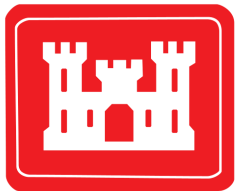


REVISION 1

**REMEDIAL INVESTIGATION REPORT  
FOR THE  
ALABAMA ARMY NATIONAL GUARD (ALARNG)  
ORGANIZATIONAL MAINTENANCE SHOP 28 (OMS-28)  
1622 SOUTH BROAD STREET  
MOBILE, MOBILE COUNTY, ALABAMA  
GROUNDWATER INCIDENT NUMBER GW 07-01-02**

*Prepared for*



**US Army Corps  
of Engineers®**

**Mobile District**

**Contract No. W91278-10-D-0089  
Delivery Order No. 0004**

**December 2012**

**SAIC®**

**SCIENCE APPLICATIONS INTERNATIONAL CORPORATION**

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

REVISION 1

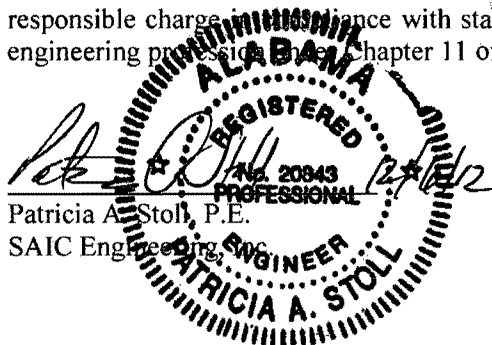
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Prepared by

Science Applications International Corporation  
151 Lafayette Drive  
Oak Ridge, TN 37830  
for  
USACE, Mobile District  
under  
Contract No. W91278-10-D-0089  
Delivery Order No. 0004

December 2012

I, the undersigned, certify that I am a qualified professional engineer with competence in the subject matter dealt with in this document. I further certify that this document has been prepared under my responsible charge and in accordance with standard professional practices, the laws and rules governing the engineering profession, and Chapter 11 of the Alabama Licensure Law and the Administrative Code.

  
Patricia A. Stoll, P.E.  
SAIC Engineering, Inc.

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- Appendix C OMS-28 Work Plan for TCE Investigation dated February 2006
- Appendix D TCE Comprehensive Investigation Report dated April 2007 (Aerostar 2007)
- Appendix E Supplemental Comprehensive Investigation Work Plan dated March 2008 (Aerostar 2008a)
- Appendix F OMS-28 Well Abandonment Report dated May 2008 (Aerostar 2008b)
- Appendix G OMS-28 Supplemental Comprehensive Investigation Report dated November 2008
- Appendix H OMS-28 1st Groundwater Monitoring Report dated April 2009
- Appendix I OMS-28 2nd Groundwater Monitoring Report dated August 2009 (Aerostar 2009a)
- Appendix J OMS-28 3rd Groundwater Monitoring Report dated December 2009 (Aerostar 2009b)
- Appendix K OMS-28 4th Groundwater Monitoring Report dated June 2010 (Aerostar 2010)
- Appendix L OMS-28 5th Groundwater Monitoring Report dated January 2011 (Aerostar 2011a)
- Appendix M OMS-28 Alabama Risk Based Corrective Action Report dated March 2011 (Aerostar 2011b)
- Appendix N Alabama Armory Commission Quit Claim Deed dated February 18, 2003

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## ACRONYMS

ADEM	Alabama Department of Environmental Management
Aerostar	Aerostar Environmental Services, Inc.
AFB	Air Force Base
ALARNG	Alabama Army National Guard
ALDOT	Alabama Department of Transportation
AMSL	above mean sea level
ARBCA	Alabama risk-based corrective action
BGS	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CI	comprehensive investigation
COC	contaminant of concern
DCE	dichloroethene
DNAPL	dense, non-aqueous-phase liquid
DO	dissolved oxygen
DoD	U. S. Department of Defense
DPT	direct-push technology
EPA	U. S. Environmental Protection Agency
FS	feasibility study
HAC	halogenated aliphatic compound
HI	hazard index
IDW	investigation-derived waste
LNAPL	light, non-aqueous-phase liquid
MAA	Mobile Airport Authority
MCL	maximum contaminant level
Mgal/day	million gallons per day
NAPL	non-aqueous-phase liquid
OMS	Organizational Maintenance Shop
OVA	organic vapor analyzer
PAH	polynuclear aromatic hydrocarbon
PCE	tetrachloroethene
PRG	preliminary remediation goal
PSL	preliminary screening level
PSV	preliminary screening value
PVC	polyvinyl chloride
QC	quality control
RBTL	risk-based target level
RI	remedial investigation
RM	risk management
ROW	right-of-way
RSL	regional screening level
SAIC	Science Applications International Corporation
SSL	soil screening level
SSTL	site-specific target level
SVOC	semivolatile organic compound
TCE	trichloroethene
USACE	U. S. Army Corps of Engineers
UST	underground storage tank

VC  
VOC

vinyl chloride  
volatile organic compound

## EXECUTIVE SUMMARY

This document summarizes the Remedial Investigation (RI) Report prepared for Organizational Maintenance Shop (OMS) 28 located at the Brookley Aeroplex. Science Applications International Corporation (SAIC) prepared this document under U. S. Army Corps of Engineers (USACE), Mobile District contract number W91278-10-D-0089, delivery order number 0004. This report summarizes, and consolidates into a single RI Report, the results presented in previously published documents relating to the trichloroethene (TCE) investigations and monitoring events performed at the site. The previous investigations that were used to develop this RI Report include the following:

- *TCE Comprehensive Investigation at the Organizational Maintenance Shop 28 (OMS-28), Alabama Army National Guard, 1622 South Broad Street, Mobile, Alabama, Groundwater Incident No. GW 07-01-02 (Aerostar 2007).*
- *Supplemental Comprehensive Investigation Report for the Alabama Army National Guard (ALARNG) Organizational Maintenance Shop 28 (OMS-28), 1622 South Broad Street, Mobile, Alabama, Groundwater Incident No. GW 07-01-02 (Aerostar 2008a).*
- *Supplemental Comprehensive Investigation Groundwater Monitoring Report for the Alabama Army National Guard (ALARNG) Organizational Maintenance Shop 28 (OMS-28), 1622 South Broad Street, Mobile, Alabama, Groundwater Incident No. GW 07-01-02 (Aerostar 2009a) for the December 2008 sampling event.*
- *Supplemental Comprehensive Investigation Groundwater Monitoring Report for the Alabama Army National Guard (ALARNG) Organizational Maintenance Shop 28 (OMS-28), 1622 South Broad Street, Mobile, Alabama, Groundwater Incident No. GW 07-01-02 (Aerostar 2009b) for the May 2009 sampling event.*
- *Supplemental Comprehensive Investigation Groundwater Monitoring Report for the Alabama Army National Guard (ALARNG) Organizational Maintenance Shop 28 (OMS-28), 1622 South Broad Street, Mobile, Alabama, Groundwater Incident No. GW 07-01-02 (Aerostar 2009c) for the September 2009 sampling event.*
- *Supplemental Comprehensive Investigation Groundwater Monitoring Report for the Alabama Army National Guard (ALARNG) Organizational Maintenance Shop 28 (OMS-28), 1622 South Broad Street, Mobile, Alabama, Groundwater Incident No. GW 07-01-02 (Aerostar 2010) for the March 2010 sampling event.*
- *Supplemental Comprehensive Investigation Groundwater Monitoring Report for the Alabama Army National Guard (ALARNG) Organizational Maintenance Shop 28 (OMS-28), 1622 South Broad Street, Mobile, Alabama, Groundwater Incident No. GW 07-01-02 (Aerostar 2011a) for the September 2010 sampling event.*
- *Alabama Risk-Based Corrective Action Report, Organizational Maintenance Shop – 28 (Aerostar 2011b).*

In preparing this report, SAIC relied solely on written information provided by secondary sources, including information provided by the customer. No additional field or sample data were collected as part of this document.

## **ES.1 OMS-28 SITE DESCRIPTION**

OMS-28 is located in the logistics/manufacturing district of the Brookley Aeroplex. The Alabama Armory Commission owns the property on which OMS-28 is located. The Alabama Army National Guard (ALARNG) operates the Field Maintenance Shop (formerly known as the OMS) in the northwest corner of the Brookley Aeroplex. Mobile Airport Authority (MAA) owns the property directly west of the OMS-28 site, and residential property is located to the north.

In 1992, four storage tanks were removed from three separate locations (Pit 1, Pit 2, and Pit 3) at the OMS. According to USACE, Pits 1 and 3 were clean-closed following the tank removal and no subsequent investigations were required after the closure. A single 2,000-gal gas/diesel underground storage tank at Pit 2 was removed in October 1992. The preliminary investigation of Pit 2 did not fully determine the extent of petroleum contamination in soil or groundwater. A secondary investigation of Pit 2 was completed in December 1994, which established the extent of petroleum contamination in soil and groundwater at the site. The 1994 secondary investigation was followed by quarterly groundwater monitoring for petroleum contamination beginning in 1995. In 2004 and 2005, additional site characterization was performed because groundwater monitoring indicated that petroleum-related contamination had extended beyond the network of monitoring wells installed during the original 1994 secondary investigation. The presence of a chlorinated solvents plume was discovered downgradient of Pit 2 during this 2004/2005 investigation. The chlorinated solvents, specifically TCE, were not related to the gasoline/diesel fuel tank being investigated and were believed to be the result of a localized solvent spill located on OMS-28 property approximately 200 ft west-northwest of Pit 2 (Aerostar 2007). No additional information regarding the details of a spill (i.e., when, amount of the spill, what was spilled, or who was responsible) has been provided in any of the historical documents.

## **ES.2 SUMMARY OF NATURE AND EXTENT OF CONTAMINATION**

### **ES.2.1 Soil**

Fifteen volatile organic compounds (VOCs) were detected sporadically in the 61 soil samples across the 27 locations with no discernible trends between 2006 and 2008. The concentrations of constituents were below their respective residential and commercial U. S. Environmental Protection Agency (EPA) regional screening levels (RSLs). The concentrations of four VOCs exceeded their respective protection of groundwater soil screening levels (SSLs). Of these, TCE and tetrachloroethene (PCE) are considered the primary contaminants of concern (COCs) exceeding the protection of groundwater SSLs.

Sixteen semivolatile organic compounds were detected in the soil samples. The concentrations of four polynuclear aromatic hydrocarbons (PAHs) exceeded their respective residential and industrial RSLs. However, all PAH detections were in surface soil and were outside the boundary of the ALARNG property and are not thought to be attributable to ALARNG activities.

There are three areas of soil contamination that may be acting as a residual source for the TCE and PCE groundwater plumes. The largest area of soil contamination exceeding the protection of groundwater SSLs is located in the vicinity of MW-8, and the area exceeding the SSLs for TCE and PCE is approximately 60 by 60 ft. The vertical extent of contamination is located throughout the unsaturated zone from ground surface to the water table observed during drilling at approximately 15 ft below ground surface (BGS). However, concentrations in the area of MW-8 are below the residential RSLs for TCE and PCE. The TCE concentrations in soil samples from HA-01, HA-02, HA-03, HA-06, HA-07, HA-08, HA-12, HA-14, HA-15, OMS-28-3, OMS-28-4, OMS-28-5, and OMS-28-6 exceeded the SSL of 0.0018 mg/kg but were less than the residential RSL of 0.91 mg/kg. The PCE concentrations in soil samples from HA-05, HA-07, and HA-13 exceeded the SSL of 0.0023 mg/kg but were less than the

residential RSL of 22 mg/kg. OMS-28-3 is located 60 ft north of MW-8, and the TCE concentration was 0.211J mg/kg at 10 to 15 ft BGS. OMS-28-4 is located 130 ft northwest of MW-8, and the TCE concentration was 0.027 mg/kg at 10 to 15 ft BGS. The concentrations in OMS-28-3 and OMS-28-4 exceeded the SSL for TCE and are from the 10- to 15-ft BGS sample interval. The precise location of these samples collection is unknown for these two samples but is probably from just above the water table. It is probable that contaminated groundwater trapped in the capillary fringe above the water table may have contributed to the exceedances.

Two smaller isolated areas of soil contamination exceeding the protection of groundwater SSLs are located approximately 200 ft northwest of MW-8 at soil sample location B-17 on MAA property and approximately 250 ft west of MW-8 at soil sample location B-13 on MAA property. The PCE concentrations in surface and subsurface soil samples from B-17 exceeded the SSL of 0.0023 mg/kg but were below the residential RSL of 22 mg/kg. The area exceeding the SSL around B-17 is estimated to be 15 by 20 ft. The vertical extent of PCE contamination in the vicinity of B-17 extends to at least 10 ft BGS; however, it probably extends deeper as the vertical extent was not delineated in B-17. The TCE concentration in the surface soil sample from B-13 exceeded the SSL of 0.0018 mg/kg but was below the residential RSL of 0.91 mg/kg. The area exceeding the SSL around B-13 is estimated to be 15 by 15 ft. The vertical extent of contamination at B-13 does not extend any deeper than 6 ft BGS.

The concentrations of TCE and PCE in the vicinity of MW-8 and at the two smaller isolated locations in the vicinity of B-17 and B-13 were below the residential and industrial RSLs for TCE and PCE.

## **ES.2.2 Groundwater**

Eighteen VOCs were detected in groundwater during the investigations from 2006 through 2008. The concentrations of 1,2-dichloroethane; benzene; *cis*-1,2-dichloroethene (DCE); chloroform; ethylbenzene; naphthalene; PCE; TCE; vinyl chloride (VC); and total xylenes exceeded their respective EPA tap water RSLs. However, by September 2010, only the concentrations of *cis*-1,2-DCE; PCE; and TCE exceeded their respective EPA tap water RSLs. TCE and PCE were the only constituents to exceed their respective maximum contaminant levels (MCLs). In September 2010, TCE was detected in three shallow wells (MW-8, OMS-28-3, and OMS-28-5). TCE was not detected in the remaining shallow wells (MW-5, MW-6, MW-9, MW-12, OMS-28-2, and OMS-28-7), which delineate the horizontal extent of the plume boundary. TCE was not detected in the three deep wells (OMS-28-1, OMS-28-4, and OMS-28-6). PCE was detected in one shallow well (OMS-28-5) and was not detected in the other shallow wells or in the deep wells. Based on the results of the September 2010 sampling event and the 2006 Phase I and II temporary wells, there appears to be a TCE plume and a PCE plume. PCE may have already degraded in the vicinity of MW-8 and is no longer being observed in that part of the TCE plume.

Vertical migration of the contaminants is limited by a stiff, dense clay that is located at 30 ft BGS. Above the stiff clay is a sandy clay or clayey sand, which also limits vertical migration. The vertical extent of groundwater contamination is determined by vertical groundwater sample delineation from deep wells OMS28-4 and OMS-28-6, which are located within the boundary of the TCE plume. These deep wells did not indicate the presence of contamination during the six consecutive groundwater sampling events between 2008 and 2010.

The estimated dimension of the groundwater TCE plume is 320 by 120 ft and of the PCE plume is 100 by 65 ft. The estimated length of the TCE plume does not account for the biodegradation of TCE that has been occurring in the subsurface; however, MW-11 was abandoned at the private property owner's request and, therefore, the well has not been resampled to verify that the TCE concentrations have decreased. Based on the depth of the screens in the shallow wells, the vertical depth of the plumes extends to approximately 20 ft BGS. However, the possibility exists that the plume may extend to the top of the

stiff clay, which is 30 to 35 ft BGS. The TCE plume is an elliptical feature oriented to the northwest from the larger area of soil contamination centered around MW-8 on OMS-28 property onto MAA property to the west. The PCE plume is an elliptical feature oriented to the northwest located near the smaller area of soil contamination in the vicinity of B-17 on MAA property. A review of the groundwater data from the shallow wells over six consecutive groundwater sampling events has demonstrated that the horizontal extent of the groundwater plumes remains relatively stable (i.e., they are no longer expanding).

### **ES.3 SUMMARY OF FATE AND TRANSPORT**

VOCs were the primary constituents detected in soil samples exceeding protection of groundwater SSLs. VOCs were the only constituents in groundwater observed in significant quantities above MCLs. The presence of PCE; TCE; and *cis*-1,2-DCE in the unsaturated soil at concentrations above SSLs protective of groundwater serves as a renewable source of groundwater contamination. Once these contaminants enter the subsurface, the important mechanisms affecting the overall fate and transport in the environment are leaching, diffusion, advection, mechanical dispersion, adsorption, and degradation.

The most important process for the natural biodegradation of the more highly chlorinated solvents, PCE and TCE, is reductive dechlorination. In general, reductive dechlorination occurs by sequential dechlorination from PCE to TCE to DCE to VC to ethene. Reductive dechlorination affects each of the chlorinated ethenes differently. Of these compounds, PCE is the most susceptible to reductive dechlorination because it is the most oxidized. Conversely, VC is the least susceptible to reductive dechlorination because it is the least oxidized of these compounds.

### **ES.4 SUMMARY OF RISK ASSESSMENT**

The maximum concentrations of PCE and TCE exceeded the 2008 residential preliminary screening values (PSVs); therefore, PCE and TCE were identified as COCs in the Alabama Risk-Based Corrective Action (ARBCA) Report (Aerostar 2011b). The receptors evaluated in the ARBCA Report were the commercial worker-adult, construction worker-adult, trespasser (adolescent), resident child (within 500 ft), and resident adult (within 500 ft).

The results of the ARBCA Risk Management (RM)-1 evaluation using default parameters did not identify a cumulative risk that exceeded appropriate risk levels for a commercial worker, construction worker, or trespasser. However, under a future use scenario of unrestricted use (i.e., residential scenario), there is a cumulative risk that exceeds risk levels for a resident child or resident adult for exposure to surface soil or groundwater.

The results of the ARBCA RM-2 evaluation using default and site-specific fate and transport parameters did not identify a cumulative risk that exceeded appropriate risk levels for a commercial worker, construction worker, or trespasser. However, under a future use scenario of unrestricted use (i.e., residential scenario), there is a cumulative risk that exceeds risk levels for a resident child or resident adult who may ingest groundwater. The ARBCA Report recognizes risk when the cumulative risk value is greater than 1E-05 and a hazard index (HI) is greater than 1. With the change to site-specific fate and transport parameters, the risk associated with exposure to surface soil was reduced.

RM-2 risk-based target levels were calculated for those receptors where a cumulative risk or HI exists. For the resident child, the cumulative risk is 7.04E-04 and the HI is 3.22. For the resident adult, the cumulative risk is 1.51E-03 and the HI is 1.38.



Current use of the site is acceptable for the commercial worker, construction worker, and trespasser. Future residents may be at risk if ingestion of groundwater was to occur at a hypothetical well for potential exposure.

## **ES.5 CONCLUSIONS AND RECOMMENDATIONS**

Four PAHs in surface soil exceeded their respective residential and industrial RSLs; however, the sample locations were outside the boundary of ALARNG property. VOC soil contamination at OMS-28 does not exceed residential or industrial RSLs (May 2012), which were used for the screening evaluation in lieu of the PSVs in accordance with e-mail guidance provided by the Alabama Department of Environmental Management. However, the concentrations of TCE and PCE in soil exceed the protection of groundwater SSLs, and the mass in soil is most likely the residual source of contamination for the two groundwater plumes. The larger source area in the vicinity of MW-8 is located on ALARNG property. There are two isolated areas of soil contamination located on MAA property, and the responsible party for this source of contamination is not known. As shown in Figure 4-6, the TCE and PCE groundwater plumes have been degrading with time, but periodic spikes in concentrations have been observed. These periodic spikes are most likely due to flushing/leaching of contaminants from the soil matrix to the groundwater following significant rain events.

No additional investigation activities are required. A feasibility study is recommended to evaluate alternatives for addressing TCE contamination in groundwater that resulted from the soil contamination at OMS-28.

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## 1.0 INTRODUCTION

Science Applications International Corporation (SAIC), contracted by the U. S. Army Corps of Engineers (USACE), Mobile District, prepared this Remedial Investigation (RI) Report for Organizational Maintenance Shop (OMS) 28 located at the Brookley Aeroplex. This RI Report summarizes the nature and extent of contaminated media identified in the *TCE Comprehensive Investigation at the Organizational Maintenance Shop 28 (OMS-28), Alabama Army National Guard, 1622 South Broad Street, Mobile, Alabama, Groundwater Incident No. GW 07-01-02* (Aerostar 2007) and the *Supplemental Comprehensive Investigation Report for the Alabama Army National Guard (ALARNG) Organizational Maintenance Shop 28 (OMS-28), 1622 South Broad Street, Mobile, Alabama, Groundwater Incident No. GW 07-01-02* (Aerostar 2008a) as contracted within the scope of work under contract number W91278-10-D-0089, delivery order number 0004.

### 1.1 PURPOSE OF THE REPORT

This report summarizes, and consolidates into a single RI Report, the results presented in previously published documents relating to the trichloroethene (TCE) investigations and monitoring events performed at the site. This RI document was developed in accordance with the U. S. Environmental Protection Agency's (EPA's) *Guidance for Conducting Remedial Investigations and Feasibility Studies Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)* (EPA 1988). The previous investigations that are summarized in this document include the following:

- The TCE Comprehensive Investigation (CI) at OMS-28 (Aerostar 2007; Appendix D of this report).
- The Supplemental CI Report for OMS-28 (Aerostar 2008a; Appendix G of this report).
- *Supplemental Comprehensive Investigation Groundwater Monitoring Report for the Alabama Army National Guard (ALARNG) Organizational Maintenance Shop 28 (OMS-28), 1622 South Broad Street, Mobile, Alabama, Groundwater Incident No. GW 07-01-02* (Aerostar 2009a, 2009b, 2009c, 2010, and 2011a; Appendices H through L, respectively, of this report).
- *Alabama Risk-Based Corrective Action Report, Organizational Maintenance Shop – 28* (Aerostar 2011b; Appendix M of this report).

In preparing this report, SAIC relied solely on written information provided by secondary sources, including information provided by the customer. Because the assessment consisted of evaluating a limited supply of information, SAIC may not have identified all potential items of concern and/or discrepancies and, therefore, warrants only that the project activities under this contract have been performed within the parameters and scope communicated by USACE, Mobile District and reflected in the contract. SAIC made no independent investigations concerning the accuracy or completeness of the information relied upon.

### 1.2 SITE BACKGROUND

#### 1.2.1 Site Description

OMS-28 is located in Mobile County, near downtown Mobile at 1622 South Broad Street, between Interstate 10 and Mobile Bay. The subject property is located in Section 1, Township 4 South, Range 1

West, and at approximate location Longitude 88°03'42" West and Latitude 30°39'11" North within the Brookley Aeroplex (Figure 1-1). The OMS-28 site is surrounded by Interstate 10 to the west and north; the Fort Floyd A. McCorkle Alabama Army National Guard (ALARNG) facility building to the east; and Hood Distribution and SpillTech, Inc. to the south on O'Donoghue Street.

OMS-28 is located in the northwest corner of the former Brookley Air Force Base (AFB). The initial 1,000 acres were acquired by the U. S. Department of Defense (DoD) in 1938 with additional land acquisitions through 1955 for a total of 3,156 acres. Brookley AFB was operated by the Air Force as a general support and supply base until June 1969 when it was officially closed. DoD returned Brookley AFB to the city of Mobile and the city created the Mobile Airport Authority (MAA) in 1972. The Brookley Aeroplex, formerly the Brookley Field Industrial Complex, includes runways and maintenance areas for aircraft, underground and aboveground fuel storage facilities, associated buildings, roads, housing, and landfills. No human consumption or agricultural wells are located within the boundaries of the Brookley Aeroplex. Currently, the Alabama Armory Commission owns the 5.9 acres of property on which OMS-28 is located, and ALARNG operates the Field Maintenance Shop (formerly known as the OMS). The Alabama Armory Commission has owned this property since 1953 when the City of Mobile conveyed 25.66 acres to the Commission. In 2002, 6.43 acres west of the OMS-28 property reverted back to the City and the City subsequently conveyed the property to the MAA. The quit claim deed is provided in Appendix N of this report.

The Brookley Aeroplex is designated by the Federal Aviation Administration as operating with a Part 139 certification. The property is now owned by the MAA, an entity of the city of Mobile. The Brookley Aeroplex is currently the region's largest industrial park and is used as an airport by MAA.

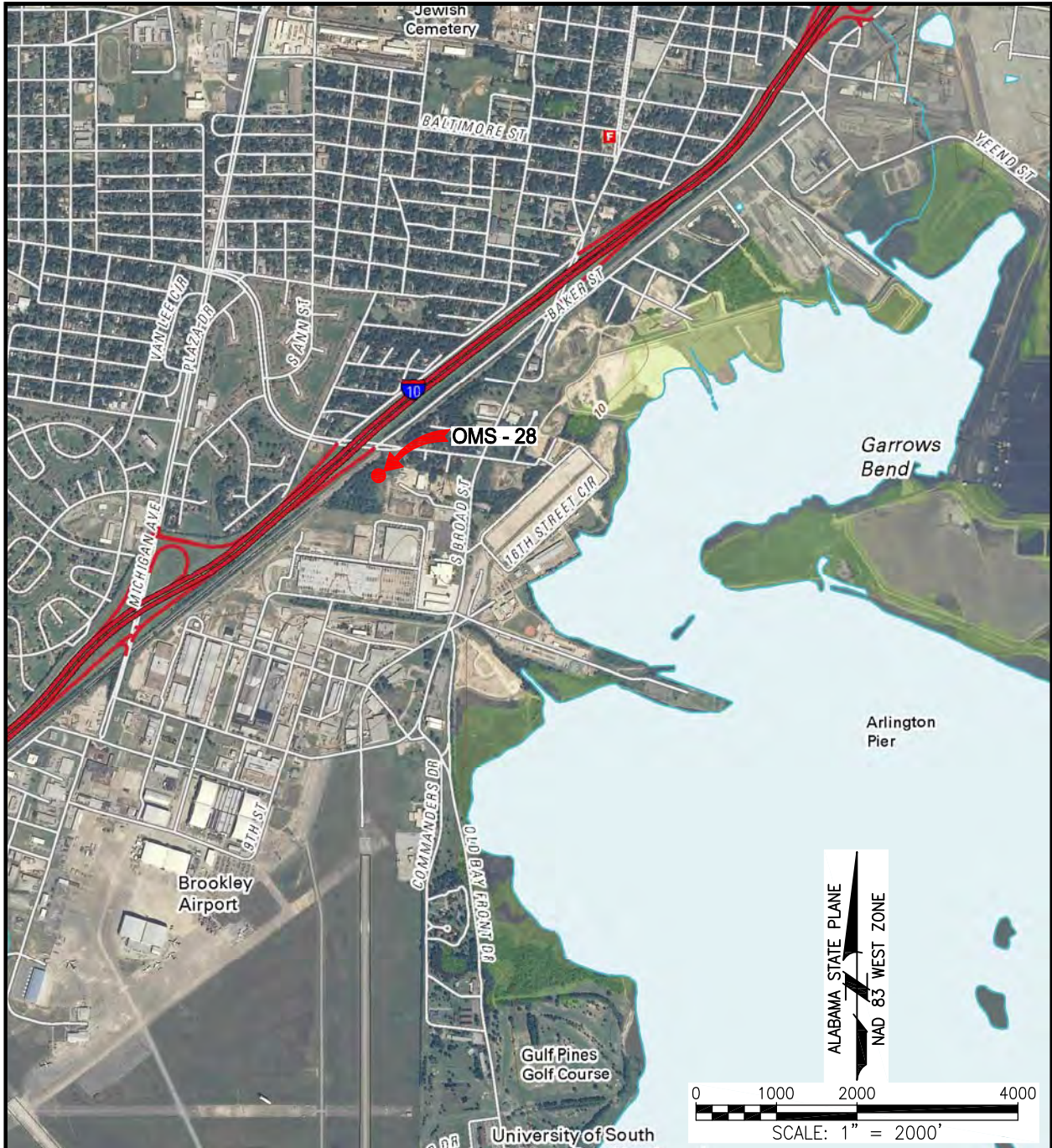
## **1.2.2 Background and History**

### **1.2.2.1 Chronology of events**

Four storage tanks were removed from three separate locations (Pit 1, Pit 2, and Pit 3) at the OMS in 1992. According to USACE, Pits 1 and 3 were clean-closed following the tank removal and no subsequent investigations were required after the closure. The chlorinated solvents plume was discovered at OMS-28 during one of the investigations for petroleum contamination associated with Pit 2.

A single 2,000-gal gas/diesel underground storage tank (UST) at Pit 2 was removed in October 1992. Following the removal of the UST, a preliminary investigation was performed by USACE for Pit 2 in October 1993 and the report was submitted to the Alabama Department of Environmental Management (ADEM). The preliminary investigation did not fully determine the extent of petroleum contamination in soil or groundwater. A secondary investigation of Pit 2 was completed in December 1994, which established the extent of petroleum contamination in soil and groundwater at the site. The 1994 secondary investigation was followed by quarterly groundwater monitoring for petroleum contamination beginning in 1995.

In 2004 and 2005, Bechtel-S performed additional site characterization because groundwater monitoring indicated that petroleum-related contamination had extended beyond the network of monitoring wells installed during the original 1994 secondary investigation. The results were reported in the *Secondary Investigation Addendum Report, OMS #28 – Pit #2, Alabama National Guard OMS, 1622 South Broad Street, Mobile, Alabama, Facility ID#: 14587-097-012257, UST Incident #93-02-15* (Bechtel-S 2005a; Appendix B of this report). During sampling for the Secondary Investigation Addendum Report in November 2004, the benzene, toluene, ethylbenzene, and xylenes (BTEX) reporting limits for MW-8 were higher than the other groundwater samples due to the dilution (by the laboratory) of this sample by a factor of 20. It was later determined that the dilution was required due to the interference by TCE in the



**SOURCE:**  
 UNITED STATES GEOLOGICAL SURVEY, MOBILE, AL, 2011.



**KEY MAP:**  
 NOT TO SCALE



**FIGURE 1-1**  
**SITE LOCATION MAP**

**OMS - 28**  
**ALABAMA ARMY NATIONAL GUARD**  
**MOBILE, ALABAMA**

<b>DRAWN BY:</b> R. BEELER	<b>REV. NO./DATE:</b> 0/05-18-12	<b>CAD FILE:</b> /11013/DWGS/L83_LOCA-01
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sample. The TCE was not related to the gasoline/diesel fuel tank being investigated and was believed to be the result of a localized solvent spill located on OMS-28 property approximately 200 ft west-northwest of Pit 2 (Aerostar 2007). No additional information regarding the details of a spill (i.e., when, amount of the spill, what was spilled, or who was responsible) has been provided in any of the historical documents. No other groundwater samples collected during that event required dilution by the laboratory.

In March 2005, all of the monitoring wells (MW-1, MW-2, MW-3, MW-5, MW-6, MW-7, and MW-8) that had been installed to delineate the extent of contamination around Pit 2 were sampled and analyzed for a full volatile organic compound (VOC) analysis. MW-4 was removed in October 2002 during concrete pavement activities. With the exception of monitoring well MW-8, TCE was not detected in the groundwater samples collected from the monitoring wells. TCE was detected in the groundwater samples collected from monitoring well MW-8 and the duplicate (MW-8) at concentrations of 460 and 430 µg/L, respectively, which was above the maximum contaminant level (MCL) of 5 µg/L. *cis*-1,2-Dichloroethene (DCE) was the only other VOC detected in the groundwater samples collected from monitoring well MW-8 and the duplicate (MW-8) at concentrations of 11 and 10 µg/L, respectively, which was below its MCL of 70 µg/L. No other contaminants exceeded ADEM initial screening limits in the groundwater samples submitted for analysis.

#### **1.2.2.2 Previous investigations**

The original investigations centered on the contamination associated with the UST located at Pit 2. The UST-related investigations that have been performed at OMS-28 are summarized in Table 1-1. ADEM determined that no further subsurface investigation was required for the UST located at Pit 2 as documented in correspondence dated January 19, 2007, from the ADEM UST Corrective Action Section (ADEM 2007). The UST-related investigations performed were documented in the following reports:

- *UST Closure Site Assessment Report, The Amory Commission of Alabama, OMS #28 and 29 – Pit #1, Pit #2 and Pit #3* (CWA 1992).
- *Preliminary Investigation Report, OMS #28 Pit #2* (PELA 1993).
- *Underground Storage Tank Secondary Investigation Report, Alabama National Guard Armory, OMS #28 and 29 – Pit #2* (PELA 1994).
- Secondary Investigation Addendum Report (Bechtel-S 2005a; Appendix B of this report).

The chlorinated solvents-related investigations performed following the discovery of TCE in MW-8 in 2005 were documented in the following reports:

- TCE CI at OMS-28 (Aerostar 2007; Appendix D of this report).
- Supplemental CI Report for OMS-28 (Aerostar 2008a; Appendix E of this report).
- Supplemental CI Groundwater Monitoring Reports for OMS-28 (Aerostar 2009a, 2009b, 2009c, 2010, and 2011a; Appendices H through L of this report).

The results of the TCE-related investigations are being compiled in this document to act as an RI Report for OMS-28.

