 114,800 µg/L for ethylbenzene; 800,000 µg/L for toluene; 1.2 µg/L for benzo(*a*)pyrene; 1.2 µg/L for chrysene; and 260 µg/L for naphthalene were proposed in the CAP–Part B Report (SAIC 2000) and approved by GA EPD in correspondence dated December 18, 2000 (Logan 2000). Benzene was the only compound to exceed its respective ACL during the CAP–Part B investigation.

The fate and transport modeling results were provided in the CAP–Part B Report (SAIC 2000). A storm drain located 230 feet northeast (downgradient) of the site is the nearest possible location at which a receptor might encounter migrating groundwater contamination due to a possible hydraulic connection between the groundwater and the potential receptor. Modeling of leaching to groundwater by percolating rainwater was performed using the Seasonal Soil Compartment Model to determine the predicted maximum concentration in the leachate at the water table interface. The predicted leachate concentration of 12,500 µg/L was above the maximum groundwater concentration of 700 µg/L at the source. The Analytical Transient 1-, 2-, 3-Dimensional Model was calibrated to the maximum predicted concentration of benzene (i.e., 12,000 µg/L) assuming a steady-state (continuous) concentration at the source.

Based on modeling results, the estimated dilution attenuation factor for benzene at the storm drain was 4.0. The modeling results indicated that benzene should be reaching the storm drain at a concentration of 3,100 µg/L, which is above the state IWQS of 71.28 µg/L, thereby predicting that the potential receptor is impacted by the current site conditions. However, actual groundwater results indicated that groundwater contamination at concentrations near the IWQS reaches the storm drain. Due to the close proximity of both releases to each other, the most conservative fate and transport modeling results were used for developing one set of ACLs and ATLs for both areas of contamination.

Considering the site characteristics, it was recommended that the free product, soil contamination above ATLs, and groundwater contamination above ACLs in the vicinity of the Former Fuel Pit 1A/DAACG area be addressed. However, additional information was necessary to determine the amount of recoverable free product at the Former Fuel Pit 1A/DAACG area prior to proposal of remediation systems for the site.

III.C. DESIGN AND OPERATION OF CORRECTIVE ACTION SYSTEMS AT THE FORMER FUEL PIT 1A/DAACG AREA (RELEASE #1)

III.C.1. System Effectiveness/Basis for Selection

The presumed remedies evaluated for aromatic hydrocarbons in soil and groundwater at the Former Fuel Pit 1A/DAACG area included free product removal, monitored natural attenuation, oxygen-injection-enhanced bioremediation, air sparging with soil vapor extraction, six-phase heating, and PHOSter® II enhanced bioremediation. The primary focus of the alternative evaluation was to find a cost-effective method of remediating the site with minimal impact to the military flight operations. Active remediation of the majority of the soil and groundwater contamination north and east of the flight line barricades would either impact military flight operations for a significant period of time or not be cost effective to implement because of the requirements that would be necessary to minimize the impact to flight operations. The majority of the recoverable free product is located southwest of the flight line barricades (summer 2001 location) where an active product removal system would not impact military flight operations.

In selecting the corrective action for the Former Fuel Pit 1A/DAACG area, the following items were taken into consideration: (1) the free product is acting as a continuous source for soil and groundwater contamination, (2) the benzene concentrations in groundwater above the ACL are located southwest of the flight line barricades, (3) the benzene concentrations in groundwater north and east of the flight line barricades are less than three times the ACL, and (4) the soil contamination is primarily associated with the interval above the soil/water interface where the free product is located. Based on these considerations and the active military flight operations, a phased approach to the corrective action is recommended for the Former Fuel Pit 1A/DAACG area. The first phase will consist of removing the free product without impacting active military flight operations in conjunction with monitored natural attenuation of the groundwater plume until free product recovery activities are terminated. Once the removal of the free product reaches an asymptotic level and the results of any monitored natural attenuation can be evaluated, HAAF will reevaluate the need for an active corrective action addressing any remaining soil and groundwater contamination.

III.C.1.a. Theory and feasibility

Data indicate that free product is floating on the groundwater at the Former Fuel Pit 1A/DAACG area, dissolved-phase hydrocarbons exist in the groundwater beneath the site, and residual saturation of hydrocarbons exists in soil at the site. The seasonal water table fluctuations of approximately 2 feet have further transported and smeared free-phase petroleum product onto soil. The BTEX compounds are both volatile and aerobically degradable by bacteria, which already exist in the subsurface.

The results of the field bailout tests indicate that there are approximately 3,000 gallons to 5,000 gallons of free product that can be recovered from the Former Fuel Pit 1A/DAACG area (Release #1). The majority of the recoverable free product is located southeast of the flight line barricades and is not within the area of active military flight operations. The free product should be removed from the subsurface so that the site conditions will be favorable to biodegradation.

The large quantity of free product in the subsurface at the Former Fuel Pit 1A/DAACG area is providing a continuous source of contamination that is dissolving into the groundwater at the site. Active free product removal in conjunction with groundwater extraction will locally depress the water table to create a cone of depression that will collect the free product and expedite its removal. In addition, groundwater extraction will expedite cleanup by removing dissolved-phase contamination. The groundwater can be easily treated by an oil/water separator and air stripper and discharged via an infiltration gallery or to a sanitary sewer.

Once the source has been removed, the subsurface conditions (dissolved oxygen, oxidation-reduction potential, background nutrient availability) will steadily improve with time. Natural attenuation may be an adequate alternative to monitoring the subsurface contamination without impacting active military flight operations. Natural attenuation is based on the premise that fuel-type hydrocarbons are readily biodegraded in most environmental systems. Biodegradation of BTEX has been documented for sites similar to the Former Fuel Pit 1A/DAACG area (e.g., shallow water table, permeable silty sand). In fact, the conditions at this site are similar to those of other sites that have proven ideal for biodegradation (Abou-Rizk et al. 1995). Groundwater samples were collected from wells at the Former Pumphouse #1 tank pit area (Release #2) in 1999 to determine whether natural attenuation of hydrocarbons was occurring. The results of the preliminary screening for aerobic and anaerobic biodegradation suggest that conditions are favorable for natural attenuation of aromatic hydrocarbons. Due to the close proximity of the releases to each other, it is reasonable to assume that biodegradation of aromatic hydrocarbons will also occur at the Former Fuel Pit 1A/DAACG area (Release #1) once the free product is removed.

During the 2001 investigation, the Georgia IWQS for benzene of 71.28 μg/L was exceeded in 12 monitoring wells. However, only five of the wells contained benzene concentrations that exceeded the GA EPD–approved benzene ACL of 285 μg/L. HAAF proposes to implement free product removal activities on the southeastern side of the flight line barricades in conjunction with monitored natural attenuation of the groundwater plume.

III.C.1.b. Remediation system

The Former Fuel Pit 1A/DAACG area is located underneath a tarmac associated with active military flight operations. The proposed first phase of the corrective action is a remediation system consisting of groundwater extraction and free product removal. The area of the free product that is thickest is located southeast of the flight line barricades, and the remediation system has been designed to cause minimal impact to the active flight operations.

Wells D-MW34 and D-MW35 will be used as groundwater extraction and free product recovery wells. In addition, another 4-inch well will be installed between these two wells for groundwater extraction and free product recovery. Groundwater will be extracted with electric submersible pumps, and free product will be removed with product recovery systems (i.e., Spillbuster, Ferret™, or equivalent). The free product will be pumped into an aboveground storage tank located at each well. The three groundwater discharge lines will manifold together near the treatment unit. Individual valves and flow meters will be included. A combined system flow rate of 9 gpm to 15 gpm is expected. Groundwater will be routed through an oil/water separator and then through an air stripper where the dissolved phase hydrocarbons will be removed and discharged directly to the atmosphere. No off-gas treatment from the air stripping unit is anticipated. The treated groundwater will be discharged via an infiltration gallery or to a sanitary sewer. Seven additional wells will be installed around the perimeter of the thickest portion of the free product plume to better define the volume of free product and the progress of the free product removal.

In conjunction with the free product removal and groundwater extraction, a monitoring only program will be implemented for the Former Fuel Pit 1A/DAACG area and will consist of annual sampling of up to 30 wells.

A plan view of the proposed well locations for the remediation system is presented in Figure 14. The process flow diagram for the system is presented in Figure 15. Any changes to the remediation system proposed in this document will be submitted to GA EPD.

III.D. IMPLEMENTATION

III.D.1. Milestone Schedule

A milestone schedule for the proposed corrective action has been prepared. A Gantt chart showing milestone activities and anticipated duration is provided in Figure 16. The actual time required to achieve asymptotic free produce recovery may be greater, or less, than presented in Figure 16; therefore, Fort Stewart will notify GA EPD USTMP of any significant changes to the schedule and will provide GA EPD USTMP with an updated Gantt chart as necessary.

III.D.2. Progress Reporting

For the Former Fuel Pit 1A/DAACG area (Release #1), quarterly free product removal progress reports will be submitted to GA EPD that will summarize the free product removal activities. In addition, annual monitoring reports will be submitted to GA EPD that will summarize free product removal activities and groundwater sampling events. If scheduling permits, the annual progress report for the Former Fuel Pit 1A/DAACG area (Release #1) may be combined with the annual monitoring only report for the Former Pumphouse #1 tank pit area (Release #2) to create a single document.

III.D.3. Certificate of Completion Report

Petition for permanent closure will be submitted with the final progress report (i.e., completion report) for the first release to reach closure criteria. An addendum to the completion report will be submitted for the second release to reach the GA EPD–approved closure criteria. GA EPD will provide final approval for decommissioning the monitoring wells, which will be requested in the final completion addendum report. Decommissioning of the monitoring wells will be completed in accordance with the USACE design manual for monitoring wells. Decommissioning will comply with all applicable state and federal standards.

The following certification will be submitted to GA EPD within 30 days of submittal of the final progress report:

> I hereby certify that the Corrective Action Plan–Part B, dated ___, 20_, for Hunter Army Airfield, Former Pumphouse #1 site (Release #1 and Release #2), Facility ID 9-025085, including any and all certified amendments/addenda thereto, has been implemented in accordance with the schedules, specifications, sampling programs, and conditions contained therein and that the plan's stated objectives have been met.
>
> _____
> Signature (Owner/Operator)

III.D.4. Inspection Schedule and Preventative Maintenance Program

For the Former Fuel Pit 1A/DAACG area (Release #1), the preventative maintenance for the remediation system will be performed in accordance with the maintenance schedule provided in the Gantt chart. Initial

startup tests and system calibrations will be conducted upon installation of the system. Site visits will be conducted biweekly for the first 2 months of operation. Depending on system performance, maintenance visits may be reduced to monthly for the remaining period of system operation. Selected personnel from HAAF will also be trained in operation of the system and adjustment procedures so that more frequent visits can be conducted if required.

The systems will be operated in accordance with the manufacturers' specifications. Anticipated system adjustments/servicing will include the items listed below.

- Adjust pumping rates from groundwater extraction wells to achieve desired drawdown.
- Check treatment units for fouling.
- Collect effluent water samples. Based on analytical results, adjust treatment units to ensure design removal efficiency is achieved.

Also, during each sampling event, wells and exposed piping and instrumentation will be visually inspected for changes or damage. Any notable observations will be recorded in the subsequent progress report.

III.D.5. Periodic Monitoring

For the Former Fuel Pit 1A/DAACG area (Release #1), groundwater samples will be collected annually from up to 30 wells (D-MW1, D-MW2, D-MW8, D-MW11, D-MW12, D-MW13, D-MW17, D-MW18, D-MW19, D-MW22, D-MW33, D-MW34, D-MW35, D-MW36, D-MW37, D-MW38, D-MW39, D-MW40, D-MW41, D-MW42, D-MW43, P1-MW11, P1-MW12, P1-MW13, P1-MW42, and five of the proposed wells) and analyzed for BTEX. PAH compounds observed during the CAP–Part A and CAP–Part B investigations were detected at concentrations below their respective ACLs; therefore, it is recommended that PAH analysis not be performed during the annual sampling. Monitoring will continue at the site until the recovery of free product reaches a quantity removed or well thickness that is agreed upon by GA EPD and HAAF. Because of the large volume of product expected to be removed and the size of the free product plume, quarterly free product removal reports will be submitted to GA EPD for review and approval. Recommendations regarding free product removal end points will be made in these reports. Free product removal activities will not be discontinued until GA EPD grants approval to terminate them. Once free product removal activities have been terminated, HAAF will provide a recommendation to GA EPD on the next phase of the corrective action. The monitoring only portion of the corrective action will continue until the benzene concentrations in groundwater are below the ACL of 285 µg/L for two sampling events. Wells may be added or removed from the monitoring plan as the boundaries of the plume change. These changes will be documented in the monitoring only reports.

During each sampling event, water levels will be measured in all monitoring wells. Specific conductivity, pH, and temperature analyses will be measured on each sample from the monitoring wells from which analytical samples are collected. The samples will be shipped to an approved laboratory for BTEX analysis in accordance with U.S. Environmental Protection Agency Method 8021B/8260B and GA EPD laboratory certification requirements.

The tarmac associated with Taxiway 3 is scheduled to be replaced, which will result in the destruction of numerous wells in the vicinity of Former Pumphouse #1 and the DAACG. Wells required for effective remediation of monitored natural attenuation will be replaced. The destroyed wells will be documented in a progress report or monitoring only report.

III.D.6. Effectiveness of Corrective Action

For the Former Fuel Pit 1A/DAACG area (Release #1), the corrective action (i.e., active product recovery followed by monitored natural attenuation) will be discontinued once the objectives of the monitoring only plan have been achieved—the recovery of free product has reached a quantifiable goal agreed upon by GA EPD and HAAF based on the quarterly free product removal reports; the benzene concentrations in groundwater are below the ACL of 285 µg/L; and the benzene, benzo(*a*)pyrene, chrysene, and indeno(*1,2,3-cd*)pyrene concentrations in soil are reduced to below their ATLs of 9.3 mg/kg, 1.4 mg/kg, 2.1 mg/kg, and 0.66 mg/kg, respectively.

III.D.7. Confirmatory Soil Sampling Plan

For the Former Fuel Pit 1A/DAACG area (Release #1), no excavation of soil is planned under the free product removal and monitoring only plan; therefore, confirmatory sampling associated with excavation of soil will not be performed. However, because there is an area of soil contamination that exceeds the benzene ATL of 9.3 mg/kg, the benzo(*a*)pyrene ATL of 1.4 mg/kg, the chrysene ATL of 2.1 mg/kg, and the indeno(*1,2,3-cd*)pyrene ATL of 0.66, three confirmatory soil samples will be collected from the area of soil contamination. The soil samples will be collected once the benzene concentrations in groundwater are approaching the ACL. The soil samples will be analyzed for only benzene, benzo(*a*)pyrene, chrysene, and indeno(*1,2,3-cd*)pyrene only. The location of these samples will be determined during the monitoring only program and will be submitted to GA EPD in a letter or annual monitoring only report for approval.

III.D.8. Stockpiled Bulk Soil Sampling

For the Former Fuel Pit 1A/DAACG area (Release #1), no stockpiled soil will be generated by this corrective action; therefore, no soil sampling will be conducted.

III.D.9. Monitoring Only Termination Conditions

For the Former Fuel Pit 1A/DAACG area (Release #1), concentrations of benzene in groundwater must be at or below the ACL, and concentrations of benzene, benzo(*a*)pyrene, chrysene, and indeno(*1,2,3-cd*)pyrene in soil must be at or below their respective ATLs prior to termination of the monitoring only program. Once the product removal activities have reached a quantifiable goal agreed to by GA EPD and HAAF based on the quarterly free product removal reports and the benzene ACL and the benzene, benzo(*a*)pyrene, chrysene, and indeno(*1,2,3-cd*)pyrene ATLs have been achieved, the remedial system and monitoring may be terminated regardless of the site ranking score.

III.D.10. Post-Completion Site Restoration Activities

After termination has been granted for either release, equipment and debris related to the corrective action will be removed from the site.

III.E. PUBLIC NOTIFICATION

The Former Pumphouse #1 site is located entirely within the confines of HAAF, which is part of the Fort Stewart Military Reservation, a federal facility. The U.S. Government owns all of the property contiguous to the site. The Fort Stewart DPW has complied with the public notice requirements defined by GA EPD guidance by publishing an announcement in the *Savannah Morning News* on April 1 and 8, 2001. A copy of the newspaper announcement used for public notification is presented in Appendix XI of this report.

IV. CLAIM FOR REIMBURSEMENT

HAAF is a federally owned facility and has funded the investigation for the Former Pumphouse #1 site, Facility ID #9-025085 using Department of Defense Environmental Restoration Funds. Application for GUST Trust Fund reimbursement is not being pursued at this time.

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V. REFERENCES

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Earth Tech 1998. *Closure Report for Pumphouse #1, Facility ID #9-025085, Underground Storage Tanks at Building 8060, 3rd Infantry Division, Hunter Army Airfield, Savannah, Georgia,* December.

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Gruszczenski, Thomas S., 1987. "Determination of a Realistic Estimate of the Actual Formation Product Thickness Using Monitor Wells: A Field Bail Out Test," *Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water – Prevention, Detection, and Restoration*, November 17–19, Houston, Texas.

Logan, William, 2000. Letter to Gregory V. Stanley, Fort Stewart Directorate of Public Works, Environmental Branch, December 18, 2000.

Miller, James A., 1990. *Groundwater Atlas of the United States*, U.S. Department of the Interior, U.S. Geological Survey, Hydrologic Inventory Atlas 730G.

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SAIC 2000. *Corrective Action Plan–Part B for Former Pumphouse #1, Facility ID #9-025085, Building 8060, Hunter Army Airfield, Georgia*, August.

SAIC 2001. *Addendum #4 to Sampling and Analysis Plan for Preliminary Groundwater and Corrective Action Plan–Part A/Part B Investigations at Former Underground Storage Tank Sites, Hunter Army Airfield, Georgia*, February.

Stanley, Gregory, 2000. Letter to Shaheer Muhammed, Georgia Environmental Protection Division, Underground Storage Tank Management Program, March 8.

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DEPARTMENT OF THE ARMY
HEADQUARTERS, 3D INFANTRY DIVISION (MECHANIZED) AND FORT STEWART
DIRECTORATE OF PUBLIC WORKS
1550 FRANK COCHRAN DRIVE
FORT STEWART, GEORGIA 31314-4927

DEC 20 2001

REPLY TO
ATTENTION OF

Office of the Directorate

CERTIFIED MAIL

Georgia Department of Natural Resources
Underground Storage Tank Management Program
Attention: Mr. William Logan
4244 International Parkway, Suite 104
Atlanta, Georgia 30354

Dear Mr. Logan:

Fort Stewart is pleased to receive the Georgia Environmental Protection Division's (GA EPD's) correspondence dated November 20, 2001 regarding the Corrective Action Plan (CAP)-Part B Addendum #1, former Building 8060, Facility Identification Number 9-025085*1 and *2, Hunter Army Airfield, Georgia.

Fort Stewart looks forward to discussing the comments in detail during the second week in January 2002, as tentatively arranged during a December 19, 2001 telephone conversation between yourself and Mr. Paul Kerl, of this directorate. However, in preparation for this conference call and in order to provide response to your comments by year end as requested in the referenced correspondence, Fort Stewart has prepared a Response to Comments Table for your use.

If it would be more convenient, Fort Stewart would be glad to arrange to meet with you in Atlanta during the month of January. Fort Stewart appreciates your assistance in clarifying and resolving these few outstanding issues. If you have any questions or comments, please contact Ms. Tressa Rutland, Directorate of Public Works, Environmental Branch, at (912) 767-2010.

Sincerely,

for Thomas C. Fry
Gregory V. Stanley
Colonel, U.S. Army
Director, Public Works

Enclosure

Fort Stewart Comment Responses
to
GA EPD Review Comments (November 20, 2001) on the
Corrective Action Plan (CAP)–Part B Addendum #1
Former Fuel Pit #1 and Former Pumphouse #1, Former Building 8060, Facility ID #9-025085,
Hunter Army Airfield, Georgia

GA EPD Review Comment	Fort Stewart Comment Response
1. Laboratory report and chain of custody documentation are not originals. Please provide original laboratory report and chain of custody documentation for soil and groundwater samples analyzed	The format on the analytical data sheets presented in the CAP-Part B Addendum #1 Report dated September 2001 was agreed upon by representatives from GA EPD USTMP and Fort Stewart during a meeting held on January 27, 1999. Based on an October 24, 2001 conference call between William Logan and Ronald Wallace with GA EPD USTMP; Tressa Rutland with Fort Stewart; and representatives from SAIC, it was agreed that all future Fort Stewart and Hunter Army Airfield UST reports will contain the original certified laboratory reports and chain of custody documentation. However, it was also agreed that reports already submitted to GA EPD USTMP would not require resubmittal of this information. The CAP-Part B Addendum #1 Report for Former Pumphouse #1 was submitted in September 2001. This information will be provided in any future reports generated for this site.
2. The quantitation limit and analytical method used for sample analysis were not provided. Please provide the quantitation limit and analytical method used for all constituents and for all samples analyzed.	The analytical methods for soil analysis were EPA Method 5035/8260B for BTEX and EPA Method 8270C for PAH compounds. The analytical methods for groundwater analysis were EPA Method 8260B for BTEX and EPA Method 8270C for PAH analysis. The quantitation limit for all samples collected was provided in the summary tables in Appendices V (soil) and VIII (groundwater). The quantitation limit for each sample and analyte is indicated by the "U" data validation qualifier, which indicates that a compound was not detected above the report sample quantitation limit.
3. Please provide a copy of the plan for public viewing at the local library, courthouse, city hall or other public facility. Please provide date and location of placement of the plan for public viewing.	A public notice was placed in Savannah Morning News on April 1 and 8, 2001 that stated a copy of the report would be provided upon request. A copy of the pubic notice and affidavit of publication were provided in Appendix XI of the report. This has been the method of public notification for Fort Stewart and Hunter Army Airfield UST related reports since 1996 and had thus far been acceptable to GA EPD, USTMP.
4. The corrective action objectives state that free product will be recovered until free product recovery had reached a "diminishing return". This statement is very vague. The EPD CAP-Part B guidelines state free product recovery should continue until free product is less than 1/8" thickness. Please amend the CAP B to provide a more defined objective.	Once the free product thickness has stopped changing dramatically, which is anticipated to be in the vicinity of 1/8-inch thickness, and no free product is being recovered by the system, the groundwater extraction and product removal systems will be turned off. Once this is done, the free product in the wells will be monitored on a monthly basis for six months to determine whether or not free product continues to accumulate in the wells. If free product should again begin to accumulate in the wells, then the free product removal technique will be re-evaluated to address the free product that might be tied up in the capillary fringe.

Georgia Department of Natural Resources
Environmental Protection Division
Underground Storage Tank Management Program
4244 International Parkway, Suite 104, Atlanta, Georgia 30354
Lonice Barrett, Commissioner
Harold F. Reheis, Director
(404)362-2687

November 20, 2001

Colonel Gregory V. Stanley
Director, Public Works
U.S. Army/HQ3d Inf. Div. (Mech.)
1550 Frank Cochran Drive
Ft. Stewart, GA 31314-4927

SUBJECT: **Corrective Action Plan (CAP) -Part B Addendum #1 Review Comments:**
Hunter AAF, Former Fuel Pit #1 and Former Pumphouse #1
Former Building 8060
Savannah, Chatham County, GA
Facility ID: 9025085*1 and *2

Dear Colonel Stanley:

The Georgia Underground Storage Tank Management Program (USTMP) has received your letter, dated October 9, 2001, that forwarded a properly certified CAP-Part B. The report was prepared by SAIC.

We have conducted a technical review of the CAP-Part B. The basis for this review is the Georgia Rules for Underground Storage Tank Management (GUST Rules, revised 1996). Our comments are outlined in the enclosure. Please amend the CAP-Part B to address these by **December 31, 2001.**

Unless one of the outlined EPD Comments requests otherwise, you are required to submit only your responses to these comments. Resubmittal of a complete CAP-Part B is not necessary.

If you have any questions, please contact me at (404) 362-2687.

Sincerely,

William E. Logan
Senior Geologist
Corrective Action Unit II

WEL:
s:/land/landdocs/williaml/pending01/9025085.15
Enclosure
cc with EPD comments: Patricia Stroll, SAIC
Lisa L. Lewis, GA EPD
Larry Rogers, EPD Coastal District
File (CA): Chatham, 9025085

EPD Review Comments

Corrective Action Plan (CAP)-Part B Addendum #1:
Hunter AAF, Former Fuel Pit #1 and Former Pumphouse #2
Former Building 8060
Savannah, Chatham County, GA
Facility ID: 9025085*1 and *2

November 20, 2001

01. Laboratory reports and chain of custody documentation are not originals. Please provide original laboratory report and chain of custody documentation for soil and groundwater samples analyzed.
02. The quantitation limit and analytical method used for sample analysis were not provided. Please provide the quantitation limit and analytical method used for all constituents and for all samples analyzed.
03. Please provide copy of the plan for public viewing at the local library, courthouse, city hall or other public facility. Please provide date and location of placement of the plan for public viewing.
04. The corrective action objectives state that free product will be recovered until free product recovery had reached a "diminishing return". This statement is very vague. The EPD CAP-Part B guidelines state free product recovery should continue until free product is less than 1/8" thickness. Please amend the CAP-B to provide a more defined objective.

