Feasibility Study

Organizational Maintenance Shop #28

1622 South Broad Street, Mobile, Alabama 36605

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LIST OF ABBREVIATIONS AND ACRONYMS

%	Percent
µg/L	micrograms per liter
AECOM	AECOM Technical Services, Inc.
ADEM	Alabama Department of Environmental Management
AFB	Air Force Base
AT123D	Analytical Transient 1-, 2-, 3-Dimensional
ARNG	Army National Guard
ALARNG	Alabama Army Air National Guard
ARAR	Applicable or Relevant and Appropriate Requirement
bgs	Below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cis-1,2-DCE	cis-1,2-dichloroethene
COC	Chemical of Concern
COPC	Chemicals of Potential Concern
COPEC	Contaminants of Potential Environmental Concern
CSM	Conceptual Site Model
DHB	*Dehalobacter*
DHC	*Dehalococcoides*
DO	Dissolved Oxygen
DoD	Department of Defense
DPT	Direct Push Technology
ELAP	Environmental Laboratory Accreditation Program
ERA	Ecological Risk Assessment
ERD	Enhanced Reductive Dechlorination
EVO	Emulsified Vegetable Oil
FMS	Field Maintenance Shop
FS	Feasibility Study
ft	foot
ft^2	square feet
HHRA	Human Health Risk Assessment
I-10	U.S. Interstate Highway 10
ISCO	In Situ Chemical Oxidation
ISCR	In Situ Chemical Reduction
LOD	Level of Detection
LUC	Land Use Control
LUCIP	Land Use Control Implementation Plan
MAA	Mobile Airport Authority
MCL	Maximum Contaminant Level
MEE	Methane, Ethane, Ethene
MIP	Membrane Interface Probe
MNA	Monitored Natural Attenuation

LIST OF ABBREVIATIONS AND ACRONYMS (Continued)

MSL	Mean Sea Level
MW	Monitoring Well
NEUR	Notice of Environmental Use Restriction
OMS	Organizational Maintenance Shop
O&M	Operation and Maintenance
ORP	Oxidation-Reduction Potential
PCE	Tetrachloroethene
PELA	P.E. LaMoreaux and Associates, Inc
POTW	Publicly Owned Treatment Works
PPE	Personal Protective Equipment
RA	Remedial Action
RAO	Remedial Action Objective
RA-O	Remedial Action - Operation
RD	Remedial Design
RG	Remedial Goal
RI	Remedial Investigation Level
SAIC	Science Applications International Corporation
SDGI	Supplemental Data Gap Investigation
SLERA	Screening Level Environmental Risk Assessment
SSL	Soil Screening Level
SSSL	Site-specific Screening Levels
SVE	Soil Vapor Extraction
TBC	To Be Considered
TCE	Trichloroethene
TOC	Total Organic Carbon
UIC	Underground Injection Control
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
UU/UE	Unlimited Use and Unrestricted Exposure
VC	Vinyl Chloride
VI	Vapor Intrusion
VOC	Volatile Organic Compound
ZVI	Zero Valent Iron

1.0 INTRODUCTION

A previous Feasibility Study (FS; Leidos, February 2014) was concurred with by the Alabama Department of Environmental Management (ADEM, May 2014) in 2014 for Organizational Maintenance Shop #28 (OMS #28, the “site”) located in Mobile, Alabama. Based on subsequent field activities and the associated results for a Supplemental Data Gap Investigation (SDGI) conducted for site soil and groundwater by AECOM Technical Services, Inc. (AECOM) between April 2017 and March 2018 (AECOM, 2019a), which included the discovery of an unrelated tetrachloroethene (PCE) spill on a vacant offsite parcel, and an updated site Risk Evaluation (AECOM, 2019b; revised in 2022 and 2023 based on ADEM comments), this new FS has been prepared for OMS #28.

Environmental investigation and cleanup at OMS #28 is conducted in accordance with Defense Environmental Restoration Program (DERP) requirements (Department of Defense [DoD], 2018). The DERP follows the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and National Contingency Plan (NCP) processes, consistent with DERP guidance. This FS for OMS #28 represents the United States Army’s compliance with both DERP and CERCLA requirements.

The purpose of an FS within the framework of CERCLA is to identify, screen, develop, and evaluate the most appropriate and effective range of contaminated media management options that ensure the protection of human health and the environment from identified hazardous substances at a contaminated site. This FS screens remedial technologies and process options and develops remedial alternatives that may be appropriate for addressing contamination present at OMS #28. Per DERP guidance (DoD, 2018), at least three remedial alternatives for each media of concern have been developed. These include no action, action to remediate the site to a protective condition with land use controls (i.e., land use controls [LUCs] or exposure controls), and action to remediate the site to a condition that allows unlimited use and unrestricted exposure (UU/UE). This FS develops and evaluates remedial alternatives for OMS #28, and it was prepared in accordance with guidance of the United States Army Corps of Engineers (USACE) and the United States Environmental Protection Agency (USEPA), including *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA, 1988).

A Proposed Plan will be developed following approval of the FS. Pursuant to Section 117 of CERCLA, a public notice and brief analysis of the Proposed Plan will be made available to the local community, and a reasonable opportunity will be provided to receive written and oral comments. The public notice will state that a public meeting to discuss the Proposed Plan will be provided if there is significant public interest.

1.1 PURPOSE

The purpose of this FS is to identify remedial action objectives (RAOs) and identify and screen remedial alternatives that address the risks and hazards caused by historical activities conducted on Alabama Army National Guard (ALARNG) property at OMS #28. The FS also provides justification for the exclusion of responsibility and remediation for offsite PCE soil and groundwater contamination,

1.2 REPORT ORGANIZATION

This FS is organized in the following six sections. The introduction (**Section 1.0**) provides the purpose, report organization, background information, and current site description. **Section 2.0** identifies the media of concern and remedial action objectives (RAO), discusses the applicable or relevant and appropriate requirements (ARAR), and presents remedial goals (RG). **Section 3.0** identifies and screens potential remedial technologies. **Section 4.0** further evaluates the remedial technologies carried through the initial screening process by developing remedial alternatives and completing a detailed analysis. **Section 5.0** compares the remedial alternatives. **Section 6.0** provides the references cited in the FS.

1.3 SITE BACKGROUND

The following subsections provide a site description, brief site history and background, and site investigation summary.

1.3.1 Site Location and Information

OMS #28 is located in Mobile County, near downtown Mobile at 1622 South Broad Street, between U.S. Interstate Highway 10 (I-10) and Mobile Bay (**Figure 1-1**). The site is bordered by undeveloped land and I-10 to the west; commercial and residential property to the north, the Fort Floyd A. McCorkle ALARNG facility building to the east; and commercial and industrial properties to the south (**Figure 1-2**). The surface features consist of vegetative cover comprised primarily of oak trees, scrub trees, grasses, and brush. The nearest residential structure is approximately 150 feet northeast of the OMS #28 maintenance building.

OMS #28 is located in the northwest corner of the former Brookley Air Force Base (AFB). The former AFB is now called the Brookley Aeroplex. The initial 1,000 acres of the AFB were acquired by DoD in 1938 with additional land acquisitions through 1955 totaling 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. Facilities at the Brookley Aeroplex include runways and maintenance areas for aircraft, underground and aboveground fuel storage facilities, associated buildings, roads, housing, and landfills. There are no human consumption or agricultural wells located within the boundaries of the Brookley Aeroplex. Currently, the Brookley Aeroplex is utilized as an industrial complex and airport by the MAA (Scientific Applications International Corporation [SAIC], 2013).

The Alabama Armory Commission owns the 5.9 acres of property on which OMS #28 is located, and ALARNG operates the Field Maintenance Shop (FMS), which was 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 to the City, and the City subsequently conveyed the property to the MAA (SAIC, May 2013).

The ALARNG renamed OMS #28 to FMS #28 several years ago; however, the site is referred to as OMS #28 in all previous ALARNG, ADEM, and USACE investigation reports. As such, in order to avoid confusion, the site is referred to herein as OMS #28. According to ALARNG personnel, site operations have not significantly changed since conversion to FMS #28 (Louis Berger, 2015).

1.3.2 Site History and Background

The Site has undergone numerous development, redevelopment, and organizational periods since initial development. The original/former OMS #28 building was constructed in the early 1950s, and the original OMS #29 building was constructed in the 1960's. The current OMS #28 building was constructed in 1978, and operations were transferred to it from the old/original building. The original/former OMS #28 building was used for storage from 1978 until its demolition in 2001. Operations within OMS #29 were also transferred to the new OMS #28 building, and the old OMS #29 building was subsequently used for storage and eventually demolished. The new OMS #28 building was expanded in 1994 to accommodate a greater volume of work. Currently, the OMS #28 building and associated property are used for vehicle staging and maintenance as well as for direct support for military police, medical, signal, communications, and field artillery units (Louis Berger, 2015).

A vehicle wash pad was formerly located in the far northwestern corner of the parking lot until 1978 (**Figure 1-2**). The wash pad was constructed as a concrete slab with no drainage system in place. Military vehicles were routinely washed in this area, and the wash water that was generated flowed freely onto the ground.

Four underground storage tanks (UST) were removed from three separate locations (i.e., Pit 1, Pit 2, and Pit 3) at the site in October 1992. Upon removal of a single 2,000-gallon gas/diesel UST at Pit 2, petroleum-related soil and groundwater contamination was identified; however, a preliminary sampling effort was unable to determine the nature and extent of the contaminants. Additional investigation in December 1994 reportedly completely delineated the extent of petroleum-related soil and groundwater contamination associated with Pit 2.

Quarterly groundwater monitoring for petroleum-related contaminants subsequently began in 1995 and continued through 2004. When analysis of quarterly groundwater sampling results indicated that petroleum contamination had migrated beyond the original site monitoring well network installed during the December 1994 groundwater investigation, further site characterization was determined to be necessary. This additional site characterization work was conducted in 2004 and 2005 by Bechtel-S and consisted of the installation of additional monitoring wells at the site in another attempt to delineate petroleum contamination associated with Pit 2 (Louis Berger, 2015). **Figure 1-2** shows the investigation area and relevant historical features.

In March 2005, TCE was detected at a concentration of 480 micrograms per liter (µg/L) in groundwater at the site for the first time in monitoring well (MW)-8. MW-8 is located approximately 40 feet east of the former vehicle wash pad. The presence of TCE in MW-8 was determined to be unrelated to the petroleum tanks that were removed from the site in the fall of 1992; however, the source of the TCE was unknown. In April/May 2006 and March 2007, soil containing TCE was detected in discrete samples collected to east of the former vehicle wash pad. Installation and sampling of additional monitoring wells in November 2008 achieved delineation of the horizontal and vertical extents of TCE and PCE groundwater contamination at the site (Louis Berger, 2015).

Historically, TCE was documented at 11 µg/L at offsite monitoring well MW-10 and 63 µg/L at MW-11 in 2006. PCE was also detected in MW-10 at 4.9 µg/L. These monitoring wells were installed northwest of the OMS #28, on private property. Monitoring wells MW-10 and MW-11 were only sampled once and were abandoned in 2008 at the property owner's request. These wells have not been replaced (Louis Berger, August 2015). Based on contemporaneous analysis of the 2010 groundwater data, the groundwater flow direction did not appear to indicate that the plume was or would impact the properties to the north of the OMS #28 building. These properties were thought to be outside and/or up gradient of the source and groundwater flow direction.

Groundwater compliance monitoring was conducted at the site in December 2008, May 2009, September 2009, March 2010, and September 2010 at monitoring wells MW-5, MW-6, MW-8, MW-9, MW-12, and OMS-28-1 through OMS-28-7. The monitoring effort was implemented to document and monitor groundwater conditions at the site (Louis Berger, August 2015).

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

An RI Report, prepared by SAIC, documented a groundwater plume that contained TCE above its United States Environmental Protection Agency (USEPA) Drinking Water Maximum Contamination Limit (MCL) that was present across the site and adjacent properties within the shallow surficial aquifer. A smaller PCE plume was also reported within the larger TCE plume boundary and was located on the adjacent MAA property. The RI documented that the horizontal extent of the TCE boundary in the area of the undeveloped properties to the north and northwest, as well as the vertical extent of the TCE groundwater plume, had not been fully delineated (SAIC, 2013).

Based on the investigative work completed prior to 2015, the potential source area for the TCE plume appeared to be within the vicinity of MW-8, which also corresponded with the largest suspected area of residual soil contamination. MW-8 is located approximately 40 feet to the east of the former wash pad along the westernmost boundary of OMS #28 in an area where military vehicles and equipment are currently stored. PCE groundwater contamination appeared to be limited to the area surrounding monitoring well OMS-28-5, which is located over 200 feet northwest of the fenced ALARNG property within a densely wooded area on MAA property, near its northern boundary with vacant property (**Figure 1-2**).

During a 2015 site reconnaissance conducted by Louis Berger with the OMS#28 supervisor and a former ALARNG employee, the former ALARNG employee indicated that the former washpad was operational until 1978. The washpad was constructed as a concrete slab with no drainage system. Military vehicles were routinely washed in this area, and the wash water was allowed to flow freely onto the surrounding ground surface (**Figure 1-2**).

During this same site reconnaissance, the former ALARNG employee stated that communication equipment repair and cleaning was also conducted as a former on-site operation at OMS#28. While neither the OMS#28 supervisor nor the former ALARNG employee were familiar with the on-site use of any TCE and/or PCE, the former ALARNG employee did identify the former use of “Gunk” cleaning agent at the site in the 1960s and 1970s. The former employee further stated that “Gunk” was used during the same time period as when the former washpad was operational, but he had no knowledge of its use in the vicinity of the washpad. According to a Material Safety Data Sheet (MSDS) obtained by Louis Berger, Gunk Electric Motor Contact Cleaner contains 90-100 percent (%) PCE (Louis Berger, 2015). No official written record of its use were discovered during the site visit.

A concrete pad measuring approximately 50 feet wide by 50 feet long was observed in the wooded area approximately 50 feet west of the fenced ALARNG property (**Figure 1-2**). The concrete pad was noted to correspond with the approximate former location of “Mollison Hall” as depicted on historical Sanborn Maps and is possibly a building foundation remnant. Online research by Louis Berger suggested that Mollison Hall was used as a recreational building for soldiers before and after World War II and is therefore, not suspected to be associated with the TCE and PCE soil and groundwater contamination observed. A historical aerial photograph review indicated that Mollison Hall had been demolished between 1972 and 1974, and only a concrete foundation remained (Louis Berger, 2015).

Based on the results of the RI, an FS was completed following submittal of the RI Report (SAIC, 2013). The remedial alternative recommended in the FS was biological/chemical treatment of groundwater and the excavation of select soil areas. The recommended alternative (Alternative 4) included the proposed injection(s) of an engineered emulsified vegetable oil (EVO) substrate package or other carbon source with zero valent iron (ZVI) and a potassium bicarbonate buffer for the treatment of TCE and PCE contained in groundwater above their respective MCLs. To expedite the remedial time frame for groundwater following injection activities, this alternative also included the excavation of the residual soil mass (i.e., soil with TCE and PCE impacts above their respective soil screening level [SSL] for the protection of groundwater) that may act as a continuing source for groundwater contamination via leaching (Leidos, 2014). The FS was concurred with by ADEM in May 2014 (ADEM, 2014).

In order to successfully implement Alternative 4, the ALARNG determined that the site’s conceptual site model (CSM) required further refinement. To complete this task, AECOM was contracted to conduct a SDGI at OMS #28. The objectives of the SDGI were to conduct an investigation to identify if other soil source areas were contributing to site groundwater contamination and to improve the delineation of the known groundwater contaminant plume. Locations for additional monitoring wells were also to be proposed based on the results of the groundwater delineation activities (AECOM, 2016). A summary of the SDGI findings is presented in **Section 1.3.4**.

A Risk Assessment Report (AECOM, 2019b) was also prepared as part of the site SDGI activities using the soil and groundwater results from samples collected during the SDGI. The Risk Assessment Report, Revision 1 was subsequently prepared to address ADEM comments dated February 25, 2021 (ADEM, 2021a) and additional ADEM comments received on November 10, 2021 (ADEM, 2021b). The Risk Assessment Report, Revision 1 (AECOM, 2022) was submitted to ADEM for review on May 19, 2022. ADEM comments provided in a letter dated October 12, 2022 (ADEM, 2022) and additional informal review comments provided in an email from Colin Mitchell dated January 11, 2023 were received for the Risk Assessment Report, Version 1. Based on these comments, Risk Assessment Report, Revision 2 was issued to ADEM on March 9, 2023. ADEM concurred with the Risk Assessment Report, Revision 2 on May 26, 2023 (ADEM, 2023). A summary of the Risk Assessment Report, Revision 2 (AECOM, 2023) is provided in **Section 1.3.6**.

1.3.3 Site Investigation Summary

As previously described, the original investigations at OMS #28 focused on the contamination associated with the UST located at Pit 2. The UST-related investigations that have been performed at OMS #28 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 Group, Inc., 1992),
- Preliminary Investigation Report, OMS #28 Pit #2 (P.E. LaMoreaux and Associates, Inc.[PELA], 1993),
- Underground Storage Tank Secondary Investigation Report, Alabama National Guard Armory, OMS#28 and 29 – Pit #2 (PELA, 1994), and
- Secondary Investigation Addendum Report (Bechtel-S, 2005).

ADEM subsequently determined that no further subsurface investigation was required for the UST located at Pit 2 (correspondence dated January 19, 2007, from the ADEM UST Corrective Action Section [ADEM, 2007]). A comprehensive summary of the UST-related investigations conducted at the site are summarized in the RI Report (SAIC, 2013).

Chlorinated solvents-related investigations conducted following the discovery of TCE in MW-8 in March 2005 were documented in the following reports:

- TCE Comprehensive Investigation Report for OMS #28 (Aerostar, 2007),
- Supplemental Comprehensive Investigation Report for OMS #28 (Aerostar, 2008),
- Supplemental Comprehensive Investigation Groundwater Monitoring Reports for OMS #28 (Aerostar, 2009a, 2009b, 2009c, 2010, 2011a),
- Alabama Risk-Based Corrective Action Report for OMS #28 (Aerostar, 2011b),
- RI Report for OMS #28 (SAIC, 2013),
- FS for OMS #28 (Leidos, 2014), and
- Historical Research Study Report (Louis Berger, 2015).

1.3.4 Supplemental Data Gap Investigation Summary

The objectives of the SDGI that was conducted by AECOM between April 2017 and March 2018 were to:

- Determine if additional soil sources could be located that were contributing to site groundwater contamination; and
- Improve the delineation of the existing groundwater plume.

The results of the SDGI were used to update the current CSM (presented in **Section 1.3.5** of this report).

Based on the characteristics of the site and patterns of contamination and receptor exposure, the site was divided into the following seven parcels for the SDGI:

- Parcel A - Undeveloped parcel northwest of the site (parcel is currently owned by the City of Mobile Water and Sewer Commission),
- Parcel B - Undeveloped parcel northwest of the site (parcel is currently owned by Armstead Diggs),
- Parcel C - Undeveloped parcel northwest of the site (parcel is currently owned by the Duval @ Broad, LLC,
- Parcel D – Undeveloped parcel northwest of the site (parcel is currently owned by Minda Carol Petty,
- Parcel E – Developed ALARNG property,
- Parcel F – Undeveloped MAA parcel west of the site, and
- Parcel G – I-10 Service Road.

An additional parcel, Parcel H (currently owned by Elnora Smith), is located immediately adjacent to and east of Parcel D. This parcel has a residential home located on it; however, SDGI activities were not conducted on Parcel H because access to this parcel was unable to be obtained. Groundwater grab samples collected along the property line between Parcel D and Parcel H, all had detections below the applicable MCLs. All eight parcels (A through H) in conjunction with associated SDGI sample locations are shown on **Figure 1-3**.

The SDGI concluded that the objectives of the investigation were achieved, and that soil source areas and groundwater contaminant plumes were sufficiently delineated to proceed to the design phase of the remedial alternatives. An offsite soil source of PCE was discovered during the SDGI on Parcel A approximately 20 feet north of the northwest MAA parcel boundary. This offsite PCE source was determined to be unrelated to historical ALARNG activities conducted on Parcel E. A summary of this offsite PCE source is presented in detail in **Section 1.3.7**. A comprehensive summary of SDGI field activities, the associated results, and conclusions are presented in the Supplemental Data Gap Investigation and Groundwater Monitoring Report (AECOM, 2019a).

1.3.5 Current Site Description

This subsection presents a current site description. Relevant information is summarized from the RI Report (SAIC, 2013), the 2014 FS Report (Leidos, 2014), the Historical Research Study Report (Louis Berger, 2015), and from the Supplemental Data Gap Investigation and Groundwater Monitoring Report (AECOM, 2019a).

1.3.5.1 Physiography and Topography

The Brookley Aeroplex lies entirely within the East Gulf Coastal Plain physiographic section, Alluvial-Deltaic Plain District, Coastal Lowlands District. The Coastal Lowlands District area is 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 feet of elevation. The barrier islands and tidal marshes in the area undergo continual modification by erosion and deposition (SAIC, 2013).

The Brookley Aeroplex is relatively flat with an elevation of approximately 20 to 30 feet above mean sea level (MSL). OMS #28 is located in the northeast corner of the Brookley Aeroplex where the elevations are closer to 30 feet above MSL (SAIC, 2013). Large areas along the Mobile and Tensaw Rivers as well as along the coast are characterized by low-lying, swampy terrain and brackish water. The Brookley Aeroplex is included within this area (SAIC, 2013).

1.3.5.2 Current Site Land Use

The Brookley Aeroplex encompasses 1,700 acres and is home to more than 100 businesses. The Brookley Aeroplex is divided into two distinct land areas: the airfield and the industrial park. The Brookley Aeroplex is located within Mobile County. Much of the land in Mobile County is used for industrial and agricultural purposes (Leidos, 2014).

The current land use for OMS #28 (ALARNG property, Parcel E) is based on a site reconnaissance performed by Louis Berger on March 31, 2015 and April 30, 2015 (Louis Berger, August 2015). The site is currently developed with the new OMS #28 building and several other smaller storage buildings. The ancillary storage buildings contained items such as miscellaneous wood items, fans, vehicle ramps, fire extinguishers, and miscellaneous metal. Each storage building is constructed as slab-on-grade. No operations, other than storage, are performed in these buildings. The majority of the OMS #28 site is developed with concrete-paved driveways and vehicle storage areas. Some areas of the site are unpaved and used for vehicle storage (Louis Berger, 2015). Current land use for the ALARNG property (Parcel E) is industrial/commercial.

The majority of the OMS #28 building consists of five vehicle bays (10 total workspaces) where routine maintenance on military vehicles is performed. The remainder of the building consists of office space and a break room. Servicing of military vehicles includes fluid changes and routine inspections to ensure safety and functionality. Waste oil generated in the work bays is deposited into one of two aboveground waste oil storage tanks located along the north side of the building. Other waste vehicle fluids are containerized in 5- or 55-gallon drums and stored in a designated “Hazardous Materials Storage Area” or “Petroleum Products Storage Area” until pick-up and offsite disposal by an outside contractor is conducted on an as-needed basis (Louis Berger, 2015).

Two vehicle wash racks are present at the site and are connected to a single oil/water separator. One wash rack is located north of the OMS #28 building and the other is located west of the building. According to onsite personnel, the northern wash rack is rarely used because the drain easily clogs. The western wash rack is equipped with a large hydraulic oil lift system capable of lifting large/heavy military vehicles. A trench drain at this rack flows into an underground cistern where the oil and water mixture separates (Louis Berger, 2015).

Land use for parcels A, B, C, D, and F is currently undeveloped.

1.3.5.3 Groundwater Use

According to the RI Report for OMS #28, there are no water supply wells within a 1,000-foot 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 all potable water for drinking and other uses being provided by the public water supply system. Potable water is supplied to the OMS #28 building by the City of Mobile municipal water supply. No future development of shallow groundwater onsite or on nearby offsite locations is likely because of the readily available public water supply and because of the poor production potential of the surficial aquifer (SAIC, 2013).

1.3.5.4 Surface Water Hydrology

Surface flow from storm water runoff varies across the site due to surface grade, vegetation, and porous surface medium (SAIC, 2013). During a 2015 site reconnaissance of the wooded property (Parcel F) located to the west of the ALARNG property (Parcel E), standing water and a drainage ditch which ultimately flowed away from the site to the west toward the railroad tracks was documented. A small potential ditch was observed running west away from the former wash pad, ultimately connecting to the area of standing water. No pipes or drains were observed during the reconnaissance (Louis Berger, 2015).

During completion of the SDGI, no drainage ditch was observed on the MAA property as previously documented during the 2015 site reconnaissance. Near MW-9, standing water was observed following heavy rainfall. This area is lower in elevation than the surrounding area. No surface water bodies were observed on ALARNG Property (Parcel E), MAA property (Parcel F), or the nearby private properties (Parcels A through D) during the SDGI activities (AECOM, 2019a).

1.3.5.5 Site Geology

According to the Supplemental Comprehensive Investigation Report for OMS #28 (Aerostar, November 2008), the general site geology with some exceptions was as indicated below:

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

bgs where clayey sand extended to a depth of 104 feet bgs. Sandy clay and silty clay were encountered from 104 feet bgs to boring termination depth at 120 feet bgs.

A geologic cross section from the RI (SAIC, 2013) and updated geologic cross sections completed as part of the SDGI (AECOM, 2019a) are located in **Appendix A**.

1.3.5.6 Site Hydrogeology

Previous site investigations determined that the shallow surficial aquifer generally flowed to the northwest. The average horizontal flow velocity was estimated to range between 2.8 and 4.5 feet per year (Leidos, February 2014). The depth to water fluctuates between approximately 3 and 11 feet bgs and is dependent on the time of year.

A groundwater elevation map of the shallow surficial aquifer is depicted on **Figure 1-4** and is based on the May 2017 water elevation measurements for nine gauged wells screened in the shallow surficial aquifer and site environmental sequence stratigraphy conducted during the SDGI. Based on this figure, the apparent groundwater flow direction for the surficial aquifer appears to be dominated by a local trough feature (paleochannel) running north-south between monitoring well OMS-28-5 on the northwest side of this trough and monitoring well OMS-28-7 on the southeast side of this trough. Shallow surficial aquifer groundwater flow converges from each side of this trough feature (paleochannel) before apparently turning to the north and northwest.

The previously established general hydrostratigraphy at OMS #28 consists of an upper sandy unit (shallow aquifer) and a lower sandy unit (lower aquifer) separated by a thick clay confining unit. The RI Report states that the upper sandy unit extends from approximately 5 feet bgs to depths ranging from 16 feet to 35 feet bgs (SAIC, 2013). Below the upper sandy unit, a stiff gray clay (confining unit) was encountered, which extends to a depth between 70 feet and 84 feet bgs in borings across the Site. Beneath the confining unit, a course-grained sand was encountered to a depth of 90 feet bgs followed by clayey sand to a depth of 104 ft bgs (SAIC, 2013). Sandy clay and silty clay were encountered from a depth of 104 ft bgs to 120 ft bgs, which was the termination depth of the exploratory boring.

Initially for the SDGI, the shallow surficial aquifer was further refined into three separate units (AECOM, 2019a). These three units included the following:

- Upper Surficial unit: extends from the water table, ranging in depth from 6 to 13 feet bgs, and typically comprised of fine-grained material without any significant coarse-grained material zones,
- Middle Surficial unit: indicated by the first coarse-grained material zone approximately 4 to 6 feet thick and ranging in depth from 12 to 26 feet bgs, and
- Lower Surficial unit: sits on top of the thick clay confining unit that separates the shallow surficial aquifer from the deep aquifer that was first identified during the RI. Indicated by the second coarse-grained material zone, approximately 3 to 5 feet thick, and encountered at greater than 26 feet bgs.

Because there was no semi-confining unit identified during the SDGI that separated the Upper and Middle Surficial aquifer units, migration of groundwater between the units is not impeded. As a result, the SDGI recommended that the Upper and Middle Surficial aquifer be combined into one aquifer zone called the

Upper/Middle Surficial aquifer unit based on the geology and hydrogeology defined through the hydraulic profiling tool/electrical conductivity data collected during the SDGI and visual interpretation of the geology. The SDGI further recommended that the Lower Surficial aquifer unit should remain separate based on the semi-confining layer separating it from the Upper/Middle Surficial aquifer unit.

1.3.6 Risk Assessment Summary

A Risk Assessment Report (AECOM, 2019b) was prepared as part of the site SDGI activities to update and refine the risk estimates presented in the 2013 RI/BRA (SAIC, 2013) using the soil and groundwater results from samples collected during the SDGI. The Risk Assessment Report, Revision 1 was subsequently prepared to address ADEM comments dated February 25, 2021 (ADEM, 2021) and additional ADEM comments received on November 10, 2021 (ADEM, 2021b). The Risk Assessment Report, Revision 1 (AECOM, 2022) was submitted to ADEM for review on May 19, 2022. ADEM comments provided in a letter dated October 12, 2022 (ADEM, 2022) and additional informal review comments provided in an email from Colin Mitchell dated January 11, 2023 were received for the Risk Assessment Report, Version 1. Based on these comments, Risk Assessment Report, Revision 2 was issued to ADEM on March 9, 2023. ADEM concurred with the Risk Assessment Report, Revision 2 on May 26, 2023 (ADEM, 2023). A summary of the Risk Assessment Report, Revision 2 (AECOM, 2023) is provided in the following subsections.

1.3.6.1 Human Health Risk Assessment

The human health risk assessment (HHRA) conducted for the Risk Assessment Report, Revision 2 (AECOM, 2023) was conducted for the eight lettered parcels shown on **Figure 1-3** (Parcels A through H) in order to evaluate potential risk to human receptors at the site. For this assessment, risks and hazards were first determined and subsequently site-specific target levels (SSSLs) were developed for those receptors potentially exposed to site-related contaminants identified as chemicals of concern (COCs) in surface soil, subsurface soil, and groundwater at the eight separate parcels. Potential receptors and exposure pathways were evaluated based on current and future land-use scenarios. **Table 1-1** provides a summary of the SSSLs that were developed for the HHRA using the most recent USEPA RSL table (USEPA, 2022). A summary of the HHRA is provided below:

1.3.6.1.1 Current Exposure Scenario

Under current conditions, potential surface-soil exposure routes are complete for trespassers at Parcels A through G and for an industrial worker at Parcel E, where an existing maintenance/office building is located. Potential exposure pathways at Parcels A through G for a trespasser and at Parcel E for an industrial worker include exposure to COPCs in surface soil through incidental ingestion, dermal absorption, and inhalation of airborne vapors.

At the three parcels from which soil samples were collected (Parcels A, E, and F), only Parcel A had a COPC (PCE) identified based on exposure to both surface soil and subsurface soil. Risk and hazard were calculated for a current trespasser at Parcel A but were below target risk and hazard levels. Risk and hazard were not calculated for a current industrial worker at Parcel E since no COPCs were identified in soil at this parcel, and no groundwater plume is within 100 feet of the building currently used by industrial workers.

Inhalation of volatile organic compounds (VOCs) in groundwater via vapors migrating from groundwater to indoor air is a potentially complete exposure route identified only for a current resident living on Parcel H and exposed to VOCs from groundwater beneath Parcel D. Although there are no residential structures located on Parcel D, there is a residential home on Parcel H adjacent to Parcel D and within 100 feet of the TCE plume beneath Parcel D. According to USEPA guidance, a VOC plume within 100 feet of an occupied structure provides a potential exposure pathway via vapor intrusion and indoor air inhalation. Risk and hazard were calculated for a current adult and child resident on Parcel H but were below target risk and hazard levels.

Therefore, under the current exposure scenario, there is no risk or hazard identified from exposure to surface or subsurface soil or from groundwater via vapor intrusion at any of the parcels on the area of investigation.

1.3.6.1.2 Future Exposure Scenario

Under future conditions, the receptors with a potential for exposure to site-related contaminants are trespassers, industrial workers, construction workers, and hypothetical on-site residents. Potential exposures to surface soil at Parcels A through G for a trespasser in the future would remain the same as under current conditions. Potential exposure pathways for future industrial workers at Parcels A through G include exposure to COPCs in surface soil through incidental ingestion, dermal absorption, and inhalation of airborne vapors and subsurface soil through incidental ingestion and dermal absorption. Industrial workers are assumed to be exposed to subsurface soil that has been excavated during construction of an industrial building and spread on the surface. Future industrial workers also are assumed to be exposed to groundwater via direct contact (ingestion and dermal) and the inhalation of VOCs in groundwater via vapors migrating from groundwater to indoor air (vapor intrusion).

Potential exposure pathways for future construction workers at Parcels A through G include exposure to COPCs in soil and groundwater through incidental ingestion, dermal absorption, and inhalation of vapors from groundwater while working in excavations that extend below the water table.

For future adult and child residents, potential exposure pathways at Parcels A through G include exposure to COPCs in surface soil through incidental ingestion, dermal absorption, and inhalation of airborne vapors and subsurface soil through incidental ingestion and dermal absorption. Residents were assumed to be exposed to subsurface soil that has been excavated during construction of a residence and spread on the surface. It was conservatively assumed that exposures to site groundwater could occur using an on-site well as a potable water source, with exposure occurring through direct ingestion, dermal contact, inhalation of vapors during showering and other household uses of water from an on-site well, and inhalation of groundwater VOCs in indoor air via the vapor intrusion pathway.

Based on the risk assessment, there is some level of carcinogenic risk and/or non-carcinogenic hazard for future receptors (construction workers, industrial workers, and/or residents) on Parcels A through F. There is no future risk for construction workers, industrial workers, and/or residents on Parcel G, and there is no future risk for residents on Parcel H.

1.3.6.1.3 Chemicals of Concern

No site-related COCs were identified for the current exposure scenarios presented above. The following site-related COCs were identified in the HHRA for the future exposure scenarios described above.

Parcel A

Future Construction Worker - PCE in surface soil, PCE in subsurface soil, PCE and TCE in groundwater

Future Industrial Worker - PCE in surface soil, PCE and TCE in groundwater

Future Resident Adult - PCE in surface soil, PCE and TCE in groundwater

Future Resident Child - PCE in surface soil, PCE and TCE in groundwater

Parcel B

Future Construction Worker - TCE in groundwater

Future Resident Adult – TCE in groundwater

Parcel C

Future Construction Worker - TCE in groundwater

Parcel D

Future Construction Worker - TCE in groundwater

Future Resident Adult - TCE in groundwater

Future Resident Child - TCE in groundwater

Parcel E

Future Construction Worker - TCE in groundwater

Future Industrial Worker - TCE in groundwater

Future Resident Adult – TCE and VC in groundwater

Future Resident Child - TCE in groundwater

Parcel F

Future Construction Worker – PCE and TCE in groundwater

Future Industrial Worker – PCE and TCE in groundwater

Future Resident Adult – cis-1,2-DCE, PCE, TCE, and VC in groundwater

Future Resident Child – cis-1,2-DCE, PCE, and TCE in groundwater

1.3.6.2 Ecological Risk Assessment

The Ecological Risk Assessment (ERA) completed for the March 2019 Risk Assessment Report (AECOM (2019b) consisted of a screening level ecological risk assessment (SLERA). The results of the SLERA determined that further evaluation of ecological risk was not warranted (AECOM, 2019b). Based on comments received from ADEM dated February 25, 2021, the ERA was continued beyond the original SLERA into Step 3.1, Refinement of Preliminary Contaminants of Potential Environmental Concern (COPEC), in order to further evaluate potential risk to small mammals caused by the PCE hotspot in soil at Parcel A. The results of the additional ecological evaluation were presented in Section 4.3.4, Ecological Risk Characterization, in the Risk Assessment Report, Revision 2 (AECOM, 2023).

Section 4.3.4 concluded that the results of additional ecological risk characterization and other lines of evidence indicated that the potential for exposure and risk to ecological receptors is minimal. PCE in surface soil, the only COPEC identified and located on Parcel A, warrants identification as a final COPEC due to its high concentrations within a small area of surface soil. However, the potential for significant exposures of multiple individual receptors is very small, and even if an individual receptor was affected, the population in this area would not be noticeably affected. Given the predicted lack of observable effects on populations, the risk would not be ecologically significant.

1.3.7 Nature and Extent of Contamination Summary

Chlorinated VOCs are present in site soil and groundwater but not in surface water or sediments, as no surface water bodies are located on or near the site. The following subsections describe the nature and extent of chlorinated VOCs in site soil and groundwater.

1.3.7.1 Soil

The 2014 FS (Leidos, 2014) identified three areas of soil that were impacted with soil above the PCE and TCE protection of groundwater SSLs (0.0023 milligrams per kilogram (mg/kg) and 0.0018 mg/kg, respectively). These three areas of impacted soil were based on soil samples that were collected during site investigations conducted between April 2006 and March 2008 (**Figure 1-5**). Additional soil sampling conducted during the SDGI using direct push technology (DPT) was used to further define these three areas and to determine if additional soil sources could be located that were contributing to site groundwater contamination (**Figures 1-6 through 1-8**). Note that in the FS text and FS tables, SDGI soil boring locations are referred to using the format OMS-28-SB##, while the FS figures use the format SB##. The OMS-28 is dropped in the FS figures to avoid making them overly cluttered and hard to view.

Area 1 is located primarily on ALARNG property (Parcel E; **Figure 1-9**). Of the 15 locations where soil samples were collected, TCE-impacted soil above its protection of groundwater SSL was detected at 9 locations. PCE was detected at 3 locations at concentrations that slightly exceeded its SSL (estimated concentrations of 0.00252 mg/kg, 0.00253 mg/kg, and 0.00505 mg/kg at HA-5, HA-7, and HA-13), respectively. The area of MCL-based protection of groundwater SSL exceedances identified in the 2014 Leidos FS is located in an approximate 70 foot (ft) by 80 ft area near MW-8. Soil sampling conducted during the SDGI confirmed that the impacted area had not increased in size from what was previously presented in the 2014 FS.

At the time of the April 2006 to March 2008 investigation, there were no exceedances of the residential or industrial soil RSLs at Area 1; however, a decrease of the residential RSL for TCE from 0.91 mg/kg to the current residential RSL for TCE of 0.41 mg/kg (USEPA, 2023) now indicates an exceedance of the current residential RSL for TCE at one soil sample location. At HA-15, which was collected in March 2007, TCE was detected at a concentration of 0.586 mg/kg. This concentration is above the residential RSL in surface soil (0-1 ft bgs) based on a carcinogenic risk of 1E-06 and a hazard quotient of 0.1. This is the only location that presents a risk to human health under a residential scenario; however, based on the Alabama Risk-Based Corrective Action Guidance Manual, Revision 3.0 (ADEM, 2017), cumulative risk to human health is based on a carcinogenic risk of 1E-05 and a hazard index of 1.0. Based on this information, the residential RSL for TCE in soil is 4.1 mg/kg, and therefore, the soil detection at HA-15 does not present a risk. The soil results at Area 1 do however have the potential for the ongoing leaching of TCE, and to a much lesser extent the ongoing leaching of PCE, to the underlying groundwater.

With regards to the leaching potential of TCE and PCE at Area 1, Mann-Kendall analysis was conducted for two site monitoring wells, one located on Parcel E, and one located immediately downgradient of Parcel E on Parcel F. Upper/Middle Surficial aquifer well MW-08 is located within the Area 1 soil footprint and the second Upper/Middle Surficial aquifer well, OMS-28-3, is located approximately 60 feet north of MW-8. Both of these wells have historically had TCE detected above the MCL, cis-1,2-DCE detected below the MCL, and VC has never been detected. PCE has also never been detected in either well, which indicates that leaching of PCE from the historical low level detections in surface soil is not occurring. A Lower Surficial (below the clay confining unit) aquifer monitoring well (OMS-28-6) was also located within the Area 1 footprint; however, TCE and any other VOCs have never been detected between the time of its installation in July 2008 until it was destroyed sometime after September 2010.

Mann-Kendall analysis is a non-parametric statistical procedure that can be used for analyzing trends in data over time. In this case, it was used to analyze TCE concentrations in MW-08 and OMS-28-3 over time using all groundwater analytical data collected to date (**Table 1-2**). The Mann-Kendall output for MW-08 indicated a decreasing trend for TCE, and the output for OMS-28-3 showed a probably decreasing trend for TCE. A review of the data for MW-08 indicates that TCE has decreased from 480 μg/L in March 2005 to an estimated concentration of 0.373 μg/L during the most recent sampling event conducted in May 2017. At OMS-28-3, TCE decreased from a high of 149 μg/L in September 2010 to 9.6 μg/L in May 2017. These results support the observation that ongoing leaching of TCE in soils at Area 1 and the surrounding vicinity is not occurring. Mann-Kendall analysis output for MW-08 and OMS-28-3 is presented in **Appendix B**.

Area 2 was originally an approximate 20 ft by 20 ft area of PCE-impacted soil above the MCL-based protection of groundwater SSL located in the northwest corner of MAA property (Parcel F) near soil boring B-17 that was identified in the 2014 FS (Leidos, 2014). Subsequent soil sampling conducted during the SDGI determined that this area of soil impacted with PCE above its MCL-based protection of groundwater SSL had increased in size on Parcel F and also that PCE-impacted soil was present at even higher concentrations on the immediately adjacent vacant property (Parcel A) to the north (**Figure 1-9**). Parcel A is currently owned by the City of Mobile Water and Sewer Commission. During the SDGI, TCE was also detected above its protection of groundwater SSL on Parcel A within the footprint of the soil impacted with PCE. TCE is a common breakdown product of PCE over time.

Two soil sample borings located near the northwest Parcel F boundary (OMS-28-SB18 and OMS-28–SB19) and completed near soil boring B-17 where PCE exceeded the MCL-based protection of groundwater SSL for PCE in March 2007 contained surface soil detections of PCE above the protection of groundwater SSL.

PCE was detected in OMS-28-SB18 above the protection of groundwater SSL between 1.5 and 4-ft bgs. At OMS-28-SB19, PCE was detected above the protection of groundwater SSL at approximately 1 foot above the water table. TCE was also detected (0.0025 mg/kg) at slightly above its MCL-based SSL at this location and depth.

The new soil source area identified during the SDGI on Parcel A is approximately 20 feet north of the northwest MAA parcel boundary. At soil boring OMS-28-SB24, PCE was detected in both the onsite mobile laboratory and offsite fixed laboratory soil samples. In the offsite fixed laboratory sample, PCE was detected above the industrial SSL of 39 mg/kg at a concentration of 329 mg/kg in surface soil and at a concentration of 53.7 mg/kg at 3 feet bgs. PCE was also detected above the residential SSL of 8.1 mg/kg at a concentration of 24.4 mg/kg at a depth of 1 foot above the water table (**Figures 1-6 through 1-8**). As a result, this small area of surface and subsurface soil at Area 2 on Parcel A is the location of a probable PCE spill area and presents a potential future risk to human health. The remainder of Area 2 does not present a risk to human health; however, it does have the potential for ongoing leaching of PCE to the underlying groundwater. An area of approximately 60 ft by 100 ft is estimated to be impacted with PCE and its degradation product TCE above the respective MCL-based protection of groundwater SSLs.

Mann-Kendall analysis was conducted for monitoring well OMS-28-5, which is located approximately 50 ft to the southeast of SDGI soil boring OMS-28-SB24. Mann-Kendall analysis indicates No Trend for the concentration of PCE in this well between July 2008 and May 2017. No Trend indicates significant scatter in the PCE concentration trend over time. TCE shows a probably increasing trend, which indicates the degradation of PCE to TCE over time since the PCE spill occurred. Based on this analysis, the ongoing leaching of PCE and TCE from soil in Area 2 to the underlying groundwater cannot be ruled out. Mann-Kendall analysis output for OMS-28-5 is presented in **Appendix B**.

The origin for the source of PCE on Parcel A is unknown. The old ruins of a small shack were found within 15 feet of soil sample OMS-28-SB24, which had the highest concentration of PCE (329 mg/kg in at 0-1 ft bgs) detected in all of the surface and subsurface samples that were collected during the SDGI. Active railroad tracks also exist within approximately 60 feet of OMS-28-SB24. PCE has only been detected at very low concentrations in soil at three locations (highest concentration of 0.00505 mg./kg) during the 2006-2008 various investigations conducted on ALARNG property (Parcel E). PCE and TCE were not detected in soil during the SDGI conducted at Parcel E. Soil boring OMS-28-SB24 is located over 200 feet northwest of the fenced ALARNG property. Parcel A and Parcel E are also separated by a heavily wooded portion of adjacent MAA property (Parcel F), which makes it even more unlikely that the ALARNG is responsible for the PCE spill discovered on Parcel A. Finally, while the former ALARNG employee admitted that “Gunk”, which contains PCE was used at the site in the 1960s and 1970s, he had no knowledge of its use in the vicinity of the former washpad, and no official written record of its use exists. For these reasons, PCE impacted soil at Parcel A was determined not to be associated with historical ALARNG activities previously conducted at Parcel E, and this parcel is not considered for further evaluation in this FS. Additional justification for the exclusion of the offsite source of PCE from this FS, including the presentation of relevant analytical data from the SDGI, is presented in **Appendix C**.

A third potential source of TCE in groundwater (Area 3) was identified on Parcel F during the installation of MW-9 in October 2006. At this location, the surface soil sample (B-13) concentration (0.0171 mg/kg) exceeded the protection of groundwater SSL for TCE (**Figure 1-5**). An area approximately 15 ft by 15 ft with surface soil impacted by TCE above its MCL-based protection of groundwater SSL was identified in the 2014 Leidos FS. Analytical results for surface and subsurface soil samples subsequently collected during the SDGI within the vicinity of location B-13/MW-9 did not exceed the analytical level of detection (LOD) for TCE and PCE. Furthermore, the groundwater concentration for TCE at MW-9 has never exceeded the laboratory LOD (**Table 1-2**). The SDGI results confirmed that a TCE source leaching to groundwater does not exist in this location.

1.3.7.2 Groundwater

The 2014 FS (Leidos, 2014) identified both a stable PCE plume and a stable TCE plume associated with OMS #28. Besides the investigation of potential additional soil sources associated with OMS #28, the SDGI was conducted to improve the delineation of the existing PCE and TCE groundwater plumes as presented in the 2014 FS. Additional delineation activities consisted of collecting temporary groundwater sampling using DPT for the Upper, Middle, and Lower Surficial aquifer units (**Figures 1-10** through **1-12**). **Figure 1-13** shows the currently estimated extent of the PCE and TCE groundwater plumes based on the SDGI results. The Upper and Middle Surficial units have been combined into one aquifer unit (referred to as the Upper/Middle Surficial aquifer unit for this figure and subsequent sections of this this FS) based on the geology and hydrogeology defined during the SDGI. The Lower Surficial unit remains separate based on the semi-confining layer that separates it from the overlying Upper/Middle Surficial unit.

Based on the results of the SDGI, PCE was not detected in groundwater on ALARNG property (Parcel E). PCE only exceeded the MCL on Parcel A and along the adjacent northwest boundary of Parcel F. The highest concentration of PCE (40,000 μg/L) was detected in the Upper Surficial aquifer at groundwater DPT location GW22 on Parcel A. OMS-28-GW22 is located in close proximity to where the highest concentration of PCE in soil (OMS-28-SB24) was subsequently detected on Parcel A. PCE from the area in the vicinity of OMS-28-SB24 appears to have percolated downward into subsurface soil and impacted the underlying groundwater.

As shown on **Figure 1-10** and **Figure 1-11,** TCE was not detected in the Upper Surficial aquifer at groundwater DPT locations GW15, GW16, and GW17, but it was detected in low concentrations in the Middle Surficial aquifer at GW15 (7.1 µg/L), GW16 (6.0 µg/L), and GW17 (6.7 µg/L). Immediately downgradient from these three points, PCE and TCE were detected at GW20 at 25.7 µg/L and 32.5 µg/L, respectively and also in GW21 at 460 µg/L and 510 µg/L, respectively. In the Middle Surficial unit, PCE was detected at 11.9 μg/L, and TCE was detected at 230 μg/L at GW21. The large increase in the concentration of TCE and the presence of PCE downgradient of GW15, GW16, and GW17 indicates a separate source of the TCE. In addition, a bio trap deployed in monitoring well OMS-28-5 for a month in December 2021 detected the presence of moderate concentrations of bacteria that are capable of using PCE and TCE as growth-supporting electron acceptors and can reduce PCE and TCE down to cis-1,2-DCE but no further (refer to **Appendix C** for further explanation).

Based on these SDGI results, it can be seen that two distinct TCE plumes exist in the Upper/Middle Surficial aquifer. One distinct TCE plume exists in the Upper/Middle Surficial aquifer on Parcel E and appears to be the result of a TCE release in the gravel-covered vehicle parking area used by the ALARNG. A review of older investigation results and the newer SDGI data indicates that PCE has never been detected in groundwater on Parcel E. The second distinct TCE plume is co-located with the PCE plume on Parcel A and adjacent Parcel F. The two Upper/Middle Surficial TCE plumes merge into one plume in the Middle Surficial aquifer as TCE migrates vertically and in the direction of groundwater flow in the vicinity of GW15, GW16, GW17, and GW21. The local groundwater trough (paleochannel) feature described in **Section 1.3.5.6** that runs north-south between monitoring well OMS-28-5 and monitoring well OMS-28-7 appears to convey Upper and Middle Surficial groundwater from Parcel E towards the northwest corner of Parcel F and adjacent Parcel A to the north thereby allowing the mixing of the two plumes to occur.

TCE was detected in the Lower Surficial aquifer in isolated locations, outside of the footprint of the TCE plumes in the Upper and Middle Surficial aquifers (**Figure 1-12**). A low concentration of TCE (10 µg/L) was detected on Parcel B at GW43, it was not detected on Parcel C above the MCL, and it was detected in low concentrations at GW64 (27.1 µg/L) and GW75 (9.02 µg/L) at Parcel D. It is suspected that the TCE has migrated downward via sand lenses within the semi-confining unit separating the Middle Surficial aquifer from the Lower Surficial aquifer. Vertical migration of groundwater contamination is limited by the thick, stiff, dense clay that is located beneath the Lower Surficial aquifer. The vertical extent of groundwater contamination was historically determined by sampling Lower Surficial aquifer (screened below the clay confining layer) monitoring wells OMS-28-4 and OMS-28-6. During six consecutive sampling events conducted between 2008 and 2010, no site-related COCs were detected within these wells (Leidos, February 2014). More recently, SDGI sampling at Lower Surficial aquifer monitoring wells OMS-28-1 and OMS-28-4 detected no site-related COCs (**Table 1-2**). OMS-28-6 could not be sampled during this time period because it was determined to be destroyed (AECOM, 2019a)**.**

1.3.7.3 Summary

Based on the findings of the nature and extent of soil and groundwater contamination summarized above, this FS will not evaluate RAOs and remedial alternatives to address onsite TCE contamination in soil (Parcel E), offsite TCE contamination in soil near MW-09 (Parcel F), or offsite PCE contamination in soil and groundwater that is located on Parcels A and F. In addition, the low concentration of TCE (10 µg/L) detected in lower surficial aquifer sample GW43 located on Parcel B will not be addressed in the FS because TCE is a breakdown product of PCE, and this detection is located downgradient of the PCE source area on Parcel A. Furthermore, this FS will not address Parcel C as there were no groundwater COC detections above the MCLs.

This FS will only provide RAOs and remedial alternatives for TCE and its degradation breakdown products (cis-1,2-DCE and VC; i.e., site-related COCs) that are attributable to historical ALARNG operations that were conducted on Parcel E. Further justification for the exclusion of the offsite source of PCE in soil and groundwater from this FS is presented in **Appendix C**.

1.3.8 Fate and Transport

When chlorinated solvents such as PCE and TCE are released to soil, they will evaporate rapidly into the atmosphere due to their relatively high vapor pressure and low absorption to soil. However, both compounds exhibit low to medium mobility in soil and therefore a portion of the released PCE and TCE will slowly leach downward through the vadose zone soil and eventually into the underlying groundwater because they are both heavier than water.

The leaching of chlorinated solvents present in soil is a process of migration involving the movement of the solvents downward through the soil via the percolation of water. Typically, the higher the amount of precipitation, the greater the chance for chemicals to leach. Many factors affect the leaching of chemicals in soil including the solubility of the chemical, biodegradation, hydrolysis, dissociation, sorption, volatility, rainfall, and evaporation.

Groundwater at the site is shallow, and the water table near the areas with MCL-based protection of groundwater SSL exceedances for PCE and/or TCE had the underlying groundwater detected between 3 and 11 feet bgs. In addition to leaching, the presence of site-related COCs in soil can serve as a renewable source of groundwater contamination via water table fluctuation over time. With each rise of the water table, groundwater can encounter contaminated soil. As discussed in **Section 1.3.7.1**, leaching of TCE from soil in the vicinity of MW-08 on ALARNG property (Area 1; Parcel E) and leaching of TCE from soil in the vicinity of MW-09 (Area 3; Parcel F) are not an issue. However, leaching from the PCE spill in soil identified on vacant Parcel A may potentially be a source of ongoing contamination to the underlying groundwater.

Infiltration from above also contributes to COC distribution in the groundwater. Once the COCs enter the groundwater, several transport mechanisms are present that spread the groundwater plume. These mechanisms include advection, mechanical dispersion, hydrodynamic dispersion, and diffusion.

The destructive degradation of chlorinated VOCs is an important factor in their overall fate and transport. The most important process for the natural degradation of the more highly chlorinated solvents, PCE and TCE, is reductive dechlorination. Reductive dechlorination is the natural biodegradation of chlorinated solvents that is associated with the accumulation of daughter products and an increase in the concentration of chloride ions.

Environmental conditions that influence the rate of reductive dechlorination include dissolved oxygen (DO), oxidation-reduction potential (ORP), pH, temperature, and the population of indigenous bacteria present. The aquifer at OMS #28 exhibits a wide range of geochemical conditions that vary from mainly oxidative conditions (elevated DO and positive ORP) in the Upper/Middle Surficial aquifer monitoring wells to more reducing conditions (low DO, negative ORP, elevated ferrous iron concentration) in the Lower Surficial aquifer monitoring wells. The pH varies from mid-4 to mid-6 standard units. As such, the naturally occurring reductive dechlorination potential of the chlorinated VOCs present in the Upper/Middle Surficial aquifer will be relatively low, and therefore the presence of chlorinated VOCs within the aquifer will persist.

2.0 IDENTIFICATION OF MEDIA OF CONCERN, REMEDIAL ACTION OBJECTIVES, AND APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Section 2.0 identifies the media of concern, RAOs and remedial goals (RGs) for the FS, as well as provides proposed Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Guidance.

2.1 IDENTIFICATION OF MEDIA OF CONCERN

Based on information presented in Section 1.3.7.1, this FS has eliminated the evaluation of remedial alternatives for TCE in onsite soil at Parcel E (referred to as Area 1) and TCE in offsite soil near MW-09 (Parcel F; referred to as Area 3). Additionally, based on information presented in **Section 1.3.7.2** and **Appendix C**, this FS has eliminated the evaluation of remedial alternatives for offsite PCE contamination in soil (referred to as Area 2) and for the offsite PCE plume in groundwater including its associated degradation products TCE, cis-1,2-DCE, and VC. Refer to **Figure 1-9** for the locations of Area 1, Area 2, and Area 3. This FS only provides remedial alternatives for site-related COCs attributable to historical operations conducted by the ALARNG on Parcel E. As such, the only media of concern identified for OMS #28 is groundwater impacted with TCE and its associated degradation products.

2.2 REMEDIAL ACTION OBJECTIVES

The RAOs included in the 2014 FS for OMS #28 (Leidos, February 2014) were:

- Prevent human ingestion of groundwater containing PCE, TCE, or their degradation products in concentrations above their respective federal MCLs; and
- Restore the properties that are not owned by the ALARNG to UU/UE condition.

No action was warranted for soil at that time because COC concentrations detected in soil did not pose a risk to identified human health receptors.

Based on the assessment of threat to human health as originally evaluated in the Risk Assessment Report (AECOM, 2019b) and as further evaluated in the Risk Assessment Report, Revision 1 (AECOM, 2022), and Risk Assessment Report, Revision 2 (AECOM, 2023), there is no risk or hazard identified from exposure to surface or subsurface soil via ingestion or inhalation, groundwater via ingestion, inhalation, or dermal contact, or from groundwater via vapor intrusion at any of the parcels within the area of investigation under the current exposure scenario. In addition, there is no ecological risk. However, there is some level of carcinogenic risk and/or non-carcinogenic hazard for future receptors (construction workers, industrial workers, and/or residents) on Parcels A through F. Parcels A and B are not addressed by these RAOs because the identified risks are associated with the PCE source area identified on Parcel A, and the identified risks on Parcel B are associated with the breakdown of PCE from Parcel A to TCE. While Parcel C has an identified future risk to a construction work, no chlorinated VOCs were identified in Parcel C groundwater above the MCLs. There is no future risk for construction workers, industrial workers, and/or residents on Parcel G, and there is no future risk for residents on Parcel H.

Accordingly, the RAOs for OMS #28 will be replaced in this FS as follows:

- Achieve, to the extent practical, the RGs (i.e., cleanup levels) for groundwater. The RGs are the following Safe Drinking Water Act MCLs:
  - TCE – 5 µg/L,
  - Cis-1,2-DCE – 70 µg/L, and
  - VC – 2 µg/L.
- Prevent potential exposure via ingestion, dermal contact, and inhalation of the future construction worker, future industrial worker, future resident adult, and future resident child to groundwater that exceeds the RGs. Mitigate potential future vapor intrusion risks to the future industrial worker, future resident adult, and future resident child caused by the TCE plume that emanates from ALARNG property (Parcel E) through notification of potential future risk to affected landowners.

Section 2.3 presents the rationale and development of RGs for the site.

2.3 REMEDIAL GOALS

In this section, RGs are established for the protection of human health and to define the extent of cleanup required to achieve the RAOs established in **Section 2.2**. RGs to achieve the RAOs presented in **Section 2.2** are proposed for Parcels D through F and are presented in **Table 2-1**. This table also provides the receptor(s) and associated exposure pathway(s) by parcel.

RGs have not been established for Parcel A because the impacted soil and groundwater is the result of a PCE spill(s) on this parcel and not related to historical operations conducted on ALARNG property (Parcel E). An RG for PCE is not established for Parcel F because the PCE detected in groundwater on this parcel is the result of the offsite PCE spill(s) on Parcel A and not the result of historical activities conducted on Parcel E. Additionally, an RG is not established for Parcel B because impacted groundwater is the result of the breakdown of PCE from Parcel A to TCE on Parcel B. No site-related COCs were identified on Parcel C above the MCLs so an RG is unnecessary. There is no risk identified for Parcels G and H. The RGs provide the framework for the development of the remedial alternatives presented in **Section 4.0**.

2.4 IDENTIFICATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TO BE CONSIDERED GUIDANCE

Substantive promulgated regulatory requirements and standards are referred to as ARARs. ARARs can apply to the detected contaminants, specific site characteristics, or particular remedial actions proposed for the site. This section discusses the identification of ARARs for OMS #28.

On December 6, 2021, the Army National Guard (ARNG) formally requested a list of preliminary ARARs for OMS #28. A list of preliminary ARARs for OMS #28 was received by the ARNG on March 8, 2022.

CERCLA compliance policy and guidance specifies that remedial actions meet Federal or State standards, requirements, criteria, or limitations that are determined to be legally applicable or relevant and appropriate to the hazardous substances detected or particular circumstances at a site or obtain a waiver (CERCLA

Section 121 (d)). State promulgated standards are considered site-specific ARARs only if they are more stringent than the Federal ARARs and are proposed in a timely manner by the state.

The NCP (40 Code of Federal Regulations [CFR] 300.5) defines “applicable requirements” as “those cleanup standards, standards of control, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at the CERCLA site”. The NCP (40 CFR 300.5) defines “relevant and appropriate requirements” as “those cleanup standards of control, and other substantive environmental protection requirements, criteria or limitations promulgated under Federal or State environmental or facility siting laws that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site”.

CERCLA actions must comply with the substantive requirements but not the administrative requirements of a law or regulation. Substantive requirements directly help the environment and are those aspects of a law or regulation that must be done and/or accomplished during the action. They typically specify numerical levels or control standards the action is required to meet. Administrative requirements are those aspects of a law or regulation that help implement the substantive requirements. CERCLA provides exemptions from administrative aspects of laws and regulations for on-site actions such as procedural documentation, permitting, reporting, record keeping, and administrative reviews.

With regards to permitting, CERCLA Section 121(e)(1) states that “No Federal, State, or local permits are required for on-site response actions conducted pursuant to CERCLA Sections 104, 106, 120, 121, or 122. The term on-site means the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for implementation of the response action”. This CERCLA Permit Exclusion is codified at 40 CFR 300.400(3).

Note that ARARs include only Federal and State environmental or facility site laws/regulations and do not include occupational safety or worker protection requirements.

Circumstances exist in which ARAR waivers may be invoked, provided that the basic premise of protection of human health and the environment is not ignored. When selected remedial actions do not attain ARARs, the lead agency must publish an explanation in the form of a waiver.

Additional information in the form of non-promulgated advisories, criteria, and guidance, which is referred to as TBC Guidance, is also considered in developing a CERCLA remedy. Unlike ARARs, identification of TBCs is not mandatory, nor is compliance with TBCs a selection criterion for a remedial action.

A discussion of potential Federal and State ARARs identified for the OMS #28 is presented in the following subsections.

2.4.1 Chemical-specific ARARs

Clean up requirements include chemical-specific health-based limits or discharge limitations in various environmental media for specific hazardous substances, pollutants, or contaminants. These requirements generally establish protective cleanup levels in the designated media or a safe level of discharge that may be established when considering a specific remedial activity. **Table 2-2** lists the potential chemical-specific ARAR that pertains to the site.

2.4.2 Location-specific ARARs

Location–specific ARARs set restrictions on the concentrations of hazardous substances or on the conduct of remedial activities based on the physical characteristics of the site or its immediate surroundings. In determining the use of location-specific ARARs for selection of remedial actions at CERCLA sites, the jurisdictional prerequisites of each regulation must be investigated. There are no Federal or State location-specific ARARs identified for this site.

2.4.3 Action-specific ARARs

Action-specific ARARs are technology-based requirements that set controls or restrictions on the design, implementation, and performance levels of remedial activities related to the management of hazardous substances, pollutants, or contaminants. These requirements are triggered by the remedial alternatives selected to address chlorinated VOCs in site groundwater. There are no Federal or State action-specific ARARs identified for this site.

2.4.4 TBC Guidance

TBC Guidance identified for impacted site media at OMS #28 is provided in **Table 2-3**.

3.0 IDENTIFICATION & SCREENING OF POTENTIAL REMEDIAL TECHNOLOGIES

3.1 OVERVIEW

Section 3.0 identifies and screens general response actions (GRA), remedial technologies, and process options that may be appropriate for satisfying the RAOs for OMS #28. Select GRAs, remedial technologies, or process options are carried forward after initial identification and screening and combined to develop remedial alternatives for OMS #28. The steps involved in the identification and screening process in this section are defined in Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (USEPA, 1988), which is consistent with DERP guidance (DoD, 2018), and include the following:

- Identification of the area and volume of the medium(s) of interest requiring remedial action. The identification will be consistent with the RAOs and the chemical and physical characteristics of the site.

- Development of GRAs for the medium(s) of interest defining particular actions, singularly or in combination, that may be taken to fulfill the RAOs for the site.

- Identification and screening of remedial technologies and process options for each GRA based on effectiveness, implementability, and cost.

3.2 ESTIMATED AREA OF IMPACTED GROUNDWATER

The areal extent of the Upper/Middle Surficial aquifer unit impacted by TCE above the MCL of 5 µg/L that emanates from the ALARNG property (Parcel E) is approximately 0.93 acres (**Figure 1-13**). Of the 0.93 acres of impacted groundwater, approximately 0.05 acres are located on Parcel D and 0.43 acres are located on heavily wooded Parcel F. The estimated areal extent of the isolated areas of the Lower Surficial aquifer unit impacted by TCE above 5 µg/L is 0.1 acres.

3.3 IDENTIFICATION OF GENERAL RESPONSE ACTIONS

GRAs are a broad class of remedial actions that may be implemented alone or in combination to satisfy site RAOs for an impacted medium. The objective of this section is to identify and describe the GRAs that may satisfy the RAOs for impacted groundwater at OMS #28. The site RAOs are met when the remedial technologies or process options applicable to a given GRA are developed into remedial alternatives.

3.3.1 No Action

The No Action GRA for groundwater will be retained throughout the FS process as recommended by the NCP (40 CFR 300) and DERP Manual (DoD, 2018). The No Action GRA will provide a comparative baseline against which other groundwater alternatives will be evaluated. Under this alternative, no remedial action for groundwater at OMS #28 would be conducted. The groundwater contaminants are left in place without implementing any containment, removal, treatment, or other mitigating actions such as access restrictions. For the No Action alternative, reductions in groundwater contaminant concentrations would not be monitored and it would not include access control actions to reduce the potential for groundwater contaminant exposure.

3.3.2 Land Use Controls

LUCs consist of both administrative (land use management systems) and physical (engineering) mechanisms to control activities at the site. Institutional controls affect site management and/or activities occurring at the site. Administrative mechanisms do not physically alter conditions and do not (or are not intended to) reduce the mobility, toxicity, or volume of contamination at the site. Administrative mechanisms limit the potential for exposure to site contamination. Physical mechanisms rely upon engineered remedies to contain or reduce contamination and/or physical barriers such as fences and signs to limit access to property.

LUCs involve managing exposure to impacted groundwater by limiting access, implementing administrative policies, preparing a Land Use Control Implementation Plan (LUCIP), and updating the master planning document. LUCs can be part of a remedy or the entire remedy, but they provide no active remedial action. As generally defined, LUCs limit human exposure by prohibiting activity, use, and/or access to properties with residual contamination.

3.3.3 Monitored Natural Attenuation

Natural attenuation is defined as the reduction of contaminant concentrations in groundwater resulting from the combined effect of aerobic and anaerobic biodegradation, dispersion, dilution, volatilization, and adsorption. Generally, biodegradation is the most important natural attenuation mechanism because it is the only natural process that results in actual contaminant destruction. Natural attenuation relies on a groundwater monitoring program to confirm its effectiveness and to quantify the reduction in contaminant mass. This monitoring program is often referred to as monitored natural attenuation (MNA). Consideration of this option often requires modeling and evaluation of contaminant degradation rates and pathways as well as predicting contaminant concentration at downgradient receptor points, especially when the plume is expanding/migrating. The primary objective of groundwater modeling is to demonstrate that the natural attenuation of site-related contamination will result in contaminant concentrations being below regulatory standards or risk-based levels within a reasonable time period. Because an extended time period is often necessary to achieve regulatory standards via natural attenuation, MNA is usually combined with other GRAs, such as LUCs and/or containment.

3.3.4 Containment

Containment is an engineering control directed toward containing or controlling the migration of groundwater contaminants. Engineered barriers can be utilized to contain residual source and/or downgradient contaminated groundwater, divert uncontaminated water from a contaminated area, or divert contaminated groundwater from a potable source. Containment reduces the risk to human health or the environment by reducing contaminant mobility. Under this GRA, no change in the concentrations of site-related groundwater COCs would be expected. Containment would be combined with groundwater monitoring to confirm the effectiveness of restricting the mobility of the COCs in the groundwater.

3.3.5 In Situ Treatment

In situ treatment includes biological, physical, and chemical remedial technology types applied to contaminated groundwater that is left in place. While in situ treatments are generally less expensive and more readily implementable than ex-situ or extraction approaches, the effectiveness and uniformity of this technique may be difficult to verify throughout an entire treatment area. In situ treatment may be combined with other GRAs (e.g., MNA, LUCs) to achieve effective reduction of COC concentrations in groundwater.

3.3.6 Removal

Removal includes groundwater extraction via pumping by recovery wells, by pumping from recovery trenches, or both. Groundwater extraction is typically combined with an ex situ treatment process to promote the reduction of COC concentrations in groundwater to acceptable levels. A decrease in COC mobility and overall concentration in groundwater would be expected with this GRA.

3.3.7 Ex Situ Treatment

Ex situ treatment includes biological, physical, and chemical remedial technology types applied to groundwater that has been extracted from the subsurface. Air stripping is common remedial technology used to treat extracted groundwater that is contaminated with chlorinated VOCs. Ex situ treatment processes are typically coupled with removal and disposal process options.

3.3.8 Discharge/Disposal

Discharge includes remedial technology types for extracted groundwater such as discharge to a publicly owned treatment works (POTW) and surface water discharge. The GRA also includes air pollution control systems for treatment of extracted vapors produced from air stripping or air sparging/soil vapor extraction (SVE). Discharge can be combined with other GRAs (e.g., groundwater extraction) to provide an effective remedial technology for the reduction of COC concentrations in groundwater.

3.4 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGY TYPES AND PROCESS OPTIONS

The purpose of this section is to screen potentially applicable remedial technology types and representative process options identified for the GRAs. The term “remedial technology” refers to general categories of technologies (e.g., chemical treatment), while the term “process option” refers to specific processes within each remedial technology (e.g., in situ chemical reduction [ISCR]).

The following sections describe remedial technology types and process options that may reasonably be considered to meet the RAOs for OMS #28. An evaluation of each technology type or process option follows each description. This evaluation, or screening, will focus on the effectiveness, implementability, and relative cost of each technology or process option in meeting the RAOs. A summary of remedial technologies, process options, and initial screening comments is presented in **Table 3-1**. The technologies or process options that are retained will ultimately be assembled into remedial alternatives for site groundwater and subsequently evaluated in detail in **Section 4.0**.

3.4.1 No Action

There are no remedial technology types or process options associated with the No Action GRA for groundwater. This GRA provides a baseline against which other remedial technology types and process options for groundwater are compared. The No Action option for groundwater is retained for comparison purposes as recommended by the NCP (40 CFR 300) and the DERP Manual (DoD, 2018).

3.4.2 Land Use Controls

LUCs consist of administrative actions designed to minimize or reduce the potential for exposure to the site-related chemical constituents that exist above their respective RGs. The implementation of this technology type is based on the DoD *Policy on Land Use Controls Associated with Environmental Restoration Activities for Active Installations* (DoD, 2001), the associated *DERP Fact Sheet* (DoD, 2002), and the *Principles and Procedures for Specifying, Monitoring and Enforcement of Land Use Controls and Other Post-ROD Actions/Principles of Agreement for Performance-Based Records of Decision in Environmental Restoration* (DoD, 2003).

LUCs for groundwater include physical, administrative, and legal mechanisms that can be effectively used and implemented to prohibit the use of, or limit access to, property to prevent exposure to groundwater chemical constituents that exist above the applicable RGs. LUCs also include monitoring of such mechanisms. LUCs help minimize the potential for human exposure to contamination, while allowing the reduction of contamination due to natural attenuation processes. The utilization of this technology is low in operational cost, but it does require ongoing implementation to ensure that the LUCs remain in place. This technology is retained for further evaluation.

3.4.3 Monitored Natural Attenuation

MNA of contaminated groundwater is useful for documenting current groundwater conditions (e.g., contaminant concentration, DO, ORP, pH, temperature, specific conductivity, depth to water). Groundwater monitoring is not effective in reducing the toxicity, mobility, or volume of the COCs; however, groundwater monitoring results can be used to determine if the risk presented by the impacted groundwater is decreasing, increasing, or remains the same as the result of natural biotic (biodegradation) and abiotic attenuation processes (dilution, dispersion, advection, evaporation, etc.). Based on the characteristics of the TCE plume that emanates from Parcel E, the natural attenuation of TCE is evident as indicated by Mann-Kendall analysis (refer to **Appendix C**). For MW-08, there is a decreasing trend for TCE, and for OMS-28-3, there is a probably decreasing trend. The enhancement of natural attenuation particularly via the biotic and/or abiotic degradation of the targeted COCs would lower the period of time to achieve the site RAOs.

For an MNA approach, existing monitoring wells would be sampled to monitor groundwater COC concentration trends associated with the TCE plume that emanates from Parcel E and to determine when RGs have been met. Groundwater monitoring would also be conducted to track the potential horizontal and vertical migration of the TCE plume. Additional monitoring wells to better define the plume boundary and to monitor upgradient and downgradient conditions are needed to be installed for an effective MNA program for groundwater at OMS #28 to be achieved. Some of the existing site monitoring wells may need to be replaced because some of the offsite wells are old and unprotected.

Groundwater monitoring is easily implemented because the materials and equipment to conduct sampling are readily available. The cost of this technology includes low to medium capital cost depending on the number of additional monitoring wells to be installed and developed. A low to medium operation and maintenance (O&M) cost would be associated with regular monitoring of the well network and would be dependent on the frequency of the required sampling.

Due to the effectiveness of this technology for documenting the degradation of site-related groundwater COCs, its relative ease of implementation, and overall cost, MNA is retained for further evaluation.

3.4.4 Containment

Hydraulic containment would use a series of extraction wells installed in a row to restrict the horizontal migration of TCE-impacted groundwater away from Parcel E. This technology would reduce the mobility of contaminants in groundwater but not their toxicity or volume. This technology would require long term O&M and also discharge to a POTW as there are no surface water bodies near the site that could accommodate discharge. Treatment prior to discharge to the POTW may also be required along with a comprehensive monitoring program. Due to lack of active treatment, difficulty in implementation, and high capital and O&M costs, groundwater containment is rejected from further evaluation.

3.4.5 In Situ Treatment

In situ groundwater treatment involves biological, physical, and/or chemical treatment. The effectiveness of any in situ treatment technology depends on the ambient conditions of the targeted groundwater aquifer and adequate distribution of the injected substrate into the targeted groundwater throughout the plume or alternatively as a series of injection points installed in a barrier wall-type application at the leading edge of the plume and perpendicular to the direction of groundwater flow. For injection technologies, the targeted site aquifer geology (i.e., sandy clays, clayey sands, silty clays) at OMS #28 would require that injection points are placed relatively close together to achieve adequate contact with the targeted groundwater COCs. A robust groundwater monitoring program would be required to assess the effectiveness of in situ treatment.

Aerobic biodegradation utilizes aerobic bacteria that metabolize a primary substrate such as dextrose using various non-specific enzymes. These non-specific enzymes can degrade TCE via a process called co-metabolism. To implement effective co-metabolism at field scale is difficult because it requires that the targeted aquifer remain oxidative and at a neutral pH or the aerobic bacteria responsible for co-metabolism will not survive. In the presence of too much substrate such as dextrose, oxygen levels can decrease sharply so supplemental oxygen in the form of air or pure oxygen is often needed to be periodically added to the targeted groundwater. Also, in the absence of sufficient substrate to metabolize, co-metabolism stops, and the aerobic bacteria can die if additional substrate is not added to the targeted aquifer in a timely manner. Based on the difficulty in implementing aerobic co-metabolism at field scale, this process option has been rejected from further evaluation.

The enhancement (biostimulation) of the natural biodegradation of chlorinated VOCs in an anaerobic environment is called enhanced reductive dechlorination (ERD). ERD involves the injection of an electron donor (organic carbon source such as EVO), which ferments to produce hydrogen and low molecular weight fatty acids) that provide carbon and energy to anaerobic microorganisms in groundwater including naturally occurring halorespiring bacteria. The chlorinated VOCs serve as electron acceptors for the halorespiring bacteria that complete the reductive dechlorination of these compounds by the sequential replacement of chlorine atoms by hydrogen. "Stall out" at cis-1,2-DCE may occur unless sufficient *Dehalococcoides* (*DHC*) is present. If stall out is an issue, bioaugmentation may be necessary to effectively degrade TCE all the way to innocuous ethene. The injected electron donor tends to last from 6 to 12 months depending on groundwater flow rates. As a result, more than one injection event is often required to sustain sufficient reducing conditions. Suitable reducing conditions for ERD include establishing a targeted aquifer ORP of at least negative 100 millivolts or less and a pH greater than 6. If the pH is less than 6, buffering may be required. Based on the targeted groundwater aquifer characteristics (slightly oxidative, slightly lowered pH, low *DHC* number), ERD can be implemented at this site; however, it will require bioaugmentation and may also require some buffering. Based on the established effectiveness of ERD at treating chlorinated VOCs, ERD will be retained for further evaluation. ERD is often combined with chemical reduction to enhance the degradation of chlorinated VOCs.

In situ chemical oxidation (ISCO) is an aggressive technology typically used to address relatively high contaminant concentrations in saturated soils and groundwater that are most often associated with source areas. This technology involves the chemical destruction of the targeted COCs in groundwater and saturated soil by subsurface injection of a strong oxidant solution. Chemical oxidants are non-specific with regards to the organics that they target; thus, they are often short-lived in the subsurface. Effective treatment requires adequate contact and the selection of an oxidant that will react with the specific contaminants (chlorinated VOCs) present in site groundwater. For sites where chlorinated solvents are the predominant COCs, Fenton’s Reagent (hydrogen peroxide with an iron catalyst), sodium persulfate, and potassium or sodium permanganate are all effective chemical oxidant choices. Following injection, the oxidant solution will follow preferential (more permeable) pathways and may not contact the targeted contaminants that have diffused into less transmissive geologic strata. This condition is often seen by observing the short-term reduction of dissolved COC concentrations, followed by a subsequent rebound in the targeted constituent concentrations (referred to as matrix back diffusion). Matrix back diffusion often necessitates the use of multiple ISCO injection events to achieve successful treatment. Based on the relatively dilute nature of the targeted TCE plume, the targeted aquifer characteristics, which include elevated organic matter content and the presence of silty clays and clayey sands, the potential need to conduct multiple injection events due to matrix back diffusion, the requirement for closely spaced injection points to obtain adequate contact between the targeted COCs and the chemical oxidant, and the unknown longevity of the selected oxidant in groundwater, ISCO will not be retained for further evaluation in this FS.