**Table 1-1. Summary of Previous UST-related Investigations at OMS-28**

<b>Description</b>	<b>Date</b>	<b>Primary Activities</b>	<b>Findings/Recommendations</b>
UST Closure (CWA 1992)	October 1992	<p>A 2,000-gal gas/diesel UST was removed from the site</p> <ul style="list-style-type: none"> <li>• Tank, piping, and 50 yd<sup>3</sup> of soil were excavated</li> <li>• Subsurface soil samples were collected while installing four monitoring wells (MW-1 through MW-4)</li> <li>• Excavated soil was spread in a thin layer on the ground surface</li> </ul>	<ul style="list-style-type: none"> <li>• UST excavation sidewall and bottom samples indicated TPH concentrations between &lt;10 and 49 mg/kg</li> <li>• Composite samples of excavated soil contained up to 427 mg/kg TPH</li> <li>• Soil boring samples indicated 26.6 mg/kg TPH at 5 ft BGS in MW-1 and &lt;10 mg/kg in all other borings (MW-2 through MW-4)</li> </ul>
UST Preliminary Investigation (PELA 1993)	October 1993	<ul style="list-style-type: none"> <li>• Collected groundwater samples from four monitoring wells (MW-1 through MW-4) for BTEX and PAHs</li> </ul>	<p>The preliminary investigation identified petroleum-contaminated soil and groundwater associated with the former UST at Pit 2</p> <ul style="list-style-type: none"> <li>• MW-1 groundwater contained 10,300 µg/L BTEX and 537 µg/L PAHs</li> <li>• MW-3 groundwater contained 24 µg/L BTEX and 9 µg/L PAHs</li> <li>• Extent of soil contamination was not defined</li> </ul>
UST Secondary Investigation (PELA 1994)	December 1994	<ul style="list-style-type: none"> <li>• One hand auger soil boring (BH-1) was installed west of MW-1 and sampled for TPH</li> <li>• Installed two new monitoring wells (MW-5 and MW-6)</li> <li>• Collected groundwater samples from six monitoring wells (MW-1 through MW-6) for BTEX, PAHs, and lead</li> <li>• Water level surveys were performed to determine the groundwater flow direction</li> </ul>	<p>The secondary investigation completely delineated the presence of petroleum contamination in soil and groundwater associated with the former UST at Pit 2. Quarterly groundwater monitoring was initiated</p> <ul style="list-style-type: none"> <li>• TPH was &lt;10 mg/kg in hand auger soil boring BH-1; the extent of soil contamination was defined</li> <li>• BTEX was 27,840 µg/L and naphthalene was 353 µg/L in MW-1</li> <li>• Trace levels of BTEX in MW-3</li> <li>• Lead concentrations exceeded the MCL in five of six wells</li> <li>• No organic contaminants were detected in new wells MW-5 and MW-6; the extent of groundwater contamination was defined</li> <li>• Groundwater gradient was 0.006 ft/ft to west (1994)</li> </ul>
UST Groundwater Monitoring	1995 through 2002	<p>Groundwater sampling of MW-1, MW-2, MW-3, MW-4, MW-5, and MW-6</p> <ul style="list-style-type: none"> <li>• February 1995 – BTEX</li> <li>• June 1995 – BTEX</li> <li>• October 1995 – BTEX</li> </ul>	<ul style="list-style-type: none"> <li>• Groundwater monitoring was initiated in February 1995 for the petroleum hydrocarbons plume</li> <li>• October 2002 UST site was covered in concrete pavement and monitoring well MW-4 was removed</li> </ul>

Table 1-1. Summary of Previous UST-related Investigations at OMS-28 (continued)

Description	Date	Primary Activities	Findings/Recommendations
		<ul style="list-style-type: none"> <li>• December 1995 – BTEX, PAHs, and lead</li> <li>• May 1996 – BTEX</li> <li>• February 1997 – BTEX</li> <li>• July 1997 – BTEX</li> <li>• October 2001 – BTEX and MTBE</li> </ul>	
ARBCA Data Acquisition	March 2004	<ul style="list-style-type: none"> <li>• Groundwater sampling from existing wells for BTEX, MTBE, PAHs, and lead</li> <li>• Aquifer tests</li> <li>• Soil sampling for BTEX (SB-03 and SB-04) and geotechnical data (SB-01 and SB-02)</li> </ul>	<ul style="list-style-type: none"> <li>• Benzene was detected &gt;MCLs in MW-1 and MW-6, thus plume migration to at least MW-6</li> <li>• Trace amounts of LNAPL were detected in MW-1</li> <li>• Declining BTEX concentrations were detected in MW-1</li> <li>• Benzene and ethylbenzene are still above MCLs</li> <li>• Only trace BTEX was detected in soil samples (SB-03)</li> </ul>
UST Secondary Investigation Addendum (Bechtel-S 2005a)	October 2004 through August 2005	<ul style="list-style-type: none"> <li>• Collected eight groundwater grab samples (GW-1 through GW-8) for BTEX and MTBE from eight DPT locations west and northwest of the concrete parking area</li> <li>• Installed two piezometers (PZ-1 and PZ-2)</li> <li>• Installed two new monitoring wells (MW-7 and MW-8) in October 2004</li> <li>• Collected groundwater samples from seven monitoring wells (MW-1, MW-2, MW-3, MW-5, MW-6, MW-7, and MW-8) for BTEX, MTBE, naphthalene, PAHs, and lead</li> <li>• Evaluated the presence of LNAPL in MW-1</li> <li>• Evaluated the groundwater chemistry to determine if natural attenuation processes are active</li> <li>• Surveyed all new and existing wells</li> <li>• Water level surveys were performed to determine the groundwater flow direction</li> </ul>	<p>The UST site was recommended for Tier 1 closure with MNA</p> <ul style="list-style-type: none"> <li>• BTEX and MTBE were not detected in the groundwater grab samples</li> <li>• Benzene was detected &gt;MCLs in MW-1 and MW-6; benzene was not detected above the MCL in MW-8</li> <li>• Trace amounts of LNAPL were detected in MW-1. The trace amounts of LNAPL present in the formation are immobile and have largely been depleted of aromatic constituents in the decades since the fuels were leaked from the former UST</li> <li>• Benzene and naphthalene were above preliminary screening levels in groundwater</li> <li>• TCE was identified at MW-8. TCE was determined to be an unknown release not associated with the presence of the former UST at Pit 2</li> <li>• Groundwater gradient was 0.0111 ft/ft to the northwest (November 2004)</li> <li>• Groundwater gradient was 0.0143 ft/ft to the northwest (March 2005)</li> </ul>



**Table 1-1. Summary of Previous UST-related Investigations at OMS-28 (continued)**

Description	Date	Primary Activities	Findings/Recommendations
Tier 1 and Tier 2 UST ARBCA Assessment (Bechtel-S 2005b)	September 2005	<ul style="list-style-type: none"> <li>• Tier 2 SSTLs for subsurface soil and groundwater were developed for BTEX, PAHs, and lead</li> <li>• SSTLs were approved in November 2006</li> </ul>	<ul style="list-style-type: none"> <li>• The UST site was recommended for closure under Tier 2 with MNA</li> <li>• Continued semiannual monitoring of upgradient, source area, downgradient, and point of compliance wells was recommended to confirm trends in contaminant concentrations</li> <li>• Monitoring for a minimum of 2 years was recommended</li> </ul>
Temporary Well Installation by ALARNG	2005	<ul style="list-style-type: none"> <li>• Installed five temporary wells (TW-1 through TW-5) to further delineate the TCE plume</li> <li>• Collected groundwater samples from five temporary wells (TW-1 through TW-5) for TCE</li> </ul>	<ul style="list-style-type: none"> <li>• Wells were installed by hand with hand-cut screen and a filter pack of sand</li> <li>• TCE was detected in the groundwater sample collected from TW-4 at an approximate concentration of 1.9 µg/L</li> <li>• None of the remaining temporary wells sampled showed detectable concentrations of TCE</li> <li>• In correspondence dated August 17, 2007, ADEM requested that temporary wells TW-1 through TW-5 be properly abandoned as they were improperly installed</li> </ul>

ALARNG = Alabama Army National Guard.

ADEM = Alabama Department of Environmental Management.

ARBCA = Alabama risk-based corrective action.

BGS = Below ground surface.

BTEX = Benzene, toluene, ethylbenzene, and xylenes.

DPT = Direct-push technology.

LNAPL = Light, nonaqueous-phase liquid.

MCL = Maximum contaminant level.

MNA = Monitored natural attenuation.

MTBE = Methyl tert-butyl ether.

OMS = Organizational Maintenance Shop.

PAH = Polynuclear aromatic hydrocarbon.

SSTL = Site-specific target level.

TCE = Trichloroethene.

TPH = Total petroleum hydrocarbons.

UST = Underground storage tank.

### 1.2.3 Regulatory History

Initially, the OMS-28 chlorinated solvents plume was following a Resource Conservation and Recovery Act cleanup path due to the actions required following the discovery of TCE under the UST regulatory requirements. In September 2010, ALARNG submitted a request to ADEM to continue the activities at the site under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). At the time, ALARNG was in the process of having an Alabama Risk-Based Corrective Action (ARBCA) Report prepared and recommended using the existing data to develop an RI/feasibility study (FS). ADEM concurred with this approach in e-mail correspondence dated September 9, 2010 (ADEM 2010b).

## 1.3 ORGANIZATION OF THE REPORT

This RI Report is structured in accordance with the outline provided in EPA's Guidance for Conducting RIs and FSs Under CERCLA (EPA 1988). The contents of each section are described below.

- **Chapter 1.0, Introduction**—This chapter identifies the objective and scope of this study, describes the installation and the site, and summarizes its history and previous UST-related studies.
- **Chapter 2.0, Environmental Setting**—This chapter presents the environmental setting at OMS-28 and the former Brookley AFB. Demographics and land use, geology, hydrogeology, hydrology, soil, and climate are discussed.
- **Chapter 3.0, Field Investigations**—This chapter presents the methods and procedures for the field investigation.
- **Chapter 4.0, Investigation Results**—This chapter presents the results of the field investigation and the nature and extent of chemical constituents in soil and groundwater.
- **Chapter 5.0, Contaminant Fate and Transport**—This chapter discusses the physical and chemical properties of the site-related constituents and their expected fate and transport in sampled environmental media.
- **Chapter 6.0, Risk Assessment**—This chapter summarizes the Risk Management (RM)-1 and RM-2 evaluation in the ARBCA Report for OMS-28 (Aerostar 2011b).
- **Chapter 7.0, Conclusions**—This chapter presents the conclusions.
- **Chapter 8.0, References**—This chapters lists the references used within this RI Report.
- **Appendices**—Typical appendices for an RI Report consist of soil boring logs, monitoring well construction diagrams, well survey data, waste manifests, laboratory analytical data, and supporting information for the ARBCA. All of this information is contained in the historical documents; therefore, the electronic copies of the following historical documents are provided as Appendices A through N.
  - Appendix A Correspondence
  - Appendix B OMS-28 Pit 2 Secondary Investigation Addendum dated August 2005 (Bechtel-S 2005a)

- Appendix C OMS-28 Work Plan for TCE Investigation dated February 2006
- Appendix D TCE Comprehensive Investigation Report dated April 2007 (Aerostar 2007)
- Appendix E Supplemental Comprehensive Investigation Work Plan dated March 2008 (Aerostar 2008a)
- Appendix F OMS-28 Well Abandonment Report dated May 2008 (Aerostar 2008b)
- Appendix G OMS-28 Supplemental Comprehensive Investigation Report dated November 2008
- Appendix H OMS-28 1st Groundwater Monitoring Report dated April 2009
- Appendix I OMS-28 2nd Groundwater Monitoring Report dated August 2009 (Aerostar 2009a)
- Appendix J OMS-28 3rd Groundwater Monitoring Report dated December 2009 (Aerostar 2009b)
- Appendix K OMS-28 4th Groundwater Monitoring Report dated June 2010 (Aerostar 2010)
- Appendix L OMS-28 5th Groundwater Monitoring Report dated January 2011 (Aerostar 2011a)
- Appendix M OMS-28 Alabama Risk Based Corrective Action Report dated March 2011 (Aerostar 2011b)
- Appendix N Alabama Armory Commission Quit Claim Deed dated February 18, 2003

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## 2.0 ENVIRONMENTAL SETTING

The general or more regional information presented in this chapter was obtained from the *Remedial Investigation Report, The Former Brookley Air Force Base, Mobile, Alabama* (Kevric 2004).

### 2.1 DEMOGRAPHY AND LAND USE

The Brookley Aeroplex covers 1,700 acres and is home to more than 100 businesses employing approximately 3,700 people in 4.6 million ft<sup>2</sup> of industrial space. The Brookley Aeroplex is divided into two distinct land areas: the airfield and the industrial park. The airfield consists of runways, taxiways, aprons, and vacant land. It is bounded by a variety of uses including residential areas, cemeteries, the National Guard, and the University of South Alabama. The industrial park, set between Interstate 10 and the airfield, stretches nearly 2 miles along the highway and contains lands occupied by aging industrial buildings and infrastructure. Industrial facilities at the Brookley Aeroplex are housed in two districts, which are the Aerospace District and the Industrial Park.

The Brookley Aeroplex Master Plan was introduced in 2003 and includes five development districts of identifiable, industrial neighborhoods, which are shown in Figure 2-1. The property north of the Brookley Aeroplex and located south of Duval Street is zoned residential.

- Aerospace – aerospace and aviation-related development;
- Light Industrial – light industrial/flex development, including owner-user and speculative products;
- Industrial/Infill/Incubator – small-scale industrial development with business incubator;
- Office/Research – office park/retail space development; and
- Logistics/Manufacturing – development to compliment Mobile Container Terminal and Intermodal Container Transfer Facility growth.

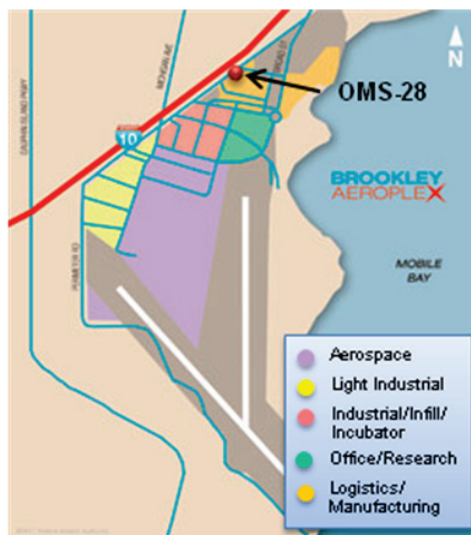


Figure 2-1. Brookley Aeroplex Land Use Map

OMS-28 is located in the logistics/manufacturing district of the Brookley Aeroplex. The Alabama Armory Commission owns the property on which OMS-28 is located. ALARNG operates the Field Maintenance Shop (formerly known as the OMS) in the northwest corner of the Brookley Aeroplex. MAA owns the property directly west of the OMS-28 site, and residential property borders the OMS-28 site to the north. There are no other known future land uses designated for this location. The use of the property will likely remain commercial due to its immediate proximity to the railroad tracks and the interstate (Interstate 10) and because it is adjacent to an ALARNG facility, airport, and industrial complex.

## **2.2 PHYSIOGRAPHY AND TOPOGRAPHY**

The Brookley Aeroplex is located within Mobile County. Much of the land in Mobile County is used for industrial and agricultural purposes. Large areas along the Mobile and Tensaw Rivers and along the coast are characterized by low-lying, swampy terrain and brackish water. The Brookley Aeroplex is included in this area.

The Brookley Aeroplex lies entirely within the East Gulf Coastal Plain physiographic section, Alluvial-Deltaic Plain District, Coastal Lowlands District.

The Alluvial-Deltaic Plain District, which consists of alluvial and terrace deposits from the rivers, has areas with very little relief and the surface topography ranges in altitude from 100 ft to sea level.

Coastal Lowlands District areas are characterized by flat to gently undulating, locally swampy plains underlain by terrigenous deposits of Holocene and late Pleistocene age. They include the mainland plain indented by many tidal streams and fringed by tidal marshes and barrier islands. The landward edge of the district is defined by the base of the Pamlico marine scarp at 25 to 30 ft of elevation. The barrier islands and tidal marshes in the area are undergoing continual modification by erosion and deposition.

The Brookley Aeroplex is relatively flat with an elevation of 20 to 30 ft above mean sea level (AMSL) (Aerostar 2011b). OMS-28 is located in the northeast corner of the Brookley Aeroplex where the elevations are closer to 30 ft AMSL.

## **2.3 CLIMATE**

The climate for the Mobile area is wet and subtropical. Temperatures typically range from the low 40's on winter nights to the low 90's on summer days. Precipitation ranges from 2.9 to 7.0 in. per month. The wettest months are March, July, and August. The average annual precipitation is 64 in. Wind speeds range from 6.9 to 10.5 miles per hour.

## **2.4 SURFACE WATER HYDROLOGY**

According to the Brookley AFB RI Report (Kevric 2004), the Brookley Aeroplex is part of the Mobile Bay Watershed. The fluvial drainage area of this watershed encompasses nearly two-thirds of the state of Alabama and crosses into Georgia, Mississippi, and Tennessee. This coastal lowlands aquifer system, according to the EPA State Health Evaluation (EPA 1999), has an Index Watershed Indicator of "Less Serious Water Quality Problems (Low Vulnerability to Stressors such as Pollutant Loading)." Furthermore, ADEM's 2010 *Alabama Unified Watershed Assessment* classified parts of Mobile Bay as Category 1 – "waters that are attaining all applicable water quality standards" or Category 5 – "waters in

which a pollutant has caused or is suspected of causing impairment” (ADEM 2010a). The Category 1 classification was associated with Mobile County. The Baldwin County portion of Mobile Bay received the Category 5 classification. These findings sited beach monitoring data where pathogen exceedances occurred in more than 10% of the samples in 2008 and 2009 due to a collection system failure.

At OMS-28, there are no current surface water body features within a 1,000-ft radius of the site (Aerostar 2011b). Surface flow from stormwater runoff across the site varies due to surface grade, vegetation, and porous surface medium.

## **2.5 GEOLOGY**

### **2.5.1 Regional Geology**

The following information was originally provided in the Brookley AFB RI Report (Kevric 2004) and also was provided in the Supplemental CI Report for OMS-28 (Aerostar 2008a).

Geologic units that occur within the study area range in age from Tertiary to Quaternary. Alluvial and terrace deposits of Quaternary age overlie Tertiary-age deposits adjacent to the floodplains of the larger streams and river and along the coastal areas, such as Mobile Bay.

Geologic units of Tertiary age that are sources of potable groundwater are the Miocene Series Undifferentiated and the Citronelle Formation. The Miocene Series outcrops in central and northern Mobile and Baldwin Counties. The Miocene Series consists of sedimentary deposits of marine and estuarine origin. The sediment consists mainly of laminated to thinly bedded clays, sands, and sandy clays. The sands range from fine- to coarse-grained and are locally cross-bedded. In outcrops, the sands weather to a variety of colors, some distinctly mottled. At some exposures, beds of sand contain gravel and petrified plant fossils and clays contain carbonized leaf remains.

The Citronelle Formation of Pliocene age overlies the Miocene Series and crops out in central and southern parts of the RI study area. The formation, which is relatively thin in northern parts of the study area, is about 200 ft thick in the subsurface in the southern part of the study area. The sediment consists of gravelly sands and sandy clays. In many areas, lenses of sandy clay and clayey sand, which range in thickness from 5 to 15 ft, are interbedded with gravelly sand. Sediment along the base of the Citronelle Formation has a high clay content, indicating that it was deposited in an estuarine environment; whereas, overlying sediment was deposited by sediment-laden streams.

Pleistocene and Holocene Series of Quaternary age deposits overlie Miocene and Pliocene sediment. Alluvial, low terrace, and coastal deposits represent complex beach, dune, lagoon, estuarine, and deltaic depositional environments. The deposits consist of very fine- to coarse-grained sand that is gravelly in many exposures. Sandy clay is interbedded with the sand at some exposures. The thickness of the alluvial, low terrace, and coastal deposits is estimated to range from 0 to 200 ft based on the first occurrence of coarse siliclastic sediment.

The Quaternary sand and gravel beds represent buried channel deposits. Their width and depth are similar to that of the present river bed sediment. The length of individual sand and gravel beds probably ranges from a few hundred to a few thousand feet. These buried channel deposits are surrounded by silt and clay sediment similar to that being deposited on the present floodplain of the river.

## 2.5.2 Site Geology

According to the Supplemental CI Report for OMS-28 (Aerostar 2008a), the general site geology with some exceptions was as follows:

- Ground surface to approximately 5 ft below ground surface (BGS) was a silty clay loam.
- Beginning at approximately 5 ft BGS, medium-grained sands, silty sands, and clayey sands were encountered in various borings.
- Beginning at depths ranging between 16 and 35 ft BGS, a gray stiff clay was encountered, which continued to a depth of 70 to 84 ft BGS.
- At depths ranging between 70 and 84 ft BGS, a coarse-grained sand was encountered. In the exploratory boring, the coarse-grained sand ended at 90 ft BGS where clayey sand extended to a depth of 104 ft BGS. Sandy clay and silty clay were encountered from 104 ft BGS to boring termination depth at 120 ft BGS.

## 2.6 HYDROLOGY

### 2.6.1 Regional Hydrology

The following information was originally provided in the Brookley AFB RI Report (Kevric 2004) and also was provided in the Supplemental CI Report for OMS-28 (Aerostar 2008a).

The Pliocene-Miocene aquifer and the alluvial-coastal aquifer are the major aquifers in the RI study area (i.e., former Brookley AFB). Although the aquifers are lithologically different, they are hydraulically connected and generally respond to stresses as a single aquifer.

Groundwater in the Pliocene-Miocene aquifer occurs in beds of sand and gravel that are lenticular in shape and of limited lateral extent. The sand and gravel beds in the Citronelle Formation and those at shallow depths in the Miocene Series Undifferentiated are hydraulically connected to land surface; therefore, the aquifer is unconfined. At depth, clayey sediment in the Miocene Series is semi-confining, which reduces vertical infiltration of water. Thus, the aquifer in deeper portions of the Miocene Series responds to short-term pumping as a confined aquifer. Wells properly constructed in the Pliocene-Miocene aquifer yield from 0.5 to 2.0 million gallons per day (Mgal/day).

The alluvial-coastal aquifer is hydraulically connected to the Pliocene-Miocene aquifer. Properly constructed wells in the alluvial-coastal aquifer have the potential to yield from 0.5 to 1.0 Mgal/day. Most high-yield wells are completed in beds of sand and gravel that originate from coastal deposits and buried river sediment. The buried channels are surrounded by silty and clayey sediment that does not yield significant amounts of water but does allow slow infiltration of water to the sand and gravel beds. Individual buried channels may be directly connected to the present channels of the Mobile River.

The source of recharge to the aquifers is rainfall, which averages 62 in./year in the study area. About 28 in./year of rainfall runs off during and immediately after storms, a small amount of rainfall infiltrates the subsurface as recharge to the aquifers, and the remainder is returned to the atmosphere by evaporation and transpiration of trees and other plants.



Groundwater discharges are primarily to streams, water bodies, and wells. Some of the larger groundwater pumping centers in the study area are the cities of Grand Bay, Fairview, Dauphin Island, Theodore, Kushla, LeMoyne, Citronelle, Mt. Vernon, Bayou La Batre, Saraland, and St. Elmo in Mobile County.

In addition to public water supply, substantial quantities of groundwater are used for irrigation. Mobile County has several chemical and paper factories and other industries that use large quantities of groundwater.

Large withdrawals of water from an aquifer often cause a depression in the potentiometric surface of the aquifer. The extent of the depression depends on the amount of water withdrawn and the water-bearing characteristics of the sediment. A large depression exists around the Prichard-Mobile area in Mobile County. Most of the groundwater withdrawals in this area are for industrial purposes. Other smaller depressions occur in the vicinity of some industries along the Mobile River in northern Mobile County. The effects of the depressions are localized because of their proximity to the Mobile River, which is hydraulically connected to the aquifers in the area. The Mobile River has an average annual discharge of about 70,000 ft<sup>3</sup> per second, which is more than adequate to recharge the aquifers as withdrawals occur. However, in tidal reaches of the Mobile River, the recharge could introduce saltwater into the aquifer.

Recharge areas for the major aquifers, within the RI study area, are susceptible to surface contamination. The topography in the study area is flat to low rolling hills. This type of terrain minimizes surface runoff, thus allowing more time for water to infiltrate into the soil.

Areas that are highly susceptible to contamination from the surface are relatively flat terrain with very permeable soil. Many of these areas are used for intensive row-crop farming where pesticides are used extensively. Along the Mobile River in the northern part of Mobile County, chemical industries are potential sources of contamination to the groundwater. Areas of the RI study area that are not considered to be highly susceptible to surface contamination are where topographic relief is greater; this promotes increased surface runoff and dispersion and dilution of surface contaminants. Other areas not susceptible to surface contamination are those covered with concrete/asphalt or other impermeable matrices.

Regions underlain by the alluvial and coastal sediment generally are areas of groundwater discharge; this decreases the likelihood of a contaminant migrating into the deep groundwater system.

## **2.6.2 Site Hydrology**

According to the January 2011 Supplemental CI Groundwater Monitoring Report for OMS-28 (Aerostar 2011a), the groundwater flow direction at the OMS-28 site in September 2010 was estimated to be to the northwest. This flow direction is consistent with the flow direction determined during the previous sampling events conducted in March 2010, November 2009, and May 2009.

## **2.7 GROUNDWATER USE**

According to the ARBCA Report (Aerostar 2011b), there are no water supply wells within a 1,000-ft radius of OMS-28. The use of groundwater in this area as a potable water source is unlikely due to its shallow nature, its proximity to Mobile Bay, and the fact that all residential water for drinking and other uses is provided by the public water supply system. Potable water is supplied to the OMS-28 facility through the city of Mobile municipal water supply. Private water supply wells in the Mobile area typically tap the deeper Miocene-Pliocene aquifer at approximately 100 ft BGS rather than the surficial

groundwater encountered at the site (Bechtel-S 2005b). No future development of shallow groundwater on-site or on nearby off-site locations is likely because of the availability of public water supplies and the poor production potential of the surficial aquifer. Based on historical data, the water table appears to fluctuate between 3 and 10 ft BGS depending on seasonal/annual fluctuations. In 2010, the water table was closer to 5 ft BGS.

## 2.8 ECOLOGY

As of April 2012, the U. S. Fish and Wildlife has listed several species of concern (candidate, recovery, endangered, or, threatened) that are known or are believed to occur in Mobile County, which include the bald eagle (*haliaeetus ieucocephalus*), wood stork (*mycteria americana*), piping plover (*charadrius melodus*), gulf sturgeon (*acipenser oxyrinchus desotoi*), West Indian manatee (*trichechus manatus*), hawksbill sea turtle (*Eretmochelys imbricata*), leatherback sea turtle (*dermochelys coriacea*), kemp's ridley sea turtle (*lepidochelys kempii*), green sea turtle (*chelonia mydas*), loggerhead sea turtle (*caretta caretta*), Alabama red-belly turtle (*Pseudemys alabamensis*), eastern indigo snake (*drymarchon corais couperi*), black pine snake (*pituophis melanoleucus lodingi*), and gopher tortoise (*gopherus polyphemus*).

Critical habitats for the piping plover, gulf sturgeon, West Indian manatee, hawksbill sea turtle, leatherback sea turtle, and green sea turtle are located at the mouth of Mobile Bay and not located within 2 miles of Brookley Aeroplex. No known ecological survey has been conducted at the Brookley Aeroplex since the ecological reconnaissance conducted as part of the Former Brookley AFB RI activities in the early 2000s. According to the U. S. Fish and Wildlife, no threatened or endangered species have been reported or confirmed on the property. The gopher tortoise, which is an upland species, is scattered in small numbers across Mobile County and may be present on or near the site (Everson 2012).

At OMS-28, the surface features consist of vegetative cover comprised of oak trees, scrub trees, grasses, and brush (Aerostar 2011b). No structures are present on the OMS-28 site (i.e., on the source soil or over the groundwater plume). The ALARNG facility building is located approximately 250 ft east of the site. The nearest residential structure is approximately 250 ft northeast of the site.

## **3.0 FIELD INVESTIGATIONS**

### **3.1 INVESTIGATIVE METHODOLOGY**

#### **3.1.1 2006 – 2007 Trichloroethene Comprehensive Investigation**

The objective of this investigation was to determine the extent of TCE contamination in the soil and groundwater at OMS-28. The work performed was conducted in three phases, which included the following:

- Collecting six groundwater samples from six existing wells for confirmatory laboratory analysis of TCE.
- Phase 1: collecting and submitting soil samples from 10 soil borings utilizing direct-push technology (DPT) via a Geoprobe™ and collecting and submitting groundwater samples from eight temporary monitoring wells utilizing DPT.
- Phase 2: collecting and submitting soil samples from three additional soil borings and three additional temporary monitoring wells utilizing DPT and installing a FLUTE™ liner in two soil borings (HA-4 and B-12).
- Phase 3: installing four permanent monitoring wells; collecting soil and groundwater samples from the four newly installed permanent monitoring wells; surveying the newly installed monitoring wells; collecting and submitting soil samples from three additional soil borings; and reporting.

Soil borings and monitoring wells are shown in Figure 3-1.

#### **3.1.2 2008 Supplemental Comprehensive Investigation**

Upon review of the TCE CI at OMS-28 (Aerostar 2007), ADEM issued a letter to ALARNG dated June 28, 2007, requiring additional investigation at the site. The objective of this investigation was to further define the horizontal and vertical extent of the contamination in groundwater. In addition, ADEM requested that soil samples be obtained from soil intervals between the upper saturated zone and the deeper saturated zone from all deep monitoring wells. The work performed included the following:

- Abandoning temporary monitoring wells TW-1 through TW-5, permanent monitoring wells MW-10 and MW-11, and piezometers PZ-1 and PZ-2.
- Drilling one exploratory boring to assess the subsurface conditions prior to installation of the soil borings and monitoring well.
- Installing four shallow monitoring wells and three double-cased deep monitoring wells using sonic rotary drilling techniques and collecting soil and groundwater samples from the seven newly installed permanent monitoring wells.

Soil borings and monitoring wells are shown in Figure 3-1.

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### 3.1.3 Groundwater Monitoring Events

As recommended in the TCE CI at OMS-28 (Aerostar 2007), groundwater sampling was conducted to perform an ARBCA assessment for the OMS-28 site. A minimum of four quarterly sampling events or 2 years of semiannual sampling events are required to perform the risk assessment. The groundwater sampling events were performed in December 2008, May 2009, November 2009, March 2010, and September 2010.

## 3.2 WELL ABANDONMENT

In May 2008, temporary monitoring wells TW-1 through TW-5, piezometers PZ-1 and PZ-2, and permanent monitoring wells MW-10 and MW-11 were abandoned prior to soil boring activities. Wells MW-10 and MW-11 were abandoned at the request of the landowner, Margaret Hope, who would not allow re-entry on her property for sampling of wells after the well installation and initial sampling event. Both USACE and the ALARNG spoke with the landowner and attempted to gain right of entry, but the landowner would only provide permission to enter the property to abandon the wells. Abandonment procedures included pulling the well screen and well casing from the subsurface and grouting each well annulus with a neat grout mixture of 95% Portland cement and 5% bentonite clay from the bottom of the annulus to approximately 1 ft BGS with a tremie pipe to ensure that vertical migration of surface water into the surficial aquifer does not occur. The *Monitoring Well Abandonment, Alabama National Guard, Organization Maintenance Shop 28, Former Brookley Air Force Base, Mobile, Alabama* Report (Aerostar 2008b), detailing the well abandonment activities, was submitted to ADEM on May 19, 2008. In a letter dated July 10, 2008, ADEM determined that the wells were properly abandoned.

## 3.3 SOIL BORINGS AND SOIL SAMPLING

### 3.3.1 2006 – 2007 Trichloroethene Comprehensive Investigation

Soil boring logs were provided in Appendix A of the TCE CI at OMS-28 (Aerostar 2007). The investigative methodology for the soil sampling was discussed in Chapter 3 of the TCE CI at OMS-28 and is briefly summarized below. Soil borings installed during the TCE CI are shown in Figure 3-1.

In April 2006, soil samples were collected from DPT borings HA-1 through HA-10 in the vicinity of the suspected source area around MW-8. Two soil samples from each boring were selected for laboratory analysis: one surficial sample and one based on the results of field screening results or the location of the soil/groundwater interface. Soil samples were analyzed for VOCs using EPA Method 8260. A FLUTE™ liner was inserted in boring HA-4 to approximately 10 ft BGS to determine if TCE was accumulating in the subsurface; however, no change in color was noted on the FLUTE™ liner, thus indicating that non-aqueous-phase liquid (NAPL) was not present.

In May 2006, soil samples were collected from three additional DPT borings (HA-11 through HA-13). One soil sample from each boring was selected for laboratory analysis based on the results of field screening results or the location of the soil/groundwater interface. Soil samples were analyzed for a selected list of VOCs using EPA Method 8260. In addition, a FLUTE™ liner was inserted in boring B-12 to approximately 20 ft BGS to determine if TCE was accumulating in the subsurface; however, no change in color was noted on the FLUTE™ liner, thus indicating that NAPL was not present. No soil samples were collected from boring B-12.

In October and November 2006, soil samples were collected from monitoring wells B-13/MW-9, B-14/MW-10, B-15/MW-11, and B-16/MW-12. Two soil samples from each boring were selected for laboratory analysis: one surficial sample and one based on the results of field screening results or the location of the soil/groundwater interface. Soil samples were originally analyzed for VOCs using EPA Method 8260, but then the laboratory was subsequently requested to report only TCE and semivolatile organic compounds (SVOCs) using EPA Method 8270.

In March 2007, soil samples were collected from borings HA-14, HA-15, and B-17. Two soil samples from each boring were selected for laboratory analysis: one surficial sample and one based on the results of field screening results or the location of the soil/groundwater interface. Soil samples were analyzed for VOCs using EPA Method 8260.

### **3.3.2 2008 Supplemental Comprehensive Investigation**

Soil boring logs were provided in Appendix B of the Supplemental CI Report for OMS-28 (Aerostar 2008a). The investigative methodology for the soil sampling was discussed in Chapter 4 of the Supplemental CI Report for OMS-28 and is briefly summarized below. Soil borings installed during the supplemental CI are shown in Figure 3-1.

An exploratory boring and permanent monitoring wells OMS-28-2 through OMS-28-7 were installed March 24 through 28, 2008. Because of delays encountered during the procurement of the Alabama Department of Transportation (ALDOT) right-of-way (ROW) permit, permanent monitoring well OMS-28-1 was not installed until June 6, 2008.

An exploratory boring was advanced in the southwest portion of the site to assess the local subsurface conditions. This exploratory boring was advanced using sonic rotary drilling techniques to a depth of 120 ft BGS. The exploratory boring was logged to determine if a confining layer was present and to determine the subsurface lithology for placement of shallow and deep wells. Shelby tube geotechnical samples were collected from the exploratory boring at the ground surface, in the unsaturated zone at a depth of 10 ft BGS, and in the saturated zone clay at a depth of 105 ft BGS. When the boring was completed and all samples had been collected, the boring annulus was filled with a neat grout mixture of 95% Portland cement and 5% bentonite clay with a “tremie” pipe to within 2 ft of the ground surface.

Borings OMS-28-2, OMS-28-3, OMS-28-5, and OMS-28-7 were shallow borings installed to depths of 20 ft BGS. Borings OMS-28-1, OMS-28-4, and OMS-28-6 were deep borings installed to depths of 80, 75, and 75 ft BGS, respectively. As with the installation of the exploratory boring, soil borings OMS-28-2 through OMS-28-7 were advanced using sonic rotary drilling techniques to allow a continuous core of subsurface material to be collected for visual identification of the soil types encountered during the boring installation.

With the exception of the installation of the exploratory boring, soil samples were collected at 5-ft intervals from each boring and screened with an organic vapor analyzer (OVA) equipped with a flame ionization detector. Three soil samples from each shallow well were selected for laboratory analysis: one surficial sample, one with the highest OVA reading, and one collected above the soil/groundwater interface. Four soil samples from each deep well were selected for laboratory analysis: one surficial sample, one with the highest OVA reading above the water table, one with the highest OVA reading below the water table, and the soil sample collected from just above the soil/groundwater interface. The soil samples were analyzed for VOCs by EPA Method 8260.

### 3.4 MONITORING WELL INSTALLATION

#### 3.4.1 2006 – 2007 Trichloroethene Comprehensive Investigation

In October 2006, monitoring wells MW-9 through MW-12 were installed. Monitoring well construction diagrams were provided in Appendix A of the TCE CI at OMS-28 (Aerostar 2007). The well installation details are discussed in Chapter 3 of the TCE CI at OMS-28. Well construction details are summarized in Table 3-1, and monitoring well locations are shown in Figure 3-1.

Each shallow well (MW-9 through MW-12) was constructed of 10 ft of 2-in., 0.010-in. factory-slotted polyvinyl chloride (PVC) screen with sufficient 2-in. PVC riser to bring the well to or just above the ground surface.