File copy

DEPARTMENT OF THE AI
HEADQUARTERS, 3D INFANTRY DIVISION (MECHANIZED) AND FORT STEWART
DIRECTORATE OF PUBLIC WORKS
1550 FRANK COCHRAN DRIVE
FORT STEWART, GEORGIA 31314-4927

OCT 09 2001

REPLY TO
ATTENTION OF

Directorate of Public Works

CERTIFIED MAIL

7099 3400 0010 5449 557

Georgia Department of Natural Resources
Underground Storage Tank Management Program
Attention: Mr. Logan
4244 International Parkway, Suite 104
Atlanta, Georgia 30354

Dear Mr. Logan:

Fort Stewart/Hunter Army Airfield (HAAF) is pleased to submit the *Corrective Action Plan (CAP)-Part B Addendum #1* for former Underground Storage Tanks (USTs) #30-39 and #50, Former Building 8060, Facility Identification Number 9-025085, Hunter Army Airfield, Georgia. This report documents the supplemental investigation activities conducted at the Former Fuel Pit #1A Departure/Arrival Air Control Group (DAACG) area of the Former Pumphouse #1 site as recommended and approved in the CAP-Part B report dated August 2000.

The enclosed report recommends active removal of free product as described in Section III.C.1.b along with annual groundwater monitoring as described in Section III.D.5. If you have any questions or comments regarding this report, please contact Ms. Tressa Rutland or Ms. Melanie Little, Directorate of Public Works, Environmental Branch, at (912) 767-2010 or (918) 296-9492, respectively.

Sincerely,

for Thomas C. Fry
Gregory V. Stanley
Colonel, U.S. Army
Director, Public Works

Enclosure

Georgia Department of Natural Resources
Environmental Protection Division
Land Protection Branch
Underground Storage Tank Management Program
4244 International Parkway, Suite 104
Atlanta, Georgia 30354
Phone (404) 362-2687
FAX (404) 362-2654

CORRECTIVE ACTION PLAN
PART B

Facility Name: Former Pumphouse #1 Site

Street Address: Former Building 8060, Near Taxiway 3

City: Hunter Army Airfield **County:** Chatham

Facility ID #: 9-025085

Submitted by UST Owner/Operator:
Name: Thomas C. Fry/Environmental Branch
Company: US Army/HQ 3d Inf. Div (Mech)
Address: Directorate of Public Works, Bldg 1137
1550 Frank Cochran Drive
City: Fort Stewart State: GA
Zip Code: 31314-4927

Prepared by:
Name: Patricia Stoll
Company: Science Applications International Corp.
Address: P.O. Box 2501
City: Oak Ridge State: TN
Zip Code: 37831

I. PLAN CERTIFICATION

A. UST Owner/Operator

I hereby certify that the information contained in this plan and in all the attachments is true, accurate, and complete, and the plan satisfies all criteria and requirements of Rule 391-3-15-.09 of the Georgia Rules for Underground Storage Tank Management.

Name: Thomas C. Fry

Signature: Thomas C. Fry Date: 10/09/01

B. Professional Engineer or Professional Geologist

Name: Patricia Stoll

Signature: Patricia Stoll

Date: 9/21/01

GEORGIA REGISTERED 22851 PROFESSIONAL ENGINEER
Patricia A. Stoll 9/21/01
Georgia Stamp or Seal

Check all boxes below that apply. Attach supporting documentation, i.e., narrative, figures, tables, maps, boring/well logs, etc., for all items checked. Supporting documentation should be three-hole punched and prepared in conformity with the guidance document "Underground Storage Tank (UST) Release: Corrective Action Plan – Part B (CAP-B) Content", GUST-7B.

II. SITE INVESTIGATION REPORT

A. Horizontal and Vertical Extent of Contamination:

- ☒ Soil (Section II.A.1)
- ☒ Groundwater (Section II.A.2)
- ☒ Free Product (Section II.A.3)
- ☒ Surface Water (Section II.A.4)

B. Local and Site Hydrogeology

- ☒ Documentation of Local Groundwater Conditions (Section II.B.1)
- ☒ Stratigraphic Boring Logs (Section II.B.2)
- ☒ Stratigraphic Cross Sections (Section II.B.3)
- ☒ Referenced or Documented Calculations of Relevant Aquifer Parameters (Section II.B.4)
- ☒ Direction of Groundwater Flow (Section II.B.5)
  - ☒ Table of Monitoring Well Data (Table 5)
  - ☒ Potentiometric Map (Figure 13)
  - ☒ Flow Net Superimposed on a Base Map (Figure 13)

III. REMEDIAL ACTION PLAN:

A. Corrective Action Completed or In-Progress:

- ☒ Recovery/Removal of Free-Product (Non-aqueous Phase Hydrocarbons)
- ☐ Remediation/Treatment of Contaminated Backfill Material & Native Soils
- ☐ Other (specify)_____

B. Objective of Corrective Action:

- ☒ Remove Free Product That Exceeds One-Eighth Inch
- ☐ Remediate Groundwater Contamination That Exceeds:
  - ☐ Maximum Contaminant Levels (MCLs)

    OR
  - ☐ In-Stream Water Quality Standards

B. Objective of Corrective Action (continued):

☐ Remediate Soil Contamination That Exceeds:

☐ Threshold Values Listed in Table A

OR

☐ Threshold Values Listed in Table B

OR

☐ Alternate Threshold Levels (ATLs)

☒ Provide Risk Based Corrective Action (Reference CAP B App. VI) (Section III.B.4)

☒ Remediate Soil and/or Groundwater Contamination That Exceeds Alternate Concentration Limits (ACLs) and Monitor Residual Contaminants

OR

☐ Monitor Soil and/or Groundwater Contamination That Exceeds Levels in Rule -.09 (3) But Is Less Than ACLs

OR

☐ No Further Action Required - Soil and/or Groundwater Contamination is Below Levels in Rule -.09 (3)

C. Design Operation of Corrective Action Systems

☒ Soil ☒ Groundwater ☒ Free Product ☐ Surface Water ☐ Not Applicable

D. Implementation (Section III.D)

Includes, as a minimum, the following:

- Milestone schedule for site remediation
- Inspection and preventive maintenance schedule for all specialized remediation equipment
- Monitoring/sampling and reporting plan for measuring interim progress and project completion
- Plan to decommission equipment/wells and close site

IV. PUBLIC NOTICE

☐ Certified Letters to Adjacent, and Potentially Affected Property Owners and Local Officials

☒ Legal Notice in Newspaper, as approved by EPD (Section III.E)

☐ Other EPD-approved Method (specify)_____

V. **CLAIM FOR REIMBURSEMENT:** (For GUST Trust Fund sites only)

- ☐ GUST Trust Fund Application (GUST-36), must be attached if applicable
- ☐ Cost Proposal
  - ☐ Non-Reimbursable Costs

    OR
  - ☐ Reimbursable Costs
    - ☐ Total Project Costs
      - ☐ Costs incurred to date, per GUST-92
      - ☐ Estimated costs to complete corrective action, per GUST-92
    - ☐ Invoices and Proofs-of-Payment for Costs Incurred to Date
- ☐ Proposed Schedule For Reimbursement
  - ☐ Lump Sum Payment Upon Completion Of Corrective Action

    OR
  - ☐ Interim Payments With Final Payment Upon Completion
- ☒ Not Applicable

II. SITE INVESTIGATION REPORT

The results of the Corrective Action Plan (CAP)–Part B investigation at the Former Pumphouse #1, Facility ID #9-025085, Former Building 8060, at Hunter Army Airfield (HAAF), Georgia, were presented in the CAP–Part B Report (SAIC 2000). This report documents the supplemental investigation activities conducted at the Former Fuel Pit 1A Departure/Arrival Air Control Group (DAACG) area of the Former Pumphouse #1 site as recommended and approved in the CAP–Part B Report.

The Former Pumphouse #1 site is located along the east–west taxiway of HAAF, as illustrated in Figure 1. The Former Pumphouse #1 site is located within an average or higher groundwater pollution susceptibility area, is more than 500 feet from a withdrawal point, and is fewer than 500 feet from a surface water body. As defined in Georgia Underground Storage Tank (GUST) Management Rule 391-5-15.09, the appropriate soil threshold levels (STLs) are presented in Table B, Column 1 of GUST Rules 391-5-15 because a surface water body is located fewer than 500 feet from the site.

According to the operational information provided by the Fort Stewart Directorate of Public Works (DPW), Former Pumphouse #1 was an aviation-gas fuel island used from about 1953 until the early 1970s that consisted of ten 25,000-gallon underground storage tanks (USTs) and a 50,000-gallon underground defueling tank. The pumphouse was inactive from the 1970s to 1995. Eight of the 25,000-gallon USTs were removed in 1995. The 8-inch cast iron piping internal to the Former Pumphouse #1 facility was removed prior to the tank removal exercise. The 50,000-gallon defueling tank and two of the 25,000-gallon tanks remained in place, partially under the pumphouse structure. In 1998 the pumphouse structure was removed along with the two remaining 25,000-gallon USTs, and the 50,000-gallon defueling tank was closed in place. The piping from the boundary of the pumphouse facility to the bulk fuel farm was also drained, pigged, and grouted in place.

Various closure activities as well as CAP–Part A and CAP–Part B investigations at the Former Pumphouse #1 site were performed between 1995 and 2000. The Former Pumphouse #1 investigations covered an area south of the active taxiway. CAP–Part A and CAP–Part B investigations were conducted at the DAACG facility in 1995 and 1996, respectively. These investigations covered the active tarmac north of the active taxiway. Review of the analytical data from all of the investigations indicated that it was necessary to combine the DAACG facility data and the Former Pumphouse #1 data to document the nature and extent of contamination. As a result, the Former Pumphouse #1 CAP–Part B Report (SAIC 2000) combined the results from all the investigations in a single report. It was submitted to the Georgia Environmental Protection Division (GA EPD) in August 2000 and approved by GA EPD in correspondence dated December 18, 2000 (Logan 2000).

As indicated in the Former Pumphouse #1 CAP–Part B Report, there are two distinct and separate plumes located within the vicinity of the Former Pumphouse #1 site. Release #1 is an area of soil and groundwater contamination near the DAACG facility in the vicinity of Former Fuel Pits 1A and 1B, approximately 900 feet west of former Building 8060 (i.e., Pumphouse #1). In February 2000, free product was identified in this area in six wells (i.e., D-MW1, D-MW2, D-MW8, D-MW11, D-MW13, and D-MW17) at thicknesses ranging from a sheen to 0.88 foot. Throughout this document Release #1 will be referred to as the Former Fuel Pit 1A/DAACG area. Release #2 is an area of soil and groundwater contamination located near the Former Pumphouse #1 facility and Former Fuel Pits 1C and 1D, approximately 200 feet north of the former tank pits. Throughout this document Release #2 will be referred to as the Former Pumphouse #1 tank pit area. Based on the proximity of the various former fuel pits to the areas of contamination, it appears that a release from Former Fuel Pit 1A is responsible for the contamination associated with Release #1 and that a release from Former Fuel Pit 1C is responsible for the contamination associated with Release #2. During the CAP–Part B investigation activities, the

horizontal and vertical extent of petroleum-related contamination in soil and groundwater was determined for both areas of contamination.

For the Former Fuel Pit 1A/DAACG area (Release #1), the CAP–Part B Report recommended additional investigation activities to further define the extent of the free product and to determine the amount of recoverable free product at the Former Fuel Pit 1A/DAACG area prior to proposing a remediation system for the site. As a result, eleven 4-inch wells were installed in February 2001 to delineate the free product area around the Former Fuel Pit 1A/DAACG area, 31 monitoring wells were sampled in March 2001, and field bailout tests were conducted in three wells to evaluate the thickness of the free-phase product. The locations of the monitoring wells installed as part of the CAP–Part B investigation and supplemental investigation activities are shown in Figure 2.

For the Former Pumphouse #1 tank pit area (Release #2), the CAP–Part B Report recommended semiannual monitoring of eight wells (i.e., D-MW5, D-MW6, P1-MW1, P1-MW2, P1-MW18, P1-MW19, P1-MW22, and P1-MW23) for benzene, toluene, ethylbenzene, and xylenes (BTEX). The CAP–Part B Report was approved by GA EPD in correspondence dated December 18, 2000 (Logan 2000). Semiannual monitoring is scheduled to begin in September 2001 and will continue at the site until the benzene concentrations in groundwater are below the alternate concentration limit (ACL) of 285 µg/L for two sampling events. Once the benzene ACL has been achieved at the Former Pumphouse #1 tank pit area, three confirmatory soil samples will be collected from the area of soil alternate threshold levels (ATLs) of 9.3 mg/kg and 2.1 mg/kg, respectively. The results of the monitoring program for the Former Pumphouse #1 tank pit area will be documented in future annual monitoring only reports. This release is not addressed in this addendum. However, the approved monitoring only program is being implemented in accordance with the GA EPD–approved CAP–Part B Report.

This addendum to the Former Pumphouse #1 CAP–Part B Report is being submitted to the GA EPD Underground Storage Tank Management Program (USTMP) to document the results of the supplemental investigation activities for the Former Fuel Pit 1A/DAACG area (Release #1) only. Science Applications International Corporation performed the supplemental investigation for the HAAF DPW Environmental Branch through the U.S. Army Corps of Engineers (USACE), Savannah District under contracts DACA21-95-D-0022, delivery order 0061 and DACA63-97-D-0041, delivery order CV01.

II.A. HORIZONTAL AND VERTICAL EXTENT OF CONTAMINATION

The horizontal and vertical extent of petroleum-related contamination in soil and groundwater was delineated by activities performed during the previous investigations at the Former Pumphouse #1 site and the DAACG facility, which were documented in the CAP–Part B Report (SAIC 2000). The supplemental investigation activities were performed in accordance with the technical approach described in the CAP–Part B Report and the requirements of the *Work Plan for Preliminary Groundwater and Corrective Action Plan–Part A Investigations at Former Underground Storage Tank Sites, Hunter Army Airfield, Georgia* (SAIC 1998) and the *Addendum #4 to Sampling and Analysis Plan for Preliminary Groundwater and Corrective Action Plan–Part A/Part B Investigations at Former Underground Storage Tank Sites, Hunter Army Airfield, Georgia* (SAIC 2001).

II.A.1. Delineation of Soil Contamination at the Former Fuel Pit 1A/DAACG Area (Release #1)

In the vicinity of the Former Fuel Pit 1A/DAACG area (Release #1), the horizontal extent of petroleum-related contamination was determined during the various investigations and was discussed in detail in the CAP–Part B Report (SAIC 2000). Concentrations of benzene, toluene, ethylbenzene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, chrysene, and indeno(*1,2,3-cd*)pyrene exceeded the applicable GUST STLs (i.e.,

Table B, Column 1), and concentrations of benzene, benzo(*a*)pyrene, chrysene, and indeno(*1,2,3-cd*)pyrene exceeded their respective ATLs.

During the installation of monitoring wells (D-MW33 through D-MW43) in February 2001, soil samples were collected for geochemical analyses. Field screening through volatile organic compound (VOC) headspace was performed on all soil samples collected from above the saturated zone during the monitoring well installations. For each 2-foot-length soil sample collected, VOC headspace readings were measured using an organic vapor analyzer. The field screening results are presented on each boring log included in Appendix IV. One soil sample was collected from each boring using field screening methods and analyzed for BTEX, polynuclear aromatic hydrocarbons (PAHs), and lead. Analytical results are summarized in Table 1 and presented Figure 3. The results from soil samples collected during the CAP–Part B supplemental investigation activities in February 2001 are summarized below.

- Benzene was detected in three of the 11 soil samples collected at concentrations ranging from 0.00048J mg/kg to 1.44J mg/kg. In addition, six samples had elevated detection limits ranging from 0.131 mg/kg to 11.3 mg/kg. Two of the concentrations and the elevated detection limits exceeded the benzene STL of 0.017 mg/kg. The elevated detection limit in well D-MW35 exceeded the GA EPD–approved benzene ATL of 9.3 mg/kg

- Toluene was detected in seven of the 11 soil samples collected at concentrations ranging from 0.0949J mg/kg to 2,550 mg/kg. The concentration in well D-MW35 exceeded the toluene STL of 115 mg/kg and the GA EPD–approved ATL of 479 mg/kg.

- Ethylbenzene was detected in nine of the 11 soil samples collected at concentrations ranging from 0.136J mg/kg to 355 mg/kg. The concentration in well D-MW35 exceeded the ethylbenzene STL of 18 mg/kg and the GA EPD–approved ATL of 187 mg/kg.

- Xylenes were detected in ten of the 11 soil samples collected at concentrations ranging from 0.0015J mg/kg to 1,860 mg/kg. The concentration in well D-MW35 exceeded the xylenes STL of 700 mg/kg and the GA EPD–approved ATL of 893 mg/kg.

- Acenaphthalene, anthracene, benzo(*a*)anthracene, chrysene, fluoranthene, fluorene, naphthalene, phenanthrene, or pyrene was detected in six of the 11 soil samples collected. The concentrations of benzo(*a*)anthracene and chrysene did not exceed the GUST STL of 0.66 mg/kg. None of the other constituents detected has a GUST STL.

II.A.2. Delineation of Groundwater Contamination at the Former Fuel Pit 1A/DAACG Area (Release #1)

BTEX and PAH compounds were detected in groundwater samples collected during the various investigations. This contamination was discussed in the CAP–Part B Report (SAIC 2000). Based on the results of fate and transport modeling, an ACL of 285 µg/L was proposed for benzene in groundwater and was approved by GA EPD in correspondence dated December 18, 2000 (Logan 2000). Benzene was the only constituent at the Former Fuel Pit 1A/DAACG area (Release #1) and the Former Pumphouse #1 tank pit area (Release #2) to exceed its In-Stream Water Quality Standard (IWQS) and ACL during the various investigations.

II.A.2.a. Horizontal extent of groundwater contamination

In the vicinity of the Former Fuel Pit 1A/DAACG area, the horizontal extent of this plume was defined during the CAP–Part B investigation. The groundwater is migrating toward the underground storm drain located to the northwest of the Former Fuel Pit 1A. The dissolved plume appears to migrate beyond the storm drain to the northwest. Several PAH compounds exceeded their respective IWQSs or risk-based screening criteria, but the concentrations did not exceed their respective ACLs. Benzene was the only contaminant to exceed its IWQS of 71.28 µg/L and ACL of 285 µg/L during the various investigations.

As a result of the recommendations presented in the CAP–Part B Report (SAIC 2000), 11 additional monitoring wells were installed in February 2001 to better delineate the extent of free product in the vicinity of the Former Fuel Pit 1A/DAACG area. In March 2001, groundwater samples were collected from selected wells within the Former Fuel Pit 1A/DAACG area and analyzed for BTEX. Thirty-one groundwater samples were collected for geochemical analysis, as presented in Table 2 and Figure 4. Monitoring well locations are shown in Figure 2.

Benzene was identified in 20 groundwater samples during the supplemental investigation. Benzene concentrations ranged from 0.2J µg/L to 765 µg/L, as illustrated in Figure 5. The concentrations in 12 samples exceed the Georgia IWQS of 71.28 µg/L. The concentrations in four samples were above the site ACL for benzene of 285 µg/L. With the exception of one sample, the analytical detection limit for benzene was 1 µg/L.

Toluene was identified in 24 groundwater samples during the supplemental investigation. Toluene concentrations ranged from 0.27J µg/L to 29,600 µg/L, as illustrated in Figure 6. The concentrations did not exceed the Georgia IWQS of 200,000 µg/L or the site ACL for toluene of 800,000 µg/L. With the exception of one sample, the analytical detection limit for toluene was 1 µg/L.

Ethylbenzene was identified in 25 groundwater samples during the supplemental investigation. Ethylbenzene concentrations ranged 0.20J µg/L to 1,280 µg/L, as illustrated in Figure 7. The concentrations did not exceed the Georgia IWQS of 28,718 µg/L or the site ACL for ethylbenzene of 114,800 µg/L .The analytical detection limit for ethylbenzene was 1 µg/L.

Total xylenes were identified in 28 groundwater samples during the supplemental investigation. Total xylenes concentrations ranged from 0.43J µg/L to 6,370 µg/L, as illustrated in Figure 8. There is no Georgia IWQS for xylenes, and the concentrations did not exceed the federal maximum contaminant level of 10,000 µg/L. An ACL was not calculated for xylenes as part of the CAP–Part B Report. The analytical detection limit for total xylenes was 3 µg/L.

II.A.2.b. Vertical extent of groundwater contamination

The vertical extent of groundwater contamination at the Former Fuel Pit 1A/DAACG area (Release #1) was delineated through soil sampling during the CAP–Part B investigation and was discussed in the CAP–Part B Report (SAIC 2000).

II.A.3. Delineation of Free Product Plume at the Former Fuel Pit 1A/DAACG Area (Release #1)

II.A.3.a CAP–Part B investigation, 2000

Free product was identified at the Former Fuel Pit 1A/DAACG area in February 2000. The free product was observed in wells D-MW1, D-MW2, D-MW8, D-MW11, D-MW13, and D-MW17 at thicknesses ranging from a sheen to 0.88 foot.

Following the CAP–Part B investigation, the interim corrective action consisted of free product recovery in the wells via absorbent socks, which were installed on February 22, 2000. The absorbent socks were removed and replaced on a bimonthly basis from May 2000 through July 2001, as indicated in Table 3. Absorbent sock removal and replacement was discontinued in several perimeter wells between December 2000 and May 2001 due to a lack of free product in these wells. During this time period, water/product level measurements were performed on a bimonthly basis.

II.A.3.b Supplemental investigation, 2001

As recommended in the CAP–Part B Report, eleven 4-inch monitoring wells (D-MW33 through D-MW43) were installed in February 2001 to supplement CAP–Part B investigation activities at this site. Water level measurements were collected from the wells in and around the product plume on March 7, 2001 (Table 3). The measured thicknesses of free product were 1.26 feet, 1.47 feet, 1.62 feet, and 0.04 foot in wells D-MW2, D-MW34, D-MW35, and D-MW38, respectively. Due to the free product recovery via absorbent socks, free product was not observed in perimeter wells D-MW1, D-MW8, D-MW11, D-MW13, and D-MW17. However, the absorbent socks were removed from the perimeter wells in December 2000 and were not reinstalled. As indicated in Table 3, the free product reappeared in the perimeter wells in May 2001, and absorbent socks were placed in the wells.

II.A.3.c. Field bailout tests

On March 10, 2001, field bailout tests were conducted in wells D-MW2 and D-MW34 using the field bailout test method (Gruszczenski 1987). The apparent product thicknesses (i.e., the thicknesses measured in the wells) were 1.35 feet in D-MW2 and 1.50 feet in D-MW34. Once the static product level and static water level were measured, the free product was pumped from each well with a peristaltic pump. As the free product recovered in the well, the product and water levels were measured. The methodology and analytical results of the bailout tests are presented in Attachment A. The results indicate that the actual formation product thicknesses were approximately 0.15 foot and 0.09 foot in wells D-MW2 and D-MW34, respectively, in March 2001. The bimonthly absorbent sock activity had been effective in removing the free product along the outer boundary of the free product plume, resulting in a smaller product area in March 2001. After several months (i.e., December 2000 through May 2001) without absorbent socks in the perimeter wells, however, the free product began to accumulate in the perimeter wells again in May 2001; therefore, the May 2001 product plume was used to calculate the product volume instead of the March 2001 product plume. In May 2001, the area of the product plume covered approximately 120,750 ft^2; however, the thickest portion of the plume covered an area of approximately 49,000 ft^2 (Figure 9). Based on the actual formation product thicknesses calculations and the area of the product plume in May 2001, there are approximately 13,000 gallons of free product floating on the groundwater table southwest of the flight line barricades and approximately 3,000 gallons of this product are estimated to be recoverable.

To confirm the results of the field bailout tests conducted in March 2001, field bailout tests were conducted in wells D-MW2, D-MW34, and D-MW35 on July 26, 2001. The measured thicknesses of free product were 1.31 feet, 1.49 feet, and 1.89 feet in wells D-MW2, D-MW34, and D-MW35, respectively

(Table 3). The area of free product in July 2001 was 147,500 ft^2; however, the thickest portion of the plume covered an area of approximately 61,200 ft^2 (Figure 10). The results indicate that the actual product thicknesses were approximately 0.15 foot, 0.32 foot, and 0.21 foot in wells D-MW2, D-MW34, and D-MW35, respectively. Based on the actual product thickness calculations (Attachment A), there are approximately 21,000 gallons of free product floating on the groundwater table southwest of the flight line barricades and approximately 5,000 gallons of this product are estimated to be recoverable.

From an aerial extent, the majority of the free product plume is located north and east of the flight line barricades, underneath an active tarmac that is associated with active military flight operations, as shown in Figures 9 and 10. The actual formation thickness north and east of the flight line barricades typically ranges from 0.01 feet to 0.04 feet. The amount of recoverable free product under the active tarmac area is very limited. However, the thickest and most recoverable portion of the free product plume is located in the vicinity of wells D-MW2, D-MW34, and D-MW35, which are located southwest of the flight line barricades.

II.A.4. Delineation of Surface Water and Sediment Contamination

Results from the surface water and sediment samples collected during the CAP–Part B investigation were discussed in the CAP–Part B Report (SAIC 2000).

II.B. REGIONAL, LOCAL, AND SITE HYDROGEOLOGY

A discussion of the regional, local, and site hydrogeology was presented in the CAP–Part B Report (SAIC 2000) and is repeated in this document for convenience.

II.B.1. Documentation of Local Groundwater Conditions

II.B.1.a. Groundwater usage

According to the *Groundwater Pollution Susceptibility Map of Georgia* (GA EPD 1992), the Former Pumphouse #1 site, Facility ID #9-025085 is located within an average or higher groundwater pollution susceptibility area. Nine water supply wells are located within the confines of the HAAF area (Figures 11 and 12). These wells have the potential to provide up to 3,890 gallons per minute (gpm) of water to occupants of the HAAF installation. Fort Stewart DPW was unable to provide documentation listing the companies responsible for well installation and drillers' logs showing as-built information and subsurface geologic data. Information concerning such documentation was requested from several water well drilling companies in the Chatham County area; however, data procurement met with very limited success. Fort Stewart DPW provided well locations, pump rates, treatments, casing depths, and total depths for eight of the nine wells located at HAAF. Because of the lack of data, documentation of subsurface geology based on HAAF drilling logs remains extremely limited; therefore, other references containing deep-well information were used to document the subsurface geology and aquifer characteristics underlying HAAF and its vicinity.