ISCR involves the placement of a sufficient quantity of reductant or reductant generating material into the subsurface with the purpose of chemically converting the targeted contaminants in the impacted groundwater to innocuous end products. Similar to other in situ injection process options, effective treatment by ISCR requires adequate contact between the reductant and the targeted contaminant so injection points at OMS #28 would need to be closely spaced. The most commonly used reductant is zero valent iron (ZVI).

In this case, ZVI would create strongly reducing conditions that promote the abiotic degradation of the targeted chlorinated VOCs in groundwater via abiotic reductive dehalogenation and dichloroelimination (beta-elimination). Hydrogenolysis occurs when a halogen such as a chlorine atom is substituted by a hydrogen atom along with the simultaneous addition of two electrons. Beta-elimination occurs when two chlorine atoms are removed from two different carbon atoms along with the simultaneous addition of two electrons. Of these two reaction mechanisms, beta-elimination is the dominant (approximately 90%) pathway for abiotic degradation via ZVI.

An advantage of beta-elimination is that it produces chloroacetylene, acetylene, ethane/ethene, and chloride ions without the accumulation of cis-1,2-DCE, which eliminates the potential for “DCE stall” that can occur under anaerobic conditions using ERD. ZVI corrodes as it comes into contact with water. The products of corrosion include ferrous iron, hydrogen gas, and hydroxyl ion. The hydrogen produced can be used by certain microorganisms to target chlorinated VOCs to dehalogenate them. As the hydroxyl ions are released, the pH of the surrounding groundwater is increased, which is more conductive for the ERD of chlorinated solvents to occur. The reactive life of ZVI has been reported to be 3 to 5 years or greater, which is much longer than chemical oxidants or many electron donors (carbon substrates) used for ERD. This longevity may potentially limit the number of future injection events due to the effect of matrix back diffusion. Because ZVI can create deeply reducing conditions, has a long reactive life, and can avoid “DCE stall”, ISCR is often combined with ERD for an enhanced in situ degradative approach. Based on this initial screening process, ISCR will be retained for additional evaluation.

In situ air sparging is a physical process that involves injecting air into the targeted aquifer to volatilize aqueous phase and soil-sorbed chlorinated VOC contaminants. A series of screened injection wells would be installed through which compressed air would be introduced into the aquifer via micro porous screens. As the air bubbles move upward and outward through the aquifer material, volatile constituents such as TCE would partition from the aqueous phase into the vapor phase. The contaminants would then be transported in the vapor phase into the overlying vadose zone where they would eventually discharge to the atmosphere via the existing pressure differential. Due to the release of chlorinated VOCs to the atmosphere, an SVE system is often required to be combined with the air sparging system. Typically, a combined air sparging/SVE system is installed as a series of vertical wells that are tied together using a common header. The number of air sparging and SVE wells needed is dependent on the size and depth of the plume, soil permeability, subsurface geology, and the flow rate of injected air. Based on the questionable effectiveness of air sparging/SVE in the targeted site geology (i.e., sandy clays, clayey sands, and silty clays), the large infrastructure footprint required, high capital and high ongoing O&M costs, air sparging/SVE is rejected from further evaluation in this FS.

3.4.6 Removal

Groundwater removal techniques involve the passive or active manipulation and management of groundwater to contain or remove the targeted contaminant plume. The selection of the appropriate extraction technique depends upon the objectives of the remedial action, the depth of contamination, and the hydrological and geological characteristics of the aquifer. Extraction techniques are most effective when the contaminated aquifer has a high hydraulic conductivity (or transmissivity) and the concentration of the targeted COCs is high. The most commonly used extraction techniques are recovery well systems, interceptor trenches, and dual phase extraction systems. An extraction system is generally effective at providing hydraulic containment of a groundwater plume; however, it is only moderately effective at meeting low concentration RGs.

Implementation of an extraction system at the OMS #28 using extraction wells would involve several technical challenges including the location of some of the extraction wells within a heavily wooded area, the relatively dilute concentration of the targeted site-related COCs, and the varying aquifer lithology. The extracted groundwater would also require ex situ treatment once it is removed. Interceptor trenches would not be implementable as they could not be installed to a depth deep enough to intercept all of the targeted TCE groundwater plume. The capital and O&M costs for an extraction system would be high. Due to effectiveness issues, implementation challenges, and associated high costs, groundwater extraction is rejected from further evaluation in this FS.

3.4.7 Ex Situ Treatment

Ex situ treatment process options are necessary if contaminated groundwater is extracted and requires treatment prior to discharge. Applicable remedial technologies evaluated include physical (liquid-phase carbon adsorption, air stripping, vapor-phase carbon adsorption) and chemical treatment (ultraviolet light/chemical oxidation). Physical ex situ treatment technologies are well established and highly effective at removing chlorinated VOCs from groundwater. However, the chlorinated VOCs are not broken down to innocuous compounds following physical treatment and therefore require proper disposal or additional treatment processes. Physical treatment process options are often paired with a chemical treatment process option such as ultraviolent light and oxidation, which are effective in destroying VOCs. A discharge process would also be required to release the treated groundwater. Implementation of ex situ treatment is challenging due to accessibility to a treatment facility and installation of the required conveyance piping for the extraction system. Ex situ treatment systems have medium to high capital costs and require substantial ongoing O&M resulting in high ongoing costs. Ex situ treatment is rejected from further evaluation in this FS.

3.4.8 Discharge/Disposal

Remedial approaches using groundwater extraction or ex situ groundwater treatment require a point of discharge for the treated/untreated wastewater or air stream (from air stripping ex situ technology). The process option evaluated consisted of groundwater discharge to a POTW. Discharge to a surface water body was not evaluated because there are no surface water bodies near the site that could accommodate discharge. Confirmation sampling and reporting would be regularly required for discharge to a POTW. Based on the previous rejection of extraction and ex situ treatment technologies from further evaluation, discharge/disposal is also eliminated from further evaluation in this FS.

3.5 SUMMARY OF REMEDIAL TECHNOLOGY TYPES/PROCESS OPTIONS RETAINED FOR REMEDIAL ALTERNATIVE DEVELOPMENT

Based on the rationale presented in **Section 3.4** and **Table 3-1**, with respect to effectiveness, implementability, and relative cost, the following groundwater remedial technologies or process options are retained for groundwater remedial alternative development.

- No Action,
- LUCs (physical and administrative)
- MNA,
- Anaerobic Biodegradation, and
- Chemical Reduction.

4.0 REMEDIAL ALTERNATIVES DEVELOPMENT AND DETAILED ANALYSIS

In this section, the remedial technologies and associated process options that were carried forward from the initial screening process conducted in **Section 3.0** are used to develop remedial alternatives for the groundwater COCs that exist above their RGs at OMS #28. At OMS #28, there are no current risks; however, remedial alternatives were developed to address groundwater risks associated with a future residential use scenario.

The remedial technologies and process options that were identified and passed initial screening in **Section 3.0** have been grouped into the following remedial alternatives.

- Alternative 1 - No Action,
- Alternative 2 – LUCs with Periodic Groundwater Monitoring, and
- Alternative 3 – ERD, ISCR, and Enhanced MNA.

These remedial alternatives will be further evaluated in this section with respect to meeting the RAOs and RGs for groundwater.

Each remedial alternative was evaluated using the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA, 1988). The RI/FS guidance provides evaluation criteria for assessing the remedial alternatives. These nine criteria are designed to enable the analysis to address the statutory requirements and considerations and the technical and policy considerations for comparing and selecting among remedial alternatives. The evaluation criteria are divided into three groups based on the function of the criteria in the overall remedy selection.

The first group*, threshold criteria*, relates to statutory requirements that each remedial alternative must satisfy to be eligible for selection. These two threshold criteria include:

- *Overall protection of human health and the environment*. The assessment against this criterion describes how the alternative, as a whole, achieves and maintains protection of human health and the environment during and after implementation.
- *Compliance with ARARs.* The assessment against this criterion describes how the alternative complies with ARARs or if a waiver is required and how it is justified. The assessment also addresses other information from advisories, criteria, and guidance that the lead and support agencies have agreed is "to be considered." The ARARs can be chemical specific, location specific and action specific. Chemical-specific ARARs are generally numerical values. Location-specific ARARs place restrictions on cleanup activities because they apply to a particular site location(s). Action-specific ARARs are related to implementation of the selected technology(ies).

The second group, *balancing criteria*, includes technical criteria upon which the detailed remedial alternatives analysis is primarily based. These five balancing criteria include:

- *Short-term effectiveness.* Addresses the effects of each alternative during construction and implementation until RAOs have been met. Specifically, this criterion evaluates the potential impact each alternative would have on the community, workers, and the environment during implementation of the remedial action.

- *Reduction of toxicity, mobility, or volume through treatment.* Addresses the USEPA's statutory preference for remedial alternatives that (1) permanently reduce the toxicity, mobility, and volume of the COCs and (2) use treatment as a principal element. This criterion focuses on the following factors:

    - Treatment process used, if any,

    - The quantity of hazardous materials treated or destroyed,

    - The degree of reduction in toxicity, mobility, and volume of impacted material,

    - The degree to which the treatment method would be irreversible,

    - The type, quantity, and characteristics of residual material that would remain after treatment, and

    - The statutory preference for treatment.

- *Long-term effectiveness and permanence.* Evaluates the long-term ability of a remedial alternative to protect human health and the environment after RGs have been achieved. The primary considerations are the magnitude of residual risk and the adequacy and reliability of controls that are necessary to manage the residual risks posed by the remaining treated or untreated residuals.

- *Implementability.* Assesses the technical and administrative feasibility of implementing an alternative. Technical feasibility addresses the difficulties and unknowns associated with a technology, the reliability of a technology, the ease of undertaking future remedial actions, and the ability to monitor the effectiveness of the system. Administrative feasibility refers to the activities required to coordinate with regulatory agencies and the availability of equipment, services, and materials.

- *Cost.* Evaluates the capital and O&M costs associated with an alternative. Present worth analysis can be used to evaluate expenditures that occur over multiple years (maximum 30 years). In general, the period of performance for costing should not exceed 30 years for the purpose of a detailed cost analysis when the duration of a remedy is indefinite. The costs provided are for comparison of remedial alternatives, and actual costs of implementation may vary (typically around -30 to +50%).

The third group is *modifying criteria* and include:

- *State Agency Acceptance* and *Community Acceptance*. This assessment reflects the community and state's (or support regulatory agency's) apparent preferences or concerns about the selected remedial alternatives.

  State Acceptance and Community Acceptance is not evaluated until the State and community comments are obtained and reviewed upon publication of the FS and Proposed Plan. State and public comments will be responded to in the Responsiveness Summary of the Decision Document. Because both of these criteria are assessed formally after public comment, they will not be discussed further in this FS.

Preliminary pricing information was solicited from select vendors for this FS. This pricing information was used in conjunction with other sources and engineering judgement to prepare the cost estimates for the remedial alternatives that were evaluated. **Table 4-1** summarizes the estimated costs for each remedial alternative. Detailed cost estimate summaries and associated assumptions for each remedial alternative are provided in **Appendix D**.

4.1 DEVELOPMENT AND EVALUATION OF REMEDIAL ALTERNATIVES FOR GROUNDWATER

The following subsections describe remedial alternatives considered for TCE-impacted groundwater associated with OMS #28.

4.1.1 Alternative 1 – No Action

A discussion of Alternative 1, No Action, is provided below.

4.1.1.1 Description

Alternative 1 is an approach where No Action is conducted. As recommended by the NCP, the No Action alternative is intended to serve as a baseline for comparison with the other groundwater remedial alternatives evaluated in this section. This alternative would leave contaminated groundwater in place with no controls to prevent human or ecological exposure. No remedial actions would be undertaken as part of this alternative to contain, remove, monitor, or treat the impacted groundwater associated with OMS #28.

4.1.1.2 Overall Protection of Human Health and the Environment

Alternative 1 would provide no protection of human health and the environment.

4.1.1.3 Compliance with Applicable or Relevant and Appropriate Requirements

Because no remedial activities are associated with this alternative, compliance with the chemical-specific ARARs would not be met until natural attenuation processes had reduced site-related groundwater COC concentrations to the applicable RGs. However, compliance with the chemical-specific ARARs for groundwater cannot be verified for this alternative because no periodic groundwater monitoring would be conducted.

4.1.1.4 Short-term Effectiveness

Alternative 1 does not include any actions which might create increased risks to the community, workers, or the environment. Risks to human health and the environment would remain the same as they are currently.

4.1.1.5 Reduction of Toxicity, Mobility, or Volume

In accordance with the NCP, the No Action alternative cannot include proactive remedial technologies and will not reduce the toxicity, mobility, or volume of groundwater COCs through treatment. Under the No Action alternative, contaminant levels in groundwater may be reduced as a result of natural attenuation processes. Based on the characteristics of the TCE plume emanating from Parcel E, natural attenuation of TCE is evident as indicated by Mann-Kendall analysis (refer to **Appendix B**). For MW-08, there is a decreasing trend for TCE, and for OMS-28-3, there is a probably decreasing trend. However, because no groundwater monitoring would be conducted under Alternative 1, the reduction of toxicity, mobility, and volume would not be able to be evaluated.

4.1.1.6 Long-term Effectiveness and Permanence

The No Action alternative does not address, control, or monitor groundwater contamination, and it relies upon the potential for COC concentrations to reduce in the groundwater over time due to natural attenuation processes. As such, this alternative provides no long-term effectiveness or permanence.

4.1.1.7 Implementability

The No Action alternative for groundwater does not require work plans, design, equipment, construction, or O&M activities. Administrative and/or regulatory implementability is unlikely due to potential difficulties with obtaining regulatory acceptance.

4.1.1.8 Cost

The total net present worth cost of Alternative 1 is $0 since there would be no remedial action for groundwater conducted.

4.1.2 Alternative 2 – LUCs with Periodic Groundwater Monitoring

A discussion of Alternative 2, LUCs with Periodic Groundwater Monitoring, is provided below.

4.1.2.1 Description

A TCE plume that emanates from Parcel E exists above the applicable RG for TCE. Alternative 2 is comprised of the following components: Refined Delineation, LUCs, Periodic Groundwater Monitoring, and Potential Vapor Intrusion (VI) Risk. While each component is described separately, this alternative is evaluated as a combined remedial alternative approach for impacted groundwater. **Figure 4-1** shows the proposed groundwater LUCs boundary to be applied as well as proposed additional monitoring well locations for the periodic groundwater monitoring program.

4.1.2.1.1 Description of Refined Delineation

As part of Alternative 2 implementation activities, additional Upper/Middle Surficial and Lower Surficial aquifer monitoring wells are recommended to be installed, developed, and subsequently sampled. These proposed monitoring wells would serve to augment the existing site monitoring well network and provide more accurate delineation of the extent of the TCE plume. The locations for these proposed monitoring wells are shown on **Figure 4-1**.

It is recommended that the current site monitoring well network be expanded during Alternative 2 implementation to include five additional Upper/Middle Surficial aquifer monitoring wells and three additional Lower Surficial aquifer monitoring wells. Following development, these eight new monitoring wells would be sampled along with one Upper/Middle surficial replacement monitoring well (OMS-28-2R) for OMS-28-2 and eight existing Upper/Middle Surficial aquifer monitoring wells (OMS-28-3, OMS28-5, OMS-28-7, MW-5, MW-6, MW-8, MW-9, and MW-12) to provide a baseline of the site-related COCs that are attributable to historical ALARNG operations that were conducted on Parcel E (i.e., TCE and its degradation breakdown products cis-1,2-DCE and VC) since the last sampling event was conducted in May 2017. Note that OMS-28-2 was found destroyed during a site visit in December 2021. The well pad and surface casing were found lying on the ground in the vicinity of the former well. The location of the former well was graded over by earthmoving machinery and was determined to no longer be viable. The actual well location could not be located. The well was destroyed during site improvements conducted by the landowner in 2021. In total, there would be 17 monitoring wells sampled as part of the periodic groundwater monitoring program.

A Remedial Design/Remedial Action (RD/RA) Work Plan would be completed prior to installing the proposed additional monitoring wells and would include site clearing details related to the installation of 4 of the 8 monitoring wells within the heavily wooded portion of Parcel F. Parcel D will not require clearing as this parcel is covered with large trees that allow for movement between them to install the one shallow monitoring well and the one deep monitoring well. Due to the length of time anticipated for Alternative 2, a small crush and run roadway will be installed along the cleared pathway from the access gate located on ALARNG property to the four proposed monitoring wells located on Parcel F. Based on the results of the SDGI, the proposed Upper/Middle Surficial aquifer monitoring wells would be screened between 10 and 25 ft bgs, and the proposed Lower Surficial aquifer wells would be screened between 27 and 32 ft bgs. The replacement well for OMS-28-2 would be screened over the same interval (10 to 20 ft bgs) as the original well.

Following the installation and development of the new monitoring wells, the existing Upper/Middle Surficial aquifer monitoring wells (OMS-28-3, OMS-28-5, OMS-28-7, MW-5, MW-6, MW-8, MW-9, and MW-12), replacement monitoring well OMS-28-2R, and the eight newly installed monitoring wells would be sampled and analyzed for site-related COCs to establish baseline conditions to compare to during future periodic groundwater monitoring events. Monitoring well installation details, development, and monitoring event results would be subsequently presented in an RA Report.

4.1.2.1.2 Description of LUCs

LUCs implemented for the TCE plume associated with historical ALARNG activities would minimize or prevent exposure of potential human residential receptors to chlorinated VOCs in groundwater. The use restrictions instituted would encompass groundwater use restrictions including, at a minimum, no water well installation and no pumping of groundwater for irrigation purposes.

A CERCLA Decision Document would document the land use restrictions. Because LUCs for properties that are not being transferred out of federal control are not recorded in deeds, the LUCs would be incorporated into existing land use planning and management systems routinely used at OMS #28 such as Geographic Information Systems/Overlay Maps, installation master plan, installation planning offices, site approval processes, inspections, and training.

To ensure effective implementation of institutional controls, a LUC remedial design or LUCIP would be developed and incorporated into the master planning document or its equivalent prior to implementation of the institutional controls. The LUCIP would present exposure assumptions and present the institutional control objectives and land restrictions for this parcel. The LUCIP would describe the LUCs (e.g., groundwater use restrictions including no water well installation and no groundwater pumping), specify the duration of the LUCs, detail how the LUCs would be established and documented, and define responsibility to maintain and manage them. The LUCIP would also explain procedures for modification or termination of the LUCs when/if the groundwater RGs are achieved and the land use becomes unrestricted.

An environmental covenant is required for all sites in Alabama per the Alabama Uniform Environmental Covenants Act (Alabama Administrative Code 335-5-1) that have not been remediated to UU/UE status. Because Parcel E is owned by the federal government, an environmental covenant cannot be executed during the period of federal ownership because the DoD has no authority to grant a real property interest for an environmental LUC (e.g., an environmental covenant) on federal property. In lieu of an environmental covenant, a Notice of Environmental Use Restriction (NEUR) for Parcel E could be prepared and submitted to ADEM for approval. This document would provide notice of the current and future use of the parcel. Currently however, the DoD NEUR template and the ADEM NEUR template differ significantly because the State of Alabama creates an enforceable property right interest, which as previously explained, the DoD cannot agree to. This issue remains unresolved between DoD and ADEM; therefore, at this time, the exact mechanism to enforce this control is unknown.

With regard to the affected offsite undeveloped parcels, the ALARNG can only recommend to the affected landowners that LUCs similar to those proposed for Parcel E be implemented. The ALARNG does not have the authority to implement, enforce, or maintain LUCs on the currently affected offsite undeveloped parcels. The notification provided by ALARNG would include recommending that landowners place an environmental covenant per the Alabama Uniform Environmental Covenants Act on their property until RAOs are met. While ARNG has no authority to implement restrictions or enforceable institutional controls on the offsite parcels to restrict groundwater use, ADEM does have the authority under Alabama Administrative Code 335-5-1 to require an environmental covenant.

4.1.2.1.3 Description of Periodic Groundwater Monitoring

In order to ensure the TCE plume that emanates from Parcel E is stable or decreasing in size, groundwater monitoring would be conducted at eight existing monitoring wells (OMS-28-3, OMS28-5, OMS-28-7, MW-5, MW-6, MW-8, MW-9, and MW-12), replacement well OMS-28-2R, and the eight proposed new monitoring well locations. Low-flow sampling techniques would be used to establish aquifer conditions and to collect groundwater samples from each of these wells. The groundwater samples would be submitted to a DoD Environmental Laboratory Accreditation Program (ELAP)-certified analytical laboratory and analyzed for VOCs via Method 8260C/D. PCE would be included in the VOC sampling suite to determine how the offsite PCE plume is potentially continuing to impact the natural attenuation of the TCE plume emanating from Parcel E. After the initial baseline (Year 1) monitoring event, groundwater monitoring at these 17 monitoring wells is proposed to occur in Year 2 and Year 4. Monitoring event results for Year 1, Year 2, and Year 4 would be presented in an RA Report. The next sampling event would occur in Year 6 and then every five years afterwards (Year 11 and Year 16) until the groundwater RGs are met. The results for the Year 6, Year 11, and Year 16 groundwater monitoring events would be presented in the corresponding Five-Year Review Report.

4.1.2.1.4 Potential VI Risk

There currently are no existing structures that are impacted by the TCE plume on Parcel E. Per the DERP (DoD, 2018), the potential for VI risk associated with the TCE plume would be documented. In the event that any future structures are planned to be built on Parcel E in an area with VI risk, the potential for VI would be addressed during the design phase of any planned building construction and any necessary mitigation measures would be included to eliminate the VI risk.

Per the DERP, for the offsite parcels with potential future VI risk (Parcels D and F), a notice of potential VI risk would be given to the offsite parcel owners in writing, and as appropriate, would include such notices in the OMS #28 Decision Document. Furthermore, offsite owners would be required to address the potential for VI in future structures at their own expense by adding appropriate mitigating measures during construction or demonstrating that there is no unacceptable risk under applicable law. The OMS #28 Decision Document would reflect such obligations, as appropriate.

4.1.2.2 Overall Protection of Human Health and the Environment

Alternative 2 would be protective of human health by restricting access to impacted groundwater on Parcel E as well as on the affected offsite parcels if LUCs are accepted. As previously described, LUCs can only be recommended for offsite parcels; however, ADEM could require them per Alabama Administrative Code 335-5-1. The proposed periodic groundwater monitoring would ensure that the TCE plume that emanates from Parcel E remains stable and would also document COC trends over time. No risk to the environment exists from TCE-impacted groundwater.

4.1.2.3 Compliance with Applicable or Relevant and Appropriate Requirements

Alternative 2 does not currently comply with the chemical-specific ARARs for groundwater. Based on groundwater TCE degradation modeling (refer to **Appendix E**), natural attenuation is anticipated to take until at least 2044 to meet the chemical-specific ARARs.

4.1.2.4 Short-term Effectiveness

<u>Community Protection</u> - Alternative 2 reduces the likelihood of contact with chlorinated VOC-impacted groundwater by implementing groundwater use restrictions for future use.

<u>Worker Protection</u> – Remediation workers may be exposed to site-related COCs during the proposed periodic groundwater monitoring activities. To minimize the potential for exposure, remediation workers and oversight personnel would be HAZWOPER-trained, and engineering controls, and personal protective equipment (PPE) would be used as necessary to prevent excessive exposure. Groundwater sampling activities would be limited in duration, and the overall exposure potential would be low.

In addition, remediation workers will be exposed to safety risks during brush/tree clearing and crush and run roadway construction for monitoring well installation on Parcel F as well as during the subsequent monitoring well installation and development activities. Daily tailgate safety meetings and the site-specific HASP would be used to address these safety risks.

<u>Environmental Impacts</u> – Clearing of trees and brush will be required to accommodate the installation of 4 of the 8 proposed monitoring wells on the heavily wooded portion of Parcel F.

<u>Time to Achieve RAO/RGs</u> – LUCs would be effective in preventing the use of impacted groundwater at the site; however, because chlorinated VOCs would remain above the applicable RGs, natural attenuation would be the only way that site-related groundwater COC concentrations (TCE, cis-1,2-DCE, and VC) would decrease over time. Periodic monitoring every five years would be conducted to evaluate COC degradation trends over time. As described in **Appendix E**, the highest groundwater TCE concentration (310 µg/L) detected during the SDGI that was related to historical activities conducted on Parcel E was located at DPT point GW07. Using this TCE concentration as the starting concentration, it was estimated that it would take until 2044 to achieve the RGs. Allowing time for approval of this FS, Proposed Plan, and DD, it is assumed that implementation of this alternative would occur in 2026. As such, at least 18 years are estimated to be needed to meet the RGs for groundwater; however, a variety of factors including matrix back diffusion and retardation of contaminant flow, may serve to increase the period of time needed to meet the RGs under Alternative 2.

4.1.2.5 Reduction of Toxicity, Mobility, or Volume

LUCs with periodic groundwater monitoring is not effective in reducing the toxicity, mobility, or volume of the site-related COCs; however, the monitoring results can be used to determine if the risk presented by the impacted groundwater is decreasing, increasing, or remains the same as the result of natural biotic (biodegradation) and abiotic attenuation processes (dilution, dispersion, advection, evaporation, etc.). Based on the characteristics of the TCE plume emanating from Parcel E, natural attenuation of TCE is evident as indicated by Mann-Kendall analysis (refer to **Appendix B**). For MW-08, there is a decreasing trend for TCE, and for OMS-28-3, there is a probably decreasing trend. This alternative does not meet the statutory preference for treatment.

4.1.2.6 Long-term Effectiveness and Permanence

The presence of the offsite PCE soil and groundwater source that is not related to historical operations and activities conducted by the ALARNG on Parcel E may potentially impact the long-term effectiveness and permanence of Alternative 2, particularly in the area of the co-mingled PCE plume from Parcel A and TCE plume from Parcel E that is observed on Parcel F at its northern boundary with Parcel A. As shown on **Figure 4-1**, a shallow/middle surficial aquifer monitoring well is proposed to be installed on the eastern edge of the co-mingled plume area. Its location will also coincide with the eastern edge of the local trough feature (paleochannel) where shallow/middle surficial aquifer groundwater flow comes from the east and then turns to the north-northwest (refer to Figure 1-4). This additional monitoring well will help to determine if there is influence from the Parcel A PCE plume migrating to the southeast at this location or if this location is dominated by flow to the west and northwest from the northeast edge of Parcel F and from Parcel E. This additional data will serve to provide information related to the long-term effectiveness and permanence of Alternative 2.

Maintenance of the proposed groundwater LUCs would be required until site-related groundwater COC concentrations (TCE, cis-1,2-DCE, and VC but not PCE) were reduced to below the applicable RGs. Adequate long-term control would be established as long as the LUCs were maintained as defined in the LUCIP. The long-term effectiveness of the LUCs would depend on CERCLA Five-Year Reviews conducted over an estimated 18 year time period. The overall effectiveness of the LUCs would also depend on the proper implementation and coordination of activities defined in the LUCIP.

4.1.2.7 Implementability

Right-of-entry access should not be an issue based on the activities that were previously conducted on both Parcels D and F during the SDGI. The extensive clearing proposed for Parcel F should not be a problem since the property is owned by MAA, and it is not used for any business-related purposes. As previously stated in Section 4.1.2.1.1, Parcel D is covered by large mature trees with room in between them to allow for monitoring well installation and development to occur without requiring clearing.

As such, LUCs, site clearing, monitoring well installation, and periodic monitoring would be relatively easy to implement as guidance documents and procedures have previously been established.

4.1.2.8 Cost

The expected duration of Alternative 2 is 18 years. The cost for Alternative 2 consists of completion of the LUCIP, implementation of the LUCs, preparation of an RD/RA Work Plan, installation and development of new site monitoring wells, completion of periodic groundwater monitoring and site inspections every five years, the generation of Five-Year Review Reports, and owner costs for the duration of the alternative. The total net present worth cost (base capital cost, periodic five-year costs, and 20% contingency) of Alternative

2 is $484,300. **Table 4-1** presents a summary of costs associated with this alternative; the detailed cost estimate is presented in **Appendix D** (**Table D-1**).

4.1.3 Alternative 3 – ERD, ISCR, and Enhanced MNA

A discussion of Alternative 3, ERD, ISCR, and Enhanced MNA, is provided below.

4.1.3.1 Description

The plume that emanates from the ALARNG property (Parcel E) exists above the applicable RG for TCE. Alternative 3 is comprised of four components: Refined Delineation, In Situ Treatment, Enhanced MNA (remedy performance monitoring), and Potential VI Risk. While each component is described separately, this alternative is evaluated as a combined remedial alternative approach. LUCs are not included as part of this alternative because there is no current risk associated with the TCE plume and land use is not anticipated to change during the completion of Alternative 3. **Figure 4-2** provides a conceptual site layout for Alternative 3.

ERD and ISCR are often combined because the synergies of a combined biotic and abiotic degradation approach offer multiple dechlorination mechanisms for the targeted chlorinated VOCs. The organic carbon source used for an ERD approach provides an electron donor and nutrient source to facilitate the consumption of competing electron acceptors and to ultimately promote the biological degradation of the targeted chlorinated VOCs via reductive dechlorination. There are several commercially engineered carbon sources that can be used to promote ERD including, but not limited to, ABC®, SRS™, and EOS®. A chemical reductant, ZVI, is mixed with these carbon sources to promote the abiotic dechlorination of the targeted chlorinated solvents via beta-elimination and hydrogenolysis. Together, the combined ERD and ISCR approach simultaneously create very low ORP in the targeted groundwater through a combination of microbiological and chemical oxygen consumption. ORP values of less than negative 500 millivolts may be obtained. In this FS, ABC® combined with ZVI, is evaluated; however, the most appropriate carbon source and chemical reductant should be evaluated and selected during the remedial design phase along with the determination of final injection quantities.

4.1.3.1.1 Description of Refined Delineation

For the purposes of developing this alternative, the current areal extent of the TCE plume that is associated with historical ALARNG activities conducted on Parcel E is approximately 0.93 acres (**Figure 1-13**). Additional monitoring wells are needed to augment the existing site monitoring well network for the following reasons:

- To better define the areal extent of the TCE plume that emanates from Parcel E, and
- To provide performance monitoring data to assess the effectiveness of this active remedial approach following the completion of injection activities.

For Alternative 3, it is recommended that the current site monitoring well network be expanded during initial implementation activities. Eight additional monitoring wells are recommended to be installed in the Upper/Middle Surficial aquifer unit, and three monitoring wells are recommended to be installed in the Lower

Surficial aquifer unit. Following development and development of these groundwater monitoring wells, the existing Upper/Middle Surficial aquifer monitoring wells (OMS-28-3, OMS28-5, OMS-28-7, MW-5, MW-6, MW-8, MW-9, and MW-12), replacement monitoring well OMS-28-2R, and the 11 newly installed monitoring wells would be sampled to provide a baseline of the site-related COCs that are attributable to historical ALARNG operations that were conducted on Parcel E (i.e., TCE, cis-1,2-DCE, and VC) since the last sampling event occurred in May 2017. Low-flow sampling techniques would be used to establish aquifer conditions and to collect groundwater samples from each of these wells. The groundwater samples would be submitted to a DoD ELAP-certified analytical laboratory and analyzed for VOCs via Method 8260C/D. PCE would be included in the VOC sampling suite to determine how the offsite PCE plume is potentially impacting the natural attenuation of the TCE plume emanating from Parcel E. **Figure 4-2** shows the locations of the monitoring wells.

A subset of these 20 wells would also be sampled for dissolved iron, total iron, methane, ethane, ethene (MEE), total organic carbon (TOC), alkalinity, and select biological parameters (*DHC* and *Dehalobacter [DHB]* microbial counts in groundwater) to establish baseline conditions prior to the completion of the proposed injection activities. In total, there would be 20 wells sampled as part of the site monitoring well network. After the initial baseline event, groundwater monitoring at these 20 monitoring wells would be conducted quarterly for the first year, semi-annually for the second year, and annually for the third year following the completion of injection activities.

An RD/RA Work Plan would be completed prior to installing the proposed additional monitoring wells and would include site clearing details related to monitoring well installation for 5 of the 12 wells within the heavily wooded portion of Parcel F. Parcel D will not require clearing as this parcel is covered with large trees that allow for movement between them to install the one shallow monitoring well and the one deep monitoring well. Based on the results of the SDGI, the proposed Upper/Middle Surficial aquifer wells would be screened between 10 and 25 ft bgs, and the proposed Lower Surficial aquifer wells would be screened between 27 and 32 ft bgs. The replacement well for OMS-28-2 would be screened over the same interval (10 to 20 ft bgs) as the original well.

The results of the baseline sampling event would be used to finalize the size of the TCE plume targeted for in situ treatment. Monitoring well installation details, development, and subsequent remedy performance monitoring events would subsequently be presented in an RA Report.

4.1.3.1.2 Description of In Situ Treatment

Besides describing additional monitoring well installation, development, and sampling activities, the RD/RA Work Plan would outline overall project objectives, scope of work, deliverables, and project schedule for the in situ treatment of the TCE plume by ERD/ISCR. A site-specific health and safety plan would also be completed prior to conducting the proposed Alternative 3 groundwater remediation activities. After completion of the first injection event, an RA Report would be prepared. The report would include site drawings, a detailed narrative of the injection event, and a discussion of any associated analytical results.

The nature and extent of groundwater contamination associated with the TCE plume that emanates from Parcel E was described in Section 1.3.7.2. In situ ERD/ISCR treatment would target TCE and its associated degradation products within the 5 µg/L isoconcentration contour for the TCE plume on Parcels D, E, and F. This 5 µg/L TCE isoconcentration contour would be further refined following the receipt and review of the baseline analytical sampling results that will be collected from the updated site monitoring well network as previously described in Section 4.1.3.1.1.

An estimated 201 temporary injection points, based on 15-ft spacing between points, would be installed using DPT for treatment of the TCE plume. Approximately 60 points would target treatment between 6 and 14 ft bgs and also between 14 and 26 ft bgs, 127 points would target treatment between 14 and 26 ft bgs, and 14 points would target treatment between 27 and 31 feet bgs. The top treatment interval would be dictated by the depth to groundwater measured at the time of the injection event. **Figure 4-2** provides a conceptual site layout for the DPT injection points.

Prior to conducting DPT injection point installation, utility clearance would be conducted and the heavily wooded portion of Parcel F (approximately 0.43 acres) where the proposed monitoring wells and temporary injection points were to be installed would be cleared. Clearing would be conducted using conventional equipment. The cost to replace trees that need to be removed on Parcel F have not been included.

Following the completion of clearing activities, a contractor that specializes in conducting in situ injections would be subcontracted to emplace the combination ERD/ISCR substrate into each of the 201 injection locations. For this FS, the substrate to be injected is called ABC®+Olé, which is a combination of ABC®-Olé and ZVI, magnesium oxide, guar, RTB-1 (biological amendment consisting of *DHC*), and sodium sulfite. A description of each of these amendments is presented in the following subsections.

<u>ABC®+Olé</u>

A combination organic carbon source/ZVI substrate known as ABC®+Olé would be used for the treatment of the TCE plume. ABC®+Olé is a combination ERD/ISCR product developed and patented by Redox Tech, LLC. The use of ABC®+Olé would result in the creation of strong reducing conditions within the targeted treatment area.

<u>Magnesium Oxide</u>

At the Site, the native pH of the targeted groundwater is slightly less than neutral (between 5 and 6 standard units). As a result, magnesium oxide, which is transformed into magnesium hydroxide upon contact with water, would be injected along with the ABC®+Olé to more aggressively raise and sustain the pH within the immediate vicinity of the DPT injection locations. The quantity of magnesium oxide to be injected would be approximately 1% by weight of the injected solution.

<u>Guar</u>

Guar is used as a stabilizing, thickening, and suspending agent for injection substrates. In this case, the added guar would be utilized to achieve the hydraulic emplacement of the ABC®+Olé mixture at each DPT injection location.

RTB-1

Bioaugmentation, by means of RTB-1, would be used to increase the effectiveness of the planned ABC®+Olé injection. Bioaugmentation is defined as the addition of high-performance microbial cultures capable of degrading targeted chlorinated VOCs. Bioaugmentation for the treatment of chlorinated ethenes entails the addition of a naturally occurring, non-pathogenic, microbial culture that contains *DHC*, which are capable of completely dechlorinating TCE and its daughter products to harmless ethene. Bioaugmentation is often used when there is incomplete dechlorination of TCE following biostimulation with an organic carbon source.

Not all *DHC* found in nature dechlorinate VC efficiently due to the lack of necessary enzymes. RTB-1 offers an enriched dechlorinating culture that includes lactate as a carbon source and uses TCE as an electron acceptor. As such, RTB-1 offers an enriched dechlorinating culture capable of efficiently degrading TCE, cis-1,2-DCE, and VC to innocuous ethene. The *DHC* present in RTB-1 dechlorinate VC to ethene via halorespiration, and not via the less efficient cometabolic processes.

Sodium Sulfite

A small quantity of sodium sulfite will be used at each temporary ERD DPT injection location. The purpose of sodium sulfite addition is to precondition the targeted groundwater by deoxygenating it prior to the injection of the strictly anaerobic RTB-1 culture.

Injections would be conducted at each of the 201 injection points using a DPT rig in a bottom to top approach. Beginning at the deepest interval for each injection point, 100 pounds of ABC®+Olé (50 pounds of ABC® and 50 pounds of ZVI), 10 pounds of magnesium oxide, 2 pounds of guar, 0.25 liters of RTB-1, and 0.025 pounds of sodium sulfate would be mixed with 50 gallons of water. In total, 139,000 pounds of ABC®+Olé, 13,900 pounds of magnesium oxide, 2,780 pounds of guar, 348 liters of RTB-1, and 35 pounds of sodium sulfate would be mixed with approximately 70,000 gallons of water to treat all 201 injection points. The quantity of ABC+Olé to be injected would be approximately 19.2% by weight of the injected solution.

The ABC®+Olé, would treat impacted groundwater that it comes into contact with and subsequently reduce the targeted TCE to harmless end products. In **Appendix E,** the estimated time to reduce TCE to below its MCL was estimated to be a little over 2.5 years. The successful degradation of the targeted COCs to below the MCLs is highly dependent upon achieving adequate contact between the ABC®+Olé substrate and the impacted groundwater. Based upon the high concentration of ABC®+Olé substrate that would be injected, multiple injection events may not be necessary. However, to be conservative, two injection events are proposed under Alternative 3. The second injection event would occur three years after the first injection event and assumes that 50% treatment of the plume to RGs was achieved by the first injection event. As a result, the second ABC®+Olé injection event would target 100 temporary injection points.

4.1.3.1.3 Description of Enhanced MNA

Following the completion of ABC®+Olé injection activities, an RA Report would be prepared to summarize the first injection event. MNA that is enhanced as a result of the ABC®+Olé injections would subsequently be used to evaluate the effectiveness of active remediation using the same 20 wells that were sampled for the baseline monitoring event. Three quarterly sampling event would be conducted for the same analytical parameters as the baseline event beginning three months after the injection event. The quarterly sampling events would be summarized in a Remedial Action-Operation (RA-O) report. Following the first year of monitoring, the sampling frequency would be reduced to semi-annual monitoring during the second year following injection and then annually during the third year following injection. An annual RA-O report would be produced for the second and third years following injection. The same 20 monitoring wells would be analyzed for the same analytical parameters for each of these performance monitoring events in accordance with the RD/RA work plan and the follow up RA-O reports. A planned second injection event details and the associated performance monitoring information would be included in the annual RA-O report to be completed following the third year of post-injection sampling.

The results from the post-injection monitoring events would be evaluated for reductions in COC concentrations, increases in contaminant breakdown products, reductions in competing electron acceptors, and for detection of residual organic carbon concentrations. A site-specific degradation rate could subsequently be calculated to update the estimate to achieve the RGs. The Enhanced MNA program to be conducted following the second proposed injection event would be similar in scope and time frame (three years) as the Enhanced MNA program proposed to be conducted following the first proposed injection event; however, only 12 monitoring wells would be sampled instead of 20 monitoring wells.

For purposes of this FS, a degradation rate for the treatment of TCE in groundwater using ERD/ZVI was calculated in order to come up with an estimated time of 7 years for Alternative 3 to achieve the applicable RGs. **Appendix E** provides further information on how this estimated time frame was calculated.

One CERCLA Five-Year Review would be completed for Alternative 3.

4.1.3.1.4 Potential VI Risk

The potential future VI risk caused by the Parcel E TCE plume is the same as previously described in Section 4.1.2.1.4. The potential risk would be addressed in the same manner as described for Alternative 2.

4.1.3.2 Overall Protection of Human Health and the Environment

Currently, there is no direct exposure to groundwater at the OMS #28 site. In approximately 7 years, the two proposed ABC®+Olé injection events would reduce the site-related groundwater COC concentrations to below the respective RGs through a combination of ERD/ISCR and enhanced MNA.

Because this alternative would reduce COC concentrations to below the RGs, the groundwater remaining after treatment would no longer pose an unacceptable risk to human health. Risks to remediation workers from contact with contaminated media would be minimal and are addressed further in Section 4.1.3.4.

Potential impact to the environment would be relatively widespread for Alternative 3. Within the area targeted for in situ treatment, approximately 0.43 acres of existing dense vegetation, including mature trees and brush would have to be cleared from Parcel F to accommodate monitoring well installation and ERD/ISCR injection activities.

4.1.3.3 Compliance with Applicable or Relevant and Appropriate Requirements

Once ERD/ISCR and enhanced MNA reduce site-related groundwater COC concentrations to below the respective RGs, chemical-specific ARARs would be met. Post-injection monitoring for VOCs would be conducted to verify attainment of the RGs.

4.1.3.4 Short-term Effectiveness

Community Protection - Alternative 3 reduces the likelihood of contact with chlorinated VOCs in groundwater due to treatment of the TCE plume emanating from Parcel E using ERD/ISCR with Enhanced MNA. Noise, dust, and traffic related to injection and monitoring well installation and injection activities would be limited in duration.

Worker Protection – Remediation workers may be exposed to COCs present in groundwater during drilling, ABC®+Olé injection, and monitoring events as well as to ZVI dust during injection events. Workers and oversight personnel would be HAZWOPER-trained, and engineering controls and PPE would be used as necessary to prevent excessive exposure. Construction and treatment activities would be limited in duration, and the overall exposure potential would be low. The site-specific HASP would be updated to encompass all new activities associated with this alternative.

In addition, remediation workers will be exposed to safety risks during brush/tree clearing on Parcel F as well as during the subsequent monitoring well installation and development activities. Daily tailgate safety meetings and the site-specific HASP would be used to address these safety risks.

Environmental Impacts – An attempt to minimize environmental impacts during implementation of Alternative 3 would be performed. With regards to tree and brush clearing on Parcel F, mulch generated from trees that were removed to accommodate injection point and monitoring well installation would be uncontaminated and therefore could be used for landscaping operations on Parcel E without any pretreatment. Trees removed from Parcel F could potentially be replanted, if requested (costs are not provided for this service in this FS). Silt fencing would be installed around the cleared area for erosion control.

Time to Achieve RAO/RGs – The estimated duration of Alternative 3 is expected to be at least 7 years. The first year will be used to draft and finalize the health and safety plan and the RD/RA work plan. Also clearing of trees and brush to accommodate injection point and monitoring well installation on Parcel F would occur during the first year. It was assumed that two substrate injection events would be conducted with associated post injection performance monitoring conducted quarterly during Year 2 and Year 5 (three quarterly events each), semi-annual monitoring conducted during Year 3 and Year 6, and annual sampling conducted during Year 4 and Year 7. It is estimated that groundwater RGs will be achieved within 5 years from the completion of the first injection event.

4.1.3.5 Reduction of Toxicity, Mobility, or Volume

Treatment of the OMS #28 TCE plume using two carbon source/ZVI injections would permanently reduce the toxicity, mobility, and volume of the targeted COCs in site groundwater via active remediation processes combined with enhanced MNA. The targeted COCs would be reduced to innocuous end products and treatment would be irreversible. Post-injection event monitoring will be conducted to confirm that site-related COCs in groundwater have been reduced to below their RGs. As such, Alternative 3 satisfies the statutory preference for remedial actions that permanently reduce the toxicity, mobility, and volume of site COCs and incorporate treatment as a principal element.

4.1.3.6 Long-term Effectiveness and Permanence

ERD combined with ISCR would permanently decrease the groundwater COC concentrations via irreversible biodegradation and irreversible abiotic degradation via β-elimination and hydrogenolysis. Implementation of this alternative would result in a rapid and permanent decrease in groundwater COC concentrations as long as adequate contact between the injected carbon source and ZVI and the targeted COCs is achieved. Post-injection monitoring for VOCs would be conducted at site monitoring wells to verify treatment and to determine whether follow-up injections were required to achieve RGs. MNA parameters and biological parameters would also be collected as part of the performance monitoring program for the site. This technology is expected to reduce site-related groundwater COC concentrations to the respective RGs in approximately 7 years.

Similar to what was previously presented for Alternative 2, the presence of the offsite PCE soil and groundwater source that is not related to historical operations and activities conducted by the ALARNG on Parcel E may potentially impact the long-term effectiveness and permanence of Alternative 3, particularly in the area of in situ treatment for the co-mingled PCE plume from Parcel A and the TCE plume from Parcel E. As shown on **Figure 4-2**, a shallow/middle surficial aquifer monitoring well is proposed to be installed on the eastern edge of the co-mingled plume area. Its location will also coincide with the eastern edge of the local trough feature (paleochannel) where shallow/middle surficial aquifer groundwater flow comes from the east and then turns to the north-northwest (refer to Figure 1-4). This additional well will help to determine if there is influence from the Parcel A PCE plume migrating to the southeast at this location or if this location is dominated by flow to the west and northwest from the northeast edge of Parcel F and from Parcel E. This additional data will serve to provide information related to the long-term effectiveness and permanence of Alternative 3.

4.1.3.7 Implementability

Right-of-entry access should not be an issue based on the activities that were previously conducted on both Parcels D and F during the SDGI. The extensive clearing proposed for Parcel F should not be a problem since the property is owned by MAA, and it is not used for any business-related purposes. As previously stated in Section 4.1.3.1.1, Parcel D is covered by large mature trees with room in between them to allow for monitoring well installation and DPT injections to occur without requiring clearing.

Emplacement of carbon source/ZVI substrate is an established remediation technique. ERD/ISCR has been demonstrated in field-scale applications with similar lithology to be capable of achieving complete destruction of groundwater COCs similar to those present at OMS #28. However, based on the targeted site aquifer lithology (potential for matrix back diffusion) and the relatively low concentration of the COCs to be treated, uncertainty associated with this alternative would remain as to whether the injected carbon source/ZVI could be emplaced effectively to sufficiently treat the targeted groundwater plume within the estimated time frame. Post-injection performance monitoring would be conducted to verify attainment of the site-related groundwater RGs. Groundwater monitoring activities would pose no technical implementation difficulties.

An estimated 49 field days would be required to complete the first ABC®+Olé injection event.

4.1.3.8 Cost

The expected duration of Alternative 3 is 7 years. The first year would be used to draft and finalize the RD/RA Work Plan, to clear portions of Parcels D and F where injection points and new monitoring wells are proposed, and to install and develop 11 new monitoring wells and one (1) replacement monitoring well. It was assumed that two ABC®+Olé substrate injection events would be completed in conjunction with post injection performance monitoring conducted quarterly in Year 2 and Year 5 (three quarterly events each), semi-annual monitoring conducted during Year 3 and Year 6, and annual sampling conducted during Year 4 and Year 7. For Years 2 through 4, 20 site monitoring wells would be sampled for VOCs. A subset of these 20 wells would also be sampled for dissolved iron, total iron, MEE, TOC, alkalinity, and biological parameters (*DHC* and *DHB*) during each event with a baseline sampling event to be conducted prior to the first injection event. For Years 5 through 7, 12 site monitoring wells would be sampled for VOCs. A subset of these 12 wells would also be sampled for dissolved iron, total iron, MEE, TOC, alkalinity, *DHC*, and *DHB*. One CERCLA five-year review would be conducted in Year 5. Monitoring well abandonment costs are included in Year 7.

The total net present worth cost (capital cost, O&M costs for remedy performance monitoring sampling, Five-Year Review, well abandonment, owner cost [11% of total alternative cost], and 20% contingency) of Alternative 3 is $2,187,700. **Table 4-1** presents a summary of costs associated with this alternative; the detailed cost estimate is presented in **Appendix D** (**Table D-2**).

5.0 REMEDIAL ALTERNATIVES COMPARATIVE ANALYSIS

A comparison of remedial alternatives for TCE-impacted groundwater associated with OMS#28 is presented in the following subsections and summarized in **Table 5-1**.

5.1 OMS #28 REMEDIAL ALTERNATIVES COMPARATIVE ANALYSIS

This section presents comparative analysis of each remedial alternative evaluated for site groundwater in **Section 4.1.1** against the criteria set forth in **Section 4.0**. The goal of this comparative analysis is to facilitate the selection of the remedial alternative deemed most suitable for TCE-impacted groundwater that emanates from Parcel E (the ALARNG property). This qualitative comparative analysis evaluates the strengths and weaknesses of the potential remedial alternatives relative to one another with respect to the specified criteria. The following subsections briefly discuss and evaluate each of the OMS #28 groundwater remedial alternatives and compares them against each of the screening criteria.

5.1.1 Overall Protection of Human Health and the Environment

The overall protection of human health and the environment is a threshold criterion that must be met for an alternative to be considered as per the NCP. Therefore, except for Alternative 1 (No Action), which is retained as a baseline alternative, all other remedial alternatives are expected to achieve the overall protection of human health and the environment over time. Because residential use is not a current use or foreseeable future use for Parcel E, Alternative 2 (LUCs with Periodic Monitoring) and Alternative 3 (ERD, ISCR, and Enhanced MNA) are equally protective because there is no current risk associated with the site. Alternative 3 is only more protective than Alternative 2 under a future residential use scenario because it actually treats rather than just monitors impacted groundwater that may pose a risk under this hypothetical exposure scenario.

Although there is no quantifiable risk to ecological receptors at this site (AECOM, 2023), Alternative 3 would provide a level of additional protectiveness over Alternative 2 through the treatment of impacted groundwater associated with the site. However, environmental impact would be more widespread for Alternative 3 than for Alternative 2. Approximately 0.43 acres of existing dense vegetation, including mature trees, brush, and grasses would have to cleared for Alternative 3 to accommodate proposed additional monitoring well and DPT injection point installation. A much smaller footprint would need to be cleared to accommodate proposed monitoring well installation for Alternative 2.

5.1.2 Compliance with ARARs

Per the NCP, compliance with ARARs is also a threshold criterion that must be met for a remedial alternative to be considered. Alternative 1 (No Action), which is retained as a baseline alternative would not comply with ARARs. Alternative 2 (LUCs with Periodic Monitoring) would require over 18 years to comply with the RGs for TCE and its associated degradation products. Alternative 3 (ERD, ISCR, and Enhanced MNA) would comply with all ARARs within approximately 7 years if adequate contact is achieved between the proposed injectate and the targeted groundwater COCs.

5.1.3 Short-term Effectiveness

Alternative 1 (No Action) would have no short-term impacts to workers, community, or the environment because no remedial action occurs. Alternative 2 (LUCs with Periodic Monitoring) would have limited impact to the community and the environment due to the clearing of trees/brush to accommodate the installation of four new monitoring wells and also due to the completion of LUC surveys at the site every five years. Alternative 3 (ERD, ISCR, and Enhanced MNA) would have the most impact to the community and environment due to large clearing operations, monitoring well installations, and chemical injection activities.

Alternatives 2 and 3 would have the similar short-term impact to the remediation workers that would be conducting sampling due to the potential for exposure to impacted groundwater; however, the applicable RGs for TCE and its degradation products would be achieved within an estimated 7-Year time period for Alternative 3 as compared to over 18 years for Alternative 2. Sampling would be conducted more frequently for Alternative 3 when compared to Alternative 2.

5.1.4 Reduction of Toxicity, Mobility, or Volume

Alternatives 1 (No Action) and 2 (LUCs with periodic monitoring) would not reduce the toxicity, mobility, or volume of contaminated groundwater; however, Alternative 2 does provide additional delineation of the extent of the plume and monitoring to determine if natural attenuation processes are occurring in the site groundwater. Alternative 3 (ERD, ISCR, and Enhanced MNA) would permanently reduce the toxicity, mobility, and volume of the targeted COCs in site groundwater via active remediation processed combined with enhanced MNA. As such, this alternative satisfies the statutory preference for remedial actions that permanently reduce the toxicity, mobility, and volume of site COCs and also incorporates treatment as a principal element.

5.1.5 Long-term Effectiveness and Permanence

In January 2022, QuantArray®-Chlor analysis was conducted by Microbial Insights of Knoxville, Tennessee for three site monitoring wells (OMS-28-5, OMS-28-3, and MW-8). Bio-traps were deployed in these three wells for approximately one month between December 10, 2021 and January 13, 2022. Based on the analysis of the bio-traps impacted by the TCE plume that emanates from Parcel E, it was determined that minimal reductive dechlorinating bacteria were present in OMS-28-3 and MW-8, and no reductase genes were detected. The low concentration of TCE remaining in both of these wells may be a contributing factor to the results of this analysis. Further discussion of the QuantArray®-Chlor analysis and the associated report are provided in **Appendix C**.

Based on the QuantArray®-Chlor analysis results, Alternative 1 (No Action) and Alternative 2 (LUCs with Periodic Monitoring) may be effective in reducing groundwater COC concentration over the long term via natural attenuation; however, as described in the previous paragraph, there is limited evidence of the necessary bacteria and the associated reductase genes to promote the biodegradation of TCE and its degradation products. Alternative 2 (LUCs with Periodic Monitoring) would employ periodic monitoring to understand any ongoing natural attenuation of the plume as well as would document the stability of the plume over time. Alternative 3 (ERD, ISCR, and Enhanced MNA) would be expected to reduce site-related groundwater COC concentrations to the respective RGs in approximately 7 years. Groundwater COCs are irreversibly degraded under Alternative 3, thereby ensuring long-term effectiveness and permanence.

However, the presence of the offsite PCE soil and groundwater source that is not related to historical operations and activities conducted by the ALARNG on Parcel E may potentially impact the long-term effectiveness and permanence of both Alternative 2 and Alternative 3, particularly in the area of in situ treatment for the co-mingled PCE plume from Parcel A and the TCE plume from Parcel E. Monitoring wells to be installed along the western edge of the TCE plume where it intermingles with the offsite PCE plume associated with Parcel A will provide additional information to further understand the long-term effectiveness and permanence of Alternatives 2 and 3.

5.1.6 Implementability

Alternative 1 (No Action) would be easy to implement as no remedial action would occur. Alternative 2 (LUCs with Periodic Monitoring) would be somewhat easy to implement; however, the DoD cannot execute an environmental covenant for Parcel E because the DoD has no authority to grant a real property interest for an environmental LUC (e.g., an environmental covenant) on federal property. In lieu of an environmental covenant, a NEUR for Parcel E could be prepared and submitted to ADEM; however, the DoD NEUR template and the ADEM NEUR template differ significantly and the issue remains unresolved at this time. The ALARNG does not have the authority to implement, enforce, or maintain LUCs on the currently affected offsite undeveloped parcels. A notification would be provided by ALARNG that would include recommending that landowners place an environmental covenant on the affected parcel per the Alabama Uniform Environmental Covenants Act until RAOs and RGs are met.

Alternative 3 would be implementable, but it would require the use of specialty technologies to emplace the proposed injectate within the targeted plume area. New monitoring wells would be installed as part of the activities conducted for both Alternatives 2 and 3. Permission would need to be obtained to clear trees and brush on Parcel F and to conduct the proposed injections on offsite Parcels D and F. Right of entry agreements for offsite Parcels D and F should not be an issue based on access that was obtained previously for the SDGI activities.

5.1.7 Cost

Alternative 1 (No Action) would have no cost associated with it. Alternative 2 (LUCs with Periodic Monitoring) has an estimated total net present worth cost of $484,300 over an estimated 18 years. Alternative 3 (ERD, ISCR, and Enhanced MNA) has total net present worth cost of $2,187,700 over an estimated 7-year period. Costs to replant trees removed during clearing activities are not included with the Alternative 2 and Alternative 3 cost estimates.

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TABLES

Table 1-1
Site Concentrations and Site-Specific Screening Levels for COCs
OMS #28
Alabama Army National Guard - Mobile, Alabama

Parcel/Receptor/Pathway/COC [1]	Site Concentration [2]	Units	Carcinogenic SSSLs Based on the Following Risk Levels [3]			Noncarcinogenic SSSLs Based on the Following Hazard Quotients [3]			MCL [4]
			10^{-6}	10^{-5}	10^{-4}	0.1	1	3	
PARCEL A									
Current and Future Trespasser									
No COCs Identified									
Future Construction Worker									
Surface Soil (Ingestion, Inhalation)									
Tetrachloroethene	329	mg/kg	572	5,720	57,200	**8.4**	**84.4**	**253**	NA
Subsurface Soil (Ingestion, Inhalation)									
Tetrachloroethene	329	mg/kg	572	5,720	57,200	**8.4**	**84.4**	**253**	NA
Groundwater (Ingestion, Dermal, Inhalation)									
Tetrachloroethene	12,235	µg/L	**172**	**1,716**	17,157	**2.7**	**27**	**80**	**5**
Trichloroethene	18	µg/L	**10.1**	101	1,006	**0.13**	**1.3**	**3.9**	**5**
Future Industrial Worker									
Surface Soil (Ingestion, Inhalation)									
Tetrachloroethene	329	mg/kg	**126**	1,260	12,600	**47.2**	472	1,416	NA
Groundwater (Ingestion, Dermal, Inhalation)									
Tetrachloroethene	12,235	µg/L	**72.7**	**727**	**7,275**	**32.7**	**327**	**982**	**5**
Trichloroethene	18	µg/L	**3.5**	35	349	**2.9**	29	85.9	**5**
Groundwater (Vapor Intrusion)									
Tetrachloroethene	13,751	µg/L	**2,127**	21,265	212,651	**790**	**7,898**	23,695	NA
Future Resident Adult [9]									
Surface Soil (Ingestion, Inhalation)									
Tetrachloroethene	329	mg/kg	**27.6**	**276**	2,760	**11.4**	**114**	342	NA
Groundwater (Ingestion, Dermal, Inhalation)									
Tetrachloroethene	12,235	µg/L	**5.7**	**57**	**565**	**2.5**	**25**	**75**	**5**
Trichloroethene	18	µg/L	**0.25**	**2.5**	25	**0.16**	**1.6**	**4.8**	**5**
Groundwater (Vapor Intrusion)									
Tetrachloroethene	13,751	µg/L	**61.4**	**614**	**6,140**	**23.7**	**237**	**712**	NA
Trichloroethene [5]	19.84	µg/L	**3.6**	36	355	NC	NC	NC	NA
Future Resident Child									
Surface Soil (Ingestion, Inhalation)									
Tetrachloroethene	329	mg/kg	—	—	—	**9.3**	**93**	**280**	NA
Groundwater (Ingestion, Dermal)									
Tetrachloroethene	12,235	µg/L	**—**	**—**	**—**	**3.9**	**39**	**118**	**5**
Trichloroethene	18	µg/L	**—**	**—**	**—**	**0.4**	**4.4**	**13**	**5**
Groundwater (Vapor Intrusion)									
Tetrachloroethene [6]	13,751	µg/L	**61.4**	**614**	**6,140**	**23.7**	**237**	**712**	NA
Trichloroethene [5, 6]	19.84	µg/L	**3.6**	36	355	NC	NC	NC	NA

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Parcel/Receptor/Pathway/COC [1]	Site Concentration [2]	Units	Carcinogenic SSSLs Based on the Following Risk Levels [3]			Noncarcinogenic SSSLs Based on the Following Hazard Quotients [3]			MCL [4]
			10^{-6}	10^{-5}	10^{-4}	0.1	1	3	
PARCEL B									
Current and Future Trespasser									
No COCs Identified									
Future Construction Worker									
Groundwater (Ingestion, Dermal, Inhalation)									
Trichloroethene	10	µg/L	20.1	201	2,012	**0.26**	**2.6**	**7.9**	**5**
Future Industrial Worker									
No COCs Identified									
Future Resident Adult [9]									
Groundwater (Ingestion, Dermal, Inhalation)									
Trichloroethene	10	µg/L	0.49	4.9	49	**0.32**	**3.2**	**9.6**	**5**
Groundwater (Vapor Intrusion)									
Trichloroethene [5]	10	µg/L	**7.1**	71	710	NC	NC	NC	NA
Future Resident Child									
No COCs Identified									
PARCEL C									
Current and Future Trespasser									
No COCs Identified									
Future Construction Worker									
Groundwater (Ingestion, Dermal, Inhalation)									
Trichloroethene	4	µg/L	20.1	201	2,012	**0.26**	**2.6**	7.9	5
Future Industrial Worker									
No COCs Identified									
Future Resident Adult [9]									
No COCs Identified									
Future Resident Child									
No COCs Identified									

Table 1-1
Site Concentrations and Site-Specific Screening Levels for COCs
OMS #28
Alabama Army National Guard - Mobile, Alabama

Parcel/Receptor/Pathway/COC (1)	Site Concentration (2)	Units	Carcinogenic SSSLs Based on the Following Risk Levels (3)			Noncarcinogenic SSSLs Based on the Following Hazard Quotients (3)			MCL (4)
			10^{-6}	10^{-5}	10^{-4}	0.1	1	3	
PARCEL D									
Current and Future Trespasser									
No COCs Identified									
Future Construction Worker									
Groundwater (Ingestion, Dermal, Inhalation)									
Trichloroethene	20	µg/L	20.1	201	2012	**0.26**	**2.6**	**7.9**	**5**
Future Industrial Worker									
No COCs Identified									
Future Resident Adult (9)									
Groundwater (Ingestion, Dermal, Inhalation)									
Trichloroethene	20	µg/L	**0.5**	**5**	49.4	**0.32**	**3.2**	**9.7**	**5**
Groundwater (Vapor Intrusion)									
Trichloroethene (5)	9.02	µg/L	**7.1**	71	710	NC	NC	NC	NA
Future Resident Child									
Groundwater (Ingestion, Dermal)									
Trichloroethene	20	µg/L	**—**	**—**	**—**	**0.87**	**8.7**	26.1	**5**
Groundwater (Vapor Intrusion)									
Trichloroethene (5, 6)	9.02	µg/L	**7.1**	71	710	NC	NC	NC	NA

Table 1-1
Site Concentrations and Site-Specific Screening Levels for COCs
OMS #28
Alabama Army National Guard - Mobile, Alabama

Parcel/Receptor/Pathway/COC [1]	Site Concentration [2]	Units	Carcinogenic SSSLs Based on the Following Risk Levels [3]			Noncarcinogenic SSSLs Based on the Following Hazard Quotients [3]			MCL [4]
			10^{-6}	10^{-5}	10^{-4}	0.1	1	3	
PARCEL E									
Current Industrial Worker									
No COCs Identified [7]									
Current and Future Trespasser									
No COCs Identified									
Future Construction Worker									
Groundwater (Ingestion, Dermal, Inhalation)									
Trichloroethene	145	µg/L	**20.1**	201	2,012	**0.26**	**2.6**	**7.9**	**5**
Future Industrial Worker									
Groundwater (Ingestion, Dermal, Inhalation)									
Trichloroethene	145	µg/L	**7**	**70**	697	**5.73**	**57**	172	**5**
Groundwater (Vapor Intrusion)									
Trichloroethene [5]	230.4	µg/L	**220**	2,204	22,044	NC	NC	NC	NA
Future Resident Adult [9]									
Groundwater (Ingestion, Dermal, Inhalation)									
Trichloroethene	145	µg/L	**0.25**	**2.5**	**25**	**0.16**	**1.6**	**5**	**5**
Vinyl Chloride	0.03	µg/L	**0.0094**	0.094	0.94	3	30	90	2
Groundwater (Vapor Intrusion)									
Trichloroethene [5]	230.4	µg/L	**6.83**	**68.3**	683	NC	NC	NC	NA
Future Resident Child									
Groundwater (Ingestion, Dermal)									
Trichloroethene	145	µg/L	**—**	**—**	**—**	**0.87**	**8.7**	**26**	**5**
Groundwater (Vapor Intrusion)									
Trichloroethene [5, 6]	230.4	µg/L	**6.83**	**68.3**	683	NC	NC	NC	NA

Table 1-1
Site Concentrations and Site-Specific Screening Levels for COCs
OMS #28
Alabama Army National Guard - Mobile, Alabama

Parcel/Receptor/Pathway/COC [1]	Site Concentration [2]	Units	Carcinogenic SSSLs Based on the Following Risk Levels [3]			Noncarcinogenic SSSLs Based on the Following Hazard Quotients [3]			MCL [4]
			10^{-6}	10^{-5}	10^{-4}	0.1	1	3	
PARCEL F									
Current and Future Trespasser									
No COCs Identified									
Future Construction Worker									
Groundwater (Ingestion, Dermal, Inhalation)									
Tetrachloroethene	190.1	µg/L	**172**	1716	17157	**2.67**	**27**	**80**	**5**
Trichloroethene	189.3	µg/L	**10.1**	**101**	1006	**0.13**	**1.3**	**3.9**	**5**
Future Industrial Worker									
Groundwater (Ingestion, Dermal, Inhalation)									
Tetrachloroethene	190.1	µg/L	**73**	727	7275	**32.7**	327	982	**5**
Trichloroethene	189.3	µg/L	**3.5**	**35**	349	**2.9**	**29**	**86**	**5**
Groundwater (Vapor Intrusion)									
Trichloroethene [5]	247.3	µg/L	**216**	2158	21576	NC	NC	NC	NA
Future Resident Adult [9]									
Groundwater (Ingestion, Dermal, Inhalation)									
cis-1,2-Dichloroethene	89.93	µg/L	**—**	**—**	**—**	**1.49**	**14.9**	**45**	**70**
Tetrachloroethene	190.1	µg/L	**3.8**	**38**	377	**1.26**	**12.6**	**38**	**5**
Trichloroethene	189.3	µg/L	**0.16**	**1.6**	**16**	**0.081**	**0.81**	**2.4**	**5**
Vinyl chloride	0.2	µg/L	**0.0063**	**0.063**	0.63	1.49	14.9	45	2
Groundwater (Vapor Intrusion)									
Tetrachloroethene	251.1	µg/L	**57.9**	579	5,786	**22.3**	**223**	670	NA
Trichloroethene [5]	247.3	µg/L	**3.35**	**33.5**	335	NC	NC	NC	NA
Future Resident Child									
Groundwater (Ingestion, Dermal)									
cis-1,2-Dichloroethene	89.93	µg/L	—	—	—	**1.2**	**12**	**36**	**70**
Tetrachloroethene	190.1	µg/L	—	—	—	**2.6**	**26**	**78**	**5**
Trichloroethene	189.3	µg/L	—	—	—	**0.29**	**2.9**	**9**	**5**
Groundwater (Vapor Intrusion)									
Tetrachloroethene [6]	251.1	µg/L	57.9	579	5,786	**22.3**	**223**	670	NA
Trichloroethene [5, 6]	247.3	µg/L	**3.35**	**33.5**	335	NC	NC	NC	NA

Table 1-1
Site Concentrations and Site-Specific Screening Levels for COCs
OMS #28
Alabama Army National Guard - Mobile, Alabama

Parcel/Receptor/Pathway/COC (1)	Site Concentration (2)	Units	Carcinogenic SSSLs Based on the Following Risk Levels (3)			Noncarcinogenic SSSLs Based on the Following Hazard Quotients (3)			MCL (4)
			10^{-6}	10^{-5}	10^{-4}	0.1	1	3	
PARCEL G									
Current and Future Trespasser									
No COCs Identified									
Future Construction Worker									
No COCs Identified									
Future Industrial Worker									
No COCs Identified									
Future Resident Adult (9)									
No COCs Identified									
Future Resident Child									
No COCs Identified									
PARCEL H									
Current and Future Resident Adult (8, 9)									
No COCs Identified									
Current and Future Resident Child (8)									
No COCs Identified									

Notes:

(1) COCs were identified as those chemicals with a significant contribution to a pathway in a use scenario for a receptor that either (a) exceeds a 1 x 10^{-4} cumulative site cancer risk or (b) exceeds a non-carcinogenic HI of 1. No Subsurface Soil COCs were identified. See Risk and Hazard tables in Appendix E of the RAR Revision 2 (AECOM, March 2023).

(2) Site concentration is the exposure point concentration shown in Tables 6 through 9 of the RAR Revision 2 (AECOM, March 2023).

(3) SSSLs were derived as follows:

For exposure to soil for the Construction Worker and Industrial Worker, and for exposure to soil and groundwater for the Resident Adult, SSSLs were calculated using USEPA's RSL Calculator (output included in Appendix G of the RAR Revision 2 (AECOM, March 2023]).

For exposure to soil for the Resident Child and for exposure to groundwater for the Construction Worker, Industrial Worker, and Resident Child, SSSLs were calculated using standard risk equations (shown in Appendix G of the RAR Revision 2 (AECOM, March 2023).

For exposure to groundwater via vapor intrusion for the Industrial Worker, Resident Adult, and Resident Child — SSSLs were identified as the "target groundwater concentration" calculated by the Johnson and Ettinger Model (output included in Appendices F.2, F.3, and F.4 of the RAR Revision 2 (AECOM, March 2023).

(4) MCL is from the Drinking Water Standards and Health Advisories Tables (USEPA, November 2018).
NA indicates an MCL is not applicable for this medium.

(5) The Johnson and Ettinger Model does not display noncarcinogenic SSSLs for this COC. Carcinogenic SSSLs are shown for the child receptor.

(6) While the Johnson and Ettinger Model calculated carcinogenic SSSLs for this COC, risk is not identified for a child receptor in risk evaluations.

(7) The current industrial worker was not quantitatively evaluated at Parcel E; no chemicals of potential concern were identified in surface soil and no groundwater plume is within 100 feet of the building currently used by industrial workers.

(8) A residence currently exists on Parcel H, immediately east of Parcel D. The residence on Parcel H is within 100 feet of the VOC plume beneath Parcel D; therefore, it was evaluated for vapor intrusion using groundwater data identified in the core of the plume at Parcel D (Locations OMS-28-GW46-16, -GW64-16, and -GW75-29). Exposure and risk for a future resident on Parcel H were assumed to be the same as under current conditions. There is no current resident on Parcel D.

(9) RSL Calculator output for the Resident Adult consists of only the adult values; it does not include the child values.

When more than one COC was identified for a given receptor's pathway, the SSSL for each COC was divided by the number of COCs for that receptor's pathway (Section 6.7.2 of ADEM, February 2017).

COCs in bold indicate the site concentration exceeds one or more SSSLs or the MCL. The SSSLs and MCL exceeded are also bolded.

A current construction worker is not evaluated for any parcel.

COC - chemical of concern
MCL - maximum contaminant level
mg/kg - milligrams per kilogram (parts per million)
NC - not calculated
RAR - Risk Assessment Report
SSSL - site-specific screening level
µg/L - micrograms per liter (parts per billion)

Sources:

ADEM, February 2017. Alabama Risk-Based Corrective Action Guidance Manual, Revision 3.0.
AECOM, March 2023. Risk Assessment Report, Revision 2.
USEPA, May 2023. Regional Screening Levels (RSLs) Summary Table

Table 1-2
Historical Groundwater COC Concentrations
OMS #28
Alabama Army National Guard - Mobile, Alabama

Well ID	Depth of Well (ft btoc)	Screened Interval (ft btoc)	Date	PCE	TCE	cis-1,2-DCE	Vinyl Chloride
Maximum Contaminant Level				5	5	70	2
Upper Surficial Aquifer Wells							
MW-5	13.6	3.3-13.3	10/18/2006	NA	0.27 U	NA	NA
			7/1/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/11/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/7/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/20/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/1/2017	0.5 U	0.5 U	0.5 U	0.5 U
MW-6	12.7	2.3-12.3	10/18/2006	NA	0.27 U	NA	NA
			7/1/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/11/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/7/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/20/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/1/2017	0.5 U	0.5 U	0.5 U	0.5 U
MW-8	15.2	4.8-14.8	3/1/2005	NA	**480**	NA	NA
			4/18/2006	NA	**97.9**	NA	NA
			10/18/2006	NA	**83 J**	**NA**	NA
			7/1/2008	0.2 U	**133**	**3.97 J**	0.0538 U
			12/11/2008	0.153 U	**46**	**3.24 J**	0.155 U
			5/8/2009	0.0998 U	**18**	**0.812 J**	0.0767 U
			9/24/2009	0.0998 U	**8.41**	0.103 U	0.0767 U
			3/19/2010	0.121 U	**41**	**2.07 J**	0.093 U
			9/8/2010	0.121 U	**13**	0.0613 U	0.093 U
			1/22/2016	0.5 U	**7.8**	0.5 U	0.5 U
			5/1/2017	0.5 U	**0.373 J**	0.5 U	0.5 U
MW-9	17.4	7.4-17.4	11/22/2006	0.072 U	0.024 U	0.051 U	0.052 U
			7/1/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/10/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/8/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/20/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/5/2017	0.5 U	0.5 U	0.5 U	0.5 U
MW-10	17.6	7.6 - 17.6	11/22/2006	**4.9**	**11**	**5.8**	**1.5**
				Abandoned at request of property owner			
MW-11	16.6	6.6 - 16.6	11/22/2006	0.072 U	**63**	0.051 U	0.052 U
				Abandoned at request of property owner			
MW-12	15.6	5.6-15.6	11/22/2006	0.072 U	0.024 U	0.051 U	0.052 U
			7/1/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/10/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/7/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/21/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/1/2017	0.5 U	0.5 U	0.5 U	0.5 U

Table 1-2
Historical Groundwater COC Concentrations
OMS #28
Alabama Army National Guard - Mobile, Alabama

Well ID	Depth of Well (ft btoc)	Screened Interval (ft btoc)	Date	PCE	TCE	cis-1,2-DCE	Vinyl Chloride
Maximum Contaminant Level				5	5	70	2
Upper Surficial Aquifer Wells							
OMS-28-2	20.0	10-20	7/1/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/10/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	**2 J**	0.0613 U	0.093 U
			9/7/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/19/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/5/2017	0.5 U	0.5 U	0.5 U	0.5 U
OMS-28-3	20.0	10-20	7/1/2008	0.2 U	**80**	**6.26**	0.0538 U
			12/11/2008	0.153 U	**94**	**9.34**	0.155 U
			5/8/2009	0.0998 U	**29**	**9.55**	0.0767 U
			9/24/2009	0.0998 U	**15.29**	0.103 U	0.0767 U
			3/19/2010	0.121 U	**12**	**1.37 J**	0.093 U
			9/8/2010	0.121 U	**149**	**9.43**	0.093 U
			1/21/2016	0.5 U	**8.92**	**1.59**	0.5 U
			5/1/2017	0.5 U	**9.6**	**1.26**	0.5 U
OMS-28-5	20.0	10-20	7/1/2008	**130**	**39**	**12**	0.0538 U
			12/11/2008	**9.2**	**14**	**8.7**	0.155 U
			5/8/2009	**234**	**162**	**20**	0.0767 U
			9/24/2009	**8.02**	**11**	**9.12**	0.0767 U
			3/19/2010	**81**	**51**	**6.3**	0.093 U
			9/8/2010	**33**	**19**	**8.69**	0.093 U
			1/20/2016	**455**	**200**	**27.8**	2.5 U
			5/5/2017	**154**	**246**	**103**	1 U
OMS-28-7	20.0	10-20	7/1/2008	0.2 U	**1.73 J**	0.0745 U	0.0538 U
			12/10/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	**0.684 J**	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/8/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/20/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/1/2017	0.5 U	0.5 U	0.5 U	0.5 U
Lower Surficial Aquifer Wells							
OMS-28-1	80.0	70-80	7/8/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/11/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/7/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/20/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/1/2017	0.5 U	0.5 U	0.5 U	0.5 U
OMS-28-4	76.0	66-76	7/8/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/10/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/19/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/8/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/20/2016	**0.88 J**	0.5 U	0.5 U	0.5 U
			5/5/2017	0.5 U	0.5 U	0.5 U	0.5 U

Table 1-2
Historical Groundwater COC Concentrations
OMS #28
Alabama Army National Guard - Mobile, Alabama

Well ID	Depth of Well (ft btoc)	Screened Interval (ft btoc)	Date	PCE	TCE	cis-1,2-DCE	Vinyl Chloride
Maximum Contaminant Level				5	5	70	2
Deep Wells							
OMS-28-6	76.0	66-76	7/8/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/10/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/8/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
				Destroyed			

Definitions:
µg/L = micrograms per Liter (parts per billion (ppb))
COC = chemical of concern
ft btoc = feet below top of casing
NA = Not Analyzed
PCE = tetrachloroethene
TCE = trichloroethene
cis-1,2-DCE = cis-1,2-dichloroethene

Notes:
All concentrations in µg/L
Bold result indicates the analyte was detected.
Shading indicates the screening value is exceeded.