**Table 3-1. Well Construction Details**

Well ID <sup>a</sup>	Date Installed	Boring Depth (ft BGS)	Screened Interval (ft BGS)	Type of Completion	Coordinates (NAD83)		Elevation (NAVD88)
					Northing <sup>b</sup>	Easting <sup>b</sup>	Top of Casing
MW-1	1994	unknown	3.4 – 13.4	2-in. PVC	238316.1 <sup>c</sup>	1791029 <sup>c</sup>	28.82 <sup>c</sup>
MW-2	1994	unknown	3.4 – 13.4	2-in. PVC	238335.5 <sup>c</sup>	1791052 <sup>c</sup>	28.53 <sup>c</sup>
MW-2	1994	unknown	3.3 – 13.3	2-in. PVC	238296.7 <sup>c</sup>	1791048 <sup>c</sup>	28.99 <sup>c</sup>
MW-5	1994	13.6	3.3 – 13.3	2-in. PVC	238317.5 <sup>c</sup>	1790928.0 <sup>c</sup>	28.14 <sup>c</sup>
MW-6	1994	12.7	2.3 – 12.3	2-in. PVC	238362.4 <sup>c</sup>	1790945.0 <sup>c</sup>	28.15 <sup>c</sup>
MW-7	2004	15.5	5.0 – 15.0	2-in. PVC	238164.7 <sup>c</sup>	1791210 <sup>c</sup>	27.55 <sup>c</sup>
MW-8	2004	15.2	4.8 – 14.8	2-in. PVC	238419.99	1790877.56	28.24
MW-9	2006	17.4	7.4 – 17.4	2-in. PVC	238466.24	1790633.49	25.45
MW-10	2006	17.6	7.6 – 17.6	2-in. PVC	<sup>d</sup>	<sup>d</sup>	<sup>d</sup>
MW-11	2006	16.6	6.6 – 16.6	2-in. PVC	<sup>d</sup>	<sup>d</sup>	<sup>d</sup>
MW-12	2006	15.6	5.6 – 15.6	2-in. PVC	238697.54	1790622.75	25.94
OMS-28-1	2008	80.0	70.0 – 80.0	2-in. PVC	238705.56	1790616.32	26.26
OMS-28-2	2008	20.0	10.0 – 20.0	2-in. PVC	238675.56	1790880.39	30.88
OMS-28-3	2008	20.0	10.0 – 20.0	2-in. PVC	238475.46	1790893.65	30.70
OMS-28-4	2008	76.0	66.0 – 76.0	2-in. PVC	238529.35	1790804.85	27.99
OMS-28-5	2008	20.0	10.0 – 20.0	2-in. PVC	238526.89	1790804.18	30.12
OMS-28-6	2008	76.0	66.0 – 76.0	2-in. PVC	238421.60	1790865.90	30.31
OMS-28-7	2008	20.0	10.0 – 20.0	2-in. PVC	238390.13	1790807.56	27.56

<sup>a</sup>Monitoring well MW-4 is not included in this table because it was destroyed prior to 2004 during paving operations.

<sup>b</sup>Monitoring wells were resurveyed by a licensed surveyor, and the survey report is provided in Appendix F of the *Supplemental Comprehensive Investigation Report for the Alabama Army National Guard (ALARNG) Organizational Maintenance Shop 28 (OMS-28), 1622 South Broad Street, Mobile, Alabama, Groundwater Incident No. GW 07-01-02 (Aerostar 2008a).*

<sup>c</sup>Wells MW-1, MW-2, MW-3, MW-5, MW-6, and MW-7 were not resurveyed in 2008; data were previously reported in the *Secondary Investigation Addendum Report, OMS #28 – Pit 2, Alabama National Guard OMS, 1622 South Broad Street, Mobile, Alabama, Facility ID#: 14587-097-012257, UST Incident #93-02-15 (Bechtel-S 2005a).*

<sup>d</sup>Monitoring wells MW-10 and MW-11 were abandoned in 2008.

BGS = Below ground surface.

NAD = North American Datum.

NAVD = North American Vertical Datum.

PVC = Polyvinyl chloride.



### **3.4.2 2008 Supplemental Comprehensive Investigation**

In March 2008, monitoring wells OMS-28-2 through OMS-28-7 were installed. Because of delays encountered during the procurement of the ALDOT ROW permit, permanent monitoring well OMS-28-1 was not installed until June 6, 2008. Monitoring well construction diagrams were provided in Appendix B of the Supplemental CI Report for OMS-28 (Aerostar 2008a). The well installation details are discussed in Chapter 4 of the Supplemental CI Report for OMS-28 and are briefly summarized below. Well construction details are summarized in Table 3-1, and monitoring well locations are shown in Figure 3-1.

Each shallow well (OMS-28-2, OMS-28-3, OMS-28-5, and OMS-28-7) was constructed of 10 ft of 2-in., 0.010-in. factory-slotted PVC screen with sufficient 2-in. PVC riser to bring the well to or just above the ground surface.

The three deep borings were converted to double-cased monitoring wells (OMS-28-1, OMS-28-4, and OMS-28-6) with their screen in a deeper aquifer. The outer casing was constructed using an 8-in.-diameter Schedule 40 PVC casing. The 8-in. casing was installed to a depth indicative of the confining strata or 80 ft BGS, whichever was shallower. The surface casing was grouted in place with a neat cement bentonite grout mixture using a tremie pipe. After allowing the cement grout to set, the boring was advanced through the next confining layer. Well installation was completed using 10 ft of 0.01-in. factory-slotted well screen set at depths of 76 to 80 ft BGS and 2-in. flush-threaded Schedule 40 PVC risers. The annulus of each borehole was filled with clean, graded quartz sand to approximately 2 ft above the top of the screen. A 2-ft layer of bentonite pellets was then gravity-fed into the annulus of each borehole. This layer of bentonite pellets was saturated with tap water and allowed to hydrate. This method enabled the lower water-bearing zone to be isolated.

## **3.5 WELL DEVELOPMENT**

Monitoring wells MW-9 through MW-12, which were installed on October 22, 2006, were developed on October 31, 2006. The wells were developed with a submersible pump until produced waters were clear and free of fines (Aerostar 2006).

Monitoring wells OMS-28-2 through OMS-28-7, which were installed March 26 through 28, 2008, were developed on April 1, 2008. Monitoring well OMS-28-1, which was installed on June 6, 2008, was developed on June 11, 2008. The monitoring wells were developed using a peristaltic pump and high-density polyethylene tubing (Aerostar 2008a). New tubing was used for each well, and each well was developed until the water was free of silt and sand.

## **3.6 GROUNDWATER SAMPLING**

### **3.6.1 2006 – 2007 Trichloroethene Comprehensive Investigation**

In February 2006, groundwater samples were collected from temporary wells TW-1, TW-3, TW-4, TW-5, PZ-1, and PZ-2. Groundwater samples were analyzed for VOCs using EPA Method 8260.

In April 2006, groundwater samples were collected from DPT borings TW-6 through TW-13 and monitoring well MW-8. Groundwater samples were analyzed for TCE using EPA Method 8260. In addition, samples were collected from MW-1, MW-2, MW-3, MW-5, MW-6, MW-7, and MW-8 and were analyzed for BTEX and naphthalene using EPA Method 8260 as part of the UST monitoring program.

In May 2006, groundwater samples were collected from temporary wells B-9/TW-14, B-10/TW-15, and B-11/TW-16. Groundwater samples were analyzed for a selected list of VOCs using EPA Method 8260.

In October and November 2006, groundwater samples were collected from monitoring wells MW-6, MW-8, MW-9, MW-10, MW-11, and MW-12. Groundwater samples were analyzed for VOCs using EPA Method 8260. In addition, samples were collected from MW-1, MW-2, MW-3, MW-5, MW-6, and MW-7 and were analyzed for BTEX and naphthalene using EPA Method 8260 as part of the UST monitoring program. In addition, the groundwater samples from these wells were analyzed for TCE as part of the TCE CI.

Wells were purged prior to collecting samples using a peristaltic pump, which was an approved method for the project. New tubing was attached to the pump at each well location. The available field parameter measurements for MW-6 and MW-8 at the time of sampling are summarized in Table 3-2. Copies of the groundwater sampling logs are provided in Appendix B and groundwater laboratory analytical reports and chains-of-custodies are provided in Appendix D of the TCE CI at OMS-28 (Aerostar 2007).

**Table 3-2. Water Quality Field Parameters**

Well	Sample Date	pH	Temperature (°C)	Conductivity (µS/cm)	Turbidity (NTU)	DO (mg/L)
MW-5	07/01/08	4.1	29.2	0.153	2	NM
	12/11/08	5.1	26.4	0.106	53	3.56
	05/08/09	3.7	23.2	0.179	10	2.20
	09/24/09	NA	NA	NA	NA	NA
	03/18/10	4.5	16.8	0.255	4	2.24
	09/07/10	4.4	30.1	0.250	4	0.31
MW-6	10/18/06	4.1	28.8	0.099	2.75	0.10
	07/01/08	4.6	26.9	0.112	1	NM
	12/11/08	5.4	26.6	0.284	27	4.33
	05/08/09	4.0	23.2	0.180	13	2.20
	09/24/09	NA	NA	NA	NA	NA
	03/18/10	4.8	16.9	0.232	2	0.80
	09/07/10	5.0	29.8	0.156	3	0.08
MW-8	04/18/06	5.74	20.3	0.351	>9.99	0.2
	10/18/06	5.73	25.9	0.491	1.3	1.21
	07/01/08	6.1	26.0	0.477	2	NM
	12/11/08	5.5	27.0	0.437	10	4.93
	05/08/09	5.1	23.0	0.777	9	2.82
	09/24/09	NA	NA	NA	NA	NA
	03/19/10	5.9	15.8	0.499	6	1.49
	09/08/10	6.2	27.9	0.544	3	1.17
MW-9	07/01/08	5.2	24.7	0.125	4	NM
	12/10/08	5.9	27.1	0.198	61	1.34
	05/08/09	4.3	23.7	0.131	18	2.98
	09/24/09	NA	NA	NA	NA	NA
	03/18/10	4.9	15.0	0.155	3	0.52
	09/08/10	5.3	23.6	0.123	6	0.42
MW-12	07/01/08	6.1	24.4	0.439	16	NM
	12/10/08	5.8	27.8	0.232	47	1.97
	05/08/09	5.3	21.9	0.528	1	2.75
	09/24/09	NA	NA	NA	NA	NA
	03/18/10	6.3	17.1	0.515	10	0.31
	09/07/10	5.6	27.4	0.433	5	0.10

**Table 3-2. Water Quality Field Parameters (continued)**

Sample ID	Sample Date	pH	Temperature (°C)	Conductivity (µS/cm)	Turbidity (NTU)	DO (mg/L)
OMS-28-1	07/08/08	6.6	22.1	0.110	108	NM
	12/11/08	5.8	27.2	0.211	54	2.12
	05/08/09	6.3	24.0	0.121	10	2.41
	09/24/09	NA	NA	NA	NA	NA
	03/18/10	9.2	22.5	0.105	1	1.40
	09/07/10	6.1	24.8	0.128	4	0.20
OMS-28-2	07/08/08	6.6	22.1	0.110	108	NM
	07/01/08	5.2	24.4	0.123	5	NM
	12/10/08	5.2	27.8	0.118	36	0.98
	05/08/09	5.1	20.9	0.139	70	2.79
	09/24/09	NA	NA	NA	NA	NA
	03/18/10	5.5	17.2	0.162	3	1.35
OMS-28-3	09/07/10	5.7	23.7	0.145	1	0.83
	07/08/08	6.0	23.4	0.311	4	NM
	12/11/08	5.1	25.8	0.241	77	0.54
	05/08/09	4.9	21.6	0.308	21	2.92
	09/24/09	NA	NA	NA	NA	NA
	03/19/10	6.2	16.2	0.352	8	0.59
OMS-28-4	09/08/10	5.7	24.8	0.293	4	0.11
	07/08/08	6.1	22.0	0.130	84	NM
	12/10/08	5.4	25.3	0.222	37	2.74
	05/08/09	4.8	22.5	0.101	79	2.43
	09/24/09	NA	NA	NA	NA	NA
	03/19/10	6.1	19.9	0.141	5	0.26
OMS-28-5	09/08/10	6.3	21.7	0.125	6	0.29
	07/01/08	5.0	22.0	0.880	4	NM
	12/11/08	5.5	27.0	0.386	11	2.30
	05/08/09	4.2	21.2	0.697	65	2.88
	09/24/09	NA	NA	NA	NA	NA
	03/19/10	5.2	17.4	0.485	7	0.61
OMS-28-6	09/08/10	5.1	22.1	0.239	9	0.25
	07/08/08	5.9	21.4	0.130	89	NM
	12/10/08	6.0	27.6	0.214	36	1.88
	05/08/09	5.1	22.5	0.127	69	2.59
	09/24/09	NA	NA	NA	NA	NA
	03/18/10	6.1	22.4	0.163	15	2.23
OMS-28-7	09/08/10	6.2	22.7	0.133	2	0.04
	07/01/08	5.3	24.6	0.214	13	NM
	12/10/08	5.4	27.7	0.099	29	2.63
	05/08/09	5.1	23.3	0.225	17	2.52
	09/24/09	NA	NA	NA	NA	NA
	03/18/10	5.9	17.3	0.237	3	2.38
	09/08/10	6.0	24.6	0.225	8	0.24

DO = Dissolved oxygen.  
µS/cm = Microsiemens per centimeter.  
NA = Not available.  
NM = Not measured.  
NTU = Nephelometric turbidity unit.

### **3.6.2 2008 Supplemental Comprehensive Investigation**

In July 2008, groundwater samples were collected from monitoring wells MW-5, MW-6, MW-8, MW-9, MW-12, and OMS-28-1 through OMS-28-7. Groundwater samples were analyzed for VOCs using EPA Method 8260.

Wells were purged prior to collecting samples using a peristaltic pump, which was an approved method for the project. New tubing was attached to the pump at each well location. The total purge volume for each well was at least three times the well volume in gallons. Field parameters measured during the groundwater purging and sampling included pH, temperature, conductivity, dissolved oxygen (DO), and turbidity. Stabilization of these parameters was assumed when successive measurements after each well volume varied by 10% or less. Purging continued until these parameters were stabilized. The field parameter measurements at the time of sampling are summarized in Table 3-2. Copies of the groundwater laboratory analytical reports and chains-of-custodies are provided in Appendix E of the Supplemental CI Report for OMS-28 (Aerostar 2008a).

### **3.6.3 Compliance Monitoring**

During monitoring events in December 2008, May 2009, September 2009, March 2010, and September 2010, monitoring wells MW-5, MW-6, MW-8, MW-9, MW-12, and OMS-28-1 through OMS-28-7 were purged prior to collecting samples using a peristaltic pump per the approved work plan (Aerostar 2008c). Groundwater samples were analyzed for VOCs using EPA Method 8260. Dedicated Teflon™ tubing was used at each well location. Purging and field parameter measurements were conducted the same as that described for the 2008 investigation activities above. The field parameter measurements at the time of sampling are summarized in Table 3-2. Copies of the groundwater laboratory analytical reports and chains-of-custodies are provided in Appendix B of the Supplemental CI Groundwater Monitoring Reports (Aerostar 2009a, 2009b, 2009c, 2010, and 2011a).

## **3.7 WATER LEVEL MEASUREMENTS**

Prior to collecting groundwater samples during the various sampling activities either during the CIs or during the compliance monitoring events between October 2005 and September 2010, static water levels were measured in OMS-28 monitoring wells using an electronic water level indicator prior to purging and sampling activities. Water levels were measured to the nearest 0.01 ft from the top of each well casing for comparison to previously surveyed well casing heights. The static water level measurements and groundwater elevation data are summarized in Table 3-3.

## **3.8 QUALITY CONTROL SAMPLES**

Field quality assurance/quality control (QC) included field instrument calibration, compliance with sample holding times, collecting field QC samples, and daily reviews by the field geologist. Three types of field QC samples collected included trip blanks, field duplicates, and rinsate blanks. The testing laboratory and Aerostar Environmental Services, Inc. (Aerostar) were required to adhere to the QC program, including spikes, blanks, and duplicates, of EPA SW-846 and Engineering Regulation 1110-1-263, *Chemical Data Quality Management for Hazardous, Toxic, Radioactive Waste Remedial Activities* (Aerostar 2006, 2008c). This guidance required the following:

- 10% of all samples collected for duplicate/split,
- 10% of all samples collected for rinsate analysis, and
- 10% of groundwater volatile sampling to be trip blanks (one per cooler).

Table 3-3. Water Level Measurements

Well	Screened Interval (ft BTOC)	Top of Casing Elevation (ft AMSL)	Date	Depth to Product (ft BTOC)	Depth to Water (ft BTOC)	Groundwater Elevation (ft AMSL)
MW-5	3.3 – 13.3	28.14	10/13/05	NA	5.10	23.04
			04/18/06	NA	6.60	21.54
			10/18/06	NA	6.60	21.54
			11/22/06	NA	6.31	21.83
			07/01/08	NA	6.47	21.67
			07/08/08	NM	NM	NM
			08/25/08	NA	3.35	24.79
			12/10/08	NA	6.15	21.99
			05/08/09	NA	5.83	22.31
			11/24/09	NA	4.40	23.74
			03/18/10	NA	4.72	23.42
09/08/10	NA	4.36	23.78			
MW-6	2.3 – 12.3	28.15	10/13/05	NA	5.22	22.93
			04/18/06	NA	6.76	21.39
			10/18/06	NA	6.70	21.45
			11/22/06	NA	6.33	21.82
			07/01/08	NA	5.84	22.31
			07/08/08	NM	NM	NM
			08/25/08	Inaccessible		
			12/10/08	NA	6.19	21.96
			05/08/09	NA	5.77	22.38
			11/24/09	NA	4.4	23.75
			03/18/10	NA	3.66	24.49
09/08/10	NA	5.35	22.80			
MW-8	4.8 – 14.8	28.24	10/13/05	NA	5.84	22.40
			04/18/06	NA	7.20	21.04
			10/18/06	NA	6.80	21.44
			11/22/06	NA	6.58	21.66
			07/01/08	NA	6.20	22.04
			07/08/08	NM	NM	NM
			08/25/08	NA	3.35	24.89
			12/10/08	NA	6.67	21.57
			05/08/09	NA	6.52	21.72
			11/24/09	NA	5.05	23.19
			03/18/10	NA	4.51	23.73
09/08/10	NA	5.10	23.14			
MW-9	7.4 – 17.4	27.45	11/22/06	NA	6.86	20.59
			07/01/08	NA	7.40	20.05
			07/08/08	NM	NM	NM
			08/25/08	NA	3.41	24.04
			12/10/08	NA	7.81	19.64
			05/08/09	NA	7.46	19.99
			11/24/09	NA	4.96	22.49
			03/18/10	NA	5.09	22.36
09/08/10	NA	5.96	21.49			

**Table 3-3. Water Level Measurements (continued)**

<b>Well</b>	<b>Screened Interval (ft BTOC)</b>	<b>Top of Casing Elevation (ft AMSL)</b>	<b>Date</b>	<b>Depth to Product (ft BTOC)</b>	<b>Depth to Water (ft BTOC)</b>	<b>Groundwater Elevation (ft AMSL)</b>
MW-12	5.6 – 15.6	25.94	11/22/06	NA	5.90	20.04
			07/01/08	NA	6.20	19.74
			07/08/08	NM	NM	NM
			08/25/08	NA	3.88	22.06
			12/10/08	NA	6.52	19.42
			05/08/09	NA	6.25	19.69
			11/24/09	NA	5.30	20.64
			03/18/10	NA	5.80	20.14
OMS-28-1	70 – 80	26.26	09/08/10	NA	4.96	20.98
			07/01/08	NA	22.86	3.40
			07/08/08	NA	22.90	3.36
			08/25/08	NA	22.45	3.81
			12/10/08	NA	23.29	2.97
			05/08/09	NA	22.10	4.16
			11/24/09	NA	22.00	4.26
			03/18/10	NA	21.30	4.96
OMS-28-2	10 – 20	30.88	09/08/10	NA	22.16	4.10
			07/01/08	NA	12.91	17.97
			07/08/08	NM	NM	NM
			08/25/08	NA	8.31	22.57
			12/10/08	NA	13.55	17.33
			05/08/09	NA	12.56	18.32
			11/24/09	NA	10.87	20.01
			03/18/10	NA	10.49	20.39
OMS-28-3	10 – 20	30.70	09/08/10	NA	11.39	19.49
			07/01/08	NA	9.05	21.65
			07/08/08	NM	NM	NM
			08/25/08	NA	7.78	22.92
			12/10/08	NA	9.60	21.10
			05/08/09	NA	9.32	21.38
			11/24/09	NA	8.43	22.27
			03/18/10	NA	7.85	22.85
OMS-28-4	66 – 76	27.99	09/08/10	NA	8.38	22.32
			07/01/08	NM	NM	NM
			07/08/08	NA	26.85	1.14
			08/25/08	NA	28.89	-0.90
			12/10/08	NA	27.19	0.80
			05/08/09	NA	26.02	1.97
			11/24/09	NA	25.91	2.08
			03/18/10	NA	25.21	2.78
			09/08/10	NA	26.03	1.96

**Table 3-3. Water Level Measurements (continued)**

Well	Screened Interval (ft BTOC)	Top of Casing Elevation (ft AMSL)	Date	Depth to Product (ft BTOC)	Depth to Water (ft BTOC)	Groundwater Elevation (ft AMSL)
OMS-28-5	10 – 20	30.12	07/01/08	NA	11.90	18.22
			07/08/08	NM	NM	NM
			08/25/08	NA	8.79	21.33
			12/10/08	NA	12.44	17.68
			05/08/09	NA	11.60	18.52
			11/24/09	NA	9.62	20.50
			03/18/10	NA	9.12	21.00
			09/08/10	NA	10.75	19.37
OMS-28-6	66 – 76	30.31	07/01/08	NM	NM	NM
			07/08/08	NA	26.70	3.61
			08/25/08	NA	25.51	4.80
			12/10/08	NA	27.07	3.24
			05/08/09	NA	26.08	4.23
			11/24/09	NA	25.67	4.64
			03/18/10	NA	25.21	5.10
			09/08/10	NA	26.10	4.21
OMS-28-7	10 – 20	27.56	07/01/08	NA	9.21	18.35
			07/08/08	NM	NM	NM
			08/25/08	NA	5.82	21.74
			12/10/08	NA	9.89	17.67
			05/08/09	NA	9.18	18.38
			05/08/09	NA	6.90	20.66
			03/18/10	NA	6.32	21.24
			09/08/10	NA	8.21	19.35

AMSL = Above mean sea level.

BTOC = Below top of casing.

NA = Not applicable; free product was not present.

NM = Not measured.

### 3.9 CIVIL SURVEY

As part of the supplemental CI in 2008, existing and newly installed monitoring wells were surveyed by Lawler and Company of Mobile, Alabama, and the survey report is provided in Appendix F of the Supplemental CI Report for OMS-28 (Aerostar 2008a). MW-5 was inaccessible due to a vehicle being parked on top of the well; therefore, the top of casing was not resurveyed. MW-6 was not resurveyed. Wells were surveyed in United States survey feet and referenced to the Alabama West State Plane Coordinate System in North American Datum of 1983. Vertical measurements were referenced to the North American Vertical Datum of 1929 measured in United States survey feet. The location coordinates and the top of casing elevations for the monitoring wells are summarized in Table 3-1.

### 3.10 INVESTIGATION-DERIVED WASTE

Soil cuttings and purged groundwater from all phases of work were placed in 55-gal drums. These drums were stored on-site in a designated secure location pending off-site disposal. During the course of the

field investigation, investigation-derived waste (IDW) was generated and handled in accordance with the Investigation-Derived Waste Management Plan. The inventory of IDW generated during the 2006 investigation activities was provided in Appendix C of the TCE CI at OMS-28 (Aerostar 2007). The inventory of IDW generated during the 2008 investigation activities and the disposal manifests are provided in Appendix D of the Supplemental CI Report for OMS-28 (Aerostar 2008a). On June 6, 2008, all soil IDW was removed from the site by SunCoast Environmental Consultants, Inc. for disposal.



## 4.0 INVESTIGATION RESULTS

### 4.1 SITE GEOLOGY/HYDROGEOLOGY

#### 4.1.1 Soil

Geotechnical soil samples were collected from an exploratory boring installed during the Supplemental CI in 2008. The results of the geotechnical parameters are summarized in Table 4-1.

**Table 4-1. Summary of Geotechnical Parameters Collected During the Supplemental CI**

Exploratory Boring Depth Interval (ft BGS)	Soil Description	Water Content (%)	Wet Bulk Density (pcf)	Dry Bulk Density (pcf)	Specific Gravity	Porosity	Hydraulic Conductivity (cm/sec)	% Sand	% Silt	% Clay
0 – 2	Clayey sand	18.46	139.66	117.89	2.65	0.29	6.78E-06	31.7	47.0	21.3
10 – 12	Silty sand	23.04	129.21	105.21	2.62	0.36	—	82.3	12.5	5.2
35 – 37	Clay	35.29	127.30	94.10	2.66	0.43	1.36E-08	5.2	39.9	54.9
105 – 107	Clay	37.74	127.11	94.33	2.66	0.43	3.13E-08	<sup>a</sup>	<sup>a</sup>	49.2

<sup>a</sup> Results on laboratory report are not clear.

BGS = Below ground surface.

CI = Comprehensive investigation.

pcf = Pounds per cubic foot.

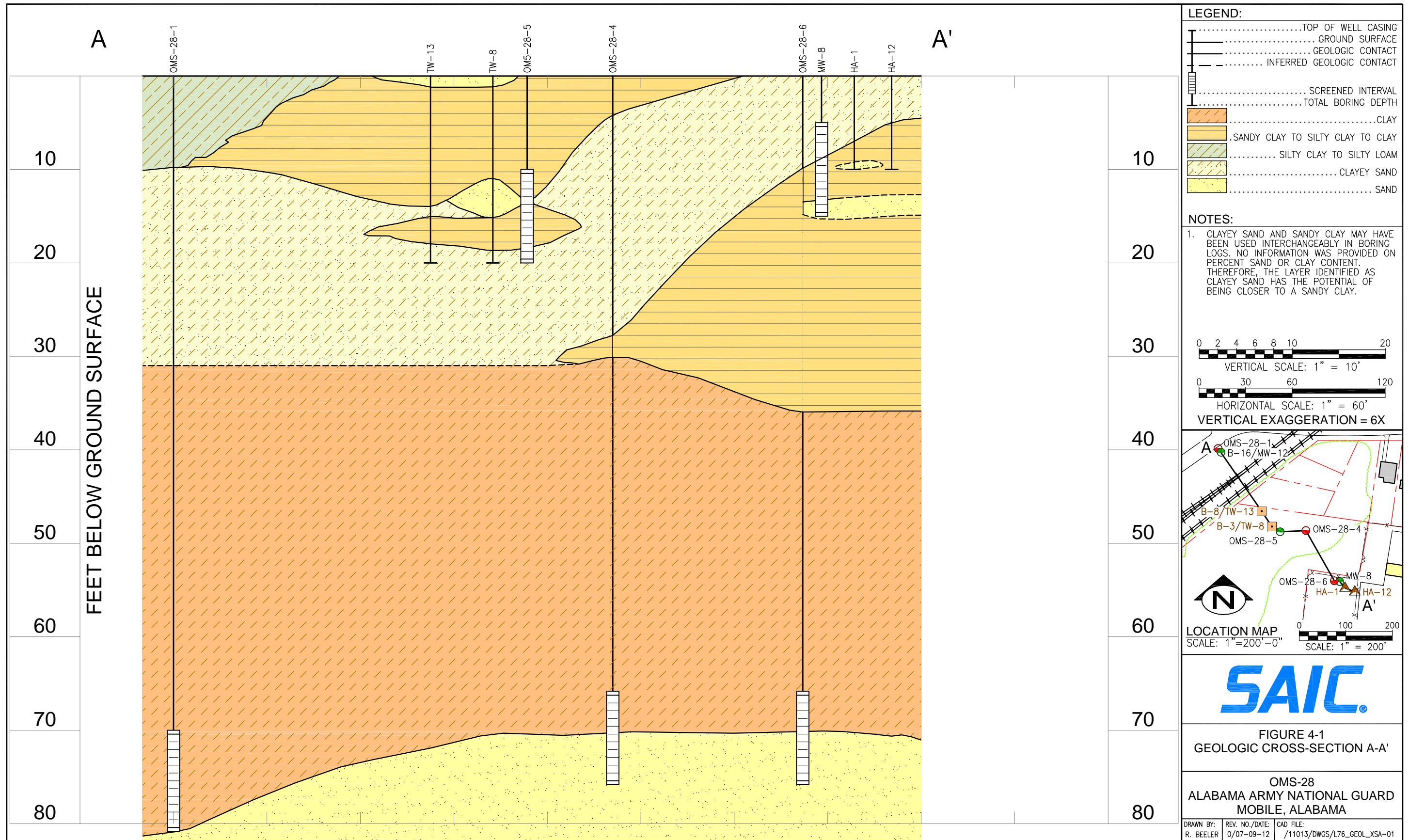
#### 4.1.2 Site Geology

According to the Supplemental CI Report for OMS-28, the general site geology, with some exceptions, was as follows:

- Ground surface to approximately 5 ft BGS was a silty clay loam.
- Beginning at approximately 5 ft BGS, medium-grained sands, silty sands, and clayey sands were encountered in various borings.
- Beginning at depths ranging between 16 and 35 ft BGS, a gray stiff clay was encountered, which continued to a depth of 70 to 84 ft BGS.
- At depths ranging between 70 and 84 ft BGS, a coarse-grained sand was encountered. In the exploratory boring, the coarse-grained sand ended at 90 ft BGS where clayey sand extended to a depth of 104 ft BGS. Sandy clay and silty clay were encountered from 104 ft BGS to boring termination depth at 120 ft BGS.

A geologic cross-section showing the various lithologies is provided in Figure 4-1.

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### 4.1.3 Hydraulic Gradient and Groundwater Flow

Measurements of groundwater elevation data collected during the groundwater compliance monitoring in 2009 to 2010 indicated that the groundwater flow direction was generally to the north-northwest for the shallow surficial aquifer. The hydraulic gradient for the shallow surficial aquifer was 0.0120 ft/ft in May 2009, 0.0126 ft/ft in November 2009, and 0.0127 ft/ft in March 2010. Based on historical data, groundwater was encountered at approximately 3 to 10 ft BGS depending on annual fluctuations. In 2010, groundwater was encountered at approximately 5 ft BGS. Shallow potentiometric surface maps for March 2010 and September 2010 are presented in Figures 4-2 and 4-3, respectively.

Previous investigations indicated the hydraulic gradient for the shallow surficial aquifer was 0.006 ft/ft in 1994, 0.0111 ft/ft in November 2004, 0.0143 ft/ft in March 2005, and 0.005 ft/ft in November 2006.

Estimates of groundwater flow velocity were calculated for portions of the saturated zone to generally characterize and provide an initial approximation of the hydrogeologic regime. These calculations require simplification of the site hydrogeologic system, assume homogeneous and isotropic aquifers not representative of the site, and are subject to uncertainties in the data used.

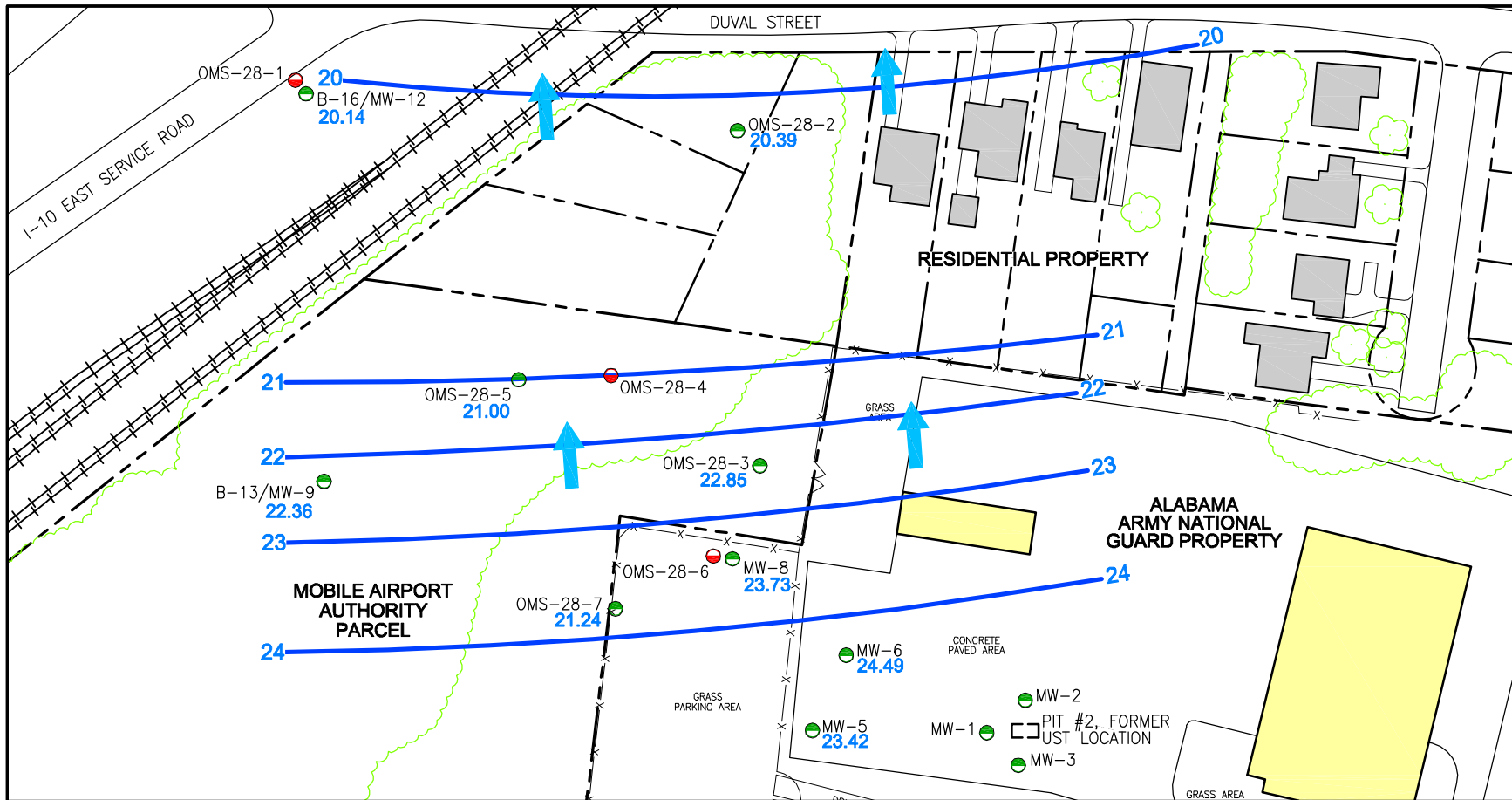
Horizontal groundwater flow velocity was calculated using Darcy's Law

$$V = Ki \div n_e$$

where

- V = horizontal flow velocity (cm/sec and ft/day),
- K = hydraulic conductivity (cm/sec and ft/day),
- I = horizontal hydraulic gradient (ft/ft),
- $n_e$  = effective porosity (unitless).

Values of the hydraulic conductivity "K" used in the calculations were based on the field hydraulic conductivity testing previously performed at the UST portion of the site. Values of K that are determined from slug-type field tests are subject to the inherent limitations due primarily to the small-scale nature of the tests and simplifications required in the data analysis. The K value was assumed to be the average hydraulic conductivity for the shallow surficial aquifer based on slug test values provided in the UST ARBCA ( $7.05 \times 10^{-5}$  cm/sec). Values of horizontal hydraulic gradient ("i") were estimated along the direction of flow based on the groundwater elevations in the available monitoring wells and the groundwater elevations contours. For the purpose of the calculations, the average hydraulic gradient of 0.0124 ft/ft was assumed. Values of effective porosity "ne" range from 0.20 for silt to 0.32 for medium-grained sand, and the value will vary depending on the silt and clay content. Literature values may not be representative of actual conditions and, therefore, may result in some uncertainty. Based on these assumptions, the average horizontal flow velocity was estimated to range between 2.8 and 4.5 ft/year.