Wells 1 and 2, both public water supply wells located in the cantonment area of HAAF, constitute the main water supply system at HAAF (Figure 12). Well 1, located at Building 711 on the corner of Moore Road and Douglas Street, is a 12-inch-diameter well with a 100-horsepower (hp) turbine pump serving a 100,000-gallon elevated storage tank (Tank 1) through 10-inch lines. Water from Well 1 is injected with hydrofluosilic acid and chlorine gas solution at the well house. Well 2, located at Building 1205 on the corner of Neal Street and Lightning Drive, is a 12-inch-diameter well with a 100-hp turbine pump serving a 200,000-gallon elevated tank (Tank 2) through 10-inch lines. Water from Well 2 is also injected with

hydrofluosilic acid and chlorine gas solution at the well house. Wells 1 and 2 provide water to a 500,000-gallon elevated storage tank (Tank 3) located on Middleground Road behind noncommissioned officer family housing. This tank provides potable water to 694 service connections, which are used by an average of at least 5,000 individuals year-round.

Wells 3, 4A, and 7 are public supply wells located outside the cantonment area of HAAF. Well 3, located at Building 8455, is a 4.0-inch-diameter well with a 1.0-hp electric submersible pump serving a 1,000-gallon hydropneumatic storage tank through 1.5-inch galvanized steel lines. Water from Well 3 is treated with calcium hypochlorite solution and is consumed by approximately 25 people during daytime hours year-round. Well 4A, located at Building 8581 at the 117th Air National Guard Facility, is a 4.0-inch-diameter well. Pumping is accomplished by a 0.75-hp turbine pump with an 80-gpm capacity. Well 4A provides water for approximately 50 people per day year-round. Well 7 is located at Building 8703 on the Forest River, west of Rio Road. Well 7 is a 4.0-inch-diameter well with a 3.0-hp submersible pump serving a 5,000-gallon hydropneumatic tank through 2.0-inch galvanized steel lines. Well 7 serves approximately 500 people on a part-time basis. Sanitary protection for Wells 3, 4A, and 7 is provided by a pump motor block, concrete slab, sealed well head, and screened casing vent.

Based on the GA EPD criteria of serving potable water to fewer than 25 occupants per day and having fewer than 15 service connections, Wells 5, 8, and 9 are classified as non-public supply wells.

Well 10 is a non-potable water source, and the water is used for cleaning military equipment at a wash-rack facility. Additional information, including capacity, borehole depth, and casing depth, is not available. The locations of supply wells found outside the boundary of HAAF are shown on Figure 17. These wells include numbers 1, 42, 13, 25, 15, 27, 14, 23, 6, and 9. The City of Savannah Bureau of Water Operations was unable to provide drilling logs or as-built well information related to these wells.

The Former Pumphouse #1 site is approximately 4,200 feet southwest (downgradient) of HAAF Well 2, which is located at Building 1205 on Lightning Road. Well 3, which is located at Building 8455, is approximately 6,700 feet southwest (downgradient) of the Former Pumphouse #1 site. Therefore, the Former Pumphouse #1 site, including both Release #1 and Release #2, is classified as being more than 500 feet from a withdrawal point. Well 2 is part of the main public water supply system at HAAF. This system supplies water to approximately 7,500 people through 525 service connections.

II.B.1.b. Aquifer description

The hydrogeology in the vicinity of HAAF is mostly influenced by two aquifer systems. These are referred to as the Principal Artesian (Floridan) Aquifer and the surficial aquifer (Miller 1990). The Principal Artesian Aquifer is the lowermost hydrologic unit and is regionally extensive from South Carolina to Georgia, Alabama, and most of Florida. Known elsewhere as the Floridan, this aquifer, approximately 800 feet in total thickness, is composed primarily of Tertiary-age limestone, including the Bug Island Formation, the Ocala Group, and the Suwannee Limestone. Groundwater from the Floridan is used primarily for drinking water (Arora 1984). According to Miller (1990), one of the largest cones of depression produced in the Floridan Aquifer exists directly beneath Savannah, Georgia. According to 1980 estimates, more than 500 million gallons of water per day were withdrawn from the Floridan Aquifer for public and industrial use in southeast Georgia, more than any other region (Miller 1990).

The confining layer for the Floridan Aquifer is the phosphatic clay of the Hawthorn Group. There are minor occurrences of aquifer material within the Hawthorn Group; however, they have limited utilization (Miller 1990). The surficial aquifer overlies the Hawthorn confining unit.

The surficial aquifer consists of widely varying amounts of sand and clay, ranging from 55 feet to 150 feet in thickness, and is composed primarily of the Satilla and Cypresshead Formations in the Savannah vicinity (Arora 1984). This aquifer is primarily used for domestic lawn and agricultural irrigation. The top of the water table ranges from approximately 2 feet to 10 feet below ground surface (BGS) (Miller 1990). Groundwater in the surficial aquifer system is under unconfined, or water table, conditions. Locally, however, thin clay beds create confined or semiconfined conditions.

Groundwater encountered at HAAF UST investigation sites is part of the surficial aquifer system. Based on the facts that all public and non-public water supply wells draw water from the Floridan Aquifer and that the Hawthorn confining unit separates the Floridan Aquifer from the surficial aquifer, it is concluded that there is no hydraulic interconnection between HAAF UST sites (and associated plumes) and water supply withdrawal points.

II.B.1.c. Surface water

The water resources survey conducted during the CAP–Part B site investigation is presented in Appendix III. Surface water bodies at HAAF include Hallstrom Lake, Lamar Canal, Buckhalter Canal, Springfield Canal, Pond 29 located northwest of Buildings 336 and 232, and an unnamed pond located along the southeastern boundary of the HAAF installation (Figure 11). Several unnamed drainage canals and ditches exist throughout HAAF. Most of these canals drain southwest into the Little Ogeechee River, which is part of the Lower Ogeechee watershed. The remaining drainage canals located on the eastern side of the HAAF installation flow east and eventually drain into the Vernon River, which is located southeast of the HAAF installation. Surface water bodies at HAAF and adjacent areas are not used as public water supplies. The ponds and lakes, as well as Lamar Canal, are perennial, whereas most of the drainage canals and ditches are intermittent. Most of the drainage canals are at least partially enclosed in culverts.

There is a groundwater divide at the Former Fuel Pit 1A/DAACG area with groundwater flowing to the south-southwest and to the northwest. To the southwest there is an underground storm drain located 510 feet south-southwest of D-MW2, which is connected to a drainage ditch located south of the former tank pit area. To the northwest there is an underground storm drain located 450 feet northwest of D-MW2 and a drainage ditch located 1,000 feet northwest of D-MW2. At the Former Pumphouse #1 tank pit area, a drainage ditch is located approximately 300 feet south of the former tank pits and may receive some of the groundwater from the site. Based on the surface water features discussed in Appendix III, the Former Pumphouse #1 site, Facility ID #9-025085 is classified as being located fewer than 500 feet from a surface water body.

There are numerous underground water, electrical, and abandoned fuel lines that connect the former fuel pits located at the edge of the taxiway north of the former tank pits. These underground lines are located upgradient of the area of contamination around the former tank pits and are within the area of contamination near the Former Fuel Pit 1A/DAACG area. The invert depth of the former fuel transfer line in the vicinity of Fuel Pit 1A is approximately 6.4 feet BGS. There are two monitoring wells that are located in the vicinity of Fuel Pit 1A, and in March 2001 the depths to groundwater in these wells were 10.49 feet in P1-MW11and 10.98 feet in P1-MW13. Therefore, the invert depth of the former fuel transfer line is located approximately 4.0 feet above the water table. During the CAP–Part B investigation in 1999, the invert depth was approximately 2.0 feet above the water table. The water and electrical lines run adjacent to the former fuel transfer line. It is estimated that the invert depths of these utilities are no more than 5 feet BGS.

II.B.2. Stratigraphic Boring Logs

The local stratigraphy of HAAF and its vicinity is presented in Section II.B.2.a, and the site stratigraphy from the CAP–Part A and CAP–Part B site investigations is presented in Section II.B.2.b.

II.B.2.a. Local stratigraphy

HAAF is located within the barrier island sequence district of the coastal plain physiographic province of the southeastern United States (Clark and Zisa 1976). The barrier island sequence district in Chatham and Bryan counties is characterized by the existence of several marine terraces (step-like topographic surfaces that decrease in elevation toward the coast). These marine terraces, and their associated deposits, are the result of sea level fluctuations that occurred during the Pleistocene epoch. The surficial (Quaternary) deposits in Chatham and Bryan counties, by decreasing elevation and age, are part of the Okefenokee, Wicomico, Penholoway, Pamlico, and Silver Bluff terrace complexes.

HAAF, as well as most of Chatham County, is underlain by the Pleistocene Pamlico Terrace. The Pleistocene Satilla Formation (formerly known as the Pamlico Formation) consists of deposits of the Pamlico Terrace complex and other terrace complexes in the region. The Satilla Formation is a lithologically heterogeneous unit that consists of variably bedded to non-bedded sand and variably bedded silty to sandy clay. During the Pleistocene, these sand and clay deposits were formed in offshore and inner continental shelf, barrier island, and marsh/lagoonal-type environments. According to the *Geologic Map of Georgia* (GA DNR 1976), clay beds of marsh origin, which were deposited on the northwestern side of the former Pamlico barrier island complex, exist in the western quarter of HAAF. Very fine- to coarse-grained sand deposits of barrier island origin are more common throughout the remaining areas of HAAF.

II.B.2.b. Site stratigraphy

As determined from soil borings drilled during the CAP–Part B site investigation, the lithologies present within 15 feet of the surface at the site appear to correlate with the regional stratigraphic section. Soil boring logs from the wells installed during the supplemental investigation are located in Appendix IV. The lithology encountered is predominantly a white, pale brown, or light gray, very fine to medium-grained sand, with variable silt and clay content. Generally, the samples with higher silt and clay content were within a few feet of the surface. Less silt and clay content was noted with depth. The boring log of deep well P1-MW40 indicates an increasing clay content from approximately 26 feet BGS to 30 feet BGS, becoming a clayey, coarse-grained sand/gravel at 30 feet BGS.

II.B.3. Stratigraphic Cross Sections

Stratigraphic cross sections have been developed and were presented in the CAP–Part B Report (SAIC 2000).

II.B.4. Geotechnical Analysis

Soil samples were collected for geotechnical analysis during the CAP–Part B investigation, and the results were presented in the CAP–Part B Report (SAIC 2000). In February 2001, soil samples were collected from wells D-MW37 and D-MW39 for various geotechnical analyses. The results are presented in Table 4 and Attachment B.

II.B.5. Direction of Groundwater Flow

II.B.5.a. Well construction details

During the supplemental investigation activities in 2001, each monitoring well casing consisted of 4-inch inside diameter, Schedule 40, flush-threaded polyvinyl chloride risers with a 10-foot screen set across the water table. The well screen slot size was 0.010 inch. Table 5 summarizes construction details for existing monitoring wells associated with the Former Fuel Pit 1A/DAACG area and the wells installed at the site during the supplemental investigation in February 2001. The existing wells were resurveyed in February 2001 so that the reference datum for all the wells was consistent. Well construction diagrams for wells D-MW33 through D-MW43 are presented in Appendix VII.

Following installation of the well casing, filter pack sand was poured while the augers were gradually removed to ensure a complete and even distribution of the filter pack. The filter pack extended to a measured level at least 2 feet above the top of the well screen. Well seals were composed of bentonite pellets and allowed to hydrate before filling of the annular space above the seal. The well seal extended to a measured level of at least 2.0 feet above the top of the filter pack. Above the well seal, the remaining annular space was completed with a 1.0-foot-long, flush-mounted, sheet-steel protective casing that was grouted in place with a concrete pad. Well casings were capped with expandable locking caps. Protective casings were covered with bolted cast-iron manhole covers. Inscribed monitoring well identification plates were placed inside each manhole cover.

II.B.5.b. Potentiometric mapping

During the supplemental investigation activities, water level measurements were collected from 18 existing monitoring wells and from the 11 newly installed monitoring wells in March 2001. Data obtained from these measurements are presented in Table 3. Groundwater in the study area is under water table conditions and is encountered between 8.12 feet and 12.81 feet BGS, at an average of 10.6 feet BGS. Figure 13 shows the potentiometric surface at the site in March 2001. Groundwater flow in the vicinity of the Former Fuel Pit 1A/DAACG area is to the northwest at a gradient of approximately 0.0086 foot/foot.

II.B.5.c. Equipotential flow net

Equipotential flow nets based on March 2001 water level measurements and the contoured potentiometric surfaces are presented in Figure 13 for the shallow and deep surficial portions of the aquifer.

III. REMEDIAL ACTION PLAN

III.A. CORRECTIVE ACTION COMPLETED OR IN PROGRESS

III.A.1. Recovery/Removal of Free Product

During sampling activities in February 2000, free product was measured in wells D-MW1, D-MW2, D-MW8, D-MW11, D-MW13, and D-MW17 at thicknesses of 0.01 foot, 0.88 foot, 0.15 foot, 0.74 foot, 0.15 foot, and a sheen, respectively. Absorbent socks were placed in each well following these measurements on February 24, 2000. The free product covered an area of approximately 400 feet by 500 feet at the Former Fuel Pit 1A/DAACG area (Release #1) in February 2000. GA EPD was notified of the free product in correspondence dated March 8, 2000 (Stanley 2000).

The absorbent socks were removed and replaced in wells with free product on a bimonthly basis from May 2000 through July 2001. Absorbent sock removal and replacement was discontinued in several perimeter wells between December 2000 and May 2001 due to a lack of free product. Field bailout tests were conducted in March 2001 and July 2001 to determine the amount of recoverable product. In July 2001, the dimensions of the free product plume were similar to those of February 2000. Bimonthly replacement of the absorbent socks will continue until a corrective action is implemented to remove the free product.

III.A.2. Remediation/Treatment of Contaminated Backfill Material and Native Soil

During UST closure activities in 1995, all contaminated soil removed during the project was tested in accordance with disposal facility requirements and transported to Kedesh, Inc., Highway 84, Ludowici, GA 31316. The closure report for Former Pumphouse #1 was not submitted to GA EPD in 1995 because review of the closure analytical data indicated that a CAP–Part A would be required (in accordance with requirements of GUST-9, Item 15, page 12, dated August 1995). However, the analytical data presented in the closure report were summarized in the CAP–Part B Report. Approximately 913 cubic yards of contaminated soil were excavated from the site.

During the UST closure activities in 1998, the excavated soil was returned to the tank pit with the concurrence of GA EPD. The 1998 closure report for Former Pumphouse #1 (Earth Tech 1998) was not submitted to GA EPD because the CAP–Part A Report, which incorporated the area of the removal activities, had already been submitted to GA EPD.

III.B. OBJECTIVES OF CORRECTIVE ACTION

III.B.1. Remove Free Product That Exceeds One-Eighth Inch at the Former Fuel Pit 1A/DAACG Area (Release #1)

In February 2000, free product in excess of 1/8 inch in thickness was observed in wells D-MW1, D-MW2, D-MW8, D-MW11, D-MW13, and D-MW17. Since February 2000, free product has been removed via absorbent socks replaced on a bimonthly basis. The thickest amount of free product is located near the southwestern boundary of the product plume in the vicinity of wells D-MW2, D-MW34, and D-MW35. Field bailout tests indicate that there are approximately 3,000 gallons to 5,000 gallons of recoverable free product at the Former Fuel Pit 1A/DAACG area. More than half of the free product plume is located north and east of the flight line barricades, underneath an active tarmac that is associated with military flight operations. The thicknesses underneath the active tarmac range from 0.01 foot to 0.04 foot.

However, the area in which the free product plume is the thickest (i.e., up to 0.32 foot actual thickness) is located southwest of the flight line barricades and is accessible without being impacted by flight line operations or without impacting flight line operations during remedial activities. It is recommended that additional free product removal activities be implemented at the site in the area southwest of the flight line barricades.

III.B.2. Remediate Groundwater Contamination at the Former Fuel Pit 1A/DAACG Area (Release #1)

As discussed in the CAP–Part B Report (SAIC 2000), previous investigations documented benzene contamination in groundwater at the Former Fuel Pit 1A/DAACG area (Release #1) at concentrations that exceeded the IWQS of 71.28 µg/L and the ACL of 285 µg/L.

The supplemental groundwater sampling conducted in March 2001 indicated that the benzene plume was similar to the plume that had been observed during the CAP–Part A and CAP–Part B investigations. The benzene concentrations in 12 wells exceeded the IWQS. The benzene concentrations in D-MW2, D-MW34, D-MW35, D-MW37, and D-MW39 exceeded the ACL. These wells are located southwest of the flight line barricades where the free product is the thickest. The majority of the groundwater plume extends 400 feet north and 300 feet east of the flight line barricades, underneath an active tarmac that is associated with military flight operations; however, the benzene concentrations underneath the active tarmac do not exceed the benzene ACL. Active remediation of the entire groundwater plume will impact active military operations. However, the majority of the groundwater contamination north and east of the flight line barricades is less than the benzene ACL. Therefore, it is recommended that a groundwater corrective action be implemented at the site in the area located southwest of the flight line barricades where benzene concentrations exceed the ACLs.

A large area of the groundwater plume exists underneath an active tarmac; therefore, the corrective action for the groundwater plume at the Former Fuel Pit 1A/DAACG area should consist of alternatives that are protective of the environment but can be implemented in a manner that causes minimal disruption of the active military flight operations. Monitored natural attenuation appears to be the most viable alternative once the free product has been removed because (1) the free product continues to act as a source for the groundwater contamination, (2) the benzene concentrations underneath the active tarmac are below the ACL, and (3) the maximum benzene concentrations during the CAP–Part B and supplemental investigations were less than three times the ACL. Monitored natural attenuation would provide for monitoring of the groundwater plume without impacting the military flight operations. It is recommended that the corrective action for groundwater consist of free product removal and monitored natural attenuation of the groundwater plume in the vicinity of the Former Fuel Pit 1A/DAACG area.

III.B.3. Remediate Soil Contamination at the Former Fuel Pit 1A/DAACG Area (Release #1)

As discussed in the CAP–Part B Report (SAIC 2000), previous investigations documented that benzene, toluene, ethylbenzene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, chrysene, and indeno(*1,2,3-cd*)pyrene contamination in soil at the Former Fuel Pit 1A/DAACG area (Release #1) exceeded the applicable GUST STLs. Benzene was the only constituent in soil to exceed its ATL of 9.3 mg/kg in six boring locations. Benzo(*a*)pyrene, chrysene, and indeno(*1,2,3-cd*)pyrene concentrations in one soil sample exceeded the ATLs of 1.4 mg/kg, 2.1 mg/kg, and 0.66 mg/kg, respectively. The soil samples with these concentrations exceeding the ATLs were collected from the capillary fringe above the soil/water interface in the area of free product, and the presence of free product may have contributed to the high concentrations. The soil contamination exceeding ATLs follows the area of free product and groundwater contamination, and a large portion is located north and east of the flight line barricades, underneath an

active tarmac that is associated with military flight operations. Active remediation of the soil contamination north and east of the flight line barricades will impact active military operations.

It is recommended that the corrective action for removal of the free product be implemented prior to recommendation of a corrective action for the soil contamination. Once the majority of the free product has been removed, additional soil borings should be installed north and east of the flight line barricades to determine if the soil concentrations have degraded to below the ATLs.

III.B.4. Provide Risk-Based Corrective Action

A risk-based approach was used in the CAP–Part B Report (SAIC 2000) to identify chemicals of potential concern (COPCs) for soil and groundwater and to develop ATLs and ACLs for various constituents. The results of the risk screening for both areas were presented in the CAP–Part B Report (SAIC 2000) and the results for the Former Fuel Pit 1A/DAACG area are summarized below.

In summary, benzene, ethylbenzene, toluene, xylenes, benzo(*a*)pyrene, benzo(*b*)fluoranthene, chrysene, and indeno(*1,2,3-cd*)pyrene were identified as COPCs for soil. ATLs of 9.3 mg/kg for benzene, 187 mg/kg for ethylbenzene, 479 mg/kg for toluene, 893 mg/kg for xylenes, 1.4 mg/kg for benzo(*a*)pyrene, 5.8 mg/kg for benzo(*b*)fluoranthene, 2.1 mg/kg chrysene, and 0.66 mg/kg for indeno(*1,2,3-cd*)pyrene were proposed in the CAP–Part B Report (SAIC 2000) and approved by GA EPD in correspondence dated December 18, 2000 (Logan 2000). Benzene, benzo(*a*)pyrene, chrysene, and indeno(*1,2,3-cd*)pyrene were the constituents that exceeded their respective ATLs during the CAP–Part A and Part B investigations.

Benzene, ethylbenzene, toluene, benzo(*a*)pyrene, chrysene, and naphthalene were identified as COPCs for groundwater. ACLs of 285 µg/L for benzene; 114,800 µg/L for ethylbenzene; 800,000 µg/L for toluene; 1.2 µg/L for benzo(*a*)pyrene; 1.2 µg/L for chrysene; and 260 µg/L for naphthalene were proposed in the CAP–Part B Report (SAIC 2000) and approved by GA EPD in correspondence dated December 18, 2000 (Logan 2000). Benzene was the only compound to exceed its respective ACL during the CAP–Part B investigation.

The fate and transport modeling results were provided in the CAP–Part B Report (SAIC 2000). A storm drain located 230 feet northeast (downgradient) of the site is the nearest possible location at which a receptor might encounter migrating groundwater contamination due to a possible hydraulic connection between the groundwater and the potential receptor. Modeling of leaching to groundwater by percolating rainwater was performed using the Seasonal Soil Compartment Model to determine the predicted maximum concentration in the leachate at the water table interface. The predicted leachate concentration of 12,500 µg/L was above the maximum groundwater concentration of 700 µg/L at the source. The Analytical Transient 1-, 2-, 3-Dimensional Model was calibrated to the maximum predicted concentration of benzene (i.e., 12,000 µg/L) assuming a steady-state (continuous) concentration at the source.

Based on modeling results, the estimated dilution attenuation factor for benzene at the storm drain was 4.0. The modeling results indicated that benzene should be reaching the storm drain at a concentration of 3,100 µg/L, which is above the state IWQS of 71.28 µg/L, thereby predicting that the potential receptor is impacted by the current site conditions. However, actual groundwater results indicated that groundwater contamination at concentrations near the IWQS reaches the storm drain. Due to the close proximity of both releases to each other, the most conservative fate and transport modeling results were used for developing one set of ACLs and ATLs for both areas of contamination.

Considering the site characteristics, it was recommended that the free product, soil contamination above ATLs, and groundwater contamination above ACLs in the vicinity of the Former Fuel Pit 1A/DAACG

area be addressed. However, additional information was necessary to determine the amount of recoverable free product at the Former Fuel Pit 1A/DAACG area prior to proposal of remediation systems for the site.

III.C. DESIGN AND OPERATION OF CORRECTIVE ACTION SYSTEMS AT THE FORMER FUEL PIT 1A/DAACG AREA (RELEASE #1)

III.C.1. System Effectiveness/Basis for Selection

The presumed remedies evaluated for aromatic hydrocarbons in soil and groundwater at the Former Fuel Pit 1A/DAACG area included free product removal, monitored natural attenuation, oxygen-injection-enhanced bioremediation, air sparging with soil vapor extraction, six-phase heating, and PHOSter® II enhanced bioremediation. The primary focus of the alternative evaluation was to find a cost-effective method of remediating the site with minimal impact to the military flight operations. Active remediation of the majority of the soil and groundwater contamination north and east of the flight line barricades would either impact military flight operations for a significant period of time or not be cost effective to implement because of the requirements that would be necessary to minimize the impact to flight operations. The majority of the recoverable free product is located southwest of the flight line barricades where an active product removal system would not impact military flight operations.

In selecting the corrective action for the Former Fuel Pit 1A/DAACG area, the following items were taken into consideration: (1) the free product is acting as a continuous source for soil and groundwater contamination, (2) the benzene concentrations in groundwater above the ACL are located southwest of the flight line barricades, (3) the benzene concentrations in groundwater are less than three times the ACL, and (4) the soil contamination is primarily associated with the interval above the soil/water interface where the free product is located. Based on these considerations and the active military flight operations, a phased approach to the corrective action is recommended for the Former Fuel Pit 1A/DAACG area. The first phase will consist of removing the free product without impacting active military flight operations. The second phase will consist of monitored natural attenuation of the groundwater plume. Once the removal of the free product reaches an asymptotic level and the results of the monitored natural attenuation can be evaluated, HAAF will reevaluate the need for an active corrective action addressing any remaining soil and groundwater contamination.

III.C.1.a. Theory and feasibility

Data indicate that free product is floating on the groundwater at the Former Fuel Pit 1A/DAACG area, dissolved-phase hydrocarbons exist in the groundwater beneath the site, and residual saturation of hydrocarbons exists in soil at the site. The seasonal water table fluctuations of approximately 2 feet have further transported and smeared free-phase petroleum product onto soil. The BTEX compounds are both volatile and aerobically degradable by bacteria, which already exist in the subsurface.

The results of the field bailout tests indicate that there are approximately 3,000 gallons to 5,000 gallons of free product that can be recovered from the Former Fuel Pit 1A/DAACG area (Release #1). The majority of the recoverable free product is located southeast of the flight line barricades and is not within the area of active military flight operations. The free product should be removed from the subsurface so that the site conditions will be favorable to biodegradation.

The large quantity of free product in the subsurface at the Former Fuel Pit 1A/DAACG area is providing a continuous source of contamination that is dissolving into the groundwater at the site. Active free product removal in conjunction with groundwater extraction will locally depress the water table to create a cone

of depression that will collect the free product and expedite its removal. In addition, groundwater extraction will expedite cleanup by removing dissolved-phase contamination. The groundwater can be easily treated by an oil/water separator and air stripper and discharged via an infiltration gallery or to a sanitary sewer.