Data Qualifiers:
U = The analyte was analyzed for, but was not detected above the limit of detection (LOD).
J = The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

Table 2-1
Remedial Goals for Groundwater by Parcel
OMS #28
Alabama Army National Guard - Mobile, Alabama

Parcel	COC	Groundwater RG (µg/L)	Receptor	Exposure Pathway
Parcel D	TCE	5	Future Construction Worker	Groundwater (Ingestion, Dermal, Inhalation)
			Future Resident Adult	Groundwater (Ingestion, Dermal, Inhalation, Vapor Intrusion)
			Future Resident Child	Groundwater (Ingestion, Dermal, Vapor Intrusion)
Parcel E	TCE	5	Future Construction Worker	Groundwater (Ingestion, Dermal, Inhalation)
			Future Industrial Worker	Groundwater (Ingestion, Dermal, Inhalation, Vapor Intrusion)
			Future Resident Adult	Groundwater (Ingestion, Dermal, Inhalation, Vapor Intrusion)
			Future Resident Child	Groundwater (Ingestion, Dermal, Vapor Intrusion)
	VC	2	Future Resident Adult	Groundwater (Ingestion, Dermal, Inhalation)
Parcel F	TCE	5	Future Construction Worker	Groundwater (Ingestion, Dermal, Inhalation)
			Future Industrial Worker	Groundwater (Ingestion, Dermal, Inhalation, Vapor Intrusion)
			Future Resident Adult	Groundwater (Ingestion, Dermal, Inhalation, Vapor Intrusion)
			Future Resident Child	Groundwater (Ingestion, Dermal, Vapor Intrusion)
	cis-1,2-DCE	70	Future Resident Adult	Groundwater (Ingestion, Dermal, Inhalation)
			Future Resident Child	Groundwater (Ingestion, Dermal, Inhalation)
	VC	2	Future Resident Adult	Groundwater (Ingestion, Dermal, Inhalation)

Notes:
RGs are not established for Parcel A because impacted groundwater is not the result of historical activities conducted on Parcel E (refer to Section 1.3.7.2 and Appendix C).
RGs are not established for Parcel B because impacted groundwater is the result of the breakdown of PCE from Parcel A to TCE on Parcel B (refer to Section 1.3.7.2).
RGs are not established for Parcel C because groundwater results collected during the SDGI have never exceeded the MCLs (refer to Section 1.3.7.2).
An RG for PCE is not established for Parcel F because the PCE detected in groundwater on this parcel is the result of an off-site PCE spill source area on Parcel A and not the result of historical activities conducted on Parcel E (refer to Section 1.3.7.2).
There was no risk identified for Parcels G or H.

Abbreviations:
cis-1,2-DCE - cis 1,2-dichloroethene
COC - chemical of concern
PCE - tetrachloroethene
RG - remedial goal
SDGI - Supplemental Data Gap Investigation
TCE - trichloroethene
VC - vinyl chloride
µg/L - micrograms per liter (parts per billion)

Table 2-2
Chemical-Specific ARARs for Groundwater
OMS #28
Alabama Army National Guard - Mobile, Alabama

Standard, Requirement, Criteria, or Limitation	Citation	Requirement	ARAR	Comments
Safe Drinking Water Act	Section 1412(b)(1) 40 CFR Part 141	The Administrator shall in accordance with the procedures established by this subsection, publish a maximum contaminant level goal and promulgate a national primary drinking water regulation for a contaminant.	Applicable	The Safe Drinking Water Act regulations apply to water supply and the use of MCLs. MCLs are listed in Appendix A to Subpart O of 40 CFR Part 141. As part of this list, MCLs are provided for organic contaminants that apply to community and non-transient, non-community water systems, including groundwater that may be utilized for such purposes. Contaminants found in site groundwater that are related to historical operations conducted at OMS #28 that exceed the identified MCLs include trichloroethene, cis-1,2-dichloroethene, and vinyl chloride.

Notes:

ARAR - Applicable or Relevant and Appropriate Requirement
CFR - Code of Federal Regulations
MCL - Maximum Contaminant Level

Table 2-3
TBC Guidance
OMS #28
Alabama Army National Guard - Mobile, Alabama

TBC	Citation	Comments
AEIRG Manual, Revison 4.0	http://adem.alabama.gov/programs/land/guidanceReports.cnt	Statewide cross-programmatic guidance prepared to assist individuals in understanding and achieving the necessary elements of environmental investigations and remediation projects in Alabama (ADEM, 2017a) .
ARBCA Guidance Manual, Revision 3.0	http://adem.alabama.gov/programs/land/guidanceReports.cnt	Guidelines for a uniform statewide cross-programmatic approach for the assessment of cumulative risk at a contaminated site and the development and selection of appropriate risk-based target levels (ADEM, 2017b).

Notes:
ADEM - Alabama Department of Environmental Management
AEIRG - Alabama Environmental Investigation and Remediation Guidance
ARBCA - Alabama Risk Based Corrective Action
TBC - To Be Considered
USEPA - United States Environmental Protection Agency

Table 3-1
Remedial Technologies and Process Options Screening
OMS #28
Alabama Army National Guard - Mobile, Alabama

General Response Action	Technology	Process Options	Description	Effectiveness	Implementability	Cost	Screening Comments	Screening Decision
No Action	No Action	None	No action. Contaminated groundwater remains in place.	Low	High	None	Does not reduce future human or environmental risk. Does not reduce toxicity, mobility, or volume of contaminants except by natural attentuation which will be limited, if any. Required for consideration as baseline alternative per the NCP.	**Retain**
Land Use Controls	Access Control	Physical (engineered) Signs, Fencing, Security	Warning signs to limit human exposure. Fencing to prohibit access/entry. Security measures to enforce non-entry.	High	High	Low Capital, Low O&M	Physical access controls reduce the risk of exposure but effectiveness depends on continued future implementation and inspections. Does not reduce toxicity, mobility, or volume of contaminants. May be appplied in combination with other process options and can be equally protective as engineered (active) remedial actions. Technically and administratively implementable. Reduction of groundwater contamination will occur over an extended time period.	**Retain**
	Use Control	Administrative Existing Land Use Management Systems at Active Installations	Admininstrative action used to restict the use of groundwater as a source of drinking water. Can also include the identification of an alternate water source.	High	High	Low Capital, Low O&M	Administrative use controls reduce the risk of exposure but effectiveness depends on continued future implementation and inspections. Does not reduce toxicity, mobility, or volume of contaminants. May be appplied in combination with other process options and can be equally as protective as engineered (active) remedial actions. Technically and administratively implementable. Reduction of groundwater contamination will occur over an extended time period. Site currently served by city water.	**Retain**
Natural Attenuation	Monitored Natural Attenuation	Groundwater Monitoring	Groundwater sampling and analysis of a representative site monitoring well network are used to demonsarate a variety of physical, chemical, and/or biological processes that act independently of active process options to naturally reduce the concentration of contaminants in groundwater.	Medium	High	Low to Medium Capital, Low to Medium O&M	Groundwater monitoring is not effective in reducing the toxicity, mobility, or volume of the COCs; however, the monitoring results can be used to determine if the risk presented by the impacted groundwater is decreasing, increasing, or remains the same as the result of natural biotic (biodegradation) and abiotic attenuation processes (dilution, dispersion, advection, evaporation, etc.). Mann-Kendall analysis indicates that the TCE plume is not expanding so some degree of natural attenuation is occurring. Based on historical groundwater parameters and sampling results, biodegradation will be limited unless the targeted GW aquifer is enhanced to promote biotic degradation. Periodic sampling of on-site and off-site groundwater monitoring wells can be conducted to document natural attenuation. Current monitoring well network needs to be augmented to better define the TCE plume.	**Retain**
Containment	Hydraulic Barrier	Extraction Wells	Use of a series of extraction wells to restrict the horizontal migration of TCE-impacted groundwater away from the ALARNG property.	Medium	Low	High Capital, High O&M	Reduces mobility of contaminants but does not reduce their toxicity or volume. This technology would require long term O&M and also discharge to a POTW as there are no surface water bodies near the site that could accommodate discharge. A comprehensive monitoring program would be necessary for POTW discharge.	**Reject**

Table 3-1
Remedial Technologies and Process Options Screening
OMS #28
Alabama Army National Guard - Mobile, Alabama

General Response Action	Technology	Process Options	Description	Effectiveness	Implementability	Cost	Screening Comments	Screening Decision
In Situ Treatment	Biological	Aerobic	This technology utilizes aerobic bacteria that metabolize a primary substrate such as dextrose using various non-specific enzymes. These non-specific enzymes can degrade TCE via a process referred to as co-metabolism.	Low	Low	High Capital, Medium O&M	Reduces toxicity, mobility, and volume of contaminants. Difficult to implement at field scale. Requires that the targeted aquifer remain oxidative and at a neutral pH or the bacteria will not survive. In the presence of too much substrate such as dextrose, oxygen levels can decrease sharply so supplemental oxygen in the form of air or pure oxygen is often needed to be added to the targeted groundwater. Also, in the absence of sufficient substrate to metabolize, co-metabolism stops, and the bacteria can die.	**Reject**
In Situ Treatment	Biological	Anaerobic	Involves the enhancement of the natural biodegradation of organics in an anaerobic environment. For chlorinated compounds, this is called ERD. This technology would consist of injecting an electron donor such as emulsified vegetable oil into the TCE-impacted groundwater to induce strong reducing conditions. The injected chemical amendment would tend to last from 6 to 12 months depending on groundwater flow rates and the targeted groundwater aquifer litholoty. "Stall out" at cis-1,2-DCE may occur unless sufficient *DHC* is present. In this occurs, bioaugmentation may be necessary to make ERD effective.	Medium High with bioaugmentation	Medium	High Capital, Low O&M	Reduces toxicity, mobility, and volume of contaminants. Equipment required includes the electron donor, mixing equipment, and the means for injection. At this site, a DPT rig could be used to conduct injections down to a depth of approximately 30 to 35 ft bgs; a drill rig would be required to conduct injection at greater depths. There would be no ongoing O&M costs associated with this technology except for associated performance monitoring, and no permanent aboveground equipment would be required. Subsurface heterogeneities or preferential flow paths may result in pockets of untreated contaminants resulting in a subsequent rebound in groundwater COC concentrations. As a result, more than one injection event may be necessary. The characteristics of the targeted aquifer will require that the ERD injection points are installed relatively close to one another. Can be combined with bioaugmentation and/or chemical reduction to be even more effective.	**Retain**
In Situ Treatment	Chemical	Chemical Oxidation	Involes the injection of an oxidizing agent such as potassium permanganate, sodium persulfate, or hydrogen peroxide to degrade the targeted COCs in groundwater to innocuous end products.	Low to Medium	Medium	High Capital, Low O&M	Reduces toxicity, mobility, and volume of contaminants. Technology is highly dependent on achieving adequate contact between the contaminants and the oxidant solution. Site lithology will require numerous injection points. Chemical oxidants are non-specific with regards to the organics they target, and they are often short-lived in the subsurface. Matrix back diffusion often requires multiple injection events. Technology is best suited for source areas with high concentrations of the targeted COCs rather than dilute source areas.	**Reject**
In Situ Treatment	Chemical	Chemical Reduction	ISCR involves the placement of a sufficient quantity of reductant or reductant generating material into the subsurface with the purpose of chemically converting the targeted contaminants in the impacted groundwater to less toxic compounds. The most commonly used reductant is ZVI. In this case, ZVI would create strongly reducing conditions that promote the abiotic degradation of the targeted chlorinated VOCs in groundwater via the beta-elimination and hydrogenolysis pathways.	Medium	Medium	High Capital, Low O&M	Reduces toxicity, mobility, and volume of contaminants. Similar to other in situ injection process options, effective treatment by ISCR requires adequate contact between the reductant and the targeted contaminant. This technology would consist of injecting a sufficient quantity of a reductant such as ZVI into the targeted groundwater. The predominant abiotic pathway (beta-elimination) using ZVI eliminates the potential for "stall out" at cis-1,2-DCE. The reactive life of ZVI has been reported to be 3 to 5 years or greater, which is much longer than chemical oxidants or many electron donors (carbon substrates) used for ERD. The failure to account for subsurface heterogeneities or preferential flow paths may result in pockets of untreated COCs and the need for additional injections of ZVI. The characteristics of the targeted aquifer will require that the ISCR injection points are installed relatively close to one another. Can be combined with bioaugmentation and/or ERD to be even more effective.	**Retain**
In Situ Treatment	Physical	Air Sparging/ SVE	In situ air sparging is a physical process that involves injecting air into the targeted aquifer to volatilize aqueous phase and soil-sorbed chlorinated VOC contaminants. A series of screened injection wells would be installed through which compressed air would be introduced into the targeted aquifer. Volatile constituents such as TCE partition from the aqueous phase into the vapor phase. Due to the release of chlorinated VOCs to the atmosphere, an SVE system is often needed to be combined with the air sparging system.	Low to Medium	Medium	High Capital, High O&M	The number of air sparging and SVE wells needed is dependent on the size and depth of the plume, soil permeability, subsurface geology, and the flow rate of injected air. Based on the questionable effectiveness of air sparging/SVE in the targeted site geology (i.e., sandy clays, clayey sands, and silty clays), the large infrastructure footprint required, high capital and high ongoing O&M costs, air sparging/SVE is rejected from further evaluation.	**Reject**

Table 3-1
Remedial Technologies and Process Options Screening
OMS #28
Alabama Army National Guard - Mobile, Alabama

General Response Action	Technology	Process Options	Description	Effectiveness	Implementability	Cost	Screening Comments	Screening Decision
Removal	Groundwater Extraction	Extraction Wells	Series of conventional pumping wells used to remove contaminated groundwater.	Low	Medium	High Capital, High O&M	Groundwater extraction and treatment is an appropriate technology for contaminated mass reduction and hydraulic containment; however, it is not useful for the restoration of aquifers to MCLs. Two main difficulties for groundwater extraction include extended treatment times and residual COC concentrations that exceed their MCLs. Actual extraction rates would not be known until the extraction well network was installed and developed but likely would be low due to site lithology consisting of silty clays and clayey silts. Based on the relatively low TCE concentrations, high capital and high O&M costs, the need for discharge to a POTW, and the long time frame to meet MCLs, if ever, extraction wells are rejected from further evaluation.	**Reject**
		Interceptor Trenches	A permeable trench used to intercept and collect groundwater.	Low	Low	High Capital, Medium O&M	Interceptor trenches are rejected from further evaluation because they would not be implementable since they could not be installed to a depth deep enough to intercept the targeted TCE groundwater plume.	**Reject**
Ex situ treatment	Physical	Liquid-phase carbon adsorption, air stripping, vapor-phase carbon adsorption	Use of liquid-phase granular activated carbon to removed VOCs from extracted groundwater. Use of air stripping to remove VOCs from extracted groundwater with subsequent treatment of the volatilized VOCs onto granular activated carbon	Medium	High	Medium Capital, High O&M	Rejected from further consideration because groundwater will not be extracted and therefore will not need to be treated ex-situ.	**Reject**
	Chemical	Ultraviolet/oxidation	Use of ultraviolet with with an oxidizers such as air, ozone, peroxide, chlorine, etc. to destroy VOCs contained in extracted groundwater.	Medium	Medium	Medium Capital, High O&M	Rejected from further consideration because groundwater will not be extracted and therefore will not need to be treated ex-situ.	**Reject**
Discharge	Disposal	POTW	Remedial approaches that use groundwater extraction or ex situ groundwater treatment require a point of discharge for the treated/untreated wastewater. Confirmation sampling and reporting would be regularly required for discharge to a POTW.	High	Medium	Medium Capital, High O&M	Rejected from further consideration because groundwater will not be extracted and therefore will not need to be treated by disposal at a POTW.	**Reject**

Abbreviations:

ALARNG - Alabama Army National Guard
cis-1,2-DCE - cis-1,2-dichloroethene
COC - Chemical of Concern
DHC - Dehalococoiddes
DPT - Direct Push Technology
ERD - Enhanced Reductive Dechlorination
ft bgs - feet below ground surface
ISCR - In Situ Chemical Reduction
MCL - Maximum Contaminant Level
NCP - National Contingency Plan
O&M - Operation and Maintenance
POTW - Publically Owned Treatment Works
SVE - Soil Vapor Extraction
TCE - Trichloroethene
VOC - Volatile Organic Compound
ZVI - Zero Valent Iron

Table 4-1
Remedial Alternatives Cost Summary
OMS #28
Alabama Army National Guard - Mobile, Alabama

Remedial Alternative	Description	Duration (Years)*	Present Worth Cost	Total Present Worth Cost (Includes 20% Contingency)	Total Present Worth Cost (-30%)**	Total Present Worth Cost (+50%)**
1	No Action	30	$0	$0	$0	$0
2	LUCs with Periodic Groundwater Monitoring	18	$403,600	$484,300	$339,000	$726,500
3	ERD, ISCR, and Enhanced MNA	7	$1,823,100	$2,187,700	$1,531,400	$3,281,600

Notes:

* In general, the period of performance for costing purposes should not exceed 30 years for the purpose of a detailed cost analysis (USEPA, 1988). In this case, the maximum value of 30 years does not apply since natural groundwater conditions are estimated to reduce chlorinated VOC concentrations in groundwater related to the TCE plume that emanates from Parcel E in approximately 18 years.
** Typically, cost estimates made during the Feasibility Study are expected to provide an accuracy of + 50% to -30% (USEPA, 1988)

ERD - Enhanced Reductive Dechlorination
ISCR - In Situ Chemical Reduction
LUCs - Land Use Controls
MNA - Monitored Natural Attenuation

Table 5-1
Qualitative Comparative Analysis of Remedial Alternatives
OMS #28
Alabama Army National Guard - Mobile, Alabama

	Evaluation Criteria	Altenative 1 No Action	Alternative 2 LUCs with Periodic Monitoring	Alternative 3 ERD, ISCR, and Enhanced MNA
Threshold Criteria				
(1)	Overall protection of human health and the environment	Provides no reduction in potential risk to human health or the environment. Does not meet the criterion for overall protection of human health and the environment.	Restricts the use of groundwater for residential purposes (drinking, watering, etc.); however, TCE and related degradation products remain in groundwater until natural attenuation processes eventually remove them. Implemention of LUCs ensures protectiveness for the duration that TCE and its related degradation products remain above the MCLs in groundwater.	Actively removes TCE and related degradation products from groundwater, thereby mitigating potential future human health and environment risk at at rate that is faster than natural attentuation.
(2)	Compliance with ARARs	This alternative does not achieve ARARs because no action is conducted.	Does not comply with the applicable ARARs until the RGs are met.	Does not comply with the applicable ARARs until the RGs are met.
Balancing Criteria				
(3)	Short-term Effectiveness	Does not pose any additional risk to the community, workers, or the environment because there are no remedial activities conducted for this alternative. There are no current risks associated with the site. Any potential future risks remain the same for this alternative.	Reduces the likelihood of contact with TCE and its degradation products in groundwater by restricting groundwater use. Limited impact to community and environment due to need to clear heavy brush and trees at the location of four proposed monitoring wells on Parcel F. Safety concerns related to tree clearing and monitoring well installation and development Potential exposure to impacted groundwater during periodic sampling. Estimate of at least 18 years to meet RGs; however, this estimate does not account for groundwater retardation and matrix back diffusion.	Impact to community and environment is greater than Alternatives 1 and 2 due to the need to remove dense vegetation including mature trees and brush (~0.48 acres) on Parcels D and F to accomodate monitoring well and injection point installation. Potential exposure to impacted groundwater during periodic performance monitoring. Safety concerns related to tree clearing, monitoring well installation and development, and injection activities. Estimate of at least 7 years to meet RGs; however, this time may increase depending on effectiveness of the treatment and potential matrix back diffusion issues. Requires additional time and coordination of labor, materials, and resources for completion.
(4)	Reduction of Toxicity, Mobility, or Volume	Does not use any treatment that would reduce the toxicity, mobility, or volume of impacted groundwater. Does not meet statutory preference for treatment.	Does not actively create a reduction in toxicity, mobility, or volume of impacted groundwater. Uses periodic monitoring to document any reduction of toxicity, mobility, or volume of impacted groundwater. Does not meet statutory preference for treatment.	Permanently reduces the toxicity, mobility, and volume of TCE and its degradation products via active remediation to innocuous end products. The process is irreversible and satisfies the statutory preference for treatment.

Table 5-1
Qualitative Comparative Analysis of Remedial Alternatives
OMS #28
Alabama Army National Guard - Mobile, Alabama

	Evaluation Criteria	Altenative 1 No Action	Alternative 2 LUCs with Periodic Monitoring	Alternative 3 ERD, ISCR, and Enhanced MNA
(5)	Long-term Effectivenes and Permanence	Does not provide monitoring of concentrations of TCE and its degradation products in groundwater over time.	LUCs provide groundwater use restrictions (no wells for drinking or watering, etc.) related to potential future residential usage of the site. Five-Year Reviews are required to ensure that the LUCs employed continue to remain effective. Ongoing impact from offsite PCE soil source and groundwater plume may impact long-term effectiveness and permanence where the PCE plume co-mingles with the TCE plume associated with Parcel E.	Alternative 3 permanently removes TCE and its degradation products that exist in groundwater above the RGs. Until the RGs are met, periodic performance monitoring will be conducted to evaluate the effectiveness of the proposed injection event(s) and to determine when the RGs are met. Ongoing impact from offsite PCE soil source and groundwater plume may impact long-term effectiveness and permanence where the PCE plume co-mingles with the TCE plume associated with Parcel E.
(6)	Implementability	There are no implementability issues associated with this alternative since no action will be conducted.	LUCs and periodic monitoring are somewhat easy to implement although the DoD can only recommend LUCs on the affected offsite parcels. The NEUR issue needs to be resolved before implementation. Clearing for new well locations and installation of new wells uses standard, readily available equipment. RIght of entry agreements for offsite Parcels D and E should not be an issue based on previous work conducted on these parcels.	In addtion to standard, readily available equipment needed for clearing and new monitoring well installation, some speciality injection equipment is required. This equipment is available from specialty injection contractors. RIght of entry agreements for offsite Parcels D and E should not be an issue based on previous work conducted on these parcels.
(7)	Cost	There are no present worth costs associated with No Action.	The estimated total net present worth cost to implement Alternative 2 is $484,300.	The estimated total net present worth cost to implement Alternative 3 is $2,187,700.

Abbreviations:
ARAR - Applicable or Relevant and Appropriate Requirements
DoD - Department of Defense
ERD - Enhanced Reductive Dechlorination
ISCR - In Situ Chemical Reduction
LUC - Land Use Controls
MNA - Monitored Natural Attenuation
NEUR - Notice of Environmental Use Restriction
RG - Remedial Goal
TCE - Trichloroethene

FIGURES

Vicinity Map

Legend

- County Boundary
- Waterbodies

Note:
OMS - Organizational Maintenance Shop

0 300 600 1,200 Feet

1 inch = 600 feet

N W E S

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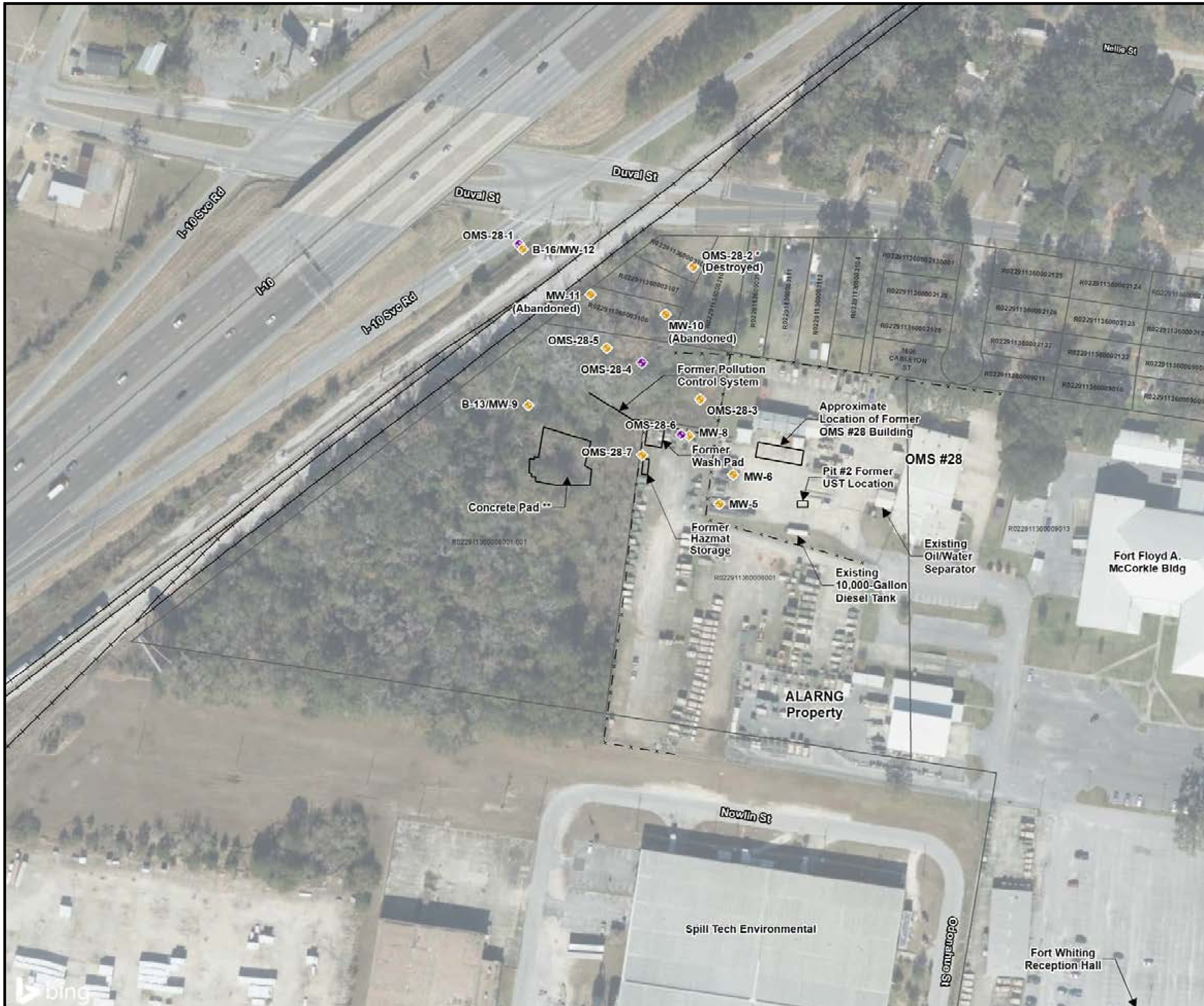
Facility Location Map

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/12/2023	Figure 1-1

Document Path: L:\Legacy\Group\earth\OMS 28\60439687\900-CADD-GIS\Brookley_GIS\Maps\FS Letter Report\20220505\Figure 1-1_OMS 28_Facility Location Map.mxd



Site Location

Legend

- Upper/Middle Surficial Monitoring Well Location
- Lower Surficial Monitoring Well Location
- Railroad
- Fenceline
- Parcel Boundary

Notes:
Wells MW-10 and MW-11 were abandoned in 2008 at the property owner's request and have not been replaced.

* Wells OMS-28-2 was found destroyed during a site visit in December 2021.

** Concrete pad is the likely remnant foundation of Mollison Hall (recreational hall for soldiers before and after World War II) that was demolished between 1972 and 1974.

ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop

0 75 150 300 Feet

1 inch = 150 feet

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Facility Site Location Map

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/12/2023	Figure 1-2

Site Location

Legend

- Upper/Middle Surficial Monitoring Well Location
- Lower Surficial Monitoring Well Location
- Discrete Groundwater Sample Location
- HPT Location
- MIP Location
- Soil Boring Location
- Fenceline
- Railroad
- Parcel Boundary
- Parcel Designation (A - H)

ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
SDGI - Supplemental Data Gap Investigation
HTP - Hydraulic Profiling Tool
MIP - Membrane Interface Probe

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0 40 80 160 Feet

1 inch = 80 feet

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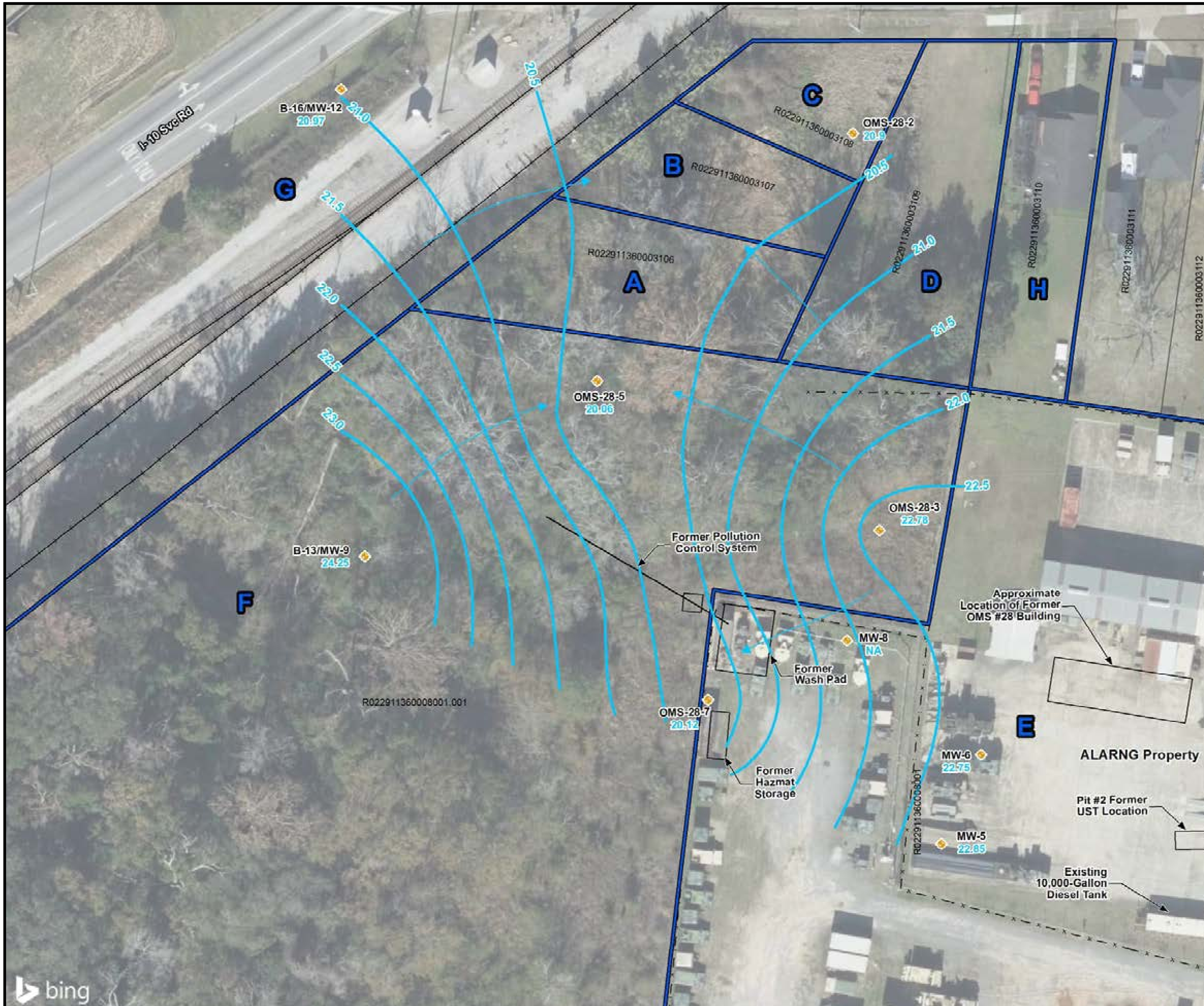
Parcel Designation and SDGI Sample Location Map

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/12/2023	Figure 1-3

Document Path: L:\Legacy\Group\earth\OMS 28\60439687\900-CADD-GIS\Brookley_GIS\Maps\FS Letter Report\20220505\Figure 1-3_OMS 28_Parcel Designation and Sample Location Map.mxd



Site Location

Legend

- Upper/Middle Surficial Monitoring Well
- 21.42 Groundwater Elevation - May 2017
- Groundwater Elevation Contour - May 2017
- Apparent Groundwater Flow Direction - May 2017
- Railroad
- Fenceline
- Parcel Boundary
- Parcel Designation (A - H)

Notes:

1. Water levels collected on May 1, 2017.
2. Contour interval 0.5 feet.
3. Only shallow wells included in contours.
4. Well MW-8 has been damaged. Water level unable to be used.
5. NA - Accurate groundwater elevation is not available.
6. Groundwater elevations referenced to feet above mean sea level, North American Vertical Datum 1929.

ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop

0 25 50 100 Feet

1 inch = 50 feet

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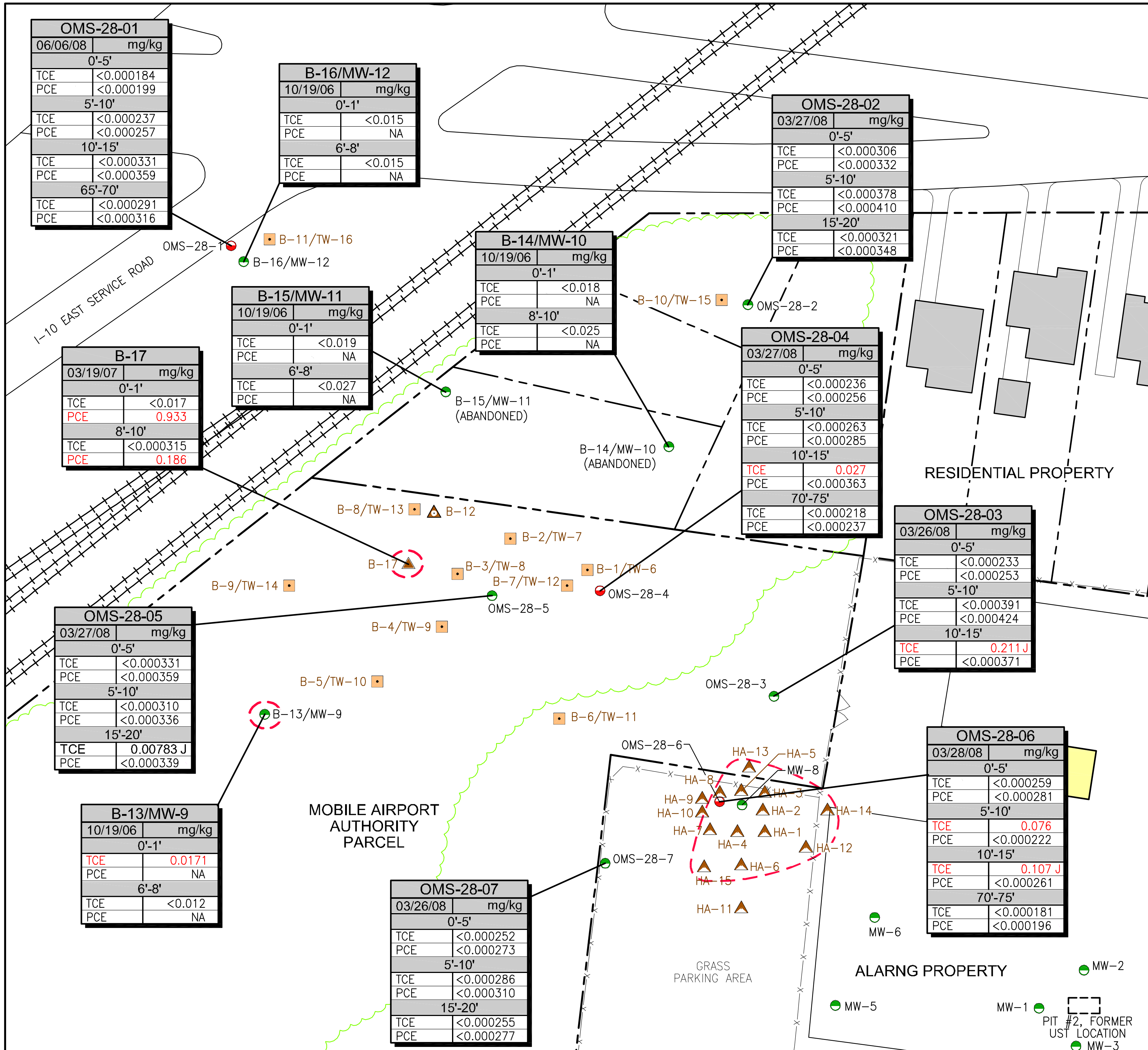
Groundwater Elevation and Flow Direction May 2017

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/12/2023	Figure 1-4



OMS-28-01	
06/06/08	mg/kg
0'-5'	
TCE	<0.000184
PCE	<0.000199
5'-10'	
TCE	<0.000237
PCE	<0.000257
10'-15'	
TCE	<0.000331
PCE	<0.000359
65'-70'	
TCE	<0.000291
PCE	<0.000316

B-16/MW-12	
10/19/06	mg/kg
0'-1'	
TCE	<0.015
PCE	NA
6'-8'	
TCE	<0.015
PCE	NA

OMS-28-02	
03/27/08	mg/kg
0'-5'	
TCE	<0.000306
PCE	<0.000332
5'-10'	
TCE	<0.000378
PCE	<0.000410
15'-20'	
TCE	<0.000321
PCE	<0.000348

B-14/MW-10	
10/19/06	mg/kg
0'-1'	
TCE	<0.018
PCE	NA
8'-10'	
TCE	<0.025
PCE	NA

B-15/MW-11	
10/19/06	mg/kg
0'-1'	
TCE	<0.019
PCE	NA
6'-8'	
TCE	<0.027
PCE	NA

B-17	
03/19/07	mg/kg
0'-1'	
TCE	<0.017
PCE	0.933
8'-10'	
TCE	<0.000315
PCE	0.186

OMS-28-04	
03/27/08	mg/kg
0'-5'	
TCE	<0.000236
PCE	<0.000256
5'-10'	
TCE	<0.000263
PCE	<0.000285
10'-15'	
TCE	0.027
PCE	<0.000363
70'-75'	
TCE	<0.000218
PCE	<0.000237

OMS-28-03	
03/26/08	mg/kg
0'-5'	
TCE	<0.000233
PCE	<0.000253
5'-10'	
TCE	<0.000391
PCE	<0.000424
10'-15'	
TCE	0.211 J
PCE	<0.000371

OMS-28-05	
03/27/08	mg/kg
0'-5'	
TCE	<0.000331
PCE	<0.000359
5'-10'	
TCE	<0.000310
PCE	<0.000336
15'-20'	
TCE	0.00783 J
PCE	<0.000339

B-13/MW-9	
10/19/06	mg/kg
0'-1'	
TCE	0.0171
PCE	NA
6'-8'	
TCE	<0.012
PCE	NA

OMS-28-07	
03/26/08	mg/kg
0'-5'	
TCE	<0.000252
PCE	<0.000273
5'-10'	
TCE	<0.000286
PCE	<0.000310
15'-20'	
TCE	<0.000255
PCE	<0.000277

OMS-28-06	
03/28/08	mg/kg
0'-5'	
TCE	<0.000259
PCE	<0.000281
5'-10'	
TCE	0.076
PCE	<0.000222
10'-15'	
TCE	0.107 J
PCE	<0.000261
70'-75'	
TCE	<0.000181
PCE	<0.000196

HA-1	
04/19/06	mg/kg
0'-1'	
TCE	0.00311 J
PCE	0.00121 J
6'-8'	
TCE	0.017
PCE	0.000822 J

HA-8	
04/19/06	mg/kg
0'-1'	
TCE	0.00286 J
PCE	<0.00266
8'-10'	
TCE	<0.00998
PCE	<0.011

HA-2	
04/19/06	mg/kg
0'-1'	
TCE	0.241 J
PCE	<0.011
8'-10'	
TCE	0.027
PCE	<0.000191

HA-9	
04/19/06	mg/kg
0'-1'	
TCE	<0.000359
PCE	<0.000389
8'-10'	
TCE	<0.012
PCE	<0.013

HA-3	
04/19/06	mg/kg
0'-1'	
TCE	0.019 J
PCE	<0.000476
8'-10'	
TCE	0.00353 J
PCE	<0.000137

HA-10	
04/19/06	mg/kg
0'-1'	
TCE	<0.000267
PCE	0.00154 J
8'-10'	
TCE	<0.000146
PCE	<0.000159

HA-4	
04/19/06	mg/kg
0'-1'	
TCE	<0.000249
PCE	<0.000271
7'-9'	
TCE	<0.000211
PCE	<0.000229

HA-11	
05/11/06	mg/kg
0'-1'	
NOT SAMPLED	
8'-10'	
TCE	<0.000169
PCE	<0.000184

HA-5	
04/19/06	mg/kg
0'-1'	
TCE	<0.000429
PCE	0.00252 J
7'-9'	
TCE	<0.00944
PCE	<0.010

HA-12	
05/11/06	mg/kg
0'-1'	
NOT SAMPLED	
8'-10'	
TCE	0.00353 J
PCE	0.00191 J

HA-6	
04/19/06	mg/kg
0'-1'	
TCE	<0.000207
PCE	<0.000225
8'-10'	
TCE	0.15
PCE	<0.000203

HA-13	
05/11/06	mg/kg
0'-1'	
NOT SAMPLED	
8'-10'	
TCE	<0.000451
PCE	0.00505 J

HA-7	
04/19/06	mg/kg
0'-1'	
TCE	<0.000437
PCE	0.00253 J
8'-10'	
TCE	0.069 J
PCE	<0.00711

HA-14	
03/19/07	mg/kg
0'-1'	
TCE	0.017
PCE	<0.000243
8'-10'	
TCE	0.00962
PCE	<0.000332

HA-15	
03/19/07	mg/kg
0'-1'	
TCE	0.586
PCE	<0.015
8'-10'	
TCE	0.132 J
PCE	<0.000326

LEGEND:

- RESIDENTIAL BUILDING
- COMMERCIAL BUILDING
- ASPHALT ROAD
- RAILROAD TRACKS
- CHAIN LINK FENCE
- PROPERTY BOUNDARY
- TREE LINE
- SOIL BORING (2006–2007)
- TEMPORARY WELL (2006–2007)
- HAND AUGER BORING (2006–2007)
- FLUTE LINER BORING (2006)
- SHALLOW MONITORING WELL
- DEEP MONITORING WELL
- XXXX ... CONTAMINATION EXCEEDING SSL
- CONTAMINATION EXCEEDING RSL
- EXCEEDS SSL

NOTES:

1. HISTORICAL LOCATIONS DIGITIZED FROM BASE MAP PROVIDED BY AEROSTAR ENVIRONMENTAL SERVICES INC. (AEROSTAR 2007).
2. MONITORING WELL LOCATIONS DATA PROVIDED BY AEROSTAR ENVIRONMENTAL SERVICES INC. (AEROSTAR 2008).
3. EPA RSLs DATED MAY 2012 ARE BEING USED IN LIEU OF AL PSVs PUBLISHED IN THE ALABAMA RISK-BASED CORRECTIVE ACTION GUIDANCE MANUAL (2008) AS PER APRIL 2, 2012 EMAIL CORRESPONDENCE BETWEEN ADEM AND ALARNG.

	PROTECTION OF GROUNDWATER SSL (mg/Kg)	RESIDENTIAL SOIL EPA RSL (mg/Kg)
TCE	0.0018	0.41
PCE	0.0023	8.1

ALABAMA STATE PLANE NAD 83 WEST ZONE

0 30 60 120

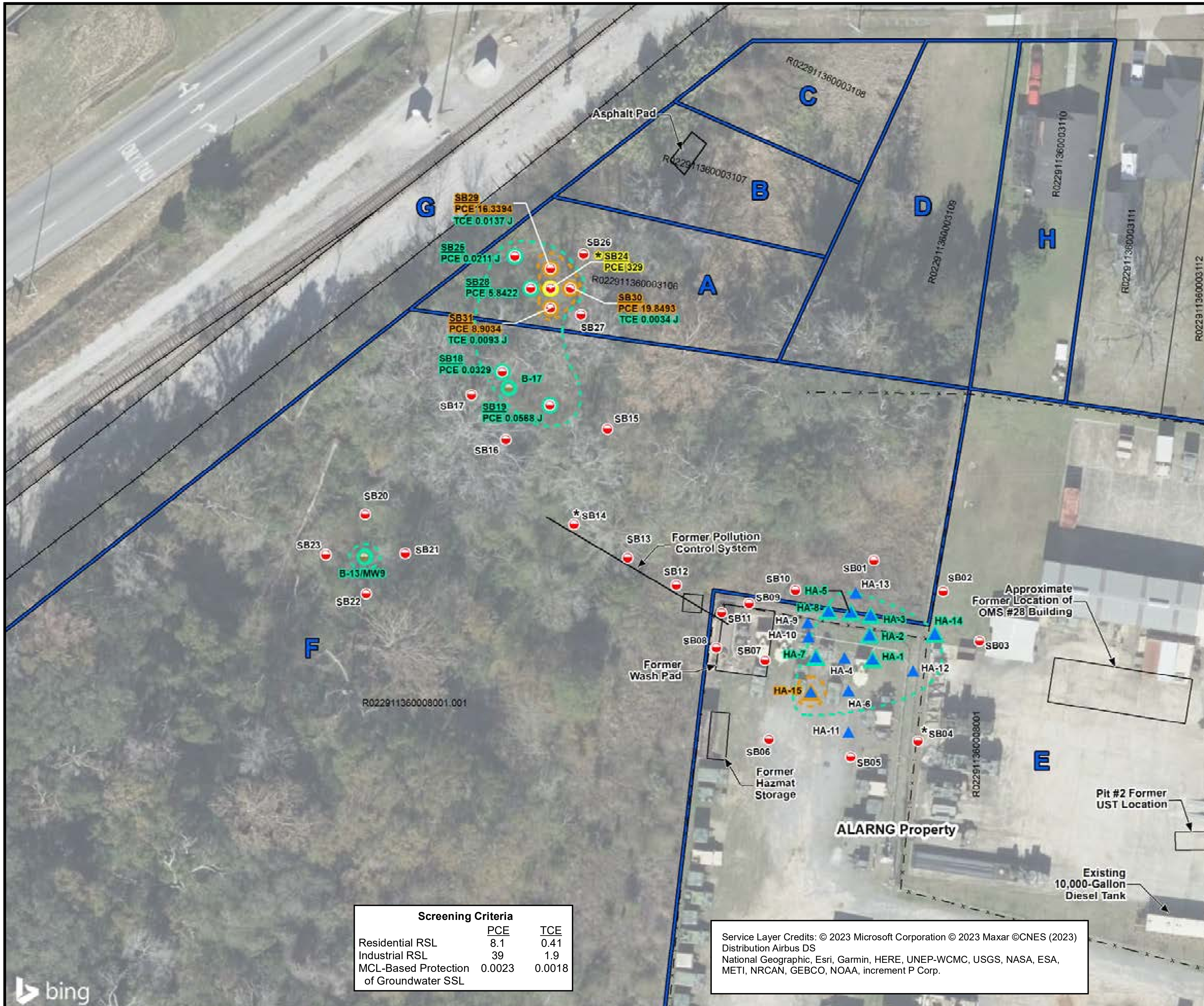
SCALE: 1" = 60'

AECOM

FIGURE 1-5
DISTRIBUTION OF COCs IN SOIL

OMS #28
ALABAMA ARMY NATIONAL GUARD
MOBILE, ALABAMA

Source:
SAIC, 2013, *RI Report for the ALARNG OMS #28*



Screening Criteria	PCE	TCE
Residential RSL	8.1	0.41
Industrial RSL	39	1.9
MCL-Based Protection of Groundwater SSL	0.0023	0.0018

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Site Location

Legend

- Hand Auger Samples Collected in 2006/2007
- Soil Boring Samples Collected in 2006/2007
- Soil Sample Locations Collected in 2017
- TCE and/or PCE Exceeded MCL- Based Protection of Groundwater SSL
- PCE or TCE Exceeded Residential RSL
- PCE Exceeded Industrial RSL
- Approximate Soil Area Exceeding MCL - Based Protection of Groundwater SSL
- Approximate Soil Area Exceeding Residential and/or Industrial RSL
- Railroad
- Fenceline
- Parcel Designation (A - H)
- Parcel Boundary

Notes:
1 - Soil Samples collected between May 8-16, 2017.
2 - Analytical results from mobile lab used unless split with fixed lab. Fixed lab samples denoted with "*".
3 - Soil concentrations in milligrams per kilogram.
4 - All samples collected from bottom of 0-1 ft bgs interval and analyzed by Method 8260.
5 - Residential and Industrial RSLs are based on risk of 1E-06 for carcinogens.
6 - No highlighting of symbol indicates TCE and PCE did not exceed any RSLs or SSL.
7 - If TCE/PCE not listed, they did not exceed any of the screening criteria.
8 - Analytical results for samples collected in 2006/2007 can be found in the TCE Comprehensive Investigation Report (Aerostar, April 2007).

J - The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
PCE - Tetrachloroethene
TCE - Trichloroethene
RSL - Regional Screening Criteria (USEPA, May 2023)
SSL - Soil Screening Level (USEPA, May 2023)
ft bgs - Feet below ground surface
MCL - Maximum Contaminant Level

0 25 50 100 Feet
1 inch = 50 feet

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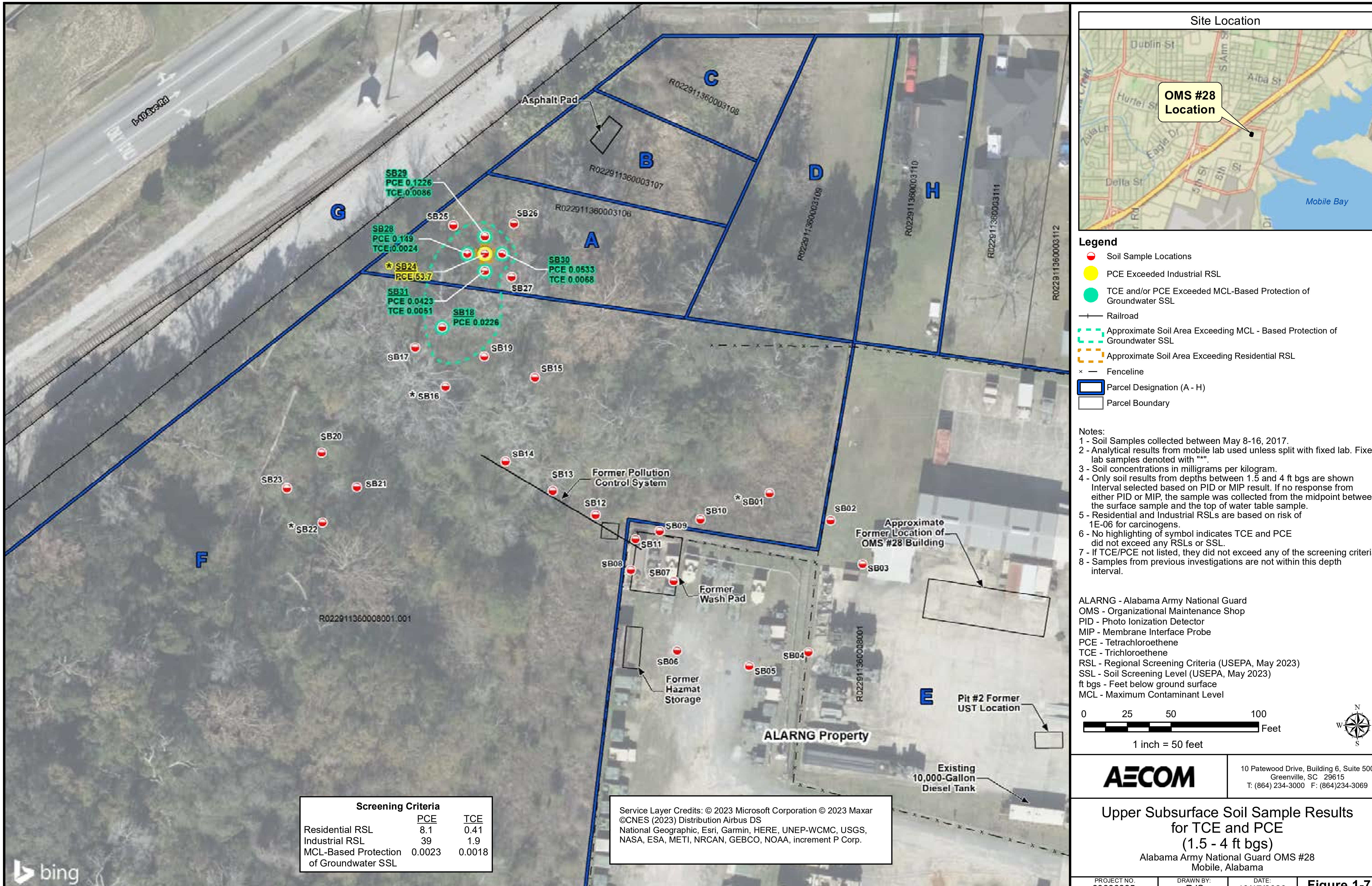
Surface Soil Sample Results - TCE and PCE (0 - 1 ft bgs)

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/17/2023	Figure 1-6

Document Path: L:\Legacy\Group\earth\OMS 28\60439687\900-CADD-GIS\Brookley_GIS\Maps\FS Letter Report\20220505\Figure 1-6_Brookley_Surface Soil Sample Results TCE and PCE - May 2017.mxd



Screening Criteria

	PCE	TCE
Residential RSL	8.1	0.41
Industrial RSL	39	1.9
MCL-Based Protection of Groundwater SSL	0.0023	0.0018

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Legend

- Soil Sample Locations
- PCE Exceeded Industrial RSL
- TCE and/or PCE Exceeded MCL-Based Protection of Groundwater SSL
- Railroad
- Approximate Soil Area Exceeding MCL - Based Protection of Groundwater SSL
- Approximate Soil Area Exceeding Residential RSL
- Fenceline
- Parcel Designation (A - H)
- Parcel Boundary

Notes:
1 - Soil Samples collected between May 8-16, 2017.
2 - Analytical results from mobile lab used unless split with fixed lab. Fixed lab samples denoted with "*".
3 - Soil concentrations in milligrams per kilogram.
4 - Only soil results from depths between 1.5 and 4 ft bgs are shown Interval selected based on PID or MIP result. If no response from either PID or MIP, the sample was collected from the midpoint between the surface sample and the top of water table sample.
5 - Residential and Industrial RSLs are based on risk of 1E-06 for carcinogens.
6 - No highlighting of symbol indicates TCE and PCE did not exceed any RSLs or SSL.
7 - If TCE/PCE not listed, they did not exceed any of the screening criteria.
8 - Samples from previous investigations are not within this depth interval.

ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
PID - Photo Ionization Detector
MIP - Membrane Interface Probe
PCE - Tetrachloroethene
TCE - Trichloroethene
RSL - Regional Screening Criteria (USEPA, May 2023)
SSL - Soil Screening Level (USEPA, May 2023)
ft bgs - Feet below ground surface
MCL - Maximum Contaminant Level

0 25 50 100 Feet
1 inch = 50 feet

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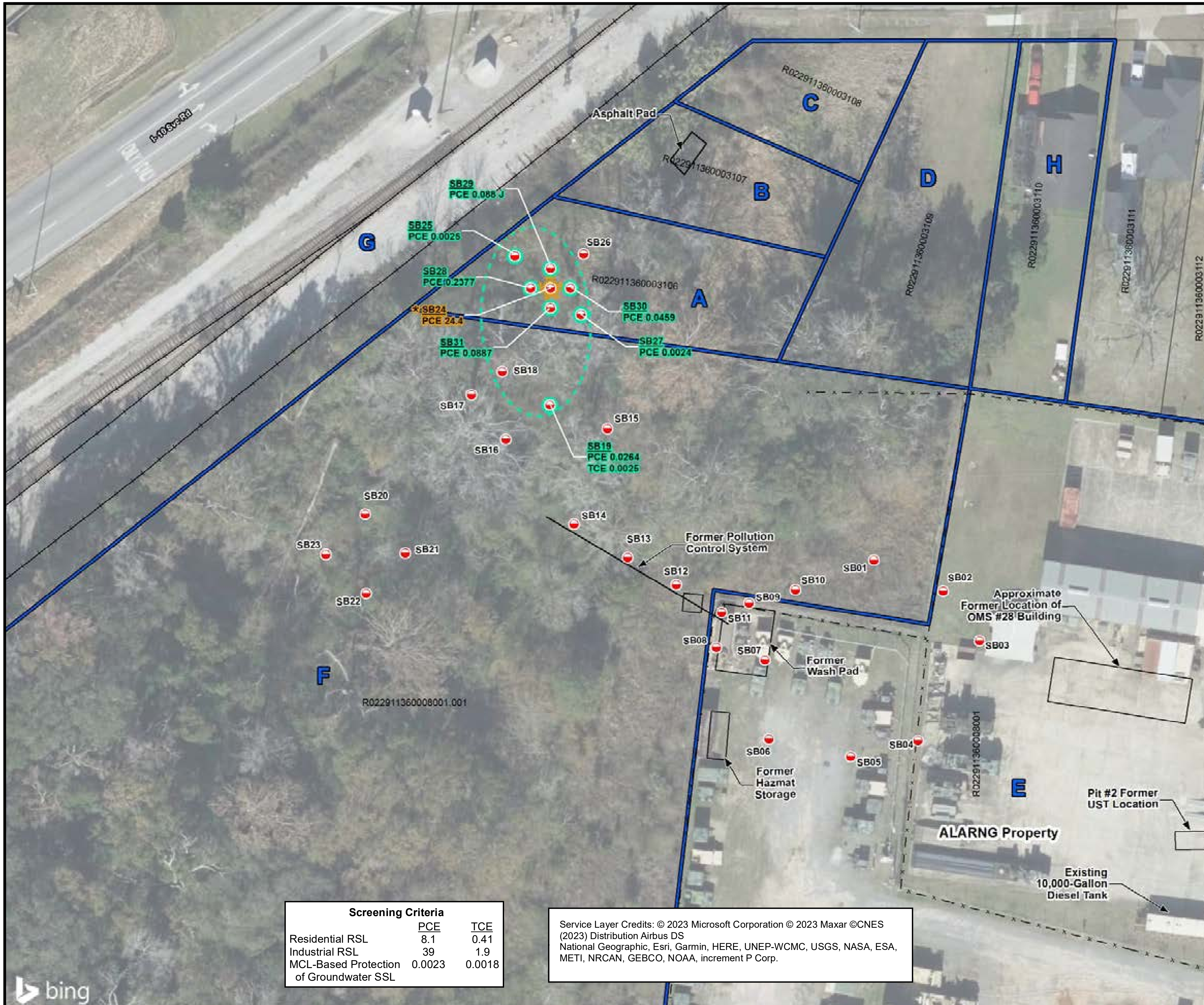
Upper Subsurface Soil Sample Results for TCE and PCE (1.5 - 4 ft bgs)

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/17/2023	Figure 1-7



Screening Criteria

	PCE	TCE
Residential RSL	8.1	0.41
Industrial RSL	39	1.9
MCL-Based Protection of Groundwater SSL	0.0023	0.0018

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National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

Site Location

Legend

- Soil Sample Locations
- PCE Exceeded Residential RSL
- TCE and/or PCE Exceeded MCL - Based Protection of Groundwater SSL
- Railroad
- Approximate Soil Area Exceeding MCL - Based Protection of Groundwater SSL
- Approximate Soil Area Exceeding Residential RSL
- Fenceline
- Parcel Designation (A - H)
- Parcel Boundary

Notes:
1 - Soil Samples collected between May 8-16, 2017.
2 - Analytical results from mobile lab used unless split with fixed lab. Fixed lab samples denoted with "*".
3 - Soil concentrations in milligrams per kilogram.
4 - Only soil results from 1-ft above water table depth varying between 2 and 6 ft bgs are shown.
5 - Residential and Industrial RSLs are based on risk of 1E-06 for carcinogens.
6 - No highlighting of symbol indicates TCE and PCE did not exceed the residential or industrial RSLs or SSL.
7 - If TCE/PCE not listed, they did not exceed any of the screening criteria.
8 - Samples from previous investigations collected at depths were below the current (May 2017) water table.

J - The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
PCE - Tetrachloroethene
TCE - Trichloroethene
RSL - Regional Screening Criteria (USEPA, May 2023)
SSL - Soil Screening Level (USEPA, May 2023)
ft bgs - Feet below ground surface
MCL - Maximum Contaminant Level

0 25 50 100 Feet
1 inch = 50 feet

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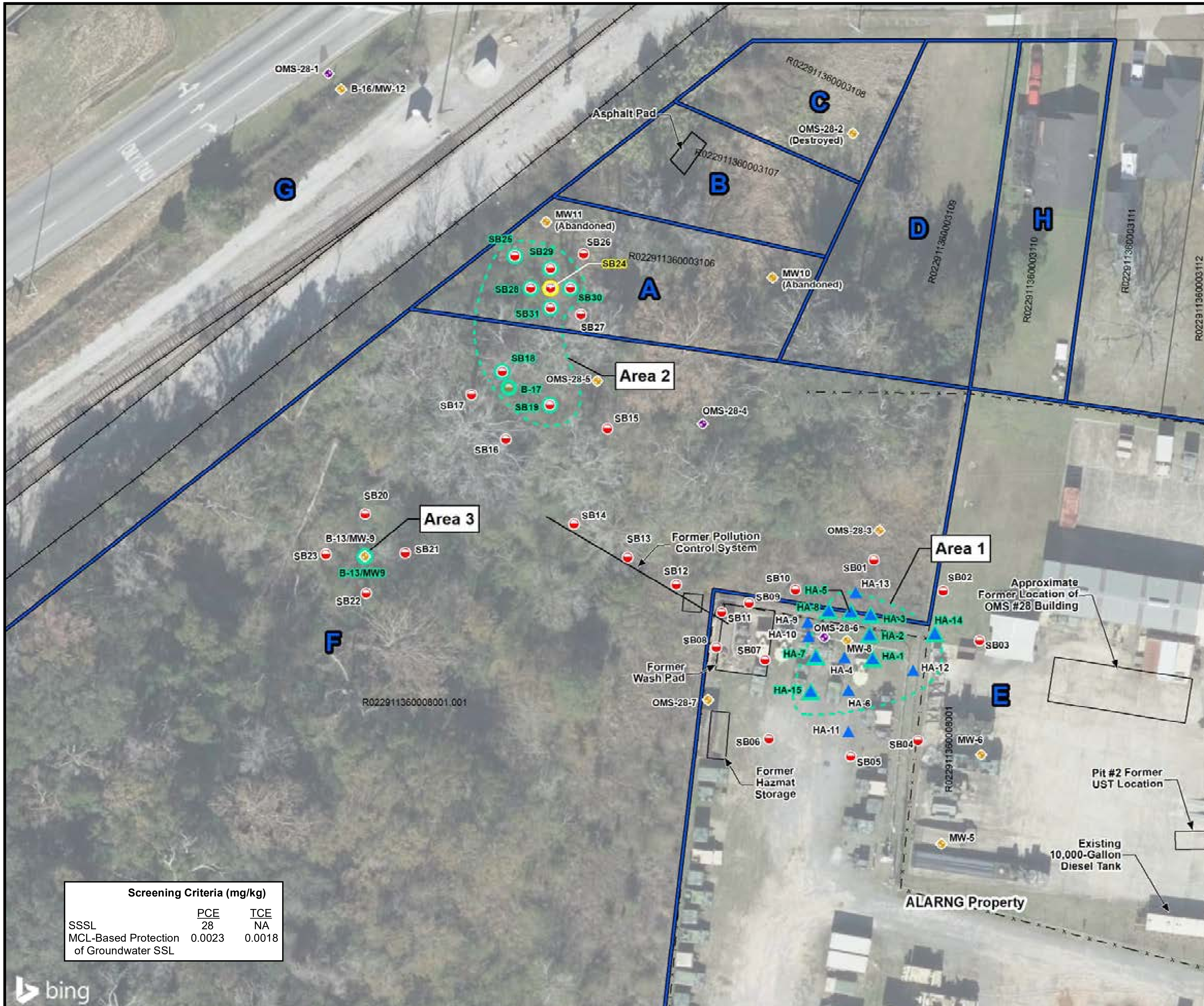
Lower Subsurface Soil Sample Results for TCE and PCE (1 Ft Above Water Table)

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/17/2023	Figure 1-8

Document Path: L:\Legacy\Group\earth\OMS 28\60439687\900-CADD-GIS\Brookley_GIS\Maps\FS Letter Report\20220505\Figure 1-8_Brookley_Lower Subsurface Soil Sample Results for TCE and PCE.mxd



Screening Criteria (mg/kg)

	PCE	TCE
SSSL	28	NA
MCL-Based Protection of Groundwater SSL	0.0023	0.0018

Site Location

Legend

- Hand Auger Samples Collected in 2006/2007
- Soil Boring Samples Collected in 2006/2007
- Soil Sample Locations Collected in 2017
- TCE and/or PCE Exceed MCL- Based Protection of Groundwater SSL
- PCE Exceeds SSSL
- Upper/Middle Surficial Monitoring Well Location
- Lower Surficial Monitoring Well Location
- Railroad
- Fenceline
- Approximate soil area exceeding MCL - Based Protection of Groundwater SSL
- Parcel Designation (A - H)
- Parcel Boundary

Notes:
ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
PCE - Tetrachloroethene
TCE - Trichloroethene
MCL - Maximum Contaminant Level
SSL - Soil Screening Level (USEPA, May 2023)
SSSL - Site Specific Screening Level (AECOM, March 2023)
NA - Not Applicable
FT - Feet

Wells MW-10 and MW-11 were abandoned in 2008 at the property owner's request.

Well OMS-28-2 was found destroyed during a site visit in December 2021.

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0 25 50 100 Feet
1 inch = 50 feet

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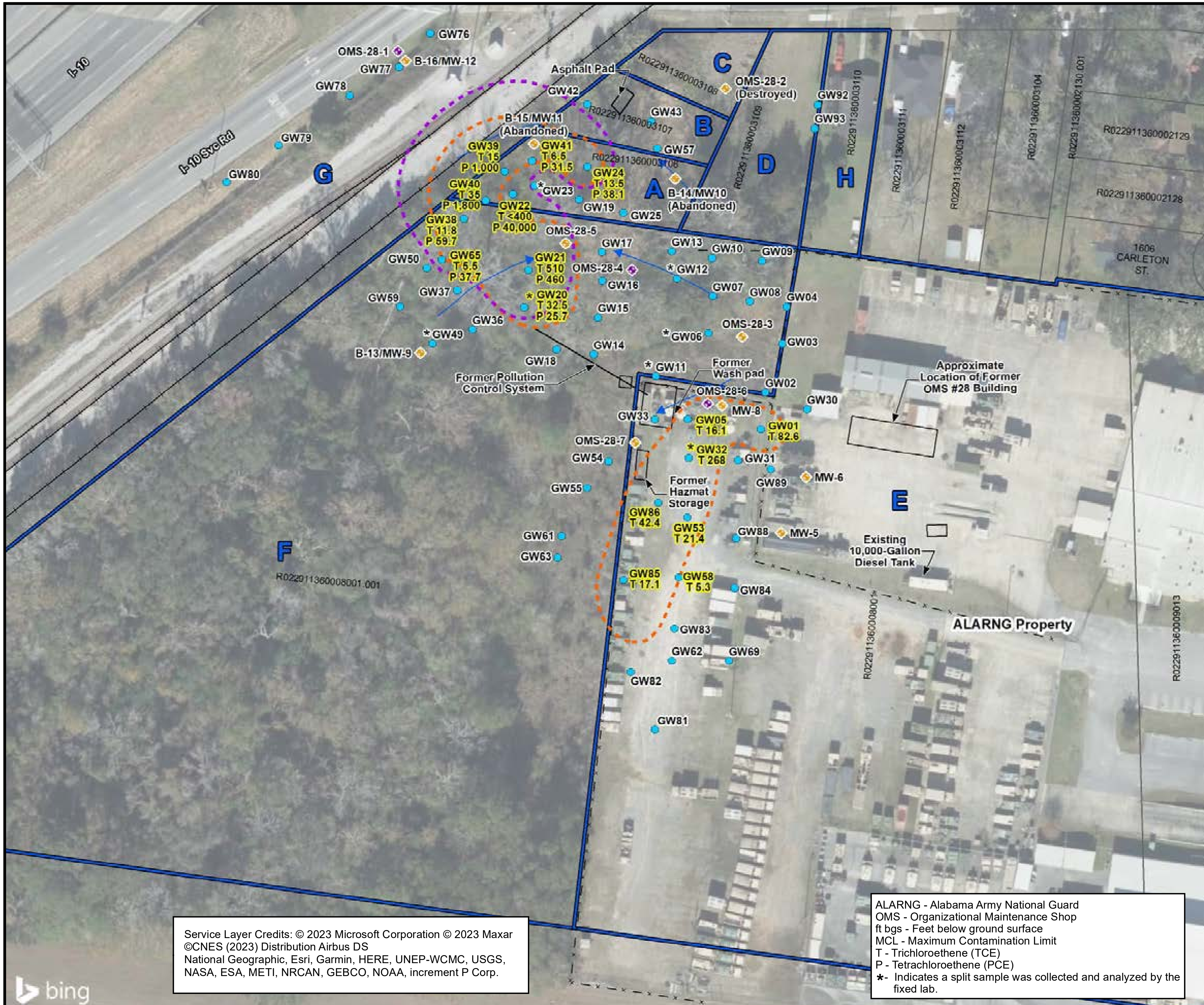
Estimated Extent of Soil Impacts (From Ground Surface to 1 Ft Above Water Table)

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/16/2023	Figure 1-9

Document Path: L:\Legacy\Group\earth\OMS 28\60439687\900-CADD-GIS\Brookley_GIS\Maps\FS Letter Report\20220505\Figure 1-9_OMS 28_Estimated Extent of Soil Impacts 0-1ft.mxd



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ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
ft bgs - Feet below ground surface
MCL - Maximum Contamination Limit
T - Trichloroethene (TCE)
P - Tetrachloroethene (PCE)
*- Indicates a split sample was collected and analyzed by the fixed lab.

Site Location

Legend

- Discrete Groundwater Sample Locations
- Upper/Middle Surficial Monitoring Well Location
- Lower Surficial Monitoring Well Location
- Apparent Groundwater Flow Direction - May 2017
- Fenceline
- Railroad
- Approximate extent of TCE Exceedance Above the MCL (5 µg/L)
- Approximate extent of PCE Exceedance Above the MCL (5 µg/L)
- Parcel Designation (A - H)
- Parcel Boundary
- Indicates PCE and/or TCE were detected above its respective MCL.

Notes:
1. Discrete groundwater investigation conducted in May 2017 (GW-01 through GW-72) and January/February 2018 (GW-73 through GW-93).
2. The laboratory analytical results from the mobile lab are used for the May 2017 results unless a split sample with the fixed lab is available.
The fixed lab results are used for the January/February 2018 samples.
3. Only groundwater results from discrete depths between 6 and 13 ft bgs are shown.
4. No highlighting of symbol indicates TCE and PCE did not exceed their respective MCLs.
5. If the TCE or PCE value is not listed, it did not exceed its respective screening criteria.
6. Wells MW-10 and MW--11 were abandoned in 2008 at the property owner's request.
7. Well OMS-28-2 was found destroyed during a site visit in December 2021.

0 40 80 160 Feet

1 inch = 80 feet

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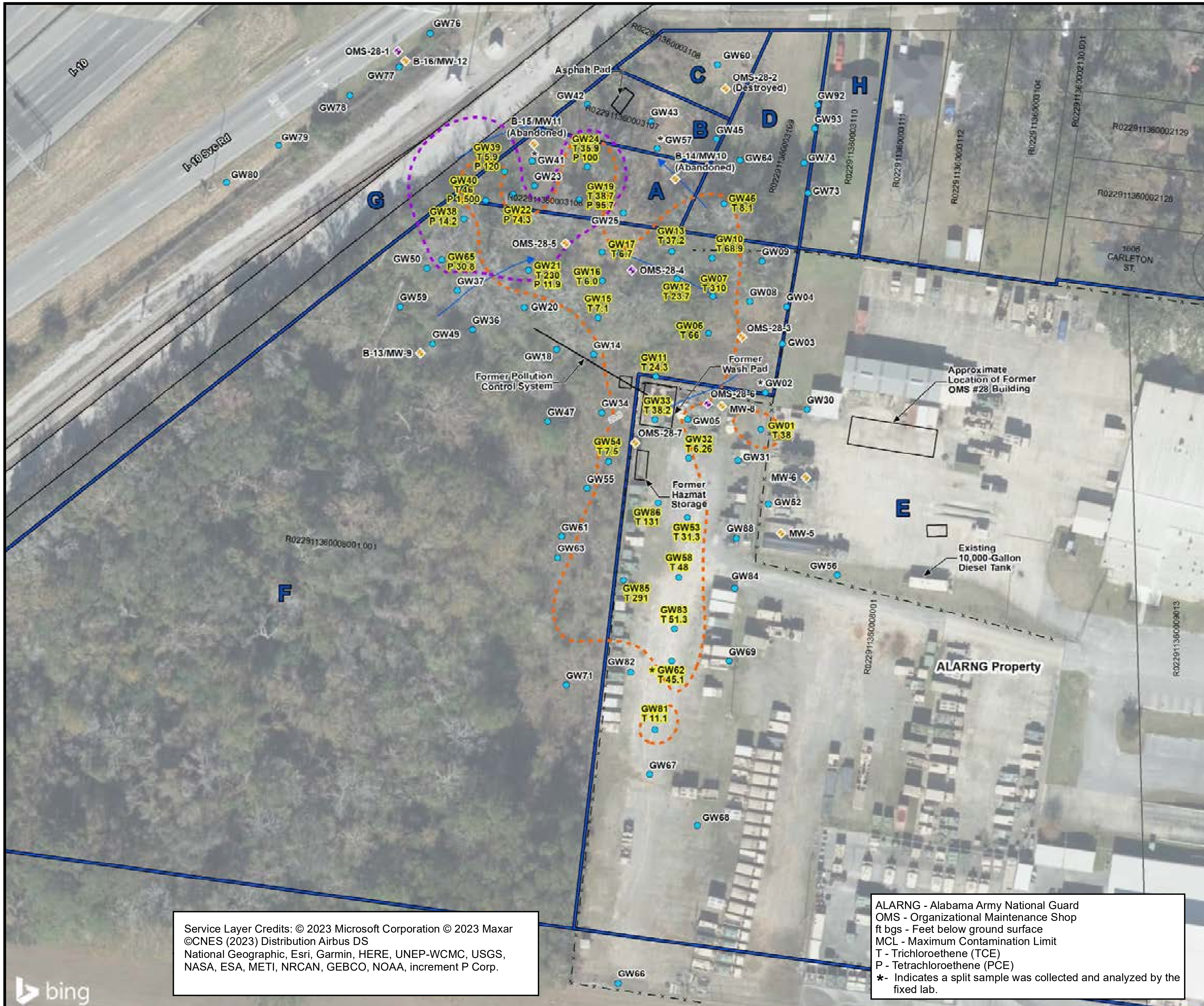
Discrete Groundwater Sampling Results for PCE & TCE - Upper Surficial (6 - 13 ft bgs)

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/16/2023	Figure 1-10

Document Path: L:\Legacy\Group\earth\OMS 28\60439687\900-CADD-GIS\Brookley_GIS\Maps\FS Letter Report\20220505\Figure 1-10_Brookley_Discrete Groundwater Sampling Results 6-13ft RJS.mxd



Site Location

Legend

- Discrete Groundwater Sample Locations
- Upper/Middle Surficial Monitoring Well Location
- Lower Surficial Monitoring Well Location
- Approximate extent of PCE Exceedance Above the MCL (5 µg/L)
- Approximate extent of TCE Exceedance Above the MCL (5 µg/L)
- Apparent Groundwater Flow Direction - May 2017
- Fenceline
- Railroad
- Parcel Boundary
- Parcel Designation (A - H)
- Indicates TCE and/or PCE were detected above their respective MCL.

Notes:
1. Discrete groundwater investigation conducted in May 2017 (GW-01 through GW-72) and January/February 2018 (GW-73 through GW-93).
2. The laboratory analytical results from the mobile lab are used for the May 2017 results unless a split sample with the fixed lab is available.
The fixed lab results are used for the January/February 2018 samples.
3. Only groundwater results from discrete depths between 12 and 26 ft bgs are shown.
4. No highlighting of symbol indicates TCE and PCE did not exceed their respective MCLs.
5. If the TCE or PCE value is not listed, it did not exceed its respective screening criteria.
6. Wells MW-10 and MW--11 were abandoned in 2008 at the property owner's request.
7. Well OMS-28-2 was found destroyed during a site visit in December 2021.

0 40 80 160 Feet

1 inch = 80 feet

ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
ft bgs - Feet below ground surface
MCL - Maximum Contamination Limit
T - Trichloroethene (TCE)
P - Tetrachloroethene (PCE)
*- Indicates a split sample was collected and analyzed by the fixed lab.