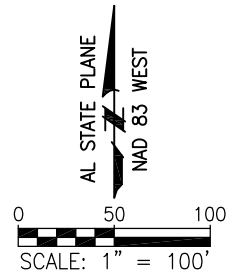


**LEGEND:**

- RESIDENTIAL BUILDING
- COMMERCIAL BUILDING
- ASPHALT ROAD
- RAILROAD TRACKS
- CHAIN LINK FENCE
- PROPERTY BOUNDARY
- TREE LINE
- SHALLOW MONITORING WELL
- DEEP MONITORING WELL
- GROUNDWATER ELEVATION (MARCH 2010)
- GROUNDWATER ELEVATION CONTOUR (FT)
- GROUNDWATER FLOW DIRECTION

**SOURCE:**

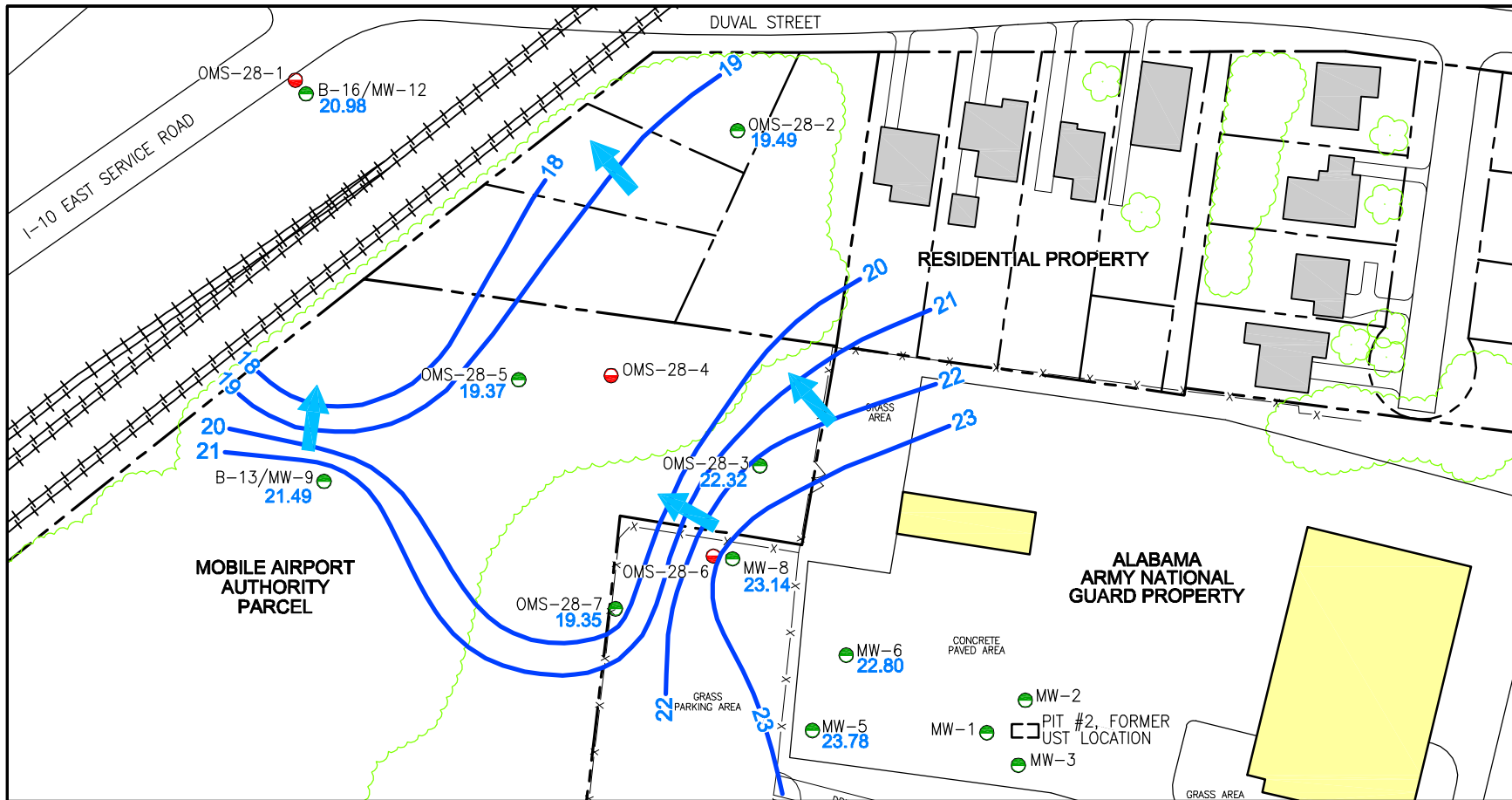
1. POTENTIOMETRIC SURFACE MAP INFORMATION PROVIDED BY AEROSTAR ENVIRONMENTAL SERVICES, INC.



**FIGURE 4-2  
SHALLOW POTENTIOMETRIC  
SURFACE MAP, MARCH 2010**

**OMS-28  
ALABAMA ARMY NATIONAL GUARD  
MOBILE, ALABAMA**

DRAWN BY: R. BEELER	REV. NO./DATE: 0/04-26-12	CAD FILE: 111013/DWGS/L76_POTN_SZ_MARCH-10
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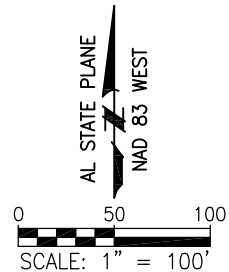


**LEGEND:**

- RESIDENTIAL BUILDING
- COMMERCIAL BUILDING
- ASPHALT ROAD
- RAILROAD TRACKS
- CHAIN LINK FENCE
- PROPERTY BOUNDARY
- TREE LINE
- SHALLOW MONITORING WELL
- DEEP MONITORING WELL
- GROUNDWATER ELEVATION (SEPT. 2010)
- GROUNDWATER ELEVATION CONTOUR (FT)
- GROUNDWATER FLOW DIRECTION

**SOURCE:**

1. POTENTIOMETRIC SURFACE MAP INFORMATION PROVIDED BY AEROSTAR ENVIRONMENTAL SERVICES, INC.



**FIGURE 4-3**  
**SHALLOW POTENTIOMETRIC**  
**SURFACE MAP, SEPTEMBER 2010**

**OMS-28**  
**ALABAMA ARMY NATIONAL GUARD**  
**MOBILE, ALABAMA**

DRAWN BY: R. BEELER	REV. NO./DATE: 0/04-25-12	CAD FILE: /11013/DWGS/L76_POTN_SZ_SEPT-10
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## 4.2 ANALYTICAL RESULTS

### 4.2.1 Soil

#### 4.2.1.1 VOCs

During the 2006 and 2007 TCE CI, 37 soil samples were collected from 20 locations (HA-1 through HA-15 and B-13 through B-17). Nine VOCs (2-butanone; acetone; bromomethane; carbon disulfide; methylene chloride; tetrachloroethene [PCE]; TCE; *cis*-1,2-DCE; and toluene) were detected in the soil samples. The detected compounds are summarized in Table 4-2 and shown in Figure 4-4. The complete analytical results are provided in Appendix D of the TCE CI at OMS-28 (Aerostar 2007).

During the 2008 Supplemental CI, 24 soil samples were collected from 7 locations (OMS-28-1 through OMS-28-7). Eleven VOCs (2-butanone; acetone; carbon disulfide; chloroform; isopropylbenzene; methyl acetate; methylcyclohexane; naphthalene; TCE, trichlorofluoromethane; and *cis*-1,2-DCE) were detected in the soil samples. The detected compounds are summarized in Table 4-3 and shown in Figure 4-4. The complete analytical results are provided in Appendix E of the Supplemental CI Report for OMS-28 (Aerostar 2008a).

#### 4.2.1.2 SVOCs

During the 2006 and 2007 TCE CI, SVOCs were analyzed on the samples collected from borings B-13 through B-16. Sixteen SVOCs (acenaphthene, acenaphthylene, anthracene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[k]fluoranthene, bis[2-ethylhexyl]phthalate, carbazole, chrysene, fluoranthene, fluorene, indeno[1,2,3-cd]pyrene, phenanthrene, and pyrene) were detected in the soil samples. The detected compounds are summarized in Table 4-2 and shown in Figure 4-4. The complete analytical results are provided in Appendix D of the TCE CI at OMS-28 (Aerostar 2007).

### 4.2.2 Groundwater

During the Pit 2 secondary investigation in 2005, groundwater samples were collected from the seven monitoring wells associated with the UST monitoring program (MW-1, MW-2, MW-3, MW-5, MW-6, MW-7, and MW-8) and analyzed for VOCs, polynuclear aromatic hydrocarbons (PAHs), and lead. The organic analytes were expanded from BTEX to full-suite VOCs in 2005 as a result of the presence of TCE in MW-8 during the November 2004 sampling for the Pit 2 secondary investigation. Wells MW-5 and MW-6 are located over 100 ft west (i.e., downgradient) of the former UST location and are located 90 to 110 ft southeast (i.e., upgradient) of MW-8. The more extensive VOC analyte list reported for March 2005 samples indicates the presence of additional fuel constituents in the source area of the former UST and downgradient groundwater at MW-6, including butylbenzenes, trimethylbenzenes, and methylnaphthalenes in addition to the previously reported BTEX and naphthalene. Of these compounds, only 1,2,3-trimethylbenzene and 1,2,4-trimethylbenzene exceeded the preliminary screening levels (PSLs), which were the EPA Region 9 preliminary remediation goals (PRGs) for tap water in this case. None of the PAHs listed in the ADEM UST closure guidance exceeded the PSLs. All lead detections were below the PSL and were consistent with the concentrations reported in the upgradient well. The detected organic compounds for MW-5, MW-6, and MW-8 are summarized in Table 4-4. The complete analytical results are provided in Appendix D of the Secondary Investigation Addendum Report (Bechtel-S 2005a).

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Table 4-2. Soil Analytical Results from the OMS-28 TCE Comprehensive Investigation (2006-2007)

Compound	CAS Number	Units	EPA RSL <sup>a,b</sup> Residential Soil	EPA RSL <sup>a,b</sup> Industrial Soil	EPA MCL-based SSL	HA-1	HA-1	HA-2	HA-2	HA-3	HA-3	HA-4	HA-4	HA-5	HA-5	HA-6	HA-6	HA-7	HA-7	HA-8
						(0-1)	(6-8)	(0-1)	(8-10)	(0-1)	(8-10)	(0-1)	(7-9)	(0-1)	(7-9)	(0-1)	(8-10)	(0-1)	(8-10)	(0-1)
						04/19/06	04/19/06	04/19/06	04/19/06	04/19/06	04/19/06	04/19/06	04/19/06	04/19/06	04/19/06	04/19/06	04/19/06	04/19/06	04/19/06	04/19/06
<i>Volatile Organic Compounds (Detected Compounds)</i>																				
2-Butanone	78-93-3	mg/kg	2,800 (n)	20,000 (n)	-	<b>0.00638 J</b>	0.00247 U	0.018 U	0.000310 U	<b>0.00912 J</b>	0.000223 U	<b>0.00279 J</b>	0.000372 U	0.000756 U	0.017 U	0.000366 U	0.000330 U	<b>0.00391 J</b>	0.012 U	<b>0.00153 J</b>
Acetone	67-64-1	mg/kg	6,100 (n)	63,000 (n)	-	<b>0.151 J</b>	<b>0.000137 J</b>	0.022 U	<b>0.00600 J</b>	<b>0.119 J</b>	<b>0.00283 J</b>	<b>0.025 J</b>	0.000446 U	<b>0.063 J</b>	0.020 U	<b>0.035</b>	<b>0.00453 J</b>	<b>0.024 J</b>	0.014 U	0.000518 U
Bromomethane	74-83-9	mg/kg	0.73 (n)	3.2 (n)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon Disulfide	75-15-0	mg/kg	82 (n)	370 (n)	-	0.000108 U	0.0000863 U	0.00635 U	0.000108 U	0.000270 U	0.0000778 U	0.000154 U	0.000130 U	0.000264 U	0.00581 U	<b>0.00179 J</b>	0.000115 U	0.000269 U	0.00404 U	<b>0.00299 J</b>
<i>cis</i> -1,2-Dichloroethene	156-59-2	mg/kg	16 (n)	200 (n)	0.021	0.000125 U	<b>0.00387 J</b>	0.00734 U	0.000125 U	0.000312 U	0.0000899 U	0.000178 U	0.000150 U	0.000306 U	0.00672 U	0.000148 U	<b>0.046</b>	0.000311 U	0.00467 U	0.000174 U
Methylene Chloride	75-09-2	mg/kg	56 (c)	960 (c)	0.0013	0.000475 U	0.00379 U	<b>0.130 J</b>	0.000476 U	0.00119 U	0.000342 U	0.000675 U	0.000571 U	0.00116 U	<b>0.096 J</b>	0.000562 U	0.000507 U	0.00118 U	<b>0.061 J</b>	0.000663 U
Tetrachloroethene	127-18-4	mg/kg	22 (c)	110 (c)	0.0023	<b>0.00121 J</b>	<b>0.000822 J</b>	0.011 U	0.000191 U	0.000476 U	0.000137 U	0.000271 U	0.000229 U	<b>0.00252 J</b>	0.010 U	0.000225 U	0.000203 U	<b>0.00253 J</b>	0.00711 U	0.00266 U
Toluene	108-88-3	mg/kg	500 (n)	4,500 (n)	0.69	<b>0.00207 J</b>	0.00435 U	0.032 U	0.000547 U	0.00136 U	0.000392 U	0.000775 U	0.000656 U	<b>0.00335 J</b>	<b>0.053 J</b>	0.000645 U	0.000583 U	0.00136 U	0.020 U	0.000761 U
Trichloroethene	79-01-6	mg/kg	0.91 (c)	6.4 (c)	0.0018	<b>0.00311 J</b>	<b>0.017</b>	<b>0.241 J</b>	<b>0.027</b>	<b>0.019 J</b>	<b>0.00353 J</b>	0.000249 U	0.000211 U	0.000429 U	0.00944 U	0.000207 U	<b>0.15</b>	0.000437 U	<b>0.069 J</b>	<b>0.00286 J</b>
<i>Semivolatile Organic Compounds (Detected Compounds)</i>																				
Acenaphthene	83-32-9	mg/kg	340 (n)	3,300 (n)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthylene	208-96-8	mg/kg	159 <sup>c</sup> (n)	1,300 <sup>c</sup> (n)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anthracene	120-12-7	mg/kg	1,700 (n)	17,000 (n)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	56-55-3	mg/kg	0.15 (c)	2.1 (c)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	50-32-8	mg/kg	0.015 (c)	0.21 (c)	0.24	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	205-99-2	mg/kg	0.15 (c)	2.1 (c)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	191-24-2	mg/kg	153 <sup>c</sup> (n)	824 <sup>c</sup> (n)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	207-08-9	mg/kg	1.5 (c)	21 (c)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	117-81-7	mg/kg	35 (c)	120 (c)	1.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbazole	86-74-8	mg/kg	24 <sup>c</sup> (c)	86 <sup>c</sup> (c)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	218-01-9	mg/kg	15 (c)	210 (c)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	206-44-0	mg/kg	230 (n)	2,200 (n)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluorene	86-73-7	mg/kg	230 (n)	2,200 (n)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	193-39-5	mg/kg	0.15 (c)	2.1 (c)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	85-01-8	mg/kg	153 <sup>c</sup> (n)	824 <sup>c</sup> (n)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	129-00-0	mg/kg	170 (n)	1,700 (n)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 4-2. Soil Analytical Results from the OMS-28 TCE Comprehensive Investigation (2006-2007)

Compound	CAS Number	Units	EPA RSL <sup>a,b</sup> Residential Soil	EPA RSL <sup>a,b</sup> Industrial Soil	EPA MCL-based SSL	HA-8 (8-10) 04/19/06	HA-9 (0-1) 04/19/06	HA-9 (8-10) 04/19/06	HA-10 (0-1) 04/19/06	HA-10 (8-10) 04/19/06	HA-11 (8-10) 05/11/06	HA-12 (8-10) 05/11/06	HA-13 (8-10) 05/11/06	HA-14 (0-1) 03/19/07	HA-14 (8-10) 03/19/07	HA-15 (0-1) 03/19/07	HA-15 (8-10) 03/19/07	B-13 (0-1) 10/19/06	
<i>Volatile Organic Compounds (Detected Compounds)</i>																			
2-Butanone	78-93-3	mg/kg	2,800 (n)	20,000 (n)	-	0.018 U	<b>0.00249 J</b>	0.021 U	<b>0.00291 J</b>	0.000258 U	NA	NA	NA	0.000396 U	<b>0.028</b>	0.024 U	0.00053 U	NA	
Acetone	67-64-1	mg/kg	6,100 (n)	63,000 (n)	-	0.021 U	<b>0.065 J</b>	0.025 U	<b>0.054 J</b>	<b>0.00215 J</b>	NA	NA	NA	<b>0.036</b>	<b>0.022 J</b>	0.028 U	<b>0.011 J</b>	NA	
Bromomethane	74-83-9	mg/kg	0.73 (n)	3.2 (n)	-	NA	NA	NA	NA	NA	NA	NA	NA	0.00191 U	<b>0.012</b>	0.010 U	0.000229 U	NA	
Carbon Disulfide	75-15-0	mg/kg	82 (n)	370 (n)	-	0.00614 U	0.000221 U	0.00740 U	<b>0.00441 J</b>	0.0000901 U	NA	NA	NA	0.000138 U	0.000189 U	0.00829 U	0.000185 U	NA	
<i>cis</i> -1,2-Dichloroethene	156-59-2	mg/kg	16 (n)	200 (n)	0.021	0.00710 U	0.000255 U	0.00855 U	0.000190 U	0.000104 U	0.000121 U	0.000184 U	0.000321 U	0.000160 U	<b>0.00678 J</b>	0.00958 U	<b>0.036</b>	NA	
Methylene Chloride	75-09-2	mg/kg	56 (c)	960 (c)	0.0013	<b>0.106 J</b>	0.000971 U	<b>0.117 J</b>	0.000722 U	0.000396 U	0.000458 U	0.000701 U	0.000122 U	0.000607 U	0.000829 U	0.036 U	0.000813 U	NA	
Tetrachloroethene	127-18-4	mg/kg	22 (c)	110 (c)	0.0023	0.011 U	0.000389 U	0.013 U	<b>0.00154 J</b>	0.000159 U	0.000184 U	<b>0.00191 J</b>	<b>0.00505 J</b>	0.000243 U	0.000332 U	0.015 U	0.000326 U	NA	
Toluene	108-88-3	mg/kg	500 (n)	4,500 (n)	0.69	0.031 U	<b>0.00348 J</b>	0.037 U	0.000829 U	0.000454 U	NA	NA	NA	0.000697 U	0.000952 U	0.042 U	0.000934 U	NA	
Trichloroethene	79-01-6	mg/kg	0.91 (c)	6.4 (c)	0.0018	0.00998 U	0.000359 U	0.012 U	0.000267 U	0.000146 U	0.000169 U	<b>0.00353 J</b>	0.000451 U	<b>0.017</b>	<b>0.00962</b>	<b>0.586</b>	<b>0.132 J</b>	<b>0.0171</b>	
<i>Semivolatile Organic Compounds (Detected Compounds)</i>																			
Acenaphthene	83-32-9	mg/kg	340 (n)	3,300 (n)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<b>0.428</b>
Acenaphthylene	208-96-8	mg/kg	159 <sup>c</sup> (n)	1,300 <sup>c</sup> (n)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.1181 U
Anthracene	120-12-7	mg/kg	1,700 (n)	17,000 (n)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<b>1.58</b>
Benzo(a)anthracene	56-55-3	mg/kg	0.15 (c)	2.1 (c)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<b>4.92</b>
Benzo(a)pyrene	50-32-8	mg/kg	0.015 (c)	0.21 (c)	0.24	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<b>4.26</b>
Benzo(b)fluoranthene	205-99-2	mg/kg	0.15 (c)	2.1 (c)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<b>5.4</b>
Benzo(g,h,i)perylene	191-24-2	mg/kg	153 <sup>c</sup> (n)	824 <sup>c</sup> (n)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<b>1.53</b>
Benzo(k)fluoranthene	207-08-9	mg/kg	1.5 (c)	21 (c)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<b>2.25</b>
Bis(2-ethylhexyl)phthalate	117-81-7	mg/kg	35 (c)	120 (c)	1.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.108 U
Carbazole	86-74-8	mg/kg	24 <sup>c</sup> (c)	86 <sup>c</sup> (c)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<b>1.07</b>
Chrysene	218-01-9	mg/kg	15 (c)	210 (c)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<b>5.18</b>
Fluoranthene	206-44-0	mg/kg	230 (n)	2,200 (n)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<b>15.6</b>
Fluorene	86-73-7	mg/kg	230 (n)	2,200 (n)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<b>0.448</b>
Indeno(1,2,3-cd)pyrene	193-39-5	mg/kg	0.15 (c)	2.1 (c)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<b>2.94</b>
Phenanthrene	85-01-8	mg/kg	153 <sup>c</sup> (n)	824 <sup>c</sup> (n)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<b>6.21</b>
Pyrene	129-00-0	mg/kg	170 (n)	1,700 (n)	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<b>7.01</b>

Table 4-2. Soil Analytical Results from the OMS-28 TCE Comprehensive Investigation (2006-2007)

Compound	CAS Number	Units	EPA RSL <sup>a,b</sup> Residential Soil	EPA RSL <sup>a,b</sup> Industrial Soil	EPA MCL-based SSL	B-13 (6-8) 10/19/06	B-14 (0-1) 10/19/06	B-14 (8-10) 10/19/06	B-15 (0-1) 10/19/06	B-15 (6-8) 10/19/06	B-16 (0-1) 10/19/06	B-16 (6-8) 10/19/06	B-17 (0-1) 03/19/07	B-17 (8-10) 03/19/07
<b>Volatile Organic Compounds (Detected Compounds)</b>														
2-Butanone	78-93-3	mg/kg	2,800 (n)	20,000 (n)	-	NA	NA	NA	NA	NA	NA	NA	0.023 U	0.000556 U
Acetone	67-64-1	mg/kg	6,100 (n)	63,000 (n)	-	NA	NA	NA	NA	NA	NA	NA	0.00765 U	0.000667 U
Bromomethane	74-83-9	mg/kg	0.73 (n)	3.2 (n)	-	NA	NA	NA	NA	NA	NA	NA	0.011 U	0.000268 U
Carbon Disulfide	75-15-0	mg/kg	82 (n)	370 (n)	-	NA	NA	NA	NA	NA	NA	NA	0.00802 U	0.000194 U
<i>ci s</i> -1,2-Dichloroethene	156-59-2	mg/kg	16 (n)	200 (n)	0.021	NA	NA	NA	NA	NA	NA	NA	0.00927 U	0.000225 U
Methylene Chloride	75-09-2	mg/kg	56 (c)	960 (c)	0.0013	NA	NA	NA	NA	NA	NA	NA	0.035 U	0.000854 U
Tetrachloroethene	127-18-4	mg/kg	22 (c)	110 (c)	0.0023	NA	NA	NA	NA	NA	NA	NA	<b>0.933</b>	<b>0.186</b>
Toluene	108-88-3	mg/kg	500 (n)	4,500 (n)	0.69	NA	NA	NA	NA	NA	NA	NA	0.040 U	0.00098 U
Trichloroethene	79-01-6	mg/kg	0.91 (c)	6.4 (c)	0.0018	0.012 U	0.018 U	0.025 U	0.019 U	0.027 U	0.015 U	0.015 U	0.017 U	0.000315 U
<b>Semivolatile Organic Compounds (Detected Compounds)</b>														
Acenaphthene	83-32-9	mg/kg	340 (n)	3,300 (n)	-	0.012 U	0.100 U	0.010 U	0.010 U	0.010 U	0.097 U	0.00899 U	NA	NA
Acenaphthylene	208-96-8	mg/kg	159 <sup>c</sup> (n)	1,300 <sup>c</sup> (n)	-	0.013 U	<b>0.123 J</b>	0.011 U	<b>0.024 J</b>	0.011	0.110 U	0.010 U	NA	NA
Anthracene	120-12-7	mg/kg	1,700 (n)	17,000 (n)	-	0.013 U	0.110 U	0.011 U	<b>0.025 J</b>	0.011 U	0.106 U	0.00988 U	NA	NA
Benzo(a)anthracene	56-55-3	mg/kg	0.15 (c)	2.1 (c)	-	0.012 U	0.103 U	0.010 U	0.011 U	0.010 U	0.099 U	0.0092 U	NA	NA
Benzo(a)pyrene	50-32-8	mg/kg	0.015 (c)	0.21 (c)	0.24	0.012 U	<b>0.467 J</b>	0.010 U	<b>0.148 J</b>	0.010 U	<b>0.225 J</b>	0.00914 U	NA	NA
Benzo(b)fluoranthene	205-99-2	mg/kg	0.15 (c)	2.1 (c)	-	0.00835 U	<b>0.576 J</b>	0.00714 U	<b>0.157 J</b>	0.00713 U	<b>0.268 J</b>	0.00639 U	NA	NA
Benzo(g,h,i)perylene	191-24-2	mg/kg	153 <sup>c</sup> (n)	824 <sup>c</sup> (n)	-	0.012 U	<b>0.196 J</b>	0.010 U	<b>0.085 J</b>	0.010 U	0.098 U	0.00914 U	NA	NA
Benzo(k)fluoranthene	207-08-9	mg/kg	1.5 (c)	21 (c)	-	0.018 U	<b>0.229 J</b>	0.016 U	<b>0.096 J</b>	0.016 U	<b>0.171 J</b>	0.00639 U	NA	NA
Bis(2-ethylhexyl)phthalate	117-81-7	mg/kg	35 (c)	120 (c)	1.4	0.012 U	0.104 U	0.010 U	<b>0.018 J</b>	0.010 U	0.100 U	0.0093 U	NA	NA
Carbazole	86-74-8	mg/kg	24 <sup>c</sup> (c)	86 <sup>c</sup> (c)	-	0.012 U	0.099 U	0.00995 U	<b>0.021 J</b>	0.00994 U	0.096 U	0.00691 U	NA	NA
Chrysene	218-01-9	mg/kg	15 (c)	210 (c)	-	0.011 U	<b>0.540 J</b>	0.00901 U	<b>0.147 J</b>	0.009 U	<b>0.293 J</b>	0.00807 U	NA	NA
Fluoranthene	206-44-0	mg/kg	230 (n)	2,200 (n)	-	0.013 U	<b>1.21 J</b>	0.011 U	<b>0.234 J</b>	0.011 U	<b>0.755 J</b>	0.010 U	NA	NA
Fluorene	86-73-7	mg/kg	230 (n)	2,200 (n)	-	0.012 U	0.099 U	0.00991 U	0.010 U	0.00989 U	0.095 U	0.00687 U	NA	NA
Indeno(1,2,3-cd)pyrene	193-39-5	mg/kg	0.15 (c)	2.1 (c)	-	0.019 U	<b>0.536 J</b>	0.016 U	<b>0.176 J</b>	0.0016 U	<b>0.376 J</b>	0.015 U	NA	NA
Phenanthrene	85-01-8	mg/kg	153 <sup>c</sup> (n)	824 <sup>c</sup> (n)	-	0.015 U	<b>0.431 J</b>	0.013 U	<b>0.103 J</b>	0.013 U	<b>0.480 J</b>	0.011 U	NA	NA
Pyrene	129-00-0	mg/kg	170 (n)	1,700 (n)	-	0.014 U	<b>0.580 J</b>	0.012 U	<b>0.154 J</b>	0.012 U	<b>0.345 J</b>	0.011 U	NA	NA

Source: TCE Comprehensive Investigation at the Organizational Maintenance Shop 28 (OMS-28), Alabama Army National Guard, 1622 South Broad Street, Mobile, Alabama, Groundwater Incident No. GW 07-01-02 (Aerostar 2007).

<sup>a</sup>EPA RSLs are being used in lieu of Alabama PSVs published in the Alabama Risk-Based Corrective Action Guidance Manual (2008) as per April 2, 2012, e-mail correspondence between the Alabama Department of Environmental Management (ADEM) and the Alabama Army National Guard (ALARNG).

<sup>b</sup>EPA RSLs dated May 2012. As per guidance from ADEM, EPA RSL values have been adjusted by 10 for non-carcinogens.

<sup>c</sup> EPA RSL is not available; used draft PSV calculated by ADEM in 2012 updated version of the Alabama Risk-Based Corrective Action Guidance Manual. Values were provided in June 20, 2012, e-mail correspondence between ADEM and ALARNG.

**Bold** values indicate a detected concentration.

**Teal shaded** values exceed a residential RSL.

**Red** values exceed an industrial RSL.

Underline values exceed EPA MCL-based SSL.

(c) indicates risk = 1E-06 for carcinogens.

CAS = Chemical Abstract Service.

EPA = U. S. Environmental Protection Agency.

(n) indicates a hazard quotient = 0.1 for non-carcinogens.

NA = Not analyzed.

NE = An RSL has not been established for this compound.

MCL = Maximum contaminant level.

OMS = Organizational Maintenance Shop.

PSV = Preliminary screening value.

RSL = Regional screening level.

SSL = Soil screening level.

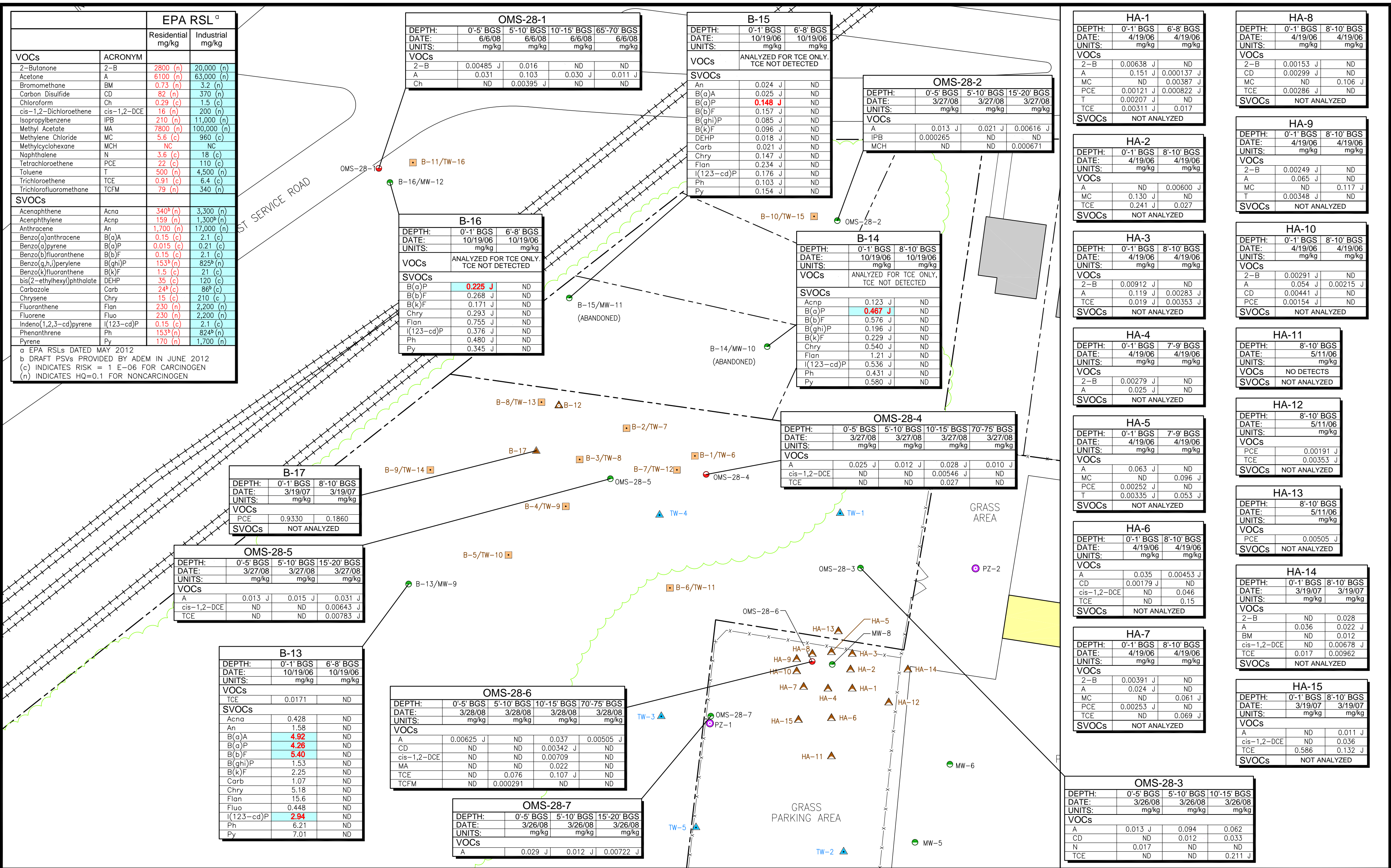
TCE = Trichloroethene.

**Qualifiers:**

J = Indicates an estimated value.

U = Indicates that the compound was analyzed for but not detected.

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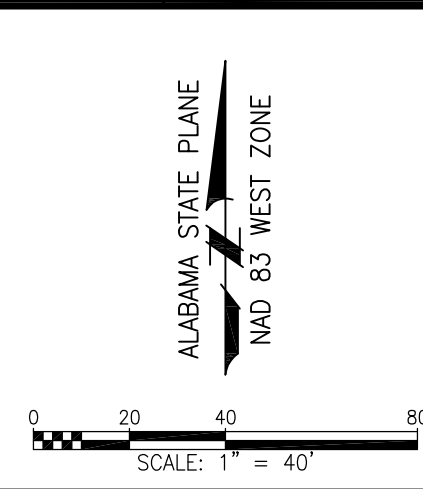


**LEGEND:**

- RESIDENTIAL BUILDING
- COMMERCIAL BUILDING
- ASPHALT ROAD
- RAILROAD TRACKS
- CHAIN LINK FENCE
- PROPERTY BOUNDARY
- TREE LINE
- SOIL BORING (2006-2007)
- TEMPORARY WELL (2006-2007)
- ABANDONED TEMPORARY WELL (2005)
- HAND AUGER BORING (2006-2007)
- EXPLORATORY BORING (2008)
- FLUTE LINER BORING (2006)
- ABANDONED PIEZOMETER (2006)
- SHALLOW MONITORING WELL
- DEEP MONITORING WELL

**NOTES:**

- HISTORICAL LOCATIONS DIGITIZED FROM BASE MAP PROVIDED BY AEROSTAR ENVIRONMENTAL SERVICES INC. (AEROSTAR 2007).
- MONITORING WELL LOCATIONS DATA PROVIDED BY AEROSTAR ENVIRONMENTAL SERVICES INC. (AEROSTAR 2008).
- HA-1 THROUGH HA-15 WERE ABANDONED IN 2006 AND 2007.
- B-1 THROUGH B-17 AND B-17 WERE ABANDONED IN 2006 AND 2007.
- MW-10 AND MW-11 ABANDONED IN 2008 AT THE REQUEST OF THE PRIVATE PROPERTY OWNER.
- TW-1 THROUGH TW-5, PZ-1, AND PZ-2 WERE ABANDONED IN 2008.
- PROPERTY BOUNDARIES BASED ON CITY OF MOBILE, GIS CITY MAP INFORMATION AS OF MAY 9, 2011.
- EPA RSLs ARE BEING USED IN LIEU OF THE AL PSVs PUBLISHED IN THE 2008 ARBCA GUIDANCE MANUAL AS PER APRIL 2, 2012 EMAIL BETWEEN ADEM AND ALARNG.
- DRAFT PSVs CALCULATED BY ADEM IN 2012 AS PART OF PROPOSED ARBCA GUIDANCE MANUAL REVISION. VALUES PROVIDED IN JUNE 20, 2012 EMAIL BETWEEN ADEM AND ALARNG.