Once the source has been removed, the subsurface conditions (dissolved oxygen, oxidation-reduction potential, background nutrient availability) will steadily improve with time. Natural attenuation may be an adequate alternative to monitoring the subsurface contamination without impacting active military flight operations. Natural attenuation is based on the premise that fuel-type hydrocarbons are readily biodegraded in most environmental systems. Biodegradation of BTEX has been documented for sites similar to the Former Fuel Pit 1A/DAACG area (e.g., shallow water table, permeable silty sand). In fact, the conditions at this site are similar to those of other sites that have proven ideal for biodegradation (Abou-Rizk et al. 1995). Groundwater samples were collected from wells at the Former Pumphouse #1 tank pit area (Release #2) in 1999 to determine whether natural attenuation of hydrocarbons was occurring. The results of the preliminary screening for aerobic and anaerobic biodegradation suggest that conditions are favorable for natural attenuation of aromatic hydrocarbons. Due to the close proximity of the releases to each other, it is reasonable to assume that biodegradation of aromatic hydrocarbons will also occur at the Former Fuel Pit 1A/DAACG area (Release #1) once the free product is removed.

During the 2001 investigation, the Georgia IWQS for benzene of 71.28 µg/L was exceeded in 12 monitoring wells. However, only five of the wells contained benzene concentrations that exceeded the GA EPD–approved benzene ACL of 285 µg/L. HAAF proposes to implement free product removal activities on the southeastern side of the flight line barricades in conjunction with monitored natural attenuation of the groundwater plume.

III.C.1.b. Remediation system

The Former Fuel Pit 1A/DAACG area is located underneath a tarmac associated with active military flight operations. The proposed first phase of the corrective action is a remediation system consisting of groundwater extraction and free product removal. The area of the free product that is thickest is located southeast of the flight line barricades, and the remediation system has been designed to cause minimal impact to the active flight operations.

Wells D-MW34 and D-MW35 will be used as groundwater extraction and free product recovery wells. In addition, another 4-inch well will be installed between these two wells for groundwater extraction and free product recovery. Groundwater will be extracted with electric submersible pumps, and free product will be removed with product recovery systems (i.e., Spillbuster, Ferret™, or equivalent). The free product will be pumped into an aboveground storage tank located at each well. The three groundwater discharge lines will manifold together near the treatment unit. Individual valves and flow meters will be included. A combined system flow rate of 9 gpm to 15 gpm is expected. Groundwater will be routed through an oil/water separator and then through an air stripper where the dissolved phase hydrocarbons will be removed and discharged directly to the atmosphere. No off-gas treatment from the air stripping unit is anticipated. The treated groundwater will be discharged via an infiltration gallery or to a sanitary sewer. Seven additional wells will be installed around the perimeter of the thickest portion of the free product plume to better define the volume of free product and the progress of the free product removal.

In conjunction with the free product removal and groundwater extraction, a monitoring only program will be implemented for the Former Fuel Pit 1A/DAACG area and will consist of annual sampling of up to 30 wells.

A plan view of the proposed well locations for the remediation system is presented in Figure 14. The process flow diagram for the system is presented in Figure 15. Any changes to the remediation system proposed in this document will be submitted to GA EPD.

III.D. IMPLEMENTATION

III.D.1. Milestone Schedule

A milestone schedule for the proposed corrective action has been prepared. A Gantt chart showing milestone activities and anticipated duration is provided in Figure 16. The actual time required to achieve asymptotic free produce recovery may be greater, or less, than presented in Figure 16; therefore, Fort Stewart will notify GA EPD USTMP of any significant changes to the schedule and will provide GA EPD USTMP with an updated Gantt chart as necessary.

III.D.2. Progress Reporting

For the Former Fuel Pit 1A/DAACG area (Release #1), annual progress reports or monitoring reports will be submitted to GA EPD that will summarize the free product removal activities and all previous sampling events for that time period. If scheduling permits, the annual progress report for the Former Fuel Pit 1A/DAACG area (Release #1) may be combined with the annual monitoring only report for the Former Pumphouse #1 tank pit area (Release #2) to create a single document.

III.D.3. Certificate of Completion Report

Petition for permanent closure will be submitted with the final progress report (i.e., completion report) for the first release to reach closure criteria. An addendum to the completion report will be submitted for the second release to reach the GA EPD–approved closure criteria. GA EPD will provide final approval for decommissioning the monitoring wells, which will be requested in the final completion addendum report. Decommissioning of the monitoring wells will be completed in accordance with the USACE design manual for monitoring wells. Decommissioning will comply with all applicable state and federal standards.

The following certification will be submitted to GA EPD within 30 days of submittal of the final progress report:

> I hereby certify that the Corrective Action Plan–Part B, dated ___, 20_, for Hunter Army Airfield, Former Pumphouse #1 site (Release #1 and Release #2), Facility ID 9-025085, including any and all certified amendments/addenda thereto, has been implemented in accordance with the schedules, specifications, sampling programs, and conditions contained therein and that the plan's stated objectives have been met.
>
> _____
> Signature (Owner/Operator)

III.D.4. Inspection Schedule and Preventative Maintenance Program

For the Former Fuel Pit 1A/DAACG area (Release #1), the preventative maintenance for the remediation system will be performed in accordance with the maintenance schedule provided in the Gantt chart. Initial startup tests and system calibrations will be conducted upon installation of the system. Site visits will be conducted biweekly for the first 2 months of operation. Depending on system performance, maintenance visits may be reduced to monthly for the remaining period of system operation. Selected personnel from HAAF will also be trained in operation of the system and adjustment procedures so that more frequent visits can be conducted if required.

The systems will be operated in accordance with the manufacturers' specifications. Anticipated system adjustments/servicing will include the items listed below.

- Adjust pumping rates from groundwater extraction wells to achieve desired drawdown.
- Check treatment units for fouling.
- Collect effluent water samples. Based on analytical results, adjust treatment units to ensure design removal efficiency is achieved.

Also, during each sampling event, wells and exposed piping and instrumentation will be visually inspected for changes or damage. Any notable observations will be recorded in the subsequent progress report.

III.D.5. Periodic Monitoring

For the Former Fuel Pit 1A/DAACG area (Release #1), groundwater samples will be collected annually from up to 30 wells (D-MW1, D-MW2, D-MW8, D-MW11, D-MW12, D-MW13, D-MW17, D-MW18, D-MW19, D-MW22, D-MW33, D-MW34, D-MW35, D-MW36, D-MW37, D-MW38, D-MW39, D-MW40, D-MW41, D-MW42, D-MW43, P1-MW11, P1-MW12, P1-MW13, P1-MW42, and five of the proposed wells) and analyzed for BTEX. PAH compounds observed during the CAP–Part A and CAP–Part B investigations were detected at concentrations below their respective ACLs; therefore, it is recommended that PAH analysis not be performed during the annual sampling. Monitoring will continue at the site until the recovery of free product reaches diminishing returns and the benzene concentrations in groundwater are below the ACL of 285 µg/L for two sampling events. Wells may be added or removed from the monitoring plan as the boundaries of the plume change. These changes will be documented in the monitoring only reports.

During each sampling event, water levels will be measured in all monitoring wells. Specific conductivity, pH, and temperature analyses will be measured on each sample from the monitoring wells from which analytical samples are collected. The samples will be shipped to an approved laboratory for BTEX analysis in accordance with U.S. Environmental Protection Agency Method 8021B/8260B and GA EPD laboratory certification requirements.

The tarmac associated with Taxiway 3 is scheduled to be replaced, which will result in the destruction of numerous wells in the vicinity of Former Pumphouse #1 and the DAACG. Wells required for effective remediation of monitored natural attenuation will be replaced. The destroyed wells will be documented in a progress report or monitoring only report.

III.D.6. Effectiveness of Corrective Action

For the Former Fuel Pit 1A/DAACG area (Release #1), the corrective action (i.e., active product recovery followed by monitored natural attenuation) will be discontinued once the objectives of the monitoring only plan have been achieved—the recovery of free product has reached a diminishing return; the benzene concentrations in groundwater are below the ACL of 285 µg/L; and the benzene, benzo(*a*)pyrene, chrysene, and indeno(*1,2,3-cd*)pyrene concentrations in soil are reduced to below their ATLs of 9.3 mg/kg, 1.4 mg/kg, 2.1 mg/kg, and 0.66 mg/kg, respectively.

III.D.7. Confirmatory Soil Sampling Plan

For the Former Fuel Pit 1A/DAACG area (Release #1), no excavation of soil is planned under the free product removal and monitoring only plan; therefore, confirmatory sampling associated with excavation of soil will not be performed. However, because there is an area of soil contamination that exceeds the benzene ATL of 9.3 mg/kg, the benzo(*a*)pyrene ATL of 1.4 mg/kg, the chrysene ATL of 2.1 mg/kg, and the indeno(*1,2,3-cd*)pyrene ATL of 0.66, three confirmatory soil samples will be collected from the area of soil contamination. The soil samples will be collected once the benzene concentrations in groundwater are approaching the ACL. The soil samples will be analyzed for only benzene, benzo(*a*)pyrene, chrysene, and indeno(*1,2,3-cd*)pyrene only. The location of these samples will be determined during the monitoring only program and will be submitted to GA EPD in a letter or annual monitoring only report for approval.

III.D.8. Stockpiled Bulk Soil Sampling

For the Former Fuel Pit 1A/DAACG area (Release #1), no stockpiled soil will be generated by this corrective action; therefore, no soil sampling will be conducted.

III.D.9. Monitoring Only Termination Conditions

For the Former Fuel Pit 1A/DAACG area (Release #1), concentrations of benzene in groundwater must be at or below the ACL, and concentrations of benzene, benzo(*a*)pyrene, chrysene, and indeno(*1,2,3-cd*)pyrene in soil must be at or below their respective ATLs prior to termination of the monitoring only program. Once the product removal activities have reached a diminishing return and the benzene ACL and the benzene, benzo(*a*)pyrene, chrysene, and indeno(*1,2,3-cd*)pyrene ATLs have been achieved, the remedial system and monitoring may be terminated regardless of the site ranking score.

III.D.10. Post-Completion Site Restoration Activities

After termination has been granted for either release, equipment and debris related to the corrective action will be removed from the site.

III.E. PUBLIC NOTIFICATION

The Former Pumphouse #1 site is located entirely within the confines of HAAF, which is part of the Fort Stewart Military Reservation, a federal facility. The U.S. Government owns all of the property contiguous to the site. The Fort Stewart DPW has complied with the public notice requirements defined by GA EPD guidance by publishing an announcement in the *Savannah Morning News* on April 1 and 8, 2001. A copy of the newspaper announcement used for public notification is presented in Appendix XI of this report.

IV. CLAIM FOR REIMBURSEMENT

HAAF is a federally owned facility and has funded the investigation for the Former Pumphouse #1 site, Facility ID #9-025085 using Department of Defense Environmental Restoration Funds. Application for GUST Trust Fund reimbursement is not being pursued at this time.

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DEPARTMENT OF THE ARMY
HEADQUARTERS, 3D INFANTRY DIVISION (MECHANIZED) AND FORT STEWART
DIRECTORATE OF PUBLIC WORKS
1550 FRANK COCHRAN DRIVE
FORT STEWART, GEORGIA 31314-4927

REPLY TO
ATTENTION OF

30 JAN 2001

Office of the Directorate

CERTIFIED MAIL

7099 3400 0010
5449 3848

Georgia Department of Natural Resources
Underground Storage Tank Management Program
Attention: Mr. William E. Logan
4244 International Parkway, Suite 104
Atlanta, Georgia 30354

Dear Mr. Logan:

Fort Stewart is pleased to receive the Georgia Environmental Protection Division's (GA EPD's) correspondence dated December 18, 2000, approving the technical proposal contained in the Corrective Action Plan (CAP)-Part B, submitted for Hunter Army Airfield's former underground storage tanks (USTs) #30-#39 and #50 (Pumphouse #1), former Building 8060, Facility Identification Number 9-025085*1 and *2.

As requested, an updated milestone schedule which adheres to the GANTT Chart provided as Figure 25 in the August 2000 CAP-Part B is provided for your use and convenience. If you have any questions or comments regarding this matter, please contact Ms. Melanie Little or Ms. Tressa Rutland, Directorate of Public Works Environmental Branch, at (405) 364-8461 or (912) 767-2010, respectively.

Sincerely,

Thomas C. Fry
for Gregory V. Stanley
Colonel, U.S. Army
Director, Public Works

Enclosure

MILESTONE SCHEDULE
(January 2001)

USTs #30 through #39 and #50, FACILITY ID. NO. 9-025085*1 and *2
PUMPHOUSE #1, FORMER BUILDING 8060

PROJECTED DATE	EVENT
December 18, 2000	CAP-Part B approved by GA EPD, USTMP.
January 2001	Procure contractor for installation of additional wells at PH#1, Release #1, site per Section III.C.1.a of the CAP-Part B report.
February-March 2001	Install required wells.
April-June 2001	Perform free-phase product thickness evaluation(s) in 3 of the 10 wells having the most measurable product.
July 2001	Conduct first semiannual sampling event at Release #2 (see Section III.C.a.1 of CAP-Part B report).
September 2001	Submit CAP-Part B Addendum to GA EPD, USTMP summarizing additional information obtained for Release #1 and recommending a course of action for Release #1.
January 2002	Conduct second semiannual sampling event at Release #2 (see Section III.C.a.1 of CAP-Part B report).
May 2002	Installation submits 1st Annual Monitoring Only Report for Release #2 to GA EPD, USTMP.

Georgia Department of Natural Resources

Environmental Protection Division
Underground Storage Tank Management Program
4244 International Parkway, Suite 104, Atlanta, Georgia 30354
Lonice C. Barrett, Commissioner
Harold F. Reheis, Director
(404)362-2687

December 18, 2000

Colonel Gregory V. Stanley
Director, Public Works
U.S. Army/HQ3d Inf. Div. (Mech.)
1550 Frank Cochran Drive
Ft. Stewart, GA 31314-4927

SUBJECT: **Notice to Implement CAP-Part B Report:**
Hunter AAF, Former Pumphouse #1
Former Building 8060
Savannah, Chatham County, GA
Facility ID: 9025085*1 and *2

Dear Colonel Stanley:

The Georgia Underground Storage Tank Management Program has received your letter, dated August 29, 2000, that forwarded a CAP-Part B Report, for our review. The report was prepared by SAIC.

The technical proposal contained in the CAP-Part B Report for further investigation, monitoring and/or remediation of the current release is hereby approved by the USTMP. As a result of your CAP-Part B Report being technically approved, you are authorized to begin implementation of this plan.

Please submit an updated milestone schedule by **January 18, 2001,** listing specific dates, events and a timetable to complete the proposed activities and submit the CAP-B Addendum. If you have any technical questions, please contact me at (404)362-2687.

Sincerely,

William E. Logan
Senior Geologist
Corrective Action Unit II

WEL;
s:\landdocs\williaml\pending00\9025085.120

cc: Patricia Stoll, P.E., SAIC
Lisa L. Lewis, GA EPD
Larry Rogers, EPD Coastal District

File (CA): Chatham; 9025085

DEPARTMENT OF THE ARMY
HEADQUARTERS, 3D INFANTRY DIVISION (MECHANIZED) AND FORT STEWART
DIRECTORATE OF PUBLIC WORKS
1550 FRANK COCHRAN DRIVE
FORT STEWART, GEORGIA 31314-4927

REPLY TO
ATTENTION OF

Aug. 29, 2000

Office of the Directorate

CERTIFIED MAIL

Georgia Department of Natural Resources
Underground Storage Tank Management Program
Attention: Mr. William Logan
4244 International Parkway, Suite 104
Atlanta, Georgia 30354

Dear Mr. Logan:

Fort Stewart/Hunter Army Airfield is pleased to submit the Corrective Action Plan (CAP)-Part B for former underground storage tanks #30 through #39 and #51, former Building 8060 (Pumphouse #1), Facility Identification Number 9-025085, Hunter Army Airfield, Georgia.

This site is located less than 500 feet from a surface water body, and the area is considered to be of average or higher groundwater pollution susceptibility. As approved by Georgia Department of Natural Resources Environmental Protection Division (GA EPD), the soil threshold levels (STLs) for this site were taken from Chapter 391-3-15, Table B, Column 1, and the In-Stream Water Quality Standards (IWQS) were used for comparison to groundwater analytical data (see bottom of page 7 of the enclosed plan).

Based on the information contained in the enclosed CAP-Part B report, the site has been sub-divided into two distinct areas:

- Release #1 (an area of soil and groundwater contamination near the Departure/Arrival Air Control Group [DAACG] that is in the vicinity of Former Fuel Pits 1A and 1B), and
- Release #2 (an area of soil and groundwater contamination near the former Pumphouse #1 facility and Fuel Pits 1C and 1D, located approximately 200 feet north of the former tank pit).

As noted on the Site Ranking Form, enclosed in Appendix X (page X-5 of the enclosed plan), Release #1 scored a 53,500 using the worst soil contamination from both the CAP-Part A and CAP-Part B investigations, and the 1996 groundwater concentration from D-MW205. However, the extent of free product associated with Release #1 has not been determined. Thus, Fort Stewart proposes additional site investigation as described in Section III.C.1.a of the plan with all additional information to be submitted to GA EPD, USTMP in a CAP-Part B Addendum (page 38).

As noted on the Site Ranking Form, enclosed in Appendix X (page X-9), Release #2 scored a 25,750 using the worst soil contamination from both the CAP-Part A and CAP-Part B investigations and the 2000 groundwater concentration from D-MW5. Thus, Fort Stewart recommends a "Monitoring Only" plan for Release #2 as described in Section III.C.1.a (page 38) and Section III.D.

We appreciate your consideration of these recommendations, and if you have any questions or comments, please contact Ms. Melanie Little or Ms. Tressa Rutland, Directorate of Public Works, Environmental Branch, at (405) 364-8461 or (912) 767-7919, respectively.

Sincerely,

for Thomas C. Fry
Gregory V. Stanley
Colonel, U.S. Army
Director, Public Works

Enclosure

FINAL

CORRECTIVE ACTION PLAN
PART B
FORMER PUMPHOUSE #1
FACILITY IDENTIFICATION NUMBER #9-025085
FORMER BUILDING 8060
HUNTER ARMY AIRFIELD, GEORGIA

Prepared for:
U.S. Army Corps of Engineers
Savannah District
Under Contract Number DACA21-95-D-0022
Delivery Order Number 0061

Prepared by:
SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
800 Oak Ridge Turnpike
Oak Ridge, Tennessee 37831

August 2000

Georgia Department of Natural Resources
Environmental Protection Division
Land Protection Branch
Underground Storage Tank Management Program
4244 International Parkway, Suite 104
Atlanta, Georgia 30354
Phone (404) 362-2687
FAX (404) 362-2654

CORRECTIVE ACTION PLAN
PART B

Facility Name: Former Pumphouse #1 Site

Street Address: Former Building 8060, near Taxiway 3

City: Hunter Army Airfield **County:** Chatham

Facility ID #: 9-025085

Submitted by UST Owner/Operator:

Name: Thomas C. Fry/Environmental Branch
Company: US Army/HQ 3d Inf. Div (Mech)
Address: Directorate of Public Works, Bldg 1137
1550 Frank Cochran Drive
City: Fort Stewart State: GA
Zip Code: 31314-4927

Prepared by:

Name: Patricia Stoll
Company: Science Applications International Corp.
Address: P.O. Box 2502
City: Oak Ridge State: TN
Zip Code: 37831

I. PLAN CERTIFICATION

A. UST Owner/Operator

I hereby certify that the information contained in this plan and in all the attachments is true, accurate, and complete, and the plan satisfies all criteria and requirements of Rule 391-3-15-.09 of the Georgia Rules for Underground Storage Tank Management.

Name: Thomas C. Fry

Signature: Thomas C. Fry Date: 08/29/00

B. Professional Engineer or Professional Geologist

Name: Patricia Stoll

Signature: Patricia A. Stoll

Date: 8/22/00

GEORGIA REGISTERED 22851 PROFESSIONAL ENGINEER P. A. STOLL

Georgia Stamp or Seal

Check all boxes below that apply. Attach supporting documentation, i.e., narrative, figures, tables, maps, boring/well logs, etc., for all items checked. Supporting documentation should be three-hole punched and prepared in conformity with the guidance document "Underground Storage Tank (UST) Release: Corrective Action Plan – Part B (CAP-B) Content", GUST-7B.

II. SITE INVESTIGATION REPORT

A. Horizontal and Vertical Extent of Contamination:

- ☒ Soil (Section II.A.1)
- ☒ Groundwater (Section II.A.2)
- ☒ Free Product (Section II.A.3)
- ☒ Surface Water (Section II.A.4)

B. Local and Site Hydrogeology

- ☒ Documentation of Local Groundwater Conditions (Section II.B.1)
- ☒ Stratigraphic Boring Logs (Section II.B.2)
- ☒ Stratigraphic Cross Sections (Section II.B.3)
- ☒ Referenced or Documented Calculations of Relevant Aquifer Parameters (Section II.B.4)
- ☒ Direction of Groundwater Flow (Section II.B.5)
  - ☒ Table of Monitoring Well Data (Table 8)
  - ☒ Potentiometric Map (Figures 19 and 20)
  - ☒ Flow Net Superimposed on a Base Map (Figure 21)

III. REMEDIAL ACTION PLAN:

A. Corrective Action Completed or In-Progress:

- ☒ Recovery/Removal of Free-Product (Non-aqueous Phase Hydrocarbons)
- ☐ Remediation/Treatment of Contaminated Backfill Material & Native Soils
- ☐ Other (specify)_____

B. Objective of Corrective Action:

- ☒ Remove Free Product That Exceeds One-Eighth Inch
- ☐ Remediate Groundwater Contamination That Exceeds:
  - ☐ Maximum Contaminant Levels (MCLs)

    OR
  - ☐ In-stream Water Quality Standards

B. **Objective of Corrective Action (continued):**

☐ Remediate Soil Contamination That Exceeds:

☐ Threshold Values Listed in Table A

OR

☐ Threshold Values Listed in Table B

OR

☐ Alternate Threshold Levels (ATLs)

☒ Provide Risk Based Corrective Action (Reference CAP B App. VI) (Section III.B.4)

☒ Remediate Soil and/or Groundwater Contamination That Exceeds Alternate Concentration Limits (ACLs) and Monitor Residual Contaminants

OR

☐ Monitor Soil and/or Groundwater Contamination That Exceeds Levels in Rule -.09 (3) But Is Less Than ACLs

OR

☐ No Further Action Required - Soil and/or Groundwater Contamination is Below Levels in Rule -.09 (3)

C. **Design Operation of Corrective Action Systems**

☒ Soil ☒ Groundwater ☒ Free Product ☐ Surface Water ☐ Not Applicable

D. **Implementation (Section III.D)**

Includes, as a minimum, the following:

- Milestone schedule for site remediation
- Inspection and preventive maintenance schedule for all specialized remediation equipment
- Monitoring/sampling and reporting plan for measuring interim progress and project completion
- Plan to decommission equipment/wells and close site

IV. **PUBLIC NOTICE**

☐ Certified Letters to Adjacent, and Potentially Affected Property Owners and Local Officials

☒ Legal Notice in Newspaper, as approved by EPD (Section III.E)

☐ Other EPD-approved Method (specify)_____

V. CLAIM FOR REIMBURSEMENT: (For GUST Trust Fund sites only)

- ☐ GUST Trust Fund Application (GUST-36), must be attached if applicable
- ☐ Cost Proposal
  - ☐ Non-Reimbursable Costs

    OR
  - ☐ Reimbursable Costs
    - ☐ Total Project Costs
      - ☐ Costs incurred to date, per GUST-92
      - ☐ Estimated costs to complete corrective action, per GUST-92
    - ☐ Invoices and Proofs-of-Payment for Costs Incurred to Date
- ☐ Proposed Schedule For Reimbursement
  - ☐ Lump Sum Payment Upon Completion Of Corrective Action

    OR
  - ☐ Interim Payments With Final Payment Upon Completion
- ☒ Not Applicable

II. SITE INVESTIGATION REPORT

This document represents the Site Investigation (SI) Report for the Former Pumphouse #1, Facility ID #9-025085, Former Building 8060, at Hunter Army Airfield (HAAF), Georgia. This Corrective Action Plan (CAP)-Part B report follows the guidance published by Georgia Environmental Protection Division (GA EPD) in February 1995; however, the organization of the appendices for this report mirrors the appendices listed in the CAP-Part A template issued by GA EPD in May 1998. Report figures and tables are located in Appendices I and II, respectively.

The Former Pumphouse #1 site is located along the east-west taxiway of HAAF, as illustrated in Figure 1. The Former Pumphouse #1 site is located within an average or higher groundwater pollution susceptibility area and is greater than 500 feet from a withdrawal point and less than 500 feet from a surface water body. As defined in Georgia Underground Storage Tank (GUST) Management Rule 391-5-15.09, the appropriate soil threshold levels (STLs) are those presented in Table B, Column 1 of Gust Rules 391-5-15 because a surface water body is located less than 500 feet from the site.

According to the operational information provided by the HAAF Directorate of Public Works (DPW), Former Pumphouse #1 was an aviation gas fuel island that was used from about 1953 until the early 1970s and consisted of ten 25,000-gallon underground storage tanks (USTs) and a 50,000-gallon underground defueling tank. The pumphouse was inactive from the 1970s to 1995.

In 1995, eight of the 25,000-gallon USTs were removed by Anderson Columbia Environmental, Inc. (ACE). The 50,000-gallon defueling tank and two of the 25,000-gallon tanks remained in place, partially under the pumphouse structure. The 8-inch cast-iron piping internal to the Former Pumphouse #1 facility was removed prior to the tank removal exercise. During UST closure activities, benzene, toluene, ethylbenzene, and xylenes (BTEX), polynuclear aromatic hydrocarbons (PAHs), and total petroleum hydrocarbons (TPH) were detected in the soil samples. Samples of the groundwater seeping into the excavation also contained the presence of BTEX and PAH constituents in the groundwater at the site. Free product was not observed during tank removal activities.