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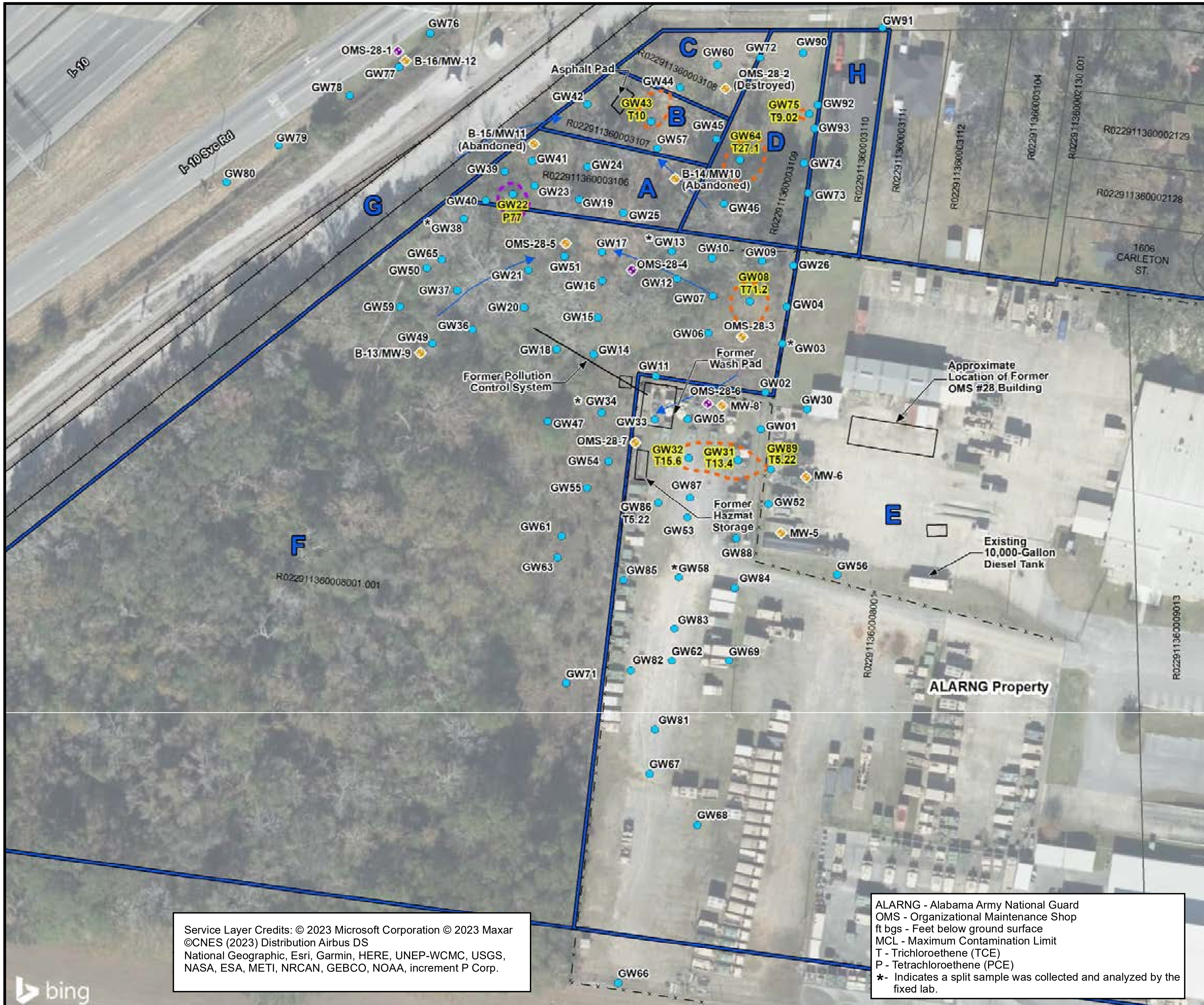
Discrete Groundwater Sampling Results for PCE & TCE - Middle Surficial (12 - 26 ft bgs)

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/16/2023	Figure 1-11



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ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
ft bgs - Feet below ground surface
MCL - Maximum Contamination Limit
T - Trichloroethene (TCE)
P - Tetrachloroethene (PCE)
*- Indicates a split sample was collected and analyzed by the fixed lab.

Site Location

Legend

- Discrete Groundwater Sample Locations
- Upper/Middle Surficial Monitoring Well Location
- Lower Surficial Monitoring Well Location
- Approximate extent of TCE Exceedance Above the MCL (5 µg/L)
- Approximate extent of PCE Exceedance Above the MCL (5 µg/L)
- Apparent Groundwater Flow Direction - May 2017
- Fenceline
- Railroad
- Parcel Designation (A - H)
- Parcel Boundary
- Indicates TCE and/or PCE were detected above their respective MCL.

Notes:
1. Discrete groundwater investigation conducted in May 2017 (GW-01 through GW-72) and January/February 2018 (GW-73 through GW-93).
2. The laboratory analytical results from the mobile lab are used for the May 2017 results unless a split sample with the fixed lab is available.
The fixed lab results are used for the January/February 2018 samples.
3. Only groundwater results from discrete depths deeper than 26 bgs are shown.
4. No highlighting of symbol indicates TCE and PCE did not exceed their respective MCLs.
5. If the TCE or PCE value is not listed, it did not exceed its respective screening criteria.
6. Wells MW-10 and MW--11 were abandoned in 2008 at the property owner's request.
7. Well OMS-28-2 was found destroyed during a site visit in December 2021.

0 40 80 160 Feet

1 inch = 80 feet

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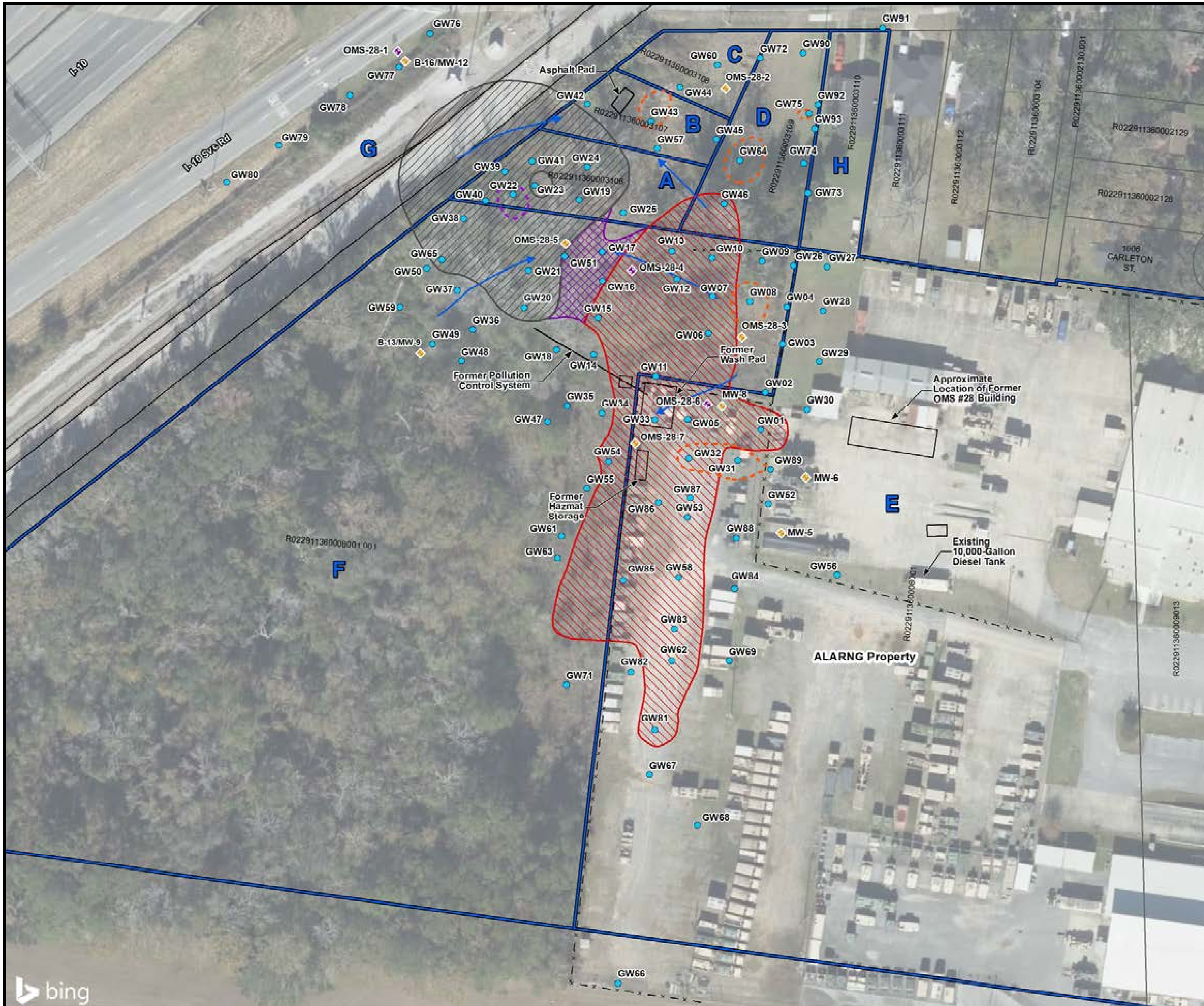
Discrete Groundwater Sampling Results for PCE & TCE - Lower Surficial (Deeper than 26 ft bgs)

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/16/2023	Figure 1-12

Document Path: L:\Legacy\Group\earth\OMS 28\60439687\900-CADD-GIS\Brookley_GIS\Maps\FS Letter Report\20220505\Figure 1-12_Brookley_Discrete Groundwater Sampling Results Deeper than 26ft RJS.mxd



Legend

- Upper/Middle Surficial Monitoring Well
- Lower Surficial Monitoring Well Locations
- Discrete Groundwater Sample Locations
- Approximate Extent of PCE Exceedance Above the MCL (5 µg/L) in the Lower Surficial Aquifer
- Approximate Extent of TCE Exceedance Above the MCL (5 µg/L) in the Lower Surficial Aquifer
- Apparent Groundwater Flow Direction - May 2017
- Fenceline
- Railroad
- PCE Plume Related to Offsite PCE Spill on Parcel A
- TCE Plume Related to TCE Spill on Parcel E
- Area of Co-Mingled PCE from Parcel A and TCE from Parcel E
- Parcel Designation (A - H)
- Parcel Boundary

Note:
ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
PCE - Tetrachloroethene
TCE - Trichloroethene
MCL - Maximum Contaminant Level
µg/L - micrograms per liter

0 40 80 160 Feet

1 inch = 80 feet

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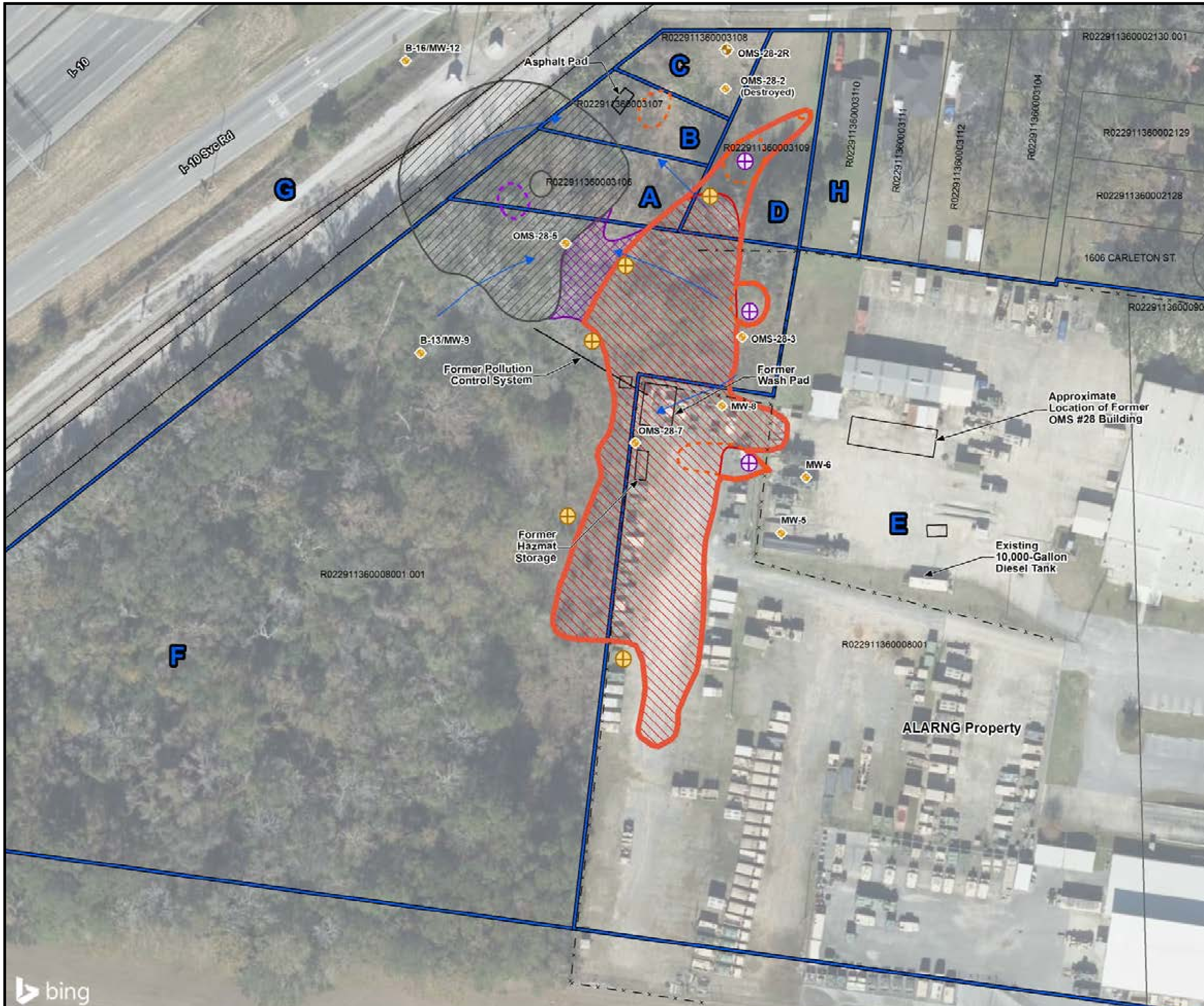
Approximate Extent of PCE and TCE Groundwater Plumes

Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/17/2023	Figure 1-13

Document Path: L:\Legacy\Group\earth\OMS 28\60439687\900-CADD-GIS\Brookley_GIS\Maps\FS Letter Report\20220505\Figure 1-13_Brookley_Approx_Extent_PCE_TCE_and_Intermix_Plumes.mxd



Site Location

Legend

- Proposed Replacement Well
- Proposed Upper/Middle Surficial Aquifer Monitoring Well Location
- Proposed Lower Surficial Aquifer Monitoring Well Location
- Existing Upper/Middle Surficial Aquifer Monitoring Well Locations
- Approximate Extent of PCE Exceedance Above the MCL (5 µg/L) in the Lower Surficial Aquifer
- Approximate Extent of TCE Exceedance Above the MCL (5 µg/L) in the Lower Surficial Aquifer
- Apparent Groundwater Flow Direction - May 2017
- Fenceline
- Railroad
- Proposed LUC Boundary
- PCE Plume Related to Offsite PCE Spill on Parcel A
- TCE Plume Related to TCE Spill on Parcel E
- Area of Co-Mingled PCE from Parcel A and TCE from Parcel E
- Parcel Designation (A - H)
- Parcel Boundary

ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
PCE - Tetrachloroethene
TCE - Trichloroethene
MCL - Maximum Contaminant Level
LUCs - Land Use Controls
µg/L - micrograms per liter

0 75 150 Feet

1 inch = 80 feet

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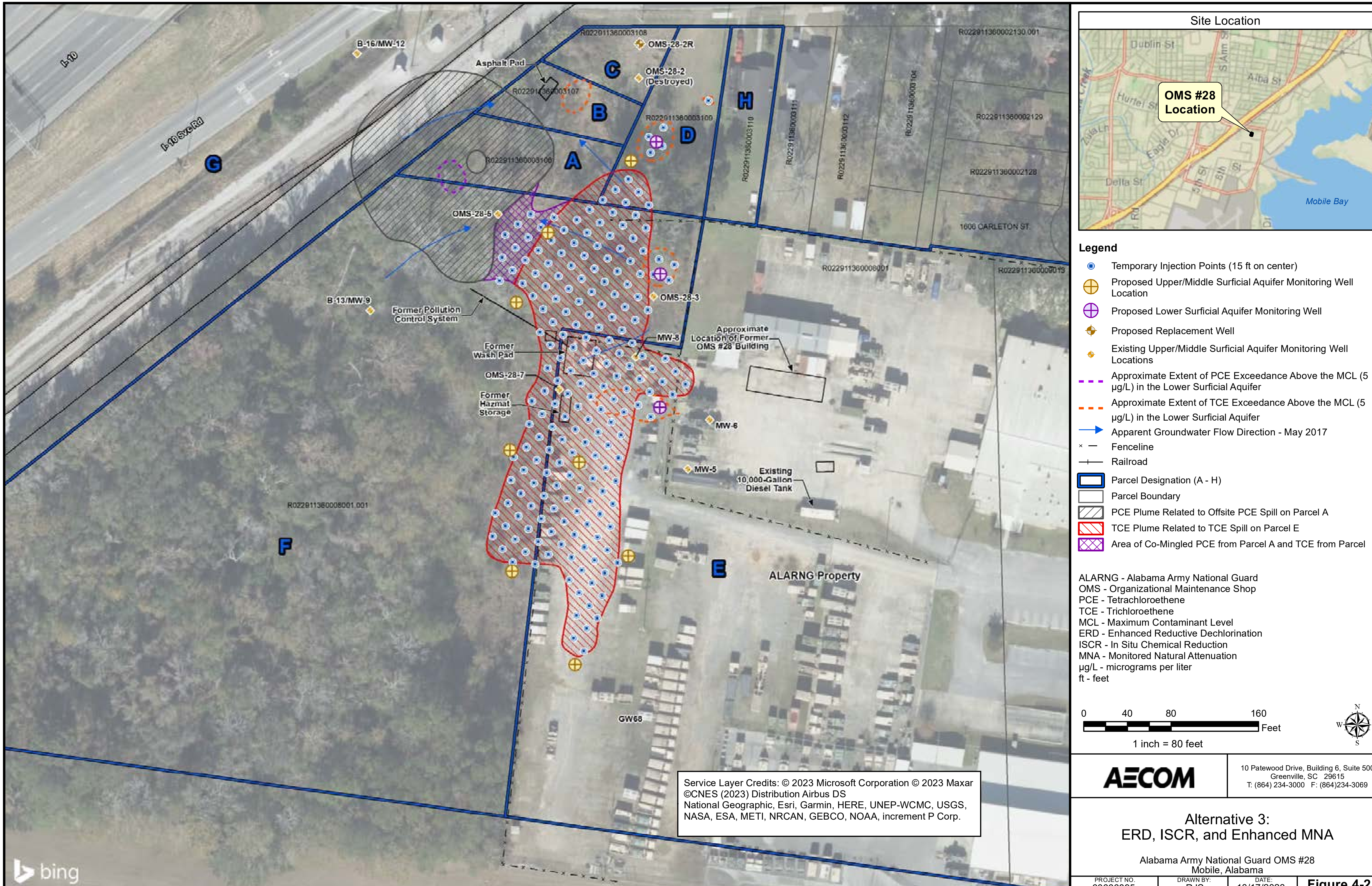
Alternative 2:
LUCs with Periodic Monitoring

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/17/2023	Figure 4-1



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APPENDICES

APPENDIX A

Geologic Cross Sections

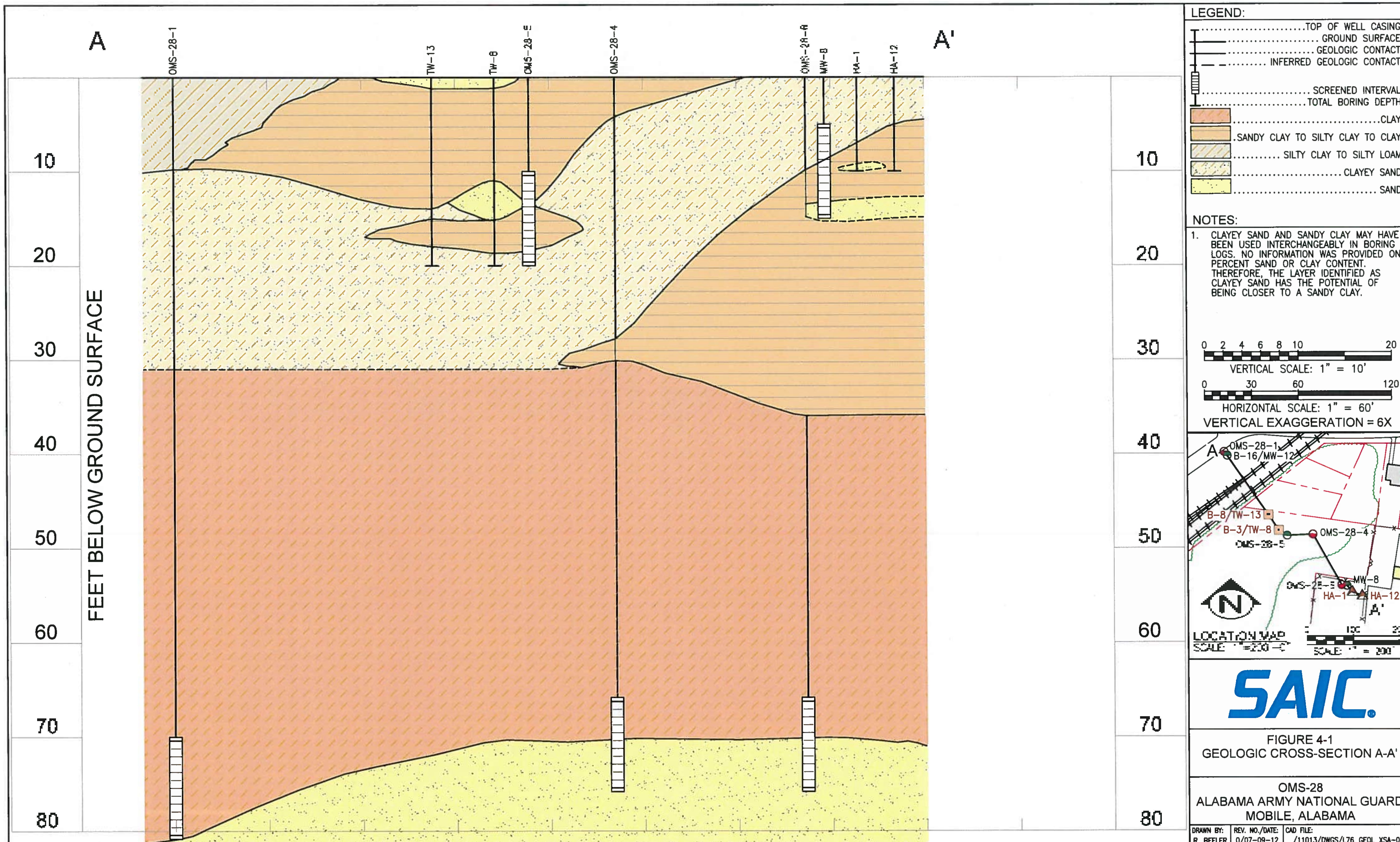
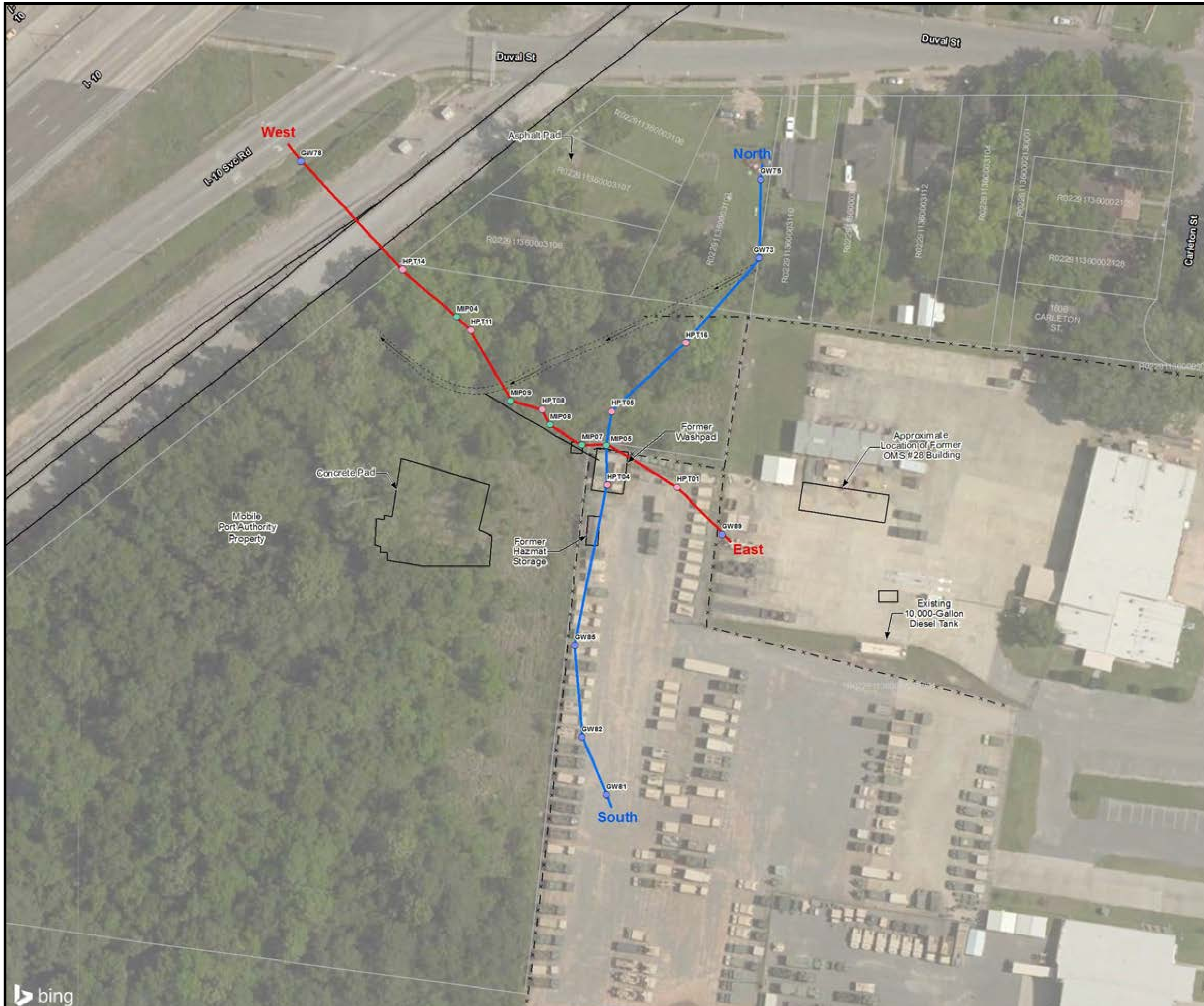
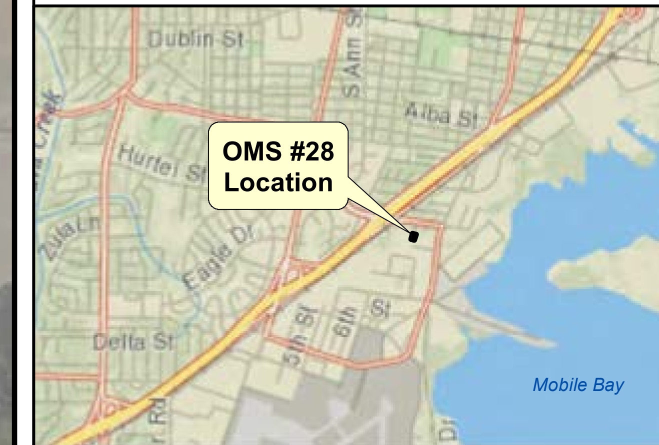


FIGURE 4-1
GEOLOGIC CROSS-SECTION A-A'



Site Location



Legend

- Shallow Monitoring Well Location
- Deep Monitoring Well Location
- Groundwater Sample Location
- HPT Location
- MIP Location
- Soil Boring Location
- Fenceline
- Railroad
- Approximate Ditch Orientation
- Approximate Ditch Orientation Flow Direction
- Parcel Boundary

0 40 80 160 Feet

1 inch = 80 feet

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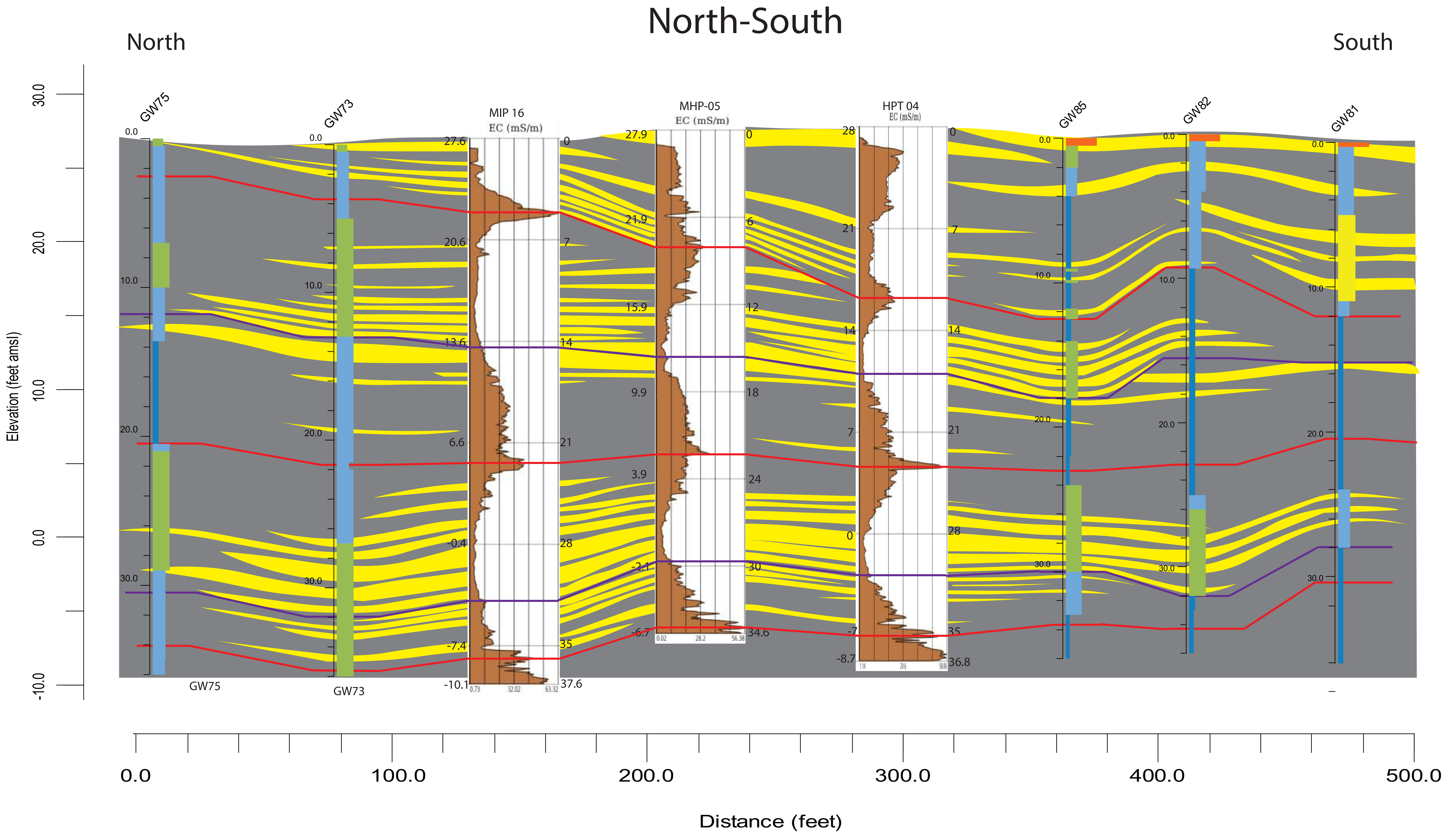
Cross-Section Location Map

Supplementary Data Gap Investigation and Groundwater Monitoring Report
Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60439687	TEG	8/14/2018	Figure 2-4

Document Path: L:\Projects\60439687 Brookley\900-CADD-GIS\Brookley_GIS\Maps\VK\2018_08_09\Figure 2-4_Cross-Section Location Map.mxd

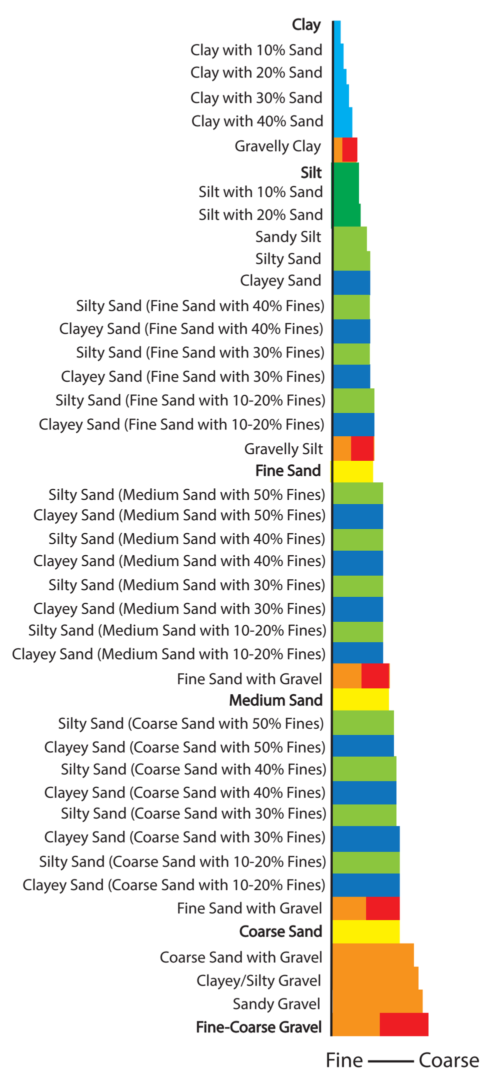


Cross Section Location

Legend

- Maximum Flooding Surface
- Sequence Boundary
- Mouth Bar Sands
- Tidal Clay

Grain Size Log



Notes:

GW75 - Discrete groundwater sampling location 75
MIP 16 - Membrane Interface Probe push location 16
HPT 04 - Hydraulic Profiling Tool push location 04
MHP-05 - Dual MIP/HPT push location 05
EC - Electrical conductivity
mS/m - miliSiemens per meter
amsl - above mean sea level

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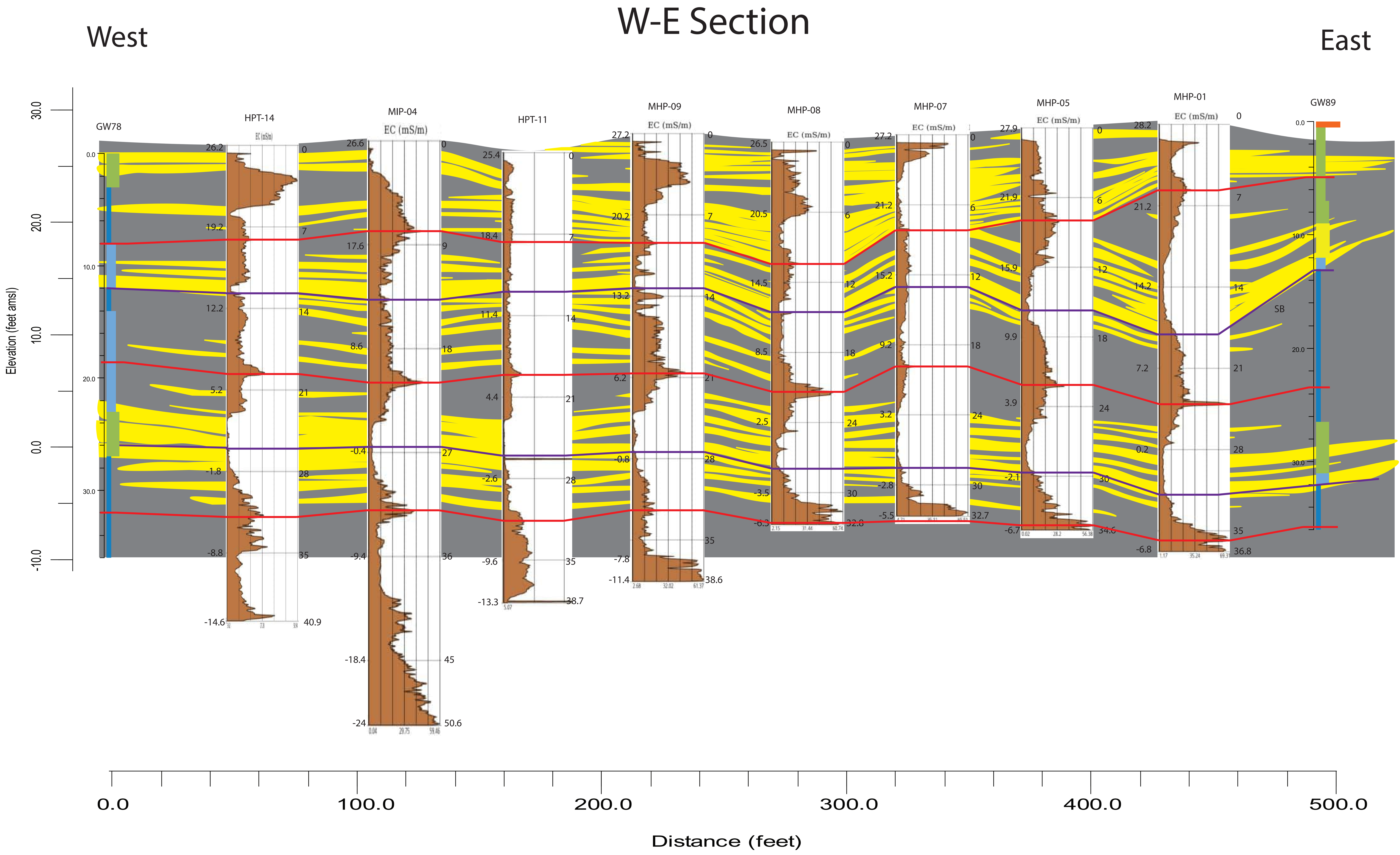
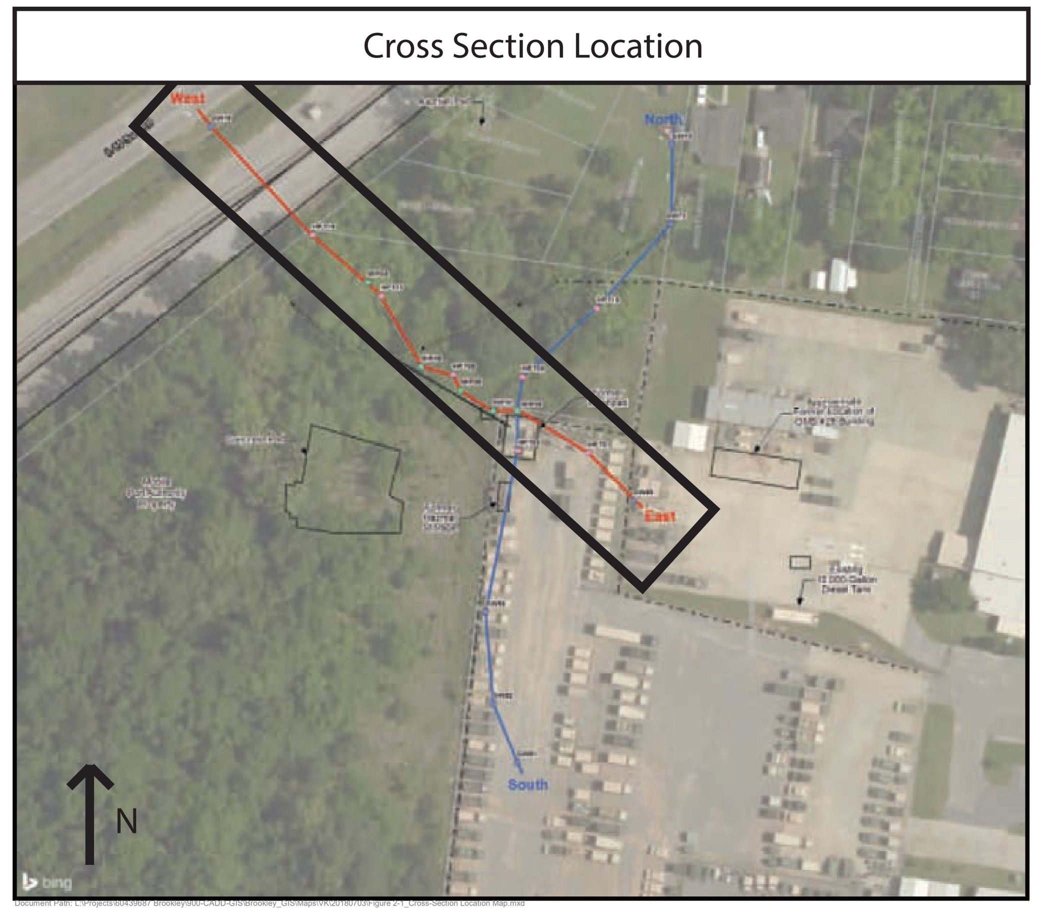
North - South Cross Section

Supplementary Data Gap Investigation
and Groundwater Monitoring Report

Army National Guard OMS #28
Mobile, Alabama

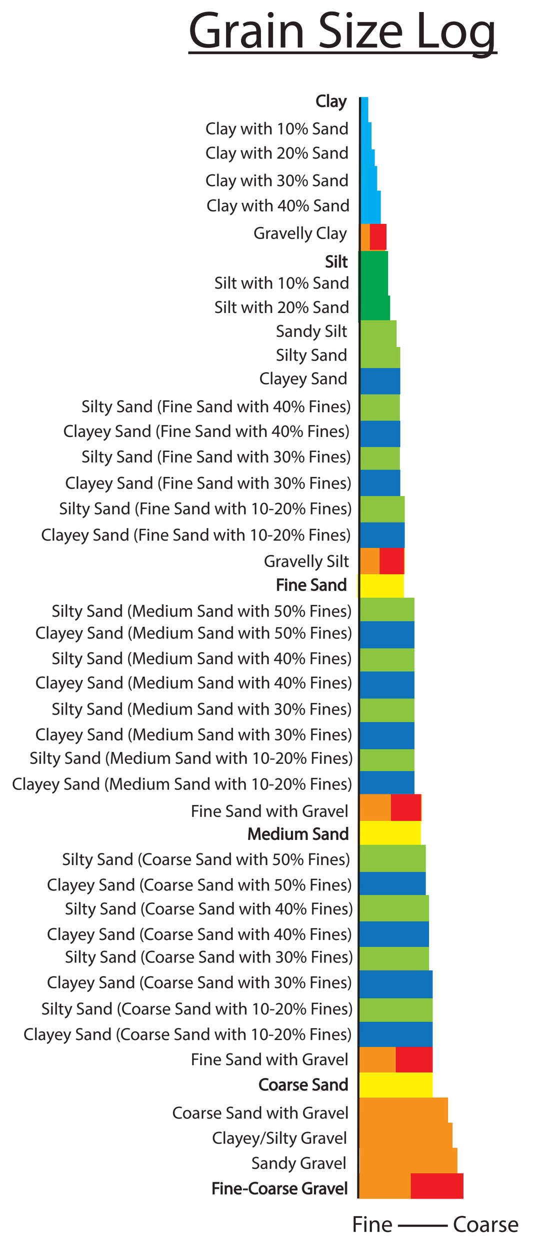
PROJECT NO.	DRAWN BY:	DATE:	
60439687	RCS	7/5/2018	Figure 2-5





Legend

- Maximum Flooding Surface
- Sequence Boundary
- Mouth Bar Sands
- Tidal Clay



Notes:

GW89 - Discrete groundwater sampling location 89

MIP-04 - Membrane Interface Probe push location 04

HPT-11 - Hydraulic Profiling Tool push location 11

MHP-05 - Dual MIP/HPT push location 05

EC - Electrical conductivity

mS/m - miliSiemens per meter

amsl - above mean sea level

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West - East Cross Section

Supplmentary Data Gap Investigation
and Groundwater Monitoring Report

Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60439687	RCS	7/5/2018	**Figure 2-6**

APPENDIX B

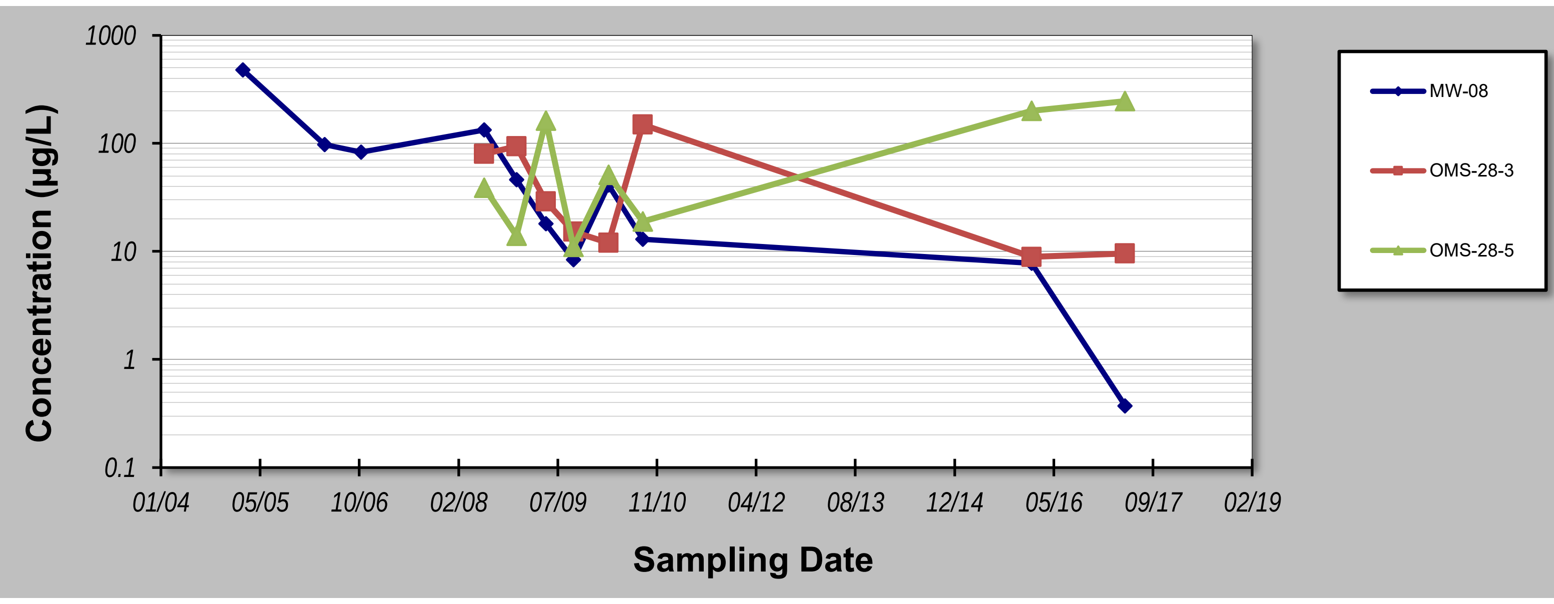
Mann-Kendall Toolkit Analysis

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **9-Feb-22**
Facility Name: **OMS #28**
Conducted By: **Timothy Renn**

Job ID: **60666895**
Constituent: **TCE - Upper Surficial aquifer**
Concentration Units: **µg/L**

Sampling Event	Sampling Date	MW-08	OMS-28-3	OMS-28-5				
		TCE - UPPER SURFICIAL AQUIFER CONCENTRATION (µg/L)						
1	1-Mar-05	480						
2	18-Apr-06	97.9						
3	18-Oct-06	83						
4	1-Jul-08	133	80	39				
5	11-Dec-08	46	94	14				
6	8-May-09	18	29	162				
7	24-Sep-09	8.41	15.29	11				
8	19-Mar-10	41	12	51				
9	8-Sep-10	13	149	19				
10	20-Jan-16	7.8	8.92	200				
11	5-May-17	0.373	9.6	246				
12								
13								
14								
15								
16								
17								
18								
19								
20								
Coefficient of Variation:		1.30	1.05	1.02				
Mann-Kendall Statistic (S):		-22	-14	12				
Confidence Factor:		99.8%	94.6%	91.1%				
Concentration Trend:		Decreasing	Prob. Decreasing	Prob. Increasing				



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

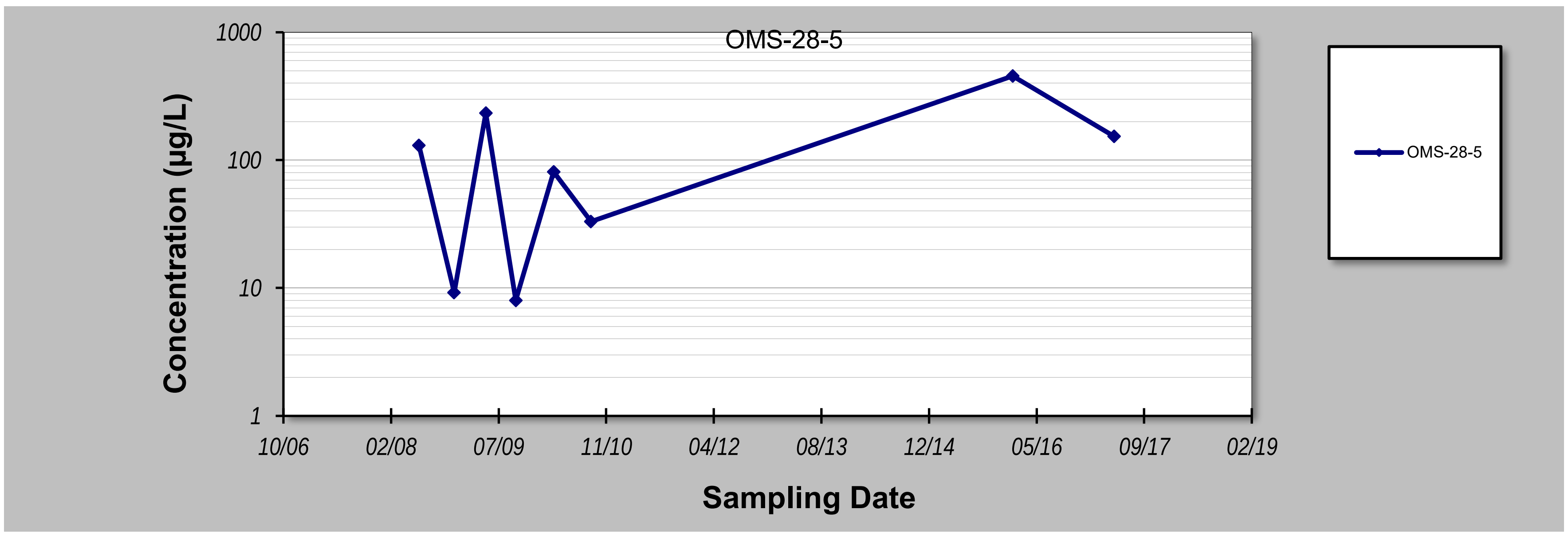
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **9-Feb-22**
Facility Name: **OMS #28**
Conducted By: **Timothy Renn**

Job ID: **60666895**
Constituent: **PCE - Upper Surficial aquifer**
Concentration Units: **µg/L**

Sampling Point ID: **OMS-28-5**

Sampling Event	Sampling Date	PCE - UPPER SURFICIAL AQUIFER CONCENTRATION (µg/L)						
		OMS-28-5						
1	1-Jul-08	130						
2	11-Dec-08	9.2						
3	8-May-09	234						
4	24-Sep-09	8.02						
5	19-Mar-10	81						
6	8-Sep-10	33						
7	20-Jan-16	455						
8	5-May-17	154						
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
	Coefficient of Variation:	1.09						
	Mann-Kendall Statistic (S):	6						
	Confidence Factor:	72.6%						
	Concentration Trend:	No Trend						



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

APPENDIX C

Exclusion of Responsibility for Offsite Tetrachloroethene (PCE) Contamination Documentation

APPENDIX C

Exclusion of Responsibility for Offsite Tetrachloroethene (PCE) Contamination Documentation
Organizational Maintenance Shop #28
Mobile County, Mobile, Alabama

INTRODUCTION

On September 10, 2020, the Army National Guard (ARNG) submitted to the Alabama Department of Environmental Management (ADEM) a letter (National Guard Bureau, 2020) that was based on the results of a Supplemental Data Gap Investigation (SDGI) and associated risk assessment that were conducted for Organization Maintenance Shop #28 (OMS #28) and the surrounding vicinity. **Figure C-1** shows OMS #28 and the surrounding vicinity. In this letter, the ARNG described a release of tetrachloroethene (PCE) into surface soil that was discovered during completion of SDGI activities on a privately owned undeveloped parcel (Parcel Identification (ID) R022911360003106 as shown on **Figure C-1 and C-2**) and located approximately 200 feet northwest of Alabama Army National Guard (ALARNG) property. Based on the SDGI results, the estimated extent of surface and subsurface soil impacted with PCE above the May 2023 United States Environmental Protection Agency (USEPA) Regional Screening Level (RSL) for residential soil is shown in plan view on **Figure C-2**, and groundwater impacted with PCE above the maximum contaminant level (MCL) is also shown on **Figure C-2**. A cross-section location map and two associated cross sections, which show the PCE contamination in offsite soil and groundwater with respect to the location of the ALARNG property, are presented as **Figures C-3 through C-5**.

ALARNG has had no known historical activities conducted on undeveloped Parcel ID R022911360003106. In addition, a commercially zoned parcel (Parcel ID R022911360008001.001 as shown on **Figure C-1 and C-2**) separates the ALARNG property from Parcel ID R022911360003106 where the PCE release occurred, which makes ALARNG involvement in the release even more unlikely. Note that the parcels identified in this document can viewed on the City of Mobile GIS City Map viewer at https://maps.cityofmobile.org/GIS/webmapping.aspx.

As a result of the SDGI, site risk assessment, and the determination that the ALARNG is not responsible for the offsite PCE release, the Feasibility Study (FS) for OMS #28, dated February 2014 and concurred with by ADEM on May 5, 2014, has been revised by the ARNG. The revised FS eliminates the evaluation of remedial alternatives for offsite PCE contamination in soil and groundwater located on Parcel IDs R022911360003106 and R022911360008001.001 and only provides remedial alternatives for chemicals of concern (COC) attributable to historical ALARNG operations conducted at OMS #28. The September 10, 2020 ARNG letter also stated that further justification for this revision would be provided in the revised FS. This document serves to provide the justification for this revision.

The ADEM Review and Response: *Responsibility for PCE Contamination* (ADEM, 2021), acknowledged receipt of the September 10, 2020 letter and the request by the ARNG to remove the offsite PCE contamination from their scope of responsibility. In this letter, ADEM requested that ARNG include all analytical data, lines of evidence, and rationale supporting the proposed removal of the offsite area contaminated with PCE from ARNG's scope of responsibility as part of the revised FS. This Exclusion of Responsibility for Offsite Tetrachloroethene (PCE) Contamination Documentation has been prepared in response to this request.

APPENDIX C

Exclusion of Responsibility for Offsite Tetrachloroethene (PCE) Contamination Documentation
Organizational Maintenance Shop #28
Mobile County, Mobile, Alabama

BACKGROUND

The OMS site has undergone numerous development, redevelopment, and organizational periods since initial development. The OMS #28 site was developed in the early 1950s, and the current OMS #28 building was constructed in 1978. The OMS site is located north of the former Brookley Air Force Base (BAFB). The Department of the Air Force officially declared BAFB excess property effective 30 June 1969. GSA completed the property disposal on 21 October 1969. BAFB maps were evaluated, and the property where the OMS is located is outside of the boundary of the former BAFB. The boundary of BAFB never extended north to the OMS #28 property or beyond the OMS #28 property to the west where the PCE soil contamination on Parcel A is located.

Various investigations were conducted at OMS #28 (the “site”) between 2005 and 2009. Following the detection of trichloroethene (TCE) at monitoring well (MW)-8 in March 2005, a comprehensive site investigation was initiated to determine the source of TCE in groundwater. A former wash pad that was in operation until 1978 and located approximately 40 feet to the west of MW-8 was identified as a potential source for the TCE and required further investigation. The wash pad was constructed as a concrete slab with no drainage system in place. Military vehicles were routinely washed in this area, and the associated wash water was allowed to flow freely onto the ground. The date of construction for the wash pad is unknown. Relevant historical site features are depicted on **Figure C-1**.

Subsequent site investigations confirmed two potential source areas for TCE groundwater contamination, one on ALARNG property and one on Parcel ID R022911360008001.001. A potential source of TCE in groundwater was confirmed on ALARNG property through soil sampling conducted in the vicinity of MW-8 between April 2006 and April 2007, where a number of surface (0 to 1 feet below ground surface [bgs]) and/or subsurface (8 to 10 feet bgs) samples exceeded the protection of groundwater soil screening level (SSL) of 0.0018 milligrams per kilogram (mg/kg) for TCE. In this area, PCE only slightly exceeded its SSL of 0.0023 mg/kg at three locations (estimated concentrations of 0.00252 mg/kg, 0.00253 mg/kg, and 0.00505 mg/kg at HA-5, HA-7, and HA-13, respectively; **Figure C-6**). A potential source of TCE in groundwater was also identified on Parcel ID R022911360008001.001 during the installation of MW-9 in October 2006, where the surface soil sample concentration (0.0171 mg/kg) exceeded the protection of groundwater SSL for TCE (**Figure C-6**).

One potential source of PCE groundwater contamination was also identified on Parcel ID R022911360008001.001 based on soil samples collected in March 2007. The potential source was identified at soil boring location B-17. In both the B-17 surface soil sample (0.933 mg/kg) and the subsurface soil sample (0.186 mg/kg) collected at B-17, PCE was detected above its protection of groundwater SSL (**Figure C-2**). B-17 was collected approximately 30 feet south of adjacent Parcel ID R022911360003106.

An SDGI was conducted at OMS #28 between April 2016 and February 2018. The objectives of the SDGI were to identify if other soil source areas were contributing to identified groundwater contamination and to improve the delineation of the known groundwater contaminant plumes. The SDGI consisted of four activities to meet these objectives:

- Sampling of existing site groundwater monitoring wells,
- Subsurface investigation using a membrane interface probe (MIP) and hydraulic profiling tool (HPT),
- Soil sampling via direct push technology (DPT), and
- Discrete groundwater sampling via DPT.

Figure C-7 shows all of the SDGI sample locations. The *Supplemental Data Gap Investigation and Groundwater Monitoring Report* (AECOM, 2019) documents SDGI activities and results. The SDGI was concurred with by ADEM on January 21, 2020 (ADEM, 2020). An overview of the significant findings from the SDGI is presented in the following four subsections.

JANUARY 2016 AND MAY 2017 SITE GROUNDWATER MONITORING WELL SAMPLING SUMMARY

During January 2016 and May 2017, eleven existing site monitoring wells were sampled for Target Compound List (TCL) Volatile Organic Compounds (VOC) by USEPA Method 8260B. **Figure C-1** shows the location of existing and abandoned site monitoring wells. During both sampling events, PCE was detected above the Maximum Contaminant Level (MCL) of 5 micrograms per liter (µg/L) in only one monitoring well, OMS-28-5. During the January 2016 groundwater sampling event, three monitoring wells (MW-8, OMS-28-3, and OMS-28-5) had detections of TCE above the MCL of 5 µg/L. During the May 2017 groundwater sampling event, TCE was detected above the MCL in OMS-28-3 and OMS-28-5; however, TCE at MW-8 was detected below the MCL at an estimated concentration of 0.373 µg/L. The January 2016 and May 2017 groundwater sampling results as well as older groundwater sampling results for site monitoring wells are presented in **Table C-1**.

MIP/HPT SUMMARY

MIP/HPT locations were investigated based on historical knowledge of site features that may have been potential sources of groundwater contamination. Specifically, the MIP/HPT borings were located in the vicinity of the former pollution control system and the former wash pad, shown on **Figure C-1**, and also within the plume boundary near soil boring B-17 (**Figure C-6**). No significant responses were identified within the MIP logs that indicated a soil source for groundwater in these areas.

DPT SOIL SAMPLING SUMMARY

Ninety-three (93) soil samples were collected from 31 locations and analyzed by an onsite mobile laboratory for PCE and TCE. As a quality check, split samples were collected at a frequency of 10 percent (%) of the total number of soil samples and sent to an offsite fixed laboratory for analysis of TCL VOCs by USEPA Method 8260B. The purpose of the soil sampling event was to refine the previous delineation of potential soil excavation areas identified in the February 2014 FS and to characterize any potential new soil source areas. Soil locations within the offsite vacant residential Parcel ID R022911360003106 were not originally planned as part of the DPT soil sampling event; however, these locations (OMS-28-SB24 through OMS-28-SB31) were added at the time field activities were being conducted based on the PCE and TCE results obtained at discrete groundwater sampling location OMS-28-GW22 (discussed in the DPT Groundwater Sampling Summary subsection).

The groundwater results for PCE and TCE at OMS-28-GW22 indicated that a possible soil source might be present near this location; therefore, additional soil samples were added to define the area around OMS-28-GW22. **Figures C-8 through C-10** show the DPT soil results, and **Tables C-2 and C-3** present the mobile and fixed lab soil sampling results, respectively. The onsite mobile laboratory analytical results and fixed laboratory results were screened against the industrial SSL, residential SSL, and the MCL-based protection of groundwater SSL as provided in the May 2018 United States Environmental Protection Agency (USEPA) Regional Screening Level (RSL) Table (USEPA, 2018a). The RSLs for PCE and TCE remain the same in the latest version of the USEPA RSL Table (USEPA, 2023).

A summary of the results for the DPT soil sampling activities include the following:

- Soil samples collected within the extent of the ALARNG facility's property boundaries and around SSL exceedances (primarily TCE) detected in 2006 and 2007 did not exhibit TCE or PCE results above the laboratory limits of detection (LOD).
- Samples collected along the former pollution control system did not exceed LODs for PCE or TCE.
- Surface and subsurface soil samples collected within the vicinity of location B-13/MW-9 (on Parcel ID R022911360008001.001) where the surface soil sample exceeded the MCL-based protection of groundwater SSL for TCE in October 2006 did not exceed LODs for TCE and PCE. Furthermore, the groundwater concentration for TCE at MW-9 has never exceeded the laboratory LOD. These results confirmed that a TCE source did not exist in this area.
- Two soil sample borings located near the northwest Parcel ID R022911360008001.001 boundary (OMS-28-SB18 and OMS-28–SB19) and completed near soil boring B-17, where PCE exceeded the MCL-based protection of groundwater SSL for PCE in March 2007 contained surface soil detections of PCE above the protection of groundwater SSL. PCE was detected in OMS-28-SB18 above the protection of groundwater SSL between 1.5 and 4 feet bgs. At OMS-28-SB19, PCE was detected above the protection of groundwater SSL at approximately 1 foot above the water table. TCE was also detected at slightly above its MCL-based SSL (0.0018 mg/kg) at this location.
- A new soil source area was identified on offsite vacant Parcel ID R022911360003106, which is located immediately north of Parcel ID R022911360008001.001. The origin for the source of PCE was unknown since there is no record of the ALARNG using PCE at the OMS #28 facility. The old ruins of a small shack were found within 15 feet of soil sample OMS-28-SB24, which had the highest concentration of PCE detected in all of the surface and subsurface samples that were collected during the SDGI. At this location, PCE was detected in both the mobile and fixed laboratory soil samples. In the fixed laboratory sample, PCE was detected above the industrial SSL of 39 mg/kg at a concentration of 329 mg/kg in surface soil and at a concentration of 53.7 mg/kg at 3 feet bgs. PCE was also detected above the residential SSL of 8.1 mg/kg at a concentration of 24.4 mg/kg at a depth of 1 foot above the water table (**Table C-3**). OMS-28-SB24 is located over 200 feet northwest of the fenced ALARNG property.

DPT GROUNDWATER SAMPLING SUMMARY

Between May 2017 and January/February 2018, 226 discrete groundwater samples were collected from 87 boring locations from the Upper, Middle, and Lower Surficial aquifer to profile PCE and TCE vertically in groundwater for the purposes of refining the conceptual site model. Similar to DPT soil sampling, split samples were collected as a quality check at a frequency of 10% of the total number of groundwater samples and sent to an offsite fixed laboratory for analysis of TCL VOCs by USEPA Method 8260B. **Figures C-11 through C-13** show the DPT groundwater results.

The onsite mobile laboratory analytical results for PCE, TCE, cis-1,2-dichloroethene (cis-1,2-DCE), and vinyl chloride (VC) from May 2017 were screened against the USEPA MCLs (USEPA, 2018b) and are presented in **Table C-4**. PCE, TCE, cis-1,2-DCE, and VC detections in the split samples, collected in May 2017 and analyzed by the fixed laboratory, were also screened against the USEPA MCLs (USEPA, 2018b) and are presented in **Table C-5**. PCE, TCE, cis-1,2-DCE, and VC detections for samples collected in January/February 2018 and analyzed by fixed laboratory were screened against the USEPA MCLs (USEPA, 2018b) and are presented in **Table C-6**. **Figure C-14** shows the approximate extent of the PCE and TCE impacts in the Upper/Middle Surficial aquifer and the Lower Surficial aquifer based on the data collected during the SDGI.

A summary of the results for the DPT groundwater sampling activities include the following:

- PCE was not detected in groundwater on the ALARNG property.
- PCE only exceeded the MCL on Parcel ID R022911360003106 and along the adjacent northwest boundary of Parcel ID R022911360008001.001. The highest concentration of PCE (40,000 µg/L) was detected in the Upper Surficial aquifer at groundwater DPT location OMS-28-GW22 on Parcel ID R022911360003106. OMS-28-GW22 is located in close proximity to where the highest concentration of PCE in soil (OMS-28-SB24) was subsequently detected. PCE from this area appears to have percolated down into subsurface soil and ultimately impacted the underlying groundwater.
- DPT groundwater analytical data indicated the PCE plume is partially degrading to TCE and creating a co-located plume in Upper Surficial groundwater that is centered around the identified PCE release.
- TCE in groundwater consists of two distinct plumes in the Upper Surficial aquifer that merge into one plume in the Middle Surficial aquifer as TCE migrates vertically. One distinct TCE groundwater plume exists in the Upper Surficial aquifer on ALARNG property. The second distinct plume of TCE is co-located with the PCE plume and the identified PCE surface spill area. TCE was detected in the Lower Surficial aquifer in isolated locations, outside of the footprint of the TCE plumes in the Upper and Middle Surficial aquifers. It is suspected that the TCE has migrated downward via sand lenses within the semi-confining unit separating the Middle Surficial aquifer from the Lower Surficial aquifer.

APPENDIX C

Exclusion of Responsibility for Offsite Tetrachloroethene (PCE) Contamination Documentation
Organizational Maintenance Shop #28
Mobile County, Mobile, Alabama

SUMMARY

Based on the information presented above, the following is a summary of why the ALARNG is not responsible for the remediation of the identified PCE release on offsite vacant Parcel ID R022911360003106 and also why PCE will not be addressed in the Revised FS.

- A PCE soil source area was identified on offsite vacant Parcel ID R022911360003106. PCE was also found in soil on the northwest portion of adjacent Parcel ID R022911360008001.001. The origin for the source of PCE is unknown. The old ruins of a small shack were found within 15 feet of soil sample OMS-28-SB24, which had the highest concentrations of PCE (329 mg/kg at 0-1 ft bgs) detected during the SDGI. PCE exceeded the industrial RSL in surface soil and shallow subsurface soil (3 feet bgs), and PCE exceeded the residential RSL in deeper subsurface soil (5 feet bgs or approximately 1 foot above the water table). OMS-28-SB24 is located over 200 feet northwest of the fenced ALARNG property and is within 60 feet of active railroad tracks that run parallel to Interstate 10. As such, the identified PCE surface spill is suggestive of offsite activity that was not the result of historical ALARNG activities associated with OMS #28.
- The heavily wooded Parcel ID R022911360008001.001 separates the ALARNG property from vacant Parcel ID R022911360003106where the PCE release occurred making ALARNG involvement in the release even more unlikely.
- Soil boring B-17, which was collected in March 2017, only contained PCE. B-17 was located in the northwest corner of Parcel ID R022911360008001.001 and approximately 30 feet south of Parcel ID R022911360003106 where the highest concentrations of PCE in soil were detected.
- PCE concentrations in groundwater only exceeded the MCL on vacant Parcel ID R022911360003106 and along the adjacent northwest boundary of Parcel ID R022911360008001.001. The highest concentration of PCE detected (40,000 µg/L) during the SDGI was found in the Upper Surficial aquifer at groundwater DPT location OMS-28-GW22, which is located on the Parcel ID R022911360003106. OMS-28-GW22 is located in close proximity to where the highest concentration of PCE in soil (OMS-28-SB24) was subsequently detected.
- PCE from the surface spill area has percolated into the subsurface soil and impacted the underlying groundwater. A PCE plume in groundwater is only present on the offsite vacant Parcel ID R022911360003106 and the adjacent northwest portion of Parcel ID R022911360008001.001. Analytical data indicates that the PCE plume is partially degrading to TCE and creating a co-located plume in Upper Surficial groundwater that is centered around the identified PCE release.
- PCE has only been detected in one site monitoring well (OMS-28-5), which is located on Parcel ID R022911360008001.001. OMS-28-5 is located approximately 30 feet south of the adjacent vacant Parcel ID R022911360003106 and approximately 50 feet southeast from where soil boring OMS-28-SB24 was collected.

- In January 2022, QuantArray®-Chlor analysis was conducted by Microbial Insights of Knoxville, Tennessee for three site monitoring wells (OMS-28-5, OMS-28-3, and MW-8). Bio-traps were deployed in these three wells for approximately one month between December 10, 2021 and January 13, 2022. A review of this report with regard to bacteria and enzymes responsible for reductive dechlorination indicates the presence of moderate concentrations of *Dehalobacter* spp. (DHBt) and *Desulfitobacterium* spp. (DSB) and a low concentration of *Dehalococcoides* (DHC) with no vinyl chloride reductases which are needed to degrade VC to ethene at OMS-28-5. DHBt and DSB are capable of using PCE and TCE as growth-supporting electron acceptors and can reduce PCE and TCE down to cis-1,2-DCE but no further. **Table C-1**, which presents results for OMS #28 monitoring wells, shows an elevated concentration of cis-1,2-DCE detected during the last sampling event conducted in May 2017 for OMS-28-5. The dissolved oxygen measurement in this well at that time was low at 0.17 milligrams per liter. The detection of elevated concentrations of TCE and cis-1,2-DCE in conjunction with low dissolved oxygen at OMS-28-5 suggests reductive dechlorination of PCE is occurring within the vicinity of this well and is the source of the co-located TCE plume in this area. The QuantArray results, provided in **Attachment 1**, do not indicate much in the way of reductive dechlorinating bacteria and no reductase enzymes at OMS-28-3 and MW-8.
- Two separate TCE plumes exist in the Upper Surficial aquifer. One distinct Upper Surficial TCE plume is located on ALARNG property and appears to be the result of a TCE release in a gravel-covered vehicle parking area used by the ALARNG. A review of older investigation results and the newer SDGI data shows that PCE has not been detected in groundwater on ALARNG property. The second distinct TCE plume is co-located with the PCE plume on vacant Parcel ID R022911360003106 and adjacent Parcel ID R022911360008001.001. The two Upper Surficial TCE plumes merge into one plume in the Middle Surficial aquifer as TCE migrates vertically.

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TABLES

Table C-1
Groundwater COC Concentrations
Alabama Army National Guard, OMS #28
Mobile, Alabama

Well ID	Depth of Well (ft btoc)	Screened Interval (ft btoc)	Date	PCE	TCE	cis-1,2-DCE	Vinyl Chloride
Maximum Contaminant Level				5	5	70	2
Upper/Middle Surficial Monitoring Wells							
MW-5	12.6	3.3-13.3	10/18/2006	NA	0.27 U	NA	NA
			7/1/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/11/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/7/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/20/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/1/2017	0.5 U	0.5 U	0.5 U	0.5 U
MW-6	12.7	2.3-12.3	10/18/2006	NA	0.27 U	NA	NA
			7/1/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/11/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/7/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/20/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/1/2017	0.5 U	0.5 U	0.5 U	0.5 U
MW-8	15.2	4.8-14.8	3/__/05	NA	**480**	NA	NA
			4/18/2006	NA	**97.9**	NA	NA
			10/18/2006	NA	**83 J**	**NA**	NA
			7/1/2008	0.2 U	**133**	**3.97 J**	0.0538 U
			12/11/2008	0.153 U	**46**	**3.24 J**	0.155 U
			5/8/2009	0.0998 U	**18**	**0.812 J**	0.0767 U
			9/24/2009	0.0998 U	**8.41**	0.103 U	0.0767 U
			3/19/2010	0.121 U	**41**	**2.07 J**	0.093 U
			9/8/2010	0.121 U	**13**	0.0613 U	0.093 U
			1/22/2016	0.5 U	**7.8**	0.5 U	0.5 U
			5/1/2017	0.5 U	**0.373 J**	0.5 U	0.5 U
MW-9	17.4	7.4-17.4	11/22/2006	0.072 U	0.024 U	0.051 U	0.052 U
			7/1/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/10/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/8/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/20/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/5/2017	0.5 U	0.5 U	0.5 U	0.5 U
MW-10	17.6	7.6 - 17.6	11/22/2006	**4.9**	**11**	**5.8**	**1.5**
				Abandoned at request of property owner			
MW-11	16.6	6.6 - 16.6	11/22/2006	0.072 U	**63**	0.051 U	0.052 U
				Abandoned at request of property owner			
MW-12	15.6	5.6-15.6	11/22/2006	0.072 U	0.024 U	0.051 U	0.052 U
			7/1/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/10/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/7/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/21/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/1/2017	0.5 U	0.5 U	0.5 U	0.5 U

Table C-1
Groundwater COC Concentrations
Alabama Army National Guard, OMS #28
Mobile, Alabama

Well ID	Depth of Well (ft btoc)	Screened Interval (ft btoc)	Date	PCE	TCE	cis-1,2-DCE	Vinyl Chloride
Maximum Contaminant Level				5	5	70	2
Upper/Middle Surficial Monitoring Wells							
OMS-28-2	20.0	10-20	7/1/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/10/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	**2 J**	0.0613 U	0.093 U
			9/7/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/19/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/5/2017	0.5 U	0.5 U	0.5 U	0.5 U
OMS-28-3	20.0	10-20	7/1/2008	0.2 U	**80**	**6.26**	0.0538 U
			12/11/2008	0.153 U	**94**	**9.34**	0.155 U
			5/8/2009	0.0998 U	**29**	**9.55**	0.0767 U
			9/24/2009	0.0998 U	**15.29**	0.103 U	0.0767 U
			3/19/2010	0.121 U	**12**	**1.37 J**	0.093 U
			9/8/2010	0.121 U	**149**	**9.43**	0.093 U
			1/21/2016	0.5 U	**8.92**	**1.59**	0.5 U
			5/1/2017	0.5 U	**9.6**	**1.26**	0.5 U
OMS-28-5	20.0	10-20	7/1/2008	**130**	**39**	**12**	0.0538 U
			12/11/2008	**9.2**	**14**	**8.7**	0.155 U
			5/8/2009	**234**	**162**	**20**	0.0767 U
			9/24/2009	**8.02**	**11**	**9.12**	0.0767 U
			3/19/2010	**81**	**51**	**6.3**	0.093 U
			9/8/2010	**33**	**19**	**8.69**	0.093 U
			1/20/2016	**455**	**200**	**27.8**	2.5 U
			5/5/2017	**154**	**246**	**103**	1 U
OMS-28-7	20.0	10-20	7/1/2008	0.2 U	**1.73 J**	0.0745 U	0.0538 U
			12/10/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	**0.684 J**	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/8/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/20/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/1/2017	0.5 U	0.5 U	0.5 U	0.5 U
Lower Surficial Monitoring Wells							
OMS-28-1	80.0	70-80	7/8/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/11/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/7/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/20/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/1/2017	0.5 U	0.5 U	0.5 U	0.5 U
OMS-28-4	76.0	66-76	7/8/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/10/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/19/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/8/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/20/2016	**0.88 J**	0.5 U	0.5 U	0.5 U
			5/5/2017	0.5 U	0.5 U	0.5 U	0.5 U

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Alabama Army National Guard, OMS #28
Mobile, Alabama

Well ID	Depth of Well (ft btoc)	Screened Interval (ft btoc)	Date	PCE	TCE	cis-1,2-DCE	Vinyl Chloride
Maximum Contaminant Level				5	5	70	2
Lower Surficial Monitoring Wells							
OMS-28-6	76.0	66-76	7/8/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/10/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/8/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
				Destroyed			

Definitions:
µg/L = micrograms per Liter (parts per billion [ppb])
cis-1,2-DCE = cis-1,2-dichloroethene
COC = chemical of concern
ft btoc = feet below top of casing
NA = Not Analyzed
PCE = tetrachloroethene
TCE = trichloroethene

Notes:
All concentrations in µg/L
Bold result indicates the analyte was detected.
Shading indicates the screening value is exceeded.