**SAIC**

**FIGURE 4-4**  
SOIL ANALYTICAL RESULTS

**OMS-28**  
ALABAMA ARMY NATIONAL GUARD  
MOBILE, ALABAMA

DRAWN BY: R. BEELER  
 REV. NO./DATE: 1/11-29-12  
 CAD FILE: /11013/DWGS/L83\_OMS28\_BOXES-01

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Table 4-3. Soil Analytical Results from the OMS-28 Supplemental Comprehensive Investigation (2008)

Compound	CAS Number	Units	EPA RSL <sup>a,b</sup> Residential Soil	EPA RSL <sup>a,b</sup> Industrial Soil	EPA MCL-based SSL	OMS-28-1 (0-5) 06/06/08	OMS-28-1 (5-10) 06/06/08	OMS-28-1 (10-15) 06/06/08	OMS-28-1 (65-70) 06/06/08	OMS-28-2 (0-5) 03/27/08	OMS-28-2 (0-5) duplicate 03/27/08	OMS-28-2 (5-10) 03/27/08	OMS-28-2 (15-20) 03/27/08	OMS-28-3 (0-5) 03/26/08	OMS-28-3 (5-10) 03/26/08	OMS-28-3 (10-15) 03/26/08	OMS-28-4 (0-5) 03/27/08	OMS-28-4 (0-5) duplicate 03/27/08	OMS-28-4 (5-10) 03/27/08
<i>Volatile Organic Compounds (Detected Compounds)</i>																			
2-Butanone	78-93-3	mg/kg	2,800 (n)	20,000 (n)	-	<b>0.00485 J</b>	<b>0.016</b>	0.000584 U	0.000513 U	0.000540 U	0.000451 U	0.000666 U	0.000566 U	0.000411 U	0.000690 U	0.000603 U	0.000415 U	0.000559 U	0.000463 U
Acetone	67-64-1	mg/kg	6,100 (n)	63,000 (n)	-	<b>0.031</b>	<b>0.103</b>	<b>0.030 J</b>	<b>0.011 J</b>	<b>0.013 J</b>	<b>0.00932 J</b>	<b>0.021 J</b>	<b>0.00616 J</b>	<b>0.013 J</b>	<b>0.094</b>	<b>0.062</b>	<b>0.025 J</b>	<b>0.00404 J</b>	<b>0.012 J</b>
Carbon Disulfide	75-15-0	mg/kg	82 (n)	370 (n)	-	0.000113 U	0.000146 U	0.000204 U	0.000179 U	0.000189 U	0.000158 U	0.000233 U	0.000198 U	0.000144 U	<b>0.012</b>	<b>0.033</b>	0.000145 U	0.000195 U	0.000162 U
Chloroform	67-66-3	mg/kg	0.29 (c)	1.5 (c)	0.022	0.000146 U	<b>0.00395 J</b>	0.000264 U	0.000232 U	0.000244 U	0.000204 U	0.000301 U	0.000256 U	0.000186 U	0.000312 U	0.000273 U	0.000188 U	0.000253 U	0.000209 U
cis -1,2-Dichloroethene	156-59-2	mg/kg	16 (n)	200 (n)	0.021	0.000131 U	0.000169 U	0.000236 U	0.000207 U	0.000218 U	0.000182 U	0.000269 U	0.000228 U	0.000166 U	0.000278 U	0.00912J	0.000168 U	0.000226 U	0.000187 U
Isopropylbenzene (cumene)	98-82-8	mg/kg	210 (n)	1,100 (n)	-	0.000159 U	0.000205 U	0.000286 U	0.000252 U	<b>0.000265</b>	0.000221 U	0.000327 U	0.000277 U	0.000202 U	0.000338 U	0.000296 U	0.000204 U	0.000274 U	0.000227 U
Methyl Acetate	79-20-9	mg/kg	7,800 (n)	100,000 (n)	-	0.00159 U	0.00205 U	0.00286 U	0.00251 U	0.00265 U	0.00221 U	0.00326 U	0.00277 U	0.00201 U	0.00338 U	0.00296 U	0.00204 U	0.00274 U	0.00227 U
Methylcyclohexane	108-87-2	mg/kg	NE	NE	-	0.000384 U	0.000496 U	0.000693 U	0.000608 U	0.000641 U	0.000535 U	0.000790 U	<b>0.000671</b>	0.000488 U	0.000818 U	0.000715 U	0.000493 U	0.000663 U	0.000549 U
Naphthalene	91-20-3	mg/kg	3.6 (c)	18 (c)	-	0.000390 U	0.000504 U	0.000704 U	0.000618 U	0.000651 U	0.000544 U	0.0008052 U	0.000682 U	<b>0.017</b>	0.000831 U	0.000727 U	0.000501 U	0.000674 U	0.000558 U
Trichloroethene	79-01-6	mg/kg	0.91 (c)	6.4 (c)	0.0018	0.000184 U	0.000237 U	0.000331 U	0.000291 U	0.000306 U	0.000256 U	0.000378 U	0.000321 U	0.000233 U	0.000391 U	<b>0.211 J</b>	0.000236 U	0.000317 U	0.000263 U
Trichlorofluoromethane	75-69-4	mg/kg	79 (n)	340 (n)	-	0.000261 U	0.000338 U	0.000472 U	0.000414 U	0.000436 U	0.000365 U	0.000538 U	0.000457 U	0.000332 U	0.000557 U	0.000487 U	0.000335 U	0.000452 U	0.000374 U

Table 4-3. Soil Analytical Results from the OMS-28 Supplemental Comprehensive Investigation (2008)

Compound	CAS Number	Units	EPA RSL <sup>a,b</sup> Residential Soil	EPA RSL <sup>a,b</sup> Industrial Soil	EPA MCL-based SSL	OMS-28-4 (10-15) 03/27/08	OMS-28-4 (70-75) 03/27/08	OMS-28-5 (0-5) 03/27/08	OMS-28-5 (0-5) duplicate 03/27/08	OMS-28-5 (5-10) 03/27/08	OMS-28-5 (15-20) 03/27/08	OMS-28-6 (0-5) 03/28/08	OMS-28-6 (5-10) 03/28/08	OMS-28-6 (10-15) 03/28/08	OMS-28-6 (70-75) 03/28/08
<i>Volatile Organic Compounds (Detected Compounds)</i>															
2-Butanone	78-93-3	mg/kg	2,800 (n)	20,000 (n)	-	0.000590 U	0.000385 U	0.000584 U	0.000491 U	0.000546 U	0.000551 U	0.000457 U	0.000360 U	0.000425 U	0.000319 U
Acetone	67-64-1	mg/kg	6,100 (n)	63,000 (n)	-	<b>0.028J</b>	<b>0.010 J</b>	<b>0.013 J</b>	<b>0.012 J</b>	<b>0.015 J</b>	<b>0.031 J</b>	<b>0.00625 J</b>	0.000431U	<b>0.037</b>	<b>0.00505 J</b>
Carbon Disulfide	75-15-0	mg/kg	82 (n)	370 (n)	-	0.000206 U	0.000134 U	0.000204 U	0.000171 U	0.000191 U	0.000193 U	0.000160 U	0.000126 U	<b>0.00342 J</b>	0.000111 U
Chloroform	67-66-3	mg/kg	0.29 (c)	1.5 (c)	0.022	0.000267 U	0.000174 U	0.000264 U	0.000222 U	0.000247 U	0.000249 U	0.000206 U	0.000163 U	0.000192 U	0.000144 U
cis-1,2-Dichloroethene	156-59-2	mg/kg	16 (n)	200 (n)	0.021	<b>0.00546 J</b>	0.000155 U	0.000236 U	0.000198 U	0.000220 U	<b>0.00643 J</b>	0.000184 U	0.000145 U	<b>0.00709</b>	0.000129 U
Isopropylbenzene (cumene)	98-82-8	mg/kg	210 (n)	1,100 (n)	-	0.000289 U	0.000189 U	0.000286 U	0.000241 U	0.000268 U	0.000270 U	0.000224 U	0.000177 U	0.000208 U	0.000156 U
Methyl Acetate	79-20-9	mg/kg	7,800 (n)	100,000 (n)	-	0.00289 U	0.00189 U	0.00286 U	0.00240 U	0.00268 U	0.00270 U	0.00224 U	0.00176 U	<b>0.022</b>	0.00156 U
Methylcyclohexane	108-87-2	mg/kg	NE	NE	-	0.000699 U	0.000456 U	0.000692 U	0.000582 U	0.000647 U	0.000654 U	0.000541 U	0.000427 U	0.000504 U	0.000378 U
Naphthalene	91-20-3	mg/kg	3.6 (c)	18 (c)	-	0.000711 U	0.000464 U	0.000703 U	0.000591 U	0.000658 U	0.000664 U	0.000550 U	0.000434 U	0.000512 U	0.000384 U
Trichloroethene	79-01-6	mg/kg	0.91 (c)	6.4 (c)	0.0018	<b>0.027</b>	0.000218 U	0.000331 U	0.000278 U	0.000310 U	<b>0.00783 J</b>	0.000259 U	<b>0.076</b>	<b>0.107 J</b>	0.000181 U
Trichlorofluoromethane	75-69-4	mg/kg	79 (n)	340 (n)	-	0.000476 U	0.000311 U	0.000471 U	0.000396 U	0.000441 U	0.000445 U	0.000369 U	<b>0.000291</b>	0.000343 U	0.000258 U



Table 4-3. Soil Analytical Results from the OMS-28 Supplemental Comprehensive Investigation (2008)

Compound	CAS Number	Units	EPA RSL <sup>a,b</sup> Residential Soil	EPA RSL <sup>a,b</sup> Industrial Soil	EPA MCL-based SSL	OMS-28-7 (0-5) 03/26/08	OMS-28-7 (5-10) 03/26/08	OMS-28-7 (15-20) 03/26/08
<i>Volatile Organic Compounds (Detected Compounds)</i>								
2-Butanone	78-93-3	mg/kg	2,800 (n)	20,000 (n)	-	0.000444 U	0.000504 U	0.000450 U
Acetone	67-64-1	mg/kg	6,100 (n)	63,000 (n)	-	<b>0.029 J</b>	<b>0.012 J</b>	<b>0.00722 J</b>
Carbon Disulfide	75-15-0	mg/kg	82 (n)	370 (n)	-	0.000155 U	0.000176 U	0.000157 U
Chloroform	67-66-3	mg/kg	0.29 (c)	1.5 (c)	0.022	0.000201 U	0.000228 U	0.000203 U
<i>cis</i> -1,2-Dichloroethene	156-59-2	mg/kg	16 (n)	200 (n)	0.021	0.000179 U	0.000204 U	0.000182 U
Isopropylbenzene (cumene)	98-82-8	mg/kg	210 (n)	1,100 (n)	-	0.000218 U	0.000247 U	0.000221 U
Methyl Acetate	79-20-9	mg/kg	7,800 (n)	100,000 (n)	-	0.00217 U	0.00247 U	0.00221 U
Methylcyclohexane	108-87-2	mg/kg	NE	NE	-	0.000526 U	0.000598 U	0.000534 U
Naphthalene	91-20-3	mg/kg	3.6 (c)	18 (c)	-	0.000535 U	0.000608 U	0.000542 U
Trichloroethene	79-01-6	mg/kg	0.91 (c)	6.4 (c)	0.0018	0.000252 U	0.000286 U	0.000255 U
Trichlorofluoromethane	75-69-4	mg/kg	79 (n)	340 (n)	-	0.000358 U	0.000407 U	0.000364 U

Source: Supplemental Comprehensive Investigation Report for the Alabama Army National Guard (AANG) Organizational Maintenance Shop 28 (OMS-28), 1622 South Broad Street, Mobile, Alabama, Groundwater Incident No. GW 07-01-02 (Aerostar 2008).

<sup>a</sup> EPA RSLs are being used in lieu of AL PSVs published in the Alabama Risk-Based Corrective Action Guidance Manual (2008) as per April 2, 2012, e-mail correspondence between the Alabama Department of

Environmental Management (ADEM) and the Alabama Army National Guard.

<sup>b</sup> EPA RSLs dated May 2012. As per guidance from ADEM, EPA RSL values have been adjusted by 10 for non-carcinogens.

**Bold** values indicate a detected concentration.

**Teal** shaded values exceed a residential RSL.

**Red** values exceed an industrial RSL.

Underline values exceed EPA MCL-based SSL.

(c) indicates risk = 1E-06 for carcinogens.

CAS = Chemical Abstracts Service.

EPA = U. S. Environmental Protection Agency.

(n) indicates a hazard quotient = 0.1 for non-carcinogens.

NE = An RSL has not been established for this compound.

MCL = Maximum contaminant level.

OMS = Organizational Maintenance Shop.

PSV = Preliminary screening value.

RSL = Regional screening level.

SSL = Soil screening level.

Qualifiers:

J = Indicates an estimated value.

U = Indicates that the compound was analyzed for but not detected.

Table 4-4. Groundwater Analytical Results from the OMS-28 Pit 2 Secondary Investigation and the OMS-28 TCE Comprehensive Investigation (2005-2007)

Compound	CAS Number	Units	EPA RSL <sup>a,b</sup> Tap Water	MCL	TW-1	TW-2	TW-3		TW-4	TW-5	PZ-1	PZ-2	TW-6	TW-7	TW-8	TW-9	TW-10	TW-11	TW-12	TW-13	TW-14	TW-15
					02/21/06	02/21/06	02/21/06	Duplicate 02/21/06	02/21/06	02/21/06	02/21/06	02/21/06	02/21/06	02/21/06	04/18/06	04/18/06	04/18/06	04/18/06	04/18/06	04/18/06	04/18/06	04/18/06
<i>Volatile Organic Compounds (Detected Compounds)</i>																						
Acetone	67-64-1	µg/L	1,200 (n)	NC	1.42 U	NS	1.42 U	1.42 U	1.42 U	1.42 U	<b>6.19 J</b>	1.42 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	71-43-2	µg/L	0.39 (c)	5	0.023 U	NS	0.023 U	0.023 U	0.023 U	0.023 U	<b>0.850 J</b>	<b>1.21</b>	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis -1,2-Dichloroethene	156-59-2	µg/L	2.8 (n)	70	0.051 U	NS	0.051 U	0.051 U	<b>1.50</b>	0.051 U	0.204 U	0.051 U	NA	NA	NA	NA	NA	NA	NA	NA	0.163 U	0.163 U
Cyclohexane	110-82-7	µg/L	1,300 (n)	NC	0.063 U	NS	0.063 U	0.063 U	0.063 U	0.063 U	0.252 U	<b>0.454 J</b>	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	100-41-4	µg/L	1.3 (c)	700	0.029 U	NS	0.029 U	0.029 U	0.029 U	0.029 U	<b>36.1</b>	<b>23.0</b>	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Isopropylbenzene (cumene)	98-82-8	µg/L	39 (n)	NC	0.030 U	NS	0.030 U	0.030 U	0.030 U	0.030 U	<b>2.91 J</b>	0.030 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methylene Chloride	75-09-2	µg/L	9.9 (c)	5	0.079 U	NS	0.079 U	0.079 U	0.078 U	0.078 U	<b>0.778 J</b>	0.078 U	NA	NA	NA	NA	NA	NA	NA	NA	0.445 U	0.445 U
Naphthalene	91-20-3	µg/L	0.14 (c)	NC	NA	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	127-18-4	µg/L	9.7 (c)	5	0.072 U	NS	0.072 U	0.072 U	0.072 U	0.072 U	0.0288 U	0.072 U	NA	NA	NA	NA	NA	NA	NA	NA	0.227 U	0.227 U
Toluene	108-88-3	µg/L	86 (n)	1,000	0.022 U	NS	0.022 U	0.022 U	0.022 U	0.022 U	0.088 U	0.022 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	79-01-6	µg/L	0.44 (c)	5	0.024 U	NS	0.024 U	0.024 U	<b>1.86</b>	0.024 U	0.096 U	0.024 U	<b>16.5</b>	<b>19.7</b>	<b>130</b>	0.270 U	0.270 U	<b>6.74</b>	0.270 U	<b>145</b>	0.270 U	0.270 U
Vinyl Chloride	75-01-4	µg/L	0.015 (c)	2	0.062 U	NS	0.062 U	0.062 U	0.062 U	0.062 U	0.062 U	0.062 U	NA	NA	NA	NA	NA	NA	NA	NA	0.089 U	0.089 U
Xylenes (total)	1330-20-7	µg/L	19 (n)	10,000	0.069 U	NS	0.069 U	<b>0.692 J</b>	0.068 U	<b>0.07</b>	<b>38.1 J</b>	<b>28.3</b>	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Butylbenzene	104-51-8	µg/L	78 (n)	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Propylbenzene	103-65-1	µg/L	53 (n)	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
sec-Butylbenzene	135-98-8	µg/L	NE	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3-Trimethylbenzene	536-73-8	µg/L	1.0 (n)	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,4-Trimethylbenzene	95-63-6	µg/L	1.5 (n)	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
<i>Polynuclear Aromatic Hydrocarbons (Detected Compounds)</i>																						
1-Methylnaphthalene	90-12-0	µg/L	0.97 (c)	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	91-57-6	µg/L	2.7 (n)	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 4-4. Groundwater Analytical Results from the OMS-28 Pit 2 Secondary Investigation and the OMS-28 TCE Comprehensive Investigation (2005-2007)

Compound	CAS Number	Units	EPA RSL <sup>a,b</sup> Tap Water	MCL	TW-16	MW-5		MW-6		MW-8				MW-9	MW-10		MW-11	MW-12
					05/11/06	03/10/05	10/18/06	03/10/05	10/18/06	03/10/05	Duplicate	04/18/06	10/18/06	11/22/06	11/22/06	Duplicate	11/22/06	11/22/06
<b>Volatile Organic Compounds (Detected Compounds)</b>																		
Acetone	67-64-1	µg/L	1,200 (n)	NC	NA	1.0 U	NA	2.5 U	NA	16 U	16 U	NA	NA	NA	NA	NA	NA	NA
Benzene	71-43-2	µg/L	0.39 (c)	5	NA	0.25 U	0.225 U	41	43	3.8 U	3.8 U	0.225 U	0.225 U	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	156-59-2	µg/L	2.8 (n)	70	0.163 U	0.25 U	NA	0.63 U	NA	11.0	10.0	NA	NA	0.051 U	5.8	5.48	0.051 U	0.051 U
Cyclohexane	110-82-7	µg/L	1,300 (n)	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	100-41-4	µg/L	1.3 (c)	700	NA	0.25 U	2.72 J	1.5	0.227 U	3.8 U	3.8 U	0.227 U	0.227 U	NA	NA	NA	NA	NA
Isopropylbenzene (cumene)	98-82-8	µg/L	39 (n)	NC	NA	0.25 U	NA	15	NA	3.8 U	3.8 U	NA	NA	NA	NA	NA	NA	NA
Methylene Chloride	75-09-2	µg/L	9.9 (c)	5	0.445 U	0.25 U	NA	0.63 U	NA	3.8 U	3.8 U	NA	NA	0.078 U	0.078 U	0.078 U	0.078 U	0.078 U
Naphthalene	91-20-3	µg/L	0.14 (c)	NC	NA	0.25 U	0.304 U	59	95	3.8 U	3.8 U	0.304 U	0.304 U	NA	NA	NA	NA	NA
Tetrachloroethene	127-18-4	µg/L	9.7 (c)	5	0.227 U	0.25 U	NA	0.63 U	NA	3.8 U	3.8 U	NA	NA	0.072 U	4.9	4.83	0.072 U	0.072 U
Toluene	108-88-3	µg/L	86 (n)	1,000	NA	0.25 U	0.213 U	0.71	0.213 U	3.8 U	3.8 U	0.213 U	0.213 U	NA	NA	NA	NA	NA
Trichloroethene	79-01-6	µg/L	0.44 (c)	5	0.270 U	0.25 U	0.270 U	0.63 U	0.270 U	460	430	97.9	83	0.024 U	11	11	63	0.024 U
Vinyl Chloride	75-01-4	µg/L	0.015 (c)	2	0.089 U	0.25 U	NA	0.63 U	NA	3.8 U	3.8 U	NA	NA	0.052 U	1.5	1.33	0.052 U	0.052 U
Xylenes (total)	1330-20-7	µg/L	19 (n)	10,000	NA	0.75 U	6.01 J	6.5	5.82 J	10.1 U	10.1 U	0.509 U	0.509 U	NA	NA	NA	NA	NA
n-Butylbenzene	104-51-8	µg/L	78 (n)	NC	NA	0.25 U	NA	4.7	NA	3.8 U	3.8 U	NA	NA	NA	NA	NA	NA	NA
n-Propylbenzene	103-65-1	µg/L	53 (n)	NC	NA	0.25 U	NA	2.3	NA	3.8 U	3.8 U	NA	NA	NA	NA	NA	NA	NA
sec-Butylbenzene	135-98-8	µg/L	NE	NC	NA	0.25 U	NA	2.6	NA	3.8 U	3.8 U	NA	NA	NA	NA	NA	NA	NA
1,2,3-Trimethylbenzene	536-73-8	µg/L	1.0 (n)	NC	NA	0.25 U	NA	6.8	NA	3.8 U	3.8 U	NA	NA	NA	NA	NA	NA	NA
1,2,4-Trimethylbenzene	95-63-6	µg/L	1.5 (n)	NC	NA	0.25 U	NA	42	NA	3.8 U	3.8 U	NA	NA	NA	NA	NA	NA	NA
<b>Polynuclear Aromatic Hydrocarbons (Detected Compounds)</b>																		
1-Methylnaphthalene	90-12-0	µg/L	0.97 (c)	NC	NA	1 U	NA	21	NA	1 U	1 U	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	91-57-6	µg/L	2.7 (n)	NC	NA	1 U	NA	29	NA	1 U	1 U	NA	NA	NA	NA	NA	NA	NA

Source: TCE Comprehensive Investigation at the Organizational Maintenance Shop 28 (OMS-28), Alabama Army National Guard (AANG), 1622 South Broad Street, Mobile, Alabama, Groundwater Incident No. GW 07-01-02 (Aerostar 2007).

<sup>a</sup> Criteria for the direct contact exposure pathway for groundwater/tap water are from Table 2-2 of the Alabama Risk-Based Corrective Action Guidance Manual, April 2008.

<sup>b</sup> EPA RSLs dated May 2012. As per guidance from the Alabama Department of Environmental Management, EPA RSL values have been adjusted by 10 for non-carcinogens.

**Bold** values indicate a detected concentration.

**Red** values exceed the EPA tap water RSL.

**Teal shaded** values exceed an MCL.

(c) indicates risk = 1E-06 for carcinogens.

CAS = Chemical Abstracts Service.

EPA = U. S. Environmental Protection Agency.

MCL = Maximum contaminant level.

(n) indicates a hazard quotient = 0.1 for non-carcinogens.

NA = Not analyzed.

NC = No criteria.

NE = An RSL has not been established for this compound.

NS = TW-2 was not sampled because MW-5 was sampled in its place.

OMS = Organizational Maintenance Shop.

RSL = Regional screening level.

**Qualifiers:**

J = Indicates an estimated value.

U = Indicates the compound was analyzed for but not detected.

During the TCE CI in 2006, six confirmatory groundwater samples were collected from six locations (TW-1, TW-3, TW-4, TW-5, PZ-1, and PZ-2) and analyzed for VOCs. As part of the Phase I activities, eight groundwater samples were collected from eight direct-push borings (B-1/TW-6 through B-8/TW-13) to delineate the extent of TCE groundwater contamination at TW-4. As part of the Phase II activities, three additional temporary wells (B-9/TW-14, B-10/TW-15, and B-11/TW-16) were installed southwest of B-8, northwest of B-8, and northeast of B-2 to further delineate the TCE in groundwater. Based on the results of the Phase I and II activities, monitoring wells MW-9, MW-10, MW-11, and MW-12 were installed in October 2006. Groundwater samples were analyzed for either TCE only or full-suite VOCs. Thirteen VOCs (acetone; benzene; *cis*-1,2-DCE; cyclohexane; ethylbenzene; isopropylbenzene; methylene chloride; naphthalene; PCE; toluene; TCE; total xylenes, and vinyl chloride [VC]) were detected in the groundwater samples. The detected compounds are summarized in Table 4-4. The complete analytical results are provided in Appendix D of the TCE CI at OMS-28 (Aerostar 2007).

During the 2008 Supplemental CI, 12 groundwater samples were collected from 12 locations (MW-5, MW-6, MW-8, MW-9, MW-12, and OMS-28-1 through OMS-28-7) and analyzed for VOCs. Sixteen VOCs (1,2-dichloroethane; acetone; benzene; *cis*-1,2-DCE; chloroform; chloromethane; cyclohexane; isopropylbenzene; methylcyclohexane; methylene chloride; naphthalene; PCE; toluene; TCE; total xylenes; and *trans*-1,2-DCE) were detected in the groundwater samples. The detected compounds are summarized in Table 4-5. The complete analytical results are provided in Appendix E of the Supplemental CI Report for OMS-28 (Aerostar 2008a).

Following the CIs, compliance monitoring was conducted in December 2008, May 2009, September 2009, March 2010, and September 2010 to confirm trends in groundwater concentrations. Groundwater samples were collected from nine shallow monitoring wells (MW-5, MW-6, MW-8, MW-9, MW-12, OMS-28-2, OMS-28-3, OMS-28-5, and OMS-28-7) and three deep monitoring wells (OMS-28-1, OMS-28-4, and OMS-28-6) and analyzed for VOCs. In December 2008, eight VOCs (benzene; *cis*-1,2-DCE; cyclohexane; isopropylbenzene; naphthalene; PCE; TCE; and total xylenes) were detected in the groundwater samples. In May 2009, 10 VOCs (acetone; benzene; *cis*-1,2-DCE; chloroform; cyclohexane; isopropylbenzene; naphthalene; PCE; TCE; and *trans*-1,2-DCE) were detected in the groundwater samples. In September 2009, four VOCs (*cis*-1,2-DCE; chloroform; PCE; and TCE) were detected in the groundwater samples. In March 2010, six VOCs (acetone; benzene; *cis*-1,2-DCE; isopropylbenzene; PCE; and TCE) were detected in the groundwater samples. In September 2010, three VOCs (*cis*-1,2-DCE; PCE; and TCE) were detected in the groundwater samples. The detected compounds are summarized in Table 4-5. The complete analytical results are provided in Appendix B of the Supplemental CI Groundwater Monitoring Reports (Aerostar 2009a, 2009b, 2009c, 2010, and 2011a).

### 4.3 SCREENING EVALUATIONS

During the original TCE CI and the Supplemental CI, the analytical results were compared to the residential and commercial preliminary screening values (PSVs) for direct contact exposure pathways published in the *Alabama Risk-Based Corrective Action Guidance Manual* (ADEM 2008). The PSVs were published in the May 2006, June 2007, and April 2008 versions of the ARBCA Guidance Manual and were based on the EPA Region 9 PRGs as of May 2006.

ADEM is in the process of revising the PSVs based on EPA's regional screening levels (RSLs) but has not released final values of the PSVs as of early 2012 for use. In e-mail correspondence dated April 2, 2012, ADEM indicated to ALARNG that facilities are being allowed to use EPA RSLs in lieu of PSVs (ADEM 2012). Therefore, ALARNG is opting to re-screen the analytical results collected since 2006 and to use the residential and industrial EPA RSLs dated May 2012 for the screening evaluation. For non-carcinogenic compounds, the EPA RSLs have been adjusted by a factor of 10 to account for potential additive effects of multiple contaminants. For clarification, all references in this document to RSLs are in reference to the EPA RSLs dated May 2012, unless specified otherwise.

Table 4-5. Groundwater Analytical Results from the OMS-28 Supplemental Comprehensive Investigation and Monitoring Events (2008-2010)

Compound	CAS Number	Units	EPA RSL <sup>a,b</sup> Tap Water	MCL <sup>a</sup>	MW-5						MW-6						
					Supp CI	Event 1	Event 2	Event 3	Event 4	Event 5	Supp CI	Event 1	Event 2	Duplicate	Event 3	Event 4	Event 5
					07/01/08	12/11/08	05/08/09	09/24/09	03/18/10	09/07/10	07/01/08	12/11/08	05/08/09	05/08/09	09/24/09	03/18/10	09/07/10
<i>Volatile Organic Compounds (Detected Compounds)</i>																	
1,2-Dichloroethane	107-06-2	µg/L	0.15 (c)	5	0.0663 U	0.0898 U	0.0640 U	0.0640 U	0.0860 U	0.0860 U	<b>0.548 J</b>	0.0898 U	0.0640 U	0.0640 U	0.0640 U	0.0860 U	0.0860 U
Acetone	67-64-1	µg/L	1,200 (n)	NC	<b>7.80 J</b>	0.914 U	0.791 U	0.791 U	1.15 U	1.15 U	<b>3.17 J</b>	0.914 U	0.791 U	0.791 U	0.791 U	1.15 U	1.15 U
Benzene	71-43-2	µg/L	0.39 (c)	5	0.0624 U	0.0649 U	0.0747 U	0.0747 U	0.0542 U	0.0542 U	<b>16</b>	<b>11</b>	<b>5.55</b>	<b>5.67</b>	0.0747 U	<b>1.84 J</b>	0.0542 U
cis -1,2-Dichloroethene	156-59-2	µg/L	2.8 (n)	70	0.0745 U	0.162 U	0.103 U	0.103 U	0.0613 U	0.0613 U	0.0745 U	0.162 U	0.103 U	0.103 U	0.103 U	0.0613 U	0.0613 U
Chloroform	67-66-3	µg/L	0.19 (c)	80	0.0426 U	0.164 U	0.287 U	0.287 U	0.0565 U	0.0565 U	0.0426 U	0.164 U	0.287 U	0.287 U	0.287 U	0.0565 U	0.0565 U
Chloromethane (methyl chloride)	74-87-3	µg/L	19 (n)	NC	0.249 U	0.101 U	0.116 U	0.116 U	0.0886 U	0.0886 U	0.249 U	0.101 U	0.116 U	0.116 U	0.116 U	0.0886 U	0.0886 U
Cyclohexane	110-82-7	µg/L	1,300 (n)	NC	0.0722 U	0.105 U	0.0722 U	0.0722 U	0.0644 U	0.0644 U	<b>4.18 J</b>	<b>1.39 J</b>	<b>2.70 J</b>	<b>2.99 J</b>	0.0722 U	0.0644 U	0.0644 U
Isopropylbenzene (cumene)	98-82-8	µg/L	39 (n)	NC	0.0569 U	0.135 U	0.0708 U	0.0708 U	0.0347 U	0.0347 U	<b>5.33</b>	<b>4.06 J</b>	<b>3.41 J</b>	<b>3.40 J</b>	0.0708 U	<b>1.03 J</b>	0.0347 U
Methylcyclohexane	108-87-2	µg/L	NE	NC	0.0921 U	0.0754 U	0.0456 U	0.0456 U	0.0722 U	0.0722 U	<b>2.99 J</b>	0.0754 U	0.0456 U	0.0456 U	0.0456 U	0.0722 U	0.0722 U
Methylene Chloride	75-09-2	µg/L	9.9 (c)	5	0.0765 U	0.0959 U	0.142 U	0.142 U	0.327 U	0.327 U	0.0765 U	0.0959 U	0.142 U	0.142 U	0.142 U	0.327 U	0.327 U
Naphthalene	91-20-3	µg/L	0.14 (c)	NC	<b>4.64 J</b>	0.118 U	0.101 U	0.101 U	0.0817 U	0.0817 U	<b>28</b>	<b>21</b>	<b>11</b>	<b>11</b>	0.101 U	0.0817 U	0.0817 U
Tetrachloroethene	127-18-4	µg/L	9.7 (c)	5	0.200 U	0.153 U	0.0998 U	0.0998 U	0.121 U	0.121 U	0.200 U	0.153 U	0.0998 U	0.0998 U	0.0998 U	0.121 U	0.121 U
Toluene	108-88-3	µg/L	86 (n)	1,000	0.0675 U	0.0755 U	0.0820 U	0.0820 U	0.0590 U	0.0590 U	0.0675 U	0.0755 U	0.0820 U	0.0820 U	0.0820 U	0.0590 U	0.0590 U
Trichloroethene	79-01-6	µg/L	0.44 (c)	5	0.164 U	0.118 U	0.0974 U	0.0974 U	0.0618 U	0.0618 U	0.164 U	0.118 U	0.0974 U	0.0974 U	0.0974 U	0.0618 U	0.0618 U
trans -1,2-Dichloroethene	156-60-5	µg/L	8.6 (n)	100	0.0573 U	0.122 U	0.0955 U	0.0955 U	0.107 U	0.107 U	0.0573 U	0.122 U	0.0955 U	0.0955 U	0.0955 U	0.107 U	0.107 U
Vinyl Chloride	75-01-4	µg/L	0.015 (c)	2	0.0538 U	0.155 U	0.0767 U	0.0767 U	0.0930 U	0.0930 U	0.0538 U	0.155 U	0.0767 U	0.0767 U	0.0767 U	0.0930 U	0.0930 U
Xylenes (total)	1330-20-7	µg/L	19 (n)	10,000	0.194 U	0.183 U	0.334 U	0.334 U	0.0502 U	0.0502 U	<b>7.01 J</b>	<b>5.23 J</b>	0.334 U	0.334 U	0.334 U	0.0502 U	0.0502 U

Table 4-5. Groundwater Analytical Results from the OMS-28 Supplemental Comprehensive Investigation and Monitoring Events (2008-2010)

Compound	CAS Number	Units	EPA RSL <sup>a,b</sup> Tap Water	MCL <sup>a</sup>	MW-8									
					Supp CI	Duplicate	Event 1	Duplicate	Event 2	Event 3	Duplicate	Event 4	Event 5	Duplicate
					07/01/08	07/01/08	12/11/08	12/11/08	05/08/09	09/24/09	09/24/09	03/19/10	09/08/10	09/08/10
<i>Volatile Organic Compounds (Detected Compounds)</i>														
1,2-Dichloroethane	107-06-2	µg/L	0.15 (c)	5	0.0663 U	0.0663 U	0.0898 U	0.0898 U	0.0640 U	0.0640 U	0.0640 U	0.0860 U	0.0860 U	0.0860 U
Acetone	67-64-1	µg/L	1,200 (n)	NC	<b>11 J</b>	<b>4.33 J</b>	0.914 U	0.914 U	<b>6.17 J</b>	0.791 U	0.791 U	<b>22 J</b>	1.15 U	1.15 U
Benzene	71-43-2	µg/L	0.39 (c)	5	0.0624 U	0.0624 U	0.0649 U	0.0649 U	0.0747 U	0.0747 U	0.0747 U	0.0542 U	0.0542 U	0.0542 U
<i>cis</i> -1,2-Dichloroethene	156-59-2	µg/L	2.8 (n)	70	<b>3.397 J</b>	<b>4.37J</b>	<b>3.24 J</b>	<b>3.16 J</b>	<b>0.812 J</b>	0.103 U	0.103 U	<b>2.07 J</b>	0.0613 U	0.0613 U
Chloroform	67-66-3	µg/L	0.19 (c)	80	0.0426 U	0.0426 U	0.164 U	0.164 U	0.287 U	0.287 U	0.287 U	0.0565 U	0.0565 U	0.0565 U
Chloromethane (methyl chloride)	74-87-3	µg/L	19 (n)	NC	<b>2.10 J</b>	0.249 U	0.101 U	0.101 U	0.116 U	0.116 U	0.116 U	0.0886 U	0.0886 U	0.0886 U
Cyclohexane	110-82-7	µg/L	1,300 (n)	NC	0.0722 U	0.0722 U	0.105 U	0.105 U	0.0722 U	0.0722 U	0.0722 U	0.0644 U	0.0644 U	0.0644 U
Isopropylbenzene (cumene)	98-82-8	µg/L	39 (n)	NC	0.0569 U	0.0569 U	0.135 U	0.135 U	0.0708 U	0.0708 U	0.0708 U	0.0347 U	0.0347 U	0.0347 U
Methylcyclohexane	108-87-2	µg/L	NE	NC	0.0921 U	0.0921 U	0.0754 U	0.0754 U	0.0456 U	0.0456 U	0.0456 U	0.0722 U	0.0722 U	0.0722 U
Methylene Chloride	75-09-2	µg/L	9.9 (c)	5	0.0765 U	0.0765 U	0.0959 U	0.0959 U	0.142 U	0.142 U	0.142 U	0.327 U	0.327 U	0.327 U
Naphthalene	91-20-3	µg/L	0.14 (c)	NC	0.245 U	0.245 U	0.118 U	0.118 U	0.101 U	0.101 U	0.101 U	0.0817 U	0.0817 U	0.0817 U
Tetrachloroethene	127-18-4	µg/L	9.7 (c)	5	0.200 U	0.200 U	0.153 U	0.153 U	0.0998 U	0.0998 U	0.0998 U	0.121 U	0.121 U	0.121 U
Toluene	108-88-3	µg/L	86 (n)	1,000	0.0675 U	0.0675 U	0.0755 U	0.0755 U	0.0820 U	0.0820 U	0.0820 U	0.0590 U	0.0590 U	0.0590 U
Trichloroethene	79-01-6	µg/L	0.44 (c)	5	<b>133</b>	<b>129</b>	<b>46</b>	<b>46</b>	<b>18</b>	<b>8.41</b>	<b>8.52</b>	<b>41</b>	<b>13</b>	<b>13</b>
<i>trans</i> -1,2-Dichloroethene	156-60-5	µg/L	8.6 (n)	100	0.0573 U	0.0573 U	0.122 U	0.122 U	0.0955 U	0.0955 U	0.0955 U	0.107 U	0.107 U	0.107 U
Vinyl Chloride	75-01-4	µg/L	0.015 (c)	2	0.0538 U	0.0538 U	0.155 U	0.155 U	0.0767 U	0.0767 U	0.0767 U	0.0930 U	0.0930 U	0.0930 U
Xylenes (total)	1330-20-7	µg/L	19 (n)	10,000	0.194 U	0.194 U	0.183 U	0.183 U	0.334 U	0.334 U	0.334 U	0.0502 U	0.0502 U	0.0502 U