In 1996, Metcalf & Eddy (M&E) conducted a CAP-Part A investigation. The CAP-Part A Report for Pumphouse #1 (M&E 1997) was submitted to GA EPD in May 1997 and describes the results of the CAP-Part A SI. As outlined in the CAP-Part A Report, a CAP-Part B SI was determined to be necessary to

- delineate the horizontal and vertical extent of petroleum contamination in soil and groundwater to concentrations below the applicable STL or In-Stream Water Quality Standards (IWQS), and

- assess the potential impact of petroleum contaminants to surface water and sediment in the drainage ditch located south (downgradient) of the site.

Based on the findings of the CAP-Part A, a CAP-Part B SI was conducted by M&E in May 1997 to determine the nature and extent of petroleum contamination. On January 27, 1999, representatives from GA EPD Underground Storage Tank Management Program (USTMP), U.S. Army Corps of Engineers (USACE), Fort Stewart DPW, and M&E met to discuss issues regarding the completion of the CAP-Part B Report. Representatives of GA EPD USTMP confirmed that the surface water drainage feature located south of the Former Pumphouse #1 constitutes a surface water body regulated by the State of Georgia under the IWQS and, as such, should be considered as the most likely receptor. In addition, representatives of GA EPD USTMP concurred that Georgia Rule, Chapter 391-3-15, Table B, Column 1, STLs are the appropriate soil screening criteria for the site. As a result of the meeting, additional surface water sampling locations were determined to be necessary downgradient of the groundwater plume

emanating from the former tank pit area. In addition, it was determined that installing monitoring wells on the south side of the drainage ditch was necessary prior to submitting the CAP-Part B Report to GA EPD. M&E performed the additional work in February and November 1999.

In 1998, Earth Tech, Inc., removed the remaining two 25,000-gallon USTs, closed the 50,000-gallon defueling tank, and removed the pumphouse structure. Soil and groundwater samples were not collected during the 1998 tank removal activities because the tanks were being removed from an area of known soil contamination that was determined during the CAP-Part A investigation. GA EPD approved the request to not conduct soil sampling at the site in correspondence dated June 17, 1998 (White 1998). The piping from the boundary of the pumphouse facility to the bulk fuel farm was also drained, pigged, and grouted in-place.

CAP-Part A and CAP-Part B investigations were conducted at the DAACG Facility in 1995 and 1996, respectively. These investigations covered the active tarmac north of the active taxiway. Various closure activities, CAP-Part A, and CAP-Part B investigations at the Former Pumphouse #1 site were performed between 1995 and 2000. The Former Pumphouse #1 investigations covered an area south of the active taxiway. Review of the analytical data from all of the investigations indicated that it was necessary to combine the DAACG Facility data and the Former Pumphouse #1 data into a single report to document that the nature and extent of contamination has been determined. In order to distinguish well and boring locations between the DAACG Facility and Former Pumphouse #1 investigations, the well/boring identifiers are prefixed with a "D" or "P1," respectively. In some areas of this document, including the boring logs and well construction diagrams, the DAACG Facility wells or borings may be prefixed with "H833," which is the building number associated with the DAACG Facility.

As indicated in correspondence to GA EPD USTMP, which was dated February 29, 2000 (Perez 2000), there are two distinct and separate plumes located within the vicinity of the Former Pumphouse #1 site. Release #1 is an area of soil and groundwater contamination located near the Departure/Arrival Air Control Group (DAACG) Facility that is in the vicinity of Former Fuel Pits 1A and 1B, located approximately 900 feet west of former Building 8060 (i.e., Pumphouse #1). Throughout this document, Release #1 will be referred to as the Former Fuel Pit 1A/DAACG area. Release #2 is an area of soil and groundwater contamination located near the Former Pumphouse #1 facility and Former Fuel Pits 1C and 1D, located approximately 200 feet north of the former tank pits. Throughout this document Release #2 will be referred to as the Former Pumphouse #1 tank pit area. Based on the proximity of the various former fuel pits to the areas of contamination, it appears that a release from Former Fuel Pit 1A is responsible for the contamination associated with Release #1 and that a release from Former Fuel Pit 1C is responsible for the contamination associated with Release #2.

Science Applications International Corporation (SAIC) used the data collected by M&E in 1997 and 1999 to prepare this CAP-Part B Report for the Fort Stewart DPW, Environmental Branch, through the USACE, Savannah District, under contract DACA21-95-D-0022, delivery order 0061. In addition, in 2000, SAIC performed selected groundwater sampling to fill data gaps.

II.A. HORIZONTAL AND VERTICAL EXTENT OF CONTAMINATION

The horizontal and vertical extent of petroleum contamination in soil and groundwater has been delineated by activities performed during the UST Closure, CAP-Part A SI, and CAP-Part B SI. The activities associated with each investigation are summarized below.

Pumphouse #1 UST Closure (conducted in 1995 by ACE.)

- Removed eight 25,000-gallon USTs (USTs 32 – 39).

- Collected three soil samples from the side walls of the excavation for BTEX, PAH, and TPH analyses.
- Collected eight groundwater samples from water seeping into the excavation for BTEX and PAH analysis.

Pumphouse #1 CAP-Part A SI (conducted in 1996 by M&E)

- Conducted a soil vapor survey.
- Installed 14 soil borings (P1-SB01 through P1-SB08 and P1-SB19 through P1-SB24) and five well borings (P1-MW01, P1-MW02, P1-MW03, P1-MW11, and P1-MW12) to collect soil samples for BTEX, PAHs, TPH-diesel-range organics (DRO), TPH-gasoline-range organics (GRO), and volatile organic compound (VOC) headspace analyses.
- Installed five monitoring wells (P1-MW01, P1-MW02, P1-MW03, P1-MW11, and P1-MW12) to collect groundwater samples for BTEX and PAH analyses.
- Collected four surface water samples for BTEX and PAH analyses.
- Collected four sediment samples for BTEX, PAHs, TPH-DRO, and TPH-GRO analyses.

Pumphouse #1 CAP-Part B SI (conducted in 1997 by M&E)

- Drilled 17 soil borings (P1-SB25 through P1-SB41) and 12 well borings (P1-MW13 through P1-MW24) to collect soil samples for BTEX, PAHs, TPH-DRO, TPH-GRO, VOC headspace, and geotechnical analyses.
- Installed 12 monitoring wells (P1-MW13 through P1-MW24) to collect groundwater samples for BTEX, PAHs, and water quality analyses.
- Collected a comprehensive round of site water level measurements.

Additional Pumphouse #1 UST Closure Activities (conducted in 1998 by Earth Tech)

- Removed two 25,000-gallon USTs (i.e., USTs 30 & 31).
- Closed in-place one 50,000-gallon underground defueling tank (i.e., UST 50).
- Demolished Pumphouse #1 (Building 8060).
- With GA EPD concurrence, no soil or groundwater samples were collected during these removal activities.

Additional Former Pumphouse #1 CAP-Part B Activities (conducted in 1999 by M&E)

- Collected five surface water samples for BTEX and PAHs from a man-made drainage ditch located downgradient of the site and installed five stream gauges, as requested by GA EPD.
- Installed one monitoring well (P1-MW36) on the south side of the drainage ditch to collect a groundwater sample, as requested by GA EPD.

- Installed one monitoring well (P1-MW42) west (i.e., downgradient) of the Former Fuel Pit 1A/DAACG area of contamination to collect a groundwater sample.
- Installed one 4-inch monitoring well (P1-MW40) to perform an aquifer test.
- Collected 14 groundwater samples for BTEX, PAH, and natural attenuation parameters.
- Collected geochemical information to evaluate natural attenuation of petroleum hydrocarbons at the site.

Data Gap Groundwater Sampling (conducted in 2000 by SAIC)

- Collected groundwater samples from D-MW01, D-MW05, D-MW08, D-MW11, D-MW13, D-MW17, P1-MW11, and P1-MW13.

The CAP-Part A and Part B SI soil/sediment and groundwater/surface water analytical laboratory results are included in Appendices V and VIII, respectively, of this document.

II.A.1. Delineation of Soil Contamination

Petroleum-related contaminants detected in soil at the Former Pumphouse #1 site during the UST closure, CAP-Part A SI, CAP-Part B SI, and the DAACG Facility CAP-Part A and CAP-Part B SI included BTEX, TPH-DRO, TPH-GRO, and numerous PAH compounds. Specifics regarding the concentrations are discussed for each investigation in the following sections.

Results from the various investigations indicate that there were two separate areas of soil contamination. These areas consist of the area in the vicinity of the former tank pits near the former pumphouse and in the vicinity around Former Fuel Pit 1A/DAACG area.

II.A.1.a. Contaminant concentrations

II.A.1.a.1. Former Pumphouse #1 UST Closure (1995)

During the UST closure conducted in 1995, three soil samples were collected from the sidewalls of the excavation. The analytical results are presented in Tables 1a and 1b. BTEX, PAH constituents, and TPH were detected in all three soil samples. The detection limit for benzene in two samples exceeds the STL of 0.017 mg/kg. The concentration of benzo(a)pyrene in one sample exceeded the STL of 0.660 mg/kg. None of the other constituents exceeded their respective STLs.

II.A.1.a.2. DAACG Facility CAP-Part A Site Investigation (March 1995)

The DAACG CAP-Part A SI was initiated after contaminated groundwater was observed during the geotechnical investigation associated with the design of the foundation for the new DAACG building that was to be constructed. The investigation was limited to an area around the current DAACG building. During the CAP-Part A SI, 21 soil samples were collected from 10 soil borings. Low concentrations of toluene, below the STL of 6 mg/kg, were detected in five of the soil samples. All other BTEX, PAH, TPH-DRO, and TPH-GRO constituents were below the detection limits.

II.A.1.a.3. DAACG Facility CAP-Part B Site Investigation (May 1996)

During the CAP-Part B SI, 184 soil samples were collected from 50 soil borings and 32 monitoring wells scattered throughout the DAACG Facility investigation area as presented in Figure 2. This investigation

covered the active area of the tarmac located north of the Former Pumphouses #1 and #2 and west of Pumphouses #3, #4, and #5. The area of this investigation covers more than the areas of contamination associated with the Former Pumphouse #1 tank pit area and Former Fuel Pit 1A/DAACG area. The analytical results were provided in the CAP-Part B Report (M&E 1996) and are summarized in tabular format in Appendix V (beginning on page V-219). The data are presented in Figures 3a through 3e of this report with the Former Pumphouse #1 CAP-Part A and CAP-Part B data. BTEX, acenaphthylene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene, TPH-DRO, and TPH-GRO were detected in soil samples throughout the investigation area. Results from the CAP-Part B SI at the DAACG Facility indicate that the extent of soil contamination to the south was not determined, but would be investigated as part of the CAP-Part A and CAP-Part B investigations associated with Former Pumphouse #1.

In the vicinity of the Former Fuel Pit 1A/DAACG area, concentrations of benzene, toluene, ethylbenzene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, and indeno(1,2,3-cd) exceeded the applicable GUST STLs (i.e., Table B, Column 1) during the CAP-Part B SI.

In the vicinity of the Former Pumphouse #1 tank pit area, concentrations of benzene and ethylbenzene exceeded the applicable GUST STLs (i.e., Table B, Column 1) during the CAP-Part B SI.

II.A.1.a.4. Former Pumphouse #1 CAP-Part A Site Investigation (November 1996)

During the CAP-Part A SI, 38 soil samples were collected from 19 soil borings and monitoring wells (P1-SB01 through P1-SB08, P1-SB19 through P1-SB24, P1-MW01, P1-MW02, P1-MW03, P1-MW11, and P1-MW12) as presented in Figure 2. The analytical results are presented in Tables 2a and 2b and Figures 3a and 3b. The results of soil samples collected during the CAP-Part A investigation are summarized below.

- Benzene was detected in 11 of the 38 soil samples at concentrations ranging from 0.16J mg/kg to 5.5J mg/kg; however, there were 7 samples with detection limits above the benzene STL of 0.017 mg/kg.
- Toluene was detected in 21 of the 38 soil samples at concentrations ranging from 0.0041J mg/kg to 160 mg/kg. Only one of the concentrations exceeded the toluene STL of 115 mg/kg.
- Ethylbenzene was detected in 23 of the 38 soil samples at concentrations ranging from 0.0067 mg/kg to 96J mg/kg. Only four of the concentrations exceeded the ethylbenzene STL of 18 mg/kg.
- Xylenes were detected in 34 of the 38 soil samples at concentrations ranging from 0.0015J mg/kg to 260J mg/kg. These concentrations did not exceed the xylenes STL of 700 mg/kg.
- Twelve PAH compounds were detected in 16 of the 38 soil samples with concentrations of benzo(a)pyrene, benzo(b)fluoranthene, and chrysene exceeding the STL of 0.660 mg/kg.
- TPH-DRO was detected in 29 of the 38 soil samples at concentrations ranging from 4.2 mg/kg to 550 mg/kg.
- TPH-GRO was detected in 28 of the 38 soil samples at concentrations ranging from 0.51 mg/kg to 21,000J mg/kg.

Results from the CAP-Part A SI indicate that there were two areas of soil contamination where concentrations of benzene, toluene, ethylbenzene, benzo(a)pyrene, benzo(b)fluoranthene, and chrysene, exceeded the applicable GUST STLs (i.e., Table B, Column 1) during the CAP-Part A SI. These areas consist of the

area in the vicinity of the Former Pumphouse #1 tank pit and the vicinity around the Former Fuel Pit 1A/DAACG area. The areas of soil contamination are shown in Figures 3b through 3e.

II.A.1.a.5. Former Pumphouse #1 CAP-Part B Site Investigation (May 1997 and November 1999)

During the CAP-Part B SI, 58 soil samples were collected for geochemical analysis from 29 soil borings and monitoring wells (P1-SB25 through P1-SB41, and P1-MW13 through P1-MW24) installed in May 1997, as presented in Figure 2. Three additional monitoring wells (P1-MW36, P1-MW40, and P1-MW42) were installed in September 1999. Well P1-MW36 was installed to determine the extent of groundwater contamination on the south side of the drainage ditch, and with GA EPD concurrence, no soil samples were collected from this boring. Well P1-MW40 was installed to be used for aquifer testing, and two soil samples were collected from this well. Well P1-MW42 was installed west of the area of contamination in the vicinity of Former Fuel Pit 1A/DAACG to determine the extent of groundwater contamination west of this area, and with GA EPD concurrence, no soil samples were collected from this boring. Analytical results are presented in Tables 2a and 2b. Sample locations and analytical results are presented in Figures 3a and 3b. Fourteen of the 32 soil borings were converted to shallow monitoring wells to delineate the extent of contamination, and one of the soil borings was converted to a deep monitoring well (P1-MW24). Field screening methods were used during drilling to select soil samples for geochemical analysis.

Analytical results for soil sampling are summarized in Tables 2a and 2b and presented in the plan view in Figure 3a. The results exceeding applicable GUST STLs are presented in the cross-sections in Figure 3b. The results of soil samples collected during the CAP-Part B investigation are summarized below.

- Benzene was detected in 5 of the 60 soil samples at concentrations ranging from 0.0014 mg/kg to 5.1J mg/kg; however, there were 13 samples with detection limits above the benzene STL of 0.017 mg/kg.

- Toluene was detected in 25 of the 60 soil samples at concentrations ranging from 0.0078 mg/kg to 180 mg/kg, and there were 9 samples with detection limits above the reporting limit. Only two of the concentrations exceeded the toluene STL of 115 mg/kg. None of the elevated detection limits exceeded the STL.

- Ethylbenzene was detected in 26 of the 60 soil samples at concentrations ranging from 0.0062 mg/kg to 82J mg/kg, and there were 5 samples with detection limits above the reporting limit. Only six of the concentrations exceeded the ethylbenzene STL of 18 mg/kg. None of the elevated detection limits exceeded the STL.

- Xylenes were detected in 35 of the 60 soil samples at concentrations ranging from 0.0062 mg/kg to 530 mg/kg. These concentrations did not exceed the xylenes STL of 700 mg/kg.

- Fourteen PAH compounds were detected in 32 of the 60 soil samples with concentrations of chrysene exceeding the STL of 0.660 mg/kg.

- TPH-DRO was detected in 31 of the 60 soil samples at concentrations ranging from 11 mg/kg to 390 mg/kg.

- TPH-GRO was detected in 31 of the 60 soil samples at concentrations ranging from 0.24 mg/kg to 9900 mg/kg.

Concentrations of benzene, ethylbenzene, and chrysene exceeded the applicable GUST STLs (i.e., Table B, Column 1) in the vicinity of the Former Pumphouse #1 tank pit area and the Fuel Pit 1A/DAACG area during the CAP-Part B SI.

II.A.1.b. Field screening results

Field screening through VOC headspace was performed on all soil samples collected from above the saturated zone during the various investigations. For each 2-foot-length soil sample collected, VOC headspace readings were measured with an organic vapor analyzer. The field screening results for the various site investigations are presented on each boring log presented in Appendix IV.

II.A.1.c. Conclusions of the Site Soil Contamination

In the vicinity of the Former Fuel Pit 1A/DAACG area (Release #1), benzene, toluene, ethylbenzene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene exceeded the applicable GUST STLs (i.e., Table B, Column 1) and benzene, benzo(a)pyrene, chrysene, and indeno(1,2,3-cd)pyrene exceeded their respective alternate threshold levels (ATLs).

In the vicinity of the Former Pumphouse #1 tank pit area (Release #2), benzene, toluene, ethylbenzene, benzo(a)pyrene, benzo(b)fluoranthene, and chrysene exceeded the applicable GUST STLs (i.e., Table B, Column 1), and benzene and chrysene exceeded their respective ATLs.

II.A.2. Delineation of Groundwater Contamination

Petroleum-related contaminants detected in groundwater at the Former Pumphouse #1 site during the previous investigations, CAP-Part A SI, and CAP-Part B SI included BTEX and numerous PAH compounds.

Results from the various investigations indicate that there are two separate areas of groundwater contamination. These areas consist of the area in the vicinity of the former tank pits near the former pumphouse and the vicinity around Former Fuel Pit 1A/DAACG.

II.A.2.a. Horizontal extent of groundwater contamination

II.A.2.a.1. UST Closure (1995)

During the 1995 UST closure activities, eight groundwater samples were collected from each of the UST tank pits as groundwater seeped into the excavation. The analytical results are presented in Tables 1c and 1d. BTEX and numerous PAH compounds were detected in all of the groundwater samples. The benzene concentrations exceeded the IWQS of 71.28 µg/L in all of the samples. Concentrations of benzo(a)anthracene, benzo(a)pyrene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene, and indeno(1,2,3-cd)pyrene exceeded their respective IWQS.

II.A.1.a.2. DAACG Facility CAP-Part A Site Investigation (March 1995)

The DAACG CAP-Part A SI was initiated after contaminated groundwater was observed during the geotechnical investigation associated with the design of the foundation for the new DAACG building that was to be constructed. The investigation was limited to an area around the current DAACG building. During the CAP-Part A SI, two groundwater samples were collected from two piezometers. BTEX constituents and naphthalene were detected in both groundwater samples. As a result, a site investigation plan for a CAP-Part B investigation was developed.

II.A.2.a.3. DAACG Facility CAP-Part B Site Investigation (May 1996)

During the CAP-Part B SI, 31 groundwater samples were collected from 32 monitoring wells scattered throughout the DAACG Facility investigation area as presented in Figure 2. The wells associated with this investigation have a D prefix. This investigation covered the active area of the tarmac located north of the Former Pumphouses #1 and #2 and west of Pumphouses #3, #4, and #5. The analytical results were provided in the CAP-Part B Report (M&E 1996) and are summarized in tabular format in Appendix VIII (page VIII-147). The data are presented in Figures 4 through 8 of this report with the Former Pumphouse #1 CAP-Part A and CAP-Part B data. BTEX, 1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, fluorene, and naphthalene were detected in groundwater samples throughout the investigation area. Results from the 1996 CAP-Part B SI at the DAACG Facility indicated that the extent of groundwater contamination to the south of the tarmac was not determined, but would be investigated as part of the CAP-Part A and CAP-Part B investigations associated with Former Pumphouse #1.

In the vicinity of the Former Fuel Pit 1A/DAACG area, concentrations of benzene exceeded the applicable IWQS during the 1996 DAACG CAP-Part B SI.

In the vicinity of the Former Pumphouse #1 tank pit area, concentrations of benzene exceeded the applicable IWQS during the 1996 DAACG CAP-Part B SI.

II.A.2.a.4. Former Pumphouse #1 CAP-Part A & Part B Site Investigation (December 1996 and May 1997)

During the Former Pumphouse #1 CAP-Part A SI in December 1996, five groundwater samples were collected for chemical analysis from five monitoring wells, as presented in Tables 3a and 3b, to determine the horizontal extent of groundwater contamination at the site. To delineate the dissolved benzene contamination plume, a CAP-Part B SI was conducted in May 1997. Twelve wells were installed during the Former Pumphouse #1 CAP-Part B SI in 1997, and 12 groundwater samples were collected. Because these two sampling events were conducted within six months of each other, they have been combined to provide sufficient aerial coverage for plume delineation. The results of the 1999 and 2000 CAP-Part B SI sampling events are discussed in Section II.A.2.a.4.

Benzene was identified in 10 groundwater samples, including a detection limit above the reporting limit, during the 1996 and 1997 investigations. Benzene concentrations ranged from 4.2J µg/L to 1100 µg/L, as illustrated in Figure 4. The concentrations in seven samples exceed the Georgia IWQS of 71.28 µg/L. The concentrations in nine samples exceed the federal maximum contaminant level (MCL) of 5 µg/L. The concentrations in 10 samples exceed the risk-based screening level of 0.36 µg/L. The concentrations in three samples were above the site alternate concentration limit (ACL) for benzene of 285 µg/L (Appendix VI). The analytical detection limit for benzene was 2.2 µg/L in all samples except for sample HT4-MW01 from well P1-MW01.

Toluene was identified in 11 groundwater samples during the 1996 and 1997 investigations at concentrations ranging from 40 µg/L to 25,000 µg/L, as illustrated in Figure 5. The concentrations did not exceed the Georgia IWQS of 200,000 µg/L; however, five of the concentrations exceeded the federal MCL of 1,000 µg/L and the risk-based screening level of 750 µg/L. None of the concentrations was above the site ACL for toluene of 800,000 µg/L (Appendix VI). The analytical detection limit for toluene was 1 µg/L in all samples.

Ethylbenzene was identified in 12 groundwater samples during the 1996 and 1997 investigations. Ethylbenzene concentrations ranged from 2.3 µg/L to 2000 µg/L, as illustrated in Figure 6. The

concentrations did not exceed the Georgia IWQS of 28,718 µg/L; however, five of the concentrations exceeded the federal MCL of 700 µg/L, and three of the concentrations exceeded the risk-based screening level of 1,300 µg/L. None of the concentrations was above the site ACL for ethylbenzene of 114,800 µg/L (Appendix VI). The analytical detection limit for ethylbenzene was 1 µg/L in all samples.

Total xylenes were identified in 11 groundwater samples during the 1996 and 1997 investigations. Total xylene concentrations ranged from 110 µg/L to 9500 µg/L, as illustrated in Figure 7. There is no Georgia IWQS for xylenes. The concentrations did not exceed the federal MCL of 10,000 µg/L or the risk-based screening level of 12,000 µg/L; thus, an ACL was not necessary. The analytical detection limit for total xylenes was 1 µg/L in all samples.

During the 1996 and 1997 investigations, several PAH compounds were estimated or detected at concentrations at or below 10 µg/L in several groundwater samples. The compounds include acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i,)perylene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene. Concentrations of benzo(a)anthracene, benzo(a)pyrene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene exceeded their IWQS of 0.0311 µg/L for all compounds. None of the PAH compounds exceeded their respective ACLs (Appendix VI).

Naphthalene was identified in eight groundwater samples during the 1996 and 1997 investigations. Naphthalene concentrations ranged from 1.5 µg/L to 16 µg/L, as illustrated in Figure 8. This compound does not have a Georgia IWQS or federal MCL; however, the concentrations in six samples are above the current risk-based screening level of 6.5 µg/L. None of the concentrations was above the site ACL for naphthalene of 260 µg/L (Appendix VI).

II.A.2.a.5. Former Pumphouse #1 CAP-Part B Site Investigation (September 1999 and February 2000)

As a result of the January 1999 meeting with GA EPD, three additional monitoring wells were installed in September 1999 to determine the vertical and horizontal extent of the dissolved benzene contamination plume that was not determined in 1997. Groundwater samples were collected from selected wells within the Former Pumphouse #1 tank pit area in November 1999. In February 2000, groundwater samples were collected from selected wells within the Former Fuel Pit 1A/DAACG Area. Twenty-two groundwater samples were collected for geochemical analysis, as presented in Tables 3a and 3b. Monitoring well locations are presented in Figure 2.

Benzene was identified in 14 groundwater samples during the 1999 and 2000 investigations. Benzene concentrations ranged from 50.3 µg/L to 4580 µg/L, as illustrated in Figure 9. The concentrations in 13 samples exceed the Georgia IWQS of 71.28 µg/L. The concentrations in 14 samples exceed the federal MCL of 5 µg/L and the risk-based screening level of 0.36 µg/L. The concentrations in nine samples were above the site ACL for benzene of 285 µg/L (Appendix VI). With the exception of two samples, the analytical detection limit for benzene was less than 1 µg/L.

Toluene was identified in 16 groundwater samples during the 1999 and 2000 investigations. Toluene concentrations ranged from 31 µg/L to 19,000 µg/L, as illustrated in Figure 10. The concentrations did not exceed the Georgia IWQS of 200,000 µg/L. However, the concentrations in seven samples exceeded the federal MCL of 1,000 µg/L and the risk-based screening level of 750 µg/L. None of the concentrations was above the site ACL for toluene of 800,000 µg/L (Appendix VI). The analytical detection limit for toluene was less than 1 µg/L.