Data Qualifiers:
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
J = The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

Table C-2
Soil Analytical Results - Mobile Laboratory
Alabama Army National Guard, OMS #28
Mobile, Alabama

		Analytes	PCE	TCE
Soil Screening Criteria	Residential SSL		8.1	0.41
	Industrial SSL		39	1.9
	MCL-Based Protection of Groundwater SSL		0.0023	0.0018
Boring Location	Sample Date	Sample Depth (feet)		
OMS-28-SB01	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	2	< 0.002 (U)	< 0.002 (U)
	5/8/2017	3	< 0.002 (U)	< 0.002 (U)
OMS-28-SB02	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	3	< 0.002 (U)	< 0.002 (U)
	5/8/2017	5	< 0.002 (U)	< 0.002 (U)
OMS-28-SB03	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	3	< 0.002 (U)	< 0.002 (U)
	5/8/2017	5	< 0.002 (U)	< 0.002 (U)
OMS-28-SB04	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	2	< 0.002 (U)	< 0.002 (U)
	5/8/2017	5	< 0.002 (U)	< 0.002 (U)
OMS-28-SB05	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	2	< 0.002 (U)	< 0.002 (U)
	5/8/2017	5	< 0.002 (U)	< 0.002 (U)
OMS-28-SB06	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	3	< 0.002 (U)	< 0.002 (U)
	5/8/2017	6	< 0.002 (U)	< 0.002 (U)
OMS-28-SB07	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	3	< 0.002 (U)	< 0.002 (U)
	5/8/2017	6	< 0.002 (U)	< 0.002 (U)
OMS-28-SB08	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	3	< 0.002 (U)	< 0.002 (U)
	5/8/2017	6	< 0.002 (U)	< 0.002 (U)
OMS-28-SB09	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	2	< 0.002 (U)	< 0.002 (U)
	5/8/2017	3	< 0.002 (U)	< 0.002 (U)
OMS-28-SB10	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	2	< 0.002 (U)	< 0.002 (U)
	5/8/2017	3	< 0.002 (U)	< 0.002 (U)
OMS-28-SB11	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	4	< 0.002 (U)	< 0.002 (U)
	5/8/2017	6	< 0.002 (U)	< 0.002 (U)
OMS-28-SB12	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	3	< 0.002 (U)	< 0.002 (U)
	5/8/2017	5	< 0.002 (U)	< 0.002 (U)
OMS-28-SB13	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	3	< 0.002 (U)	< 0.002 (U)
	5/8/2017	5	< 0.002 (U)	< 0.002 (U)
OMS-28-SB14	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	3	< 0.002 (U)	< 0.002 (U)
	5/8/2017	5	< 0.002 (U)	< 0.002 (U)
OMS-28-SB15	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	3	< 0.002 (U)	< 0.002 (U)
	5/8/2017	5	< 0.002 (U)	< 0.002 (U)

Table C-2
Soil Analytical Results - Mobile Laboratory
Alabama Army National Guard, OMS #28
Mobile, Alabama

		Analytes	PCE	TCE
Soil Screening Criteria	**Residential SSL**		**8.1**	**0.41**
	Industrial SSL		**39**	**1.9**
	MCL-Based Protection of Groundwater SSL		**0.0023**	**0.0018**
Boring Location	**Sample Date**	**Sample Depth (feet)**		
OMS-28-SB16	5/10/2017	1	< 0.002 (U)	< 0.002 (U)
	5/10/2017	2.5	< 0.002 (U)	< 0.002 (U)
	5/10/2017	4	< 0.002 (U)	< 0.002 (U)
OMS-28-SB17	5/10/2017	1	< 0.002 (U)	< 0.002 (U)
	5/10/2017	2.5	**0.0016 J**	< 0.002 (U)
	5/10/2017	5	< 0.002 (U)	< 0.002 (U)
OMS-28-SB18	5/10/2017	1	**0.0329**	< 0.002 (U)
	5/10/2017	2.5	**0.0226**	< 0.002 (U)
	5/10/2017	5	< 0.002 (U)	< 0.002 (U)
OMS-28-SB19	5/10/2017	1	**0.0568 J**	< 0.002 (U)
	5/10/2017	2.5	**0.0012 J**	< 0.002 (U)
	5/10/2017	5	**0.0264**	**0.0025**
OMS-28-SB20	5/10/2017	1	< 0.002 (U)	< 0.002 (U)
	5/10/2017	1.5	< 0.002 (U)	< 0.002 (U)
	5/10/2017	2	< 0.002 (U)	< 0.002 (U)
OMS-28-SB21	5/10/2017	1	< 0.002 (U)	< 0.002 (U)
	5/10/2017	1.5	< 0.002 (U)	< 0.002 (U)
	5/10/2017	2	< 0.002 (U)	< 0.002 (U)
OMS-28-SB22	5/10/2017	1	< 0.002 (U)	< 0.002 (U)
	5/10/2017	1.5	< 0.002 (U)	< 0.002 (U)
	5/10/2017	2	< 0.002 (U)	< 0.002 (U)
OMS-28-SB23	5/10/2017	1	< 0.002 (U)	< 0.002 (U)
	5/10/2017	1.5	< 0.002 (U)	< 0.002 (U)
	5/10/2017	2	< 0.002 (U)	< 0.002 (U)
OMS-28-SB24	5/10/2017	1	**180**	< 0.002 (U)
	5/10/2017	3	**23.1425**	< 0.002 (U)
	5/10/2017	5	**5.3593**	< 0.002 (U)
OMS-28-SB25	5/12/2017	1	**0.0211 J**	< 0.002 (U)
	5/12/2017	3	< 0.002 (U)	< 0.002 (U)
	5/12/2017	5	**0.0025**	< 0.002 (U)
OMS-28-SB26	5/12/2017	1	< 0.002 (U)	< 0.002 (U)
	5/12/2017	3	< 0.002 (U)	< 0.002 (U)
	5/12/2017	5	< 0.002 (U)	< 0.002 (U)
OMS-28-SB27	5/12/2017	1	**0.0012 J**	< 0.002 (U)
	5/12/2017	3	< 0.002 (U)	< 0.002 (U)
	5/12/2017	5	**0.0024**	< 0.002 (U)
OMS-28-SB28	5/16/2017	1	**5.8422**	< 0.002 (U)
	5/16/2017	3	**0.1491 J**	**0.0024**
	5/16/2017	5	**0.2377**	**0.0017**
OMS-28-SB29	5/16/2017	1	**16.3394**	**0.0137 J**
	5/16/2017	3	**0.1226**	**0.0086**
	5/16/2017	5	**0.088 J**	< 0.002 (UJ)
OMS-28-SB30	5/16/2017	1	**19.8493**	**0.0034 J**
	5/16/2017	3	**0.0533**	**0.0068**
	5/16/2017	5	**0.0459**	< 0.002 (U)

Table C-2
Soil Analytical Results - Mobile Laboratory
Alabama Army National Guard, OMS #28
Mobile, Alabama

		Analytes	PCE	TCE
Soil Screening Criteria	**Residential SSL**		**8.1**	**0.41**
	Industrial SSL		**39**	**1.9**
	MCL-Based Protection of Groundwater SSL		**0.0023**	**0.0018**
Boring Location	**Sample Date**	**Sample Depth (feet)**		
OMS-28-SB31	5/16/2017	1	**8.9034**	**0.0093 J**
	5/16/2017	3	**0.0423**	**0.0051**
	5/16/2017	5	**0.0887**	< 0.002 (U)

Notes:

Soil samples were analyzed utilizing a DOD certified mobile laboratory for TCE and PCE by Method 8260B.

Results are reported in mg/kg.

Soil Screening Criteria is based on the USEPA Regional Screening Level (RSL) Table for Residential, Industrial, and MCL-based Protection of Groundwater Soil Screening Levels (SSLs), based on a risk of 1E-06 for carcinogens and HQ 0.1 for noncarcinogens (USEPA, November 2021).

Bold results indicates the analyte was detected.

Shading indicates the respective screening value is exceeded.

Data Qualifiers:

< - the numeric value presented is the sample specific detection limit

U - The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.

J - The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

UJ -The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

Definitions:

mg/kg - milligrams per kilogram

DOD - Department of Defense

HQ - Hazard Quotient

MCL - Maximum Contaminant Level

PCE - Tetrachloroethene

SSL - Soil Screening Level

TCE - Trichloroethene

USEPA - United States Environmental Protection Agency

Table C-3
Split Soil Sample Results - Fixed Laboratory
Alabama Army National Guard, OMS #28
Mobile, Alabama

Detected Analytes			2-Butanone	4-Methyl-2-pentanone	Acetone	Benzene	Cyclohexane	Methyl-cyclohexane	Methylene chloride	Styrene	PCE	Toluene	Xylenes (total)
Soil Screening Criteria	Residential		2,700	3,300	7,000	1.2	650	NS	35	600	8.1	490	58
	Industrial		19,000	14,000	110,000	5.1	2,700	NS	320	3,500	39	4,700	250
	MCL-Based Protection of Groundwater SSL		0.12*	0.14*	0.37*	0.0026	1.3*	NS	0.0013	0.11	0.0023	0.69	9.9
Boring ID	**Sample Date**	**Sample Depth (feet)**											
OMS-28-SB01	5/8/2017	2	< 0.00143 U	< 0.000358 U	**0.00980 J**	< 0.000358 U	< 0.000358 U	< 0.000358 U	**0.0113**	< 0.000358 U	< 0.000715 U	< 0.000358 U	< 0.00107 U
OMS-28-SB04	5/8/2017	1	< 0.00158 U	< 0.000395 U	**0.00437 J**	**0.000499 J**	**0.000698 J**	**0.00143 J**	**0.00314 J**	< 0.000395 U	< 0.00079 U	**0.00137 J**	**0.000862 J**
OMS-28-SB11	5/8/2017	6	< 0.00201 U	< 0.000502 U	< 0.00201 U	< 0.000502 U	< 0.000502 U	< 0.000502 U	**0.00909 J**	< 0.000502 U	< 0.001 U	< 0.000502 U	< 0.00151 U
OMS-28-SB14	5/8/2017	1	**0.00403 J**	**0.00139 J**	**0.083**	< 0.000443 U	< 0.000443 U	< 0.000443 U	**0.00192 J**	< 0.000443 U	< 0.000886 U	< 0.000443 U	< 0.00133 U
OMS-28-SB16	5/10/2017	4	< 0.00181 U	< 0.000453 U	< 0.00181 U	< 0.000453 U	< 0.000453 U	< 0.000453 U	**0.00273 J**	< 0.000453 U	< 0.000906 U	< 0.000453 U	< 0.00136 U
OMS-28-SB22	5/10/2017	2	< 0.00187 U	< 0.000468 U	**0.00616 J**	< 0.000468 U	< 0.000468 U	< 0.000468 U	**0.00418 J**	< 0.000468 U	< 0.000936 U	< 0.000468 U	< 0.0014 U
OMS-28-SB24	5/10/2017	1	< 12.3 U	< 3.07 U	< 12.3 U	< 3.07 U	< 3.07 U	< 3.07 U	< 12.3 U	< 3.07 U	**329**	< 3.07 U	< 9.22 U
OMS-28-SB24	5/10/2017	3	< 1.86 U	< 0.464 U	< 1.86 U	< 0.464 U	< 0.464 U	< 0.464 U	< 1.86 U	< 0.464 U	**53.7**	< 0.464 U	< 1.39 U
OMS-28-SB24	5/10/2017	5	< 0.92 U	< 0.23 U	< 0.92 U	< 0.23 U	< 0.23 U	< 0.23 U	< 0.92 U	< 0.23 U	**24.4**	< 0.23 U	< 0.69 U

Notes:
* - indicates the analyte is a noncarcinogen and the risk-based SSL is used as no MCL-Based Protection of Groundwater SSL is available.
Soil samples were analyzed in the field by GCAL Laboratory for a target compound list (TCL) of Volatile Organic Compounds via Method SW8260B. Only detected analytes are shown.
Results are reported in mg/kg.
Soil Screening Criteria is based on the USEPA Regional Screening Level (RSL) Table for Residential, Industrial, and MCL-based Protection of Groundwater Soil Screening Levels (SSLs), based on a risk of 1E-06 for carcinogens and HQ 0.1 for noncarcinogens (USEPA, November 2021).
Bold results indicates the analyte was detected.
Shading indicates the respective screening value is exceeded.

Data Qualifiers:
< - the numeric value presented is the sample specific detection limit
U - The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
J - The result is an estimated quality. The associated numerical value is the approximate concentration of the analyte in the sample.

Definitions:
HQ - Hazard Quotient
mg/kg - milligrams per kilogram
MCL - Maximum Contaminant Level
NS - No Standard
PCE - Tetrachloroethene
SSL - Soil Screening Level
TCE - Trichloroethene
USEPA - Environmental Protection Agency

Table C-4
Discrete Groundwater Results, May 2017 - Mobile Laboratory
Alabama Army National Guard, OMS #28
Mobile, Alabama

			Chemicals of Concern	PCE	TCE
Groundwater Screening Criteria	Maximum Contaminant Levels			5	5
Boring Location	Sample Depth (ft bgs)	Sample Zone	Sample Date		
OMS-28-GW01	6-10	Upper Surficial	5/2/2017	< 1 (U)	**82.16**
	15-19	Middle Surficial	5/2/2017	< 1 (U)	**38**
	28-32	Lower Surficial	5/2/2017	< 1 (U)	< 1 (U)
OMS-28-GW02	8-12	Upper Surficial	5/3/2017	< 1 (U)	**0.63 J**
	15-19	Middle Surficial	5/3/2017	< 1 (U)	< 1 (U)
	27-31	Lower Surficial	5/3/2017	< 1 (U)	< 1 (U)
OMS-28-GW03	8-12	Upper Surficial	5/4/2017	< 1 (U)	< 1 (U)
	16-20	Middle Surficial	5/4/2017	< 1 (U)	< 1 (U)
	30-34	Lower Surficial	5/4/2017	< 1 (U)	< 1 (U)
OMS-28-GW04	6-10	Upper Surficial	5/3/2017	< 1 (U)	**1.37**
	13-17	Middle Surficial	5/3/2017	< 1 (U)	< 1 (U)
	27-31	Lower Surficial	5/3/2017	< 1 (U)	< 1 (U)
OMS-28-GW05	7-11	Upper Surficial	5/2/2017	< 1 (U)	**16.1**
	15-19	Middle Surficial	5/2/2017	< 1 (U)	**3.14**
	29-33	Lower Surficial	5/2/2017	< 1 (U)	< 1 (U)
OMS-28-GW06	7-11	Upper Surficial	5/17/2017	< 1 (U)	**0.63 J**
	13-17	Middle Surficial	5/17/2017	< 1 (U)	**65.95**
	28-32	Lower Surficial	5/17/2017	< 1 (U)	< 1 (U)
OMS-28-GW07	7-11	Upper Surficial	5/19/2017	< 1 (U)	< 1 (U)
	14-18	Middle Surficial	5/19/2017	< 1 (U)	**310**
	27-31	Lower Surficial	5/19/2017	< 1 (U)	< 1 (U)
OMS-28-GW08	6-10	Upper Surficial	5/3/2017	< 1 (U)	< 1 (U)
	13-17	Middle Surficial	5/3/2017	< 1 (U)	< 1 (U)
	27-31	Lower Surficial	5/3/2017	< 1 (U)	**71.17**
OMS-28-GW09	6-10	Upper Surficial	5/3/2017	< 1 (U)	< 1 (U)
	12-16	Middle Surficial	5/3/2017	< 1 (U)	< 1 (U)
	29-33	Lower Surficial	5/3/2017	< 1 (U)	< 1 (U)
OMS-28-GW10	6-10	Upper Surficial	5/9/2017	< 1 (U)	< 1 (U)
	12-16	Middle Surficial	5/9/2017	< 1 (U)	**68.9**
	29-33	Lower Surficial	5/9/2017	< 1 (U)	< 1 (U)
OMS-28-GW11	7-11	Upper Surficial	5/13/2017	< 1 (U)	< 1 (U)
	15-19	Middle Surficial	5/13/2017	< 1 (U)	**24.3**
	26-30	Lower Surficial	5/13/2017	< 1 (U)	< 1 (U)
OMS-28-GW12	8-12	Upper Surficial	5/19/2017	< 1 (U)	< 1 (U)
	14-18	Middle Surficial	5/19/2017	< 1 (U)	**23.67**
	28-32	Lower Surficial	5/19/2017	< 1 (U)	< 1 (U)
OMS-28-GW13	8-12	Upper Surficial	5/9/2017	< 1 (U)	**1.5**
	14-18	Middle Surficial	5/9/2017	< 1 (U)	**37.2**
	28-32	Lower Surficial	5/9/2017	< 1 (U)	< 1 (U)
OMS-28-GW14	7-11	Upper Surficial	5/13/2017	< 1 (U)	< 1 (U)
	16-20	Middle Surficial	5/13/2017	< 1 (U)	**3.6**
	26-30	Lower Surficial	5/13/2017	< 1 (U)	< 1 (U)
OMS-28-GW15	8-12	Upper Surficial	5/5/2017	< 1 (U)	**2.77**
	15-19	Middle Surficial	5/5/2017	< 1 (U)	**7.11**
	26-30	Lower Surficial	5/5/2017	< 1 (U)	< 1 (U)

Table C-4
Discrete Groundwater Results, May 2017 - Mobile Laboratory
Alabama Army National Guard, OMS #28
Mobile, Alabama

			Chemicals of Concern	PCE	TCE
Groundwater Screening Criteria	Maximum Contaminant Levels			5	5
Boring Location	Sample Depth (ft bgs)	Sample Zone	Sample Date		
OMS-28-GW16	8-12	Upper Surficial	5/4/2017	< 1 (U)	**0.52 J**
	15-19	Middle Surficial	5/4/2017	< 1 (U)	**5.95**
	26-30	Lower Surficial	5/4/2017	< 1 (U)	< 1 (U)
OMS-28-GW17	8-12	Upper Surficial	5/4/2017	< 1 (U)	**1.59**
	15-19	Middle Surficial	5/4/2017	< 1 (U)	**6.7**
	24-28	Lower Surficial	5/4/2017	< 1 (U)	< 1 (U)
OMS-28-GW18	8-12	Upper Surficial	5/5/2017	< 1 (U)	**1.55**
	14-18	Middle Surficial	5/5/2017	< 1 (U)	**2.7**
	26-30	Lower Surficial	5/5/2017	< 1 (U)	< 1 (U)
OMS-28-GW19	8-12	Upper Surficial	5/9/2017	**2.2**	**3.3**
	15-19	Middle Surficial	5/9/2017	**95.7**	**38.7**
	26-30	Lower Surficial	5/9/2017	< 1 (U)	< 1 (U)
OMS-28-GW20	8-12	Upper Surficial	5/4/2017	**12.71**	**16.09**
	15-19	Middle Surficial	5/4/2017	< 1 (U)	< 1 (U)
	24-28	Lower Surficial	5/4/2017	< 1 (U)	< 1 (U)
OMS-28-GW21	8-12	Upper Surficial	5/5/2017	**460**	**510**
	14-18	Middle Surficial	5/5/2017	**11.85**	**230**
	26-30	Lower Surficial	5/5/2017	< 1 (U)	< 1 (U)
OMS-28-GW22	7-11	Upper Surficial	5/9/2017	**40,000**	< 1 (U)
	16-20	Middle Surficial	5/9/2017	**74.3**	**0.82 J**
	24-28	Lower Surficial	5/9/2017	**77**	**0.92 J**
OMS-28-GW23	8-12	Upper Surficial	5/10/2017	**0.72 J**	**0.63 J**
	16-20	Middle Surficial	5/10/2017	< 1 (U)	< 1 (U)
	24-28	Lower Surficial	5/10/2017	< 1 (U)	< 1 (U)
OMS-28-GW24	8-12	Upper Surficial	5/12/2017	**38.1**	**13.5**
	15-19	Middle Surficial	5/9/2017	**100**	**35.9**
	26-30	Lower Surficial	5/9/2017	**1.2**	< 1 (U)
OMS-28-GW25	8-12	Upper Surficial	5/16/2017	< 1 (U)	< 1 (U)
	15-19	Middle Surficial	5/9/2017	**1.4**	**0.8 J**
	24-28	Lower Surficial	5/9/2017	< 1 (U)	**0.89 J**
OMS-28-GW26	27-31	Lower Surficial	5/9/2017	< 1 (U)	< 1 (U)
OMS-28-GW30	6-11	Upper Surficial	5/4/2017	< 1 (U)	< 1 (U)
	16-20	Middle Surficial	5/4/2017	< 1 (U)	< 1 (U)
	29-33	Lower Surficial	5/4/2017	< 1 (U)	< 1 (U)
OMS-28-GW31	8-12	Upper Surficial	5/2/2017	< 1 (U)	< 1 (U)
	15-19	Middle Surficial	5/2/2017	< 1 (U)	< 1 (U)
	27-31	Lower Surficial	5/2/2017	< 1 (U)	**13.35**
OMS-28-GW32	8-12	Upper Surficial	5/2/2017	< 1 (U)	**140**
	15-19	Middle Surficial	5/2/2017	< 1 (U)	**6.26**
	27-31	Lower Surficial	5/2/2017	< 1 (U)	**15.6**
OMS-28-GW33	8-12	Upper Surficial	5/2/2017	< 1 (U)	< 1 (U)
	15-19	Middle Surficial	5/2/2017	< 1 (U)	**38.21**
	29-33	Lower Surficial	5/2/2017	< 1 (U)	< 1 (U)
OMS-28-GW34	15-19	Middle Surficial	5/17/2017	< 1 (U)	**2.56**
	28-32	Lower Surficial	5/17/2017	< 1 (U)	< 1 (U)

Table C-4
Discrete Groundwater Results, May 2017 - Mobile Laboratory
Alabama Army National Guard, OMS #28
Mobile, Alabama

			Chemicals of Concern	PCE	TCE
Groundwater Screening Criteria	**Maximum Contaminant Levels**			**5**	**5**
Boring Location	**Sample Depth (ft bgs)**	**Sample Zone**	**Sample Date**		
OMS-28-GW36	8-12	Upper Surficial	5/11/2017	< 1 (U)	< 1 (U)
	14-18	Middle Surficial	5/11/2017	< 1 (U)	< 1 (U)
	25-29	Lower Surficial	5/11/2017	< 1 (U)	< 1 (U)
OMS-28-GW37	8-12	Upper Surficial	5/11/2017	< 1 (U)	< 1 (U)
	15-19	Middle Surficial	5/11/2017	< 1 (U)	< 1 (U)
	24-28	Lower Surficial	5/11/2017	< 1 (U)	< 1 (U)
OMS-28-GW38	8-12	Upper Surficial	5/11/2017	**59.7**	**11.8**
	14-18	Middle Surficial	5/11/2017	**14.2**	**1.5**
	26-30	Lower Surficial	5/11/2017	< 1 (U)	< 1 (U)
OMS-28-GW39	9-13	Upper Surficial	5/10/2017	**1,000**	**15**
	16-20	Middle Surficial	5/10/2017	**120**	**5.9**
	24-28	Lower Surficial	5/10/2017	< 1 (U)	< 1 (U)
OMS-28-GW40	9-13	Upper Surficial	5/11/2017	**1,800**	**35**
	16-20	Middle Surficial	5/11/2017	**1,500**	**46**
	24-28	Lower Surficial	5/11/2017	< 1 (U)	< 1 (U)
OMS-28-GW41	8-12	Upper Surficial	5/11/2017	**31.5**	**6.5**
	16-20	Middle Surficial	5/11/2017	**0.61 J**	< 1 (U)
	24-28	Lower Surficial	5/11/2017	< 1 (U)	< 1 (U)
OMS-28-GW42	8-12	Upper Surficial	5/10/2017	**3.6**	**1.7**
	16-20	Middle Surficial	5/10/2017	**1.6**	**1.8**
	24-28	Lower Surficial	5/10/2017	**1.3**	< 1 (U)
OMS-28-GW43	8-12	Upper Surficial	5/12/2017	**0.56 J**	< 1 (U)
	16-20	Middle Surficial	5/12/2017	< 1 (U)	< 1 (U)
	24-28	Lower Surficial	5/12/2017	< 1 (U)	**10**
OMS-28-GW44	24-28	Lower Surficial	5/16/2017	< 1 (U)	**4.43**
OMS-28-GW45	14-18	Middle Surficial	5/12/2017	< 1 (U)	**1**
	28-32	Lower Surficial	5/12/2017	< 1 (U)	**0.62 J**
OMS-28-GW46	12-16	Middle Surficial	5/12/2017	< 1 (U)	**8.1**
	29-33	Lower Surficial	5/12/2017	< 1 (U)	**1.3**
OMS-28-GW47	15-19	Middle Surficial	5/17/2017	< 1 (U)	**3.32**
	28-32	Lower Surficial	5/17/2017	< 1 (U)	< 1 (U)
OMS-28-GW49	8-12	Upper Surficial	5/15/2017	< 1 (U)	< 1 (U)
	14-18	Middle Surficial	5/15/2017	< 1 (U)	< 1 (U)
	26-30	Lower Surficial	5/15/2017	< 1 (U)	< 1 (U)
OMS-28-GW50	9-13	Upper Surficial	5/15/2017	< 1 (U)	< 1 (U)
	14-18	Middle Surficial	5/15/2017	< 1 (U)	< 1 (U)
	26-30	Lower Surficial	5/15/2017	< 1 (U)	< 1 (U)
OMS-28-GW51	26-30	Lower Surficial	5/13/2017	< 1 (U)	< 1 (U)
OMS-28-GW52	15-19	Middle Surficial	5/15/2017	< 1 (U)	< 1 (U)
	27-31	Lower Surficial	5/13/2017	< 1 (U)	< 1 (U)
OMS-28-GW53	8-12	Upper Surficial	5/13/2017	< 1 (U)	**21.4**
	15-19	Middle Surficial	5/13/2017	< 1 (U)	**31.3**
	27-31	Lower Surficial	5/13/2017	< 1 (U)	< 1 (U)

Table C-4
Discrete Groundwater Results, May 2017 - Mobile Laboratory
Alabama Army National Guard, OMS #28
Mobile, Alabama

			Chemicals of Concern	PCE	TCE
Groundwater Screening Criteria	**Maximum Contaminant Levels**			**5**	**5**
Boring Location	**Sample Depth (ft bgs)**	**Sample Zone**	**Sample Date**		
OMS-28-GW54	8-12	Upper Surficial	5/13/2017	< 1 (U)	< 1 (U)
	15-19	Middle Surficial	5/13/2017	< 1 (U)	**7.5**
	28-32	Lower Surficial	5/13/2017	< 1 (U)	< 1 (U)
OMS-28-GW55	8-12	Upper Surficial	5/13/2017	< 1 (U)	**0.65 J**
	15-19	Middle Surficial	5/13/2017	< 1 (U)	**2.9**
	28-32	Lower Surficial	5/13/2017	< 1 (U)	< 1 (U)
OMS-28-GW56	14-18	Middle Surficial	5/15/2017	< 1 (U)	< 1 (U)
	27-31	Lower Surficial	5/15/2017	< 1 (U)	< 1 (U)
OMS-28-GW57	8-12	Upper Surficial	5/17/2017	< 1 (U)	< 1 (U)
	12-16	Middle Surficial	5/12/2017	< 1 (U)	< 1 (U)
	29-33	Lower Surficial	5/12/2017	< 1 (U)	< 1 (U)
OMS-28-GW58	8-12	Upper Surficial	5/15/2017	< 1 (U)	**5.34**
	15-19	Middle Surficial	5/15/2017	< 1 (U)	**48.02**
	27-31	Lower Surficial	5/15/2017	< 1 (U)	< 1 (U)
OMS-28-GW59	8-12	Upper Surficial	5/16/2017	**1.86**	< 1 (U)
	14-18	Middle Surficial	5/16/2017	< 1 (U)	< 1 (U)
	26-30	Lower Surficial	5/16/2017	< 1 (U)	< 1 (U)
OMS-28-GW60	29-33	Lower Surficial	5/16/2017	< 1 (U)	< 1 (U)
OMS-28-GW61	8-12	Upper Surficial	5/17/2017	< 1 (U)	< 1 (U)
	15-19	Middle Surficial	5/17/2017	< 1 (U)	**2.01**
	27-31	Lower Surficial	5/17/2017	< 1 (U)	< 1 (U)
OMS-28-GW62	8-12	Upper Surficial	5/16/2017	< 1 (U)	**3.47**
	15-19	Middle Surficial	5/16/2017	< 1 (U)	**20.45**
	26-30	Lower Surficial	5/16/2017	< 1 (U)	< 1 (U)
OMS-28-GW63	8-12	Upper Surficial	5/17/2017	< 1 (U)	< 1 (U)
	15-19	Middle Surficial	5/17/2017	< 1 (U)	**2.41**
	26-30	Lower Surficial	5/17/2017	< 1 (U)	< 1 (U)
OMS-28-GW64	12-16	Middle Surficial	5/17/2017	< 1 (U)	< 1 (U)
	29-33	Lower Surficial	5/17/2017	< 1 (U)	**27.1**
OMS-28-GW65	8-12	Upper Surficial	5/17/2017	**37.71**	**5.49**
	15-19	Middle Surficial	5/17/2017	**30.75**	**2.02**
	25-29	Lower Surficial	5/17/2017	< 1 (U)	< 1 (U)
OMS-28-GW66	22-26	Middle Surficial	5/18/2017	< 1 (U)	< 1 (U)
	45-49	Lower Surficial	5/18/2017	< 1 (U)	< 1 (U)
OMS-28-GW67	22-26	Middle Surficial	5/18/2017	< 1 (U)	**0.91 J**
	48-52	Lower Surficial	5/18/2017	< 1 (U)	< 1 (U)
OMS-28-GW68	22-26	Middle Surficial	5/18/2017	< 1 (U)	< 1 (U)
	53-57	Lower Surficial	5/18/2017	< 1 (U)	< 1 (U)
OMS-28-GW69	22-26	Middle Surficial	5/18/2017	< 1 (U)	< 1 (U)
	45-49	Lower Surficial	5/19/2017	< 1 (U)	< 1 (U)
OMS-28-GW71	15-19	Middle Surficial	5/19/2017	< 1 (U)	**4.7**
	29-33	Lower Surficial	5/19/2017	< 1 (U)	< 1 (U)

Table C-4
Discrete Groundwater Results, May 2017 - Mobile Laboratory
Alabama Army National Guard, OMS #28
Mobile, Alabama

				PCE	**TCE**
			Chemicals of Concern	**PCE**	**TCE**
Groundwater Screening Criteria	**Maximum Contaminant Levels**			**5**	**5**
Boring Location	**Sample Depth (ft bgs)**	**Sample Zone**	**Sample Date**		
OMS-28-GW72	29-33	Lower Surficial	5/19/2017	< 1 (U)	< 1 (U)

Notes:
Groundwater samples were analyzed in the field by Columbia Technology's mobile laboratory for TCE and PCE via Method SW8260B.
The Screening Criteria is based on the USEPA Maximum Contamination Limit.
Results are reported in (µg/L).
Bold results indicates the analyte was detected.
Shading indicates the screening value was exceeded.
Sample Depth is reported as feet below ground surface (ft bgs).

Data Qualifiers:
< - the numeric value presented is the sample specific detection limit.
U - The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
J - The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

Definitions:
µg/L - microgram per liter
MCL - Maximum Contaminant Level
PCE - Tetrachloroethene
TCE - Trichloroethene
USEPA - United States Environmental Protection Agency

Table C-5
Split Groundwater Sample Results - May 2017
Alabama Army National Guard, OSM # 28
Mobile, Alabama

Sample ID	MCL	OMS-28-GW02	OMS-28-GW03	OMS-28-GW06	OMS-28-GW11
Sample Depth (ft bgs)		15-19	30-34	7-11	7-11
Sample Date		5/3/2017	5/4/2017	5/17/2017	5/13/2017
TCL Volatile Organic Compounds Method SW8260B (µg/L)					
cis-1,2-Dichloroethene	70	< 0.5 (U)	< 0.5 (U)	< 0.5 (U)	< 0.5 (U)
Tetrachloroethene	5	< 0.5 (U)	< 0.5 (U)	< 0.5 (U)	< 0.5 (U)
Trichloroethene	5	< 0.5 (U)	< 0.5 (U)	**1.07**	< 0.5 (U)
Vinyl Chloride SW8260 SIM (µg/L)					
Vinyl chloride	2	**0.011 J**	< 0.015 (U)	< 0.015 (U)	< 0.015 (U)

Sample ID	MCL	OMS-28-GW12	OMS-28-GW13	OMS-28-GW20	OMS-28-GW23
Sample Depth (ft bgs)		8-12	28-32	8-12	8-12
Sample Date		5/19/2017	5/9/2017	5/5/2017	5/10/2017
TCL Volatile Organic Compounds Method SW8260B (µg/L)					
cis-1,2-Dichloroethene	70	< 0.5 (U)	< 0.5 (U)	**0.927 J**	< 0.5 (U)
Tetrachloroethene	5	< 0.5 (U)	< 0.5 (U)	**25.7**	**0.863 J**
Trichloroethene	5	< 0.5 (U)	< 0.5 (U)	**32.5**	**0.751 J**
Vinyl Chloride SW8260 SIM (µg/L)					
Vinyl chloride	2	NA	< 0.015 (U)	**0.024**	< 0.015 (U)

Sample ID	MCL	OMS-28-GW32	OMS-28-GW34	OMS-28-GW38	OMS-28-GW41
Sample Depth (ft bgs)		8-12	27-31	26-30	16-20
Sample Date		5/2/2017	5/17/2017	5/11/2017	5/11/2017
TCL Volatile Organic Compounds Method SW8260B (µg/L)					
cis-1,2-Dichloroethene	70	**3.71**	< 0.5 (U)	< 0.5 (U)	< 0.5 (U)
Tetrachloroethene	5	< 1 (U)	< 0.5 (U)	< 0.5 (U)	< 0.5 (U)
Trichloroethene	5	**268**	< 0.5 (U)	< 0.5 (U)	< 0.5 (U)
Vinyl Chloride SW8260 SIM (µg/L)					
Vinyl chloride	2	**0.022**	< 0.015 (U)	< 0.015 (U)	**0.0063**

Sample ID	MCL	OMS-28-GW49	OMS-28-GW57	OMS-28-GW58	OMS-28-GW62
Sample Depth (ft bgs)		8-12	12-16	27-31	15-19
Sample Date		5/15/2017	5/12/2017	5/15/2017	5/16/2017
TCL Volatile Organic Compounds Method SW8260B (µg/L)					
cis-1,2-Dichloroethene	70	< 0.5 (U)	< 0.5 (U)	< 0.5 (U)	**3.41**
Tetrachloroethene	5	< 0.5 (U)	< 0.5 (U)	< 0.5 (U)	< 0.5 (U)
Trichloroethene	5	< 0.5 (U)	< 0.5 (U)	< 0.5 (U)	**45.1**
Vinyl Chloride SW8260 SIM (µg/L)					
Vinyl chloride	2	< 0.015 (U)	< 0.015 (U)	< 0.015 (U)	**0.008 J**

Notes:

Groundwater samples were analyzed by GCAL for TCL VOCs by Method 8260B except vinyl chloride.
Vinyl chloride analyzed by ALS Environmental by Method 8260SIM.

Results are reported in µg/L.

The groundwater screening criteria is based on the USEPA Maximum Contamination Limit (MCL).

Bold text indicates analyte concentration detected above the limit of detection (LOD).

Gray shading and bold text indicates the analyte was detected in exceedance of its respective screening value.

Data Qualifiers:

J - Estimated value detected below the limit of detection.

U - Indicates not detected at the limit of detection indicated.

Definitions:

µg/L - micrograms per liter

ft bgs - feet below ground surface

LOD - Limit of Detection

MCL - Maximum Contamination Level

SIM - Select Ion Method

TCL - target compound list

USEPA - United States Environmental Protection Agency

Table C-6
Groundwater Summary Results, January/February 2018
Alabama Army National Guard, OMS #28
Mobile, Alabama

Sample ID	MCL	OMS-28-GW73	OMS-28-GW73	OMS-28-GW74	OMS-28-GW74	OMS-28-GW75	OMS-28-GW76	OMS-28-GW76
Sample Depth (ft bgs)		12-16	29-33	11-15	29-33	25-29	9-13	16-20
Sample Date		1/29/2018	1/29/2018	1/30/2018	1/30/2018	1/30/2018	1/31/2018	1/31/2018
Select Volatile Organic Compounds Method SW8260B (µg/L)								
cis-1,2-Dichloroethene	70	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)
Tetrachloroethene	5	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)
Trichloroethene	5	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	**9.02**	< 0.500 (U)	< 0.500 (U)
Vinyl Chloride SW8260 SIM (µg/L)								
Vinyl Chloride	2	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)

Sample ID	MCL	OMS-28-GW76	OMS-28-GW77	OMS-28-GW77	OMS-28-GW77	OMS-28-GW78	OMS-28-GW78	OMS-28-GW78
Sample Depth (ft bgs)		24-28	8-12	16-20	23-27	8-12	16-20	23-27
Sample Date		1/31/2018	2/1/2018	2/1/2018	2/2/2018	1/31/2018	1/31/2018	2/1/2018
Select Volatile Organic Compounds Method SW8260B (µg/L)								
cis-1,2-Dichloroethene	70	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)
Tetrachloroethene	5	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)
Trichloroethene	5	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)
Vinyl Chloride SW8260 SIM (µg/L)								
Vinyl Chloride	2	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)

Sample ID	MCL	OMS-28-GW79	OMS-28-GW79	OMS-28-GW79	OMS-28-GW80	OMS-28-GW80	OMS-28-GW80	OMS-28-GW81
Sample Depth (ft bgs)		7-11	13-17	23-27	7-11	13-17	23-27	14-18
Sample Date		2/1/2018	2/1/2018	2/1/2018	2/1/2018	2/2/2018	2/2/2018	1/30/2018
Select Volatile Organic Compounds Method SW8260B (µg/L)								
cis-1,2-Dichloroethene	70	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	**1.29**
Tetrachloroethene	5	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)
Trichloroethene	5	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	**11.1**
Vinyl Chloride SW8260 SIM (µg/L)								
Vinyl Chloride	2	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)

Table C-6
Groundwater Summary Results, January/February 2018
Alabama Army National Guard, OMS #28
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Sample ID	MCL	OMS-28-GW81	OMS-28-GW82	OMS-28-GW82	OMS-28-GW83	OMS-28-GW83	OMS-28-GW83	OMS-28-GW84
Sample Depth (ft bgs)		**24-28**	**15-19**	**27-31**	**8-12**	**12-16**	**27-31**	**8-12**
Sample Date		**1/31/2018**	**2/2/2018**	**2/2/2018**	**2/2/2018**	**2/2/2018**	**2/2/2018**	**2/5/2018**
Select Volatile Organic Compounds Method SW8260B (µg/L)								
cis-1,2-Dichloroethene	70	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	**1.28**	< 0.500 (U)	< 0.500 (U)
Tetrachloroethene	5	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)
Trichloroethene	5	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	**3.59**	**51.3**	**0.644 J**	< 0.500 (U)
Vinyl Chloride SW8260 SIM (µg/L)								
Vinyl Chloride	2	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)

Sample ID	MCL	OMS-28-GW84	OMS-28-GW84	OMS-28-GW85	OMS-28-GW85	OMS-28-GW85	OMS-28-GW86	OMS-28-GW86
Sample Depth (ft bgs)		**13-17**	**27-31**	**9-13**	**15-19**	**27-31**	**8-12**	**12-16**
Sample Date		**2/5/2018**	**2/5/2018**	**2/2/2018**	**2/2/2018**	**2/2/2018**	**2/3/2018**	**2/3/2018**
Select Volatile Organic Compounds Method SW8260B (µg/L)								
cis-1,2-Dichloroethene	70	< 0.500 (U)	< 0.500 (U)	**0.521 J**	**7.56**	< 0.500 (U)	**2.9**	**4.34**
Tetrachloroethene	5	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 1.00 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)
Trichloroethene	5	< 0.500 (U)	< 0.500 (U)	**17.1**	**291**	< 0.500 (U)	**42.4**	**131**
Vinyl Chloride SW8260 SIM (µg/L)								
Vinyl Chloride	2	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	**0.028 J**	< 0.050 (U)	< 0.050 (U)	**0.034 J**

Sample ID	MCL	OMS-28-GW86	OMS-28-GW87	OMS-28-GW88	OMS-28-GW88	OMS-28-GW88	OMS-28-GW89	OMS-28-GW90
Sample Depth (ft bgs)		**27-31**	**27-31**	**8-12**	**13-17**	**27-31**	**27-31**	**29-33**
Sample Date		**2/3/2018**	**2/3/2018**	**2/5/2018**	**2/5/2018**	**2/5/2018**	**1/30/2018**	**2/5/2018**
Select Volatile Organic Compounds Method SW8260B (µg/L)								
cis-1,2-Dichloroethene	70	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	**1.03**	< 0.500 (U)
Tetrachloroethene	5	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)
Trichloroethene	5	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	**0.894 J**	**5.22**	**1.28**
Vinyl Chloride SW8260 SIM (µg/L)								
Vinyl Chloride	2	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)

Table C-6
Groundwater Summary Results, January/February 2018
Alabama Army National Guard, OMS #28
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Sample ID	**MCL**	**OMS-28-GW91**	**OMS-28-GW92**	**OMS-28-GW92**	**OMS-28-GW92**	**OMS-28-GW93**	**OMS-28-GW93**	**OMS-28-GW93**
Sample Depth		**29-33**	**8-12**	**12-16**	**29-33**	**8-12**	**12-16**	**29-33**
Sample Date		**2/6/2018**	**2/6/2018**	**2/6/2018**	**2/6/2018**	**2/6/2018**	**2/6/2018**	**2/6/2018**
Select Volatile Organic Compounds Method SW8260B (µg/L)								
cis-1,2-Dichloroethene	70	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)
Tetrachloroethene	5	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)
Trichloroethene	5	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	**0.584 J**
Vinyl Chloride SW8260 SIM (µg/L)								
Vinyl Chloride	2	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)

Notes:

Groundwater samples were analyzed by GCAL for TCL VOCs by Method 8260B except vinyl chloride.
Vinyl chloride analyzed by ALS Environmental by Method 8260SIM.

Results are reported in µg/L.

The groundwater screening criteria is based on the USEPA Maximum Contamination Limit (MCL).

Bold text indicates analyte concentration detected above the limit of detection (LOD).

Gray shading and bold text indicates the analyte was detected in exceedance of its respective screening value.

Data Qualifiers:

J - Estimated value detected below the limit of detection.

U - Indicates not detected at the limit of detection indicated.

Definitions:

µg/L - micrograms per liter

ft bgs - feet below ground surface

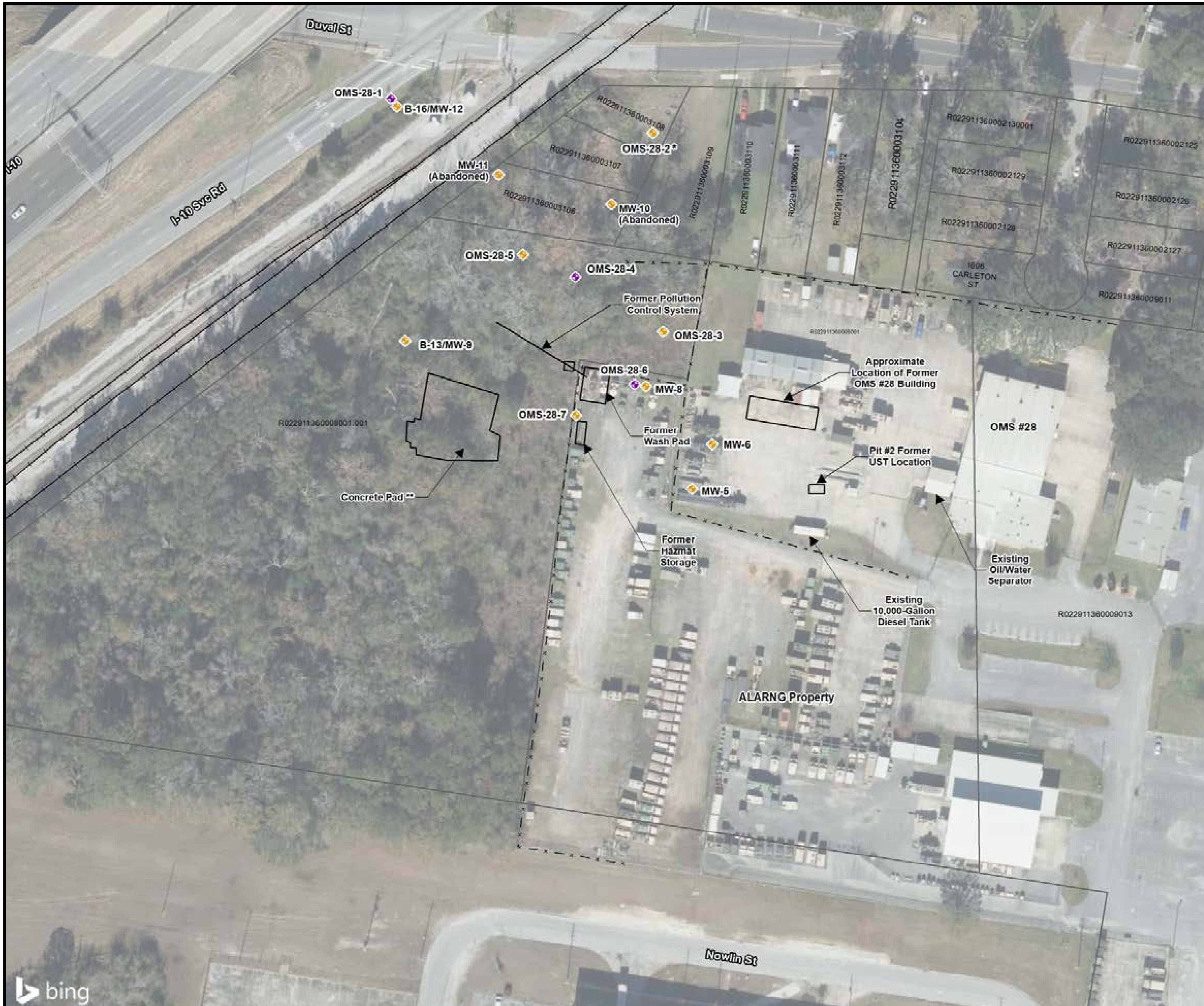
LOD - Limit of Detection

MCL - Maximum Contamination Level

TCL - target compound list

USEPA - United States Environmental Protection Agency

FIGURES



Site Location

Legend

- Upper/Middle Surficial Monitoring Well Location
- Lower Surficial Monitoring Well Location
- Railroad
- Fenceline
- Parcel Boundary

Notes:

Wells MW-10 and MW-11 were abandoned in 2008 at the property owner's request and have not been replaced.

* Well OMS-28-2 was found destroyed during a site visit conducted in December 2021.

** Concrete pad is the likely remnant foundation of Mollison Hall (recreational hall for soldiers before and after World War II) that was demolished between 1972 and 1974.

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National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

0 50 100 200 Feet

1 inch = 100 feet

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Facility Site Location Map

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/9/2023	Figure C-1

Document Path: L:\Legacy\Group\earth\OMS 28\60439687\900-CADD-GIS\Brookley_GIS\Maps\FS Letter Report\20220505\Figure C-1_Facility Site Location Map.mxd

Screening Criteria	PCE
Residential RSL	8.1 mg/kg
MCL	5 µg/L

Site Location

Legend

- Discrete Groundwater Sample Locations
- Discrete Soil Boring Location
- Upper/Middle Surficial Monitoring Well Location
- Lower Surficial Monitoring Well Location
- Railroad
- PCE Exceeds Residential Soil RSL
- PCE Plume Related to Offsite PCE Spill on Parcel A
- Fenceline
- Parcel Boundary

Notes:

Wells MW-10 and MW-11 were abandoned in 2008 at the property owner's request and have not been replaced.

* Well OMS-28-2 was found destroyed during a site visit conducted in December 2021.

ALARNG - Alabama Army National Gaurd
PCE - Tetrachloroethene

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0 30 60 120 Feet

1 inch = 60 feet

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Plan View of Offsite PCE Contamination in Soil and Groundwater

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/9/2023	**Figure C-2**

Site Location

Legend

- Upper/Middle Surficial Monitoring Well
- Lower Surficial Monitoring Well Location
- Discrete Groundwater Sample Location
- HPT Location
- MIP Location
- Soil Boring Location
- Cross-Section A-A'
- Cross-Section B-B'
- Fenceline
- Railroad
- Parcel Designation (A - H)
- Parcel Boundary

Note:

* Well OMS-28-2 was found destroyed during a site visit conducted in December 2021.

HPT - Hydraulic Profiling Tool

MIP - Membrane Interface Probe

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0 40 80 160 Feet

1 inch = 80 feet

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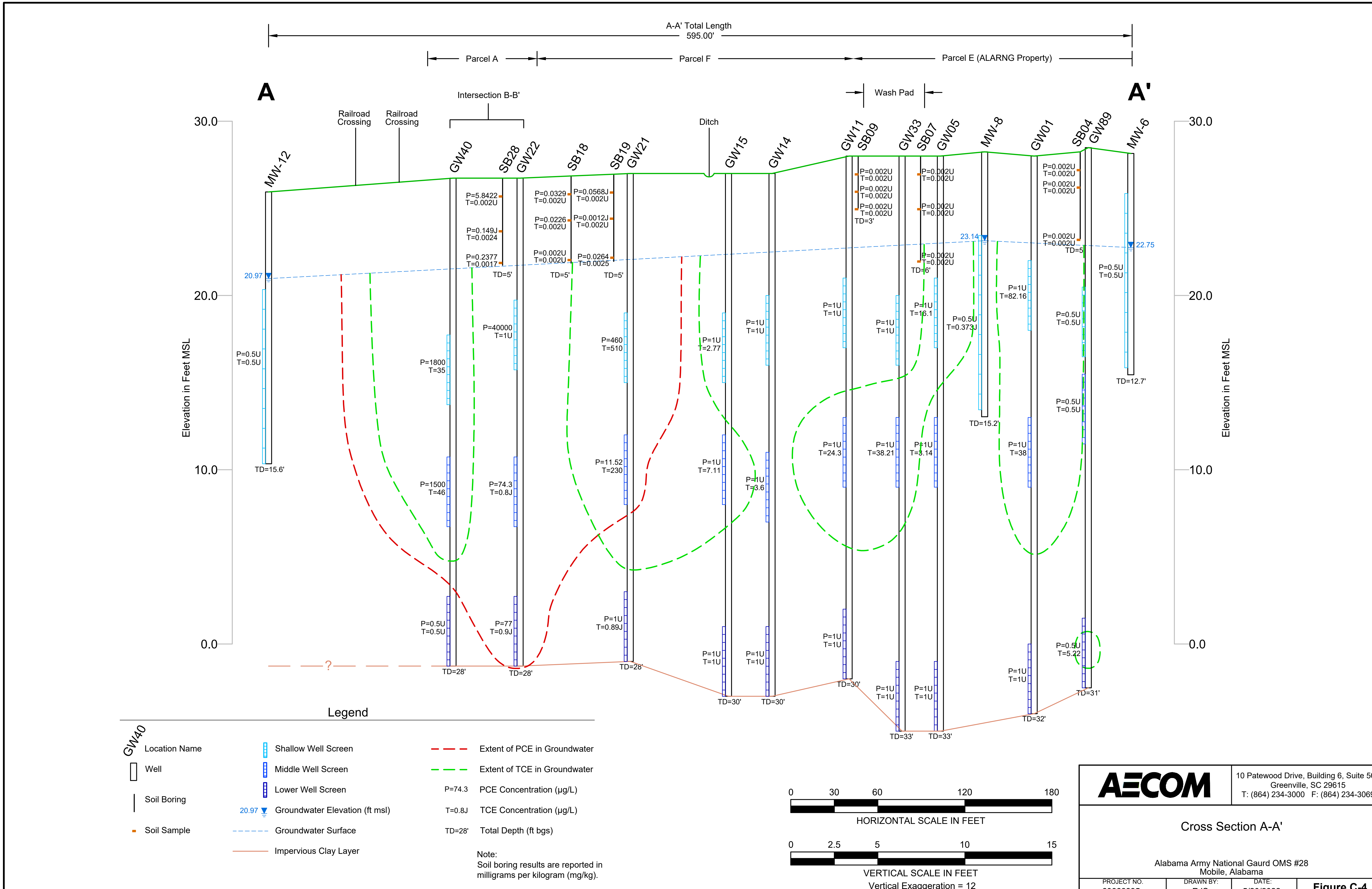
Cross-Section Location Map

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/9/2023	Figure C-3

Document Path: L:\Legacy\Group\earth\OMS 28\60439687\900-CADD-GIS\Brookley_GIS\Maps\FS Letter Report\20220505\Figure C-3_OMS 28_Cross Section Location Map.mxd


A-A' Total Length
595.00'
Parcel A
Parcel F
Parcel E (ALARNG Property)
Wash Pad
A
A'
Intersection B-B'
Railroad Crossing
Railroad Crossing
Ditch
30.0
20.0
10.0
0.0
Elevation in Feet MSL
MW-12
GW40
SB28
GW22
SB18
SB19
GW21
GW15
GW14
GW11
SB09
GW33
SB07
GW05
MW-8
GW01
SB04
GW89
MW-6
20.97
23.14
22.75
P=0.5U
T=0.5U
TD=15.6'
P=5.8422
T=0.002U
P=0.149J
T=0.0024
P=0.2377
T=0.0017
TD=5'
P=1800
T=35
P=1500
T=46
P=0.5U
T=0.5U
TD=28'
P=40000
T=1U
P=74.3
T=0.8J
P=77
T=0.9J
TD=28'
P=0.0329
T=0.002U
P=0.0226
T=0.002U
P=0.002U
T=0.002U
TD=5'
P=0.0568J
T=0.002U
P=0.0012J
T=0.002U
P=0.0264
T=0.0025
TD=5'
P=460
T=510
P=11.52
T=230
P=1U
T=0.89J
TD=28'
P=1U
T=2.77
P=1U
T=7.11
P=1U
T=1U
TD=30'
P=1U
T=1U
P=1U
T=3.6
P=1U
T=1U
TD=30'
P=0.002U
T=0.002U
P=0.002U
T=0.002U
P=0.002U
T=0.002U
TD=3'
P=1U
T=1U
P=1U
T=24.3
P=1U
T=1U
TD=30'
P=1U
T=1U
P=1U
T=38.21
P=1U
T=1U
TD=33'
P=0.002U
T=0.002U
P=0.002U
T=0.002U
P=0.002U
T=0.002U
TD=6'
P=1U
T=16.1
P=1U
T=3.14
P=1U
T=1U
TD=33'
P=0.5U
T=0.373J
TD=15.2'
P=1U
T=82.16
P=1U
T=38
P=1U
T=1U
TD=32'
P=0.002U
T=0.002U
P=0.002U
T=0.002U
P=0.002U
T=0.002U
TD=5'
P=0.5U
T=0.5U
P=0.5U
T=0.5U
P=0.5U
T=5.22
TD=31'
P=0.5U
T=0.5U
TD=12.7'
?
Legend
GW40 Location Name
Well
Soil Boring
Soil Sample
Shallow Well Screen
Middle Well Screen
Lower Well Screen
20.97 Groundwater Elevation (ft msl)
Groundwater Surface
Impervious Clay Layer
Extent of PCE in Groundwater
Extent of TCE in Groundwater
P=74.3 PCE Concentration (µg/L)
T=0.8J TCE Concentration (µg/L)
TD=28' Total Depth (ft bgs)
Note:
Soil boring results are reported in milligrams per kilogram (mg/kg).
0 30 60 120 180
HORIZONTAL SCALE IN FEET
0 2.5 5 10 15
VERTICAL SCALE IN FEET
Vertical Exaggeration = 12
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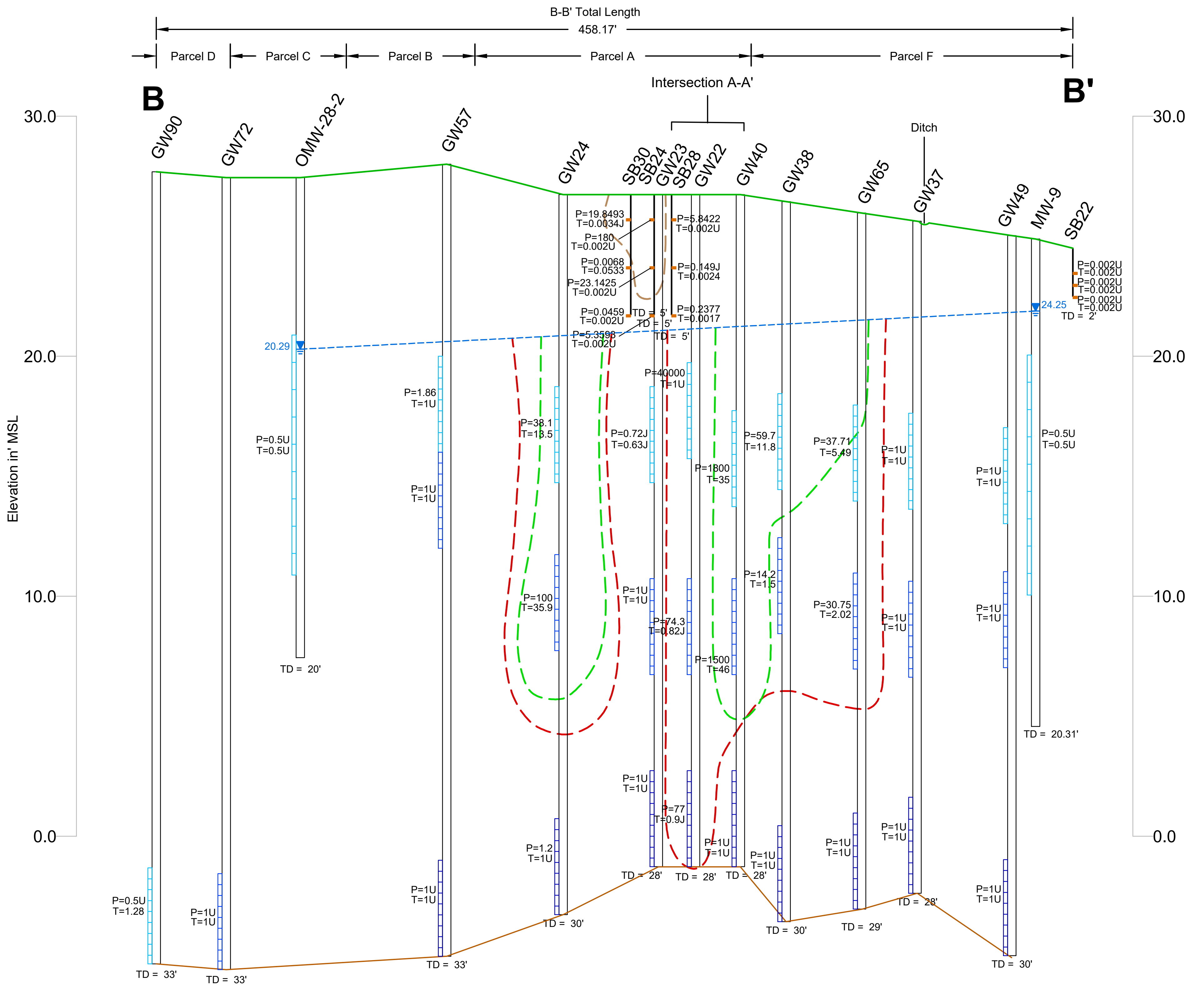
Cross Section A-A'
Alabama Army National Gaurd OMS #28
Mobile, Alabama
PROJECT NO.
60666895
DRAWN BY:
RJS
DATE:
5/20/2022
Figure C-4



Legend

GW57 Location Name	Shallow Well Screen	Extent of PCE in Soil (Residential RSL 8.1 mg/kg)
Well	Middle Well Screen	Extent of PCE in Groundwater (5 µg/L)
Soil Boring	Lower Well Screen	Extent of TCE in Groundwater (5 µg/L)
	20.29 Groundwater Elevation (ft msl)	P=38.1 PCE Concentration (µg/L)
Soil Sample	Groundwater Surface	T=13.5 TCE Concentration (µg/L)
	Impervious Clay Layer	TD=33' Total Depth (ft bgs)

Note:
Soil boring results are reported in milligrams per kilogram (mg/kg).

0 30 60 120 180
HORIZONTAL SCALE IN FEET

0 2.5 5 10 15
VERTICAL SCALE IN FEET
Vertical Exaggeration = 12

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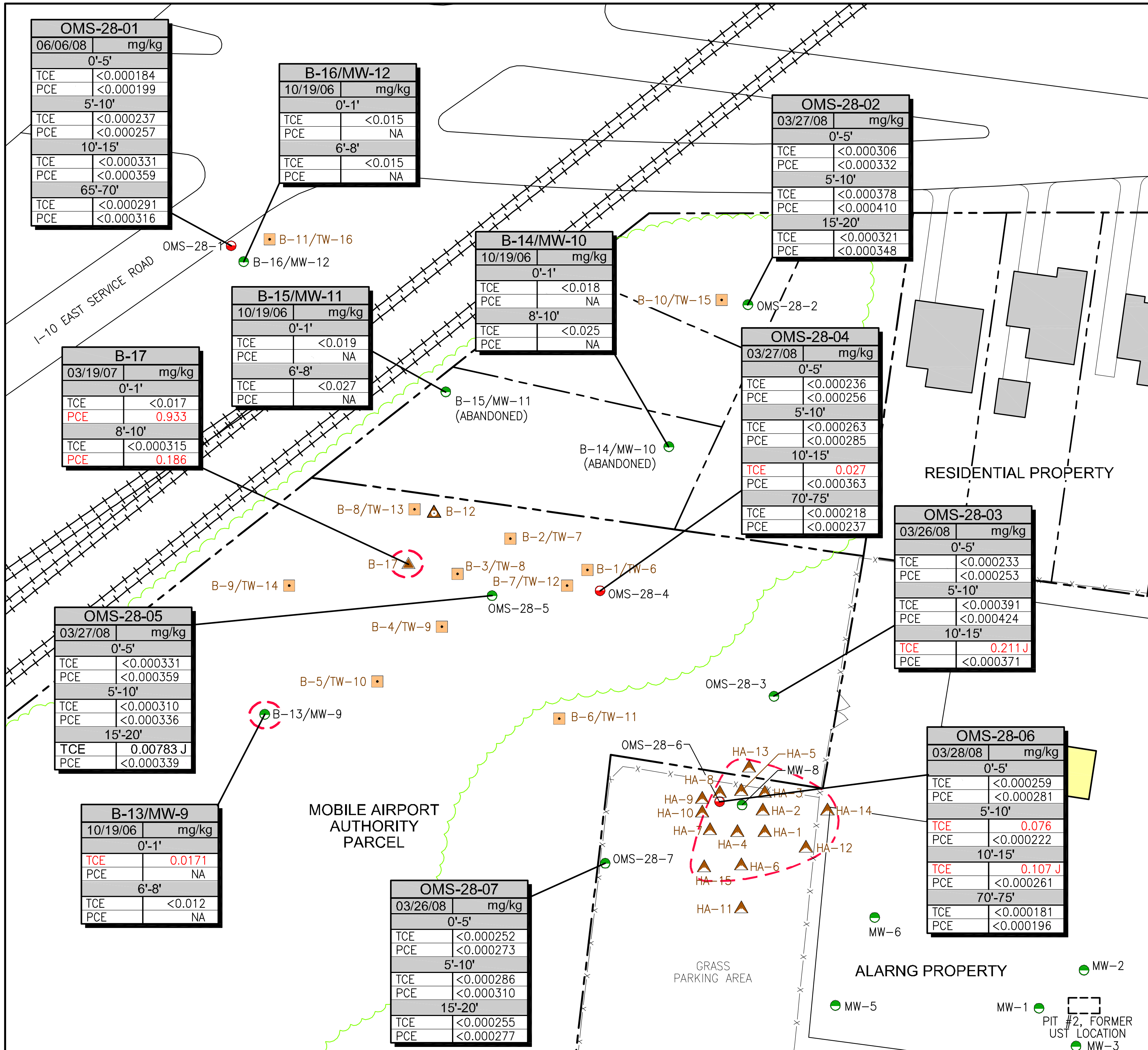
Cross Section B-B'

Alabama Army National Gaurd OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	5/20/2022	Figure C-5



HA-1	
04/19/06	mg/kg
0'-1'	
TCE	0.00311 J
PCE	0.00121 J
6'-8'	
TCE	0.017
PCE	0.000822 J

HA-2	
04/19/06	mg/kg
0'-1'	
TCE	0.241 J
PCE	<0.011
8'-10'	
TCE	0.027
PCE	<0.000191

HA-3	
04/19/06	mg/kg
0'-1'	
TCE	0.019 J
PCE	<0.000476
8'-10'	
TCE	0.00353 J
PCE	<0.000137

HA-4	
04/19/06	mg/kg
0'-1'	
TCE	<0.000249
PCE	<0.000271
7'-9'	
TCE	<0.000211
PCE	<0.000229

HA-5	
04/19/06	mg/kg
0'-1'	
TCE	<0.000429
PCE	0.00252 J
7'-9'	
TCE	<0.00944
PCE	<0.010

HA-6	
04/19/06	mg/kg
0'-1'	
TCE	<0.000207
PCE	<0.000225
8'-10'	
TCE	0.15
PCE	<0.000203

HA-7	
04/19/06	mg/kg
0'-1'	
TCE	<0.000437
PCE	0.00253 J
8'-10'	
TCE	0.069 J
PCE	<0.00711

HA-8	
04/19/06	mg/kg
0'-1'	
TCE	0.00286 J
PCE	<0.00266
8'-10'	
TCE	<0.00998
PCE	<0.011

HA-9	
04/19/06	mg/kg
0'-1'	
TCE	<0.000359
PCE	<0.000389
8'-10'	
TCE	<0.012
PCE	<0.013

HA-10	
04/19/06	mg/kg
0'-1'	
TCE	<0.000267
PCE	0.00154 J
8'-10'	
TCE	<0.000146
PCE	<0.000159

HA-11	
05/11/06	mg/kg
0'-1'	
NOT SAMPLED	
8'-10'	
TCE	<0.000169
PCE	<0.000184

HA-12	
05/11/06	mg/kg
0'-1'	
NOT SAMPLED	
8'-10'	
TCE	0.00353 J
PCE	0.00191 J

HA-13	
05/11/06	mg/kg
0'-1'	
NOT SAMPLED	
8'-10'	
TCE	<0.000451
PCE	0.00505 J

HA-14	
03/19/07	mg/kg
0'-1'	
TCE	0.017
PCE	<0.000243
8'-10'	
TCE	0.00962
PCE	<0.000332

HA-15	
03/19/07	mg/kg
0'-1'	
TCE	0.586
PCE	<0.015
8'-10'	
TCE	0.132 J
PCE	<0.000326

LEGEND:

- RESIDENTIAL BUILDING
- COMMERCIAL BUILDING
- ASPHALT ROAD
- RAILROAD TRACKS
- CHAIN LINK FENCE
- PROPERTY BOUNDARY
- TREE LINE
- SOIL BORING (2006–2007)
- TEMPORARY WELL (2006–2007)
- HAND AUGER BORING (2006–2007)
- FLUTE LINER BORING (2006)
- SHALLOW MONITORING WELL
- DEEP MONITORING WELL
- XXXX CONTAMINATION EXCEEDING SSL
- CONTAMINATION EXCEEDING RSL
- EXCEEDS SSL

NOTES:

1. HISTORICAL LOCATIONS DIGITIZED FROM BASE MAP PROVIDED BY AEROSTAR ENVIRONMENTAL SERVICES INC. (AEROSTAR 2007).
2. MONITORING WELL LOCATIONS DATA PROVIDED BY AEROSTAR ENVIRONMENTAL SERVICES INC. (AEROSTAR 2008).
3. EPA RSLs DATED MAY 2012 ARE BEING USED IN LIEU OF AL PSVs PUBLISHED IN THE ALABAMA RISK-BASED CORRECTIVE ACTION GUIDANCE MANUAL (2008) AS PER APRIL 2, 2012 EMAIL CORRESPONDENCE BETWEEN ADEM AND ALARNG.

	PROTECTION OF GROUNDWATER SSL (mg/Kg)	RESIDENTIAL SOIL EPA RSL (mg/Kg)
TCE	0.0018	0.41
PCE	0.0023	8.1

ALABAMA STATE PLANE NAD 83 WEST ZONE

0 30 60 120

SCALE: 1" = 60'

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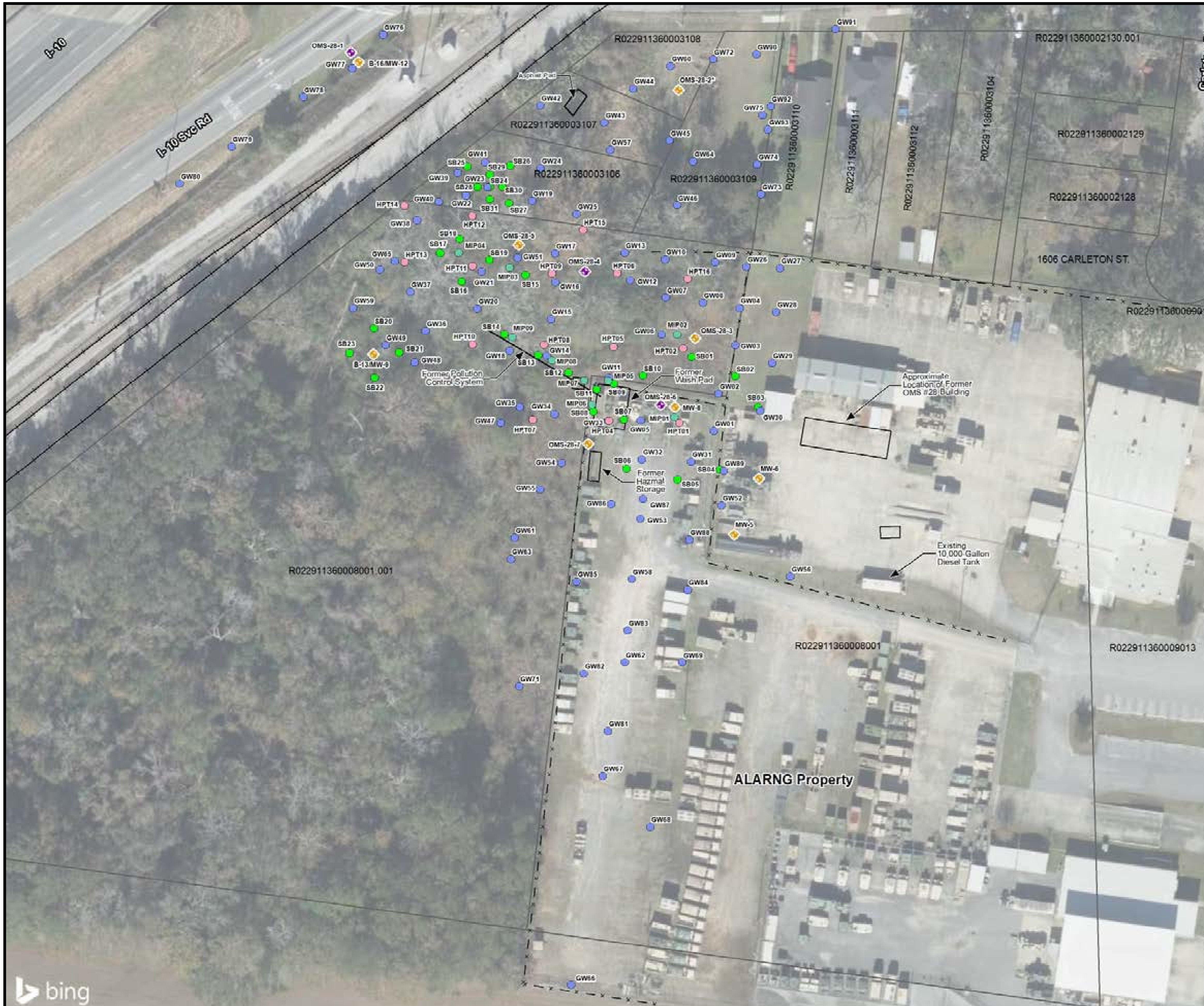
FIGURE C-6
DISTRIBUTION OF COCs IN SOIL

OMS #28
ALABAMA ARMY NATIONAL GUARD
MOBILE, ALABAMA

Source:
SAIC, 2013, *RI Report for the ALARNG OMS #28*



Site Location

Legend

- Upper/Middle Surficial Monitoring Well Location
- Lower Surficial Monitoring Well Location
- Discrete Groundwater Sample Location
- HPT Location
- MIP Location
- Soil Boring Location
- Fenceline
- Railroad
- Parcel Boundary

Note:

* Well OMS-28-2 was found to be destroyed during a site visit conducted in December 2021.