Table 4-5. Groundwater Analytical Results from the OMS-28 Supplemental Comprehensive Investigation and Monitoring Events (2008-2010)

Compound	CAS Number	Units	EPA RSL <sup>a,b</sup> Tap Water	MCL <sup>a</sup>	MW-9						MW-12					
					Supp CI	Event 1	Event 2	Event 3	Event 4	Event 5	Supp CI	Event 1	Event 2	Event 3	Event 4	Event 5
					07/01/08	12/10/08	05/08/09	09/24/09	03/18/10	09/08/10	07/01/08	12/10/08	05/08/09	09/24/09	03/18/10	09/07/10
<i>Volatile Organic Compounds (Detected Compounds)</i>																
1,2-Dichloroethane	107-06-2	µg/L	0.15 (c)	5	0.0663 U	0.0898 U	0.0640 U	0.0640 U	0.0860 U	0.0860 U	0.0663 U	0.0898 U	0.0640 U	0.0640 U	0.0860 U	0.0860 U
Acetone	67-64-1	µg/L	1,200 (n)	NC	<b>4.72 J</b>	0.914 U	0.791 U	0.791 U	1.15 U	1.15 U	<b>3.63 J</b>	0.914 U	0.791 U	0.791 U	1.15 U	1.15 U
Benzene	71-43-2	µg/L	0.39 (c)	5	0.0624 U	0.0649 U	0.0747 U	0.0747 U	0.0542 U	0.0542 U	0.0624 U	0.0649 U	0.0747 U	0.0747 U	0.0542 U	0.0542 U
<i>cis</i> -1,2-Dichloroethene	156-59-2	µg/L	2.8 (n)	70	0.0745 U	0.162 U	0.103 U	0.103 U	0.0613 U	0.0613 U	0.0745 U	0.162 U	0.103 U	0.103 U	0.0613 U	0.0613 U
Chloroform	67-66-3	µg/L	0.19 (c)	80	0.0426 U	0.164 U	0.287 U	0.287 U	0.0565 U	0.0565 U	0.0426 U	0.164 U	0.287 U	0.287 U	0.0565 U	0.0565 U
Chloromethane (methyl chloride)	74-87-3	µg/L	19 (n)	NC	0.249 U	0.101 U	0.116 U	0.116 U	0.0886 U	0.0886 U	0.249 U	0.101 U	0.116 U	0.116 U	0.0886 U	0.0886 U
Cyclohexane	110-82-7	µg/L	1,300 (n)	NC	0.0722 U	0.105 U	0.0722 U	0.0722 U	0.0644 U	0.0644 U	0.0722 U	0.105 U	0.0722 U	0.0722 U	0.0644 U	0.0644 U
Isopropylbenzene (cumene)	98-82-8	µg/L	39 (n)	NC	0.0569 U	0.135 U	0.0708 U	0.0708 U	0.0347 U	0.0347 U	0.0569 U	0.135 U	0.0708 U	0.0708 U	0.0347 U	0.0347 U
Methylcyclohexane	108-87-2	µg/L	NE	NC	0.0921 U	0.0754 U	0.0456 U	0.0456 U	0.0722 U	0.0722 U	0.0921 U	0.0754 U	0.0456 U	0.0456 U	0.0722 U	0.0722 U
Methylene Chloride	75-09-2	µg/L	9.9 (c)	5	0.0765 U	0.0959 U	0.142 U	0.142 U	0.327 U	0.327 U	0.0765 U	0.0959 U	0.142 U	0.142 U	0.327 U	0.327 U
Naphthalene	91-20-3	µg/L	0.14 (c)	NC	0.245 U	0.118 U	0.101 U	0.101 U	0.0817 U	0.0817 U	0.245 U	0.118 U	0.101 U	0.101 U	0.0817 U	0.0817 U
Tetrachloroethene	127-18-4	µg/L	9.7 (c)	5	0.200 U	0.153 U	0.0998 U	0.0998 U	0.121 U	0.121 U	0.200 U	0.153 U	0.0998 U	0.0998 U	0.121 U	0.121 U
Toluene	108-88-3	µg/L	86 (n)	1,000	0.0675 U	0.0755 U	0.0820 U	0.0820 U	0.0590 U	0.0590 U	0.0675 U	0.0755 U	0.0820 U	0.0820 U	0.0590 U	0.0590 U
Trichloroethene	79-01-6	µg/L	0.44 (c)	5	0.164 U	0.118 U	0.0974 U	0.0974 U	0.0618 U	0.0618 U	0.164 U	0.118 U	0.0974 U	0.0974 U	0.0618 U	0.0618 U
<i>trans</i> -1,2-Dichloroethene	156-60-5	µg/L	8.6 (n)	100	0.0573 U	0.122 U	0.0955 U	0.0955 U	0.107 U	0.107 U	0.0573 U	0.122 U	0.0955 U	0.0955 U	0.107 U	0.107 U
Vinyl Chloride	75-01-4	µg/L	0.015 (c)	2	0.0538 U	0.155 U	0.0767 U	0.0767 U	0.0930 U	0.0930 U	0.0538 U	0.155 U	0.0767 U	0.0767 U	0.0930 U	0.0930 U
Xylenes (total)	1330-20-7	µg/L	19 (n)	10,000	0.194 U	0.183 U	0.334 U	0.334 U	0.0502 U	0.0502 U	0.194 U	0.183 U	0.334 U	0.334 U	0.0502 U	0.0502 U

Table 4-5. Groundwater Analytical Results from the OMS-28 Supplemental Comprehensive Investigation and Monitoring Events (2008-2010)

Compound	CAS Number	Units	EPA RSL <sup>a,b</sup> Tap Water	MCL <sup>a</sup>	OMS-28-1 (Deep Well)							OMS-28-2						
					Supp CI	Duplicate	Event 1	Event 2	Duplicate	Event 3	Event 4	Event 5	Supp CI	Event 1	Event 2	Event 3	Event 4	Event 5
					07/08/08	07/08/08	12/11/08	05/08/09	05/08/09	09/24/09	03/18/10	09/07/10	07/01/08	12/10/08	05/08/09	09/24/09	03/18/10	09/07/10
<i>Volatile Organic Compounds (Detected Compounds)</i>																		
1,2-Dichloroethane	107-06-2	µg/L	0.15 (c)	5	0.0663 U	0.0663 U	0.0898 U	0.0640 U	0.0640 U	0.0640 U	0.0860 U	0.0860 U	0.0663 U	0.0898 U	0.0640 U	0.0640 U	0.0860 U	0.0860 U
Acetone	67-64-1	µg/L	1,200 (n)	NC	<b>9.05 J</b>	<b>6.78 J</b>	0.914 U	0.791 U	0.791 U	0.791 U	1.15 U	1.15 U	<b>3.38 J</b>	0.914 U	0.791 U	0.791 U	1.15 U	1.15 U
Benzene	71-43-2	µg/L	0.39 (c)	5	0.0624 U	0.0624 U	0.0649 U	0.0747 U	0.0747 U	0.0747 U	0.0542 U	0.0542 U	0.0624 U	0.0649 U	0.0747 U	0.0747 U	0.0542 U	0.0542 U
<i>cis</i> -1,2-Dichloroethene	156-59-2	µg/L	2.8 (n)	70	0.0745 U	0.0745 U	0.162 U	0.103 U	0.103 U	0.103 U	0.0613 U	0.0613 U	0.0745 U	0.162 U	0.103 U	0.103 U	0.0613 U	0.0613 U
Chloroform	67-66-3	µg/L	0.19 (c)	80	<b>44</b>	<b>45</b>	0.164 U	<b>3.33 J</b>	<b>3.38 J</b>	<b>0.582 J</b>	0.0565 U	0.0565 U	0.0426 U	0.164 U	0.287 U	0.287 U	0.0565 U	0.0565 U
Chloromethane (methyl chloride)	74-87-3	µg/L	19 (n)	NC	<b>1.51 J</b>	<b>1.84 J</b>	0.101 U	0.116 U	0.116 U	0.116 U	0.0886 U	0.0886 U	<b>1.11 J</b>	0.101 U	0.116 U	0.116 U	0.0886 U	0.0886 U
Cyclohexane	110-82-7	µg/L	1,300 (n)	NC	0.0722 U	0.0722 U	0.105 U	0.0722 U	0.0722 U	0.0722 U	0.0644 U	0.0644 U	0.0722 U	0.105 U	0.0722 U	0.0722 U	0.0644 U	0.0644 U
Isopropylbenzene (cumene)	98-82-8	µg/L	39 (n)	NC	0.0569 U	0.0569 U	0.135 U	0.0708 U	0.0708 U	0.0708 U	0.0347 U	0.0347 U	0.0569 U	0.135 U	0.0708 U	0.0708 U	0.0347 U	0.0347 U
Methylcyclohexane	108-87-2	µg/L	NE	NC	0.0921 U	0.0921 U	0.0754 U	0.0456 U	0.0456 U	0.0456 U	0.0722 U	0.0722 U	0.0921 U	0.0754 U	0.0456 U	0.0456 U	0.0722 U	0.0722 U
Methylene Chloride	75-09-2	µg/L	9.9 (c)	5	<b>9.05 J</b>	<b>9.07 J</b>	0.0959 U	0.142 U	0.142 U	0.142 U	0.327 U	0.327 U	0.0765 U	0.0959 U	0.142 U	0.142 U	0.327 U	0.327 U
Naphthalene	91-20-3	µg/L	0.14 (c)	NC	0.245 U	0.245 U	<b>4.51 J</b>	0.101 U	0.101 U	0.101 U	0.0817 U	0.0817 U	0.245 U	0.118 U	0.101 U	0.101 U	0.0817 U	0.0817 U
Tetrachloroethene	127-18-4	µg/L	9.7 (c)	5	0.200 U	0.200 U	0.153 U	0.0998 U	0.0998 U	0.0998 U	0.121 U	0.121 U	0.200 U	0.153 U	0.0998 U	0.0998 U	0.121 U	0.121 U
Toluene	108-88-3	µg/L	86 (n)	1,000	0.0675 U	<b>0.434 J</b>	0.0755 U	0.0820 U	0.0820 U	0.0820 U	0.0590 U	0.0590 U	0.0675 U	0.0755 U	0.0820 U	0.0820 U	0.0590 U	0.0590 U
Trichloroethene	79-01-6	µg/L	0.44 (c)	5	0.164 U	0.164 U	0.118 U	0.0974 U	0.0974 U	0.0974 U	0.0618 U	0.0618 U	0.164 U	0.118 U	0.0974 U	0.0974 U	<b>2.00 J</b>	0.0618 U
<i>trans</i> -1,2-Dichloroethene	156-60-5	µg/L	8.6 (n)	100	0.0573 U	0.0573 U	0.122 U	0.0955 U	0.0955 U	0.0955 U	0.107 U	0.107 U	0.0573 U	0.122 U	0.0955 U	0.0955 U	0.107 U	0.107 U
Vinyl Chloride	75-01-4	µg/L	0.015 (c)	2	0.0538 U	0.0538 U	0.155 U	0.0767 U	0.0767 U	0.0767 U	0.0930 U	0.0930 U	0.0538 U	0.155 U	0.0767 U	0.0767 U	0.0930 U	0.0930 U
Xylenes (total)	1330-20-7	µg/L	19 (n)	10,000	0.194 U	0.194 U	0.183 U	0.334 U	0.334 U	0.334 U	0.0502 U	0.0502 U	0.194 U	0.183 U	0.334 U	0.334 U	0.0502 U	0.0502 U



Table 4-5. Groundwater Analytical Results from the OMS-28 Supplemental Comprehensive Investigation and Monitoring Events (2008-2010)

Compound	CAS Number	Units	EPA RSL <sup>a,b</sup> Tap Water	MCL <sup>a</sup>	OMS-28-3							OMS-28-4 (Deep Well)							
					Supp CI	Event 1	Event 2	Event 3	Event 4	Duplicate	Event 5	Supp CI	Event 1	Duplicate	Event 2	Event 3	Duplicate	Event 4	Event 5
					07/01/08	12/11/08	05/08/09	09/24/09	03/19/10	03/19/10	09/08/10	07/08/08	12/10/08	12/10/08	05/08/09	09/24/09	09/24/09	03/19/10	09/08/10
<i>Volatile Organic Compounds (Detected Compounds)</i>																			
1,2-Dichloroethane	107-06-2	µg/L	0.15 (c)	5	0.0663 U	0.0898 U	0.0640 U	0.0640 U	0.0860 U	0.0860 U	0.0860 U	0.0663 U	0.0898 U	0.0898 U	0.0640 U	0.0640 U	0.0640 U	0.0860 U	0.0860 U
Acetone	67-64-1	µg/L	1,200 (n)	NC	<b>2.18 J</b>	0.914 U	0.791 U	0.791 U	<b>6.17 J</b>	<b>5.29 J</b>	1.15 U	<b>2.07 J</b>	0.914 U	0.914 U	0.791 U	0.791 U	0.791 U	<b>4.55 J</b>	1.15 U
Benzene	71-43-2	µg/L	0.39 (c)	5	0.0624 U	0.0649 U	0.0747 U	0.0747 U	0.0542 U	0.0542 U	0.0542 U	0.0624 U	0.0649 U	0.0649 U	0.0747 U	0.0747 U	0.0747 U	0.0542 U	0.0542 U
cis-1,2-Dichloroethene	156-59-2	µg/L	2.8 (n)	70	<b>6.26</b>	<b>9.34</b>	<b>9.55</b>	0.103 U	<b>1.37 J</b>	<b>1.21 J</b>	<b>9.43</b>	0.0745 U	0.162 U	0.162 U	0.103 U	0.103 U	0.103 U	0.0613 U	0.0613 U
Chloroform	67-66-3	µg/L	0.19 (c)	80	<b>0.252 J</b>	0.164 U	0.287 U	0.287 U	0.0565 U	0.0565 U	0.0565 U	<b>0.219 J</b>	0.164 U	0.164 U	0.287 U	0.287 U	0.287 U	0.0565 U	0.0565 U
Chloromethane (methyl chloride)	74-87-3	µg/L	19 (n)	NC	<b>0.835 J</b>	0.101 U	0.116 U	0.116 U	0.0886 U	0.0886 U	0.0886 U	0.249 U	0.101 U	0.101 U	0.116 U	0.116 U	0.116 U	0.0886 U	0.0886 U
Cyclohexane	110-82-7	µg/L	1,300 (n)	NC	0.0722 U	0.105 U	0.0722 U	0.0722 U	0.0644 U	0.0644 U	0.0644 U	0.0722 U	0.105 U	0.105 U	0.0722 U	0.0722 U	0.0722 U	0.0644 U	0.0644 U
Isopropylbenzene (cumene)	98-82-8	µg/L	39 (n)	NC	0.0569 U	0.135 U	0.0708 U	0.0708 U	0.0347 U	0.0347 U	0.0347 U	0.0569 U	0.135 U	0.135 U	0.0708 U	0.0708 U	0.0708 U	0.0347 U	0.0347 U
Methylcyclohexane	108-87-2	µg/L	NE	NC	0.0921 U	0.0754 U	0.0456 U	0.0456 U	0.0722 U	0.0722 U	0.0722 U	0.0921 U	0.0754 U	0.0754 U	0.0456 U	0.0456 U	0.0456 U	0.0722 U	0.0722 U
Methylene Chloride	75-09-2	µg/L	9.9 (c)	5	0.0765 U	0.0959 U	0.142 U	0.142 U	0.327 U	0.327 U	0.327 U	0.0765 U	0.0959 U	0.0959 U	0.142 U	0.142 U	0.142 U	0.327 U	0.327 U
Naphthalene	91-20-3	µg/L	0.14 (c)	NC	0.245 U	0.118 U	0.101 U	0.101 U	0.0817 U	0.0817 U	0.0817 U	0.245 U	0.118 U	0.118 U	0.101 U	0.101 U	0.101 U	0.0817 U	0.0817 U
Tetrachloroethene	127-18-4	µg/L	9.7 (c)	5	0.200 U	0.153 U	0.0998 U	0.0998 U	0.121 U	0.121 U	0.121 U	0.200 U	0.153 U	0.153 U	0.0998 U	0.0998 U	0.0998 U	0.121 U	0.121 U
Toluene	108-88-3	µg/L	86 (n)	1,000	0.0675 U	0.0755 U	0.0820 U	0.0820 U	0.0590 U	0.0590 U	0.0590 U	0.0675 U	0.0755 U	0.0755 U	0.0820 U	0.0820 U	0.0820 U	0.0590 U	0.0590 U
Trichloroethene	79-01-6	µg/L	0.44 (c)	5	<b>80</b>	<b>94</b>	<b>29</b>	<b>15.29</b>	<b>12</b>	<b>13</b>	<b>149</b>	0.164 U	0.118 U	0.118 U	0.0974 U	0.0974 U	0.0974 U	0.0618 U	0.0618 U
trans-1,2-Dichloroethene	156-60-5	µg/L	8.6 (n)	100	0.0573 U	0.122 U	0.0955 U	0.0955 U	0.107 U	0.107 U	0.107 U	0.0573 U	0.122 U	0.122 U	0.0955 U	0.0955 U	0.0955 U	0.107 U	0.107 U
Vinyl Chloride	75-01-4	µg/L	0.015 (c)	2	0.0538 U	0.155 U	0.0767 U	0.0767 U	0.0930 U	0.0930 U	0.0930 U	0.0538 U	0.155 U	0.155 U	0.0767 U	0.0767 U	0.0767 U	0.0930 U	0.0930 U
Xylenes (total)	1330-20-7	µg/L	19 (n)	10,000	0.194 U	0.183 U	0.334 U	0.334 U	0.0502 U	0.0502 U	0.0502 U	0.194 U	0.183 U	0.183 U	0.334 U	0.334 U	0.334 U	0.0502 U	0.0502 U

Table 4-5. Groundwater Analytical Results from the OMS-28 Supplemental Comprehensive Investigation and Monitoring Events (2008-2010)

Compound	CAS Number	Units	EPA RSL <sup>a,b</sup> Tap Water	MCL <sup>a</sup>	OMS-28-5					OMS-28-6 (Deep Well)						
					Supp CI	Event 1	Event 2	Event 3	Event 4	Event 5	Supp CI	Event 1	Event 2	Event 3	Event 4	Event 5
					07/01/08	12/11/08	05/08/09	09/24/09	03/19/10	09/08/10	07/08/08	12/10/08	05/08/09	09/24/09	03/18/10	09/08/10
<i>Volatile Organic Compounds (Detected Compounds)</i>																
1,2-Dichloroethane	107-06-2	µg/L	0.15 (c)	5	0.0663 U	0.0898 U	0.0640 U	0.0640 U	0.0860 U	0.0860 U	0.0663 U	0.0898 U	0.0640 U	0.0640 U	0.0860 U	0.0860 U
Acetone	67-64-1	µg/L	1,200 (n)	NC	<b>3.55 J</b>	0.914 U	0.791 U	0.79 U	<b>11 J</b>	1.15 U	<b>3.05 J</b>	0.914 U	0.791 U	0.791 U	1.15 U	1.15 U
Benzene	71-43-2	µg/L	0.39 (c)	5	0.0624 U	0.0649 U	0.0747 U	0.0747 U	0.0542 U	0.0542 U	0.0624 U	0.0649 U	0.0747 U	0.0747 U	0.0542 U	0.0542 U
<i>cis</i> -1,2-Dichloroethene	156-59-2	µg/L	2.8 (n)	70	<b>12</b>	<b>8.7</b>	<b>20</b>	<b>9.12</b>	<b>6.3</b>	<b>8.69</b>	0.0745 U	0.162 U	0.103 U	0.103 U	0.0613 U	0.0613 U
Chloroform	67-66-3	µg/L	0.19 (c)	80	0.0426 U	0.164 U	0.287 U	0.287 U	0.0565 U	0.0565 U	0.0426 U	0.164 U	0.287 U	0.287 U	0.0565 U	0.0565 U
Chloromethane (methyl chloride)	74-87-3	µg/L	19 (n)	NC	0.249 U	0.101 U	0.116 U	0.116 U	0.0886 U	0.0886 U	0.249 U	0.101 U	0.116 U	0.116 U	0.0886 U	0.0886 U
Cyclohexane	110-82-7	µg/L	1,300 (n)	NC	0.0722 U	0.105 U	0.0722 U	0.0722 U	0.0644 U	0.0644 U	0.0722 U	0.105 U	0.0722 U	0.0722 U	0.0644 U	0.0644 U
Isopropylbenzene (cumene)	98-82-8	µg/L	39 (n)	NC	0.0569 U	0.135 U	0.0708 U	0.0708 U	0.0347 U	0.0347 U	0.0569 U	0.135 U	0.0708 U	0.0708 U	0.0347 U	0.0347 U
Methylcyclohexane	108-87-2	µg/L	NE	NC	0.0921 U	0.0754 U	0.0456 U	0.0456 U	0.0722 U	0.0722 U	0.0921 U	0.0754 U	0.0456 U	0.0456 U	0.0722 U	0.0722 U
Methylene Chloride	75-09-2	µg/L	9.9 (c)	5	0.0765 U	0.0959 U	0.142 U	0.142 U	0.327 U	0.327 U	0.0765 U	0.0959 U	0.142 U	0.142 U	0.327 U	0.327 U
Naphthalene	91-20-3	µg/L	0.14 (c)	NC	0.245 U	0.118 U	0.101 U	0.101 U	0.0817 U	0.0817 U	0.245 U	0.118 U	0.101 U	0.101 U	0.0817 U	0.0817 U
Tetrachloroethene	127-18-4	µg/L	9.7 (c)	5	<b>130</b>	<b>9.2</b>	<b>234</b>	<b>8.02</b>	<b>81</b>	<b>33</b>	0.200 U	0.153 U	0.0998 U	0.0998 U	0.121 U	0.121 U
Toluene	108-88-3	µg/L	86 (n)	1,000	0.0675 U	0.0755 U	0.0820 U	0.0820 U	0.0590 U	0.0590 U	0.0675 U	0.0755 U	0.0820 U	0.0820 U	0.0590 U	0.0590 U
Trichloroethene	79-01-6	µg/L	0.44 (c)	5	<b>39</b>	<b>14</b>	<b>162</b>	<b>11</b>	<b>51</b>	<b>19</b>	0.164 U	0.118 U	0.0974 U	0.0974 U	0.0618 U	0.0618 U
<i>trans</i> -1,2-Dichloroethene	156-60-5	µg/L	8.6 (n)	100	<b>5</b>	0.122 U	<b>2.41 J</b>	0.0955 U	0.107 U	0.107 U	0.0573 U	0.122 U	0.0955 U	0.0955 U	0.107 U	0.107 U
Vinyl Chloride	75-01-4	µg/L	0.015 (c)	2	0.0538 U	0.155 U	0.0767 U	0.0767 U	0.0930 U	0.0930 U	0.0538 U	0.155 U	0.0767 U	0.0767 U	0.0930 U	0.0930 U
Xylenes (total)	1330-20-7	µg/L	19 (n)	10,000	0.194 U	0.183 U	0.334 U	0.334 U	0.0502 U	0.0502 U	0.194 U	0.183 U	0.334 U	0.334 U	0.0502 U	0.0502 U

Table 4-5. Groundwater Analytical Results from the OMS-28 Supplemental Comprehensive Investigation and Monitoring Events (2008-2010)

Compound	CAS Number	Units	EPA RSL <sup>a,b</sup> Tap Water	MCL <sup>a</sup>	OMS-28-7					
					Supp CI	Event 1	Event 2	Event 3	Event 4	Event 5
					07/01/08	12/10/08	05/08/09	09/24/09	03/18/10	09/08/10
<b>Volatile Organic Compounds (Detected Compounds)</b>										
1,2-Dichloroethane	107-06-2	µg/L	0.15 (c)	5	0.0663 U	0.0898 U	0.0640 U	0.0640 U	0.0860 U	0.0860 U
Acetone	67-64-1	µg/L	1,200 (n)	NC	<b>4.87 J</b>	0.914 U	0.791 U	0.791 U	1.15 U	1.15 U
Benzene	71-43-2	µg/L	0.39 (c)	5	0.0624 U	0.0649 U	0.0747 U	0.0747 U	0.0542 U	0.0542 U
cis -1,2-Dichloroethene	156-59-2	µg/L	2.8 (n)	70	0.0745 U	0.162 U	0.103 U	0.103 U	0.0613 U	0.0613 U
Chloroform	67-66-3	µg/L	0.19 (c)	80	0.0426 U	0.164 U	0.287 U	0.287 U	0.0565 U	0.0565 U
Chloromethane (methyl chloride)	74-87-3	µg/L	19 (n)	NC	0.249 U	0.101 U	0.116 U	0.116 U	0.0886 U	0.0886 U
Cyclohexane	110-82-7	µg/L	1,300 (n)	NC	0.0722 U	0.105 U	0.0722 U	0.0722 U	0.0644 U	0.0644 U
Isopropylbenzene (cumene)	98-82-8	µg/L	39 (n)	NC	0.0569 U	0.135 U	0.0708 U	0.0708 U	0.0347 U	0.0347 U
Methylcyclohexane	108-87-2	µg/L	NE	NC	0.0921 U	0.0754 U	0.0456 U	0.0456 U	0.0722 U	0.0722 U
Methylene Chloride	75-09-2	µg/L	9.9 (c)	5	0.0765 U	0.0959 U	0.142 U	0.142 U	0.327 U	0.327 U
Naphthalene	91-20-3	µg/L	0.14 (c)	NC	0.245 U	<b>4.28 J</b>	0.101 U	0.101 U	0.0817 U	0.0817 U
Tetrachloroethene	127-18-4	µg/L	9.7 (c)	5	0.200 U	0.153 U	0.0998 U	0.0998 U	0.121 U	0.121 U
Toluene	108-88-3	µg/L	86 (n)	1,000	0.0675 U	0.0755 U	0.0820 U	0.0820 U	0.0590 U	0.0590 U
Trichloroethene	79-01-6	µg/L	0.44 (c)	5	<b>1.73 J</b>	0.118 U	<b>0.684 J</b>	0.0974 U	0.0618 U	0.0618 U
trans -1,2-Dichloroethene	156-60-5	µg/L	8.6 (n)	100	0.0573 U	0.122 U	0.0955 U	0.0955 U	0.107 U	0.107 U
Vinyl Chloride	75-01-4	µg/L	0.015 (c)	2	0.0538 U	0.155 U	0.0767 U	0.0767 U	0.0930 U	0.0930 U
Xylenes (total)	1330-20-7	µg/L	19 (n)	10,000	0.194 U	0.183 U	0.334 U	0.334 U	0.0502 U	0.0502 U

Source: Supplemental Comprehensive Investigation Report for the Alabama Army National Guard (AANG), Organizational Maintenance Shop 28 (OMS-28), 1622 South Broad Street, Mobile, Alabama, Groundwater Incident No. GW 07-01-02 (Aerostar 2008).

<sup>a</sup> EPA tap water RSLs and MCLs are being used in lieu of Alabama PSVs published in the Alabama Risk-Based Corrective Action Guidance Manual (2008) as per April 2, 2012, e-mail correspondence between the Alabama Department of Environmental Management (ADEM) and the Alabama Army National Guard.

<sup>b</sup> EPA RSLs dated May 2012. As per guidance from ADEM, EPA RSL values have been adjusted by 10 for non-carcinogens.

**Bold** values indicate a detected concentration.

**Red** values exceed the EPA tap water RSL.

**Teal shaded** values exceed an MCL.

(c) indicates risk = 1E-06 for carcinogens.

CAS = Chemical Abstracts Service.

EPA = U. S. Environmental Protection Agency.

MCL = Maximum contaminant level.

(n) indicates a hazard quotient = 0.1 for non-carcinogens.

NC = No criteria.

NE = An RSL has not been established for this compound.

OMS = Organizational Maintenance Shop.

PSV = Preliminary screening value.

RSL = Regional screening level.

Supp CI = Supplemental comprehensive investigation.

Qualifiers:

J = Indicates an estimated value.

U = Indicates the compound was analyzed for but not detected.

### 4.3.1 Soil

For the VOCs, the concentrations of all detected VOCs were less than their respective residential and industrial RSLs.

For SVOCs, four PAHs (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, and indeno[1,2,3-cd]pyrene) were the contaminants that exceeded their respective residential and commercial PSVs and residential and industrial RSLs. However, all PAH detections were in surface soil and were outside the boundary of the ALARNG property and are not thought to be attributable to ALARNG activities.

### 4.3.2 Groundwater

In 2005, as part of the UST monitoring program, 1,2,3-trimethylbenzene; 1,2,4-trimethylbenzene; 1-methylnaphthalene; and 2-methylnaphthalene exceeded the EPA tap water RSL in MW-6.

During the TCE CI in 2006, the concentrations of benzene; *cis*-1,2-DCE; ethylbenzene; naphthalene; TCE; VC; and total xylenes exceeded their respective EPA tap water RSL. The concentrations of benzene and TCE exceeded their respective MCL. The concentrations of TCE exceeding the MCL were observed in temporary wells TW-6, TW-7, TW-8, TW-11, and TW-13 and in permanent wells MW-8, MW-10, and MW-11. The concentration of benzene exceeding the MCL and the concentration of naphthalene exceeding the EPA tap water RSL were limited to MW-6, which is downgradient of the former UST and upgradient of the chlorinated solvents plume. The concentrations of benzene and naphthalene were below the site-specific target levels (SSTLs) developed under the UST program.

During the 2008 supplemental CI, the concentrations of 1,2-dichloroethane; benzene; *cis*-1,2-DCE; chloroform; naphthalene; PCE; and TCE exceeded their respective EPA tap water RSLs. The concentrations of benzene in well MW-6; methylene chloride in well OMS-28-1; PCE in well OMS-28-5; and TCE in wells MW-8, OMS-28-3, and OMS-28-5 exceeded their respective MCLs. Benzene has been below the MCL in MW-6 since September 2009. The methylene chloride exceedence of the MCL in deep monitoring well OMS-28-1 occurred in July 2008; however, there have been five sampling events of non-detects since that sampling event.

During the fifth compliance monitoring event in September 2010, the concentrations of PCE and TCE exceeded their respective MCLs. The concentrations of *cis*-1,2-DCE; PCE; and TCE exceeded their respective EPA tap water RSLs.

## 4.4 NATURE AND EXTENT OF CONTAMINATION

### 4.4.1 Soil

The PAHs were observed in samples from 0 to 1 ft BGS in borings B-13, B-14, B-15, and B-16. These borings are located over 200 ft west and northwest of MW-8 in the wooded areas of the property adjacent to ALARNG. Because these were the only borings with samples analyzed for SVOCs, it is difficult to determine the spatial distribution. There does not appear to be any vertical distribution with depth. The results are presented in Figure 4-4. PAHs are common contaminants at many hazardous waste sites because they were used during or generated from site-related activities. However, PAHs also may be present in background soil because they are found in vehicle exhaust, asphalt pavement, and combustion particles. OMS-28 is a maintenance facility and vehicles are parked in the grassy area south of MW-8 along the property line. B-16 is located adjacent to the Interstate 10 service road near Duval Street. PAHs are eliminated as contaminants of concern (COCs) because the concentrations were below the SSTLs developed under the UST program.

Fifteen VOCs (2-butanone; acetone; bromomethane; carbon disulfide; chloroform; *cis*-1,2-DCE; isopropylbenzene; methyl acetate; methylcyclohexane; methylene chloride; naphthalene; PCE; toluene; TCE; and trichlorofluoromethane) were detected sporadically in the 61 soil samples across the 27 locations with no discernible trends between 2006 and 2008. The concentrations of constituents were below their respective residential and industrial EPA RSLs (May 2012). The concentrations of four VOCs (*cis*-1,2-DCE; methylene chloride; PCE; and TCE) exceeded their respective protection of groundwater MCL-based soil screening level (SSL)

- *cis*-1,2-DCE exceeded the SSL of 0.021 mg/kg in borings HA-06 (0.046 mg/kg at 8 to 10 ft BGS) and HA-15 (0.036 mg/kg at 8 to 10 ft BGS).
- Methylene chloride exceeded the SSL of 0.0013 mg/kg in borings HA-02 (0.130 mg/kg at 0 to 1 ft BGS), HA-05 (0.096J mg/kg at 7 to 9 ft BGS), HA-07 (0.061J mg/kg at 8 to 10 ft BGS), HA-08 (0.106J mg/kg at 8 to 10 ft BGS), and HA-09 (0.117J mg/kg at 8 to 10 ft BGS).
- PCE exceeded the SSL of 0.0023 mg/kg in borings HA-05 (0.00252J mg/kg at 0 to 1 ft BGS), HA-07 (0.00253J mg/kg at 0 to 1 ft BGS), HA-13 (0.00505J mg/kg at 8 to 10 ft BGS), and B-17 (0.933 mg/kg at 0 to 1 ft BGS and 0.186 mg/kg at 8 to 10 ft BGS).
- TCE exceeded the SSL of 0.0018 mg/kg in borings HA-01 (0.00311J mg/kg at 0 to 1 ft BGS and 0.017 mg/kg at 6 to 8 ft BGS), HA-02 (0.241J mg/kg at 0 to 1 ft BGS and 0.027 mg/kg at 8 to 10 ft BGS), HA-03 (0.019J mg/kg at 0 to 1 ft BGS and 0.00353J mg/kg at 8 to 10 ft BGS), HA-06 (0.15 mg/kg at 8 to 10 ft BGS), HA-07 (0.069J mg/kg at 8 to 10 ft BGS), HA-08 (0.00286J mg/kg at 0 to 1 ft BGS), HA-12 (0.00353J mg/kg at 8 to 10 ft BGS), HA-14 (0.017 mg/kg at 0 to 1 ft BGS and 0.00962 mg/kg at 8 to 10 ft BGS), HA-15 (0.586 mg/kg at 0 to 1 ft BGS and 0.132J mg/kg at 8 to 10 ft BGS), B-13 (0.0171 mg/kg at 0 to 1 ft BGS), OMS-28-3 (0.211J mg/kg at 10 to 15 ft BGS), OMS-28-4 (0.027 mg/kg at 10 to 15 ft BGS), OMS-28-5 (0.00783J mg/kg at 15 to 20 ft BGS), and OMS-28-6 (0.076 mg/kg at 5 to 10 ft BGS and 0.107J mg/kg at 10 to 15 ft BGS).