Ethylbenzene was identified in 19 groundwater samples during the 1999 and 2000 investigations. Ethylbenzene concentrations ranged from 100 µg/L to 1800 µg/L, as illustrated in Figure 11. The concentrations did not exceed the Georgia IWQS of 28,718 µg/L. The concentrations in 6 samples exceeded the risk-based screening level of 1,300 µg/L, and the concentrations in 11 samples exceeded the MCL of 700 µg/L. None of the concentrations was above the site ACL for ethylbenzene of 114,800 µg/L (Appendix VI). The analytical detection limit for ethylbenzene was less than 1 µg/L.

Total xylenes were identified in 19 groundwater samples during the 1999 and 2000 investigations. Total xylene concentrations ranged from 404 µg/L to 10,000 µg/L, as illustrated in Figure 12. There is no Georgia IWQS for xylenes. The concentrations did not exceed the federal MCL of 10,000 µg/L or the risk-based screening level of 12,000 µg/L; thus an ACL was not necessary. The analytical detection limit for total xylenes was less than 2 µg/L.

During the 1999 and 2000 investigations, PAHs were only analyzed from the groundwater samples associated with the three wells installed in September 1999. Naphthalene was the only PAH compound detected at a concentration of 2.1 µg/L in well P1-MW40. This compound does not have a Georgia IWQS or federal MCL; however, the concentration in the sample was below the current risk-based screening level of 6.5 µg/L and the site ACL for naphthalene of 260 µg/L (Appendix VI).

II.A.2.a.6. Conclusions of the Horizontal Extent of Site Groundwater Contamination

Figures 4 through 12 demonstrate that the horizontal and vertical extent of petroleum contaminants in groundwater has been delineated to the appropriate analytical detection. Petroleum contaminants identified in groundwater at the Former Pumphouse #1 site include BTEX constituents as well as PAH constituents. The results of the CAP-Part B SI indicate that there are two separate plumes related to the operation of the Former Pumphouse #1 that are known as the Former Fuel Pit 1A/DAACG area (Release #1) and the Former Pumphouse #1 tank pit area (Release #2).

The Former Pumphouse #1 tank pit area plume is located in the vicinity of Former Fuel Pits 1C and 1D and the former tank pits located at former Building 8060. The horizontal extent of this plume was defined during the CAP-Part B SI. The groundwater is migrating toward the drainage ditch located to the south of the former tank pits; however, the dissolved plume does not migrate beyond the drainage ditch to the south. Several PAH compounds exceeded their respective IWQS or risk-based screening criteria, but the concentrations did not exceed their respective ACLs. Benzene was the only contaminant to exceed its IWQS and ACL during the various investigations.

Another plume of groundwater contamination is located in the vicinity of the Former Fuel Pit 1A/DAACG area. The horizontal extent of this plume was defined during the CAP-Part B SI. The groundwater is migrating toward the underground storm drain located to the northwest of the Former Fuel Pit 1A. The dissolved plume appears to migrate beyond the storm drain to the northwest. Several PAH compounds exceeded their respective IWQS or risk-based screening criteria, but the concentrations did not exceed their respective ACLs. Benzene was the only contaminant to exceed its IWQS and ACL during the various investigations.

II.A.2.b. Vertical extent of groundwater contamination

In the Former Pumphouse #1 tank pit area, the vertical extent of groundwater contamination was delineated through soil sampling at P1-MW40 and D-SB23. Soil samples were collected from 2-foot intervals to the total boring depth, and VOC headspace readings were measured for each interval. Boring D-SB23 was drilled to 20.0 feet below ground surface (BGS) and soil samples were collected from 1.5 – 3.5, 8.0 – 10.0, 13.0 – 15.0, and 18.0 – 20.0 feet BGS; the results are presented in Appendix V (page V-238).

The sample collected at 8.0 – 10.0 feet contained the highest concentrations of BTEX compounds, and benzene was detected at 0.091 mg/kg in the 18.0 – 20.0 foot sample, which is above the STL. Well P1-MW40 was drilled to 60.0 feet BGS and soil samples were collected from 8.0 – 10.0 and 48.0 – 50.0 feet BGS. The results are presented in Table 2a. The sample collected at 10.0 – 12.0 feet contained concentrations of BTEX, PAHs, TPH-DRO, and TPH-GRO. No BTEX, PAHs, TPH-DRO, or TPH-GRO constituents were detected in the 48.0 – 50.0 feet BGS sample interval, but the interval did contain a benzene detection limit of 0.029 mg/kg that is slightly above the STL. Since there was no estimated concentration of benzene below the elevated detection limit, benzene is probably not present above the STL at that depth. Thus, the vertical extent of groundwater contamination has been delineated and is confined to the Surficial Aquifer (i.e., less than 50.0 feet BGS). In addition, well P1-MW24 was installed near the downgradient perimeter of the plume and screened from 29.5 – 34.5 feet BGS. BTEX and PAH constituents were not detected in the groundwater sample from this well.

Within the Former Fuel Pit 1A/DAACG area, the vertical extent of groundwater contamination was delineated through soil sampling at D-SB02, D-SB06, and D-SB10. Soil samples were collected from 2-foot intervals to the total boring depth and VOC headspace readings were measured for each interval. Each boring was drilled to 20.0 feet BGS and soil samples were collected from 1.5 – 3.5, 8.0 – 10.0, 13.0 – 15.0, and 18.0 – 20.0 feet BGS; the results are presented in Appendix V (pages V-230, V-231, V-232, and V-233, respectively). In boring D-SB02, no BTEX compounds were detected in any of the samples; however, several PAH compounds were detected at the 8.0 – 10.0-foot interval. In boring D-SB06, BTEX compounds were detected at the 8.0 – 10.0-foot interval and no PAH compounds were detected in any of the samples. In boring D-SB10, BTEX compounds were detected in the three lower samples with the highest concentrations at the 8.0 – 10.0 foot interval. Benzene was present in the 18.0 – 20.0-foot interval at a concentration of 0.22 mg/kg. The vertical extent of groundwater contamination has been delineated to 20 feet BGS within the Surficial Aquifer at the Former Fuel Pit 1A/DAACG area; however, there may be some minor contamination below 20 feet BGS.

II.A.3. Delineation of Free Product Plume

Free product was identified at the Former Fuel Pit 1A/DAACG area in February 2000. The free product was observed in wells D-MW1, D-MW2, D-MW6, D-MW8, D-MW11, D-MW13, and D-MW17 at thicknesses ranging from a sheen to 0.88 feet, as shown in Figure 13 and Table 8.

Interim corrective action consisted of free product recovery in the wells via absorbent socks, which were installed on February 22, 2000. The absorbent socks were removed and replaced on May 24, 2000, and July 24, 2000.

II.A.4. Delineation of Surface Water and Sediment Contamination

II.A.4.a. CAP-Part A Investigation (December 1996)

Surface water and sediment samples were collected from four locations around the Former Pumphouse #1 site (Figure 14 and Tables 4 and 5). The sampling points were located in the drainage ditch that is approximately 300 feet south of the former tank pits of the Former Pumphouse #1 site. Surface water flow is to the west toward Lamar Canal.

BTEX constituents were detected in three of the four surface water samples and no PAH constituents were detected in any of the surface water samples. At location P1-SWE07, located 325 feet southwest of the former tank pits, benzene was detected at 19J µg/L, toluene was detected at 230J µg/L, ethylbenzene was detected at 30J µg/L, and xylenes were detected at 270 µg/L. At location P1-SWE08, located 500 feet southwest of the former tank pits, benzene was detected at 5.2J µg/L, toluene was detected at 50J µg/L,

ethylbenzene was detected at 3.8J µg/L, and xylenes were detected at 55 µg/L. At location P1-SWE09, located 1900 feet west of the former tank pits, toluene was detected at 1.8J µg/L and xylenes were detected at 3.1J µg/L. Each of these concentrations was below its respective IWQS.

No BTEX constituents were detected in any of the four sediment samples although P1-SWE07 had a benzene detection limit of 0.62 mg/kg. At P1-SWE07, TPH-GRO was detected at 130J mg/kg and total PAHs were 0.6 mg/kg. At P1-SWE09, TPH-DRO was detected at 24 mg/kg and total PAHs were 12.3 mg/kg. At P1-SWE10, TPH-GRO was detected at 0.98J mg/kg and total PAHs were 15.7 mg/kg. Elevated TPH-DRO detection limits above 10 mg/kg were observed in sediment samples from P1-SWE07, P1-SWE08, and P1-SWE10. These sediment locations are southwest of the site.

II.A.4.b. CAP-Part B Investigation (February 1999)

As a result of the January 1999 meeting with GA EPD, five additional surface water samples were collected at locations east of P1-SWE08, which were more directly downgradient of the Former Pumphouse #1 tank pit area (Figure 15 and Table 4) than the CAP-Part A locations and more likely to intercept the dissolved groundwater plume. GA EPD approved the surface water sample locations during the January 1999 meeting. No BTEX or PAH constituents were detected at locations P1-SW5 and PW-SW6. Benzene was detected at 11.1 µg/L at P1-SW7, 9 µg/L at P1-SW8, and 8.5 µg/L at P1-SW9. Toluene was detected at 96 µg/L at P1-SW7, 144 µg/L at P1-SW8, and 185 µg/L at P1-SW9. Ethylbenzene was detected at 36.4 µg/L at P1-SW7, 5.4 µg/L at P1-SW8, and 32 µg/L at P1-SW9. Total xylenes were detected at 76.8 µg/L at P1-SW7, 133.8 µg/L at P1-SW8, and 182.5 µg/L at P1-SW9. No PAH constituents were detected in any of the surface water samples. Each of these concentrations was below its respective IWQS. As a result of this surface water sampling, it appears that the dissolved groundwater plume emanating from Former Pumphouse #1 tank pit area is impacting the drainage ditch, but at concentrations below the respective IWQS.

With GA EPD concurrence, sediment samples were not collected in February 1999.

II.B. REGIONAL, LOCAL, AND SITE HYDROGEOLOGY

Discussion of the regional, local, and site hydrogeology is based on field observations and other investigative activities performed, including a water resource survey, during the CAP-Part A and CAP-Part B investigations of the Former Pumphouse #1 site.

II.B.1. Documentation of Local Groundwater Conditions

II.B.1.a. Groundwater usage

According to the Fort Stewart DPW, nine water supply wells are located within the confines of the HAAF area (Figures 16 and 17). These wells have the potential to provide up to 3,890 gallons per minute (gpm) of water to occupants of the HAAF installation. The Fort Stewart DPW was unable to provide documentation listing the companies responsible for well installation and drillers' logs showing as-built information and subsurface geologic data. Information concerning such documentation was requested from several water well drilling companies in the Chatham County area; however, data procurement met with very limited success. The Fort Stewart DPW provided well locations, pump rates, treatments, casing depths, and total depths for eight of the nine wells located at HAAF. Because of the lack of data, documentation of subsurface geology based on HAAF drill logs remains extremely limited. Therefore, other references containing deep-well information were used to document the subsurface geology and aquifer characteristics underlying HAAF and the vicinity.

Wells 1 and 2, both public water supply wells located in the cantonment area of HAAF, constitute the main water supply system at HAAF (Figure 17). Well 1, located at Building 711 on the corner of Moore Road and Douglas Street, is a 12-inch-diameter well with a 100-hp turbine pump serving a 100,000-gallon elevated storage tank (Tank 1) through 10-inch lines. Water from Well 1 is injected with hydrofluosilic acid and chlorine gas solution at the well house. Well 2, located at Building 1205 on the corner of Neal Street and Lightning Drive, is a 12-inch-diameter well with a 100-hp turbine pump serving a 200,000-gallon elevated tank (Tank 2) through 10-inch lines. Water from Well 2 is also injected with hydrofluosilic acid and chlorine gas solution at the well house. Wells 1 and 2 provide water to a 500,000-gallon elevated storage tank (Tank 3) located on Middleground Road behind noncommissioned officer (NCO) family housing. This tank provides potable water to 694 service connections, which are used by an average of at least 5,000 individuals year-round.

Wells 3, 4A, and 7 are public supply wells located outside the cantonment area of HAAF. Well 3, located at Building 8455, is a 4.0-inch-diameter well with a 1.0-hp electric submersible pump serving a 1,000-gallon hydropneumatic storage tank through 1.5-inch galvanized steel lines. Water from Well 3 is treated with calcium hypochlorite solution and is consumed by approximately 25 people during daytime hours, year-round. Well 4A, located at Building 8581 at the 117th Air National Guard Facility, is a 4.0-inch-diameter well. Pumpage is accomplished with a 0.75-hp turbine pump with 80-gpm capacity. Well 4A provides water for approximately 50 people per day year-round. Well 7 is located at Building 8703 on the Forest River, west of Rio Road. Well 7 is a 4.0-inch diameter well with a 3.0-hp submersible pump serving a 5,000-gallon hydropneumatic tank through 2.0-inch galvanized steel lines. Well 7 serves approximately 500 people on a part-time basis. Sanitary protection for Wells 3, 4A, and 7 is provided by a pump motor block, concrete slab, sealed well head, and screened casing vent.

Based on the GA EPD criteria of serving potable water to less than 25 occupants per day and having less than 15 service connections, Wells 5, 8, and 9 are classified as non-public supply wells.

Well 10 is a non-potable water source and the water is used for cleaning military equipment at a wash-rack facility. Additional information, including capacity, borehole depth, and casing depth, is not available.
The locations of supply wells found outside the boundary of HAAF are shown on Figure 17. These wells include #1, 42, 13, 25, 15, 27, 14, 23, 6, and 9. The City of Savannah Bureau of Water Operations was unable to provide drilling logs or as-built well information.

The Former Pumphouse #I site is located approximately 4,200 feet southwest (downgradient) of HAAF Well 2, which is located at Building 1205 on Lightning Road. Well 3, which is located at Building 8455, is approximately 6,700 feet southwest (downgradient) of the Former Pumphouse #1 site. Therefore, the Former Pumphouse #1 site is classified as being greater than 500 feet to a withdrawal point. Well 2 is part of the main public water supply system at HAAF. This system supplies water to approximately 7,500 people through 525 service connections.

II.B.1.b. Aquifer description

The hydrogeology in the vicinity of HAAF is mostly influenced by two aquifer systems. These are referred to as the Principal (Floridan) Aquifer and the Surficial Aquifer (Miller 1990). The Principal Aquifer is the lowermost hydrologic unit and is regionally extensive from South Carolina to Georgia, Alabama, and most of Florida. Known elsewhere as the Floridan, this aquifer, approximately 800 feet in total thickness, is composed primarily of Tertiary-age limestone, including the Bug Island Formation, the Ocala Group, and the Suwannee Limestone. Groundwater from the Floridan is used primarily for drinking water (Arora 1984). According to Miller (1990), one of the largest cones of depression produced in the Floridan Aquifer exists directly beneath Savannah, Georgia. According to 1980 estimates, more than

500 million gallons of water per day were withdrawn from the Floridan Aquifer for public and industrial use in southeast Georgia, more than any other region (Miller 1990).

The confining layer for the Floridan Aquifer is the phosphatic clay of the Hawthorn Group. There are minor occurrences of aquifer material within the Hawthorn Group; however, they have limited utilization (Miller 1990). The Surficial Aquifer overlies the Hawthorn confining unit.

The Surficial Aquifer consists of widely varying amounts of sand and clay, ranging from 55 to 150 feet in thickness, and is composed primarily of the Satilla and Cypresshead Formations in the Savannah vicinity (Arora 1984). This aquifer is primarily used for domestic lawn and agricultural irrigation. The top of the water table ranges from approximately 2 to 10 feet BGS (Miller 1990). Groundwater in the Surficial Aquifer system is under unconfined, or water table, conditions. However, locally, thin clay beds create confined or semiconfined conditions.

Groundwater encountered at HAAF UST investigation sites is part of the Surficial Aquifer system. Based on the fact that all public and non-public water supply wells draw water from the Floridan Aquifer, and that the Hawthorn confining unit separates the Floridan Aquifer from the Surficial Aquifer, it is concluded that there is no hydraulic interconnection between HAAF UST sites (and associated plumes) and water supply withdrawal points.

II.B.1.c. Surface water

The water resources survey conducted during the CAP-Part B SI is presented in Appendix III. Surface water bodies at HAAF include Hallstrom Lake, Lamar Canal, Buckhalter Canal, Springfield Canal, Pond 29 located northwest of Buildings 336 and 232, and an unnamed pond located along the southeast boundary of the HAAF installation (Figure 18). Several unnamed drainage canals and ditches exist throughout HAAF. Most of these canals drain southwest into the Little Ogeechee River, which is part of the Lower Ogeechee watershed. The remaining drainage canals located on the east side of the HAAF installation flow east and eventually drain into the Vernon River, which is located southeast of the HAAF installation. Surface water bodies at HAAF and adjacent areas are not used as public water supplies. The ponds and lakes, as well as Lamar Canal, are perennial, whereas most of the drainage canals and ditches are intermittent. Most of the drainage canals are at least partially enclosed in culverts.

There is a groundwater divide at the Former Fuel Pit 1A/DAACG area with groundwater flowing to the south-southwest and to the northwest. To the southwest, there is an underground storm drain located 510 feet south-southwest of D-MW2, which is connected to a drainage ditch located south of the former tank pit area. To the northwest, there is an underground storm drain located 450 feet northwest of D-MW2 and a drainage ditch located 1000 feet northwest of D-MW2. At the Former Pumphouse #1 tank pit area, a drainage ditch is located approximately 300 feet south of the former tank pits and may receive some of the groundwater from the site. Based on the surface water features discussed in Appendix III, the Former Pumphouse #1 site, Facility ID #9-025085, is classified as being located less than 500 feet to a surface water body.

There are numerous underground water, electrical, and abandoned fuel lines that connect the former fuel pits located at the edge of the taxiway north of the former tank pits. These underground lines are located upgradient of the area of contamination around the former tank pits and are located within the area of contamination near the Former Fuel Pit 1A/DAACG area. The invert depth of the former fuel transfer line in the vicinity of Fuel Pit 1A is approximately 6.4 feet BGS. There are two monitoring wells that are located in the vicinity of Fuel Pit 1A, and in November 1999, the depths to groundwater in these wells were 8.74 feet in P1-MW11and 9.22 feet in P1-MW13. Thus, the invert depth of the former fuel transfer line is

located approximately 2.0 feet above the water table. The water and electrical lines run adjacent to the former fuel transfer line. It is estimated that the invert depths of these utilities are no more than 5 feet BGS.

The invert depth of the former fuel transfer line in the vicinity of Fuel Pit 1C, which is located north of the former tank pit area, is approximately 7.6 feet BGS. There are two monitoring wells that are located in the vicinity of Fuel Pit 1C, and in November 1999, the depths to groundwater in these wells were 8.71 feet in P1-MW3 and 8.83 feet in P1-MW22. Thus, the invert depth of the former fuel transfer line is located approximately 1.0 feet above the water table. The water and electrical lines run adjacent to the former fuel transfer line. It is estimated that the invert depths of these utilities are no more than 5 feet BGS.

II.B.2. Stratigraphic Boring Logs

The local stratigraphy of HAAF and the vicinity is presented in Section II.B.2.a, and the site stratigraphy from the CAP-Part A and CAP-Part B SIs is presented in Section II.B.2.b.

II.B.2.a. Local stratigraphy

HAAF is located within the Barrier Island Sequence District of the Coastal Plain Physiographic Province of the Southeast United States (Clark and Zisa 1976). The Barrier Island Sequence District in Chatham and Bryan Counties is characterized by the existence of several marine terraces (step-like topographic surfaces that decrease in elevation toward the coast). These marine terraces, and their associated deposits, are the result of sea level fluctuations that occurred during the Pleistocene Epoch. The surficial (Quaternary) deposits in Chatham and Bryan Counties, in decreasing elevation and age, are part of the Okefenokee, Wicomico, Penholoway, Pamlico, and Silver Bluff terrace complexes.

HAAF, as well as most of Chatham County, is underlain by the Pleistocene Pamlico Terrace. The Pleistocene Satilla Formation (formerly known as the Pamlico Formation) consists of deposits of the Pamlico Terrace complex and other terrace complexes in the region. The Satilla Formation is a lithologically heterogeneous unit that consists of variably bedded to non-bedded sand and variably bedded silty to sandy clay. During the Pleistocene, these sand and clay deposits were formed in offshore and inner continental shelf, barrier island, and marsh/lagoonal-type environments. According to the Geologic Map of Georgia, clay beds of marsh origin, which were deposited on the northwest side of the former Pamlico Barrier Island complex, exist in the western quarter of HAAF. Very fine- to coarse-grained sand deposits of barrier island origin are more common throughout the remaining areas of HAAF.

II.B.2.b. Site stratigraphy

As determined from soil borings drilled during the CAP-Part B SI, the lithologies present within 15 feet of the surface at the site appear to correlate with the regional stratigraphic section. CAP-Part A and CAP-Part B soil boring logs are located in Appendix IV. The lithology encountered is predominantly a white, pale brown, or light gray, very fine to medium-grained sand, with variable silt and clay content. Generally, the samples with higher silt and clay content were within a few feet of the surface. Less silt and clay content was noted with depth. The boring log of the deep well P1-MW40 indicates an increasing clay content from approximately 26 feet BGS to 30 feet BGS, becoming a clayey, coarse grained sand/gravel at 30 feet BGS.

II.B.3. Stratigraphic Cross-Sections

Stratigraphic cross-sections have been developed based on the CAP-Part B SI soil boring logs. Cross-sections A-A' (west/east from Former Fuel Pit 1A to the former tank pit area), B-B' (north/south through the former tank pit area), and C-C' (southeast/northeast through the Former Fuel Pit 1A/DAACG area), presented in Figure 3a, show the site geology as determined by drilling and sampling activities.

II.B.4. Referenced or Documented Calculations

Referenced or documented calculations performed to support the CAP-Part B SI include those used in developing and interpreting the results of geotechnical analysis and groundwater slug testing.

II.B.4.a. Geotechnical Analysis

Disturbed soil samples were collected from wells P1-MW13, P1-MW14, P1-MW17, P1-MW18, P1-MW19, P1-MW20, P1-MW23, and P1-MW24 for grain size analysis. In addition, undisturbed soil samples were collected from wells P1-MW15, P1-MW16, P1-MW21, and P1-MW22 and soil boring P1-SB33 in order to determine selected engineering properties of the saturated zone underlying the Former Pumphouse #1 site. The engineering properties measured included moisture content, porosity, specific gravity, bulk density, and permeability, as presented in Table 6 and Attachment A. Geotechnical samples were not collected from the five additional well borings drilled in 1999.

II.B.4.b. Slug Testing

Slug-out tests were conducted on shallow wells P1-MW01, P1-MW02, and P1-MW24 (i.e., deep well) on November 2, 1999. The slug test data were evaluated using the Bouwer and Rice method in the AQTESOLVE Professional v.4.5 (1999) software. Calculated hydraulic conductivity values are 1.32×10^{-2} ft/min (6.7×10^{-3} cm/s), 1.75×10^{-2} ft/min (8.9×10^{-3} cm/s), and 4.5×10^{-3} ft/min (2.3×10^{-3} cm/s), respectively. The average hydraulic conductivity of the surficial aquifer near Former Pumphouse #1, based on slug test data, is 1.17×10^{-2} ft/min (6.0×10^{-3} cm/s). Calculations for determining the hydraulic conductivity and transmissivity from the slug test data are presented in Attachment A.

II.B.4.c. Aquifer Testing

Aquifer testing was performed at the Former Pumphouse #1 site on November 2-5, 1999. An 8-hour step test was performed using well P1-MW40 to determine the optimum pumping rate for this well, which turned out to be 3 gallons per minute (gpm). Static water levels and barometric pressure was monitored for a 24-hour period (steady state) before the 24-hour aquifer test was conducted. The 24-hour aquifer test was conducted with P1-MW40 as the pumping well and wells P1-MW02, P1-MW03, P1-MW22, P1-MW23, and D-MW5 as observation wells. Water levels were also recorded during the recovery period after pumping stopped. Water levels and barometric pressure were measured using electronic data loggers. All aquifer test data and methodologies are discussed in Attachment A.

Discharge water generated during the step drawdown and 24-hour aquifer pumping tests was containerized in an above ground, 21,000-gallon-capacity frac tank. Two samples of the water in the tank were used to characterize the liquid for proper disposal. A total of 5,678 gallons of waste water was generated from well pumping activities. All fluids were removed from the frac tank on December 9, 1999, and were transported to Industrial Water Services, Inc., in Jacksonville, Florida, for recycling. A manifest documenting the proper disposal of all fluids generated at the site in November is provided in Attachment A (page A-60).

The drawdown data were corrected for barometric influence. Both drawdown data and the pumping well recovery data were then evaluated using AQTESOLVE Professional v.4.5 (1999) groundwater test data analysis software for unconfined aquifers. After correcting for barometric influences, only the data from P1-MW03 yielded sufficient response to enable evaluation with the software. Figure 18 provides a summary of water level and barometric measurements over the pumping period. As illustrated, water level measurements from wells P1-MW02 and P1-MW22 changed so little over the testing period that evidence of pumping influence could not be accurately determined. Therefore, data from these wells

were not evaluated quantitatively. In addition to the aquifer withdrawal data analysis, the recovery data for P1-MW40 (the pumping well) were also evaluated quantitatively. Details of calculations performed on the data are provided in Attachment A.

The computer program generated a match line for P1-MW03 using the Neuman solution yielding a transmissivity (T) of 0.4035 ft^2/min (6.25 cm^2/s) assuming a saturated aquifer thickness of 60 feet. A hand-picked visual straight line in the Theis recovery solution was selected to match the last portion of the recovery data for MW40, which would be representative of the aquifer and not the sand pack. This straight-line solution produced a transmissivity of 0.089 ft^2/min (1.38 cm^2/s), assuming a saturated aquifer thickness of 60 feet.