HPT - Hydraulic Profiling Tool

MIP - Membrane Interface Probe

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0 40 80 160 Feet

1 inch = 80 feet

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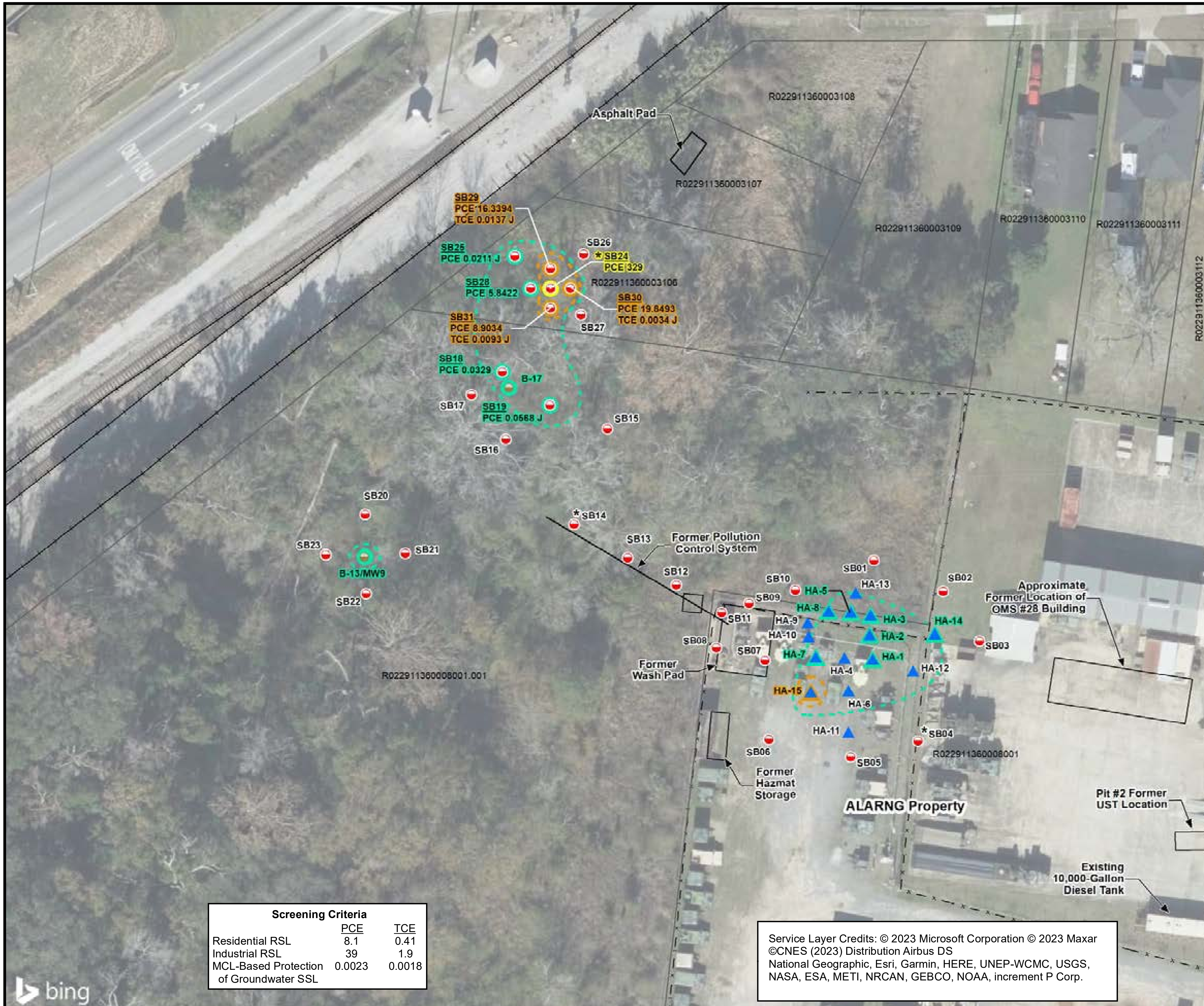
Supplemental Data Gap Investigation Sample Location Map

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/9/2023	Figure C-7

Document Path: L:\Legacy\Group\earth\OMS 28\60439687\900-CADD-GIS\Brookley_GIS\Maps\FS Letter Report\20220505\Figure C-7_Discrete GW Sample_MWs_SBs_MIP_HPT.mxd



Screening Criteria

	PCE	TCE
Residential RSL	8.1	0.41
Industrial RSL	39	1.9
MCL-Based Protection of Groundwater SSL	0.0023	0.0018

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Site Location

Legend

- Hand Auger Samples Collected in 2006/2007
- Soil Boring Samples Collected in 2006/2007
- Soil Sample Locations Collected in 2017
- TCE and/or PCE Exceed MCL- Based Protection of Groundwater SSL
- TCE and/or PCE Exceed Residential RSL
- TCE and/or PCE Exceed Industrial RSL
- Approximate soil area exceeding MCL - Based on Protection of Groundwater SSL
- Approximate soil area exceeding Residential and/or RSL
- Railroad
- Fenceline

Notes:
1 - Soil Samples collected between May 8-16, 2017.
2 - Analytical results from mobile lab used unless split with fixed lab. Fixed lab samples denoted with "*".
3 - Soil concentrations in milligrams per kilogram.
4 - All samples collected from bottom of 0-1 ft bgs interval and analyzed by Method 8260.
5 - Residential and Industrial RSLs are based on risk of 1E-06 forcarcinogens.
6 - No highlighting of symbol indicates TCE and PCE did not exceed any RSLs or SSL.
7 - If TCE/PCE not listed, they did not exceed any of the screening criteria.
8 - Analytical results for samples collected in 2006/2007 can be found in the TCE Comprehensive Investigation Report (Aerostar, April 2007).

ft bgs - Feet below ground surface
J - The result of an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
RSL - Regional Screening Criteria (USEPA, May 2018)
SSL - Soil Screening Level (USEPA, May 2018)

0 25 50 100 Feet
1 inch = 50 feet

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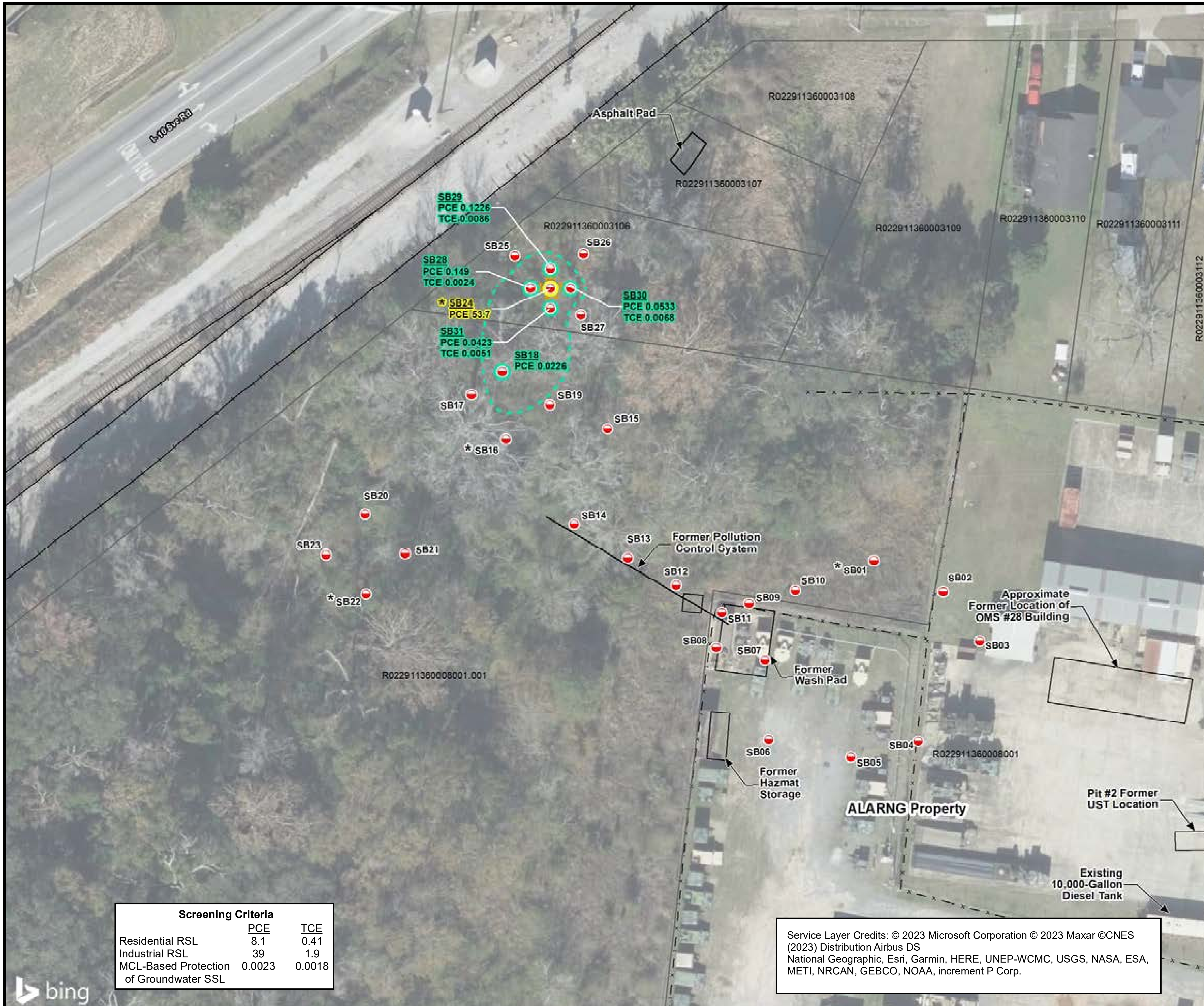
Surface Soil Sample Results - PCE and TCE (0 - 1 ft bgs)

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/9/2023	Figure C-8



Screening Criteria	PCE	TCE
Residential RSL	8.1	0.41
Industrial RSL	39	1.9
MCL-Based Protection of Groundwater SSL	0.0023	0.0018

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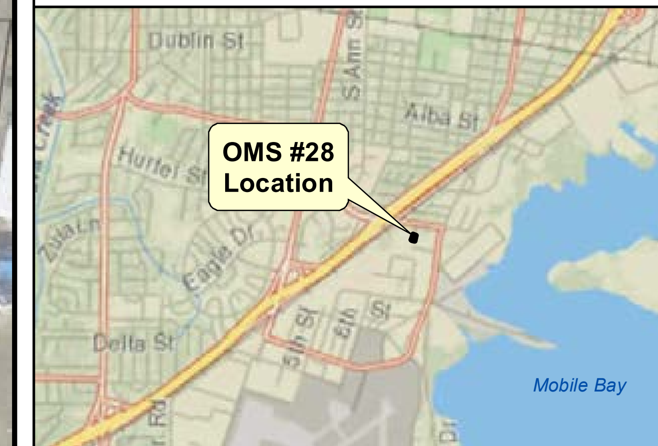
Site Location



Legend

- Soil Sample Locations
- TCE and PCE Exceeded Residential RSL
- TCE and PCE Exceeded MCL-Based Protection of Groundwater SSL
- Railroad
- Parcel Boundary
- Fenceline
- Approximate soil area exceeding MCL - Based on Protection of Groundwater SSL
- Approximate soil area exceeding Residential RSL

Notes:
1 - Soil Samples collected between May 8-16, 2017.
2 - Analytical results from mobile lab used unless split with fixed lab. Fixed lab samples denoted with "*".
3 - Soil concentrations in milligrams per kilogram.
4 - Only soil results from depths between 1.5 and 4 ft bgs are shown Interval selected based on PID or MIP result. If no response from either PID or MIP, the sample was collected from the midpoint between the surface sample and the top of water table sample.
5 - Residential and Industrial RSLs are based on risk of 1E-06 for carcinogens.
6 - No highlighting of symbol indicates TCE and PCE did not exceed any RSLs or SSL.
7 - If TCE/PCE not listed, they did not exceed any of the screening criteria.
8 - If TCE or PCE not listed, it didn't exceed any of the screening criteria.
9 - Samples from previous investigations are not within this depth interval.

ft bgs - Feet below ground surface
MCL - Maximum Contminant Level
RSL - Regional Screening Criteria (USEPA, May 2018)
SSL - Soil Screening Level (USEPA, May 2018)

0 25 50 100 Feet

1 inch = 50 feet

N W E S

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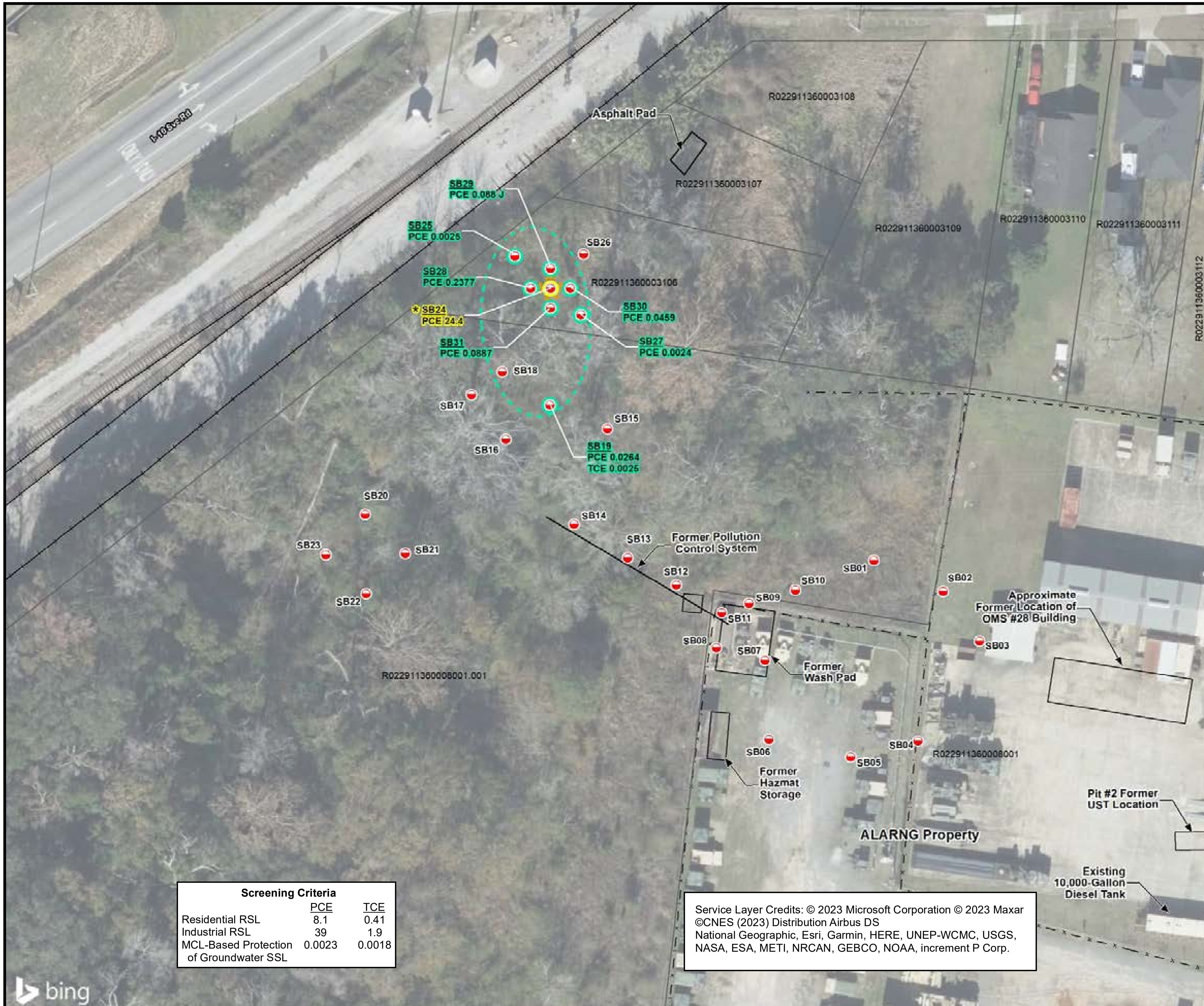
Upper Subsurface Soil Sample Results for PCE and TCE (1.5 - 4 ft bgs)

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/9/2023	Figure C-9



Screening Criteria

	PCE	TCE
Residential RSL	8.1	0.41
Industrial RSL	39	1.9
MCL-Based Protection of Groundwater SSL	0.0023	0.0018

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National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

Site Location

Legend

- Soil Sample Locations
- TCE and PCE Exceeded Residential RSL
- TCE and PCE Exceed MCL - Based Protection of Groundwater SSL
- Railroad
- Parcel Boundary
- Fenceline
- Approximate soil area exceeding MCL - Based on Protection of Groundwater SSL
- Approximate soil area exceeding Residential and/or Industrial RSL

Notes:
1 - Soil Samples collected between May 8-16, 2017.
2 - Analytical results from mobile lab used unless split with fixed lab. Fixed lab samples denoted with "*".
3 - Soil concentrations in milligrams per kilogram.
4 - Only soil results from 1-ft above water table depth varying between 2 and 6 ft bgs are shown.
5 - Residential and Industrial RSLs are based on risk of 1E-06 for carcinogens.
6 - No highlighting of symbol indicates TCE and PCE did not exceed the residential or industrial RSLs or SSL.
7 - If TCE/PCE not listed, they did not exceed any of the screening criteria.
8 - Samples from previous investigations collected at depths were below the current (May 2017) water table.

J - The result of an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

ft bgs - Feet Below Ground Surface
MCL - Maximum Contaminant Level
RSL - Regional Screening Criteria (USEPA, May 2018)
SSL - Soil Screening Level (USEPA, May 2018)

0 25 50 100 Feet

1 inch = 50 feet

N W E S

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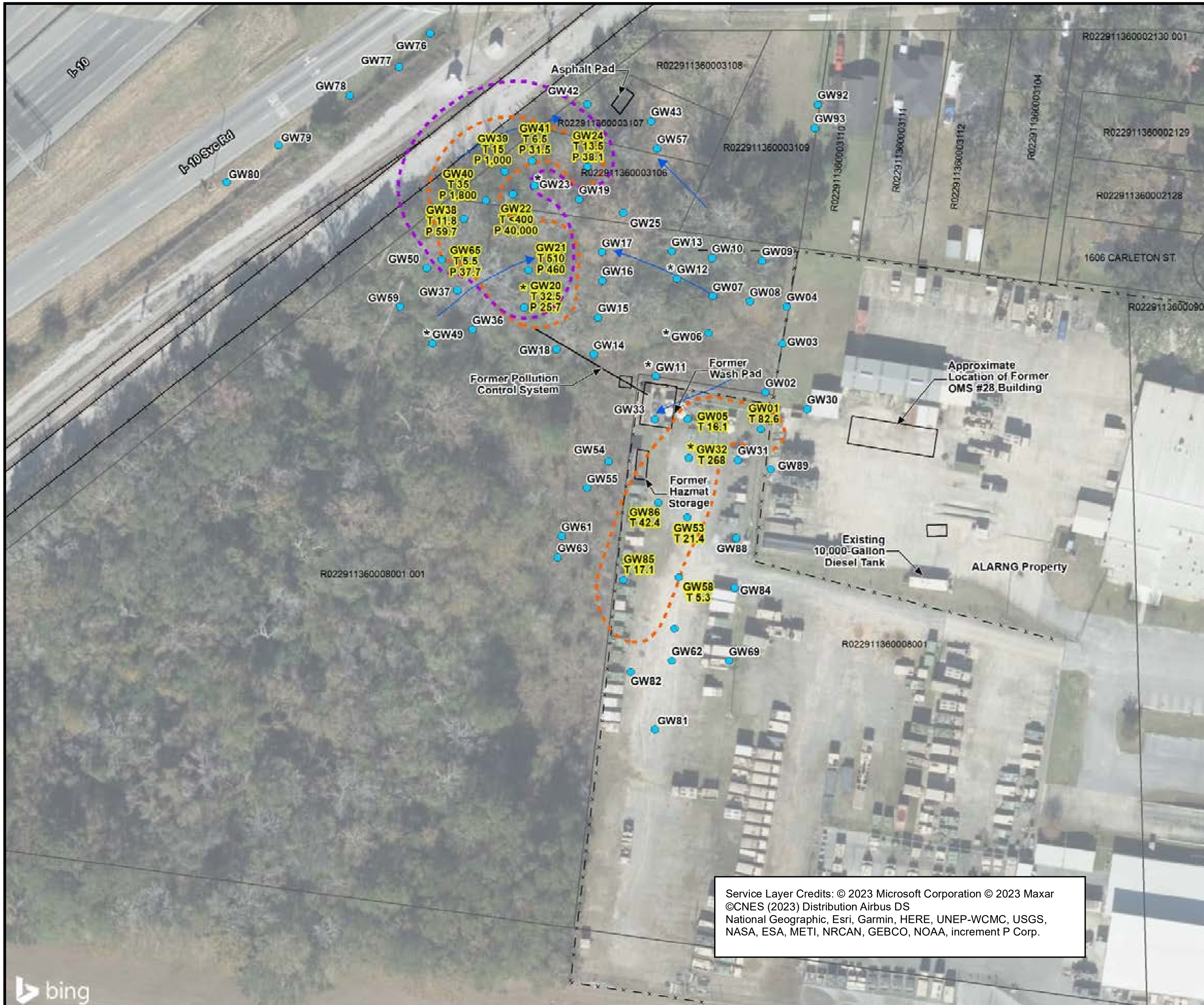
Lower Subsurface Soil Sample Results for PCE and TCE (1ft above water table)

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/9/2023	Figure C-10



Site Location

Legend

- Discrete Groundwater Sample Locations
- Apparent Groundwater Flow Direction - May 2017
- Fenceline
- Railroad
- Approximate extent of TCE Exceedance of the MCL (5 µg/L)
- Approximate extent of PCE Exceedance of the MCL (5 µg/L)
- Parcel Boundary
- Indicates PCE and/or TCE were detected above its respective MCL.

Notes:
1. Discrete groundwater investigation conducted in May 2017 (GW-01 through GW-72) and January/February 2018 (GW-73 through GW-93).
2. The laboratory analytical results from the mobile lab are used for the May 2017 results unless a split sample with the fixed lab is available. The fixed lab results are used for the January/February 2018 samples.
3. Only groundwater results from discrete depths between 6 and 13 ft bgs are shown.
4. No highlighting of symbol indicates TCE and PCE did not exceed their respective MCLs.
5. If the TCE or PCE value is not listed, it did not exceed its MCL.

ft bgs = Feet below ground surface
MCL = Maximum Contamination Limit
T - Trichloroethene (TCE)
P - Tetrachloroethene (PCE)
*- Indicates a split sample was collected and analyzed by the fixed lab.

0 40 80 160 Feet

1 inch = 80 feet

N W E S

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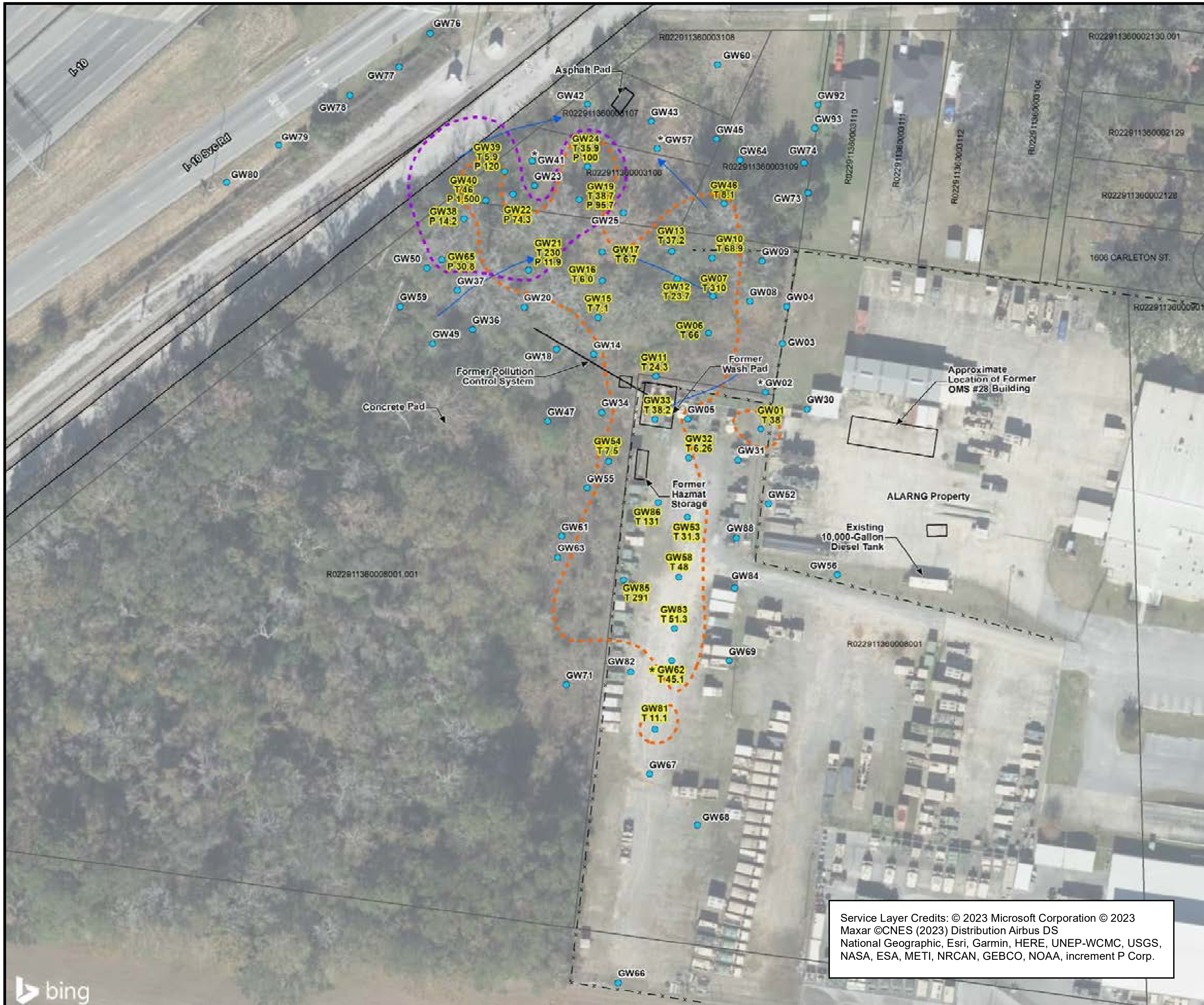
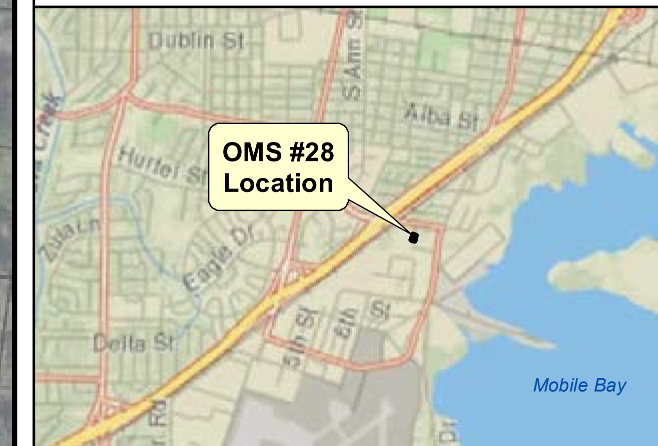
Discrete Groundwater Sampling Results for PCE & TCE - Upper Surficial (6 - 13 ft bgs)

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/9/2023	Figure C-11



Site Location



Legend

- Discrete Groundwater Sample Locations
- Apparent Groundwater Flow Direction - May 2017
- Fenceline
- Railroad
- Approximate extent of TCE Exceedance of the MCL (5 µg/L)
- Approximate extent of PCE Exceedance of the MCL (5 µg/L)
- Parcel Boundary
- Indicates TCE and/or PCE were detected above their respective MCL.

Notes:
1. Discrete groundwater investigation conducted in May 2017 (GW-01 through GW-72) and January/February 2018 (GW-73 through GW-93).
2. The laboratory analytical results from the mobile lab are used for the May 2017 results unless a split sample with the fixed lab is available. The fixed lab results are used for the January/February 2018 samples.
3. Only groundwater results from discrete depths between 12 and 26 ft bgs are shown.
4. No highlighting of symbol indicates TCE and PCE did not exceed their respective MCLs.
5. If the TCE or PCE value is not listed, it did not exceed its MCL.

ft bgs= Feet below ground surface
MCL = Maximum Contamination Limit (USEPA, April 2012)
T - Trichloroethene (TCE)
P - Tetrachloroethene (PCE)
*- Indicates a split sample was collected and analyzed by the fixed lab.

0 40 80 160 Feet

1 inch = 80 feet

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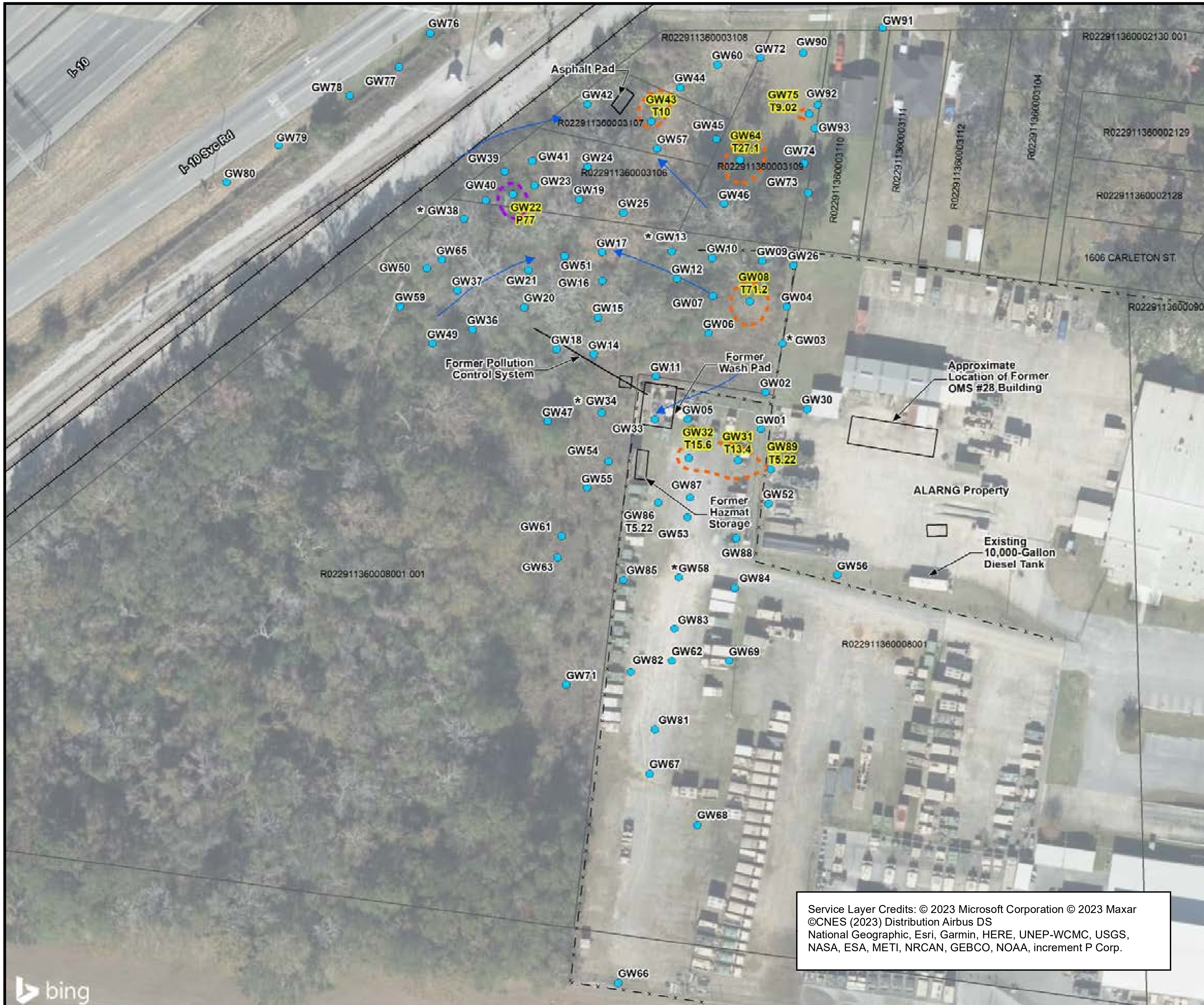
Discrete Groundwater Sampling Results for PCE & TCE - Middle Surficial (12 - 26 ft bgs)

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/9/2023	Figure C-12

Document Path: L:\Legacy\Group\earth\OMS 28\60439687\900-CADD-GIS\Brookley_GIS\Maps\FS Letter Report\20220505\Figure C-12_Brookley_Discrete Groundwater Sampling Results 12-26ft RJS.mxd



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Site Location

Legend

- Discrete Groundwater Sample Locations
- Apparent Groundwater Flow Direction - May 2017
- Fenceline
- Railroad
- Approximate extent of PCE Exceedance of the MCL (5 µg/L)
- Approximate extent of TCE Exceedance of the MCL (5 µg/L)
- Parcel Boundary
- Indicates TCE and/or PCE were detected above their respective MCL.

Notes:
1. Discrete groundwater investigation conducted in May 2017 (GW-01 through GW-72) and January/February 2018 (GW-73 through GW-93).
2. The laboratory analytical results from the mobile lab are used for the May 2017 results unless a split sample with the fixed lab is available. The fixed lab results are used for the January/February 2018 samples.
3. Only groundwater results from discrete depths deeper than 26 bgs are shown.
4. No highlighting of symbol indicates TCE and PCE did not exceed their respective MCLs.
5. If the TCE or PCE value is not listed, it did not exceed its MCL.

ft bgs = Feet below ground surface
MCL = Maximum Contamination Limit (USEPA, April 2012)
T - Trichloroethene (TCE)
P - Tetrachloroethene (PCE)
*- Indicates a split sample was collected and analyzed by the fixed lab.

0 40 80 160 Feet
1 inch = 80 feet

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Discrete Groundwater Sampling Results for PCE & TCE - Lower Surficial (Deeper Than 26 ft bgs)
Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/9/2023	Figure C-13

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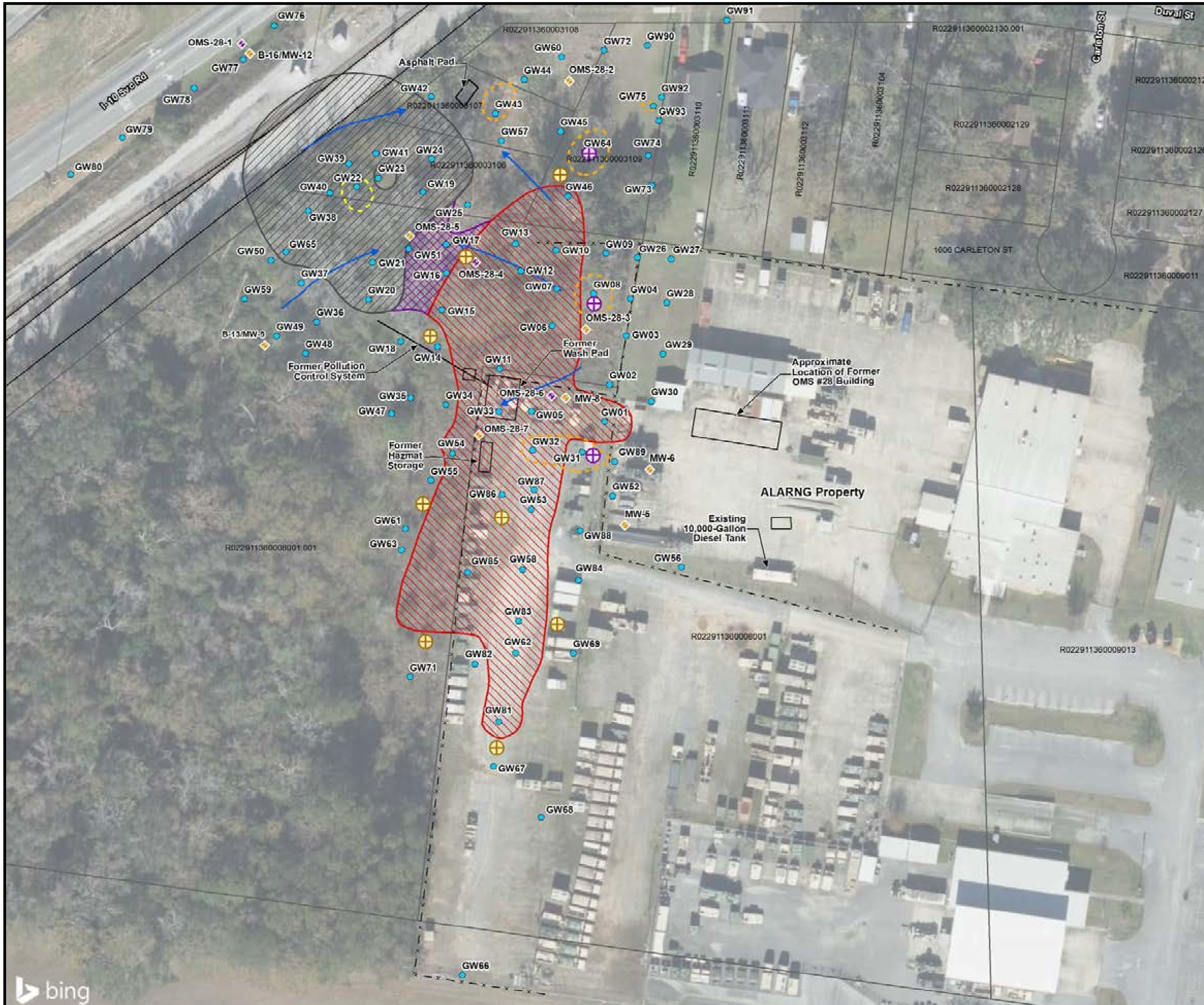

Site Location

Legend

- Proposed Upper/Middle Surficial Aquifer Monitoring Well Location
- Proposed Lower Surficial Aquifer Monitoring Well Location
- Upper/Middle Surficial Monitoring Well Location
- Lower Surficial Monitoring Well Location
- Discrete Groundwater Sample Locations
- Approximate Extent of PCE Exceedance of the MCL (5 µg/L) in the Lower Surficial Aquifer
- Approximate Extent of TCE Exceedance of the MCL (5 µg/L) in the Lower Surficial Aquifer
- Fenceline
- Railroad
- PCE Plume Related to Offsite PCE Spill on Parcel
- TCE Plume related to TCE Spill on Parcel E
- Area of Co-Mingled PCE from Parcel A and TCE from Parcel E
- Parcel Boundary

T - Trichloroethene (TCE)
P - Tetrachloroethene (PCE)

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0 40 80 160 Feet

1 inch = 80 feet

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Approximate Extent of PCE and TCE Groundwater Plumes

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/9/2023	Figure C-14

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ATTACHMENT 1

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SITE LOGIC Report

QuantArray®-Chlor Study

Contact: Tim Renn

Phone: 864-234-3053

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Email: timothy.renn@aecom.com

MI Identifier: 031TA

Report Date: 01/25/2022

Project: OMS 28, 60666895.2
Comments:

microbialinsights

The QuantArray®-Chlor Approach

Quantification of *Dehalococcoides*, the only known bacterial group capable of complete reductive dechlorination of PCE and TCE to ethene, has become an indispensable component of assessment, remedy selection, and performance monitoring at sites impacted by chlorinated solvents. While undeniably a key group of halorespiring bacteria, *Dehalococcoides* are not the only bacteria of interest in the subsurface because reductive dechlorination is not the only potential biodegradation pathway operative at contaminated sites, and chlorinated ethenes are not always the primary contaminants of concern. The QuantArray®-Chlor not only includes a variety of halorespiring bacteria (*Dehalococcoides*, *Dehalobacter*, *Dehalogenimonas*, etc.) to assess the potential for reductive dechlorination of chloroethenes, chloroethanes, chlorobenzenes, chlorophenols, and chloroform, but also provides quantification of functional genes involved in aerobic (co)metabolic pathways for biodegradation of chlorinated solvents and even competing biological processes. Thus, the QuantArray®-Chlor will give site managers the ability to simultaneously yet economically evaluate the potential for biodegradation of a spectrum of common chlorinated contaminants through a multitude of anaerobic and aerobic (co) metabolic pathways to give a much more clear and comprehensive view of contaminant biodegradation.

The QuantArray®-Chlor is used to quantify specific microorganisms and functional genes to evaluate the following:

Anaerobic Reductive Dechlorination	Quantification of important halorespiring bacteria (e.g. *Dehalococcoides*, *Dehalobacter*, *Dehalogenimonas*, *Desulfitobacterium* spp.) and key functional genes (e.g. vinyl chloride reductases, TCE reductase, chloroform reductase) responsible for reductive dechlorination of a broad spectrum of chlorinated solvents.
Aerobic Cometabolism	Several different types of bacteria including methanotrophs and some toluene/phenol utilizing bacteria can co-oxidize TCE, DCE, and vinyl chloride. The QuantArray®-Chlor quantifies functional genes like soluble methane monooxygenase encoding enzymes capable of co-oxidation of chlorinated ethenes.
Aerobic (Co)metabolism of Vinyl Chloride	Ethene oxidizing bacteria are capable of cometabolism of vinyl chloride. In some cases, ethenotrophs can also utilize vinyl chloride as a growth supporting substrate. The QuantArray®-Chlor targets key functional genes in ethene metabolism.

How do QuantArrays® work?

The QuantArray®-Chlor in many respects is a hybrid technology combining the highly parallel detection of microarrays with the accurate and precise quantification provided by qPCR into a single platform. The key to highly parallel qPCR reactions is the nanoliter fluidics platform for low volume, solution phase qPCR reactions.

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How are QuantArray® results reported?

One of the primary advantages of the QuantArray®-Chlor is the simultaneous quantification of a broad spectrum of different microorganisms and key functional genes involved in a variety of pathways for chlorinated hydrocarbon biodegradation. However, highly parallel quantification combined with the various metabolic and cometabolic capabilities of different target organisms can complicate data presentation. Therefore, in addition to Summary Tables, QuantArray® results will be presented as Microbial Population Summary and Comparison Figures to aid in data interpretation and subsequent evaluation of site management activities.

Types of Tables and Figures:

Microbial Population Summary	Figure presenting the concentrations of QuantArray®-Chlor target populations (e.g. *Dehalococcoides*) and functional genes (e.g. vinyl chloride reductase) relative to typically observed values.
Summary Tables	Tables of target population concentrations grouped by biodegradation pathway and contaminant type.
Comparison Figures	Depending on the project, sample results can be presented to compare changes over time or examine differences in microbial populations along a transect of the dissolved plume.

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Results

Table 1: Summary of the QuantArray®-Chlor results obtained for samples OMS-28-5, OMS-28-3, and MW-8.

Sample Name Sample Date	OMS-28-5 01/13/2022	OMS-28-3 01/13/2022	MW-8 01/13/2022
Reductive Dechlorination	cells/bead	cells/bead	cells/bead
Dehalococcoides (DHC)	**2.92E+01**	<2.50E+01	<2.50E+01
tceA Reductase (TCE)	<2.50E+01	<2.50E+01	<2.50E+01
BAV1 Vinyl Chloride Reductase (BVC)	<2.50E+01	<2.50E+01	<2.50E+01
Vinyl Chloride Reductase (VCR)	<2.50E+01	<2.50E+01	<2.50E+01
Dehalobacter spp. (DHBt)	**7.27E+04**	<2.50E+02	<2.50E+02
Dehalobacter DCM (DCM)	<2.50E+02	<2.50E+02	<2.50E+02
Dehalogenimonas spp. (DHG)	<2.50E+02	<2.50E+02	**9.37E+03**
cerA Reductase (CER)	<2.50E+02	<2.50E+02	<2.50E+02
trans-1,2-DCE Reductase (TDR)	<2.50E+02	<2.50E+02	<2.50E+02
Desulfitobacterium spp. (DSB)	**8.99E+04**	<2.50E+02	<2.50E+02
Dehalobium chlorocoercia (DECO)	<2.50E+02	<2.50E+02	<2.50E+02
Desulfuromonas spp. (DSM)	<2.50E+02	**2.20E+03**	<2.50E+02
PCE Reductase (PCE-1)	<2.50E+02	<2.50E+02	<2.50E+02
PCE Reductase (PCE-2)	<2.50E+02	<2.50E+02	<2.50E+02
Chloroform Reductase (CFR)	<2.50E+02	<2.50E+02	<2.50E+02
1,1 DCA Reductase (DCA)	<2.50E+02	<2.50E+02	<2.50E+02
1,2 DCA Reductase (DCAR)	<2.50E+02	<2.50E+02	<2.50E+02
Aerobic (Co)Metabolic			
Soluble Methane Monooxygenase (SMMO)	<2.50E+02	**2.84E+03**	<2.50E+02
Toluene Dioxygenase (TOD)	<2.50E+02	**3.48E+02**	**2.88E+02**
Phenol Hydroxylase (PHE)	**7.21E+03**	**7.47E+01 (J)**	**3.30E+04**
Trichlorobenzene Dioxygenase (TCBO)	<2.50E+02	<2.50E+02	<2.50E+02
Toluene Monooxygenase 2 (RDEG)	<2.50E+02	<2.50E+02	**4.27E+04**
Toluene Monooxygenase (RMO)	**7.01E+02**	**7.52E+01 (J)**	<2.50E+02
Ethene Monooxygenase (EtnC)	<2.50E+02	<2.50E+02	<2.50E+02
Epoxyalkane Transferase (EtnE)	<2.50E+02	<2.50E+02	**3.04E+03**
Dichloromethane Dehalogenase (DCMA)	<2.50E+02	<2.50E+02	<2.50E+02
Other			
Total Eubacteria (EBAC)	**5.67E+06**	**1.10E+07**	**7.99E+06**
Sulfate Reducing Bacteria (APS)	**9.12E+04**	**3.13E+03**	**2.60E+02**
Methanogens (MGN)	**4.21E+01 (J)**	**1.70E+01 (J)**	**9.70E+00 (J)**

Legend:

NA = Not Analyzed
NS = Not Sampled
J = Estimated Gene Copies Below PQL but Above LQL
I = Inhibited
< = Result Not Detected

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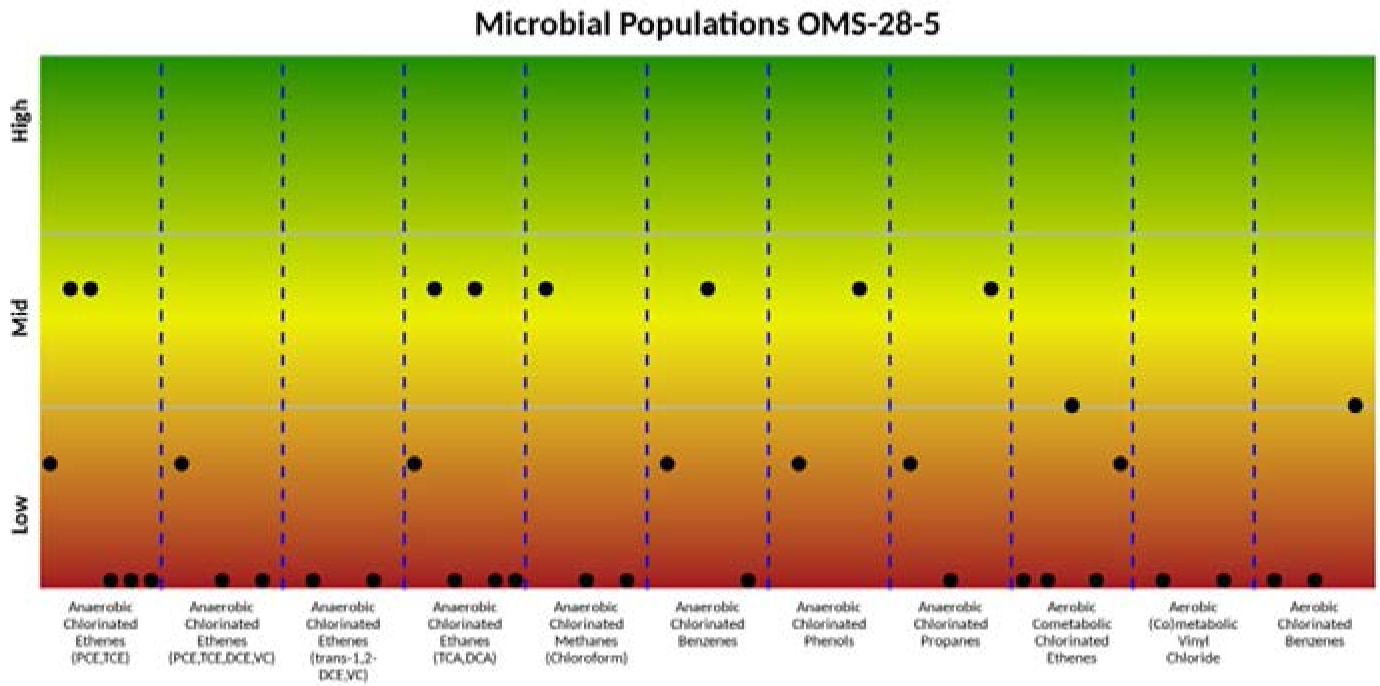

Figure 1: Microbial population summary to aid in evaluating potential pathways and biodegradation of specific contaminants.

Anaerobic - Reductive Dechlorination or Dichloroelimination		Aerobic - (Co)metabolism	
Chlorinated Ethenes (PCE, TCE)	DHC, DHBt, DSB, DSM, PCE-1, PCE-2	Chlorinated Ethenes (TCE,DCE,VC)	sMMO, TOD, PHE, RDEG, RMO
Chlorinated Ethenes (PCE, TCE, DCE, VC)	DHC, BVC, VCR	(Co)metabolic Vinyl Chloride	etnC, etnE
Chlorinated Ethenes (trans-1,2-DCE, VC)	TDR, CER	Chlorinated Benzenes	TOD, TCBO, PHE
Chlorinated Ethanes (TCA and 1,2-DCA)	DHC, DHBt, DHG, DSB[1], DCA, DCAR		
Chlorinated Methanes (Chloroform)	DHBt, DCM, CFR		
Chlorinated Benzenes	DHC, DHBt[2], DECO		
Chlorinated Phenols	DHC, DSB		
Chlorinated Propanes	DHC, DHG, DSB[1]		

[1] *Desulfitobacterium dichloroeliminans* DCA1. [2] Implicated in reductive dechlorination of dichlorobenzene and potentially chlorobenzene.

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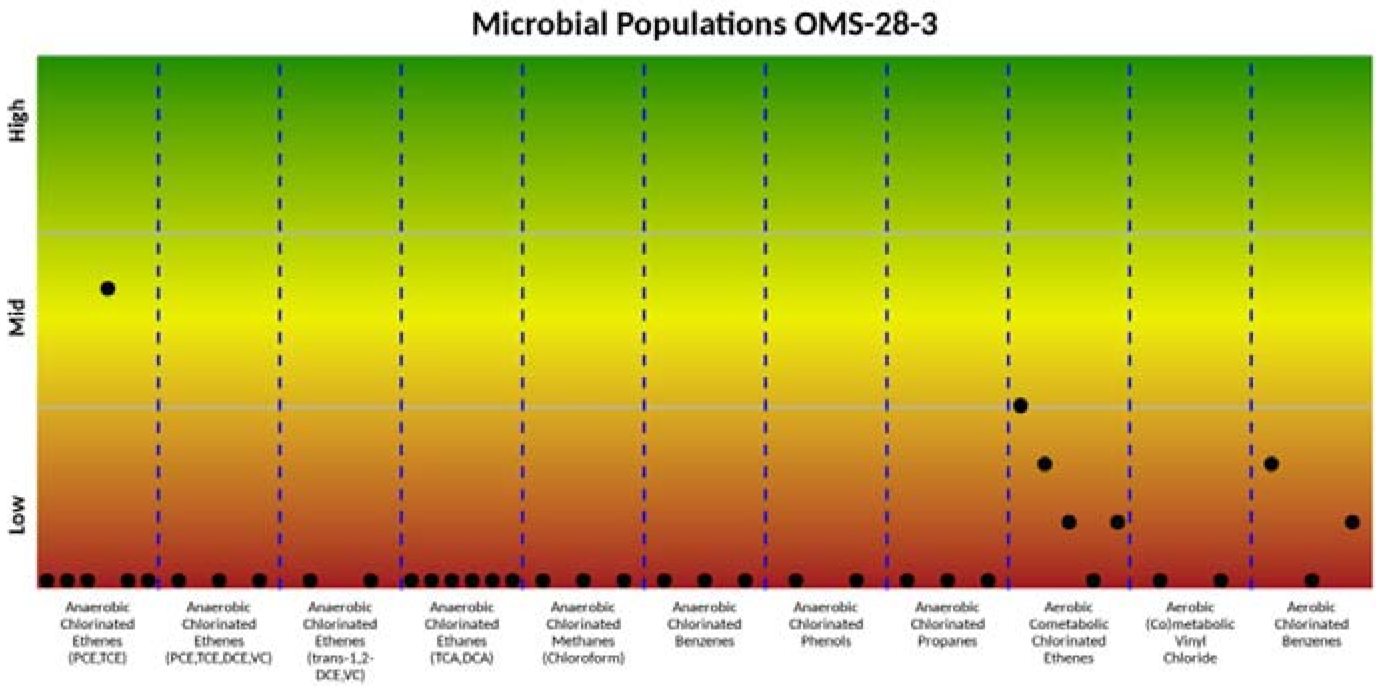

Figure 2: Microbial population summary to aid in evaluating potential pathways and biodegradation of specific contaminants.

Anaerobic - Reductive Dechlorination or Dichloroelimination		Aerobic - (Co)metabolism	
Chlorinated Ethenes (PCE, TCE)	DHC, DHBt, DSB, DSM, PCE-1, PCE-2	Chlorinated Ethenes (TCE,DCE,VC)	sMMO, TOD, PHE, RDEG, RMO
Chlorinated Ethenes (PCE, TCE, DCE, VC)	DHC, BVC, VCR	(Co)metabolic Vinyl Chloride	etnC, etnE
Chlorinated Ethenes (trans-1,2-DCE, VC)	TDR, CER	Chlorinated Benzenes	TOD, TCBO, PHE
Chlorinated Ethanes (TCA and 1,2-DCA)	DHC, DHBt, DHG, DSB[1], DCA, DCAR		
Chlorinated Methanes (Chloroform)	DHBt, DCM, CFR		
Chlorinated Benzenes	DHC, DHBt[2], DECO		
Chlorinated Phenols	DHC, DSB		
Chlorinated Propanes	DHC, DHG, DSB[1]		

[1]*Desulfitobacterium dichloroeliminans* DCA1. [2]Implicated in reductive dechlorination of dichlorobenzene and potentially chlorobenzene.

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Microbial Populations MW-8

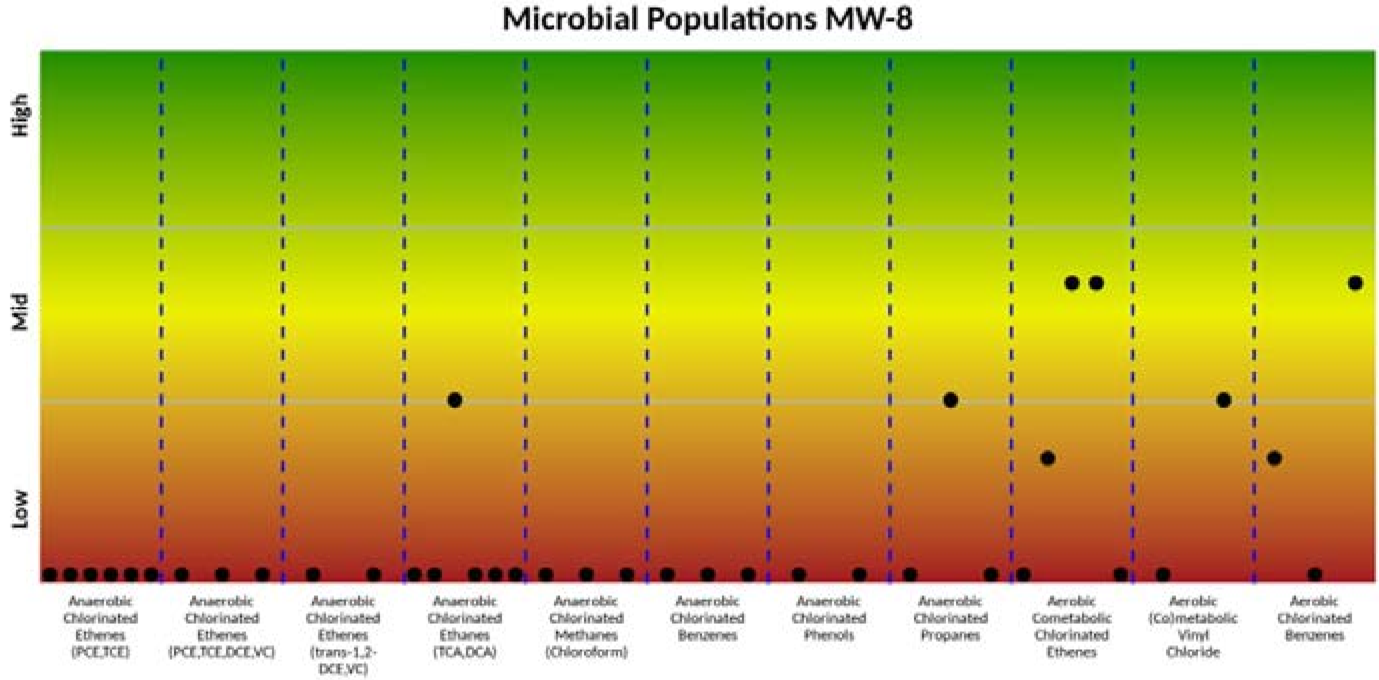

Figure 3: Microbial population summary to aid in evaluating potential pathways and biodegradation of specific contaminants.

Anaerobic - Reductive Dechlorination or Dichloroelimination		Aerobic - (Co)metabolism	
Chlorinated Ethenes (PCE, TCE)	DHC, DHBt, DSB, DSM, PCE-1, PCE-2	Chlorinated Ethenes (TCE,DCE,VC)	sMMO, TOD, PHE, RDEG, RMO
Chlorinated Ethenes (PCE, TCE, DCE, VC)	DHC, BVC, VCR	(Co)metabolic Vinyl Chloride	etnC, etnE
Chlorinated Ethenes (trans-1,2-DCE, VC)	TDR, CER	Chlorinated Benzenes	TOD, TCBO, PHE
Chlorinated Ethanes (TCA and 1,2-DCA)	DHC, DHBt, DHG, DSB[1], DCA, DCAR		
Chlorinated Methanes (Chloroform)	DHBt, DCM, CFR		
Chlorinated Benzenes	DHC, DHBt[2], DECO		
Chlorinated Phenols	DHC, DSB		
Chlorinated Propanes	DHC, DHG, DSB[1]		

[1] *Desulfitobacterium dichloroeliminans* DCA1. [2] Implicated in reductive dechlorination of dichlorobenzene and potentially chlorobenzene.

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Table 2: Summary of the QuantArray®-Chlor results for microorganisms responsible for reductive dechlorination for samples OMS-28-5, OMS-28-3, and MW-8.

Sample Name Sample Date	OMS-28-5 01/13/2022	OMS-28-3 01/13/2022	MW-8 01/13/2022
Reductive Dechlorination	cells/bead	cells/bead	cells/bead
Dehalococcoides (DHC)	**2.92E+01**	<2.50E+01	<2.50E+01
tceA Reductase (TCE)	<2.50E+01	<2.50E+01	<2.50E+01
BAV1 Vinyl Chloride Reductase (BVC)	<2.50E+01	<2.50E+01	<2.50E+01
Vinyl Chloride Reductase (VCR)	<2.50E+01	<2.50E+01	<2.50E+01
Dehalobacter spp. (DHBt)	**7.27E+04**	<2.50E+02	<2.50E+02
Dehalobacter DCM (DCM)	<2.50E+02	<2.50E+02	<2.50E+02
Dehalogenimonas spp. (DHG)	<2.50E+02	<2.50E+02	**9.37E+03**
Desulfitobacterium spp. (DSB)	**8.99E+04**	<2.50E+02	<2.50E+02
Dehalobium chlorocoercia (DECO)	<2.50E+02	<2.50E+02	<2.50E+02
Desulfuromonas spp. (DSM)	<2.50E+02	**2.20E+03**	<2.50E+02

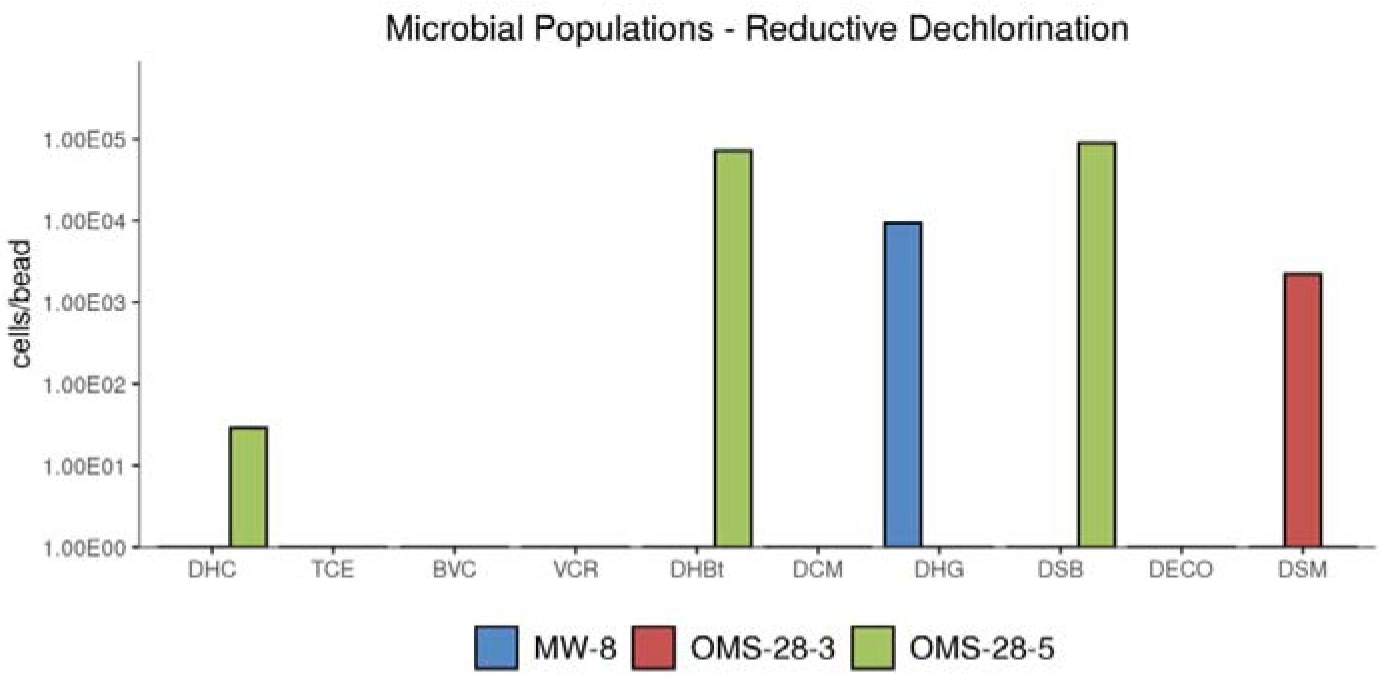

Figure 4: Comparison - microbial populations involved in reductive dechlorination.

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Table 3: Summary of the QuantArray®-Chlor results for microorganisms responsible for reductive dechlorination for samples OMS-28-5, OMS-28-3, and MW-8.

Sample Name **Sample Date**	**OMS-28-5** **01/13/2022**	**OMS-28-3** **01/13/2022**	**MW-8** **01/13/2022**
Reductive Dechlorination	cells/bead	cells/bead	cells/bead
Chloroform Reductase (CFR)	<2.50E+02	<2.50E+02	<2.50E+02
1,1 DCA Reductase (DCA)	<2.50E+02	<2.50E+02	<2.50E+02
1,2 DCA Reductase (DCAR)	<2.50E+02	<2.50E+02	<2.50E+02
PCE Reductase (PCE-1)	<2.50E+02	<2.50E+02	<2.50E+02
PCE Reductase (PCE-2)	<2.50E+02	<2.50E+02	<2.50E+02
Dehalogenimonas trans-1,2-DCE Reductase (TDR)	<2.50E+02	<2.50E+02	<2.50E+02
Dehalogenimonas cerA Reductase (CER)	<2.50E+02	<2.50E+02	<2.50E+02

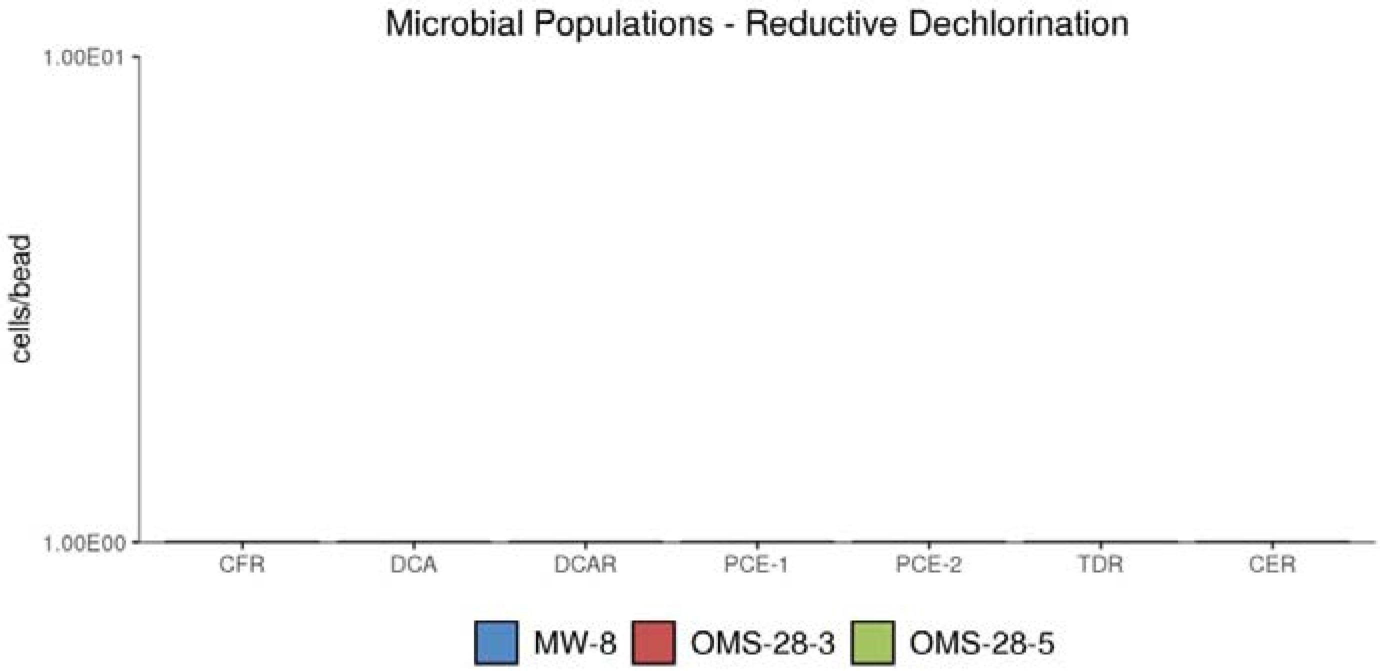

Figure 5: Comparison - microbial populations involved in reductive dechlorination.

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Table 4: Summary of the QuantArray®-Chlor results for microorganisms responsible for aerobic (co)metabolism for samples OMS-28-5, OMS-28-3, and MW-8.

Sample Name Sample Date	OMS-28-5 01/13/2022	OMS-28-3 01/13/2022	MW-8 01/13/2022
Aerobic (Co)Metabolic	cells/bead	cells/bead	cells/bead
Soluble Methane Monooxygenase (SMMO)	<2.50E+02	**2.84E+03**	<2.50E+02
Toluene Dioxygenase (TOD)	<2.50E+02	**3.48E+02**	**2.88E+02**
Phenol Hydroxylase (PHE)	**7.21E+03**	**7.47E+01 (J)**	**3.30E+04**
Trichlorobenzene Dioxygenase (TCBO)	<2.50E+02	<2.50E+02	<2.50E+02
Toluene Monooxygenase 2 (RDEG)	<2.50E+02	<2.50E+02	**4.27E+04**
Toluene Monooxygenase (RMO)	**7.01E+02**	**7.52E+01 (J)**	<2.50E+02
Ethene Monooxygenase (EtnC)	<2.50E+02	<2.50E+02	<2.50E+02
Epoxyalkane Transferase (EtnE)	<2.50E+02	<2.50E+02	**3.04E+03**
Dichloromethane Dehalogenase (DCMA)	<2.50E+02	<2.50E+02	<2.50E+02

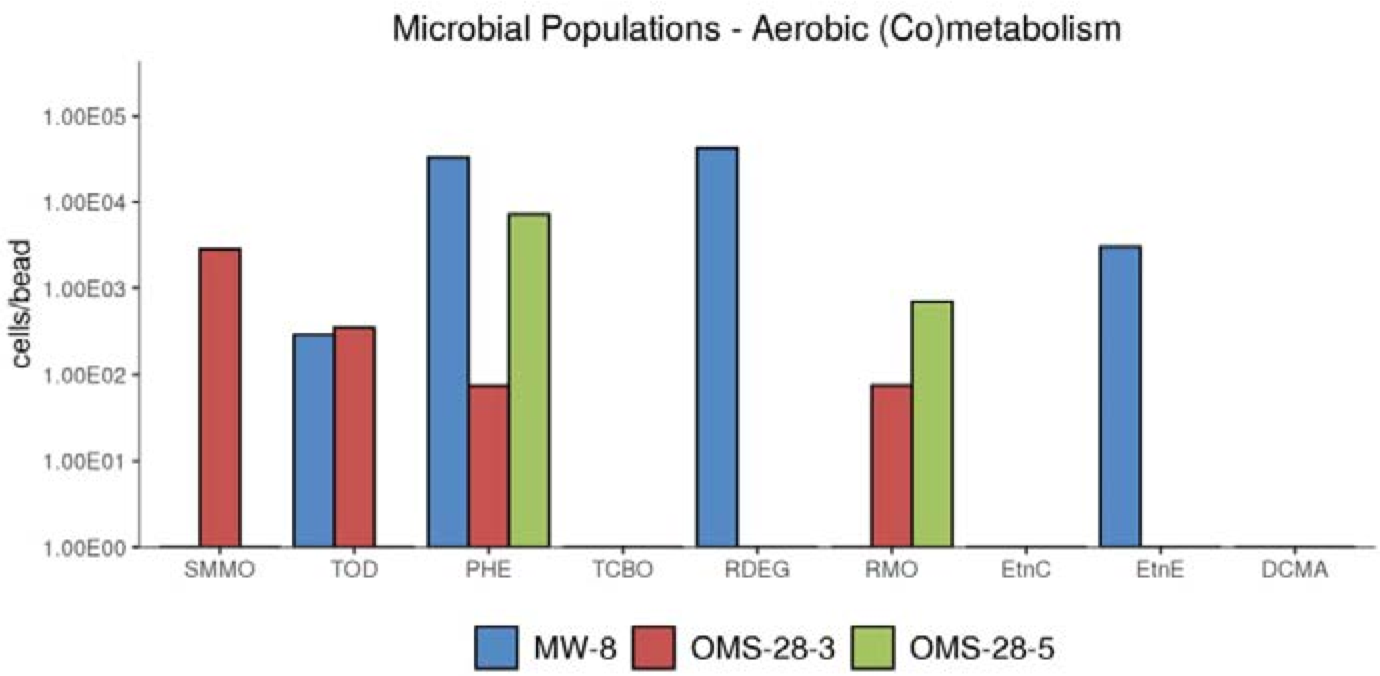

Figure 6: Comparison - microbial populations involved in aerobic (co)metabolism.

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Table 5: Summary of the QuantArray® results for total bacteria and other populations for samples OMS-28-5, OMS-28-3, and MW-8.

Sample Name Sample Date	OMS-28-5 01/13/2022	OMS-28-3 01/13/2022	MW-8 01/13/2022
Other	cells/bead	cells/bead	cells/bead
Total Eubacteria (EBAC)	**5.67E+06**	**1.10E+07**	**7.99E+06**
Sulfate Reducing Bacteria (APS)	**9.12E+04**	**3.13E+03**	**2.60E+02**
Methanogens (MGN)	**4.21E+01 (J)**	**1.70E+01 (J)**	**9.70E+00 (J)**

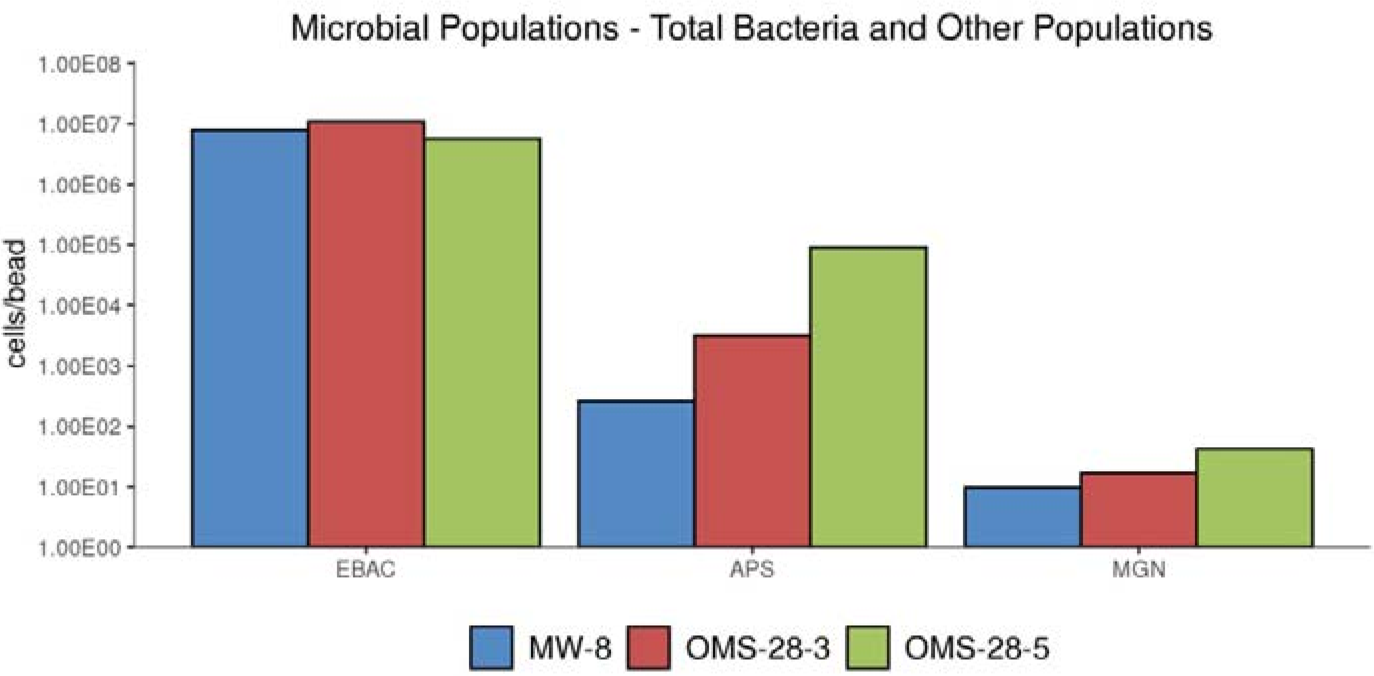

Figure 7: Comparison - microbial populations.

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Interpretation

The overall purpose of the QuantArray®-Chlor is to give site managers the ability to simultaneously yet economically evaluate the potential for biodegradation of a spectrum of common chlorinated contaminants through a multitude of anaerobic and aerobic (co)metabolic pathways in order to provide a clearer and more comprehensive view of contaminant biodegradation. The following discussion describes the interpretation of results in general terms and is meant to serve as a guide.

Reductive Dechlorination - Chlorinated Ethenes: While a number of bacterial cultures including *Dehalococcoides*, *Dehalobacter*, *Desulfitobacterium*, and *Desulfuromonas* spp. capable of utilizing PCE and TCE as growth-supporting electron acceptors have been isolated [1–5], *Dehalococcoides* may be the most important because they are the only bacterial group that has been isolated to date which is capable of complete reductive dechlorination of PCE to ethene [6]. In fact, the presence of *Dehalococcoides* has been associated with complete reductive dechlorination to ethene at sites across North America and Europe [7], and Lu et al. [8] have proposed using a *Dehalococcoides* concentration of 1×10^4 cells/mL as a screening criterion to identify sites where biological reductive dechlorination is predicted to proceed at "generally useful" rates.

At chlorinated ethene sites, any "stall" leading to the accumulation of daughter products, especially vinyl chloride, would be a substantial concern. While *Dehalococcoides* concentrations greater than 1×10^4 cells/mL correspond to ethene production and useful rates of dechlorination, the range of chlorinated ethenes degraded varies by strain within the *Dehalococcoides* genus [6, 9], and the presence of co-contaminants and competitors can have complex impacts on the halorespiring microbial community [10–15]. Therefore, QuantArray®-Chlor also provides quantification of a suite of reductive dehalogenase genes (PCE, TCE, BVC, VCR, CER, and TDR) to more definitively confirm the potential for reductive dechlorination of all chlorinated ethene compounds including vinyl chloride.

Perhaps most importantly, QuantArray®-Chlor quantifies TCE reductase (TCE) and both known vinyl chloride reductase genes (BVC, VCR) from *Dehalococcoides* to conclusively evaluate the potential for complete reductive dechlorination of chlorinated ethenes to non-toxic ethene [16–18]. In addition, the analysis also includes quantification of reductive dehalogenase genes from *Dehalogenimonas* spp. capable of reductive dechlorination of chlorinated ethenes. More specifically, these are the trans-1,2-DCE dehalogenase gene (TDR) from strain WBC-2 [19] and the vinyl chloride reductase gene (CER) from GP, the only known organisms other than *Dehalococcoides* capable of vinyl chloride reduction [20]. Finally, PCE reductase genes responsible for sequential reductive dechlorination of PCE to *cis*-DCE by *Sulfurospirillum* and *Geobacter* spp. are also quantified. In mixed cultures, evidence increasingly suggests that partial dechlorinators like *Sulfurospirillum* and *Geobacter* may be responsible for the majority of reductive dechlorination of PCE to TCE and *cis*-DCE while *Dehalococcoides* functions more as *cis*-DCE and vinyl chloride reducing specialists [10, 21].

Reductive Dechlorination - Chlorinated Ethanes: Under anaerobic conditions, chlorinated ethanes are susceptible to reductive dechlorination by several groups of halorespiring bacteria including *Dehalobacter*, *Dehalogenimonas*, and *Dehalococcoides*. While the reported range of chlorinated ethanes utilized varies by genus, species, and sometimes at the strain level, several general observations can be made regarding biodegradation pathways and daughter product formation. *Dehalobacter* spp. have been isolated that are capable of sequential reductive dechlorination of 1,1,1-TCA through 1,1-DCA to chloroethane [13]. Biodegradation of 1,1,2-TCA by several halorespiring bacteria including *Dehalobacter* and *Dehalogenimonas* spp. proceeds via dichloroelimination producing vinyl chloride [22–24]. Similarly, 1,2-DCA biodegradation by *Dehalobacter*, *Dehalogenimonas*, and *Dehalococcoides* occurs via dichloroelimination producing ethene. While not utilized by many *Desulfitobacterium* isolates, at least one strain, *Desulfitobacterium dichloroeliminans* strain DCA1, is also capable of dichloroelimination of 1,2-DCA [25]. The 1,2-dichloroethane reductive dehalogenase gene (DCAR) from members of *Desulfitobacterium* and *Dehalobacter* is known to dechlorinate 1,2-DCA to ethene, while the 1,1-dichloroethane reductive dehalogenase (DCA) targets the gene responsible for 1,1-DCA dechlorination in some strains of *Dehalobacter*. In addition to chloroform,chloroform reductase (CFR) has also been shown to be responsible for reductivedechlorination of 1,1,1-TCA [26].

Reductive Dechlorination - Chlorinated Methanes: Chloroform is a common co-contaminant at chlorinated solvent sites and can inhibit reductive dechlorination of chlorinated ethenes. Grostern et al. demonstrated that a *Dehalobacter* population was capable of reductive dechlorination of chloroform to produce dichloromethane [27]. The *cfrA* gene encodes the reductase which catalyzes this initial step in chloroform biodegradation [26]. Justicia-Leon et al. have since shown that dichloromethane can support growth of a distinct group of *Dehalobacter* strains via fermentation [28]. The *Dehalobacter* DCM assay targets the 16S rRNA gene of these strains.