TCE is the contaminant in soil that most frequently exceeds the protection of groundwater SSL, with detections in both unsaturated and saturated soil samples. The majority of these borings exceeding the SSL are located in the vicinity of well MW-8. According to the boring logs, depth to water encountered during drilling of the various OMS-28-x wells ranged from 12 to 15 ft BGS. Any soil samples collected close to or below 15 ft BGS were most likely saturated soil samples, and it is uncertain how much of the contaminated groundwater contributed to the detections exceeding the protection of groundwater SSL. However, soil samples between 0 and 15 ft BGS in HA-01, HA-02, HA-03, HA-07, HA-08, HA-12, HA-14, HA-15, and OMS-28-06 in the vicinity of MW-8 exceeded the TCE protection of groundwater SSL, thus indicating that there is sufficient contaminant mass tied up in the soil matrix to be leaching to groundwater with precipitation events. In addition, there is an isolated detection from the 0 to 1-ft interval in B-13 where the sample exceeded the TCE protection of groundwater SSL.

PCE is second most frequently detected contaminant in soil that exceeds the protection of groundwater SSL, with detections in both unsaturated and saturated soil samples. The borings are located in the vicinity of well MW-8 and boring B-17. The latter location is not associated with OMS-28 but is located on MAA property approximately 200 ft northwest of well MW-8.

Methylene chloride and *cis*-1,2-DCE were predominately detected at concentrations above their respective SSLs in saturated soil samples collected below the water table. Although methylene chloride is detected at a similar frequency as PCE, it is a common laboratory contaminant and has not been typically observed in the groundwater at the site, with the exception of detections in a deep well and a temporary piezometer. For the samples collected in the vicinity of MW-8 with *cis*-1,2-DCE concentrations exceeding the SSL, it is uncertain how much of the contaminated groundwater contributed to the exceedence.

There are three areas of soil contamination that may be acting as a residual source for the groundwater plumes. The largest area of soil contamination is located on OMS-28 property in the vicinity of MW-8, and the area exceeding the protection of groundwater SSL for TCE is approximately 60 by 60 ft, as shown on Figure 4-5. The vertical extent of contamination is located throughout the unsaturated zone from ground surface to the water table observed during drilling at approximately 15 ft BGS. A smaller isolated area of PCE soil contamination is located on MAA property approximately 200 ft northwest of MW-8 at soil sample location B-17 and is estimated to be 15 by 20 ft, as shown on Figure 4-5. The vertical extent of PCE contamination in the vicinity of B-17 extends to at least 10 ft BGS; however, it probably extends deeper as the vertical extent was not delineated in B-17. In addition, there is a small isolated area of TCE surface soil contamination located on MAA property approximately 240 ft west of MW-8 at soil sample location B-13 that is estimated to be 15 by 15 ft, as shown on Figure 4-5. The vertical extent of contamination at B-13 does not extend any deeper than 6 ft BGS. The TCE and PCE analytical results for soil are presented in Figure 4-5.

#### 4.4.2 Groundwater

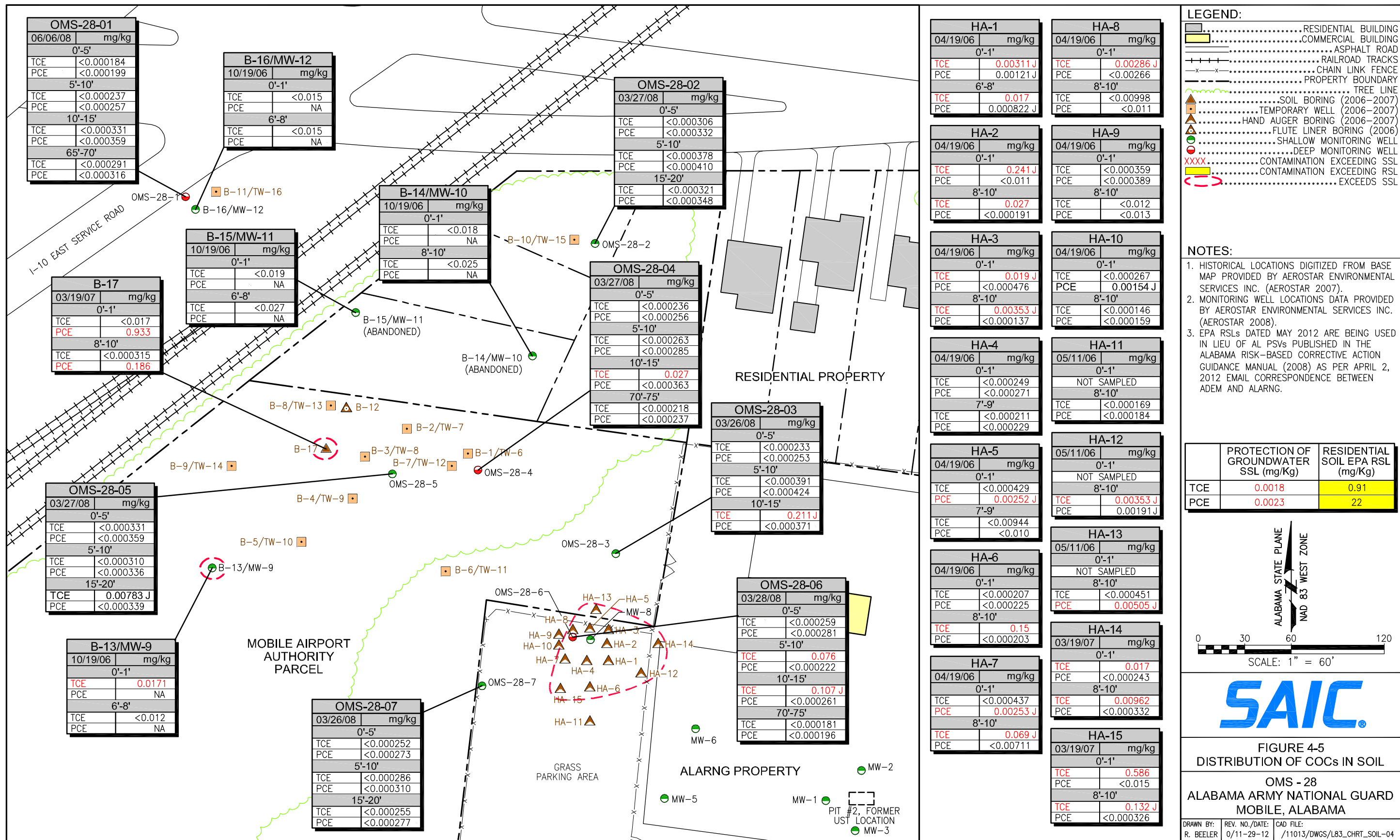
Based on the screening evaluation discussed in Section 4.3.2, the primary COCs exceeding the MCLs are TCE and PCE. Benzene is not considered a COC in the vicinity of the TCE plume area because it has been non-detect in all of the TCE compliance monitoring wells except for MW-6 and below the MCL in MW-6 since May 2009. Methylene chloride is not considered a COC in the vicinity of the TCE plume area because it was only detected above the MCL in deep well OMS-28-1 during one sampling event and has been below the MCL since December 2008. This section focuses on the TCE and PCE detections.

In July 2008, TCE was detected in four shallow wells: MW-8 (133 µg/L), OMS-28-3 (80 µg/L), OMS-28-5 (390 µg/L), and OMS-28-7 (1.73J µg/L). TCE was not detected in the remaining shallow wells (MW-5, MW-6, MW-9, MW-12, and OMS-28-2), which delineate the horizontal extent of the plume boundary. TCE was not detected in the three deep wells (OMS-28-1, OMS-28-4, and OMS-28-6), thus indicating that TCE has not migrated vertically through the clay. The TCE concentration observed in MW-8 had decreased since TCE was originally found in the well in March 2005 (460 µg/L). PCE was detected in one shallow well (OMS-28-5 [139 µg/L]). PCE was not detected in the other shallow wells or in the deep wells.

In December 2008, TCE was detected in three shallow wells: MW-8 (46 µg/L), OMS-28-3 (94 µg/L), and OMS-28-5 (14 µg/L). TCE was not detected in the remaining shallow wells (MW-5, MW-6, MW-9, MW-12, OMS-28-2, and OMS-28-7), which delineate the horizontal extent of the plume boundary. TCE was not detected in the three deep wells (OMS-28-1, OMS-28-4, and OMS-28-6). PCE was detected in one shallow well (OMS-28-5 [9.2 µg/L]). PCE was not detected in the other shallow wells or in the deep wells.

In May 2009, TCE was detected in four shallow wells: MW-8 (18 µg/L), OMS-28-3 (29 µg/L), OMS-28-5 (162 µg/L), and OMS-28-7 (0.0684J µg/L). TCE was not detected in the remaining shallow wells (MW-5, MW-6, MW-9, MW-12, and OMS-28-2), which delineate the horizontal extent of the plume boundary. TCE was not detected in the three deep wells (OMS-28-1, OMS-28-4, and OMS-28-6). PCE was detected in one shallow well (OMS-28-5 [234 µg/L]). PCE was not detected in the other shallow wells or in the deep wells.

In September 2009, TCE was detected in three shallow wells: MW-8 (8.41 µg/L), OMS-28-3 (15.29 µg/L), and OMS-28-5 (11µg/L). TCE was not detected in the remaining shallow wells (MW-5, MW-6, MW-9, MW-12, OMS-28-2, and OMS-28-7), which delineate the horizontal extent of the plume boundary. TCE was not detected in the three deep wells (OMS-28-1, OMS-28-4, and OMS-28-6). PCE was detected in one shallow well (OMS-28-5 [8.02 µg/L]). PCE was not detected in the other shallow wells or in the deep wells.



In March 2010, TCE was detected in three shallow wells: MW-8 (41 µg/L), OMS-28-3 (12 µg/L), and OMS-28-5 (51 µg/L). OMS-28-2, which is located at the northern extent of the site, exhibited an estimated detection of 2J µg/L. This appears to be an anomaly in the sampling data as TCE or any other halogenated compound has never been detected in this well. TCE was not detected in the remaining shallow wells (MW-5, MW-6, MW-9, MW-12, and OMS-28-7), which delineate the horizontal extent of the plume boundary. TCE was not detected in the three deep wells (OMS-28-1, OMS-28-4, and OMS-28-6). PCE was detected in one shallow well (OMS-28-5 [81 µg/L]). PCE was not detected in the other shallow wells or in the deep wells.

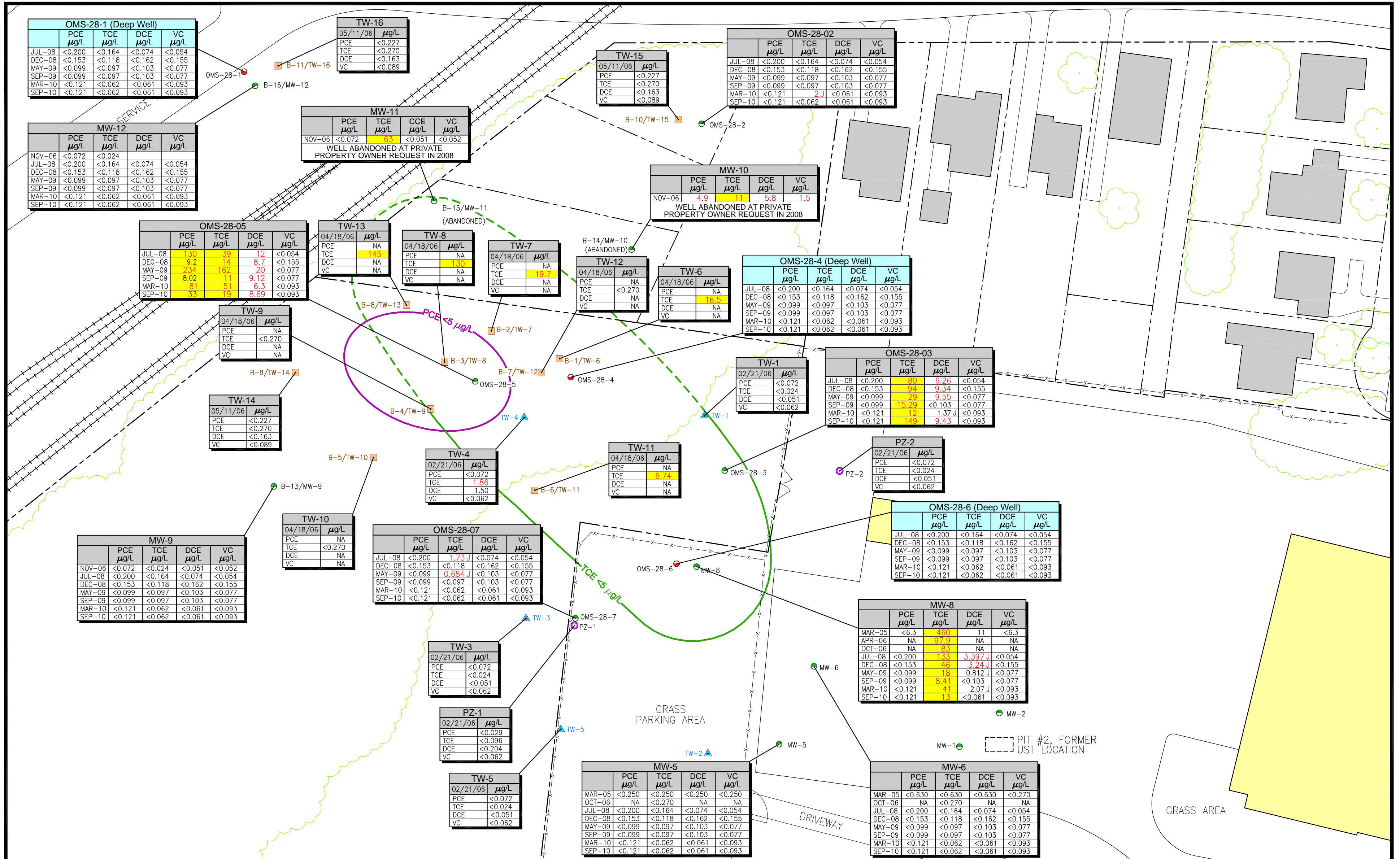
In September 2010, TCE was detected in three shallow wells: MW-8 (13 µg/L), OMS-28-3 (149 µg/L), and OMS-28-5 (19 µg/L). TCE was not detected in the remaining shallow wells (MW-5, MW-6, MW-9, MW-12, OMS-28-2, and OMS-28-7), which delineate the horizontal extent of the plume boundary. TCE was not detected in the three deep wells (OMS-28-1, OMS-28-4, and OMS-28-6). PCE was detected in one shallow well (OMS-28-5 [33 µg/L]). PCE was not detected in the other shallow wells or in the deep wells.

Sixteen other VOCs (1,2-dichloroethane; acetone; benzene; *cis*-1,2-DCE; chloroform; chloromethane; cyclohexane; ethylbenzene; isopropylbenzene; methylcyclohexane; methylene chloride; naphthalene; toluene; total xylenes; *trans*-1,2-DCE; and VC) were detected in groundwater during the investigations from 2006 through 2008. Benzene was previously considered as a COC as part of the UST monitoring program. In the vicinity of the TCE plume, benzene has been non-detect in all of the TCE compliance monitoring wells except for MW-6. Since May 2009, benzene has been below the MCL in MW-6 and, as a result, it is not considered a COC under the TCE investigation. The concentrations of 1,2-dichloroethane; benzene; *cis*-1,2-DCE; chloroform; ethylbenzene; naphthalene; VC; and total xylenes exceeded their respective EPA tap water RSLs. However, by September 2010, none of these other VOCs exceeded their EPA tap water RSLs, and only the concentration of *cis*-1,2-DCE exceeded the EPA tap water RSL but was below the MCL.

Based on the results of the September 2010 sampling event and the 2006 Phase I and II temporary wells, there appears to be a TCE plume and a PCE plume (Figure 4-6). The PCE and TCE plume boundaries have been delineated by the non-detect values in wells MW-5, MW-6, MW-9, MW-12, OMS-28-2, and OMS-28-7. Wells MW-5 and MW-6 are located to the southeast of MW-8 and are upgradient of the TCE/PCE source area. Wells MW-9 and OMS-28-7 are located to the west of the existing TCE plume. Wells MW-12 and MW-28-2 are located to the northwest and north of the site, respectively, and are downgradient of the plumes. The PCE may have already degraded in the vicinity of MW-8 and is no longer being observed in that part of the TCE plume.

The estimated dimension of the groundwater TCE plume is 320 by 120 ft and of the PCE plume is 100 by 65 ft and both are illustrated on Figure 4-6. The estimated length of the TCE plume does not account for biodegradation of TCE that has been occurring in the subsurface; however, MW-11 was abandoned at the private property owner's request and, therefore, the well has not been resampled to verify that the TCE concentrations have decreased. Based on the depth of the screens in the shallow wells, the vertical depth of the plumes extends to approximately 20 ft BGS. However, the possibility exists that the plume may extend to the top of the stiff clay, which is 30 to 35 ft BGS. The TCE plume is an elliptical feature oriented to the northwest from the larger area of soil contamination centered around MW-8 on OMS-28 property onto MAA property to the west. The PCE plume is an elliptical feature oriented to the northwest located near the smaller area of soil contamination in the vicinity of B-17 on the MAA property.





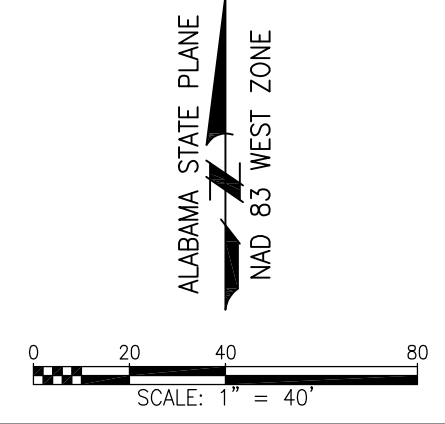
**LEGEND:**

- RESIDENTIAL BUILDING
- COMMERCIAL BUILDING
- ASPHALT ROAD
- RAILROAD TRACKS
- CHAIN LINK FENCE
- PROPERTY BOUNDARY
- TREE LINE
- TEMPORARY WELL (2006-2007)
- ABANDONED TEMPORARY WELL (2005)
- ABANDONED PIEZOMETER (2006)
- SHALLOW MONITORING WELL
- DEEP MONITORING WELL
- TCE PLUME BOUNDARY (SEPT 2010)
- PCE PLUME BOUNDARY (SEPT 2010)
- CONTAMINATION EXCEEDING RSL
- CONTAMINATION EXCEEDING MCL

- NOTES:**
- HISTORICAL LOCATIONS DIGITIZED FROM BASE MAP PROVIDED BY AEROSTAR ENVIRONMENTAL SERVICES INC. (AEROSTAR 2007).
  - MONITORING WELL LOCATIONS PROVIDED BY AEROSTAR ENVIRONMENTAL SERVICES INC. (AEROSTAR 2008).
  - MW-1, MW-2, MW-3 HAVE NOT BEEN ANALYZED FOR FULL SUITE VOCs, ONLY BTEX UNDER THE UST PROGRAM.
  - OTHER VOCs WERE DETECTED SPORADICALLY.
  - DASHED LINE OF TCE PLUME BOUNDARY IS BASED ON PRIMARILY 2006 DATA AND DOES NOT ACCOUNT FOR BIODEGRADATION TAKING PLACE.

	EPA TAPWATER RSL $\mu\text{g/L}$	MCL $\mu\text{g/L}$
TRICHLOROETHENE (TCE)	0.44 (c)	5
TETRACHLOROETHENE (PCE)	9.7 (c)	5
cis-1,2-DICHLOROETHENE (DCE)	2.8 (n)	70
VINYL CHLORIDE (VC)	0.015 (c)	2

(c) INDICATES RISK = 1 E-06 FOR CARCINOGEN  
(n) INDICATES HQ = 0.1 FOR NONCARCINOGEN



**SAIC**

FIGURE 4-6  
GROUNDWATER QUALITY MAP  
(CHLORINATED SOLVENTS)

OMS-28  
ALABAMA ARMY NATIONAL GUARD  
MOBILE, ALABAMA

DRAWN BY: R. BEELER  
REV. NO./DATE: 0/05-17-12  
CAD FILE: /11013/DWGS/L83\_OMS28\_GW\_SOLV-01

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Vertical migration of the contaminants is limited by a stiff, dense clay that is located at 30 ft BGS. Above the stiff clay is a sandy clay or clayey sand, which also limits vertical migration. The vertical extent of groundwater contamination is determined by vertical groundwater sample delineation from deep wells OMS-28-4 and OMS-28-6, which are located within the boundary of the TCE plume. These deep wells did not indicate the presence of contamination during the six consecutive groundwater sampling events between 2008 and 2010.

A review of the groundwater data from the shallow wells over six consecutive groundwater sampling events has demonstrated that the horizontal extent of the groundwater plumes remains relatively stable (i.e., they are no longer expanding).

As shown in Table 4-5, degradation of PCE and TCE is occurring in the groundwater at the site. The benzene plume from the former UST site (OMS-28 Pit 2), located approximately 200 ft southeast of MW-8, may have, at some point, provided low concentrations of benzene on the upgradient side of the TCE plume, as indicated by the concentrations observed in MW-6, which could have acted as a carbon source for the in-situ bacteria. Intermittent spikes in groundwater TCE concentrations appear to be associated with flushing or leaching of contaminants due to a rain event.

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## **5.0 CONTAMINANT FATE AND TRANSPORT**

This chapter discusses the physical and chemical processes that affect contaminant migration in matrices at OMS-28. The properties of the chemicals detected beneath the site are reviewed, and the interactions of these chemicals within groundwater and surface water are summarized. Difficulties and concerns associated with their presence in the subsurface also are presented.

### **5.1 POTENTIAL ROUTES OF MIGRATION**

Contaminant presence at the site is apparently a result of operational activities at the location of the OMS-28 site. The reader is referred to Chapter 4.0 for a discussion of sample analytical results. Based on the analysis of the field data collected by Aerostar between 2006 and 2010, the following contamination has been identified:

- Organic constituents have been detected in the surface and subsurface soil at OMS-28. TCE and PCE are the primary contaminants detected.
- Organics are present in OMS-28 groundwater. TCE and PCE are the primary contaminants detected, entering the subsurface media and producing secondary source areas.

As indicated by previous sampling results, potential routes of migration for PCE, TCE, and associated degradation products within the area of the site are principally leaching through subsurface soil and flow within the groundwater. The following paragraphs discuss the persistence of chlorinated hydrocarbons in the environment and factors affecting the length of persistence.

### **5.2 CONTAMINANT PERSISTENCE**

VOCs were detected in soil samples exceeding protection of groundwater SSLs from the site. SVOCs were sporadically detected in surface soil samples that were located outside the limits of the ALARNG property. VOCs were the only constituents observed in significant quantities above MCLs. Therefore, this discussion focuses on VOC properties.

#### **5.2.1 Chemical Properties of Contaminants**

From the perspective of groundwater and surface water contamination, the most significant contaminant characteristic is solubility (Gorelick et al. 1993). The solubility of a solute is defined as the mass of the solute that will dissolve in a unit volume of solution under specified conditions. The solubility defines the maximum possible concentration that commonly occurs in groundwater or surface water for any given contaminant.

Halogenated organic compounds are characterized by a variable number of single, double, and triple bonds and the presence of chlorine, bromine, fluorine, or iodine. These compounds are widely used and have been frequently found as contaminants in groundwater. PCE and TCE are examples of these compounds. Each of these chemicals has a low flammability and a high vapor density, which makes them very useful as solvents for the degreasing of metal parts. PCE and TCE are denser than water, and if spilled on the ground in quantities great enough to overcome the residual saturation, may migrate vertically downward through an aquifer (Fetter 1993). They also are soluble in water and can migrate in a dissolved phase in the direction of groundwater flow.

Regardless of whether a liquid is composed of a single type of molecule, such as TCE, or a mixture, it is the nature of the intermolecular bonding in the liquid that contributes to its generally low solubility in water. Liquids with infinite solubilities (e.g., acetone) are referred to as being miscible with water. Liquids with finite solubilities (e.g., TCE) are generally referred to as immiscible with water, even if the solubility is high.

Low-density immiscible liquids, or light, non-aqueous-phase liquids (LNAPLs), will float on the surface of the higher-density groundwater and surface water. High-density liquids, or dense, non-aqueous-phase liquids (DNAPLs), sink through water until they reach the aquifer or surface water bottom. Gasoline is an example of an LNAPL, and PCE and TCE are examples of DNAPLs. While these liquids do not go completely into solution in groundwater, they do contain compounds with limited solubilities in water (Gorelick et al. 1993).

### **5.2.2 Site-specific Chemical Properties**

The various VOCs detected in soil and groundwater at the site are classified as halogenated aliphatic compounds (HACs) (i.e., PCE; TCE; and 1,2-DCE). Table 5-1 lists the physical properties for the various organic contaminants detected at OMS-28.

HACs are characterized by open-chain structures; a variable number of single, double, and triple bonds; and the presence of chlorine, bromine, fluorine, or iodine. HACs have many applications, such as solvents, degreasers, dry cleaning agents, refrigerants, and organics synthesis agents. TCE was the most frequently detected HAC in OMS-28 groundwater samples.

### **5.2.3 Contaminant Transport – Groundwater**

Surface and subsurface soil sampled within the immediate vicinity of MW-8 indicated contamination by PCE; TCE; and *cis*-1,2-DCE. The concentrations of these contaminants in soil are less than the RSLs and the concentrations exceed their respective protection of groundwater SSLs, as indicated in Tables 4-2 and 4-3. Leaching of chemicals from soil is a process of migration involving the movement of a chemical downward through soil by percolation of water. Typically, with more precipitation, there is a greater chance for chemicals to leach. Leaching is a concern because of the potential for a chemical to move through the soil and contaminate the groundwater. Many factors affect whether or not a chemical leaches in soil, including solubility of the chemical, biodegradation, hydrolysis, dissociation, sorption, volatility, rainfall, and evaporation. A chemical that is water-soluble can leach in soil and is likely to be biodegraded by soil microbes. If biodegradation is rapid, then leaching may be minimal. A chemical that is insoluble in water can be adsorbed in soil, moved with soil particles, and perhaps biodegrade very slowly, if at all.

The presence of chlorinated hydrocarbons in the unsaturated soil at concentrations above SSLs protective of groundwater serves as a renewable source of groundwater contamination. As the water table fluctuates over time, the saturated portion of the flow system repeatedly comes in contact with contaminated soil (Gorelick et al. 1993). Each rise of the water table serves to recharge the contaminants in the groundwater. Infiltration from above also contributes to the contaminant distribution in groundwater. Once a chemical enters the groundwater regime, several transport mechanisms are present that may aid in the spreading of the contamination. These mechanisms include diffusion, advection, mechanical dispersion, and hydrodynamic dispersion.

Diffusion is the process by which a contaminant in water will move from an area of greater concentration toward an area where it is less concentrated. Diffusion will occur as long as a concentration gradient exists, even if the fluid is not moving, and as a result, a contaminant may spread away from the place

Table 5-1. Physical Properties of Organic Contaminants at the OMS-28 Site

Chemical	Specific Gravity (g/cc)	Water Solubility (mg/L)	Henry's Law (atm-m <sup>3</sup> -mol)	K <sub>oc</sub> (L/kg)	Diffusivity in Air (cm <sup>2</sup> /sec)	Diffusivity in Water (cm <sup>2</sup> /sec)	Estimated Half-life (days)	
							Soil	GW
1,2-Dichloroethane	1.25 <sup>a</sup>	8,600 <sup>b</sup>	1.18E-03 <sup>b</sup>	39.6 <sup>b</sup>	0.086 <sup>c</sup>	1.10E-05 <sup>c</sup>	28 – 180 <sup>d</sup>	56 – 2,850 <sup>d</sup>
2-Butanone	0.80 <sup>a</sup>	2.23E+05 <sup>b</sup>	5.69E-05 <sup>b</sup>	4.54 <sup>b</sup>	0.091 <sup>c</sup>	1.02E-05 <sup>c</sup>	1 – 7 <sup>d</sup>	2 – 14 <sup>d</sup>
Acetone	0.79 <sup>a</sup>	1.00E+06 <sup>b</sup>	3.5E-05 <sup>b</sup>	2.364 <sup>b</sup>	0.105 <sup>c</sup>	1.15E-05 <sup>c</sup>	1 – 7 <sup>d</sup>	2 – 14 <sup>d</sup>
Benzene	0.88 <sup>a</sup>	1,790 <sup>b</sup>	5.55E-03 <sup>b</sup>	145.8 <sup>b</sup>	0.089 <sup>c</sup>	1.03E-05 <sup>c</sup>	5 – 16 <sup>d</sup>	10 – 720 <sup>d</sup>
Carbon Disulfide	1.26 <sup>a</sup>	2,160 <sup>b</sup>	1.44E-02 <sup>b</sup>	21.73 <sup>b</sup>	0.106 <sup>c</sup>	1.30E-05 <sup>c</sup>	—	—
cis-1,2-Dichloroethene	1.28 <sup>a</sup>	6,410 <sup>b</sup>	4.08E-03 <sup>b</sup>	39.6 <sup>b</sup>	0.088 <sup>c</sup>	1.13E-05 <sup>c</sup>	—	—
Chloroform	1.48 <sup>a</sup>	7,950 <sup>b</sup>	3.67E-03 <sup>b</sup>	31.82 <sup>b</sup>	0.077 <sup>c</sup>	1.09E-05 <sup>c</sup>	28 – 180 <sup>d</sup>	56 – 1,800 <sup>d</sup>
Chloromethane	0.91 <sup>a</sup>	5,320 <sup>b</sup>	8.82E-03 <sup>b</sup>	13.22 <sup>b</sup>	0.124 <sup>c</sup>	1.36E-05 <sup>c</sup>	—	—
Cyclohexane	0.77 <sup>a</sup>	0.102 <sup>b</sup>	0.15 <sup>b</sup>	—	0.080 <sup>c</sup>	9.11E-06 <sup>c</sup>	28 – 180 <sup>d</sup>	56 – 360 <sup>d</sup>
Ethylbenzene	0.86 <sup>a</sup>	169 <sup>b</sup>	7.88E-03 <sup>b</sup>	446.1 <sup>b</sup>	0.068 <sup>c</sup>	8.46E-06 <sup>c</sup>	3 – 10 <sup>d</sup>	6 – 228 <sup>d</sup>
Isopropylbenzene	0.86 <sup>a</sup>	61.3 <sup>b</sup>	1.15E-02 <sup>b</sup>	697.8 <sup>b</sup>	0.060 <sup>c</sup>	7.86E-06 <sup>c</sup>	—	—
Methyl Acetate	0.93 <sup>a</sup>	2.43E+05 <sup>b</sup>	1.15E-04 <sup>b</sup>	3.064 <sup>b</sup>	0.096 <sup>c</sup>	1.10E-05 <sup>c</sup>	—	—
Methylene Chloride	1.33 <sup>a</sup>	13,000 <sup>b</sup>	3.25E-03 <sup>b</sup>	21.73 <sup>b</sup>	0.099 <sup>c</sup>	1.25E-05 <sup>c</sup>	7 – 28 <sup>d</sup>	14 – 56 <sup>d</sup>
Naphthalene	1.02 <sup>a</sup>	31 <sup>b</sup>	4.40E-04 <sup>b</sup>	1,544 <sup>b</sup>	0.060 <sup>c</sup>	8.38E-06 <sup>c</sup>	16.6 – 48 <sup>d</sup>	228 <sup>d</sup>
Tetrachloroethene	1.62 <sup>a</sup>	206 <sup>b</sup>	1.77E-02 <sup>b</sup>	94.94 <sup>b</sup>	0.050 <sup>c</sup>	9.45E-06 <sup>c</sup>	180 – 360 <sup>d</sup>	360 – 720 <sup>d</sup>
Toluene	0.86 <sup>a</sup>	526 <sup>b</sup>	6.64E-03 <sup>b</sup>	233.9 <sup>b</sup>	0.078 <sup>c</sup>	9.20E-06 <sup>c</sup>	4 – 22 <sup>d</sup>	7 – 28 <sup>d</sup>
Trichloroethene	1.46 <sup>a</sup>	1,280 <sup>b</sup>	9.85E-03 <sup>b</sup>	60.7 <sup>b</sup>	0.069 <sup>c</sup>	1.02E-05 <sup>c</sup>	180 – 360 <sup>d</sup>	321 – 1,642 <sup>d</sup>
Trichlorofluoromethane	1.49 <sup>a</sup>	1,100 <sup>b</sup>	9.70E-02 <sup>b</sup>	43.89 <sup>b</sup>	0.065 <sup>c</sup>	1.00E-05 <sup>c</sup>	180 – 360 <sup>d</sup>	360 – 720 <sup>d</sup>
trans-1,2-Dichloroethene	1.25 <sup>a</sup>	4,520 <sup>b</sup>	4.08E-03 <sup>b</sup>	39.6 <sup>b</sup>	0.086 <sup>c</sup>	1.12E-05 <sup>c</sup>	—	—
Vinyl Chloride	0.91 <sup>a</sup>	8,800 <sup>b</sup>	2.78E-02 <sup>b</sup>	21.73 <sup>b</sup>	0.107 <sup>c</sup>	1.20E-05 <sup>c</sup>	28 – 180 <sup>d</sup>	56 – 2,850 <sup>d</sup>
Xylenes (total)	0.86 <sup>a</sup>	106 <sup>b</sup>	5.18E-03 <sup>b</sup>	382.9 <sup>b</sup>	0.085 <sup>c</sup>	9.90E-06 <sup>c</sup>	7 – 28 <sup>d</sup>	14 – 360 <sup>d</sup>

<sup>a</sup>EPA 1996. *Soil Screening Guidance: Technical Background Document*, OSWER Directive 9355.4-17A.

<sup>b</sup>EPA 2011. *Estimation Programs Interface Suite™ for Microsoft® Windows*, Version 4.10.

<sup>c</sup>EPA 2001. *WATER9*, Version 1.0.0.

<sup>d</sup>Howard et al. 1991. *Handbook of Environmental Degradation Rates*.

— = Value not provided.

GW = Groundwater.

OMS = Organizational Maintenance Shop.

where it is introduced into a porous medium. Diffusion also may occur when the concentration of a contaminant is higher in one stratum than in an adjacent stratum (Fetter 1993) provided that the adjacent stratum has the requisite porosity.

Advection is the movement of dissolved solute with flowing groundwater (Gorelick et al. 1993). The amount of contaminant being transported is a function of its concentration in the groundwater and the quantity of groundwater flowing, and advection will transport contaminants at different rates in each stratum.

Groundwater flow through different porous media occurs at variable rates due to the arrangement of particles in the subsurface. As contaminated groundwater travels through the stratum, the fluid does not all travel at the same velocity and, as a result, mixing occurs along the flow path. This mixing is termed mechanical dispersion and it results in a dilution of the contaminant at the advancing edge of flow (Fetter 1993).

Mechanical dispersion is composed of two contaminant front-mixing methods: longitudinal and transverse dispersion. Longitudinal dispersion occurs along the direction of the flow path, while transverse dispersion occurs normal to the flow path and causes lateral spreading of the contaminant. Mechanical dispersion and diffusion combine in groundwater flow to create hydrodynamic dispersion. This process begins when a contaminant enters the aquifer. Once introduced, the advecting groundwater carries the mass of contaminant with it and, in the process, the contaminant spreads, thereby decreasing the maximum concentration with time. However, the contamination is now spread over a much wider area.