II.B.5. Direction of Groundwater Flow

II.B.5.a. Well construction details

Each monitoring well casing consisted of 2-inch inside diameter schedule 40 flush-thread polyvinyl chloride (PVC) risers with a 10-foot screen set across the water table. The well screen slot size was 0.010 inches. Exceptions to the typical monitoring well construction were P2-MW24, which is a 2-inch well screened from 29.5 – 34.5 feet to determine groundwater quality at depth, and P2-MW40, which is a 4-inch well screened from 3.8 – 33.8 in order to conduct aquifer testing. Table 7 summarizes construction details for all monitoring wells. Well construction diagrams are presented in Appendix VII. Following installation of the well casing, filter pack sand was poured while the augers were gradually removed to ensure a complete and even distribution of the filter pack. The filter pack extended to a measured level at least 2 feet above the top of the well screen.

Well seals were composed of bentonite pellets and allowed to hydrate before filling the annular space above the seal. The well seal extended to a measured level of at least 2.0 feet above the top of the filter pack.

Above the well seal, the remaining annular space was completed with a 1.0-foot-long flush-mount sheet steel protective casing that was grouted in place with a concrete pad. Well casings were capped with expandable locking caps. Protective casings were covered with bolted cast-iron manhole covers. Inscribed monitoring well identification plates were placed inside of each manhole cover.

II.B.5.b. Potentiometric mapping

Water level measurements were collected from existing monitoring wells during the CAP-Part A SI and from the new monitoring wells installed during the CAP-Part B SI. Data obtained from these measurements are presented in Table 8. During the CAP-Part A SI in December 1996, there was a groundwater divide at the site with groundwater flowing to the south-southwest and the northwest with an average gradient of 0.004 ft/ft.

Water level measurements were collected during the CAP-Part B SI in May 1997, November 1999, and February 2000. Data obtained from these measurements are presented in Table 8. Figure 19 shows the potentiometric surface at the site in November 1999. Groundwater in the study area is under water table conditions and is encountered between 6.06 to 12.29 feet BGS, averaging 9.21 feet BGS. Groundwater flow at the Former Pumphouse #1 tank pit area is generally to the southwest with the man-made ditches affecting localized flow, and the flow gradient is approximately 0.012 ft/ft. At the far western edge of the site near the Former Fuel Pit 1A/DAACG area, the groundwater flow changes to a more northwest direction at a gradient of approximately 0.0086 ft/ft. Figure 20 shows the potentiometric surface at the site in February 2000, and the flow in the former tank pit area is to the southwest with an average gradient of

0.0067 ft/ft. At the far western edge of the site near the Former Fuel Pit 1A/DAACG area, the groundwater flow changes to a more northwest direction at a gradient of approximately 0.0067 ft/ft.

II.B.5.c. Equipotential flow net

An equipotential flow net based on the February 2000 water level measurements and the contoured potentiometric surface is presented in Figure 21.

III. REMEDIAL ACTION PLAN

III.A. CORRECTIVE ACTION COMPLETED OR IN PROGRESS

III.A.1. Recovery/Removal of Free Product

The contractor responsible for investigating the site from 1996 through 1999 did not use a product probe for free product measurements and, as a result, the presence of free product was not identified during this time period. During sampling activities in February 2000, free product was measured in wells D-MW1, D-MW2, D-MW8, D-MW11, D-MW13, and D-MW17 at a thickness of 0.01 feet, 0.88 feet, 0.15 feet, 0.74 feet, 0.15 feet, and a sheen, respectively. Absorbent socks were placed in each well following these measurements on February 24, 2000. The free product covered an area of approximately 400 feet × 500 feet at the Former Fuel Pit 1A/DAACG area (Release #1). GA EPD was notified of the free product in correspondence dated March 8, 2000 (Stanley 2000). The absorbent socks were removed and replaced in May and July 2000.

III.A.2. Remediation/Treatment of Contaminated Backfill Material and Native Soils

During UST closure activities in 1995, all contaminated soil removed during the project was tested in accordance with disposal facility requirements and transported to Kedesh, Inc., Highway 84, Ludowici, GA 31316. The Closure Report for Former Pumphouse #1 was not submitted to GA EPD in 1995 because review of the closure analytical data indicated that a CAP-Part A would be required (i.e., per requirements of GUST-9, Item 15, page 12, dated August 1995). However, the analytical data presented in the closure report is summarized in Table 1 of this CAP-Part B Report. Approximately 913 cubic yards of contaminated soil were excavated from the site.

During the UST closure activities in 1998, the excavated soil was returned to the tank pit with the concurrence of GA EPD. The 1998 Closure Report for Former Pumphouse #1 (Earth Tech 1998) was not submitted to GA EPD because the CAP-Part A Report, which incorporated the area of the removal activities, had already been submitted to GA EPD.

III.B. OBJECTIVES OF CORRECTIVE ACTION

III.B.1. Remove Free Product that Exceeds One-Eighth Inch

Former Fuel Pit 1A/DAACG Area (Release #1)

During the CAP-Part A and Part B investigations in 1996 through 1999, free product was not observed in the wells at the Former Fuel Pit 1A/DAACG area (Release #1) since a oil/water interface probe was not used during water level measurements. However, additional sampling and product/water level measurements conducted in February 2000 indicated free product, exceeding 1/8 inch in thickness, exists at the site. Removal of the free product is recommended; however, the amount of recoverable free product and the best method for removal are not known. Thus, additional investigation activities are necessary to determine this information.

Former Pumphouse #1 Tank Pit Area (Release #2)

The previous investigations, CAP-Part A SI, and CAP-Part B SI determined that there is no evidence of free product at the Former Pumphouse #1 tank pit area (Release #2) that exceeds an eighth of an inch;

therefore, no recovery/removal of free product has been performed, nor was it required based on known site conditions.

III.B.2. Remediate Groundwater Contamination

Former Fuel Pit 1A/DAACG Area (Release #1)

The CAP-Part A and CAP-Part B investigations documented groundwater contamination that exceeded IWQS. In May 1996, the maximum benzene concentration at the site was 700 µg/L in well D-MW2, located north of the Former Fuel Pit 1A. This concentration was the maximum concentration observed for Release #1 during the CAP-Part A and CAP-Part B investigations. Well D-MW2 was not sampled in February 2000; however, other wells in the vicinity had similar concentrations in 2000 as they had in 1996, which indicates that the free product is providing a continuous source for contamination in the groundwater. The dissolved benzene plume appears to be impacting an underground storm drain, which is located approximately 450 feet northwest of well D-MW2. This is evidenced by low concentrations of benzene in well D-MW18 located on the northwest side of the storm drain.

Groundwater in the vicinity of the Former Fuel Pit 1A/DAACG area is generally flowing to the northwest, but groundwater in the southern portion of the plume is flowing to the south-southwest. The man-made drainage ditches are affecting the localized flow. Conservative fate and transport modeling using the Analytical Transient 1-, 2-, 3-Dimensional Model (AT123D) (Attachment B) predicts that benzene (the most conservative representative compound) should be exceeding its IWQS at the underground storm drain located 450 feet northwest of well D-MW2. The model results for this compound indicate that there is minimal groundwater impact at a distance of 1,000 feet from the center of the Former Fuel Pit 1A/DAACG area of contamination. Concentrations of benzene in the vicinity of the Former Fuel Pit 1A/DAACG area exceed the benzene ACL of 285 µg/L. Therefore, corrective action consisting of remediation or monitored natural attenuation of the groundwater plume in the vicinity of the Former Fuel Pit 1A/DAACG area should be considered once the free product has been removed.

Former Pumphouse #1 Tank Pit Area (Release #2)

The CAP-Part A and CAP-Part B investigations documented groundwater contamination that exceeded IWQS. In February 2000, the maximum benzene concentration at the site was 4850 µg/L in well D-MW2, located 250 feet north of the former tank pit area near Fuel Pit 1C. This concentration was the maximum concentration observed during the CAP-Part A and CAP-Part B investigations. As with the Former Fuel Pit 1A/DAACG area, the concentrations in 2000 are similar to those observed in 1996, indicating that residual contamination in the soil is acting as a source. The dissolved benzene appears to be impacting a man-made drainage ditch, which is located approximately 300 feet southeast of the former tank pits. This is evidenced by low concentrations of benzene in the drainage ditch surface water and a lack of benzene in the monitoring wells located on the south and southeast side (i.e., downgradient) of the drainage ditch.

Groundwater in the vicinity of the former tank pits is generally flowing to the southwest with a man-made drainage ditch affecting the localized flow. Conservative fate and transport modeling using the AT123D (Attachment B) predicts that benzene (the most conservative representative compound) should be exceeding its IWQS at the drainage ditch located 300 feet southeast of the site. The model results for this compound indicate that there is minimal groundwater impact at a distance of 1,000 feet from the former tank pits. Concentrations of benzene in the vicinity of the former tank pit exceed the benzene ACL of 285 µg/L. Therefore, corrective action consisting of remediation or monitored natural attenuation of the groundwater plume in the vicinity of the former tank pits is recommended.

III.B.3. Remediate Soil Contamination

Former Fuel Pit 1A/DAACG Area (Release #1)

The results from the various CAP-Part A and CAP-Part B investigations for the DAACG Facility and Former Pumphouse #1 indicate that 20 soil samples exceeded the GUST STL (i.e., 0.017 mg/kg) for benzene, 1 soil sample exceeded the GUST STL (i.e., 115 mg/kg) for toluene, and 5 soil samples exceeded the GUST STL (i.e., 18 mg/kg) for ethylbenzene. As discussed in Section III.B.4, the toluene concentrations were below the risk-based screening level (i.e., 408,800 mg/kg) that is protective of soil exposure during industrial land use and below the ATL for toluene of 479 mg/kg that was developed based on fate and transport modeling (Appendix VI). The ethylbenzene concentrations were below the risk-based screening level (i.e., 204,400 mg/kg) that is protective of soil exposure during industrial land use and below the ATL for ethylbenzene of 187 mg/kg that was developed based on fate and transport modeling (Appendix VI).

As discussed in Section III.B.4, the benzene concentrations are below the risk-based screening criteria (i.e., 197.4 mg/kg) that is protective of soil exposure during industrial land use in all but two samples that were collected from well D-MW17 and boring D-SB10. The benzene concentrations exceed the ATL of 9.3 mg/kg, which was developed based on fate and transport modeling, in six boring locations. These soil samples are located above the soil/water interface near the area of free product; thus, corrective action consisting of remediation or monitored natural attenuation for leaching of soil contaminants to groundwater is recommended for this area.

Former Pumphouse #1 Tank Pit Area (Release #2)

The results from the various CAP-Part A and CAP-Part B investigations for the DAACG Facility and Former Pumphouse #1 indicate that 26 soil samples exceeded the GUST STL (i.e., 0.017 mg/kg) for benzene, 3 soil samples exceeded the GUST STL (i.e., 115 mg/kg) for toluene, and 5 soil samples exceeded the GUST STL (i.e., 18 mg/kg) for ethylbenzene. As discussed in Section III.B.4, the toluene concentrations were below the risk-based screening level (i.e., 408,800 mg/kg) that is protective of soil exposure during industrial land use and below the ATL for toluene of 479 mg/kg that was developed based on fate and transport modeling (Appendix VI). The ethylbenzene concentrations were below the risk-based screening level (i.e., 204,400 mg/kg) that is protective of soil exposure during industrial land use and below the ATL for ethylbenzene of 187 mg/kg that was developed based on fate and transport modeling (Appendix VI).

As discussed in Section III.B.4, the benzene concentrations are below the risk-based screening criteria (i.e., 197.4 mg/kg) that is protective of soil exposure during industrial land use in all of the samples. The benzene concentrations exceed the ATL of 9.3 mg/kg, which was developed based on fate and transport modeling, in two boring locations. These soil samples are located above the soil/water interface north of Former Fuel Pit 1C; thus, corrective action consisting of remediation or monitored natural attenuation for leaching of soil contaminants to groundwater is recommended for this area.

III.B.4. Provide Risk-based Corrective Action

A risk-based approach was used to determine the need for further action at the Former Pumphouse #1 site. Due to the nature of the contamination (petroleum hydrocarbon contamination of soil and groundwater), the risk-based approach was limited to human health concerns. Ecological risk concerns are minimal because of the land use surrounding the Former Pumphouse #1 site. The site is located within an active airfield at HAAF, and the primary purpose of the drainage ditch located south is to collect and divert storm water away from the airfield.

The methods for assessing human health concerns for the site were derived from GUST CAP-Part B guidance (GA EPD 1995) and recent GA EPD guidance (GA EPD 1996). These were supplemented by the additional guidance documents on risk assessment methods referenced in this section. In general, the risk-based corrective action (RBCA) approach is performed in two steps:

1. Results are screened against readily available regulatory levels and risk-based screening levels to identify chemicals of potential concern (COPCs).

2. Site-specific ACLs are developed for COPCs using the results of the fate and transport modeling and identified receptor locations.

The following sections present the conceptual model of the exposure setting and potential receptors as well as the general methodology employed to perform the screening for COPCs and the development of ACLs.

III.B.4.a. Potential receptor survey

The exposure assessment identifies any potentially complete pathways between the contaminant source and potential receptors. This involves identifying potential current and future receptors, release mechanisms through which contamination might come into contact with the receptors, and routes of exposure through which receptors might be exposed. Figure 22 presents potentially complete and incomplete pathways for contaminant sources at the Former Pumphouse #1 site.

The Former Pumphouse #1 site is located within an active military installation and within an access-controlled fence of an active airfield. The land use at the site is currently military industrial. Installation housing areas are located more than 0.5 miles to the northeast. A man-made drainage ditch is located approximately 300 feet southeast of the former tank pits. The man-made surface water drainage feature eventually empties into Springfield Canal, which flows southwest and joins the Little Ogeechee River more than 3.8 miles downstream of the site. The drainage ditch is located adjacent to the flight line and aircraft taxiway and access to the area is restricted; thus the drainage ditch is not used for recreational purposes.

No connection between site contamination and current off-site receptors has been identified. Site contamination has migrated to the Surficial Aquifer. The Hawthorn Group, which is approximately 90 feet of clay, separates the Surficial Aquifer from the deep drinking water aquifer, the Floridan Aquifer. There appears to be no vertical migration from the Surficial Aquifer to the Floridan Aquifer. One of the HAAF's current water supply wells (i.e., Well 3) is located approximately 6,700 feet downgradient of the Former Pumphouse #1 site.

Current on-site receptors have not been identified for the site. Potential future on-site receptors might include industrial workers and military residents.

Potential future on-site industrial receptors may come in direct contact with site soil contamination during construction or excavation activities. Due to the restricted access to the site, no near-term, on-site receptors are likely to come into contact with groundwater even though the Surficial Aquifer discharges into the drainage ditch.

III.B.4.b. Screening for chemicals of potential concern

III.B.4.b.1. Screening Methodology

The purpose of a risk evaluation screening is to identify the COPCs and areas of concern at a site, and possibly to identify sites for which no further action is needed. The first step in the risk process uses

screening levels that are readily obtainable and that, due to their conservative nature, can be used with a high degree of confidence to indicate sites for which no further action is required.
An American Society for Testing and Materials (ASTM) (1995) Tier 1-type risk evaluation process has been applied to the data collected for the Former Pumphouse #1 site to identify any COPCs and media for which no further action is needed. The risk evaluation screen involves the steps listed below:

- identify potential migration and exposure pathways associated with the site, and identify potential exposure scenarios that should be used to select screening levels;
- identify risk-based screening levels and regulatory-based screening levels for each contaminant;
- compare site-related concentrations to screening levels to determine if any COPCs exist at the site; and
- compare detection limits to screening levels to identify potential false-negative screening results.

The screening levels for the Former Pumphouse #1 site data have been taken from the following sources based on GA EPD guidance (GA EPD 1996):

- Georgia IWQS (GA EPD 1998b),
- GUST STLs (i.e., Table B, column 1),
- soil screening levels developed by the U.S. Environmental Protection Agency (EPA) (1996), and
- soil and groundwater risk-based concentrations developed by EPA Region 3 (EPA 1999).

These values reflect screening levels based on a combination of regulatory screening levels (i.e., IWQS and GUST STLs), and calculated risk-based values (i.e., EPA Region 3 risk-based concentrations).

Screening levels inherently incorporate assumptions about land use. In identifying COPCs, it is generally accepted that screening levels will reflect any potential future land uses and, thus, they usually reflect a conservative residential use scenario (EPA 1991; EPA 1996; EPA 1999; ASTM 1995). Based on GA EPD guidance, risk-based screening levels reflect residential land use for groundwater and industrial land use for surface and subsurface soils (i.e., > 2 feet BGS) (GA EPD 1996).

Default residential exposure scenarios for groundwater assume that use of the land could someday be residential and that the following exposures could occur:

- ingestion of groundwater, and
- inhalation of volatiles during showering.

The default industrial exposure assumptions for surface and subsurface soils assume that the following exposures could occur:

- incidental ingestion of soil, and
- inhalation of volatiles and dust.

EPA's *Soil Screening Guidance* (EPA 1996) provides two options for selecting soil values that address protection of groundwater. One value assumes no contaminant dilution or attenuation would occur between the soil and groundwater; a second value assumes a 20-fold dilution attenuation factor (DAF). A DAF of 20 was used to develop soil screening values protective of groundwater at the Former Pumphouse #1 site.

If applicable or relevant and appropriate requirement (ARAR)- or risk-based values are not available, it generally means that (1) the constituent is not considered to be toxic except perhaps at extremely high

concentrations (e.g., aluminum, sodium); (2) the dose-response data do not indicate a toxic effect; or (3) EPA is currently reviewing toxicity information, and no reference dose or cancer slope factor is currently available.

III.B.4.b.2. Screening Results

The risk screening process is a systematic screening of sample results to identify site-related COPCs. Constituent concentrations below risk- or regulatory-based screening levels are not considered COPCs and are not evaluated further. Analytical results for the DAACG Facility and Former Pumphouse #1 investigations were combined based on the location of the sample with respect to the two separate releases. Tables 9 and 10 present the results of the risk-based screening for the Former Fuel Pit 1A/DAACG Area (Release #1), soil and groundwater, respectively. Tables 11 through 14 present the results of the risk-based screening for the Former Pumphouse #1 Tank Pit Area (Release #2) soil, sediment, groundwater, and surface water, respectively.

Former Fuel Pit 1A/DAACG Area (Release #1)

In the vicinity of the Former Fuel Pit 1A/DAACG Area, 138 soil samples were collected from 66 borehole locations between 1996 and 1999. Benzene, ethylbenzene, toluene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene were detected in soil at concentrations above their respective STLs. BTEX, benzo(a)pyrene, and benzo(b)fluoranthene were detected in soil at concentrations above their respective leaching to groundwater screening. Benzene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene were detected in soil at concentrations above the risk-based screening criteria. BTEX and several PAHs were detected at concentrations below their respective screening values. As a result, BTEX, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene were identified as COPCs for soil at the Former Fuel Pit 1A/DAACG Area (Release #1) site.

The detection limits for the benzene, toluene, and/or several PAHs exceeded STLs and/or risk-based screening levels in several samples during the various investigations. Many results were estimated due to detections below the detection limits. The results for several PAHs were rejected (R qualified) based on low surrogate recoveries in one sample (H833-SB0301 from boring D-SB03). No COPCs for soils were selected for the site based on the detection limit screening or qualifier screening.

In the vicinity of the Former Fuel Pit 1A/DAACG Area, 38 groundwater samples were collected from 30 monitoring wells between 1996 and 2000. Benzene, benzo(a)pyrene, and chrysene were detected in groundwater at concentrations above their respective IWQS. Benzene, ethylbenzene, toluene, and naphthalene were detected in groundwater at concentrations above their risk-based screening levels. BTEX and several PAHs were detected at concentrations below their respective screening values. As a results, benzene, ethylbenzene, toluene, benzo(a)pyrene, chrysene, and naphthalene were identified as COPCs for groundwater at the Former Fuel Pit 1A/DAACG Area (Release #1) site.

The groundwater detection limit for benzene exceeded the risk-based screening level during the various investigations. The detection limit for benzene exceeded the IWQS in one sample. Detection limits achieved for several PAHs during the various investigations exceeded their respective IWQS and/or risk-based screening levels for the groundwater data. For these constituents, screening levels represent values below analytically achievable levels. No groundwater data were rejected. No additional COPCs were selected for groundwater based on the detection limit or qualifier screening.

Former Pumphouse #1 Tank Pit Area (Release #2)

In the vicinity of the Former Pumphouse #1 Tank Pit Area, 92 soil samples were collected from 45 borehole locations between 1996 and 1999. Benzene, ethylbenzene, toluene, benzo(b)fluoranthene, and chrysene were detected in soil at concentrations above their respective STLs. Benzene, ethylbenzene, toluene, and xylenes were detected in soil at concentrations above their respective leaching to groundwater screening. Toluene, ethylbenzene, xylenes, and several PAHs were detected at concentrations below their respective screening values. As a result, benzene, ethylbenzene, toluene, xylenes, benzo(b)fluoranthene, and chrysene, were identified as COPCs for soil at the Former Pumphouse #1 Tank Pit Area (Release #2) site.

The detection limits for the benzene, toluene, and/or several PAHs exceeded STLs and/or risk-based screening levels in several samples during the various investigations. Many results were estimated due to detections below the detection limits. No soil data were rejected. No COPCs for soils were selected for the site based on the detection limit screening or qualifier screening.

In the vicinity of the Former Pumphouse #1 Tank Pit Area, 29 groundwater samples were collected from 17 monitoring wells between 1996 and 1999. Benzene, benzo(a)anthracene, benzo(a)pyrene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene were detected in groundwater at concentrations above their respective IWQS. Benzene, ethylbenzene, toluene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, and naphthalene were detected in groundwater at concentrations above their risk-based screening levels. Toluene, ethylbenzene, xylenes, and several PAHs were detected at concentrations below their respective screening values. As a result, benzene, ethylbenzene, toluene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, and naphthalene were identified as COPCs for groundwater at the Former Pumphouse #1 Tank Pit Area (Release #2) site.

The groundwater detection limit for benzene exceeded the risk-based screening level during the various investigations. The detection limit for benzene exceeded the IWQS in two samples. Detection limits achieved for several PAHs during the various investigations exceeded their respective IWQS and/or risk-based screening levels for the groundwater data. For these constituents, screening levels represent values below analytically achievable levels. Acenaphthene and fluorene data were rejected in two samples (MW1701 and MW1901) based on low surrogate recoveries. No additional COPCs were selected for groundwater based on the detection limit or qualifier screening.

No constituents were detected above their respective IWQS for surface water data collected during the 1996 CAP-Part A investigation and 1999 CAP-Part B investigation. Benzene, ethylbenzene, toluene, and xylenes were detected below screening levels during both investigations. The detection limits for several PAHs exceeded their respective IWQS. These standards represent values below analytically achievable levels. No COPCs for surface water were selected for the Former Pumphouse #1 Tank Pit Area (Release #2) site.

Benzo(a)pyrene, benzo(b)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene were detected in sediment at concentrations above their respective STLs during the 1996 CAP-Part A investigation. Several PAHs were detected in sediment at concentrations below their respective screening levels. Sediment data were not collected during the 1999 CAP-Part B investigation. The detection limit for benzene in sample HT4-SE07 and several PAHs in sample HT4-SE08 exceeded screening values, but no COPCs were selected based on this screen. Benzo(a)pyrene, benzo(b)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene were identified as COPCs for sediments for the Former Pumphouse #1 Tank Pit Area (Release #2) site.

III.B.4.c. Site-specific levels

Detections exceeding the conservative generic screening levels are considered COPCs. ATLs and ACLs are developed, when appropriate, for the COPCs using site-specific information. ATLs and ACLs were developed from available regulatory screening levels. When regulatory screening levels were not available, ACLs were developed based on risk-based levels.

III.B.4.c.1. Alternate Threshold Levels

Benzene, ethylbenzene, toluene, xylenes, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene were identified as COPCs for soil at the Former Fuel Pit 1A/DAACG Area (Release #1) site. Benzene, ethylbenzene, toluene, xylenes, benzo(b)fluoranthene, and chrysene, were identified as COPCs for soil at the Former Pumphouse #1 Tank Pit Area (Release #2) site. The COPCs for both areas of contamination are the same except for indeno(1,2,3-cd)pyrene, which is located only at the Former Fuel Pit 1A/DAACG Area (Release #1) site. Due to the close proximity of both releases to each other, the most conservative fate and transport modeling results were utilized for developing one set of ATLs for both areas of contamination. ATL calculations for the constituents are presented in Appendix VI and are based on the results of the AT123D modeling for the Former Fuel Pit 1A/DAACG Area (Release #1) site. The ATLs for soil at the Former Pumphouse #1 site, Release #1 and Release #2, were determined to be as follows:

- 9.3 mg/kg for benzene,
- 479 mg/kg for toluene,
- 187 mg/kg for ethylbenzene,
- 893 mg/kg for total xylenes,
- 1.4 mg/kg for benzo(a)pyrene,
- 5.8 mg/kg benzo(b)fluoranthene,
- 2.1 mg/kg chrysene, and
- 0.66 mg/kg indeno(1,2,3-cd)pyrene.

III.B.4.c.2. Alternate Concentration Limits

Benzene, ethylbenzene, toluene, benzo(a)pyrene, chrysene, and naphthalene were identified as COPCs for groundwater at the Former Fuel Pit 1A/DAACG Area (Release #1) site. Benzene, ethylbenzene, toluene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, and naphthalene were identified as COPCs for groundwater at the Former Pumphouse #1 Tank Pit Area (Release #2) site. The COPCs for both areas of contamination are the same except for benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, which are located only at the Former Pumphouse #1 tank pit area (Release #2) site.