Reductive Dechlorination - Chlorinated Benzenes: Chlorinated benzenes are an important class of industrial solvents and chemical intermediates in the production of drugs, dyes, herbicides, and insecticides. The physical-chemical properties of chlorinated benzenes as well as susceptibility to biodegradation are functions of their degree of chlorination and the positions of chlorine substituents. Under anaerobic conditions, reductive dechlorination of higher chlorinated benzenes including hexachlorobenzene (HCB),

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pentachlorobenzene (PeCB), tetrachlorobenzene (TeCB) isomers, and trichlorobenzene (TCB) isomers has been well documented [29], although biodegradation of individual compounds and isomers varies between isolates. For example, *Dehalococcoides* strain CBDB1 reductively dechlorinats HCB, PeCB, all three TeCB isomers, 1,2,3-TCB, and 1,2,4-TCB [9, 30]. *Dehalobium chlorocoercia* DF-1 has been shown to be capable of reductive dechlorination of HCB, PeCB, and 1,2,3,5-TeCB [31]. The dichlorobenzene (DCB) isomers and chlorobenzene (CB) were considered relatively recalcitrant under anaerobic conditions. However, new evidence has demonstrated reductive dechlorination of DCBs to CB and CB to benzene [32] with corresponding increases in concentrations of *Dehalobacter* spp. [33].

Reductive Dechlorination - Chlorinated Phenols: Pentachlorophenol (PCP) was one of the most widely used biocides in the U.S. and despite residential use restrictions, is still extensively used industrially as a wood preservative. Along with PCP, the tetrachlorophenol and trichlorophenol isomers were also used as fungicides in wood preserving formulations. 2,4-Dichlorophenol and 2,4,5-TCP were used as chemical intermediates in herbicide production (e.g. 2,4-D) and chlorophenols are known byproducts of chlorine bleaching in the pulp and paper industry. While the range of compounds utilized varies by strain, some *Dehalococcoides* isolates are capable of reductive dechlorination of PCP and other chlorinated phenols. For example, *Dehalococcoides* strain CBDB1 is capable of utilizing PCP, all three tetrachlorophenol (TeCP) congeners, all six trichlorophenol (TCP) congeners, and 2,3-dichlorophenol (2,3-DCP). PCP dechlorination by strain CBDB1 produces a mixture of 3,5-DCP, 3,4-DCP, 2,4-DCP, 3-CP, and 4-CP [34]. In the same study, however, *Dehalococcoides* strain 195 dechlorinated a more narrow spectrum of chlorophenols which included 2,3-DCP, 2,3,4-TCP, and 2,3,6-TCP, but no other TCPs or PCP. Similar to *Dehalococcoides*, some species and strains of *Desulfitobacterium* are capable of utilizing PCP and other chlorinated phenols. *Desulfitobacterium hafniense* PCP-1 is capable of reductive dechlorination of PCP to 3-CP [35]. However, the ability to biodegrade PCP is not universal among *Desulfitobacterium* isolates. *Desulfitobacterium* sp. strain PCE1 and *D. chlororespirans* strain Co23, for example, can utilize some TCP and DCP isomers, but not PCP for growth [2, 36].

Reductive Dechlorination - Chlorinated Propanes: *Dehalogenimonas* is a recently described bacterial genus of the phylum Chloroflexi which also includes the well-known chloroethene-respiring *Dehalococcoides* [23]. The *Dehalogenimonas* isolates characterized to date are also halorespiring bacteria, but utilize a rather unique range of chlorinated compounds as electron acceptors including chlorinated propanes (1,2,3-TCP and 1,2-DCP) and a variety of other vicinally chlorinated alkanes including 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, and 1,2-dichloroethane [23].

Aerobic - Chlorinated Ethene Cometabolism: Under aerobic conditions, several different types of bacteria including methane-oxidizing bacteria (methanotrophs), and many benzene, toluene, ethylbenzene, xylene, and (BTEX)-utilizing bacteria can cometabolize or co-oxidize TCE, DCE, and vinyl chloride [37]. In general, cometabolism of chlorinated ethenes is mediated by monooxygenase enzymes with "relaxed' specificity that oxidize a primary (growth supporting) substrate (*e.g.* methane) and co-oxidize the chlorinated compound (*e.g.*TCE). QuantArray®-Chlor provides quantification of a suite of genes encoding oxygenase enzymes capable of co-oxidation of chlorinated ethenes including soluble methane monooxygenase (sMMO). Soluble methane monooxygenases co-oxidize a broad range of chlorinated compounds [38–41] including TCE, *cis*-DCE, and vinyl chloride. Furthermore, soluble methane monooxygenases are generally believed to support greater rates of aerobic cometabolism [40]. QuantArray®-Chlor also quantifies aromatic oxygenase genes encoding ring hydroxylating toluene monooxygenase genes (RMO, RDEG), toluene dioxygenase (TOD) and phenol hydroxylases (PHE) capable of TCE co-oxidation [42–46]. TCE or a degradation product has been shown to induce expression of toluene monooxygenases in some laboratory studies [43, 47] raising the possibility of TCE cometabolism with an alternative (non-aromatic) growth substrate. Moreover, while a number of additional factors must be considered, recent research under ESTCP Project 201584 has shown positive correlations between concentrations of monooxygenase genes (soluble methane monooxygenase, ring hydroxylating monooxygenases, and phenol hydroxylase) and the rate of TCE degradation [48].

Aerobic - Chlorinated Ethane Cometabolism: While less widely studied than cometabolism of chlorinated ethenes, some chlorinated ethanes are also susceptible to co-oxidation. As mentioned previously, soluble methane monooxygenases (sMMO) exhibit very relaxed specificity. In laboratory studies, sMMO has been shown to co-oxidize a number of chlorinated ethanes including 1,1,1-TCA and 1,2-DCA [38, 40].

Aerobic - Vinyl Chloride Cometabolism: Beginning in the early 1990s, numerous microcosm studies demonstrated aerobic oxidation of vinyl chloride under MNA conditions without the addition of exogenous primary substrates. Since then, strains of

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Mycobacterium, *Nocardioides*, *Pseudomonas*, *Ochrobactrum*, and *Ralstonia* species have been isolated which are capable of aerobic growth on both ethene and vinyl chloride (see Mattes et al. [49] for a review). The initial steps in the pathway are the monooxygenase (*etn*ABCD) catalyzed conversion of ethene and vinyl chloride to their respective epoxyalkanes (epoxyethane and chlorooxirane), followed by epoxyalkane:CoM transferase (*etn*E) mediated conjugation and breaking of the epoxide [50].

Aerobic - Chlorinated Benzenes: In general, chlorobenzenes with four or less chlorine groups are susceptible to aerobic biodegradation and can serve as growth-supporting substrates. Toluene dioxygenase (TOD) has a relatively relaxed substrate specificity and mediates the incorporation of both atoms of oxygen into the aromatic ring of benzene and substituted benzenes (toluene and chlorobenzene). Comparison of TOD levels in background and source zone samples from a CB-impacted site suggested that CBs promoted growth of TOD-containing bacteria [51]. In addition, aerobic biodegradation of some trichlorobenzene and even tetrachlorobenzene isomers is initiated by a group of related trichlorobenzene dioxygenase genes (TCBO). Finally, phenol hydroxylases catalyze the continued oxidation and in some cases, the initial oxidation of a variety of monoaromatic compounds. In an independent study, significant increases in numbers of bacteria containing PHE genes corresponded to increases in biodegradation of DCB isomers [51].

Aerobic - Chlorinated Methanes: Many aerobic methylotrophic bacteria, belonging to diverse genera (*Hyphomicrobium*, *Methylobacterium*, *Methylophilus*, *Pseudomonas*, *Paracoccus*, and *Alibacter*) have been isolated which are capable of utilizing dichloromethane (DCM) as a growth substrate. The DCM metabolic pathway in methylotrophic bacteria is initiated by a dichloromethane dehalogenase (DCMA) gene. DCMA is responsible for aerobic biodegradation of dichloromethane by methylotrophs by first producing formaldehyde which is then further oxidized [52]. As discussed in previous sections, soluble methane monooxygenase (sMMO) exhibits relaxed specificity and co-oxidizes a broad spectrum of chlorinated hydrocarbons. In addition to chlorinated ethenes, sMMO has been shown to co-oxidize chloroform in laboratory studies [38, 41].

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APPENDIX D

Detailed Remedial Alternatives Cost Estimates

Table D-1
Cost Estimate for Alternative 2, Land Use Controls with Periodic Groundwater Monitoring
OMS #28
Alabama Army National Guard - Mobile, Alabama

COST ESTIMATE WORKSHEET SUMMARY

Alternative 2	Site:	OMS #28
Land Use Controls with	Location:	ALARNG, Mobile, AL
Periodic Groundwater Monitoring	Phase:	Feasilbility Study
	Base Year:	2023

Labor Rates:

Project Manager	$171.65	**Travel:**		
Env. Engineer - Senior	$166.40	Per Diem	$59.00	/day
Geologist - Senior	$148.29	Lodging	$100.00	/day
Env. Engineer - Mid	$125.27	Mileage	$0.655	/mile
Geologist - Mid	$110.73	Rental Car	$85.00	/day
Env. Engineer - Junior	$87.00	Adm Assist/Clerical - Mid	$72.73	
Geologist - Junior	$75.71	Risk Assessor	$144.06	
GIS/CADD - Mid	$95.50	CIH/Safety Manager - Mid	$129.69	
Contracts/Admin/Procurement - Mid	$111.98	Chemist - Mid	$117.02	
		Database Manager	$82.17	

LUC Implentation - Year 1

Includes:
1. Prepare Draft, Draft Final, and Final LUCIP.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor (LUCIP generation):					
Project Manager	19	$171.65	/hr	$3,227.02	
Env. Engineer - Senior	50	$166.40	/hr	$8,320.00	
Env. Engineer - Junior	80	$87.00	/hr	$6,960.00	
GIS/CADD - Mid	24	$95.50	/hr	$2,292.00	
Adm Assist/Clerical - Mid	24	$72.73	/hr	$1,745.52	
Materials (LUCIP):					
Document Repro/Ship (D, DF, F)	3	$500.00	/ea	$1,500.00	
Travel:					
Per Diem	1	$59.00	/day	$59.00	
Lodging	0	$100.00	/day	$0.00	
Milage	200	$0.655	/mile	$131.00	Destin to Mobile (~100 mi.)
			Year 1 LUC Cost Subtotal	$24,234.54	
			Total LUC Capital Cost Year 1 (Rounded)	**$24,200**	

Draft RD/RA Work Plan - Year 1

Includes:
1. Complete Draft RD/RA Workplan to install 5 new Shallow/Middle Surficial Aquifer monitoring wells, 1 replacement for well OMS-28-2, and 3 Lower Surficial Aquifer monitoring wells.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	12	$171.65	/hr	$2,128.46	
Env. Engineer - Senior	20	$166.40	/hr	$3,328.00	
Env. Engineer - Junior	80	$87.00	/hr	$6,960.00	
GIS/CADD - Mid	16	$95.50	/hr	$1,528.00	
Adm Assist/Clerical - Mid	8	$72.73	/hr	$581.84	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
			Year 1 Draft RD/RA Work Plan Subtotal	$15,026.30	
			Year 1 Draft RD/RA Work Plan Subtotal (Rounded)	**$15,000**	

Draft Final RD/RA Work Plan/Health & Safety Plan - Year 1

Includes:
1. Complete Draft RD/RA Workplan to install 5 new Shallow/Middle Surficial Aquifer monitoring wells, 1 replacement for well OMS-28-2, and 3 Lower Surficial Aquifer monitoring wells.
2. Prepare HASP.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	9	$171.65	/hr	$1,476.19	
Env. Engineer - Senior	12	$166.40	/hr	$1,996.80	
Env. Engineer - Junior	50	$87.00	/hr	$4,350.00	
GIS/CADD - Mid	16	$95.50	/hr	$1,528.00	
Adm Assist/Clerical - Mid	8	$72.73	/hr	$581.84	
CIH/Safety Manager - Mid	4	$129.69	/hr	$518.76	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
			Year 1 Draft Final RA/RD Work Plan/HASP Cost Subtotal	$10,951.59	
			Year 1 Draft Final RA/RD Work Plan/HASP Cost Subtotal (Rounded)	**$11,000**	

Table D-1
Cost Estimate for Alternative 2, Land Use Controls with Periodic Groundwater Monitoring
OMS #28
Alabama Army National Guard - Mobile, Alabama

Final RD/RA Work Plan - Year 1

Includes:

1. Complete Draft RD/RA Workplan to install 5 new Shallow/Middle Surficial Aquifer monitoring wells, 1 replacement for well OMS-28-2, and 3 Lower Surficial Aquifer monitoring wells.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	5	$171.65	/hr	$926.91	
Env. Engineer - Senior	8	$166.40	/hr	$1,331.20	
Env. Engineer - Junior	30	$87.00	/hr	$2,610.00	
GIS/CADD - Mid	8	$95.50	/hr	$764.00	
Adm Assist/Clerical - Mid	8	$72.73	/hr	$581.84	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
Year 1 Final RA/RD Work Plan/HASP Cost Subtotal				$6,713.95	
Year 1 Final RA/RD Work Plan/HASP Cost Subtotal (Rounded)				**$6,700**	

Site Prep/Clearing/Monitoring Well Installation and Development - Year 1

Includes:

1. Private utility locate.
2. Clearing of the locations for 4 new monitoring wells that will be located in heavily wooded area on Parcel F.
3. Install and develop 5 new Shallow/Middle Surficial Aquifer monitoring wells, 1 replacement for well OMS-28-2, and 3 new Lower Surficial Aquifer monitoring wells.
4. Build crush and run rock road to the 4 new monitoring wells on Parcel F to provide continued access to the wells for duration of Alternative 2.
5. Oversight provided by one mid-level geologist.

Assumptions:

1. 1 new shallow replacement monitoring well located on Parcel C.
2. 1 new shallow surficial and 1 new lower surficial monitoring well located on Parcel D.
3. 1 new shallow surfiical and 1 new deep surficial monitoring well located on Parcel E.
4. 3 new shallow surficial and 1 new deep surficial monitoring well located on Parcel F.
5. Total of 9 new monitoring wells to be installed.

Total field days (12 hour work days [M - F]) = 4

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	10	$171.65	/hr	$1,647.84	Fieldwork coordination
Env. Engineer - Senior	12	$166.40	/hr	$1,996.80	Fieldwork coordination
Geologist - Mid	64	$110.73	/hr	$7,086.72	Oversight
Contracts/Admin/Procurement - Mid	16	$111.98	/hr	$1,791.68	Procure subcontractors
CIH/Safety Manager - Mid	4	$129.69	/hr	$518.76	Safety Review
Services:					
Private utility clearance	1	$1,600.00	/day	$1,600.00	Daily Rate
Mobilization/Demobilization	1	$750.00	LS	$750.00	WHE Quote - 6/21/2023
Site Clearing for 4 Wells on Parcel F	1	$2,500.00	LS	$2,500.00	WHE Quote - 6/21/2023
Crush and Run Road for Parcel F Wells	1	$4,000.00	LS	$4,000.00	WHE Quote - 6/21/2023
DPT Rig & Crew for Well Installation	4	$3,200.00	/day	$12,800.00	WHE Quote - 6/21/2023
Per Diem	4	$600.00	/day	$2,400.00	WHE Quote - 6/21/2023
2-inch PVC Well Materials	241	$22.00	/ft	$5,302.00	WHE Quote - 6/21/2023
Decontamination Pad	1	$350.00	/ea	$350.00	WHE Quote - 6/21/2023
Surface Completion	9	$600.00	/ea	$5,400.00	WHE Quote - 6/21/2023
Bollards	27	$75.00	/ea	$2,025.00	WHE Quote - 6/21/2023
55-Gal Drums for Soil & Development Water	18	$95.00	/ea	$1,710.00	WHE Quote - 6/21/2023
Well Development	9	$250.00	/ea	$2,250.00	WHE Quote - 6/21/2023
Transportation of Drums for Disposal	1	$1,000.00	/ea	$1,000.00	WHE Quote - 6/21/2023
Disposal of Drums	18	$150.00	/ea	$2,700.00	WHE Quote - 6/21/2023
Analytical:					
TCLP VOCs	1	$150.00	/ea	$150	Waste Characterization
Travel (AECOM):					
Per Diem	4	$59.00	/day	$236.00	
Lodging	4	$100.00	/day	$400.00	
Mileage	220	$0.655	/mile	$144.10	Destin, FL to Mobile (~100 mi.)
Year 1 Site Prep/Clearing/Monitoring Well Installation and Development Subtotal				$58,758.90	
Year 1 Site Prep/Clearing/Monitoring Well Installation and Development (Rounded)				**$58,800**	

Table D-1
Cost Estimate for Alternative 2, Land Use Controls with Periodic Groundwater Monitoring
OMS #28
Alabama Army National Guard - Mobile, Alabama

Periodic Groundwater Monitoring & Reporting - Baseline (Year 1), Year 2, Year 4, and Years 6, 11, & 16

Includes:
1. Cost presented is for the individual sampling event (Baseline, Year 5, Year 10, and Year 15).
2. Sample 8 new wells, 1 replacement well OMS-28-2R, and 8 existing wells.
3. Data verification and evaluation.

4. Number of wells sampled =	17	wells	
5. Field crew =	2	personnel	
6. Sampling Duration =	2	days	(10 hr day)
7. Total VOC Samples =	21	samples	(17 wells + 10% FD + 5%MS/MSD + 10% TB)
10. Total events =	1	event	
11. Total prep/mobe/demobe time (per person) =	8	hrs	
12. Total field time with prep/mobe/demobe (per person) =	28	hrs	(10 hr days)

Data Management and QA/QC Assumptions:

Geologist - Junior	1 hr/sample
Chemist - Mid	0.75 hr/sample
Database Manager	1.5 hr/sample
Env. Engineer - Senior	0.175 hr/sample

Service/Materials	Unit	Unit Cost	Cost	Notes
Report Labor:				
Project Manager	21	$171.65 /hr	$3,604.65	
Env. Engineer - Senior	40	$166.40 /hr	$6,656.00	
Geologist - Mid	60	$110.73 /hr	$6,643.80	
Env. Engineer - Junior	40	$87.00 /hr	$3,480.00	
GIS/CADD - Mid	30	$95.50 /hr	$2,865.00	
Adm Assist/Clerical - Mid	40	$72.73 /hr	$2,909.20	
Materials:				
Document Repro/Ship (D, DF, F)	3	$500.00 /ea	$1,500.00	
Data Management Labor:				
Geologist - Junior	21	$75.71 /hr	$1,589.91	
Chemist - Mid	16	$117.02 /hr	$1,872.32	
Database Manager	32	$82.17 /hr	$2,629.44	
Env. Engineer - Senior	4	$166.40 /hr	$665.60	
Procurement:				
Contracts/Admin/Procurement - Mid	12	$111.98 /hr	$1,343.76	Procure Lab and IDW Disposal
Office Oversight:				
Project Manager	6	$171.65 /hr	$1,029.90	
Env. Engineer - Senior	4	$166.40 /hr	$665.60	
Sampling Field Labor:				
Env. Engineer - Junior	28	$87.00 /hr	$2,436.00	
Geologist - Junior	28	$75.71 /hr	$2,119.88	
Materials:				
Sampling Equipment	2	$189.75 /ea	$379.50	AECOM Equip. Rental Rate
Drums	1	$95.00 /ea	$95.00	Based on WHE Quote
IDW Transporation	1	$1000.00 /ea	$1,000.00	Based on WHE Quote
IDW Disposal	1	$150.00 /ea	$150.00	Based on WHE Quote
Analytical:				
VOCs (8260D)	21	$50.00 /ea	$1,062.50	Pace Analytical Cost
Daily Shipping	2	$100.00 /ea	$200.00	Fed Ex Cost
Travel:				
Per Diem	4	$59.00 /day	$236.00	
Lodging	4	$100.00 /day	$400.00	
Mileage	400	$0.655 /mile	$262.00	Destin, FL to Mobile (~100 mi.)
Periodic Groundwater Monitoring/Reporting Cost Subtotal(single event)			$45,796	
Periodic Groundwater Monitoring/Reporting Cost Subtotal (single event) (Rounded)			$45,800	
Periodic Groundwater Monitoring/Reporting Cost Subtotal (four events) (Rounded)			**$274,800**	

Table D-1
Cost Estimate for Alternative 2, Land Use Controls with Periodic Groundwater Monitoring
OMS #28
Alabama Army National Guard - Mobile, Alabama

Periodic LUC Surveillance/Five-Year Review - Years 6, 11, & 16

Includes:
1. One site visit for one person.
2. Assume 2 hours for mobe, 4 hours on site, and 2 hours for demobe for one junior geologist.
3. Draft, Draft-Final, and Final 5-Year Review

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	29	$171.65	/hr	$4,977.85	
Env. Engineer - Senior	60	$166.40	/hr	$9,984.00	
Env. Engineer - Mid	120	$125.27	/hr	$15,032.40	
Geologist - Junior	32	$75.71	/hr	$2,422.72	
GIS/CADD - Mid	40	$95.50	/hr	$3,820.00	
Adm Assist/Clerical - Mid	40	$72.73	/hr	$2,909.20	
Materials:					
Document Repro/Ship (D, DF, F)	3	$500.00	/ea	$1,500.00	
Travel:					
Per Diem	1	$59.00	/day	$59.00	
Lodging	0	$100.00	/day	$0.00	
Mileage	200	$0.655	/mile	$131.00	Destin, FL to Mobile (~100 mi.)
Periodic LUC Surveillance/Five-Year Review Cost Subtotal (Single Event)				$40,836.17	
Periodic LUC Surveillance/Five-Year Review Cost Subtotal (Single Event) (Rounded)				$40,800.00	
Periodic LUC Surveillance/Five-Year Review Cost Subtotal (Three Events) (Rounded)				**$122,400**	

Alternative 2 Total Cost (Rounded)	**$512,900**
Alternative 2 Total Net Present Worth Cost (Rounded)	**$403,600**
Total Contingency (20%)	**$80,700**
Alternative 2 Total Net Present Worth Cost (Rounded)	**$484,300**

Table D-1
Cost Estimate for Alternative 2
Land Use Controls with Periodic Groundwater Monitoring
OMS #28
Alabama Army National Guard - Mobile, Alabama

PRESENT WORTH SUMMARY

Alternative 2	Site:	OMS #28
Land Use Controls with	Location:	ALARNG, Mobile, AL
Periodic Monitoring	Phase:	Feasilbility Study
	Base Year:	2023

Present Value Analysis

30-year discount rate 4.2% (OMB Circular A-94 Appendix C) - Revised December 12, 2022

Year	Capital Cost	Annual O&M	Periodic Costs	Total Costs	Present Worth
0	$0	-	-	$0	$0
1	$115,700	$45,800	-	$161,500	$154,990
2	-	$45,800	-	$45,800	$42,182
3	-	-	-	$0	$0
4	-	$45,800	-	$45,800	$38,850
5	-	-	-	$0	$0
6	-	$45,800	$40,800	$86,600	$67,657
7	-	-	-	$0	$0
8	-	-	-	$0	$0
9	-	-	-	$0	$0
10	-	-	-	$0	$0
11	-	$45,800	$40,800	$86,600	$55,077
12	-	-	-	$0	$0
13	-	-	-	$0	$0
14	-	-	-	$0	$0
15	-	-	-	$0	$0
16	-	$45,800	$40,800	$86,600	$44,837
17	-	-	-	$0	$0
18	-	-	-	$0	$0
19	-	-	-	$0	$0
20	-	-	-	$0	$0
21	-	-	-	$0	$0
22	-	-	-	$0	$0
23	-	-	-	$0	$0
24	-	-	-	$0	$0
25	-	-	-	$0	$0
26	-	-	-	$0	$0
27	-	-	-	$0	$0
28	-	-	-	$0	$0
29	-	-	-	$0	$0
30	-	-	-	$0	$0
TOTALS	**$115,700**	**$274,800**	**$122,400**	**$512,900**	**$403,594**

Table D-2
Cost Estimate for Alternative 3, ERD, ISCR, and Enhanced MNA
OMS #28
Alabama Army National Guard - Mobile, Alabama

COST ESTIMATE WORKSHEET SUMMARY

Alternative 3	Site:	OMS #28
ERD, ISCR, and Enhanced MNA	Location:	ALARNG, Mobile, AL
	Phase:	Feasilbility Study
	Base Year:	2023

Labor Rates:

Project Manager	$171.65	**Travel:**		
Env. Engineer - Senior	$166.40	Per Diem	$59.00	/day
Geologist - Senior	$148.29	Lodging	$100.00	/day
Env. Engineer - Mid	$125.27	Mileage	$0.655	/mile
Geologist - Mid	$110.73	Rental Car	$85.00	/day
Env. Engineer - Junior	$87.00	Adm Assist/Clerical - Mid	$72.73	
Geologist - Junior	$75.71	Risk Assessor	$144.06	
GIS/CADD - Mid	$95.50	CIH/Safety Manager - Mid	$129.69	
Contracts/Admin/Procurement - Mid	$111.98	Chemist - Mid	$117.02	
		Database Manager	$82.17	

Draft RD/RA Work Plan - Year 1

Includes:
1. Complete Draft RD/RA Workplan for ERD, ISCR, and Enhanced MNA.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	28	$171.65	/hr	$4,806.20	
Env. Engineer - Junior	120	$87.00	/hr	$10,440.00	
Env. Engineer - Senior	80	$166.40	/hr	$13,312.00	
GIS/CADD - Mid	40	$95.50	/hr	$3,820.00	
Adm Assist/Clerical - Mid	40	$72.73	/hr	$2,909.20	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
Year 1 Draft RD/RA Work Plan Subtotal				$35,787.40	
Year 1 Draft RD/RA Work Plan Subtotal (Rounded)				**$35,800**	

Draft Final RD/RA Work Plan/Health & Safety Plan - Year 1

Includes:
1. Complete Draft Final RD/RA Workplan for ERD, ISCR, and Enhanced MNA.
2. Prepare HASP.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	20	$171.65	/hr	$3,501.66	
Env. Engineer - Junior	80	$87.00	/hr	$6,960.00	
Env. Engineer - Senior	40	$166.40	/hr	$6,656.00	
Geologist - Junior	40	$75.71	/hr	$3,028.40	
GIS/CADD - Mid	20	$95.50	/hr	$1,910.00	
Adm Assist/Clerical - Mid	20	$72.73	/hr	$1,454.60	
CIH/Safety Manager - Mid	4	$129.69	/hr	$518.76	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
Year 1 Draft Final RD/RA Work Plan/Health & Safety Plan Subtotal				$24,529.42	
Year 1 Draft Final RD/RA Work Plan/Health & Safety Plan Subtotal (Rounded)				**$24,500**	

Final RD/RA Work Plan - Year 1

Includes:
1. Complete Final RD/RA Workplan for ERD, ISCR, and Enhanced MNA.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	14	$171.65	/hr	$2,403.10	
Env. Engineer - Junior	60	$87.00	/hr	$5,220.00	
Env. Engineer - Senior	40	$166.40	/hr	$6,656.00	
GIS/CADD - Mid	20	$95.50	/hr	$1,910.00	
Adm Assist/Clerical - Mid	20	$72.73	/hr	$1,454.60	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
Year 1 Final RA/RD Work Plan Cost Subtotal				$18,143.70	
Year 1 Final RA/RD Work Plan Cost Subtotal				**$18,100**	

Table D-2
Cost Estimate for Alternative 3, ERD, ISCR, and Enhanced MNA
OMS #28
Alabama Army National Guard - Mobile, Alabama

Request for Proposal Preparation (RFP) and Contractor Selection - Year 1

Includes:
1. Prepare and issue an RFP with a standardized rate sheet for site clearing and groundwater injection activities.
2. Evaluate proposals, select contractors, and establish contracts.
3. Conduct site walk for subcontracotors. Assume 2 hours mobe, 4 hours on site, and 2 hours demobe (Florida Panhandle to Mobile, AL and back).

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	12	$171.65	/hr	$1,991.14	
Env. Engineer - Senior	60	$166.40	/hr	$9,984.00	
Env. Engineer - Junior	48	$87.00	/hr	$4,176.00	
GIS/CADD - Mid	8	$95.50	/hr	$764.00	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
Travel:					
Per Diem	1	$59.00	/day	$59.00	
Mileage	200	$0.655	/mile	$131.00	Destin to Mobile (~100 mi.)
	Year 1 RFP and Contractor Selection Subtotal			$17,605.14	
	Year 1 RFP and Contractor Selection Subtotal (Rounded)			**$17,600**	

Site Prep/Clearing/Monitoring Well Installation and Development - Year 1

Includes:

1. Private utility locate.
2. Clearing of the locations for 5 new monitoring wells that will be located in heavily wooded area on Parcel F.
3. Install and develop 8 new Shallow/Middle Surficial Aquifer monitoring wells, 1 replacement for well OMS-28-2, and 3 new Lower Surficial Aquifer monitoring wells.
4. Build crush and run rock road to the 5 new monitoring wells on Parcel F to provide continued access to the wells for duration of Alternative 3.
5. Oversight provided by one mid-level geologist.

Assumptions:

1. Approximate Parcel F area to be cleared and grubbed (acres) = 0.43
2. 1 new shallow replacement monitoring well located on Parcel C.
3. 1 new shallow surficial and 1 new lower surficial monitoring well located on Parcel D.
4. 3 new shallow surfiical and 1 new deep surficial monitoring well located on Parcel E.
5. 4 new shallow surficial and 1 new deep surficial monitoring well located on Parcel F.
6. Total of 12 new monitoring wells to be installed.

Total field days (12 hour work days [M - F]) = 7

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	15	$171.65	/hr	$2,540.42	Fieldwork coordination
Env. Engineer - Senior	20	$166.40	/hr	$3,328.00	Fieldwork coordination
Geologist - Mid	100	$110.73	/hr	$11,073.00	Oversight
Contracts/Admin/Procurement - Mid	24	$111.98	/hr	$2,687.52	Procure subcontractors
CIH/Safety Manager - Mid	4	$129.69	/hr	$518.76	Safety Review
Services:					
Private utility clearance	1	$1,600.00	/day	$1,600.00	Daily Rate
Mobilization/Demobilization	1	$750.00	/LS	$750.00	WHE Quote - 6/21/2023
Site Clearing for Injection Area on Parcel F	1	$7,500.00	LS	$7,500.00	WHE Quote - 6/21/2023
Crush and Run Road for Parcel F Wells	1	$4,500.00	LS	$4,500.00	WHE Quote - 6/21/2023
DPT Rig & Crew for Well Installation	7	$3,200.00	/day	$22,400.00	WHE Quote - 6/21/2023
Per Diem	7	$600.00	/day	$4,200.00	WHE Quote - 6/21/2023
2-inch PVC Well Materials	316	$22.00	/ft	$6,952.00	WHE Quote - 6/21/2023
Decontamination Pad	1	$350.00	/ea	$350.00	WHE Quote - 6/21/2023
Surface Completion	12	$600.00	/ea	$7,200.00	WHE Quote - 6/21/2023
Bollards	36	$75.00	/ea	$2,700.00	WHE Quote - 6/21/2023
55-Gal Drums for Soil & Development Water	24	$95.00	/ea	$2,280.00	WHE Quote - 6/21/2023
Well Development	12	$250.00	/ea	$3,000.00	WHE Quote - 6/21/2023
Transportation of Drums for Disposal	1	$1,000.00	/ea	$1,000.00	WHE Quote - 6/21/2023
Disposal of Drums	24.00	$150.00	/ea	$3,600.00	WHE Quote - 6/21/2023
Analytical:					
TCLP VOCs	2	$150.00	/ea	$300	Waste Characterization
Travel:					
Per Diem	7	$59.00	/day	$413.00	
Lodging	7	$100.00	/day	$700.00	
Mileage	270	$0.655	/mile	$176.85	Destin to Mobile (~100 mi.)
	Year 1 Site Prep/Clearing/Monitoring Well Installation and Development Subtotal			$89,769.55	
	Year 1 Site Prep/Clearing/Monitoring Well Installation and Development (Rounded)			**$89,800**	

Table D-2
Cost Estimate for Alternative 3, ERD, ISCR, and Enhanced MNA
OMS #28
Alabama Army National Guard - Mobile, Alabama

Baseline Sampling Event - Year 1

Includes:

1. Baseline GW monitoring event for VOCs for 20 wells.
2. Baseline GW monitoring event for MNA for 6 wells and for qPCR for 4 wells.
3. Data verification and evaluation (baseline results reported in RA Report).

4. Number of wells sampled =	20	wells	
5. Field crew =	2	personnel	
6. Sampling Duration =	2.5	days	(10 hr days)
7. Total VOC Samples =	25	samples	(20 wells + 10% FD + 5%MS/MSD + 10% TB)
8. Total MNA Samples =	6	samples	(6 wells with no FDs or TBs)
9. Total qPCR Samples =	4	samples	(4 wells with no FDs or TBs)
10. Total events =	1	event	
11. Total prep/mobe/demobe time (per person) =	8	hrs	
12. Total field time with prep/mobe/demobe (per person) =	33	hrs	(10 hr days)

Data Management and QA/QC Assumptions:

Geologist - Junior	1	hr/sample
Chemist - Mid	0.75	hr/sample
Database Manager	1.5	hr/sample
Env. Engineer - Senior	0.175	hr/sample

Service/Materials	Unit	Unit Cost		Cost	Notes
Data Management Labor:					
Geologist - Junior	31	$75.71	/hr	$2,347.01	
Chemist - Mid	24	$117.02	/hr	$2,808.48	
Database Manager	47	$82.17	/hr	$3,861.99	
Env. Engineer - Senior	6	$166.40	/hr	$998.40	
Procurement:					
Contracts/Admin/Procurement - Mid	12	$111.98	/hr	$1,343.76	Procure Lab and IDW Disposal
Office Oversight:					
Project Manager	7	$171.65	/hr	$1,201.55	
Env. Engineer - Senior	4	$166.40	/hr	$665.60	
Sampling Field Labor:					
Env. Engineer - Junior	33	$87.00	/hr	$2,871.00	
Geologist - Junior	33	$75.71	/hr	$2,498.43	
Materials:					
Sampling Equipment	2	$182.93	/ea	$365.86	AECOM Equip. Rental Rate
Drums	2	$95.00	/ea	$190.00	Based on WHE Quote
IDW Management:					
IDW Transporation	1	$1000.00	/ea	$1,000.00	Based on WHE Quote
IDW Disposal	1	$150.00	/ea	$150.00	Based on WHE Quote
Analytical:					
VOCs (8260D)	25	$50.00	/ea	$1,250.00	Pace Analytical Cost
Dissolved Iron	6	$15.00	/ea	$90.00	Pace Analytical Cost
Total Iron	6	$15.00	/ea	$90.00	Pace Analytical Cost
Methane, Ethane, Ethene	6	$65.00	/ea	$390.00	Pace Analytical Cost
Total Organic Carbon	6	$25.00	/ea	$150.00	Pace Analytical Cost
Total Alkalinity	6	$15.00	/ea	$90.00	Pace Analytical Cost
DHC/DHB	4	$375.00	/ea	$1,500.00	Microbial Insights cost
Daily Shipping	3	$100.00	/ea	$300.00	Fed Ex cost
Travel:					
Per Diem	5	$59.00		$295.00	
Lodging	5	$100.00		$500.00	
Mileage	420	$0.655		$275.10	Destin, FL to Mobile (~100 mi.)
		Year 1 Baseline Sampling Cost Subtotal		$25,232.18	
		Year 1 Baseline Sampling Cost Subtotal (Rounded)		**$25,200**	

Table D-2
Cost Estimate for Alternative 3, ERD, ISCR, and Enhanced MNA
OMS #28
Alabama Army National Guard - Mobile, Alabama

First ERD/ICSR Injection Event - Year 2

Includes:

1. One injection event with 201 injection points based on 15-foot spacing between the points.
2. Injection intervals (60 points between 6 and 14 ft bgs, 127 points between 14 and 26 ft bgs, 14 points between 27 and 31 ft bgs).
3. Individual injections are conducted every 2 vertical feet apart over the entire injection interval in a bottom-to-top approach.
4. 100 lbs ABC+Ole, 10 lbs magnesium oxide, 2 lbs guar, 0.25 liters RTB-1, and 0.025 lbs sodium sulfite in approximately 50 gallons of water per injection interval.
5. Estimated injection total of 1,600 gallons per day.
6. Estimate of 49 days to complete. 44 days of injection and 5 days of mobe/set up/demobe. Three injection crew members with oversight by Mid-level Engineer.

Service/Materials	Unit	Unit Cost		Cost	Notes
Office Labor:					
Project Manager	4	$171.65	/hr	$686.60	
Env. Engineer - Senior	40	$166.40	/hr	$6,656.00	Coordination for field work
Contracts/Admin/Procurement - Mid	4	$111.98	/hr	$447.92	Finalize procurement
Field Labor:					
Env. Engineer - Mid	490	$125.27	/hr	$61,382.30	10 hour days for 49 days
Travel:					
Per Diem	49	$59.00	/day	$2,891.00	
Lodging	49	$100.00	/day	$4,900.00	
Mileage	850	$0.655	/mile	$556.75	Destin, FL to Mobile (~100 mi.)
Injection Subcontractor:					
Project Management	1	$2,500.00	/LS	$2,500.00	Redox Tech, LLC quote
Mobe/Demobe	5	$3,500.00	/day	$17,500.00	Redox Tech, LLC quote
DPT Injection (3-person crew)	44	$5,500.00	/day	$242,000.00	Redox Tech, LLC quote
Materials:					
ABC+Ole	139,000	$1.50	/lb	$208,500.00	Redox Tech, LLC quote
Magnesium Oxide (pH buffer)	13,900	$0.75	/lb	$10,425.00	Redox Tech, LLC quote
Guar	2,780	$2.75	/lb	$7,645.00	Redox Tech, LLC quote
RTB-1	347.5	$140.00	/liter	$48,650.00	Redox Tech, LLC quote
Sodium Sulfite	35	$2.00	/lb	$70.00	Redox Tech, LLC quote
		Year 2 First Injection Event Cost Subtotal		$614,810.57	
		Year 2 First Injection Event Cost Subtotal (Rounded)		**$614,800**	

Post-First Injection Quarterly Performance Monitoring - Year 2

Assumptions:
1. Four quarterly performance monitoring events conducted by two staff.
2. The same 20 wells sampled during the baseline sampling event will be sampled for the same parameters with the same assumptions.
3. Cost will be the same as the baseline sampling event multiplied by four sampling events.

Year 2 Post-Injection Quarterly Monitoring Event Cost Subtotal	$100,928.74
Year 2 Post-Injection Quarterly Monitoring Event Cost Subtotal (Rounded)	**$100,900**

Draft RA Report - Year 2

Includes:
1. Complete Draft RA Report that summarizes the baseline sampling event and the first ERD/ISCR event.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	26	$171.65	/hr	$4,462.90	
Env. Engineer - Senior	60	$166.40	/hr	$9,984.00	
Env. Engineer - Mid	120	$125.27	/hr	$15,032.40	
GIS/CADD - Mid	40	$95.50	/hr	$3,820.00	
Adm Assist/Clerical - Mid	40	$72.73	/hr	$2,909.20	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
		Year 2 Draft RA Report Cost Subtotal		$36,708.50	
		Year 2 Draft RA Report Cost Subtotal (Rounded)		**$36,700**	

Draft Final RA Report - Year 2

Includes:
1. Complete Draft Final RA Report that summarizes the baseline sampling event and the first ERD/ISCR event.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	13	$171.65	/hr	$2,231.45	
Env. Engineer - Senior	30	$166.40	/hr	$4,992.00	
Env. Engineer - Mid	60	$125.27	/hr	$7,516.20	
GIS/CADD - Mid	20	$95.50	/hr	$1,910.00	
Adm Assist/Clerical - Mid	20	$72.73	/hr	$1,454.60	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
		Year 2 Draft Final RA Report Cost Subtotal		$18,604.25	
		Year 2 Draft Final RA Report Cost Subtotal (Rounded)		**$18,600**	

Table D-2
Cost Estimate for Alternative 3, ERD, ISCR, and Enhanced MNA
OMS #28
Alabama Army National Guard - Mobile, Alabama

Final RA Report - Year 2

Includes:
1. Complete Final RA Report that summarizes the baseline sampling event and the first ERD/ISCR event.

Service/Materials	Unit	Unit Cost		Cost
Labor:				
Project Manager	10	$171.65	/hr	$1,716.50
Env. Engineer - Senior	40	$166.40	/hr	$6,656.00
Env. Engineer - Mid	40	$125.27	/hr	$5,010.80
GIS/CADD - Mid	20	$95.50	/hr	$1,910.00
Adm Assist/Clerical - Mid	20	$72.73	/hr	$1,454.60
Materials:				
Document Reproduction	1	$500.000	/ea	$500.00
		Year 2 Final RA Report Cost Subtotal		$17,247.90
		Year 2 Final RA Report Cost Subtotal (Rounded)		**$17,200**

Post-First Injection Semi-Annual Performance Monitoring - Year 3

Assumptions:
1. Two semi-annual performance monitoring events conducted by two staff.
2. The same 20 wells sampled during the baseline sampling event will be sampled for the same parameters with the same assumptions.
3. Cost will be the same as the baseline sampling event multiplied by two sampling events.

Year 3 Post-Injection Semi-Annual Monitoring Event Cost Subtotal	$50,464.37
Year 3 Post-Injection Semi-Annual Monitoring Event Cost Subtotal (Rounded)	**$50,500**

Draft RA-O Report - Year 3

Includes:
1. Complete Draft RA-O Report.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	26	$171.65	/hr	$4,462.90	
Env. Engineer - Senior	60	$166.40	/hr	$9,984.00	
Env. Engineer - Mid	120	$125.27	/hr	$15,032.40	
GIS/CADD - Mid	40	$95.50	/hr	$3,820.00	
Adm Assist/Clerical - Mid	40	$72.73	/hr	$2,909.20	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
		Year 3 Draft RA-O Report Cost Subtotal		$36,708.50	
		Year 3 Draft RA-O Report Cost Subtotal (Rounded)		**$36,700**	

Draft Final RA-O Report - Year 3

Includes:
1. Complete Draft Final RA-O Report.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	13	$171.65	/hr	$2,231.45	
Env. Engineer - Senior	30	$166.40	/hr	$4,992.00	
Env. Engineer - Mid	60	$125.27	/hr	$7,516.20	
GIS/CADD - Mid	20	$95.50	/hr	$1,910.00	
Adm Assist/Clerical - Mid	20	$72.73	/hr	$1,454.60	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
		Year 3 Draft Final RA-O Report Cost Subtotal		$18,604.25	
		Year 3 Draft Final RA-O Report Cost Subtotal (Rounded)		**$18,600**	

Final RA-O Report - Year 3

Includes:
1. Complete Final RA-O Report.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	10	$171.65	/hr	$1,716.50	
Env. Engineer - Senior	40	$166.40	/hr	$6,656.00	
Env. Engineer - Mid	40	$125.27	/hr	$5,010.80	
GIS/CADD - Mid	20	$95.50	/hr	$1,910.00	
Adm Assist/Clerical - Mid	20	$72.73	/hr	$1,454.60	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
		Year 3 Final RA-O Report Cost Subtotal		$17,247.90	
		Year 3 Final RA-O Report Cost Subtotal (Rounded)		**$17,200**	

Table D-2
Cost Estimate for Alternative 3, ERD, ISCR, and Enhanced MNA
OMS #28
Alabama Army National Guard - Mobile, Alabama

Post-First Injection Annual Performance Monitoring - Year 4

Assumptions:
1. One annual performance monitoring event conducted by two staff.
2. The same 20 wells sampled during the baseline sampling event will be sampled for the same parameters with the same assumptions.
3. Cost will be the same as the baseline sampling event.
4. RA-O report will provide details for a second ERD/ISCR injection event and the associated monitoring details.

Year 4 Post-Injection Annual Monitoring Event Cost Subtotal	$25,232.18
Year 4 Post-Injection Annual Monitoring Event Cost Subtotal (Rounded)	**$25,200**

Draft RA-O Report - Year 4

Includes:
1. Complete Draft RA-O Report.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	26	$171.65	/hr	$4,462.90	
Env. Engineer - Senior	60	$166.40	/hr	$9,984.00	
Env. Engineer - Mid	120	$125.27	/hr	$15,032.40	
GIS/CADD - Mid	40	$95.50	/hr	$3,820.00	
Adm Assist/Clerical - Mid	40	$72.73	/hr	$2,909.20	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
Year 4 Draft RA-O Report Cost Subtotal				$36,708.50	
Year 4 Draft RA-O Report Cost Subtotal (Rounded)				**$36,700**	

Draft Final RA-O Report - Year 4

Includes:
1. Complete Draft Final RA-O Report.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	13	$171.65	/hr	$2,231.45	
Env. Engineer - Senior	30	$166.40	/hr	$4,992.00	
Env. Engineer - Mid	60	$125.27	/hr	$7,516.20	
GIS/CADD - Mid	20	$95.50	/hr	$1,910.00	
Adm Assist/Clerical - Mid	20	$72.73	/hr	$1,454.60	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
Year 4 Draft Final RA-O Report Cost Subtotal				$18,604.25	
Year 4 Draft Final RA-O Report Cost Subtotal (Rounded)				**$18,600**	

Final RA-O Report - Year 4

Includes:
1. Complete Final RA-O Report.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	10	$171.65	/hr	$1,716.50	
Env. Engineer - Senior	40	$166.40	/hr	$6,656.00	
Env. Engineer - Mid	40	$125.27	/hr	$5,010.80	
GIS/CADD - Mid	20	$95.50	/hr	$1,910.00	
Adm Assist/Clerical - Mid	20	$72.73	/hr	$1,454.60	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
Year 4 Final RA-O Report Cost Subtotal				$17,247.90	
Year 4 Draft RA-O Report Cost Subtotal (Rounded)				**$17,200**	

Table D-2
Cost Estimate for Alternative 3, ERD, ISCR, and Enhanced MNA
OMS #28
Alabama Army National Guard - Mobile, Alabama

Second ERD/ICSR Injection Event - Year 5

Includes:

1. One injection event with 100 injection points based on 15-foot spacing between the points.
2. Injection intervals (30 points between 6 and 14 ft bgs, 62 points between 14 and 26 ft bgs, 8 points between 27 and 31 ft bgs).
3. Individual injections are conducted every 2 vertical feet apart over the entire injection interval in a bottom-to-top approach.
4. 100 lbs ABC+Ole, 10 lbs magnesium oxide, 2 lbs guar, 0.25 liters RTB-1, and 0.025 lbs sodium sulfite in approximately 50 gallons of water per injection interval.
5. Estimated completion of 1,600 gallons of injectate per day
6. Estimate 25 days to complete. 23 days of field work and 2 days of mobe/demobe. Three injection crew members with oversight by Jr. Engineer.

Service/Materials	Unit	Unit Cost		Cost	Notes
Office Labor:					
Project Manager	5	$171.65	/hr	$858.25	
Env. Engineer - Senior	40	$166.40	/hr	$6,656.00	Coordination for field work
Contracts/Admin/Procurement - Mid	8	$111.98	/hr	$895.84	Finalize procurement
Field Labor:					
Env. Engineer - Junior	250	$87.00	/hr	$21,750.00	10 hour days for 25 days
Travel:					
Per Diem	25	$59.00	/day	$1,475.00	
Lodging	25	$100.00	/day	$2,500.00	
Mileage	430	$0.655	/mile	$281.65	Destin, FL to Mobile (~100 mi.)
Injection Subcontractor:					
Project Management	1	$2,500.00	/LS	$2,500.00	Based on Redox Tech quote
Mobe/Demobe	2	$3,500.00	/day	$7,000.00	Based on Redox Tech quote
DPT Injection (3-person crew)	23	$5,500.00	/day	$126,500.00	Based on Redox Tech quote
Materials:					
ABC+Ole	68,800	$1.50	/lb	$103,200.00	Based on Redox Tech quote
Magnesium Oxide (pH buffer)	6,880	$0.75	/lb	$5,160.00	Based on Redox Tech quote
Guar	1,376	$2.75	/lb	$3,784.00	Based on Redox Tech quote
RTB-1	172	$140.00	/liter	$24,080.00	Based on Redox Tech quote
Sodium Sulfite	17	$2.00	/lb	$34.00	Based on Redox Tech quote
	Year 5 Second Injection Event Cost Subtotal			$306,674.74	
	Year 5 Second Injection Event Cost Subtotal (Rounded)			**$306,700**	

Table D-2
Cost Estimate for Alternative 3, ERD, ISCR, and Enhanced MNA
OMS #28
Alabama Army National Guard - Mobile, Alabama

Post Second-Injection Quarterly Sampling Event - Year 5

Includes:
1. GW monitoring event for VOCs for 12 wells.
2. GW monitoring event for MNA for 4 wells and for qPCR for 2 wells.
3. Data verification and evaluation (results reported in RA-O Report).

4. Number of wells sampled =	12	wells	
5. Field crew =	2	personnel	
6. Sampling Duration =	1.5	days	(10 hr days)
7. Total VOC Samples =	15	samples	(12 wells + 10% FD + 5%MS/MSD + 10% TB)
8. Total MNA Samples =	4	samples	(4 wells with no FDs or TBs)
9. Total qPCR Samples =	2	samples	(2 wells with no FDs or TBs)
10. Total event =	1	events	
11. Total prep/mobe/demobe time =	8	hrs	
12. Total field time with prep/mobe/demobe =	23	hrs	(10 hr days)

Data Management and QA/QC Assumptions:

Geologist - Junior	1	hr/sample
Chemist - Mid	0.75	hr/sample
Database Manager	1.5	hr/sample
Env. Engineer - Senior	0.175	hr/sample

Service/Materials	Unit	Unit Cost		Cost	Notes
Data Management Labor:					
Geologist - Junior	19	$75.71	/hr	$1,438.49	
Chemist - Mid	15	$117.02	/hr	$1,755.30	
Database Manager	29	$82.17	/hr	$2,382.93	
Env. Engineer - Senior	4	$166.40	/hr	$665.60	
Procurement:					
Contracts/Admin/Procurement - Mid	6	$111.98	/hr	$671.88	Procure Lab and IDW Disposal
Office Oversight:					
Project Manager	5	$171.65	/hr	$858.25	
Env. Engineer - Senior	4	$166.40	/hr	$665.60	
Sampling Field Labor:					
Env. Engineer - Junior	23	$87.00	/hr	$2,001.00	
Geologist - Junior	23	$75.71	/hr	$1,741.33	
Materials:					
Sampling Equipment	2	$179.57	/ea	$359.14	AECOM Equip. Rental Rate
Drums	1	$95.00	/ea	$95.00	Based on WHE Quote
IDW Management:					
IDW Transporation	1	$1000.00	/ea	$1,000.00	Based on WHE Quote
IDW Disposal	1	$150.00	/ea	$150.00	Based on WHE Quote
Analytical:					
VOCs	15	$50.00	/ea	$750.00	Based on Pace Analytical
Dissolved Iron	4	$15.00	/ea	$60.00	Based on Pace Analytical
Total Iron	4	$15.00	/ea	$60.00	Based on Pace Analytical
Methane, Ethane, Ethene	4	$65.00	/ea	$260.00	Based on Pace Analytical
Total Organic Carbon	4	$25.00	/ea	$100.00	Based on Pace Analytical
Total Alkalinity	4	$15.00	/ea	$60.00	Based on Pace Analytical
DHC/DHB	2	$375.00	/ea	$750.00	Based on Pace Analytical
Daily Shipping	2	$100.00	/ea	$200.00	Fed Ex Cost
Travel:					
Per Diem	4	$59.00		$236.00	
Lodging	4	$100.00		$400.00	
Mileage	210	$0.655		$137.55	
Year 5 Post-Second Injection Event Quarterly Sampling Cost Subtotal (1 event)				$16,798.07	
Year 5 Post-Second Injection Event Sampling Cost Subtotal (4 events)				$67,192.30	
Year 5 Post-Second Injection Event Sampling Cost Subtotal (4 events) (Rounded)				**$67,200**	

RA-O Report - Year 5

Assumptions:

1. Cost of Draft, Draft Final, and Final RA-O Report together.
2. 75% of the total cost ($72,500) to do the Draft, Draft Final, and Final RA-O Reports following the first injection event.

Year 5 RA-O Report Subtotal (Rounded) **$54,375**

Table D-2
Cost Estimate for Alternative 3, ERD, ISCR, and Enhanced MNA
OMS #28
Alabama Army National Guard - Mobile, Alabama

CERCLA Five-Year Review - Year 5

Includes:
1. One site visit for one person.
2. Assume 2 hours for mobe, 4 hours on site, 2 hours demobe for site visit.
3. Draft, Draft-Final, and Final 5-Year Review

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	27	$171.65	/hr	$4,634.55	
Env. Engineer - Junior	120	$87.00	/hr	$10,440.00	
Env. Engineer - Mid	60	$125.27	/hr	$7,516.20	
Geologist - Junior	8	$75.71	/hr	$605.68	
GIS/CADD - Mid	30	$95.50	/hr	$2,865.00	
Adm Assist/Clerical - Mid	40	$72.73	/hr	$2,909.20	
Materials:					
Document Repro/Ship (D, DF, F)	3	$500.00	/ea	$1,500.00	
Travel:					
Per Diem	1	$59.00	/day	$59.00	
Lodging	0	$100.00	/day	$0.00	
Mileage	200	$0.655	/mile	$131.00	Destin, FL to Mobile, AL
		CERCLA Five-Year Review Cost Subtotal		$30,660.63	
		CERCLA Five-Year Review Cost Subtotal (Rounded)		**$30,700**	

Post Second-Injection Semi-Annual Sampling Event - Year 6

Assumptions:
1. Two semi-annual performance monitoring events conducted by two staff.
2. The same 12 wells sampled during the Year 5 sampling events will be sampled for the same parameters with the same assumptions.
3. Cost will be the same as one Year 5 quarterly sampling event multiplied by two sampling events.

Year 6 Post-Injection Semi-Annual Monitoring Event Cost Subtotal $33,596.15

Year 6 Post-Injection Semi-Annual Monitoring Event Cost Subtotal (Rounded) $33,600

RA-O Report - Year 6

Assumptions:

1. Rolls cost of Draft, Draft Final, and Final RA-O Report together.
2. 75% of the total cost ($72,500) to do the Draft, Draft Final, and Final RA-O Reports following the first injection event.

Year 6 RA-O Report Subtotal (Rounded) $54,375

Post Second-Injection Annual Sampling Event - Year 7

Assumptions:
1. One annual performance monitoring events conducted by two staff.
2. The same 12 wells sampled during the Year 5 & 6 sampling events will be sampled for the same parameters with the same assumptions.
3. Cost will be the same as one Year 5 quarterly sampling event.

Year 7 Post-Injection Semi-Annual Monitoring Event Cost Subtotal $16,798.07

Year 7 Post-Injection Semi-Annual Monitoring Event Cost Subtotal (Rounded) $16,800

Draft RA Completion Report - Year 7

Includes:
1. Complete Draft RA Completion Report.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	28	$171.65	/hr	$4,806.20	
Env. Engineer - Senior	80	$166.40	/hr	$13,312.00	
Env. Engineer - Mid	120	$125.27	/hr	$15,032.40	
GIS/CADD - Mid	40	$95.50	/hr	$3,820.00	
Adm Assist/Clerical - Mid	40	$72.73	/hr	$2,909.20	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
		Year 7 Draft RA Completion Report Cost Subtotal		$40,379.80	
		Year 7 Draft RA Completion Report Cost Subtotal (Rounded)		**$40,400**	

Table D-2
Cost Estimate for Alternative 3, ERD, ISCR, and Enhanced MNA
OMS #28
Alabama Army National Guard - Mobile, Alabama

Draft Final RA Completion Report - Year 7

Includes:
1. Complete Draft Final RA Completion Report.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	14	$171.65	/hr	$2,403.10	
Env. Engineer - Senior	40	$166.40	/hr	$6,656.00	
Env. Engineer - Mid	60	$125.27	/hr	$7,516.20	
GIS/CADD - Mid	20	$95.50	/hr	$1,910.00	
Adm Assist/Clerical - Mid	20	$72.73	/hr	$1,454.60	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
Year 7 Draft Final RA Completion Report Cost Subtotal				$20,439.90	
Year 7 Draft Final RA Completion Report Cost Subtotal (Rounded)				**$20,400**	

Final RA Completion Report - Year 7

Includes:
1. Complete Final RA Completion Report.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	10	$171.65	/hr	$1,716.50	
Env. Engineer - Senior	40	$166.40	/hr	$6,656.00	
Env. Engineer - Mid	40	$125.27	/hr	$5,010.80	
GIS/CADD - Mid	20	$95.50	/hr	$1,910.00	
Adm Assist/Clerical - Mid	20	$72.73	/hr	$1,454.60	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
Year 7 Final RA Completion Report Cost Subtotal				$17,247.90	
Year 7 Final RA Completion Report Cost Subtotal (Rounded)				**$17,200**	

Monitoring Well Abandonment - Year 7

Includes:
1. Abandonment of all site monitoring wells (22 total). Includes 2 deep wells that are not part of the proposed monitoring program.
2. Well abandonment (2 days with consultant oversight).
3. Oversight of disposal of 2 drums of non-hazardous water (1 day).

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor (Well Abandonment):					
Project Manager	4	$171.65	/hr	$686.60	
Geologist - Junior	28	$75.71	/hr	$2,119.88	Well abandon & IDW oversight
Contracts/Admin/Procurement - Mid	8	$111.98	/hr	$895.84	Subcontractor produrment
Travel:					
Per Diem	3	$59.00	/day	$177.00	
Lodging	1	$100.00	/day	$100.00	
Mileage	400	$0.66	/mile	$262.00	Destin, FL to Mobile, AL
Drilling Subcontractor Services:					
Project Mobe/Demobe	1	$750.00	/ea	$750.00	WHE Quote - 6/21/2023
Well Abanonment	607	$5.00	/LF	$3,032.50	
Decontamination Pad	1	$350.00	LS	$350.00	WHE Quote - 6/21/2023
Per Diem	2	$600.00	/day	$1,200.00	WHE Quote - 6/21/2023
55-Gal Drums for Soil & Water	2	$95.00	/ea	$190.00	WHE Quote - 6/21/2023
Transportation of Drums for Disposal	1	$1,000.00	/ea	$1,000.00	WHE Quote - 6/21/2023
Disposal of Drums	2	$150.00	/ea	$300.00	WHE Quote - 6/21/2023
Analytical:					
TCLP VOCs	1	$150.00	/ea	$150	Waste Characterization
Year 7 Monitoring Well Abandonment Subtotal				$11,213.82	
Year 7 Monitoring Well Abandonment Subtotal (Rounded)				**$11,200**	

Table D-2
Cost Estimate for Alternative 3, ERD, ISCR, and Enhanced MNA
OMS #28
Alabama Army National Guard - Mobile, Alabama

Owner Cost

Includes:
1. Initiate
2. Contract
3. Oversee
4. Direct
5. Implement
6. Closeout
7. One quarter of total Owner Cost applied as Periodic Cost in Year 0, Year 2, Year 4, and Year 7 of the Present Worth Value cost spreadsheet.

Owner Cost (11% of total alternative cost)	$206,013.50
Owner Cost (Rounded)	**$206,000**

Alternative 3 Total Cost (Rounded)	**$2,078,900**
Alternative 3 Total Net Present Worth (Rounded)	**$1,823,100**
Total Contingency (20%)	**$364,600**
Alternative 3 Total Net Present Worth Cost (Rounded)	**$2,187,700**

Table D-2
Cost Estimate for Alternative 3
ERD, ISCR, and Enhanced MNA
OMS #28
Alabama Army National Guard - Mobile, Alabama

PRESENT WORTH SUMMARY

Alternative 3	Site:	OMS #28
ERD, ISCR, and	Location:	ALARNG, Mobile, AL
Enhanced MNA	Phase:	Feasilbility Study
	Base Year:	2023

Present Value Analysis

30-year discount rate (i) 4.2% (OMB Circular A-94 Appendix C) - Revised December 12, 2022

Year	Capital Cost	Annual O&M	Periodic Costs	Total Costs	Present Worth
0	$0	-	$51,500	$51,500	$51,500
1	$211,000	-	-	$211,000	$202,495
2	$614,800	$173,400	$51,500	$839,700	$773,372
3		$123,000	-	$123,000	$108,718
4	-	$97,700	$51,500	$149,200	$126,560
5	$306,700	$121,575	$30,700	$458,975	$373,637
6	-	$87,975	-	$87,975	$68,731
7	-	$94,800	$62,700	$157,500	$118,088
TOTALS	**$1,132,500**	**$698,450**	**$247,900**	**$2,078,850**	**$1,823,103**

APPENDIX E

Groundwater COC Degradation Rate Estimates

Groundwater TCE Degradation Rate Estimates

OMS #28

Contract No.: W91278-20-D-0020
Delivery Order/Call No. W91278-20-D-0020

Prepared for:
United States Army Corps of Engineers, Mobile District
United States Army National Guard

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June 2022

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LIST OF ATTACHMENTS

ATTACHMENT	TITLE
1	First-Order Decay Rate Estimates
2	Literature-Derived Decay Rate Estimates

LIST OF ABBREVIATIONS AND ACRONYMS

µg/L	micrograms per liter
ALARNG	Alabama Army National Guard
cis-1,2-DCE	cis-1,2-dichloroethene
COC	Chemicals of Concern
ERD	Enhanced Reductive Dechlorination
FS	Feasibility Study
ISCR	In Situ Chemical Reduction
MCL	Maximum Contaminant Level
MNA	Monitored Natural Attenuation
MW	Monitoring Well
OMS #28	Organizational Maintenance Shop # 28
PCE	Tetrachloroethene
RGs	Remedial Goals
TCE	Trichloroethene
VC	Vinyl Chloride

1.0 INTRODUCTION

In the Feasibility Study (FS) for Operational Maintenance Shop # 28 (OMS #28), Alternative 3 (Enhanced Reductive Dechlorination [ERD], In Situ Chemical Reduction [ISCR] and Enhanced Monitored Natural Attenuation [MNA]) actively addresses site-specific groundwater chemicals of concern (COCs) associated with historical activities conducted by Alabama Army National Guard (ALARNG) at OMS #28 (Parcel E). These COCs include trichloroethene (TCE) and its associated breakdown products cis-1,2-dichloroethene (cis-1,2-DCE) and vinyl chloride (VC). An estimated time to meet the remedial goals (RGs) established in the FS for TCE in groundwater is developed in the following subsections. Note that cis-1,2-DCE and VC have never been detected in groundwater impacted by historical ALARNG activities conducted at OMS #28.

1.1 FIRST-ORDER DECAY RATE CALCULATION METHOD

Based on site investigative work completed prior to 2015, the potential source area for the TCE plume that emanates from ALARNG property appears to be the gravel parking area located within the vicinity of monitoring well (MW)-8. For Alternative 3, a site-specific degradation rate was first calculated using the first-order decay rate calculation method based upon analytical data collected from OMS-28-3, which is located approximately 50 feet north of the TCE source area.

Only two other wells have TCE in them besides OMS-28-3. MW-08, which is located in the TCE source area on ALARNG property, had TCE detected at a concentration (0.373 micrograms per liter [µg/L]) that was less than the maximum contaminant level (MCL) of 5 µg/L the last time it was sampled in May 2017. As a result, MW-08 has already met the RG for groundwater, and a degradation rate calculation is unnecessary. OMS-28-5 has consistently had tetrachloroethene (PCE), TCE, and cis-1,2-DCE detected in it; however, as explained in **Appendix C**, PCE and its breakdown products including TCE and cis-1,2-DCE are related to an offsite PCE spill that is not related to historical ALARNG activities conducted at OMS #28. Therefore, a first-order decay rate was also not developed for this monitoring well.

The results of the evaluation for OMS-28-3 indicated a slightly decreasing degradation trend for TCE. Because the concentration (9.6 µg/L) of TCE detected in this well in May 2017 was only slightly above the MCL, the estimated time to clean up was 3.1 years. However, a review of the concentrations of TCE in source area groundwater detected during the Supplemental Data Gap Investigation via direct push technology sampling indicated that the highest concentration of TCE near the ALARNG property source area was detected at OMS-28-GW07 at a concentration of 310 µg/L. Using this concentration, the estimated time to reach the MCL for TCE was 19.6 years. **Attachment 1** contains the first-order decay rate calculations for OMS-28-3.

Upon further review of these results, it can be seen that the regression line R-squared value calculated for TCE was poor (0.4018). The R-squared value is a statistical measure of how close the data fits to the plotted COC degradation regression line. As a result, the predicted time to reach the RG of the MCL for TCE in site groundwater is highly uncertain based on the groundwater results for OMS-28-3. As such, another method to estimate the time for TCE to meet the MCL was evaluated.

1.2 LITERATURE-BASED ESTIMATION METHOD

The site-specific first-order decay rate calculation result described in Section 1.1 appears to be artificially high and suspect due to the large scatter in the data. A slower degradation rate would be expected based on the characteristics of the TCE groundwater plume, which include being oxidative and also somewhat acidic. For highly oxidized compounds such as TCE, natural attenuation under these conditions would be expected to be slow. Natural attenuation of this plume would primarily be a function of non-destructive mechanisms such as mechanical dispersion, advection, and dilution rather than destructive biological processes, which would be inhibited by the ambient site groundwater conditions. The length of time that the site-related groundwater COCs have remained in groundwater at OMS #28 is also indicative of a lack of ongoing destructive biological degradation. As a result, an estimate for the rate of degradation of the TCE plume was calculated based on using the most conservative (i.e., longest) published half-lives available for this compound, which were found in the *Handbook of Environmental Degradation Rates* (Howard et al., 1991).

For TCE, its half-life in groundwater ranged between 10.7 months and 4.5 years. The highest concentration of TCE detected for the plume that emanates from the ALARNG property was observed at temporary groundwater sampling location OMS-28-GW07 in May 2017. Conservatively using the longest half-life for TCE, it was estimated that it would take almost 27 years, starting in June 2017, to reach the RG of 5 µg/L for TCE in the year 2044 (**Attachment 2**). Assuming that the FS, Proposed Plan, and Decision Document are all concurred with by the end of 2025, it is estimated that it would take a little over 18 years to achieve the RG for TCE. It should be noted that these estimated time frames assume that there is not an ongoing contributing source of these COCs to the impacted groundwater, and they do not take into account the effects of potential matrix back diffusion.

Based upon a subsequent literature review, a degradation rate for TCE via the proposed ERD, ISCR, and Enhanced MNA remedial alternative was also estimated. In the article *Enhanced Bioremediation Field Experience: Using Observed Half Lives in Design and Prediction* (Moreno et. al., 2015), it was observed that degradation half-lives were approximately ten times faster when using zero valent iron than without it. As such, the degradation half-live for TCE was increased by 10 times for this alternative. The predicted time for TCE to reach its RG assuming that the first injection event would occur in 2027 was a little over 2.5 years (**Attachment 2**). This allows for one year after the approval of the Decision Document at the end of 2025 in order to prepare a Remedial Design/Remedial Action Work Plan for the proposed injection work. This estimated timeframe assumes that contact between the injected ERD/ISCR project and the targeted TCE plume can be adequately achieved. To be conservative, at least two ERD/ISCR injection events are recommended.

In total, the duration of Alternative 3 (ERD, ISCR, and Enhanced MNA) is expected to be approximately 7 years.

2.0 REFERENCES

Howard et al., 1991. Handbook of Environmental Degradation Rates, Lewis Publishers, Chelsea, Michigan.

Moreno et. al., 2015. Enhanced Bioremediation Field Experience: Using Observed Half Lives in Design and Prediction ..\..\Moreno et al_Using Observed Half Lives in Design and Prediction.pdf

Attachments

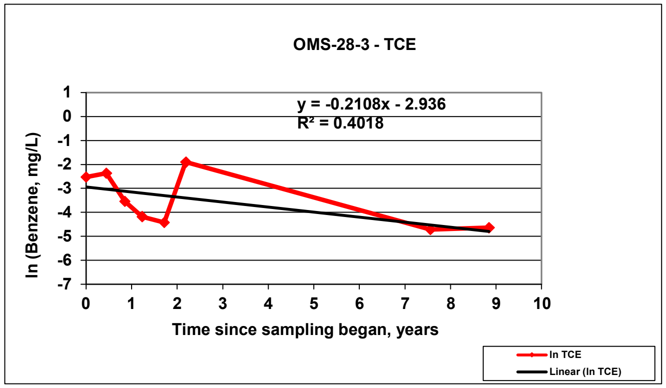
Attachment 1
First-Order Decay Rate Estimates

Attachment 1
First-Order Decay Rate Calculation for TCE in OMS-28-3
OMS #28
Alabama Army National Guard, Mobile, Alabama

Facility Name: **OMS #28**

Well ID: **OMS-28-3, OMS-GW32**

Sampling Date	Depth to Ground Water feet	TCE OMS-28-3 mg/L	TCE OMS-28-3 ug/L	ln TCE OMS-28-3 mg/L	Elapsed time since 7/1/08 years
1-Jul-08		0.0800	80	-2.526	0.00
11-Dec-08		0.0940	94	-2.364	0.45
8-May-09		0.0290	29	-3.540	0.85
24-Sep-09		0.0153	15.29	-4.181	1.23
19-Mar-10		0.0120	12	-4.423	1.72
8-Sep-10		0.1490	149	-1.904	2.19
20-Jan-16		0.0089	8.92	-4.719	7.56
5-May-17		0.0096	9.6	-4.646	8.85
MCL		***0.005***	***5***	***-5.298317367***	



Formula

$t = -[\ln(C_{CL}/C_o)] / k_{point}$

where:

t = Time to achieve cleanup levels, years
C_{CL} = Cleanup level for contaminant of concern, mg/L
C_o = Initial concentration of contaminant of concern, mg/L
k_{point} = First-order decay rate constant at one monitoring point, years^{-1}
= slope of the trend line, y

Solutions - Note: R2 value indicates data is not a good fit; use predictions with caution

OMS-28-3, TCE			
Enter C_{CL}	⟹	**0.005**	
Enter C_o	⟹	**0.0096**	
Enter k_{point}	⟹	**0.2108**	
Estimated time to reach cleanup level		**3.1**	**years**

Solutions - Note: R2 value indicates data is not a good fit; use predictions with caution

OMS-28-GW07, TCE			
Enter C_{CL}	⟹	**0.005**	
Enter C_o	⟹	**0.31**	
Enter k_{point}	⟹	**0.2108**	
Estimated time to reach cleanup level		**19.6**	**years**

Attachment 2
Literature-Derived Decay Rate Estimates

Attachment 2
Literature-specific TCE Degradation Rate Set Up Table
OMS #28
Alabama Army National Guard, Mobile, Alabama

Context	k_{point} (day^{-1})	$t_{1/2}$ (days)	Molecular Weight	Reference
TCE Natural Attenuation	0.00042	1643	131.39	Howard et. al.
TCE ERD (w/iron)	0.00422	164	131.39	Moreno et. al.