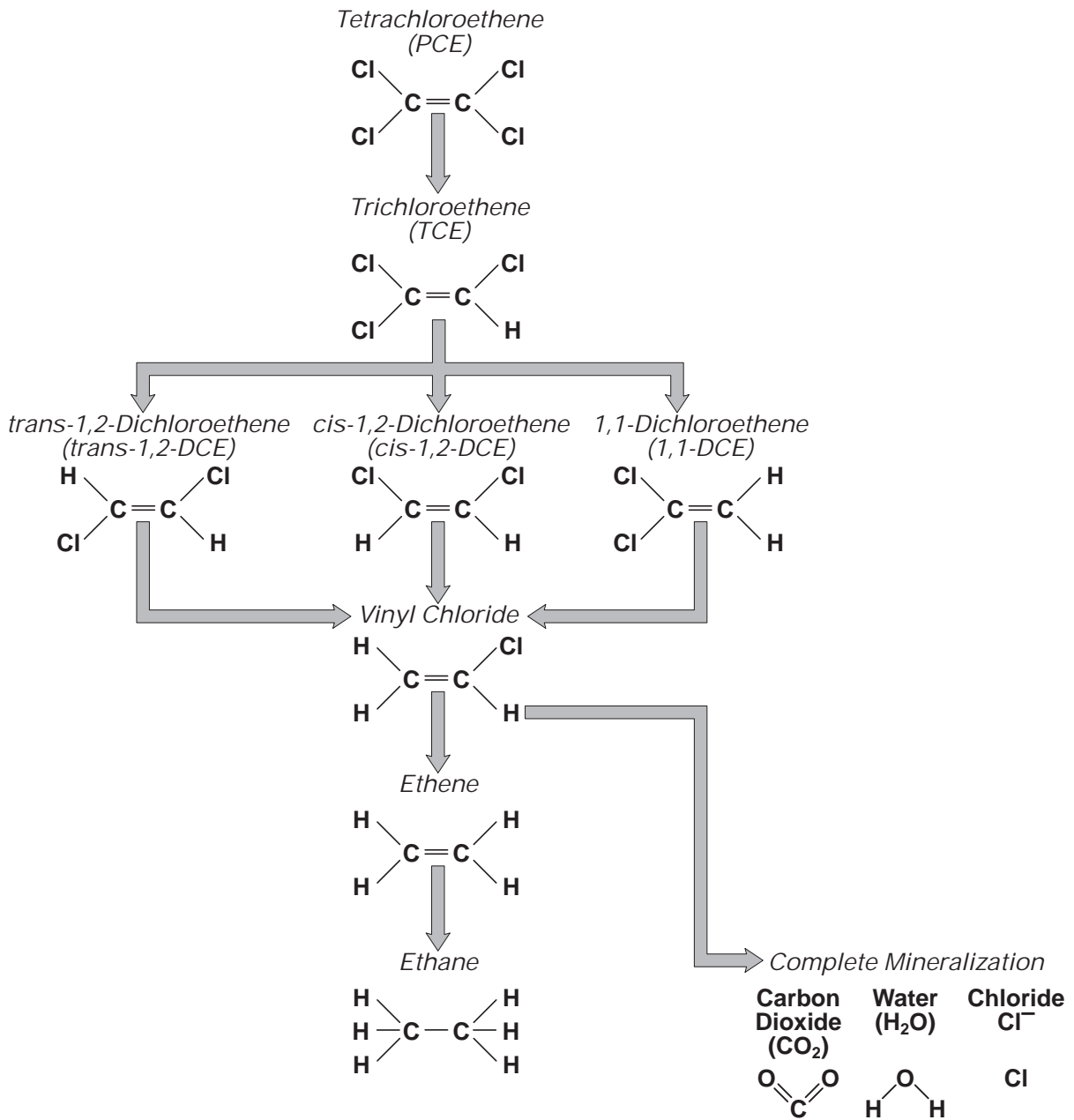
The adsorption of a solute onto an aquifer material (e.g., clay) results in a reduction of concentration in the aqueous phase and a retardation of the velocity of contaminant migration. The degree of retardation experienced by a particular organic contaminant will depend on the fraction of organic carbon ( $f_{oc}$ ) of the aquifer materials. The higher the  $f_{oc}$ , the more sites there are available for adsorption.

#### **5.2.4 Degradation Mechanisms in the Natural Environment**

Degradation of contaminants is an important factor in evaluating the fate and transport. The potential degradation pathways of the primary contaminants, PCE and TCE, are described below.

The most important process for the natural biodegradation of the more highly chlorinated solvents, PCE and TCE, is reductive dechlorination (EPA 1998). During this process, the chlorinated hydrocarbon is used as an electron acceptor, not as a source of carbon, and a chlorine atom is removed and replaced with a hydrogen atom. Figure 5-1 illustrates the transformation of chlorinated ethenes via reductive dechlorination. In general, reductive dechlorination occurs by sequential dechlorination from PCE to TCE to DCE to VC to ethene. Depending upon environmental conditions, this sequence may be interrupted, with other processes then acting upon the products. During reductive dechlorination, all three isomers of DCE can theoretically be produced. However, Bouwer (1994) reports that, under the influence of biodegradation, *cis*-1,2-DCE is a more common intermediate than *trans*-1,2-DCE, and that 1,1-DCE is the least prevalent of the three DCE isomers when they are present as daughter products. Reductive dechlorination of chlorinated solvent compounds is associated with the accumulation of daughter products and an increase in the concentration of chloride ions. Reductive dechlorination affects each of the chlorinated ethenes differently. Of these compounds, PCE is the most susceptible to reductive dechlorination because it is the most oxidized. Conversely, VC is the least susceptible to reductive dechlorination because it is the least oxidized of these compounds. As a result, the rate of reductive dechlorination decreases as the degree of chlorination decreases (Vogel and McCarty 1985; Bouwer 1994).





EPA 1998. *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater*, Office of Research and Development, Washington, DC, EPA/600/R-98/128, September.

**Figure 5-1. Reductive Dehalogenation of Chlorinated Ethenes**

Of the potential daughter products resulting from the degradation of PCE and TCE, *cis*-1,2-DCE has been detected in groundwater samples collected from monitoring wells MW-8, OMS-28-3, and OMS-28-5. However, VC has not been detected in these wells. None of the daughter compounds from degradation of PCE and TCE were detected at concentrations above their respective MCLs.

Overall, the aquifer at the OMS-28 site appears to exhibit a range of geochemical conditions. Historical DO readings indicate more aerobic conditions, but more recent readings indicate more anaerobic conditions. The groundwater monitoring events between 2008 and 2010 indicate that degradation of PCE and TCE has been taking place. The periodic spikes in TCE concentrations after observed declines correlated with rain events, which indicate that some contaminant mass trapped in the soil pores is being flushed through the system during these infiltration events.

Environmental conditions influencing the type and rate of these reactions include pH, temperature, state of oxidation or reduction, types of bacteria present and populations, amount of organic carbon, a significant presence of DO in the groundwater, and types of other chemicals present.

## 6.0 RISK ASSESSMENT

### 6.1 ALABAMA RISK-BASED CORRECTIVE ACTION REPORT

An ARBCA was completed for the OMS-28 site in 2011. The objective of the assessment was to perform the ARBCA for the OMS-28 site to provide a risk-based approach for the assessment of cumulative risk and for development and selection of appropriate risk-based target levels (RBTLs) for the site. This section summarizes the results of the ARBCA. The complete ARBCA was documented in the ARBCA Report (Aerostar 2011b) and is included in Appendix M of this report. The ARBCA evaluation was based on the PSVs published in the April 2008 version of the ARBCA Guidance Manual.

#### 6.1.1 Release Scenario and Source Characterization

##### 6.1.1.1 Screening for COCs

Surface soil, subsurface soil, and groundwater data were compared to the 2008 residential and commercial PSVs. Both PCE and TCE were identified as COCs in surface soil and groundwater. TCE was the only COC identified in subsurface soil. These COCs are discussed in further detail in Section 6.1.2.

##### 6.1.1.2 Distribution of COCs

**Soil.** The primary soil source was located in the vicinity of MW-8 (soil exposure domain) and lies entirely within the OMS-28 property boundary. A smaller, isolated soil exposure domain was identified at soil sample location B-17. This smaller exposure domain has a PCE concentration at the surface and at the 8- to 10-ft interval that exceeds the 2008 residential PSV. Soil samples were not collected from 1 to 8 ft. The 8- to 10-ft sample was collected within groundwater and, therefore, it cannot be determined if the soil was contaminated from the surface to this depth or if contaminated groundwater contributed to the exceedence.

**Groundwater.** Based on the results of the wells monitored during the 2008 to 2010 groundwater monitoring events, the estimated dimensions of the TCE groundwater contaminant extent (groundwater exposure domain) were 180 by 120 ft and 14 ft deep. The groundwater contamination extent is a thin elliptical feature oriented northwest from the primary soil exposure domain on OMS-28 property onto MAA property to the west. The vertical extent of groundwater contamination is determined by vertical groundwater sample delineation. A review of the groundwater data from six consecutive groundwater sampling events has demonstrated the groundwater exposure domain remains relatively static (i.e., no longer expanding).

**Surface Water.** There are no surface waters within 1,000 ft of the site and no surface water data were collected.

**Soil Vapors.** Soil vapor measurements were not collected at the site. No physical structures exist above either the soil or groundwater exposure domains.

**Sediment.** Sediment was not evaluated for as part of the ARBCA because there are no surface water features at the site. No sediment data were collected.

## 6.1.2 Preliminary Screening Level Evaluation

**Surface Soil.** Surface soil samples (0 to 1 ft BGS) were collected in 2006 and 2007 during the TCE CI (Aerostar 2007) and the supplemental CI (Aerostar 2008a). The concentration of PCE exceeded the 2008 residential PSV (0.48 mg/kg) in the surface sample collected from boring B-17 (0.933 mg/kg). The concentrations of TCE exceeded both the 2008 residential PSV (0.053 mg/kg) and commercial PSV (0.11 mg/kg) in surface samples collected from borings HA-2 (0.241 mg/kg) and HA-15 (0.586 mg/kg). All other surface samples were either non-detect for VOCs or were detected below their respective PSVs for VOCs. The concentrations of 0.933 mg/kg for PCE and 0.586 mg/kg for TCE were selected as the maximum representative concentrations in surface soil for the exposure domain.

**Subsurface Soil.** Subsurface soil samples (>1 ft BGS) were collected in 2006 and 2007 during the TCE CI and the supplemental CI. The concentrations of PCE in the subsurface samples collected were either non-detect or were detected below the 2008 residential PSV (0.48 mg/kg) and 2008 commercial PSV (1.3 mg/kg). TCE was reported above the 2008 residential PSV (0.053 mg/kg) in soil borings OMS-28-6 (0.076 mg/kg at 5 to 10 ft BGS and 0.107J mg/kg at 10 to 15 ft BGS) and HA-7 (0.069 mg/kg at 8 to 10 ft BGS). TCE was reported above the 2008 residential PSV (0.053 mg/kg) and 2008 commercial PSV (0.110 mg/kg) in soil borings HA-6 (0.15 mg/kg at 8 to 10 ft BGS), HA-15 (0.132J mg/kg at 8 to 10 ft BGS), and OMS-28-3 (0.211J mg/kg at 10 to 15 ft BGS). All other subsurface samples collected at the site were either non-detect for VOCs or were detected below their respective 2008 PSVs for VOCs. The concentration of 0.211 mg/kg for TCE was selected as the maximum representative concentration in subsurface soil for the exposure domain.

**Groundwater.** From July 2008 to September 2010, there were six quarterly groundwater sampling events that included the sampling of TCE and PCE. PCE was reported above the 2008 PSV (5 µg/L) in monitoring well OMS-28-5 (9.2 to 234 µg/L) during the six sampling events. TCE was reported above the 2008 PSV (5 µg/L) in monitoring wells MW-8 (8.41 to 133 µg/L), OMS-28-3 (12 to 149 µg/L), and OMS-28-5 (11 to 162 µg/L) during the six sampling events. The concentrations of 234 µg/L for PCE (OMS-28-5 reported in May 2009) and 162 µg/L for TCE (OMS-28-5 reported in May 2009) were selected as the maximum representative concentrations in groundwater for the groundwater exposure domain. Monitoring wells MW-8, OMS-28-3, and OMS-28-5 define the groundwater contaminant extent.

**Surface Water/Sediment.** No surface water or sediment samples were collected as part of the evaluation, and there are no surface water bodies within 1,000 ft of the site.

## 6.1.3 Exposure Assessment

**Sources.** Based on analytical data collected during the November 2004 and March 2005 secondary investigation, TCE was determined to be present in the groundwater sample from MW-8. The TCE was reported to not be associated with the former UST but to be a separate “solvent spill” downgradient (i.e., west) of the former UST. Through subsequent investigations in 2006 and 2007, TCE has been fully delineated in soil. A release date for the TCE was not determined based on available information. Therefore, the contaminated soil was assumed to be the source. It was noted that two separate areas of soil contamination were identified: one near MW-8 and one near B-17. However, because the contamination is similar and the concentrations at both areas are similar, the model recognized one soil source. The smaller soil exposure area has a PCE concentration at the 0 to 1-ft BGS interval that exceeded the 2008 residential PSV. The ARBCA evaluation focused on both of the soil exposure areas as one and used the MCL for both TCE and PCE.

**Release Mechanisms.** The release mechanism was unknown because there was no report or documentation of a release, only the presence of the chemicals. There was no apparent potential above ground source at the site; therefore, the soil itself was considered the current source for further release of TCE and PCE from the soil matrix either through mechanical or chemical disturbance.

**Transport Media.** The release of TCE and PCE has shown impact to surficial and subsurface soil as well as the groundwater below the soil source. TCE and PCE were transported by leaching from recharge events and transported through the subsurface to the groundwater below the source soil. Groundwater movement has transported the TCE and PCE over time to represent the current groundwater contaminant extent.

**Receptors.** The receptors evaluated were the commercial worker-adult, construction worker-adult, trespasser (adolescent), resident child (within 500 ft), and resident adult (within 500 ft).

#### **6.1.4 Site Conceptual Exposure Models for Exposure Domains**

**Current Conditions.** Current use of the site includes commercial and occasional construction workers. Trespassers also were included as potential receptors. Human receptors within 500 ft of the site boundary are required to be evaluated as part of the ARBCA, and this includes a resident adult and resident child.

**Future Conditions.** The Alabama Armory Commission owns the property where the primary source in the vicinity of MW-8 exists in soil. However, groundwater contamination from this source in the vicinity of MW-8 extends onto the MAA property and the smaller soil exposure domain in the vicinity of B-17 is on MAA property. Future use of the site is currently determined to be the same as the current use.

However, for the purpose of evaluating a future residential use of the site as unrestricted, the resident adult and resident child were evaluated.

#### **6.1.5 Risk Management-1 Evaluation**

The results of the ARBCA RM-1 evaluation using default parameters did not identify a cumulative risk that exceeded appropriate risk levels for a commercial worker, construction worker, or trespasser. A cumulative risk that exceeds risk levels is present for the future use scenario for a resident child or resident adult for surface soil or groundwater.

RM-1 RBTLs were calculated for the resident adult and resident child for exposure to TCE and PCE in surface soil and groundwater where a cumulative risk or hazard index (HI) exists and exceeds the acceptable risk. RM-1 RBTLs were compared to the representative concentrations. RM-1 RBTLs were exceeded; therefore, an RM-2 evaluation was recommended.

#### **6.1.6 Risk Management-2 Evaluation**

The results of the ARBCA RM-2 evaluation using default and site-specific fate and transport parameters did not identify a cumulative risk that exceeded appropriate risk levels for a commercial worker, construction worker, or trespasser. A cumulative risk that exceeds risk levels is present for the future use scenario for a resident child or resident adult who may ingest groundwater. The ARBCA Report recognizes risk when the cumulative risk value is greater than 1E-05 and an HI is greater than 1.

RM-2 RBTLs were calculated for those receptors (i.e., surface soil for the trespasser, commercial worker, and construction worker and surface soil and groundwater for the resident adult and resident child) where

a cumulative risk or HI exists. The cumulative risk for a resident child is 7.04E-04 and the HI is 3.22. The cumulative risk and HI for a resident adult are 1.51E-03 and 1.38, respectively.

For a future use scenario of unrestricted use (i.e., residential scenario), RBTLs for corrective action would be required. The residential child RBTL for surficial soil was calculated as 0.00832 mg/kg for TCE and 0.0132 mg/kg for PCE. The residential adult RBTL for surficial soil was calculated as 0.00388 mg/kg for TCE and 0.00618 mg/kg for PCE. These RBTLs are lower than the ADEM 2008 residential soil PSVs of 0.0530 mg/kg for TCE and 0.480 mg/kg for PCE. In addition, the RBTLs are significantly lower than the May 2012 residential soil RSLs of 0.91 mg/kg for TCE and 22 mg/kg for PCE. To eliminate exposure risk to groundwater, the residential child RBTL was calculated to be 2.3 µg/L for TCE and 3.32 µg/L for PCE. The groundwater residential adult RBTL is 1.07 µg/L for TCE and 1.55 µg/L for PCE. These RBTLs are lower than the ADEM 2008 groundwater PSVs and EPA MCLs of 5 µg/L for TCE and 5 µg/L for PCE.

The RM-2 model, for protection of groundwater use without biodegradation, identified allowable concentrations of TCE at the soil source, groundwater source, sentry well, and hypothetical well for potential exposure. As a precaution, the potential exposure was placed at the closest downgradient residential property boundary and was located approximately 155 ft from the downgradient edge of the soil source. The groundwater source and the sentry well were both the same well (MW-8) in the model. Allowable concentrations for TCE were identified as 1.12 mg/kg at the soil source, 25.8 µg/L at the groundwater source/sentry well, and 5.0 µg/L at the point of exposure. Allowable concentrations for PCE were identified as 1.16 mg/kg at the soil source, 25.8 µg/L at the groundwater source/sentry well, and 5.0 µg/L at the point of exposure. Therefore, to be protective at the potential exposure, the source soil would need to achieve a cleanup level of 1.12 mg/kg for TCE and 1.16 mg/kg for PCE, and groundwater would need to achieve levels of 25.8 µg/L at the source (i.e., MW-8) for TCE. If the future potential point of exposure is the source, then 5.0 µg/L will be the allowable concentration of TCE or PCE at MW-8.

Assuming that biodegradation takes place, the allowable concentrations are only slightly higher than assuming no biodegradation and were on the same order of magnitude. Allowable concentrations for TCE were identified as 1.45 mg/kg at the soil source, 33.5 µg/L at the groundwater source/sentry well, and 5.0 µg/L at the point of exposure. Allowable concentrations for PCE were identified as 1.49 mg/kg at the soil source, 33.2 µg/L at the groundwater source/sentry well, and 5.0 µg/L at the point of exposure.

### **6.1.7 Alabama Risk-Based Corrective Action Conclusions**

Current use of the site is acceptable for the commercial worker, construction worker, and trespasser. Residents may be at risk if ingestion of groundwater was to occur at a hypothetical well for potential exposure.

The soil source will continue to be a source for groundwater as long as recharge events can occur. Grass and other vegetative growth over the soil prevent dermal contact and inhalation of particulates as long as the area is maintained as a grass cover and mowing or other landscaping activities are kept to a minimum so as not to disturb the surface soil. Furthermore, engineering controls such as asphalt paving or concrete would preclude recharge moving through the source soil and, thus, reduce the potential for further leaching and release. Evidence that the groundwater plume is static (i.e., no longer expanding) indicates that the ground cover minimizes recharge to the subsurface and, thus, reduces contaminant migration.

### **6.1.8 Risk Management Recommendations**

The ARBCA Report recommended development of a Risk Management Plan to manage or remediate risk at the site. The current plan is to follow the CERCLA process to develop, select, and implement a remedy that will be protective of human health.

### **6.2 ECOLOGICAL EXPOSURE**

Because there are no surface waters or streams and a sensitive population was not identified as being present, an ecological exposure pathway was not evaluated as part of the ARBCA Report (Aerostar 2011b). No further ecological risk assessment has been performed.

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## 7.0 CONCLUSIONS

### 7.1 NATURE AND EXTENT OF CONTAMINATION

#### 7.1.1 Soil

Fifteen VOCs (2-butanone; acetone; bromomethane; carbon disulfide; chloroform; *cis*-1,2-DCE; isopropylbenzene; methyl acetate; methylcyclohexane; methylene chloride; naphthalene; PCE; toluene; TCE; and trichlorofluoromethane) were detected sporadically in the 61 soil samples across the 27 locations with no discernible trends between 2006 and 2008. The concentrations of constituents were below their respective residential and industrial EPA RSLs (May 2012). The concentrations of four VOCs (*cis*-1,2-DCE; methylene chloride; PCE; and TCE) exceeded their respective protection of groundwater SSLs. Of these, TCE and PCE were considered the primary COCs exceeding the protection of groundwater SSLs.

Sixteen SVOCs (acenaphthene, acenaphthylene, anthracene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[k]fluoranthene, bis[2-ethylhexyl]phthalate, carbazole, chrysene, fluoranthene, fluorene, indeno[1,2,3-cd]pyrene, phenanthrene, and pyrene) were detected in the soil samples. The concentrations of four PAHs exceeded their respective residential and industrial RSLs. In addition, all PAH detections were in surface soil and were outside the boundary of the ALARNG property and are not thought to be attributable to ALARNG activities.

There are three areas of soil contamination that may be acting as a residual source for the TCE and PCE groundwater plumes. The largest area of soil contamination exceeding the protection of groundwater SSLs is located in the vicinity of MW-8, and the area exceeding the SSL for TCE and PCE is approximately 60 by 60 ft. The vertical extent of contamination is located throughout the unsaturated zone from ground surface to the water table observed during drilling at approximately 15 ft BGS. However, concentrations in the area of MW-8 are below the residential RSLs for TCE and PCE. The TCE concentrations in soil samples from HA-01, HA-02, HA-03, HA-06, HA-07, HA-08, HA-12, HA-14, HA-15, OMS-28-3, OMS-28-4, OMS-28-5, and OMS-28-6 exceeded the SSL of 0.0018 mg/kg but were less than the residential RSL of 0.91 mg/kg. The PCE concentrations in soil samples from HA-05, HA-07, and HA-13 exceeded the SSL of 0.0023 mg/kg but were less than the residential RSL of 22 mg/kg. OMS-28-3 is located 60 ft north of MW-8, and the TCE concentration was 0.211J mg/kg at 10 to 15 ft BGS. OMS-28-4 is located 130 ft northwest of MW-8, and the TCE concentration was 0.027 mg/kg at 10 to 15 ft BGS. The concentrations in OMS-28-3 and OMS-28-4 at 10 to 15 ft BGS exceeded the SSL for TCE. The precise location of these samples collection is unknown for these two samples but is probably from just above the water table. It is probable that contaminated groundwater trapped in the capillary fringe above the water table may have contributed to the exceedances.

Two smaller isolated areas of soil contamination exceeding the protection of groundwater SSLs are located approximately 200 ft northwest of MW-8 at soil sample location B-17 on MAA property and approximately 250 ft west of MW-8 at soil sample location B-13 on MAA property. The PCE concentrations in surface and subsurface soil samples from B-17 exceeded the SSL of 0.0023 mg/kg but were below the residential RSL of 22 mg/kg. The area exceeding the SSL around B-17 is estimated to be 15 by 20 ft. The vertical extent of PCE contamination in the vicinity of B-17 extends to at least 10 ft BGS; however, it probably extends deeper as the vertical extent was not delineated in B-17. The TCE concentration in the surface soil sample from B-18 exceeded the SSL of 0.0018 mg/kg but was below the residential RSL of 0.91 mg/kg. The area exceeding the SSL around B-13 is estimated to be 15 by 15 ft. The vertical extent of contamination at B-13 does not extend any deeper than 6 ft BGS.

The concentrations of TCE and PCE in the vicinity of MW-8 and at the two smaller isolated locations in the vicinity of B-17 and B-13 were below the residential and industrial RSLs for TCE and PCE.

### 7.1.2 Groundwater

Eighteen VOCs (1,2-dichloroethane; acetone; benzene; *cis*-1,2-DCE; chloroform; chloromethane; cyclohexane; ethylbenzene; isopropylbenzene; methylcyclohexane; methylene chloride; naphthalene; PCE; toluene; TCE; total xylenes; *trans*-1,2-DCE; and VC) were detected in groundwater during the investigations from 2006 through 2008. The concentrations of 1,2-dichloroethane; benzene; *cis*-1,2-DCE; chloroform; ethylbenzene; naphthalene; PCE; TCE; VC; and total xylenes exceeded their respective EPA tap water RSLs. However, by September 2010, only the concentrations of *cis*-1,2-DCE; PCE; and TCE exceeded their respective EPA tap water RSLs. The concentrations of TCE and PCE exceeded their respective MCLs. In September 2010, TCE was detected in three shallow wells (MW-8, OMS-28-3, and OMS-28-5). TCE was not detected in the remaining shallow wells (MW-5, MW-6, MW-9, MW-12, OMS-28-2, and OMS-28-7), which delineate the horizontal extent of the plume boundary. TCE was not detected in the three deep wells (OMS-28-1, OMS-28-4, and OMS-28-6). PCE was detected in one shallow well (OMS-28-5) and was not detected in the other shallow wells or in the deep wells. Based on the results of the September 2010 sampling event and the 2006 Phase I and II temporary wells, there appears to be a TCE plume and a PCE plume. The PCE may have already degraded in the vicinity of MW-8 and is no longer being observed in that part of the TCE plume.

Vertical migration of the contaminants is limited by a stiff, dense clay that is located at 30 ft BGS. Above the stiff clay is a sandy clay or clayey sand, which also limits vertical migration. The vertical extent of groundwater contamination is determined by vertical groundwater sample delineation from deep wells OMS-28-4 and OMS-28-6, which are located within in the boundary of the TCE plume. These deep wells did not indicate the presence of contamination during the six consecutive groundwater sampling events between 2008 and 2010.

The estimated dimension of the groundwater TCE plume is 320 by 120 ft and of the PCE plume is 100 by 65 ft. The estimated length of the TCE plume does not account for biodegradation of the TCE that has been occurring in the subsurface; however, MW-11 was abandoned at the private property owner's request and, therefore, the well has not been resampled to verify that the TCE concentrations have decreased. Based on the depth of the screens in the shallow wells, the vertical depth of the plumes extends to approximately 20 ft BGS. However, the possibility exists that the plume may extend to the top of the stiff clay, which is 30 to 35 ft BGS. The TCE plume is an elliptical feature oriented to the northwest from the larger area of soil contamination centered around MW-8 on OMS-28 property onto MAA property to the west. The PCE plume is an elliptical feature oriented to the northwest located near the smaller area of soil contamination in the vicinity of B-17 on the MAA property. A review of the groundwater data from the shallow wells over six consecutive groundwater sampling events has demonstrated that the horizontal extent of the groundwater plumes remains relatively stable (i.e., they are no longer expanding).

## 7.2 FATE AND TRANSPORT

VOCs were the primary constituents detected in soil samples exceeding protection of groundwater SSLs. VOCs were the only constituents in groundwater observed in significant quantities above MCLs. The presence of PCE; TCE; and *cis*-1,2-DCE in the unsaturated soil at concentrations above SSLs protective of groundwater serves as a renewable source of groundwater contamination. Once these contaminants

enter the subsurface, there are several mechanisms that affect the overall fate and transport in the environment.

- Leaching is a concern because of the potential for a chemical to move through the soil and contaminate the groundwater.
- Diffusion is the process by which a contaminant in water will move from an area of greater concentration toward an area where it is less concentrated.
- Advection is the movement of dissolved solute with flowing groundwater.
- Mechanical dispersion or mixing occurs because, as contaminated groundwater travels through the stratum, the fluid does not travel all at the same velocity.
- Adsorption of a solute onto an aquifer material (e.g., clay) results in a reduction of concentration in the aqueous phase and a retardation of the velocity of contaminant migration.
- Degradation of contaminants is an important factor in evaluating the fate and transport.

The most important process for the natural biodegradation of the more highly chlorinated solvents, PCE and TCE, is reductive dechlorination. In general, reductive dechlorination occurs by sequential dechlorination from PCE to TCE to DCE to VC to ethene. Reductive dechlorination affects each of the chlorinated ethenes differently. Of these compounds, PCE is the most susceptible to reductive dechlorination because it is the most oxidized. Conversely, VC is the least susceptible to reductive dechlorination because it is the least oxidized of these compounds.

### **7.3 RISK ASSESSMENT**

The maximum concentrations of PCE and TCE exceeded the 2008 residential PSVs; therefore, PCE and TCE were identified as COCs in the ARBCA Report (Aerostar 2011b). Current and future use of the site includes commercial and occasional construction workers. A trespasser could be a potential receptor. There are residential homes within 500 ft of the site boundary. For the purpose of evaluating a future residential use of the site as unrestricted, the resident adult and resident child were considered in the evaluation. As a result, the receptors evaluated in the ARBCA Report were the commercial worker-adult, construction worker-adult, trespasser (adolescent), resident child (within 500 ft), and resident adult (within 500 ft).

The results of the ARBCA RM-1 evaluation using default parameters did not identify a cumulative risk that exceeded appropriate risk levels for a commercial worker, construction worker, or trespasser. However, under the future use scenario of unrestricted use (i.e., residential scenario), there is a cumulative risk that exceeds risk levels for a resident child or resident adult for exposure to surface soil or groundwater.

The results of the ARBCA RM-2 evaluation using default and site-specific fate and transport parameters did not identify a cumulative risk that exceeded appropriate risk levels for a commercial worker, construction worker, or trespasser. However, under the future use scenario of unrestricted use (i.e., residential scenario), there is a cumulative risk that exceeds risk levels for a resident child or resident adult who may ingest groundwater. The ARBCA Report recognizes risk when the cumulative risk value is greater than 1E-05 and an HI is greater than 1. With the change to site-specific fate and transport parameters, the risk associated with exposure to surface soil was reduced.

RM-2 RBTLs were calculated for those receptors where a cumulative risk or HI exists. For the resident child, the cumulative risk is 7.04E-04 and the HI is 3.22. For the resident adult, the cumulative risk is 1.51E-03 and the HI is 1.38.

Currently, there is no risk to receptors (i.e., commercial worker, construction worker, or trespasser) under the current land use scenario. However, RBTLs for corrective action were developed to achieve a future use scenario of unrestricted use (i.e., residential scenario). For surficial soil, the calculated RBTLs were 0.00832 mg/kg (TCE) and 0.0132 mg/kg (PCE) for the residential child and 0.00388 mg/kg (TCE) and 0.00618 mg/kg (PCE) for the residential adult. These RBTLs are lower than the ADEM 2008 residential PSVs of 0.0530 mg/kg for TCE and 0.480 mg/kg for PCE. In addition, the RBTLs are significantly lower than the November 2011 residential soil RSLs of 0.91 mg/kg for TCE and 0.55 mg/kg for PCE.

To eliminate the exposure risk to groundwater under the residential scenario, the calculated RBTLs were 2.3 µg/L (TCE) and 3.32 µg/L (PCE) for the residential child and 1.07 µg/L (TCE) and 1.55 µg/L (PCE) for the residential adult. These RBTLs are lower than the ADEM 2008 groundwater PSVs and EPA MCLs of 5 µg/L for TCE and 5 µg/L for PCE.

For protection of groundwater use without biodegradation, the RM-2 model identified allowable concentrations of TCE at the soil source, groundwater source (i.e., MW-8), sentry well (i.e., MW-8), and hypothetical well for potential exposure (i.e., located approximately 155 ft from the downgradient edge of the soil source). To be protective at the hypothetical well for potential exposure, allowable concentrations for TCE were identified as 1.12 mg/kg at the soil source, 25.8 µg/L at the groundwater source/sentry well, and 5.0 µg/L at the hypothetical well for potential exposure. Allowable concentrations for PCE were identified as 1.16 mg/kg at the soil source, 25.8 µg/L at the groundwater source/sentry well, and 5.0 µg/L at the hypothetical well for potential exposure. If the future potential point of exposure is the source, then the MCL of 5.0 µg/L will be the allowable concentration of TCE or PCE at MW-8.

Current use of the site is acceptable for the commercial worker, construction worker, and trespasser. Future residents may be at risk if ingestion of groundwater was to occur at a hypothetical well for potential exposure.

## **7.4 RECOMMENDATIONS**

Four PAHs in surface soil exceeded their respective residential and industrial RSLs; however, the sample locations were outside the boundary of the ALARNG property. VOC soil contamination at OMS-28 does not exceed residential or industrial RSLs (May 2012), which were used for the screening evaluation in lieu of PSVs in accordance with e-mail guidance provided by ADEM. However, the concentrations of TCE and PCE in soil exceed the protection of groundwater SSLs, and the mass in soil is most likely the residual source of contamination for the two groundwater plumes. The larger source area in the vicinity of MW-8 is located on ALARNG property. There are two isolated areas of soil contamination located on MAA property, and the responsible party for this source of contamination is not known. As shown in Figure 4-6, the TCE and PCE groundwater plumes have been degrading with time, but periodic spikes in concentrations have been observed. These periodic spikes are most likely due to flushing/leaching of contaminants from the soil matrix to the groundwater following significant rain events.

No additional investigation activities are required. An FS is recommended to evaluate alternatives for addressing TCE contamination in groundwater that resulted from the soil contamination at OMS-28.

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**APPENDICES**

**ELECTRONIC COPIES PROVIDED ON COMPACT DISC**

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- Appendix A Correspondence
  - TCE Comprehensive Investigation Report dated April 2007
    - ADEM letter 28 June 2007
    - ADEM letter 17 August 2007
  - Supplemental Comprehensive Investigation Work Plan dated March 2008
    - USACE letter 18 March 2008
    - ADEM letter 16 April 2008
    - ALARNG letter 1 May 2008
    - ADEM letter 10 July 2008
  - Well Abandonment Report dated May 2008
    - USACE letter 27 May 2008
    - ADEM letter 10 July 2008
  - Supplemental Comprehensive Investigation Report dated November 2008
    - USACE letter 12 November 2008
    - ADEM letter 15 July 2009
  - 1st Groundwater Monitoring Report dated April 2009
    - USACE letter 23 April 2009
    - ADEM letter 15 July 2009
  - 2nd Groundwater Monitoring Report dated August 2009
    - USACE letter 14 August 2009
    - ADEM letter 8 October 2009
  - 3rd Groundwater Monitoring Report dated December 2009
    - USACE letter 11 December 2009
    - ADEM letter 28 January 2010
  - 4th Groundwater Monitoring Report dated June 2010
    - USACE letter 22 June 2010
    - ADEM letter 6 August 2010
    - ALARNG letter 14 September 2010
  - 5th Groundwater Monitoring Report dated January 2011
    - ALARNG letter 28 December 2010
    - ADEM letter 31 March 2011
    - ALARNG letter 11 April 2011
  - Alabama Risk Based Corrective Action Report dated March 2011
    - ALARNG letter 16 March 2011
- Appendix B OMS-28 Pit 2 Secondary Investigation Addendum dated August 2005
- Appendix C OMS-28 Work Plan for TCE Investigation dated February 2006
- Appendix D OMS-28 TCE Comprehensive Investigation Report dated April 2007
- Appendix E OMS-28 Supplemental Comprehensive Investigation Work Plan dated March 2008
- Appendix F OMS-28 Well Abandonment Report dated May 2008
- Appendix G OMS-28 Supplemental Comprehensive Investigation Report dated November 2008
- Appendix H OMS-28 1st Groundwater Monitoring Report dated April 2009

- Appendix I OMS-28 2nd Groundwater Monitoring Report dated August 2009
- Appendix J OMS-28 3rd Groundwater Monitoring Report dated December 2009
- Appendix K OMS-28 4th Groundwater Monitoring Report dated June 2010
- Appendix L OMS-28 5th Groundwater Monitoring Report dated January 2011
- Appendix M OMS-28 Alabama Risk Based Corrective Action Report dated March 2011
- Appendix N Alabama Armory Commission Quit Claim Deed dated February 18, 2003

## **CD OF ELECTRONIC DOCUMENTS**