To be conservative, the chemical properties of benzene were used to evaluate contaminant migration from each plume. Benzene was modeled to a potential downgradient location where a receptor may come in contact with migrating site contamination. The receptors were determined to be a storm drain located 230 feet downgradient of the center of the source area for the Former Fuel Pit 1A/DAACG Area (Release #1) and a drainage ditch located 325 feet downgradient of the center of the source area for the Former Pumphouse #1 Tank Pit Area (Release #2). Fate and transport modeling was used to develop a site-specific DAF between each source and the receptor location (see III.B.4.c.3 below). The modeling results estimated a DAF for benzene of 4 for the storm drain for Release #1 and a DAF for benzene of 5.25 for the drainage ditch for Release #2. As discussed in Appendix VI, the DAF for PAH constituents was estimated to be 40. Due to the close proximity of both releases to each other, the most conservative fate

and transport modeling results (i.e., Release #1) were utilized for developing one set of ACLs for both areas of contamination. Compound specific regulatory levels or risk-based screening criteria were used in conjunction with the site-specific DAF identified for the potential migration of contamination from the site to determine the ACL for each compound. The ACL calculations are presented in Appendix VI. The ACLs for both areas of contamination were determined to be as follows:

- 285 μg/L for benzene (i.e., 4 × 71.28 μg/L),
- 800,000 μg/L for toluene (i.e., 4 × 200,000 μg/L),
- 114,800 μg/L for toluene (i.e., 4 × 28,718 μg/L),
- 1.2 μg/L for benzo(a)anthracene (i.e., 40 × 0.0311 μg/L),
- 1.2 μg/L for benzo(a)pyrene (i.e., 40 × 0.0311 μg/L),
- 3.6 μg/L for benzo(b)fluoranthene (i.e., 40 × 0.092 μg/L),
- 1.2 μg/L for benzo(k)fluoranthene (i.e., 40 × 0.0311 μg/L),
- 1.2 μg/L for chrysene (i.e., 40 × 0.0311 μg/L),
- 1.2 μg/L for dibenzo(a,h)anthracene (i.e., 40 × 0.0311 μg/L),
- 1.2 μg/L for indeno(1,2,3-cd)pyrene (i.e., 40 × 0.0311 μg/L), and
- 260 μg/L for naphthalene (i.e., 40 × 6.5 μg/L).

Benzene was the only compound to exceed its respective ACL. At the Former Fuel Pit 1A/DAACG area (Release #1), the benzene concentrations exceeded the ACL in wells D-MW2, D-MW8, D-MW11, D-MW17, and D-MW19. At the Former Pumphouse #1 tank pit area (Release #2), the benzene concentrations exceeded the ACL in wells D-MW5, P1-MW2, and P1-MW3. In 1996/1997, benzene also exceeded the ACL in wells P1-MW1 and P1-MW19, but in 1999/2000, the benzene concentrations in these two wells were below the ACL.

III.B.4.c.3. Fate and Transport Model

Site-specific DAFs between the source and the receptor locations were developed. The DAF is a numerical value that represents the attempt to mathematically quantify the natural physical, chemical, and biological processes (e.g., advection-dispersion, sorption-retardation, biodegradation, and volatilization) that result in the decrease of a chemical concentration in an environmental medium. In simple terms, the DAF is the ratio of chemical concentration at the source (or the point of origin) to the concentration at the exposure point. The DAFs reflect the natural attenuation concepts outlined in the ASTM's RBCA protocol (ASTM 1995).

Fate and transport models are used as tools for developing DAFs. The application of fate and transport models at any release site must ensure that the modeling results are protective of human health and the environment. Therefore, the selection process of a predictive model at a release site must consider its performance, characteristics, and applicability to the site being considered. The following characteristics were considered before selecting an appropriate model for the Installation:

- the model provides conservative predictions,
- the model is technically sound,
- the model is a public-domain model or is readily available,
- the model has received adequate peer review,
- the model has been applied to other similar sites, and
- the model is easy to use.

The AT123D meets all of the above criteria and was selected for performing fate and transport analysis for this site. AT123D is a well-known and commonly used analytical groundwater pollutant fate and transport model. This model computes the spatial-temporal concentration distribution of chemicals in the

aquifer system and predicts the transient spread of a chemical plume through a groundwater aquifer. The fate and transport processes accounted for in AT123D are advection, dispersion, adsorption/retardation, and decay. This model can be used as a tool for estimating the dissolved concentration of a chemical in one, two, or three dimensions in the groundwater resulting from a mass release (either continuous or instant or depleting source) over a source area (i.e., point, line, area, or volume source).

Vertical migration of the contaminant plume through the confining unit to the Principal Artesian aquifer is improbable. The confining unit has a vertical hydraulic conductivity on the order of 10^{-8} cm/sec and ranges from 15 to 90 feet in thickness. Assuming a vertical gradient of 1.0 ft/ft and an effective porosity of 0.06 (Mills et al. 1985) for the confining unit, the groundwater travel time is estimated to be 87 years. Therefore, it would take more than 400 years for the benzene contamination to migrate through the confining layer. The surficial aquifer in which the contaminant plume is located is not used as a source of drinking water.

There are two areas of soil and groundwater contamination at the Former Pumphouse #1 site. One area of contamination surrounds the former fuel pit labeled 1A, referred to as Release #1, and the former tank pits associated with the former pumphouse building, referred to as Release #2. The fate and transport modeling was conducted for both sites and the results are provided in Attachment B.

Former Fuel Pit 1A/DAACG Area (Release #1)

At the Former Fuel Pit 1A/DAACG area, there is a large area of free product and soil contamination located 1 to 2 feet above the water table. As a result, the source dimension was assumed to be the area of soil contamination, which is approximately 350 feet × 640 feet with the center of the source area located near D-SB06. The maximum soil concentration of benzene (i.e., 410 mg/kg in D-MW17 at 8.0 – 10.0 ft) in this area was above the soil/water interface. The majority of the soil contamination with the highest concentrations is located under 18 inches of concrete; thus, leaching of contaminants to groundwater will be more a result of fluctuations in the water table than percolating rainwater. In order to predict the maximum concentration in groundwater, leaching to groundwater by percolating rainwater was modeled with SESOIL to determine the predicted maximum concentration in the leachate at the water table interface. Since the predicted leachate concentration (i.e., 12,500 µg/L) was above the maximum observed groundwater concentration (i.e., 700 µg/L in D-MW2) within the source area, the steady-state model was developed by calibrating the model against the maximum predicted concentration (i.e., 12,500 µg/L). Modeling of the lateral migration to the receptor was performed using AT123D. An underground storm drain is located approximately 230 feet northwest (downgradient) from the center of the source area. This is the nearest potential preferential pathway that might encounter migrating groundwater contamination due to a possible hydraulic connection between the surficial groundwater and the storm drain.

The fate and transport modeling results are presented in Attachment B. The steady-state (i.e., continuous concentration at the source) model was developed by calibrating the model against the maximum predicted benzene concentration at the site, which occurred in well D-MW17 (i.e., 12,500 µg/L) in 1996 based on leaching of soil contamination to groundwater. In reality, the source of benzene will deplete due to biodegradation and natural attenuation. The modeling results indicate that benzene should reach the storm drain at a concentration of 3100 µg/L, which is above the state IWQS of 71.28 µg/L. Actual groundwater results indicate that the surficial groundwater contamination near the IWQS reaches the storm drain.

Based on modeling results, the Former Fuel Pit 1A/DAACG Area estimated a DAF for benzene at the drainage ditch is 4.0. Simulations were also performed to predict the maximum concentrations of benzene over a simulation period of two years in the monitoring wells at the Former Fuel Pit 1A/DAACG Area. The predicted maximum benzene concentrations are presented in Table 15.

Former Pumphouse #1 Tank Pit Area (Release #2)

At the Former Pumphouse #1 tank pit area, there is a large area of soil contamination located 1 to 2 feet above the water table. As a result, the source dimension was assumed to be the area of soil contamination, which is approximately 325 feet × 575 feet with the center of the source area located near P1-SB30. The maximum soil concentration of benzene (i.e., 160 mg/kg in D-SB22 at 7.3 – 9.3 ft) in this area was above the soil/water interface. The majority of the soil contamination with the highest concentrations is located under 18 inches of concrete; thus, leaching of contaminants to groundwater will be more a result of fluctuations in the water table than percolating rainwater. In order to predict the maximum concentration in groundwater, leaching to groundwater by percolating rainwater was modeled with SESOIL to determine the predicted maximum concentration in the leachate at the water table interface. Since the predicted leachate concentration (i.e., 5990 μg/L) was above the maximum observed groundwater concentration (i.e., 4580 μg/L) within the source area, the steady-state model was developed by calibrating the model against the maximum predicted concentration (i.e., 5990 μg/L). Modeling of the lateral migration to the receptor was performed using AT123D. A man-made drainage ditch is located approximately 375 feet southwest (downgradient) from the center of the source area. This is the nearest potential receptor that might encounter migrating groundwater contamination due to a possible hydraulic connection between the surficial groundwater and the surface water body.

The fate and transport modeling results are presented in Attachment B. The steady-state (i.e., continuous concentration at the source) model was developed by calibrating the model against the maximum predicted benzene concentration at the site, which occurred in well D-SB22 (i.e., 5990 μg/L) in 1996 based on leaching of soil contamination to groundwater. In reality, the source of benzene will deplete due to biodegradation and natural attenuation. The modeling results indicate that benzene should reach the man-made drainage ditch at a concentration of 1140 μg/L, which is above the state IWQS of 71.28 μg/L. Actual groundwater and surface water results indicate that the groundwater is discharging into the drainage ditch; however, the benzene concentrations in the surface water do not exceed the IWQS. Therefore, the surface water body adjacent to the Former Pumphouse #1 site, Facility ID #9-025085, site is being impacted from former UST operations, but at concentrations below the IWQS of 71.28 μg/L.

Based on modeling results, the estimated DAF for benzene at the drainage ditch is 5.25. Simulations were also performed to predict the maximum concentrations of benzene over a simulation period of two years in the monitoring wells at the site. The predicted maximum benzene concentrations are presented in Table 15.

ATLs and ACLs for the Former Pumphouse #1 site were calculated using the smallest DAF (i.e., most conservative) of the two separate plumes. Thus, the DAF for benzene associated with the Former Pumphouse #1 tank pit area was not used.

III.B.4.d. Conclusions and recommendations

The conclusions below are based on a review of the results of the various investigations conducted between 1996 and 2000 at the Former Pumphouse #1 site using a risk-based approach:

- Free product was detected at the Former Fuel Pit 1A/DAACG Area (Release #1) in February 2000. An oil/water interface probe was not used at either plume prior to February 2000.

- The horizontal and vertical extent of soil contamination below applicable GUST STLs was delineated during the various investigations.

- The horizontal and vertical extent of groundwater contamination associated with the former pumphouse operations (Release #1 and Release #2) was delineated to below federal MCLs during the various investigations.

- Risk-based screening results show that concentrations of benzene, ethylbenzene, toluene, xylenes, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene in soil exceeded their respective initial screening levels.

- Using the results of the fate and transport modeling, only the benzene, benzo(a)pyrene, chrysene, and indeno(1,2,3-cd)pyrene concentrations in soil exceeded the site-specific ATLs of 9.3 mg/kg, 1.4 mg/kg, 2.1 mg/kg, and 0.66 mg/kg, respectively, at the Former Fuel Pit 1A/DAACG area (Release #1).

- Using the results of the fate and transport modeling, only the benzene and chrysene concentrations in soil exceeded the site-specific ATLs of 9.3 mg/kg and 2.1 mg/kg, respectively, at the Former Pumphouse #1 tank pit area (Release #2).

- Risk-based screening results show that concentrations of benzene, ethylbenzene, toluene, xylenes, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenze(a,h)anthracene, indeno(1,2,3-cd)pyrene, and naphthalene in groundwater exceeded their respective initial screening levels. However, benzene was the only constituent where concentrations in groundwater exceeded its ACL of 285 μg/L .

- Contaminant concentrations detected in the surface water samples collected downgradient of the site indicate that contaminated groundwater is discharging into the man-made drainage ditch, but the concentrations do not exceed IWQS.

- Fate and transport modeling of benzene, assuming a continuous, steady-state source, indicates that contamination will exceed the state IWQS at the nearest defined downgradient receptor for each plume, the storm drain for Release #1 and the drainage ditch for Release #2. However, surface water sampling data indicates that contamination in the surface water does not exceed the respective IWQS.

- Based on the CAP-Part B data, the environmental site ranking score for the Former Pumphouse #1 tank pit area is 25,750 (Appendix X) and the environmental site ranking score for Former Fuel Pit 1A/DAACG area is 53,500 (Appendix X).

Considering the site characteristics, it is recommended that the free product, soil contamination above ATLs, and groundwater contamination above ACLs in the area around the vicinity of the Former Fuel Pit 1A/DAACG area be addressed. However, additional information is necessary to determine the amount of recoverable free product at the Former Fuel Pit 1A/DAACG area prior to proposing remediation systems for the site. For the area in the vicinity of Former Pumphouse #1 tank pit area, the soil contamination above ATLs and groundwater contamination above ACLs need to be addressed. Monitored natural attenuation is recommended for the Former Pumphouse #1 tank pit area. In addition, Fort Stewart/HAAF will evaluate "hot-spot" treatment pending a cost effective analysis and availability of funding.

III.C. DESIGN AND OPERATION OF CORRECTIVE ACTION SYSTEMS

III.C.1. System Effectiveness/Basis for Selection

The presumed remedies evaluated for aromatic hydrocarbons in soil and groundwater at this site include monitored natural attenuation, oxygen injection enhanced bioremediation, air sparging with soil vapor extraction, six-phase heating, and PHOSter® II enhanced bioremediation. A three-step screening process was used to select the preferred remedy for the Former Pumphouse #1 site. This alternative selection process is illustrated in Figure 23. At the Former Fuel Pit 1A/DAACG area, additional information on the amount of recoverable free product is necessary prior to the design and implementation of a corrective action system. At the Former Pumphouse #1 tank pit area, monitored natural attenuation is proposed. Fort Stewart/HAAF will evaluate "hot-spot" treatment pending a cost effective analysis and availability of funding.

III.C.1.a. Theory and feasibility

Former Fuel Pit 1A/DAACG Area (Release #1)

Free product was identified in several wells in the area in February 2000. The wells in this area are spaced over 200 feet apart. Ten additional 4-inch monitoring wells are proposed to delineate the free product area around the Former Fuel Pit 1A/DAACG as shown in Figure 24. Following the installation and development of these wells, free-phase product thickness evaluations will be conducted in the 3 of the 10 wells having the most measurable free product.

The free-phase product testing proposed for the three wells selected will be conducted to determine the actual amount of product on the groundwater surface in the vicinity of the wells. The procedure to be used to determine the free-phase product thickness will be the field bailout test method (Gruszczenski 1987). Free-phase product and groundwater level measurements will be taken using an oil/water interface probe, which detects product and water, by different conductivity values. The test method includes the following steps:

- Measure the static product surface level and groundwater surface to determine the thickness of a product and depth to groundwater in the well. A free-phase product level will be recorded as the interface probe is lowered into the well.

- Remove the free-phase product and groundwater from the well using a disposable top-filling bailer (or peristaltic pump). All measurable free-phase product will be extracted from the groundwater surface in each well. The interface probe will be lowered into the screened interval or near the bottom of the well to confirm the removal of the product.

- Measure the volume of product and groundwater extracted from the well and record the results.

- Measure the free-phase product surface and groundwater surface levels in each well and record the results at 10-minute intervals for the first hour and periodically thereafter while recovery from purging is occurring in the well (maximum duration of 48 hours). The extracted free-phase product and water will be placed in containers for later disposal.

The results of the free-phase product testing using the field bailout test method are similar to a rising head slug test. The results of the test yield two basic curve types, depending on the amount of free-phase product accumulation in the well. A Type I curve is associated with free-phase product accumulations of

less than 12 inches and indicates a one-to-one correspondence between the measured and actual formation free-phase product thickness. Type II curves are associated with free-phase product accumulations greater than 12 inches and result in interpretation of an inflection point prior to stabilization of water and free-phase product levels. This inflection point will be used to interpret the measured and actual formation of free-phase product thickness.

Graphs of the water/free-phase product levels versus time will be generated to observe the slope of the water/free-phase product interface and to determine inflection points. The actual product thickness is determined by measuring the difference between the product line and the water/free-phase product interface line at the inflection point. The difference between the water/free-phase product interface level at the time of inflection and the stabilized top of the free-phase product level is the sum of the actual product thickness and capillary fringe. The height of the capillary fringe is determined by subtracting this difference from the actual product thickness measured at the inflection point. Graphs will be generated with a depth measurement on the y axis and the time of the test along the x axis. The graphs will indicate the top of the free-phase product and the top of the water table. These curves will be used to generate and determine the apparent product thickness on the groundwater as a sum of the actual thickness and capillary fringe.

Using the test bailout method by Gruszczenski can result in reasonable determination of the actual free-phase product thickness in any particular formation. The procedure uses principles similar to the bailout slug test and interpretation of the groundwater surface as impacted by free-phase product accumulation. The information is used to determine the thickness of the actual free-phase product.

The results of the free-phase product testing will be combined with existing site data in order to evaluate remedial alternatives for Release #1. The corrective action recommendations will be summarized in a CAP-Part B Addendum Report that will be submitted to GA EPD USTMP for review and approval.

Former Pumphouse #1 Tank Pit Area (Release #2)

Natural attenuation is based on the premise that fuel-type hydrocarbons are readily biodegraded in most environmental systems. Biodegradation of BTEX has been documented for sites similar to the Former Pumphouse #1 tank pit area (e.g., shallow water table, permeable silty sand). In fact, the conditions at this site are similar to other sites that are ideal for biodegradation (Abou-Rizk et al. 1995). Finally, the source has been removed; therefore, subsurface conditions (dissolved oxygen, oxidation-reduction potential, background nutrient availability) will steadily improve with time.

In order to determine if natural attenuation of hydrocarbons was occurring, nine groundwater samples were collected from nine wells (P1-MW1, P1-MW2, P1-MW3, P1-MW19, P1-MW21, P1-MW22, P1-MW23, D-MW5, and D-MW6) in 1999. The groundwater samples were analyzed for BTEX, oxygen reduction potential, total organic carbon, sulfate, nitrate, ferrous iron, methane, ethane, ethene, alkalinity, dissolved oxygen, temperature, and pH. The results of the natural attenuation evaluation are presented in Attachment C. The results of the preliminary screening for aerobic and anaerobic biodgradation suggest that conditions are favorable for natural attenuation of aromatic hydrocarbons. The benzene concentrations at the downgradient perimeter of the plume decreased between 1996 and 1999. However, the benzene concentrations near the source, north of Former Fuel Pit 1C, have remained constant between 1996 and 2000.

During the 1999 and 2000 investigations, the Georgia IWQS for benzene of 71.28 μg/L was exceeded in seven monitoring wells. However, only four of the wells contained benzene concentrations that exceeded the benzene ACL of 285 μg/L. Fort Stewart proposes to implement monitored natural attenuation as a corrective action for this site. In addition, Fort Stewart/HAAF will evaluate "hot-spot" treatment

alternatives to be implemented upon availability of funding. Any future corrective action measures will be submitted in an addendum to this CAP-Part B Report.

III.D. IMPLEMENTATION

III.D.1. Milestone Schedule

A milestone schedule for the proposed corrective action and additional investigation has been prepared. A Gantt chart showing milestone activities and anticipated duration is provided in Figure 25. The actual time required to achieve the site remedial levels (i.e., ACLs) may be greater, or less, than presented in Figure 25. Therefore, Fort Stewart will notify GA EPD USTMP of any significant changes to the proposed remediation time and/or investigation time and will provide GA EPD USTMP an updated Gantt chart, as necessary.

III.D.2. Progress Reporting

For the Former Fuel Pit 1A/DAACG area (Release #1), the progress reporting requirements will be discussed in an addendum to the CAP-Part B Report that describes the corrective action to be implemented.

For the Former Pumphouse #1 tank pit area, annual monitoring reports will be submitted to GA EPD that will summarize all previous sampling events for that period.

III.D.3. Certificate of Completion Report

Petition for permanent closure will be submitted with the final progress report (i.e., completion report) for the first release to reach closure criteria. An addendum to the completion report will be submitted for the second release to reach the closure criteria. GA EPD will provide final approval for decommissioning the monitoring wells, which will be requested in the final completion addendum report. Decommissioning of monitoring wells will be completed according to the U.S. Army Corps of Engineers design manual for monitoring wells. Decommissioning will comply with all applicable state and federal standards.

The following certification will be submitted to EPD within 30 days of submitting the final progress report:

> I hereby certify that the Corrective Action Plan-Part B, dated _____, 20___, for Hunter Army Airfield, Former Pumphouse #1 site, Facility ID 9-025085, including any and all certified amendments/addenda thereto, has been implemented in accordance with the schedules, specifications, sampling programs, and conditions contained therein, and that the plan's stated objectives have been met.
>
> _____
> Signature (Owner/Operator)

III.D.4. Inspection Schedule and Preventative Maintenance Program

For the Former Fuel Pit 1A/DAACG area (Release #1), the inspection schedule and preventative maintenance program will be discussed in an addendum to the CAP-Part B Report that describes the corrective action to be implemented.

For the Former Pumphouse #1 tank pit area (Release #2), the wells will be visually inspected for changes or damage during each sampling event. Any notable observations will be recorded in the subsequent monitoring only report. Any required repairs to ensure the monitoring wells remain in conformance with GA EPD and EPA performance standards will be made as needed.

III.D.5. Periodic Monitoring

For the Former Fuel Pit 1A/DAACG area (Release #1), the periodic monitoring requirements will be discussed in an addendum to the CAP-Part B Report that describes the corrective action to be implemented.

For the Former Pumphouse #1 tank pit area (Release #2), groundwater samples will be collected semiannually from D-MW5, D-MW6, P1-MW1, P1-MW2, P1-MW18, P1-MW19, P1-MW22, and P1-MW23 and analyzed for BTEX. PAH compounds that were observed during the CAP-Part A and CAP-Part B investigations were detected at concentrations below their respective ACLs. Thus, it is recommended that PAH analysis not be performed during the semiannual sampling. Monitoring will continue at the site until the benzene concentrations in groundwater are below the ACL of 285 µg/L for two sampling events or until a "hot-spot" treatment is completed at the site.

During each sampling event, water levels will be measured in all monitoring wells. Specific conductivity, pH, and temperature analyses will be completed on each sample from the monitoring wells where analytical samples are collected. The samples will be shipped to an approved laboratory for BTEX analysis using EPA Method 8021B/8260B and PAH analysis using EPA Methods 8100/8270C/8310.

III.D.6. Effectiveness of Corrective Action

The corrective action to be implemented at the Former Fuel Pit 1A/DAACG area will be determined in an addendum to this CAP-Part B Report. Once the corrective action is implemented and the remedial objectives met, the corrective action will be discontinued. The objectives of the corrective action are to reduce the benzene concentrations in groundwater to below the ACL of 285 µg/L and to reduce the benzene, benzo(a)pyrene, chrysene, and indeno(1,2,3-cd)pyrene to below the ATLs of 9.3 mg/kg, 4.2 mg/kg, 8.6 mg/kg, and 2.7 mg/kg, respectively.

For the Former Pumphouse #1 tank pit area (Release #2), the corrective action will be discontinued once the objectives of the monitoring only plan have been achieved. That is the benzene concentrations in groundwater will be reduced below the ACL of 285 µg/L, and the benzene and chrysene concentrations in soil will be reduced below their ATLs of 9.3 mg/kg and 2.2 mg/kg, respectively.

III.D.7. Confirmatory Soil Sampling Plan

For the Former Fuel Pit 1A/DAACG area (Release #1), the confirmatory soil sampling plan will be discussed in an addendum to the CAP-Part B Report that describes the corrective action to be implemented.

For the Former Pumphouse #1 tank pit area (Release #2), no excavation of soil is planned under the monitoring only plan; therefore, confirmatory sampling associated with excavation of soil will not be performed. However, since there is an area of soil contamination that exceeds the benzene ATL of 9.3 mg/kg and the chrysene ATL of 2.2 mg/kg, three confirmatory soil samples will be collected from the area of soil contamination. The soil samples will be collected once the benzene concentrations in groundwater are approaching the ACL. The soil samples will only be analyzed for benzene and chrysene.

The location of these samples will be determined during the monitoring only program and will be submitted to GA EPD in a letter or annual monitoring only report for approval.

III.D.8. Stockpiled Bulk Soil Sampling

For the Former Fuel Pit 1A/DAACG area (Release #1), stockpiled bulk soil sampling, if necessary, will be discussed in an addendum to the CAP-Part B Report that describes the corrective action to be implemented.

For the Former Pumphouse #1 tank pit area (Release #2), no stockpiled soil will be generated with this corrective action; therefore, no soil sampling will be conducted.

III.D.9. Corrective Action Termination Conditions

For the Former Fuel Pit 1A/DAACG area (Release #1), termination conditions will be provided in an addendum to the CAP-Part B Report that describes the corrective action to be implemented.

For the Former Pumphouse #1 tank pit area (Release #2), concentrations of benzene in groundwater must be at or below the ACL, and concentrations of benzene and chrysene in soil must be at or below their respective ATLs prior to terminating the monitoring only program. Once the benzene ACL and the benzene and chrysene ATLs are achieved, the remedial system and monitoring may be terminated regardless of the site ranking score.

III.D.10. Post-Completion Site Restoration Activities

After termination has been granted for either release, equipment and debris related to the corrective action will be removed from the site.

III.E. PUBLIC NOTIFICATION

The Former Pumphouse #1 site is located entirely within the confines of the Hunter Army Airfield, which is part of the Fort Stewart Military Reservation, a federal facility. The U.S. Government owns all of the property contiguous to the site. The Fort Stewart DPW has complied with the public notice requirements defined by GA EPD guidance by publishing an announcement in the *Savannah Morning News* on April 16 and 23, 2000. A copy of the newspaper announcement used for public notification is presented in Appendix XI of this report.

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