ERD - Enhanced Reductive Dechlorination
k_{point} - First-order decay rate constant
$t_{1/2}$ - Half life
TCE - Trichlorethene

Attachment 2
TCE Degradation Rate Calculation - Natural Attenuation
OMS #28
Alabama Army National Guard, Mobile, Alabama

Site ID	**OMS #28**
Start (Calendar Year)	**2017.6**
Lag time (months)	**0**
	TCE NA
Half Life $t_{1/2}$ (days)	1643
Degradation Rate k_{point} (day-1)	0.00042
Goal	**5**
$[Contaminant]_0$ - ppb*	**310**
Molecular weight	131.39

***Based on groundwater sample result from OMS-28-GW07 collected on 5/19/2017.**

		TCE		
Year	**Days**	**TCE Goal**	**[TCE]**	**[TCE] mol**
2017.6	0	5.0	310.0	2.36E-06
2018.0	150	5.0	291.0	2.21E-06
2019.0	510	5.0	250.0	1.90E-06
2020.0	870	5.0	214.8	1.63E-06
2021.0	1230	5.0	184.5	1.40E-06
2022.0	1590	5.0	158.5	1.21E-06
2023.0	1980	5.0	134.5	1.02E-06
2024.0	2340	5.0	115.5	8.79E-07
2025.0	2700	5.0	99.2	7.55E-07
2026.0	3060	5.0	85.3	6.49E-07
2027.0	3420	5.0	73.2	5.57E-07
2028.0	3780	5.0	62.9	4.79E-07
2028.0	3810	5.0	62.1	4.73E-07
2028.1	3840	5.0	61.3	4.67E-07
2029.0	4170	5.0	53.4	4.06E-07
2030.0	4530	5.0	45.9	3.49E-07
2032.0	5250	5.0	33.8	2.58E-07
2033.0	5610	5.0	29.1	2.21E-07
2034.0	6000	5.0	24.7	1.88E-07
2035.0	6360	5.0	21.2	1.61E-07
2036.0	6720	5.0	18.2	1.39E-07
2037.0	7080	5.0	15.6	1.19E-07
2038.0	7440	5.0	13.4	1.02E-07
2039.0	7800	5.0	11.5	8.78E-08
2040.0	8160	5.0	9.9	7.55E-08
2041.0	8550	5.0	8.4	6.40E-08
2042.0	8910	5.0	7.2	5.50E-08
2043.0	9270	5.0	6.2	4.72E-08
2044.0	9630	5.0	5.3	4.06E-08
2044.4	9780	5.0	**5.0**	3.81E-08

Attachment 2
TCE Degradation Rate Calculation With Zero Valent Iron Enhancement
OMS #28
Alabama Army National Guard, Mobile, Alabama

Site ID	**OMS #28**
Start (Calendar Year)	**2027**
Lag time (months)	**0**
	TCE (w/ ZVI)
Half Life $t_{1/2}$ (days)	164
Degradation Rate k_{point} (day-1)	0.00422
Remedial Goal (RG)	**5**
$[Contaminant]_0$ - ppb	**310**
Molecular weight	131.39

*** Based on groundwater sampling results for OMS-28-GW07 collected on 5/19/2017.**

		TCE		
Year	**Days**	**TCE Goal**	**[TCE]**	**[TCE] mol**
2027.0	0	5.0	310.0	2.36E-06
2027.5	180	5.0	145.1	1.10E-06
2028.5	540	5.0	31.8	2.42E-07
2029.5	930	5.0	6.1	4.67E-08
2029.6	960	5.0	5.4	4.11E-08
2029.7	990	5.0	**4.8**	3.62E-08

TABLES

Table 1-1
Site Concentrations and Site-Specific Screening Levels for COCs
OMS #28
Alabama Army National Guard - Mobile, Alabama

Parcel/Receptor/Pathway/COC [1]	Site Concentration [2]	Units	Carcinogenic SSSLs Based on the Following Risk Levels [3]			Noncarcinogenic SSSLs Based on the Following Hazard Quotients [3]			MCL [4]
			10^{-6}	10^{-5}	10^{-4}	0.1	1	3	
PARCEL A									
Current and Future Trespasser									
No COCs Identified									
Future Construction Worker									
Surface Soil (Ingestion, Inhalation)									
Tetrachloroethene	329	mg/kg	572	5,720	57,200	**8.4**	**84.4**	**253**	NA
Subsurface Soil (Ingestion, Inhalation)									
Tetrachloroethene	329	mg/kg	572	5,720	57,200	**8.4**	**84.4**	**253**	NA
Groundwater (Ingestion, Dermal, Inhalation)									
Tetrachloroethene	12,235	μg/L	**172**	**1,716**	17,157	**2.7**	**27**	**80**	**5**
Trichloroethene	18	μg/L	**10.1**	101	1,006	**0.13**	**1.3**	**3.9**	**5**
Future Industrial Worker									
Surface Soil (Ingestion, Inhalation)									
Tetrachloroethene	329	mg/kg	**126**	1,260	12,600	**47.2**	472	1,416	NA
Groundwater (Ingestion, Dermal, Inhalation)									
Tetrachloroethene	12,235	μg/L	**72.7**	**727**	**7,275**	**32.7**	**327**	**982**	**5**
Trichloroethene	18	μg/L	**3.5**	35	349	**2.9**	29	85.9	**5**
Groundwater (Vapor Intrusion)									
Tetrachloroethene	13,751	μg/L	**2,127**	21,265	212,651	**790**	**7,898**	23,695	NA
Future Resident Adult [9]									
Surface Soil (Ingestion, Inhalation)									
Tetrachloroethene	329	mg/kg	**27.6**	**276**	2,760	**11.4**	**114**	342	NA
Groundwater (Ingestion, Dermal, Inhalation)									
Tetrachloroethene	12,235	μg/L	**5.7**	**57**	**565**	**2.5**	**25**	**75**	**5**
Trichloroethene	18	μg/L	**0.25**	**2.5**	25	**0.16**	**1.6**	**4.8**	**5**
Groundwater (Vapor Intrusion)									
Tetrachloroethene	13,751	μg/L	**61.4**	**614**	**6,140**	**23.7**	**237**	**712**	NA
Trichloroethene [5]	19.84	μg/L	**3.6**	36	355	NC	NC	NC	NA
Future Resident Child									
Surface Soil (Ingestion, Inhalation)									
Tetrachloroethene	329	mg/kg	—	—	—	**9.3**	**93**	**280**	NA
Groundwater (Ingestion, Dermal)									
Tetrachloroethene	12,235	μg/L	**—**	**—**	**—**	**3.9**	**39**	**118**	**5**
Trichloroethene	18	μg/L	**—**	**—**	**—**	**0.4**	**4.4**	**13**	**5**
Groundwater (Vapor Intrusion)									
Tetrachloroethene [6]	13,751	μg/L	**61.4**	**614**	**6,140**	**23.7**	**237**	**712**	NA
Trichloroethene [5, 6]	19.84	μg/L	**3.6**	36	355	NC	NC	NC	NA

Table 1-1
Site Concentrations and Site-Specific Screening Levels for COCs
OMS #28
Alabama Army National Guard - Mobile, Alabama

Parcel/Receptor/Pathway/COC (1)	Site Concentration (2)	Units	Carcinogenic SSSLs Based on the Following Risk Levels (3)			Noncarcinogenic SSSLs Based on the Following Hazard Quotients (3)			MCL (4)
			10^{-6}	10^{-5}	10^{-4}	0.1	1	3	
PARCEL B									
Current and Future Trespasser									
No COCs Identified									
Future Construction Worker									
Groundwater (Ingestion, Dermal, Inhalation)									
Trichloroethene	10	µg/L	20.1	201	2,012	**0.26**	**2.6**	**7.9**	**5**
Future Industrial Worker									
No COCs Identified									
Future Resident Adult (9)									
Groundwater (Ingestion, Dermal, Inhalation)									
Trichloroethene	10	µg/L	0.49	4.9	49	**0.32**	**3.2**	**9.6**	**5**
Groundwater (Vapor Intrusion)									
Trichloroethene (5)	10	µg/L	**7.1**	71	710	NC	NC	NC	NA
Future Resident Child									
No COCs Identified									
PARCEL C									
Current and Future Trespasser									
No COCs Identified									
Future Construction Worker									
Groundwater (Ingestion, Dermal, Inhalation)									
Trichloroethene	4	µg/L	20.1	201	2,012	**0.26**	**2.6**	7.9	5
Future Industrial Worker									
No COCs Identified									
Future Resident Adult (9)									
No COCs Identified									
Future Resident Child									
No COCs Identified									

Table 1-1
Site Concentrations and Site-Specific Screening Levels for COCs
OMS #28
Alabama Army National Guard - Mobile, Alabama

Parcel/Receptor/Pathway/COC (1)	Site Concentration (2)	Units	Carcinogenic SSSLs Based on the Following Risk Levels (3)			Noncarcinogenic SSSLs Based on the Following Hazard Quotients (3)			MCL (4)
			10^{-6}	10^{-5}	10^{-4}	0.1	1	3	
PARCEL D									
Current and Future Trespasser									
No COCs Identified									
Future Construction Worker									
Groundwater (Ingestion, Dermal, Inhalation)									
Trichloroethene	20	µg/L	20.1	201	2012	**0.26**	**2.6**	**7.9**	**5**
Future Industrial Worker									
No COCs Identified									
Future Resident Adult (9)									
Groundwater (Ingestion, Dermal, Inhalation)									
Trichloroethene	20	µg/L	**0.5**	**5**	49.4	**0.32**	**3.2**	**9.7**	**5**
Groundwater (Vapor Intrusion)									
Trichloroethene (5)	9.02	µg/L	**7.1**	71	710	NC	NC	NC	NA
Future Resident Child									
Groundwater (Ingestion, Dermal)									
Trichloroethene	20	µg/L	**—**	**—**	**—**	**0.87**	**8.7**	26.1	**5**
Groundwater (Vapor Intrusion)									
Trichloroethene (5, 6)	9.02	µg/L	**7.1**	71	710	NC	NC	NC	NA

Table 1-1
Site Concentrations and Site-Specific Screening Levels for COCs
OMS #28
Alabama Army National Guard - Mobile, Alabama

Parcel/Receptor/Pathway/COC [1]	Site Concentration [2]	Units	Carcinogenic SSSLs Based on the Following Risk Levels [3]			Noncarcinogenic SSSLs Based on the Following Hazard Quotients [3]			MCL [4]
			10^{-6}	10^{-5}	10^{-4}	0.1	1	3	
PARCEL E									
Current Industrial Worker									
No COCs Identified [7]									
Current and Future Trespasser									
No COCs Identified									
Future Construction Worker									
Groundwater (Ingestion, Dermal, Inhalation)									
Trichloroethene	145	µg/L	**20.1**	201	2,012	**0.26**	**2.6**	**7.9**	**5**
Future Industrial Worker									
Groundwater (Ingestion, Dermal, Inhalation)									
Trichloroethene	145	µg/L	**7**	**70**	697	**5.73**	**57**	172	**5**
Groundwater (Vapor Intrusion)									
Trichloroethene [5]	230.4	µg/L	**220**	2,204	22,044	NC	NC	NC	NA
Future Resident Adult [9]									
Groundwater (Ingestion, Dermal, Inhalation)									
Trichloroethene	145	µg/L	**0.25**	**2.5**	**25**	**0.16**	**1.6**	**5**	**5**
Vinyl Chloride	0.03	µg/L	**0.0094**	0.094	0.94	3	30	90	2
Groundwater (Vapor Intrusion)									
Trichloroethene [5]	230.4	µg/L	**6.83**	**68.3**	683	NC	NC	NC	NA
Future Resident Child									
Groundwater (Ingestion, Dermal)									
Trichloroethene	145	µg/L	**—**	**—**	**—**	**0.87**	**8.7**	**26**	**5**
Groundwater (Vapor Intrusion)									
Trichloroethene [5, 6]	230.4	µg/L	**6.83**	**68.3**	683	NC	NC	NC	NA

Table 1-1
Site Concentrations and Site-Specific Screening Levels for COCs
OMS #28
Alabama Army National Guard - Mobile, Alabama

Parcel/Receptor/Pathway/COC [1]	Site Concentration [2]	Units	Carcinogenic SSSLs Based on the Following Risk Levels [3]			Noncarcinogenic SSSLs Based on the Following Hazard Quotients [3]			MCL [4]
			10^{-6}	10^{-5}	10^{-4}	0.1	1	3	
PARCEL F									
Current and Future Trespasser									
No COCs Identified									
Future Construction Worker									
Groundwater (Ingestion, Dermal, Inhalation)									
Tetrachloroethene	190.1	µg/L	**172**	1716	17157	**2.67**	**27**	**80**	**5**
Trichloroethene	189.3	µg/L	**10.1**	**101**	1006	**0.13**	**1.3**	**3.9**	**5**
Future Industrial Worker									
Groundwater (Ingestion, Dermal, Inhalation)									
Tetrachloroethene	190.1	µg/L	**73**	727	7275	**32.7**	327	982	**5**
Trichloroethene	189.3	µg/L	**3.5**	**35**	349	**2.9**	**29**	**86**	**5**
Groundwater (Vapor Intrusion)									
Trichloroethene [5]	247.3	µg/L	**216**	2158	21576	NC	NC	NC	NA
Future Resident Adult [9]									
Groundwater (Ingestion, Dermal, Inhalation)									
cis-1,2-Dichloroethene	89.93	µg/L	**—**	**—**	**—**	**1.49**	**14.9**	**45**	**70**
Tetrachloroethene	190.1	µg/L	**3.8**	**38**	377	**1.26**	**12.6**	**38**	**5**
Trichloroethene	189.3	µg/L	**0.16**	**1.6**	**16**	**0.081**	**0.81**	**2.4**	**5**
Vinyl chloride	0.2	µg/L	**0.0063**	**0.063**	0.63	1.49	14.9	45	2
Groundwater (Vapor Intrusion)									
Tetrachloroethene	251.1	µg/L	**57.9**	579	5,786	**22.3**	**223**	670	NA
Trichloroethene [5]	247.3	µg/L	**3.35**	**33.5**	335	NC	NC	NC	NA
Future Resident Child									
Groundwater (Ingestion, Dermal)									
cis-1,2-Dichloroethene	89.93	µg/L	—	—	—	**1.2**	**12**	**36**	**70**
Tetrachloroethene	190.1	µg/L	—	—	—	**2.6**	**26**	**78**	**5**
Trichloroethene	189.3	µg/L	—	—	—	**0.29**	**2.9**	**9**	**5**
Groundwater (Vapor Intrusion)									
Tetrachloroethene [6]	251.1	µg/L	57.9	579	5,786	**22.3**	**223**	670	NA
Trichloroethene [5, 6]	247.3	µg/L	**3.35**	**33.5**	335	NC	NC	NC	NA

Table 1-1
Site Concentrations and Site-Specific Screening Levels for COCs
OMS #28
Alabama Army National Guard - Mobile, Alabama

Parcel/Receptor/Pathway/COC [1]	Site Concentration [2]	Units	Carcinogenic SSSLs Based on the Following Risk Levels [3]			Noncarcinogenic SSSLs Based on the Following Hazard Quotients [3]			MCL [4]
			10^{-6}	10^{-5}	10^{-4}	0.1	1	3	
PARCEL G									
Current and Future Trespasser									
No COCs Identified									
Future Construction Worker									
No COCs Identified									
Future Industrial Worker									
No COCs Identified									
Future Resident Adult [9]									
No COCs Identified									
Future Resident Child									
No COCs Identified									
PARCEL H									
Current and Future Resident Adult [8, 9]									
No COCs Identified									
Current and Future Resident Child [8]									
No COCs Identified									

Notes:

(1) COCs were identified as those chemicals with a significant contribution to a pathway in a use scenario for a receptor that either (a) exceeds a 1 x 10^{-4} cumulative site cancer risk or (b) exceeds a non-carcinogenic HI of 1. No Subsurface Soil COCs were identified. See Risk and Hazard tables in Appendix E of the RAR Revision 2 (AECOM, March 2023).

(2) Site concentration is the exposure point concentration shown in Tables 6 through 9 of the RAR Revision 2 (AECOM, March 2023).

(3) SSSLs were derived as follows:

For exposure to soil for the Construction Worker and Industrial Worker, and for exposure to soil and groundwater for the Resident Adult, SSSLs were calculated using USEPA's RSL Calculator (output included in Appendix G of the RAR Revision 2 (AECOM, March 2023]).

For exposure to soil for the Resident Child and for exposure to groundwater for the Construction Worker, Industrial Worker, and Resident Child, SSSLs were calculated using standard risk equations (shown in Appendix G of the RAR Revision 2 (AECOM, March 2023).

For exposure to groundwater via vapor intrusion for the Industrial Worker, Resident Adult, and Resident Child — SSSLs were identified as the "target groundwater concentration" calculated by the Johnson and Ettinger Model (output included in Appendices F.2, F.3, and F.4 of the RAR Revision 2 (AECOM, March 2023).

(4) MCL is from the Drinking Water Standards and Health Advisories Tables (USEPA, November 2018).
NA indicates an MCL is not applicable for this medium.

(5) The Johnson and Ettinger Model does not display noncarcinogenic SSSLs for this COC. Carcinogenic SSSLs are shown for the child receptor.

(6) While the Johnson and Ettinger Model calculated carcinogenic SSSLs for this COC, risk is not identified for a child receptor in risk evaluations.

(7) The current industrial worker was not quantitatively evaluated at Parcel E; no chemicals of potential concern were identified in surface soil and no groundwater plume is within 100 feet of the building currently used by industrial workers.

(8) A residence currently exists on Parcel H, immediately east of Parcel D. The residence on Parcel H is within 100 feet of the VOC plume beneath Parcel D; therefore, it was evaluated for vapor intrusion using groundwater data identified in the core of the plume at Parcel D (Locations OMS-28-GW46-16, -GW64-16, and -GW75-29). Exposure and risk for a future resident on Parcel H were assumed to be the same as under current conditions. There is no current resident on Parcel D.

(9) RSL Calculator output for the Resident Adult consists of only the adult values; it does not include the child values.

When more than one COC was identified for a given receptor's pathway, the SSSL for each COC was divided by the number of COCs for that receptor's pathway (Section 6.7.2 of ADEM, February 2017).

COCs in bold indicate the site concentration exceeds one or more SSSLs or the MCL. The SSSLs and MCL exceeded are also bolded.

A current construction worker is not evaluated for any parcel.

COC - chemical of concern
MCL - maximum contaminant level
mg/kg - milligrams per kilogram (parts per million)
NC - not calculated
RAR - Risk Assessment Report
SSSL - site-specific screening level
µg/L - micrograms per liter (parts per billion)

Sources:

ADEM, February 2017. Alabama Risk-Based Corrective Action Guidance Manual, Revision 3.0.
AECOM, March 2023. Risk Assessment Report, Revision 2.
USEPA, May 2023. Regional Screening Levels (RSLs) Summary Table

Table 1-2
Historical Groundwater COC Concentrations
OMS #28
Alabama Army National Guard - Mobile, Alabama

Well ID	Depth of Well (ft btoc)	Screened Interval (ft btoc)	Date	PCE	TCE	cis-1,2-DCE	Vinyl Chloride
Maximum Contaminant Level				5	5	70	2
Upper Surficial Aquifer Wells							
MW-5	13.6	3.3-13.3	10/18/2006	NA	0.27 U	NA	NA
			7/1/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/11/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/7/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/20/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/1/2017	0.5 U	0.5 U	0.5 U	0.5 U
MW-6	12.7	2.3-12.3	10/18/2006	NA	0.27 U	NA	NA
			7/1/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/11/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/7/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/20/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/1/2017	0.5 U	0.5 U	0.5 U	0.5 U
MW-8	15.2	4.8-14.8	3/1/2005	NA	**480**	NA	NA
			4/18/2006	NA	**97.9**	NA	NA
			10/18/2006	NA	**83 J**	**NA**	NA
			7/1/2008	0.2 U	**133**	**3.97 J**	0.0538 U
			12/11/2008	0.153 U	**46**	**3.24 J**	0.155 U
			5/8/2009	0.0998 U	**18**	**0.812 J**	0.0767 U
			9/24/2009	0.0998 U	**8.41**	0.103 U	0.0767 U
			3/19/2010	0.121 U	**41**	**2.07 J**	0.093 U
			9/8/2010	0.121 U	**13**	0.0613 U	0.093 U
			1/22/2016	0.5 U	**7.8**	0.5 U	0.5 U
			5/1/2017	0.5 U	**0.373 J**	0.5 U	0.5 U
MW-9	17.4	7.4-17.4	11/22/2006	0.072 U	0.024 U	0.051 U	0.052 U
			7/1/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/10/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/8/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/20/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/5/2017	0.5 U	0.5 U	0.5 U	0.5 U
MW-10	17.6	7.6 - 17.6	11/22/2006	**4.9**	**11**	**5.8**	**1.5**
				Abandoned at request of property owner			
MW-11	16.6	6.6 - 16.6	11/22/2006	0.072 U	**63**	0.051 U	0.052 U
				Abandoned at request of property owner			
MW-12	15.6	5.6-15.6	11/22/2006	0.072 U	0.024 U	0.051 U	0.052 U
			7/1/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/10/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/7/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/21/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/1/2017	0.5 U	0.5 U	0.5 U	0.5 U

Table 1-2
Historical Groundwater COC Concentrations
OMS #28
Alabama Army National Guard - Mobile, Alabama

Well ID	Depth of Well (ft btoc)	Screened Interval (ft btoc)	Date	PCE	TCE	cis-1,2-DCE	Vinyl Chloride
Maximum Contaminant Level				5	5	70	2
Upper Surficial Aquifer Wells							
OMS-28-2	20.0	10-20	7/1/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/10/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	**2 J**	0.0613 U	0.093 U
			9/7/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/19/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/5/2017	0.5 U	0.5 U	0.5 U	0.5 U
OMS-28-3	20.0	10-20	7/1/2008	0.2 U	**80**	**6.26**	0.0538 U
			12/11/2008	0.153 U	**94**	**9.34**	0.155 U
			5/8/2009	0.0998 U	**29**	**9.55**	0.0767 U
			9/24/2009	0.0998 U	**15.29**	0.103 U	0.0767 U
			3/19/2010	0.121 U	**12**	**1.37 J**	0.093 U
			9/8/2010	0.121 U	**149**	**9.43**	0.093 U
			1/21/2016	0.5 U	**8.92**	**1.59**	0.5 U
			5/1/2017	0.5 U	**9.6**	**1.26**	0.5 U
OMS-28-5	20.0	10-20	7/1/2008	**130**	**39**	**12**	0.0538 U
			12/11/2008	**9.2**	**14**	**8.7**	0.155 U
			5/8/2009	**234**	**162**	**20**	0.0767 U
			9/24/2009	**8.02**	**11**	**9.12**	0.0767 U
			3/19/2010	**81**	**51**	**6.3**	0.093 U
			9/8/2010	**33**	**19**	**8.69**	0.093 U
			1/20/2016	**455**	**200**	**27.8**	2.5 U
			5/5/2017	**154**	**246**	**103**	1 U
OMS-28-7	20.0	10-20	7/1/2008	0.2 U	**1.73 J**	0.0745 U	0.0538 U
			12/10/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	**0.684 J**	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/8/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/20/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/1/2017	0.5 U	0.5 U	0.5 U	0.5 U
Lower Surficial Aquifer Wells							
OMS-28-1	80.0	70-80	7/8/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/11/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/7/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/20/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/1/2017	0.5 U	0.5 U	0.5 U	0.5 U
OMS-28-4	76.0	66-76	7/8/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/10/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/19/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/8/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/20/2016	**0.88 J**	0.5 U	0.5 U	0.5 U
			5/5/2017	0.5 U	0.5 U	0.5 U	0.5 U

Table 1-2
Historical Groundwater COC Concentrations
OMS #28
Alabama Army National Guard - Mobile, Alabama

Well ID	Depth of Well (ft btoc)	Screened Interval (ft btoc)	Date	PCE	TCE	cis-1,2-DCE	Vinyl Chloride
Maximum Contaminant Level				5	5	70	2
Deep Wells							
OMS-28-6	76.0	66-76	7/8/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/10/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/8/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
				Destroyed			

Definitions:
µg/L = micrograms per Liter (parts per billion (ppb))
COC = chemical of concern
ft btoc = feet below top of casing
NA = Not Analyzed
PCE = tetrachloroethene
TCE = trichloroethene
cis-1,2-DCE = cis-1,2-dichloroethene

Notes:
All concentrations in µg/L
Bold result indicates the analyte was detected.
Shading indicates the screening value is exceeded.

Data Qualifiers:
U = The analyte was analyzed for, but was not detected above the limit of detection (LOD).
J = The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

Table 2-1
Remedial Goals for Groundwater by Parcel
OMS #28
Alabama Army National Guard - Mobile, Alabama

Parcel	COC	Groundwater RG (µg/L)	Receptor	Exposure Pathway
Parcel D	TCE	5	Future Construction Worker	Groundwater (Ingestion, Dermal, Inhalation)
			Future Resident Adult	Groundwater (Ingestion, Dermal, Inhalation, Vapor Intrusion)
			Future Resident Child	Groundwater (Ingestion, Dermal, Vapor Intrusion)
Parcel E	TCE	5	Future Construction Worker	Groundwater (Ingestion, Dermal, Inhalation)
			Future Industrial Worker	Groundwater (Ingestion, Dermal, Inhalation, Vapor Intrusion)
			Future Resident Adult	Groundwater (Ingestion, Dermal, Inhalation, Vapor Intrusion)
			Future Resident Child	Groundwater (Ingestion, Dermal, Vapor Intrusion)
	VC	2	Future Resident Adult	Groundwater (Ingestion, Dermal, Inhalation)
Parcel F	TCE	5	Future Construction Worker	Groundwater (Ingestion, Dermal, Inhalation)
			Future Industrial Worker	Groundwater (Ingestion, Dermal, Inhalation, Vapor Intrusion)
			Future Resident Adult	Groundwater (Ingestion, Dermal, Inhalation, Vapor Intrusion)
			Future Resident Child	Groundwater (Ingestion, Dermal, Vapor Intrusion)
	cis-1,2-DCE	70	Future Resident Adult	Groundwater (Ingestion, Dermal, Inhalation)
			Future Resident Child	Groundwater (Ingestion, Dermal, Inhalation)
	VC	2	Future Resident Adult	Groundwater (Ingestion, Dermal, Inhalation)

Notes:
RGs are not established for Parcel A because impacted groundwater is not the result of historical activities conducted on Parcel E (refer to Section 1.3.7.2 and Appendix C).
RGs are not established for Parcel B because impacted groundwater is the result of the breakdown of PCE from Parcel A to TCE on Parcel B (refer to Section 1.3.7.2).
RGs are not established for Parcel C because groundwater results collected during the SDGI have never exceeded the MCLs (refer to Section 1.3.7.2).
An RG for PCE is not established for Parcel F because the PCE detected in groundwater on this parcel is the result of an off-site PCE spill source area on Parcel A and not the result of historical activities conducted on Parcel E (refer to Section 1.3.7.2).
There was no risk identified for Parcels G or H.

Abbreviations:
cis-1,2-DCE - cis 1,2-dichloroethene
COC - chemical of concern
PCE - tetrachloroethene
RG - remedial goal
SDGI - Supplemental Data Gap Investigation
TCE - trichloroethene
VC - vinyl chloride
µg/L - micrograms per liter (parts per billion)

Table 2-2
Chemical-Specific ARARs for Groundwater
OMS #28
Alabama Army National Guard - Mobile, Alabama

Standard, Requirement, Criteria, or Limitation	Citation	Requirement	ARAR	Comments
Safe Drinking Water Act	Section 1412(b)(1) 40 CFR Part 141	The Administrator shall in accordance with the procedures established by this subsection, publish a maximum contaminant level goal and promulgate a national primary drinking water regulation for a contaminant.	Applicable	The Safe Drinking Water Act regulations apply to water supply and the use of MCLs. MCLs are listed in Appendix A to Subpart O of 40 CFR Part 141. As part of this list, MCLs are provided for organic contaminants that apply to community and non-transient, non-community water systems, including groundwater that may be utilized for such purposes. Contaminants found in site groundwater that are related to historical operations conducted at OMS #28 that exceed the identified MCLs include trichloroethene, cis-1,2-dichloroethene, and vinyl chloride.

Notes:

ARAR - Applicable or Relevant and Appropriate Requirement
CFR - Code of Federal Regulations
MCL - Maximum Contaminant Level

Table 2-3
TBC Guidance
OMS #28
Alabama Army National Guard - Mobile, Alabama

TBC	Citation	Comments
AEIRG Manual, Revison 4.0	http://adem.alabama.gov/programs/land/guidanceReports.cnt	Statewide cross-programmatic guidance prepared to assist individuals in understanding and achieving the necessary elements of environmental investigations and remediation projects in Alabama (ADEM, 2017a) .
ARBCA Guidance Manual, Revision 3.0	http://adem.alabama.gov/programs/land/guidanceReports.cnt	Guidelines for a uniform statewide cross-programmatic approach for the assessment of cumulative risk at a contaminated site and the development and selection of appropriate risk-based target levels (ADEM, 2017b).

Notes:
ADEM - Alabama Department of Environmental Management
AEIRG - Alabama Environmental Investigation and Remediation Guidance
ARBCA - Alabama Risk Based Corrective Action
TBC - To Be Considered
USEPA - United States Environmental Protection Agency

Table 3-1
Remedial Technologies and Process Options Screening
OMS #28
Alabama Army National Guard - Mobile, Alabama

General Response Action	Technology	Process Options	Description	Effectiveness	Implementability	Cost	Screening Comments	Screening Decision
No Action	No Action	None	No action. Contaminated groundwater remains in place.	Low	High	None	Does not reduce future human or environmental risk. Does not reduce toxicity, mobility, or volume of contaminants except by natural attentuation which will be limited, if any. Required for consideration as baseline alternative per the NCP.	**Retain**
Land Use Controls	Access Control	Physical (engineered) Signs, Fencing, Security	Warning signs to limit human exposure. Fencing to prohibit access/entry. Security measures to enforce non-entry.	High	High	Low Capital, Low O&M	Physical access controls reduce the risk of exposure but effectiveness depends on continued future implementation and inspections. Does not reduce toxicity, mobility, or volume of contaminants. May be appplied in combination with other process options and can be equally protective as engineered (active) remedial actions. Technically and administratively implementable. Reduction of groundwater contamination will occur over an extended time period.	**Retain**
	Use Control	Administrative Existing Land Use Management Systems at Active Installations	Admininstrative action used to restict the use of groundwater as a source of drinking water. Can also include the identification of an alternate water source.	High	High	Low Capital, Low O&M	Administrative use controls reduce the risk of exposure but effectiveness depends on continued future implementation and inspections. Does not reduce toxicity, mobility, or volume of contaminants. May be appplied in combination with other process options and can be equally as protective as engineered (active) remedial actions. Technically and administratively implementable. Reduction of groundwater contamination will occur over an extended time period. Site currently served by city water.	**Retain**
Natural Attenuation	Monitored Natural Attenuation	Groundwater Monitoring	Groundwater sampling and analysis of a representative site monitoring well network are used to demonsarate a variety of physical, chemical, and/or biological processes that act independently of active process options to naturally reduce the concentration of contaminants in groundwater.	Medium	High	Low to Medium Capital, Low to Medium O&M	Groundwater monitoring is not effective in reducing the toxicity, mobility, or volume of the COCs; however, the monitoring results can be used to determine if the risk presented by the impacted groundwater is decreasing, increasing, or remains the same as the result of natural biotic (biodegradation) and abiotic attenuation processes (dilution, dispersion, advection, evaporation, etc.). Mann-Kendall analysis indicates that the TCE plume is not expanding so some degree of natural attenuation is occurring. Based on historical groundwater parameters and sampling results, biodegradation will be limited unless the targeted GW aquifer is enhanced to promote biotic degradation. Periodic sampling of on-site and off-site groundwater monitoring wells can be conducted to document natural attenuation. Current monitoring well network needs to be augmented to better define the TCE plume.	**Retain**
Containment	Hydraulic Barrier	Extraction Wells	Use of a series of extraction wells to restrict the horizontal migration of TCE-impacted groundwater away from the ALARNG property.	Medium	Low	High Capital, High O&M	Reduces mobility of contaminants but does not reduce their toxicity or volume. This technology would require long term O&M and also discharge to a POTW as there are no surface water bodies near the site that could accommodate discharge. A comprehensive monitoring program would be necessary for POTW discharge.	**Reject**

Table 3-1
Remedial Technologies and Process Options Screening
OMS #28
Alabama Army National Guard - Mobile, Alabama

General Response Action	Technology	Process Options	Description	Effectiveness	Implementability	Cost	Screening Comments	Screening Decision
In Situ Treatment	Biological	Aerobic	This technology utilizes aerobic bacteria that metabolize a primary substrate such as dextrose using various non-specific enzymes. These non-specific enzymes can degrade TCE via a process referred to as co-metabolism.	Low	Low	High Capital, Medium O&M	Reduces toxicity, mobility, and volume of contaminants. Difficult to implement at field scale. Requires that the targeted aquifer remain oxidative and at a neutral pH or the bacteria will not survive. In the presence of too much substrate such as dextrose, oxygen levels can decrease sharply so supplemental oxygen in the form of air or pure oxygen is often needed to be added to the targeted groundwater. Also, in the absence of sufficient substrate to metabolize, co-metabolism stops, and the bacteria can die.	**Reject**
		Anaerobic	Involves the enhancement of the natural biodegradation of organics in an anaerobic environment. For chlorinated compounds, this is called ERD. This technology would consist of injecting an electron donor such as emulsified vegetable oil into the TCE-impacted groundwater to induce strong reducing conditions. The injected chemical amendment would tend to last from 6 to 12 months depending on groundwater flow rates and the targeted groundwater aquifer litholoty. "Stall out" at cis-1,2-DCE may occur unless sufficient *DHC* is present. In this occurs, bioaugmentation may be necessary to make ERD effective.	Medium High with bioaugmentation	Medium	High Capital, Low O&M	Reduces toxicity, mobility, and volume of contaminants. Equipment required includes the electron donor, mixing equipment, and the means for injection. At this site, a DPT rig could be used to conduct injections down to a depth of approximately 30 to 35 ft bgs; a drill rig would be required to conduct injection at greater depths. There would be no ongoing O&M costs associated with this technology except for associated performance monitoring, and no permanent aboveground equipment would be required. Subsurface heterogeneities or preferential flow paths may result in pockets of untreated contaminants resulting in a subsequent rebound in groundwater COC concentrations. As a result, more than one injection event may be necessary. The characteristics of the targeted aquifer will require that the ERD injection points are installed relatively close to one another. Can be combined with bioaugmentation and/or chemical reduction to be even more effective.	**Retain**
	Chemical	Chemical Oxidation	Involes the injection of an oxidizing agent such as potassium permanganate, sodium persulfate, or hydrogen peroxide to degrade the targeted COCs in groundwater to innocuous end products.	Low to Medium	Medium	High Capital, Low O&M	Reduces toxicity, mobility, and volume of contaminants. Technology is highly dependent on achieving adequate contact between the contaminants and the oxidant solution. Site lithology will require numerous injection points. Chemical oxidants are non-specific with regards to the organics they target, and they are often short-lived in the subsurface. Matrix back diffusion often requires multiple injection events. Technology is best suited for source areas with high concentrations of the targeted COCs rather than dilute source areas.	**Reject**
		Chemical Reduction	ISCR involves the placement of a sufficient quantity of reductant or reductant generating material into the subsurface with the purpose of chemically converting the targeted contaminants in the impacted groundwater to less toxic compounds. The most commonly used reductant is ZVI. In this case, ZVI would create strongly reducing conditions that promote the abiotic degradation of the targeted chlorinated VOCs in groundwater via the beta-elimination and hydrogenolysis pathways.	Medium	Medium	High Capital, Low O&M	Reduces toxicity, mobility, and volume of contaminants. Similar to other in situ injection process options, effective treatment by ISCR requires adequate contact between the reductant and the targeted contaminant. This technology would consist of injecting a sufficient quantity of a reductant such as ZVI into the targeted groundwater. The predominant abiotic pathway (beta-elimination) using ZVI eliminates the potential for "stall out" at cis-1,2-DCE. The reactive life of ZVI has been reported to be 3 to 5 years or greater, which is much longer than chemical oxidants or many electron donors (carbon substrates) used for ERD. The failure to account for subsurface heterogeneities or preferential flow paths may result in pockets of untreated COCs and the need for additional injections of ZVI. The characteristics of the targeted aquifer will require that the ISCR injection points are installed relatively close to one another. Can be combined with bioaugmentation and/or ERD to be even more effective.	**Retain**
	Physical	Air Sparging/ SVE	In situ air sparging is a physical process that involves injecting air into the targeted aquifer to volatilize aqueous phase and soil-sorbed chlorinated VOC contaminants. A series of screened injection wells would be installed through which compressed air would be introduced into the targeted aquifer. Volatile constituents such as TCE partition from the aqueous phase into the vapor phase. Due to the release of chlorinated VOCs to the atmosphere, an SVE system is often needed to be combined with the air sparging system.	Low to Medium	Medium	High Capital, High O&M	The number of air sparging and SVE wells needed is dependent on the size and depth of the plume, soil permeability, subsurface geology, and the flow rate of injected air. Based on the questionable effectiveness of air sparging/SVE in the targeted site geology (i.e., sandy clays, clayey sands, and silty clays), the large infrastructure footprint required, high capital and high ongoing O&M costs, air sparging/SVE is rejected from further evaluation.	**Reject**

Table 3-1
Remedial Technologies and Process Options Screening
OMS #28
Alabama Army National Guard - Mobile, Alabama

General Response Action	Technology	Process Options	Description	Effectiveness	Implementability	Cost	Screening Comments	Screening Decision
Removal	Groundwater Extraction	Extraction Wells	Series of conventional pumping wells used to remove contaminated groundwater.	Low	Medium	High Capital, High O&M	Groundwater extraction and treatment is an appropriate technology for contaminated mass reduction and hydraulic containment; however, it is not useful for the restoration of aquifers to MCLs. Two main difficulties for groundwater extraction include extended treatment times and residual COC concentrations that exceed their MCLs. Actual extraction rates would not be known until the extraction well network was installed and developed but likely would be low due to site lithology consisting of silty clays and clayey silts. Based on the relatively low TCE concentrations, high capital and high O&M costs, the need for discharge to a POTW, and the long time frame to meet MCLs, if ever, extraction wells are rejected from further evaluation.	**Reject**
		Interceptor Trenches	A permeable trench used to intercept and collect groundwater.	Low	Low	High Capital, Medium O&M	Interceptor trenches are rejected from further evaluation because they would not be implementable since they could not be installed to a depth deep enough to intercept the targeted TCE groundwater plume.	**Reject**
Ex situ treatment	Physical	Liquid-phase carbon adsorption, air stripping, vapor-phase carbon adsorption	Use of liquid-phase granular activated carbon to removed VOCs from extracted groundwater. Use of air stripping to remove VOCs from extracted groundwater with subsequent treatment of the volatilized VOCs onto granular activated carbon	Medium	High	Medium Capital, High O&M	Rejected from further consideration because groundwater will not be extracted and therefore will not need to be treated ex-situ.	**Reject**
	Chemical	Ultraviolet/oxidation	Use of ultraviolet with with an oxidizers such as air, ozone, peroxide, chlorine, etc. to destroy VOCs contained in extracted groundwater.	Medium	Medium	Medium Capital, High O&M	Rejected from further consideration because groundwater will not be extracted and therefore will not need to be treated ex-situ.	**Reject**
Discharge	Disposal	POTW	Remedial approaches that use groundwater extraction or ex situ groundwater treatment require a point of discharge for the treated/untreated wastewater. Confirmation sampling and reporting would be regularly required for discharge to a POTW.	High	Medium	Medium Capital, High O&M	Rejected from further consideration because groundwater will not be extracted and therefore will not need to be treated by disposal at a POTW.	**Reject**

Abbreviations:

ALARNG - Alabama Army National Guard
cis-1,2-DCE - cis-1,2-dichloroethene
COC - Chemical of Concern
DHC - Dehalococoiddes
DPT - Direct Push Technology
ERD - Enhanced Reductive Dechlorination
ft bgs - feet below ground surface
ISCR - In Situ Chemical Reduction
MCL - Maximum Contaminant Level
NCP - National Contingency Plan
O&M - Operation and Maintenance
POTW - Publically Owned Treatment Works
SVE - Soil Vapor Extraction
TCE - Trichloroethene
VOC - Volatile Organic Compound
ZVI - Zero Valent Iron

Table 4-1
Remedial Alternatives Cost Summary
OMS #28
Alabama Army National Guard - Mobile, Alabama

Remedial Alternative	Description	Duration (Years)*	Present Worth Cost	Total Present Worth Cost (Includes 20% Contingency)	Total Present Worth Cost (-30%)**	Total Present Worth Cost (+50%)**
1	No Action	30	$0	$0	$0	$0
2	LUCs with Periodic Groundwater Monitoring	18	$403,600	$484,300	$339,000	$726,500
3	ERD, ISCR, and Enhanced MNA	7	$1,823,100	$2,187,700	$1,531,400	$3,281,600

Notes:

* In general, the period of performance for costing purposes should not exceed 30 years for the purpose of a detailed cost analysis (USEPA, 1988). In this case, the maximum value of 30 years does not apply since natural groundwater conditions are estimated to reduce chlorinated VOC concentrations in groundwater related to the TCE plume that emanates from Parcel E in approximately 18 years.
** Typically, cost estimates made during the Feasibility Study are expected to provide an accuracy of + 50% to -30% (USEPA, 1988)

ERD - Enhanced Reductive Dechlorination
ISCR - In Situ Chemical Reduction
LUCs - Land Use Controls
MNA - Monitored Natural Attenuation

Table 5-1
Qualitative Comparative Analysis of Remedial Alternatives
OMS #28
Alabama Army National Guard - Mobile, Alabama

	Evaluation Criteria	Altenative 1 No Action	Alternative 2 LUCs with Periodic Monitoring	Alternative 3 ERD, ISCR, and Enhanced MNA
Threshold Criteria				
(1)	Overall protection of human health and the environment	Provides no reduction in potential risk to human health or the environment. Does not meet the criterion for overall protection of human health and the environment.	Restricts the use of groundwater for residential purposes (drinking, watering, etc.); however, TCE and related degradation products remain in groundwater until natural attenuation processes eventually remove them. Implemention of LUCs ensures protectiveness for the duration that TCE and its related degradation products remain above the MCLs in groundwater.	Actively removes TCE and related degradation products from groundwater, thereby mitigating potential future human health and environment risk at at rate that is faster than natural attentuation.
(2)	Compliance with ARARs	This alternative does not achieve ARARs because no action is conducted.	Does not comply with the applicable ARARs until the RGs are met.	Does not comply with the applicable ARARs until the RGs are met.
Balancing Criteria				
(3)	Short-term Effectiveness	Does not pose any additional risk to the community, workers, or the environment because there are no remedial activities conducted for this alternative. There are no current risks associated with the site. Any potential future risks remain the same for this alternative.	Reduces the likelihood of contact with TCE and its degradation products in groundwater by restricting groundwater use. Limited impact to community and environment due to need to clear heavy brush and trees at the location of four proposed monitoring wells on Parcel F. Safety concerns related to tree clearing and monitoring well installation and development Potential exposure to impacted groundwater during periodic sampling. Estimate of at least 18 years to meet RGs; however, this estimate does not account for groundwater retardation and matrix back diffusion.	Impact to community and environment is greater than Alternatives 1 and 2 due to the need to remove dense vegetation including mature trees and brush (~0.48 acres) on Parcels D and F to accomodate monitoring well and injection point installation. Potential exposure to impacted groundwater during periodic performance monitoring. Safety concerns related to tree clearing, monitoring well installation and development, and injection activities. Estimate of at least 7 years to meet RGs; however, this time may increase depending on effectiveness of the treatment and potential matrix back diffusion issues. Requires additional time and coordination of labor, materials, and resources for completion.
(4)	Reduction of Toxicity, Mobility, or Volume	Does not use any treatment that would reduce the toxicity, mobility, or volume of impacted groundwater. Does not meet statutory preference for treatment.	Does not actively create a reduction in toxicity, mobility, or volume of impacted groundwater. Uses periodic monitoring to document any reduction of toxicity, mobility, or volume of impacted groundwater. Does not meet statutory preference for treatment.	Permanently reduces the toxicity, mobility, and volume of TCE and its degradation products via active remediation to innocuous end products. The process is irreversible and satisfies the statutory preference for treatment.

Table 5-1
Qualitative Comparative Analysis of Remedial Alternatives
OMS #28
Alabama Army National Guard - Mobile, Alabama

	Evaluation Criteria	Altenative 1 No Action	Alternative 2 LUCs with Periodic Monitoring	Alternative 3 ERD, ISCR, and Enhanced MNA
(5)	Long-term Effectivenes and Permanence	Does not provide monitoring of concentrations of TCE and its degradation products in groundwater over time.	LUCs provide groundwater use restrictions (no wells for drinking or watering, etc.) related to potential future residential usage of the site. Five-Year Reviews are required to ensure that the LUCs employed continue to remain effective. Ongoing impact from offsite PCE soil source and groundwater plume may impact long-term effectiveness and permanence where the PCE plume co-mingles with the TCE plume associated with Parcel E.	Alternative 3 permanently removes TCE and its degradation products that exist in groundwater above the RGs. Until the RGs are met, periodic performance monitoring will be conducted to evaluate the effectiveness of the proposed injection event(s) and to determine when the RGs are met. Ongoing impact from offsite PCE soil source and groundwater plume may impact long-term effectiveness and permanence where the PCE plume co-mingles with the TCE plume associated with Parcel E.
(6)	Implementability	There are no implementability issues associated with this alternative since no action will be conducted.	LUCs and periodic monitoring are somewhat easy to implement although the DoD can only recommend LUCs on the affected offsite parcels. The NEUR issue needs to be resolved before implementation. Clearing for new well locations and installation of new wells uses standard, readily available equipment. RIght of entry agreements for offsite Parcels D and E should not be an issue based on previous work conducted on these parcels.	In addtion to standard, readily available equipment needed for clearing and new monitoring well installation, some speciality injection equipment is required. This equipment is available from specialty injection contractors. RIght of entry agreements for offsite Parcels D and E should not be an issue based on previous work conducted on these parcels.
(7)	Cost	There are no present worth costs associated with No Action.	The estimated total net present worth cost to implement Alternative 2 is $484,300.	The estimated total net present worth cost to implement Alternative 3 is $2,187,700.

Abbreviations:
ARAR - Applicable or Relevant and Appropriate Requirements
DoD - Department of Defense
ERD - Enhanced Reductive Dechlorination
ISCR - In Situ Chemical Reduction
LUC - Land Use Controls
MNA - Monitored Natural Attenuation
NEUR - Notice of Environmental Use Restriction
RG - Remedial Goal
TCE - Trichloroethene

FIGURES

Vicinity Map

Legend

County Boundary

Waterbodies

Note:
OMS - Organizational Maintenance Shop

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National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

0 300 600 1,200 Feet

1 inch = 600 feet

AECOM

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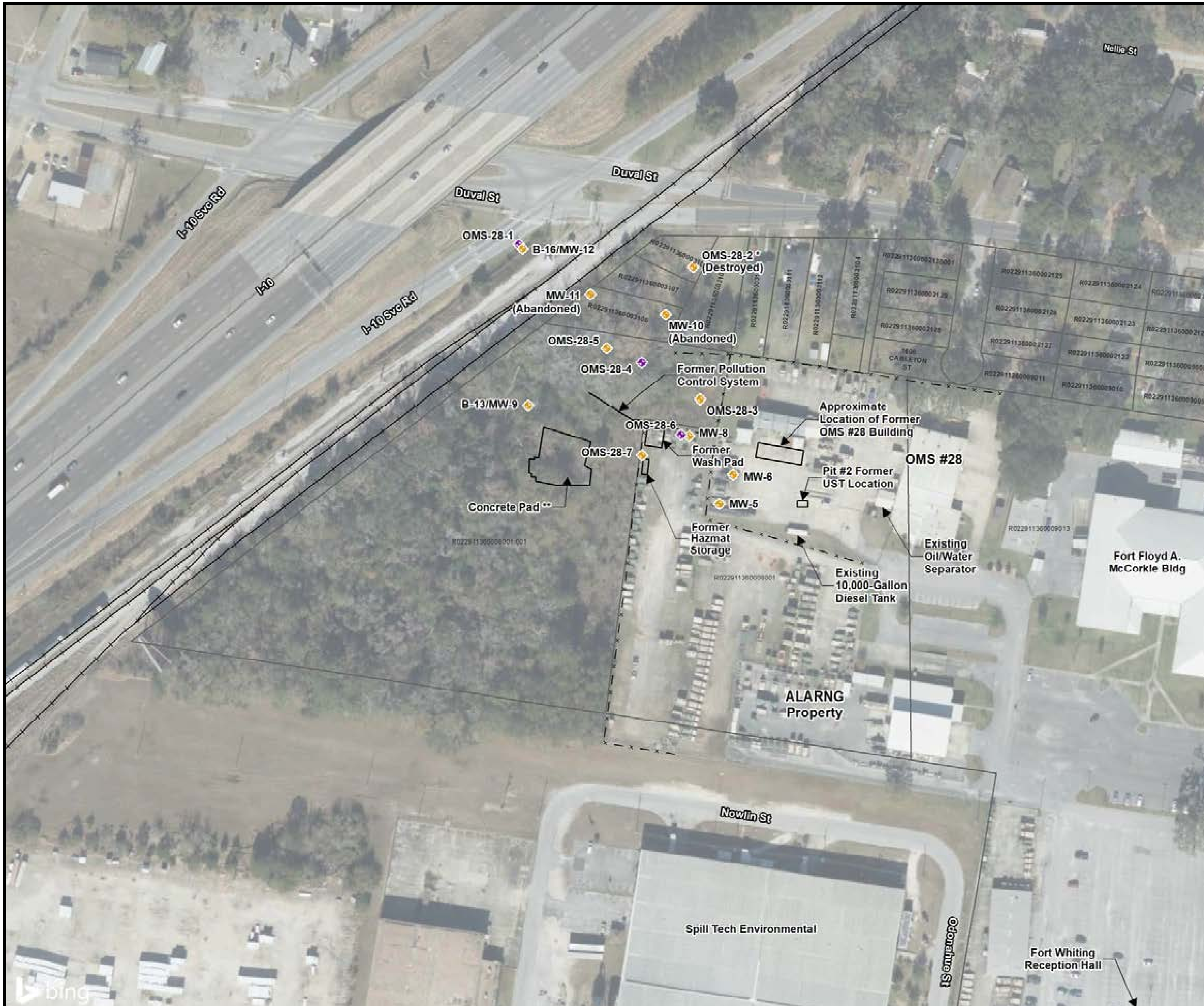
Facility Location Map

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/12/2023	Figure 1-1

Document Path: L:\Legacy\Group\earth\OMS 28\60439687\900-CADD-GIS\Brookley_GIS\Maps\FS Letter Report\20220505\Figure 1-1_OMS 28_Facility Location Map.mxd



Site Location

Legend

- Upper/Middle Surficial Monitoring Well Location
- Lower Surficial Monitoring Well Location
- Railroad
- Fenceline
- Parcel Boundary

Notes:
Wells MW-10 and MW-11 were abandoned in 2008 at the property owner's request and have not been replaced.

* Wells OMS-28-2 was found destroyed during a site visit in December 2021.

** Concrete pad is the likely remnant foundation of Mollison Hall (recreational hall for soldiers before and after World War II) that was demolished between 1972 and 1974.

ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop

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0 75 150 300 Feet

1 inch = 150 feet

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Facility Site Location Map

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/12/2023	Figure 1-2

Document Path: L:\Legacy\Group\earth\OMS 28\60439687\900-CADD-GIS\Brookley_GIS\Maps\FS Letter Report\20220505\Figure 1-2_Facility Site Location Map.mxd

Site Location

Legend

- Upper/Middle Surficial Monitoring Well Location
- Lower Surficial Monitoring Well Location
- Discrete Groundwater Sample Location
- HPT Location
- MIP Location
- Soil Boring Location
- Fenceline
- Railroad
- Parcel Boundary
- Parcel Designation (A - H)

ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
SDGI - Supplemental Data Gap Investigation
HTP - Hydraulic Profiling Tool
MIP - Membrane Interface Probe

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0 40 80 160 Feet

1 inch = 80 feet

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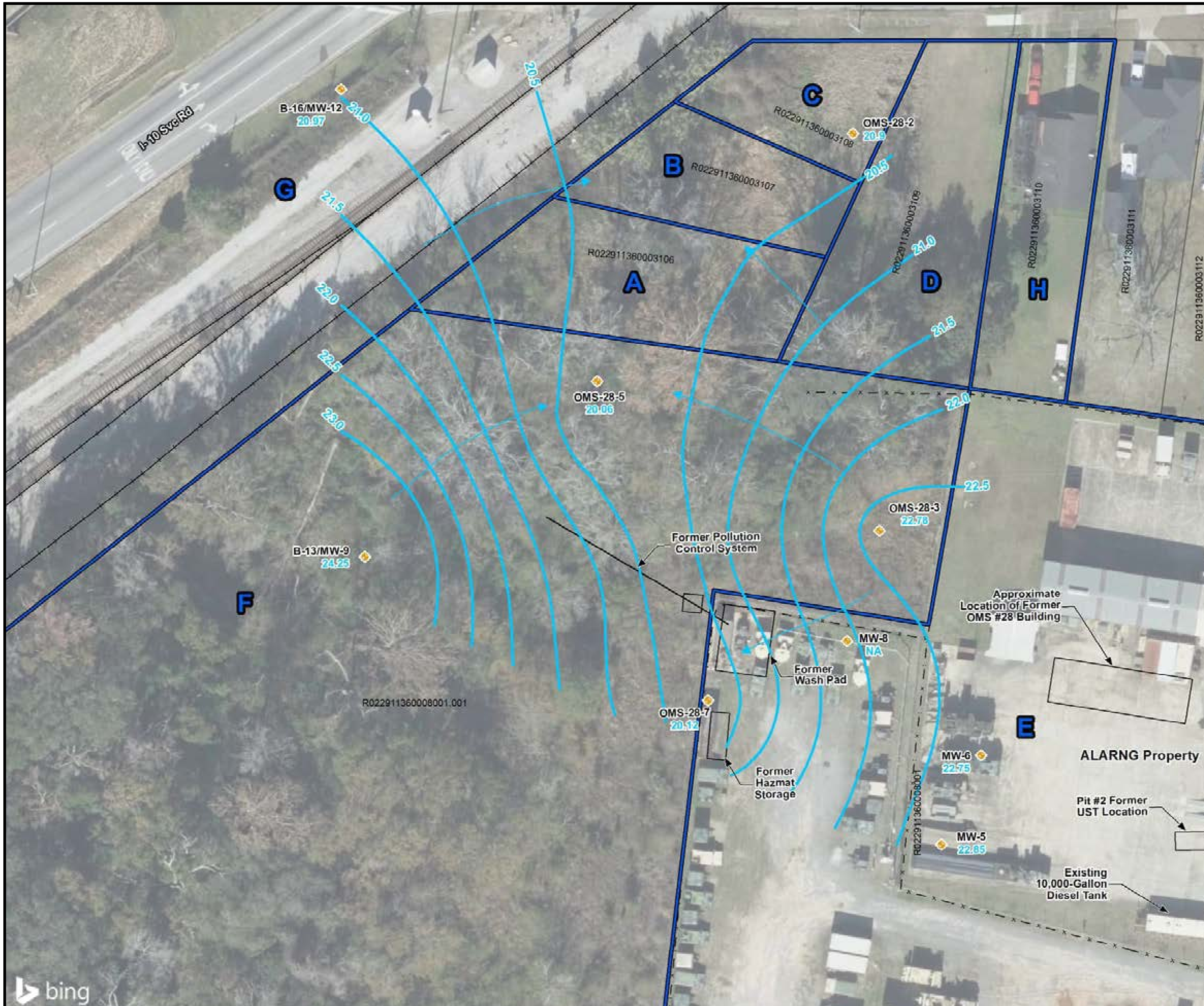
Parcel Designation and SDGI Sample Location Map

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/12/2023	Figure 1-3

Document Path: L:\Legacy\Group\earth\OMS 28\60439687\900-CADD-GIS\Brookley_GIS\Maps\FS Letter Report\20220505\Figure 1-3_OMS 28_Parcel Designation and Sample Location Map.mxd



Site Location

Legend

- Upper/Middle Surficial Monitoring Well
- 21.42 Groundwater Elevation - May 2017
- Groundwater Elevation Contour - May 2017
- Apparent Groundwater Flow Direction - May 2017
- Railroad
- Fenceline
- Parcel Boundary
- Parcel Designation (A - H)

Notes:

1. Water levels collected on May 1, 2017.
2. Contour interval 0.5 feet.
3. Only shallow wells included in contours.
4. Well MW-8 has been damaged. Water level unable to be used.
5. NA - Accurate groundwater elevation is not available.
6. Groundwater elevations referenced to feet above mean sea level, North American Vertical Datum 1929.

ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop

0 25 50 100 Feet

1 inch = 50 feet

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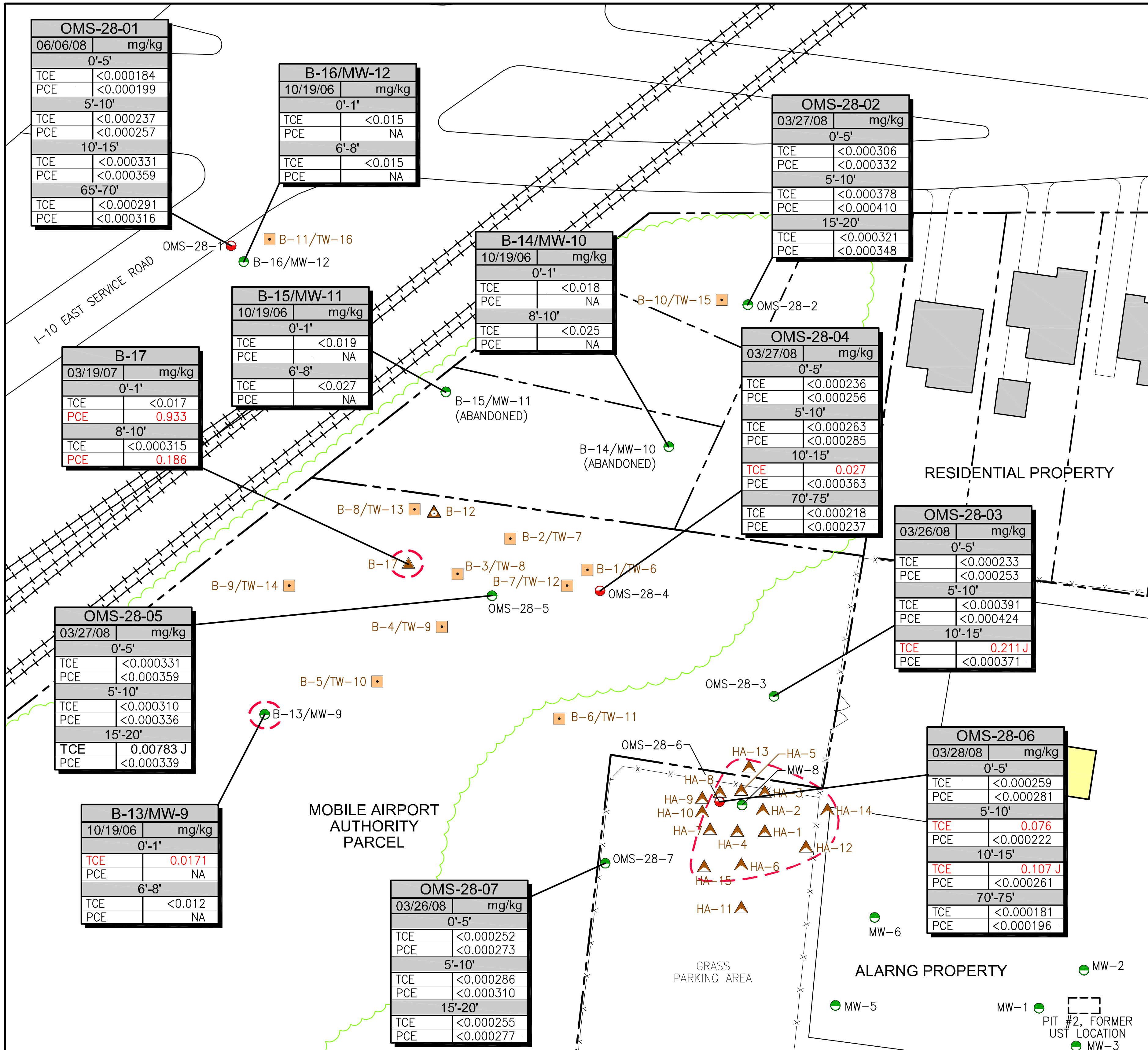
Groundwater Elevation and Flow Direction May 2017

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/12/2023	Figure 1-4



OMS-28-01	
06/06/08	mg/kg
0'-5'	
TCE	<0.000184
PCE	<0.000199
5'-10'	
TCE	<0.000237
PCE	<0.000257
10'-15'	
TCE	<0.000331
PCE	<0.000359
65'-70'	
TCE	<0.000291
PCE	<0.000316

B-16/MW-12	
10/19/06	mg/kg
0'-1'	
TCE	<0.015
PCE	NA
6'-8'	
TCE	<0.015
PCE	NA

OMS-28-02	
03/27/08	mg/kg
0'-5'	
TCE	<0.000306
PCE	<0.000332
5'-10'	
TCE	<0.000378
PCE	<0.000410
15'-20'	
TCE	<0.000321
PCE	<0.000348

B-14/MW-10	
10/19/06	mg/kg
0'-1'	
TCE	<0.018
PCE	NA
8'-10'	
TCE	<0.025
PCE	NA

B-15/MW-11	
10/19/06	mg/kg
0'-1'	
TCE	<0.019
PCE	NA
6'-8'	
TCE	<0.027
PCE	NA

B-17	
03/19/07	mg/kg
0'-1'	
TCE	<0.017
PCE	0.933
8'-10'	
TCE	<0.000315
PCE	0.186

OMS-28-04	
03/27/08	mg/kg
0'-5'	
TCE	<0.000236
PCE	<0.000256
5'-10'	
TCE	<0.000263
PCE	<0.000285
10'-15'	
TCE	0.027
PCE	<0.000363
70'-75'	
TCE	<0.000218
PCE	<0.000237

OMS-28-03	
03/26/08	mg/kg
0'-5'	
TCE	<0.000233
PCE	<0.000253
5'-10'	
TCE	<0.000391
PCE	<0.000424
10'-15'	
TCE	0.211 J
PCE	<0.000371

OMS-28-05	
03/27/08	mg/kg
0'-5'	
TCE	<0.000331
PCE	<0.000359
5'-10'	
TCE	<0.000310
PCE	<0.000336
15'-20'	
TCE	0.00783 J
PCE	<0.000339

B-13/MW-9	
10/19/06	mg/kg
0'-1'	
TCE	0.0171
PCE	NA
6'-8'	
TCE	<0.012
PCE	NA

OMS-28-06	
03/28/08	mg/kg
0'-5'	
TCE	<0.000259
PCE	<0.000281
5'-10'	
TCE	0.076
PCE	<0.000222
10'-15'	
TCE	0.107 J
PCE	<0.000261
70'-75'	
TCE	<0.000181
PCE	<0.000196

OMS-28-07	
03/26/08	mg/kg
0'-5'	
TCE	<0.000252
PCE	<0.000273
5'-10'	
TCE	<0.000286
PCE	<0.000310
15'-20'	
TCE	<0.000255
PCE	<0.000277

HA-1	
04/19/06	mg/kg
0'-1'	
TCE	0.00311 J
PCE	0.00121 J
6'-8'	
TCE	0.017
PCE	0.000822 J

HA-2	
04/19/06	mg/kg
0'-1'	
TCE	0.241 J
PCE	<0.011
8'-10'	
TCE	0.027
PCE	<0.000191

HA-3	
04/19/06	mg/kg
0'-1'	
TCE	0.019 J
PCE	<0.000476
8'-10'	
TCE	0.00353 J
PCE	<0.000137

HA-4	
04/19/06	mg/kg
0'-1'	
TCE	<0.000249
PCE	<0.000271
7'-9'	
TCE	<0.000211
PCE	<0.000229

HA-5	
04/19/06	mg/kg
0'-1'	
TCE	<0.000429
PCE	0.00252 J
7'-9'	
TCE	<0.00944
PCE	<0.010

HA-6	
04/19/06	mg/kg
0'-1'	
TCE	<0.000207
PCE	<0.000225
8'-10'	
TCE	0.15
PCE	<0.000203

HA-7	
04/19/06	mg/kg
0'-1'	
TCE	<0.000437
PCE	0.00253 J
8'-10'	
TCE	0.069 J
PCE	<0.00711

HA-8	
04/19/06	mg/kg
0'-1'	
TCE	0.00286 J
PCE	<0.00266
8'-10'	
TCE	<0.00998
PCE	<0.011

HA-9	
04/19/06	mg/kg
0'-1'	
TCE	<0.000359
PCE	<0.000389
8'-10'	
TCE	<0.012
PCE	<0.013

HA-10	
04/19/06	mg/kg
0'-1'	
TCE	<0.000267
PCE	0.00154 J
8'-10'	
TCE	<0.000146
PCE	<0.000159

HA-11	
05/11/06	mg/kg
0'-1'	
NOT SAMPLED	
8'-10'	
TCE	<0.000169
PCE	<0.000184

HA-12	
05/11/06	mg/kg
0'-1'	
NOT SAMPLED	
8'-10'	
TCE	0.00353 J
PCE	0.00191 J

HA-13	
05/11/06	mg/kg
0'-1'	
NOT SAMPLED	
8'-10'	
TCE	<0.000451
PCE	0.00505 J

HA-14	
03/19/07	mg/kg
0'-1'	
TCE	0.017
PCE	<0.000243
8'-10'	
TCE	0.00962
PCE	<0.000332

HA-15	
03/19/07	mg/kg
0'-1'	
TCE	0.586
PCE	<0.015
8'-10'	
TCE	0.132 J
PCE	<0.000326

LEGEND:

- RESIDENTIAL BUILDING
- COMMERCIAL BUILDING
- ASPHALT ROAD
- RAILROAD TRACKS
- CHAIN LINK FENCE
- PROPERTY BOUNDARY
- TREE LINE
- SOIL BORING (2006–2007)
- TEMPORARY WELL (2006–2007)
- HAND AUGER BORING (2006–2007)
- FLUTE LINER BORING (2006)
- SHALLOW MONITORING WELL
- DEEP MONITORING WELL
- XXXX CONTAMINATION EXCEEDING SSL
- CONTAMINATION EXCEEDING RSL
- EXCEEDS SSL

NOTES:

1. HISTORICAL LOCATIONS DIGITIZED FROM BASE MAP PROVIDED BY AEROSTAR ENVIRONMENTAL SERVICES INC. (AEROSTAR 2007).
2. MONITORING WELL LOCATIONS DATA PROVIDED BY AEROSTAR ENVIRONMENTAL SERVICES INC. (AEROSTAR 2008).
3. EPA RSLs DATED MAY 2012 ARE BEING USED IN LIEU OF AL PSVs PUBLISHED IN THE ALABAMA RISK-BASED CORRECTIVE ACTION GUIDANCE MANUAL (2008) AS PER APRIL 2, 2012 EMAIL CORRESPONDENCE BETWEEN ADEM AND ALARNG.

	PROTECTION OF GROUNDWATER SSL (mg/Kg)	RESIDENTIAL SOIL EPA RSL (mg/Kg)
TCE	0.0018	0.41
PCE	0.0023	8.1

ALABAMA STATE PLANE NAD 83 WEST ZONE

0 30 60 120

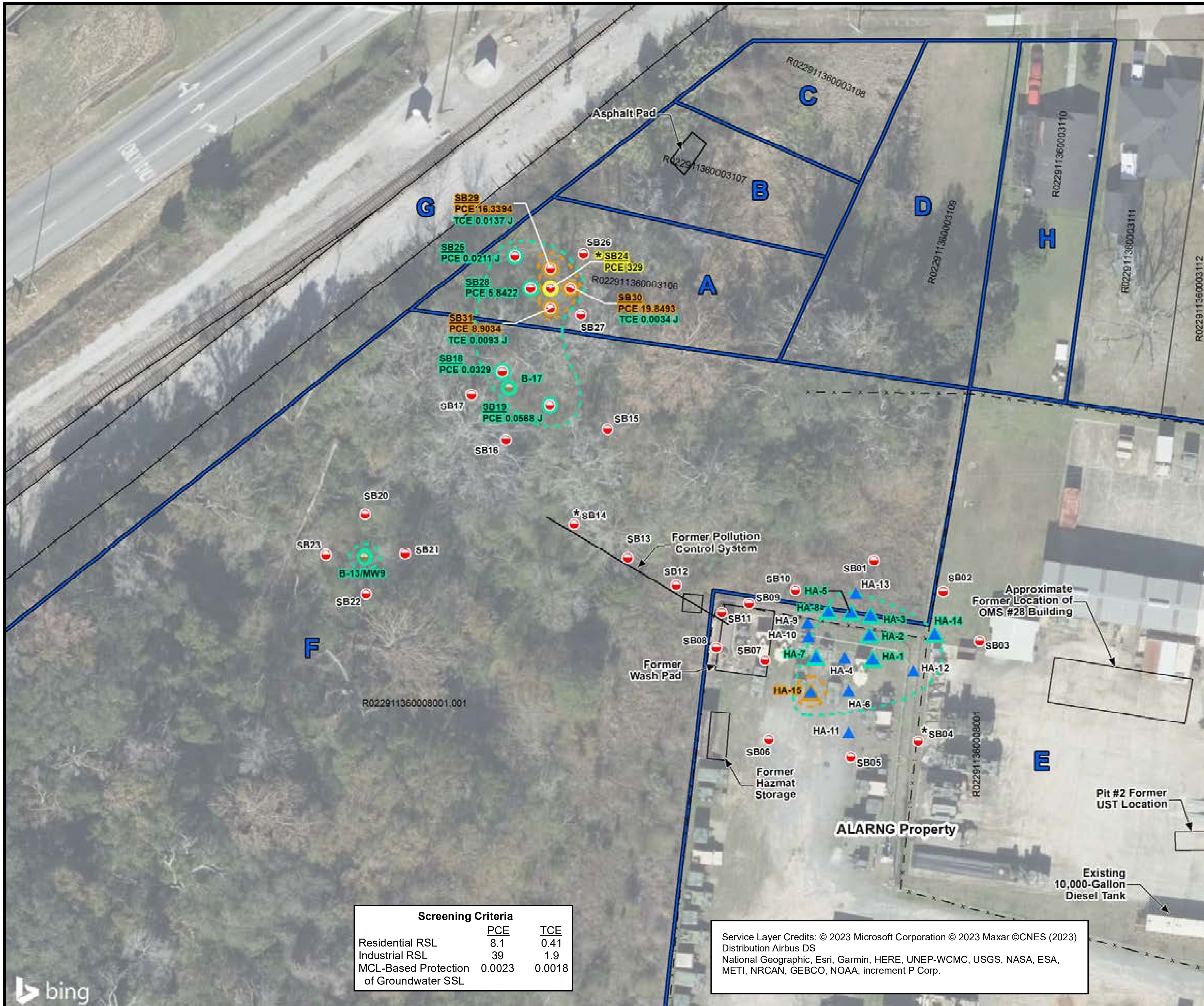
SCALE: 1" = 60'

AECOM

FIGURE 1-5
DISTRIBUTION OF COCs IN SOIL

OMS #28
ALABAMA ARMY NATIONAL GUARD
MOBILE, ALABAMA

Source:
SAIC, 2013, *RI Report for the ALARNG OMS #28*



Screening Criteria

	PCE	TCE
Residential RSL	8.1	0.41
Industrial RSL	39	1.9
MCL-Based Protection of Groundwater SSL	0.0023	0.0018

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National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

Site Location

Legend

- Hand Auger Samples Collected in 2006/2007
- Soil Boring Samples Collected in 2006/2007
- Soil Sample Locations Collected in 2017
- TCE and/or PCE Exceeded MCL- Based Protection of Groundwater SSL
- PCE or TCE Exceeded Residential RSL
- PCE Exceeded Industrial RSL
- Approximate Soil Area Exceeding MCL - Based Protection of Groundwater SSL
- Approximate Soil Area Exceeding Residential and/or Industrial RSL
- Railroad
- Fenceline
- Parcel Designation (A - H)
- Parcel Boundary

Notes:
1 - Soil Samples collected between May 8-16, 2017.
2 - Analytical results from mobile lab used unless split with fixed lab. Fixed lab samples denoted with "*".
3 - Soil concentrations in milligrams per kilogram.
4 - All samples collected from bottom of 0-1 ft bgs interval and analyzed by Method 8260.
5 - Residential and Industrial RSLs are based on risk of 1E-06 for carcinogens.
6 - No highlighting of symbol indicates TCE and PCE did not exceed any RSLs or SSL.
7 - If TCE/PCE not listed, they did not exceed any of the screening criteria.
8 - Analytical results for samples collected in 2006/2007 can be found in the TCE Comprehensive Investigation Report (Aerostar, April 2007).

J - The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
PCE - Tetrachloroethene
TCE - Trichloroethene
RSL - Regional Screening Criteria (USEPA, May 2023)
SSL - Soil Screening Level (USEPA, May 2023)
ft bgs - Feet below ground surface
MCL - Maximum Contaminant Level

0 25 50 100 Feet
1 inch = 50 feet

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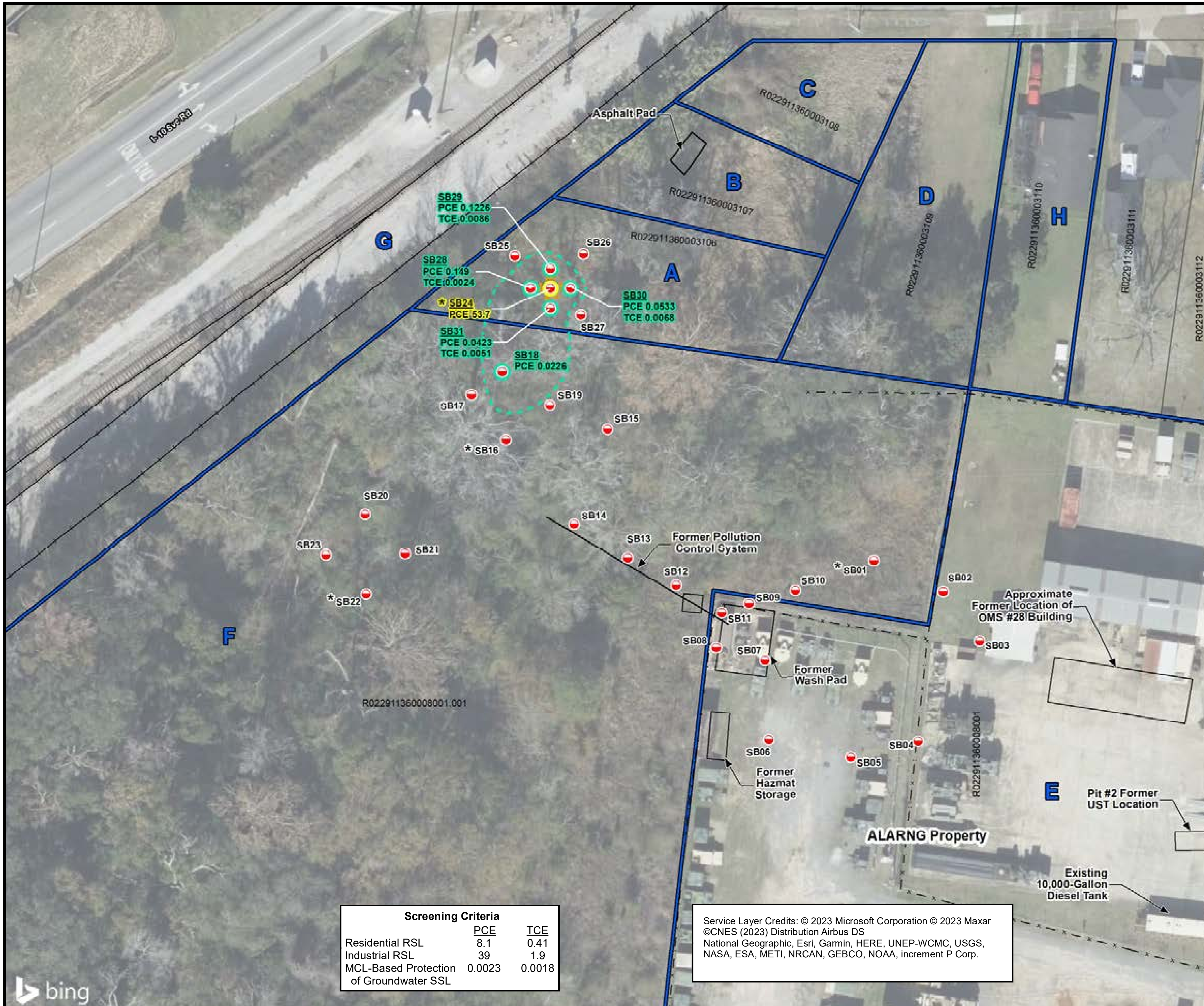
Surface Soil Sample Results - TCE and PCE (0 - 1 ft bgs)

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/17/2023	Figure 1-6

Document Path: L:\Legacy\Group\earth\OMS 28\60439687\900-CADD-GIS\Brookley_GIS\Maps\FS Letter Report\20220505\Figure 1-6_Brookley_Surface Soil Sample Results TCE and PCE - May 2017.mxd



Screening Criteria	PCE	TCE
Residential RSL	8.1	0.41
Industrial RSL	39	1.9
MCL-Based Protection of Groundwater SSL	0.0023	0.0018

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Site Location

Legend

- Soil Sample Locations
- PCE Exceeded Industrial RSL
- TCE and/or PCE Exceeded MCL-Based Protection of Groundwater SSL
- Railroad
- Approximate Soil Area Exceeding MCL - Based Protection of Groundwater SSL
- Approximate Soil Area Exceeding Residential RSL
- Fenceline
- Parcel Designation (A - H)
- Parcel Boundary

Notes:
1 - Soil Samples collected between May 8-16, 2017.
2 - Analytical results from mobile lab used unless split with fixed lab. Fixed lab samples denoted with "*".
3 - Soil concentrations in milligrams per kilogram.
4 - Only soil results from depths between 1.5 and 4 ft bgs are shown Interval selected based on PID or MIP result. If no response from either PID or MIP, the sample was collected from the midpoint between the surface sample and the top of water table sample.
5 - Residential and Industrial RSLs are based on risk of 1E-06 for carcinogens.
6 - No highlighting of symbol indicates TCE and PCE did not exceed any RSLs or SSL.
7 - If TCE/PCE not listed, they did not exceed any of the screening criteria.
8 - Samples from previous investigations are not within this depth interval.

ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
PID - Photo Ionization Detector
MIP - Membrane Interface Probe
PCE - Tetrachloroethene
TCE - Trichloroethene
RSL - Regional Screening Criteria (USEPA, May 2023)
SSL - Soil Screening Level (USEPA, May 2023)
ft bgs - Feet below ground surface
MCL - Maximum Contaminant Level

0 25 50 100 Feet

1 inch = 50 feet

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Upper Subsurface Soil Sample Results for TCE and PCE (1.5 - 4 ft bgs)

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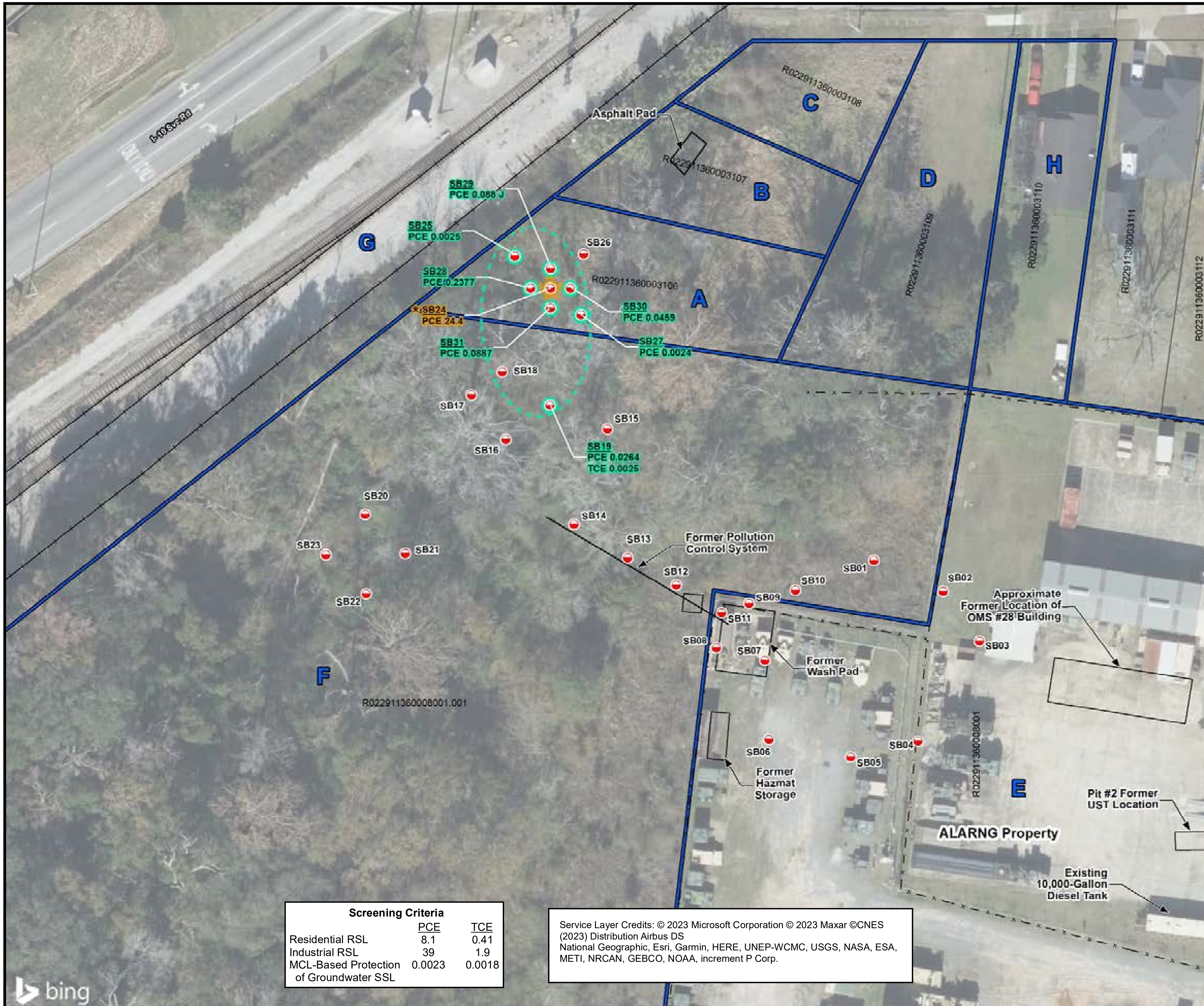
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/17/2023	Figure 1-7



Screening Criteria

	PCE	TCE
Residential RSL	8.1	0.41
Industrial RSL	39	1.9
MCL-Based Protection of Groundwater SSL	0.0023	0.0018

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Site Location

Legend

- Soil Sample Locations
- PCE Exceeded Residential RSL
- TCE and/or PCE Exceeded MCL - Based Protection of Groundwater SSL
- Railroad
- Approximate Soil Area Exceeding MCL - Based Protection of Groundwater SSL
- Approximate Soil Area Exceeding Residential RSL
- Fenceline
- Parcel Designation (A - H)
- Parcel Boundary

Notes:
1 - Soil Samples collected between May 8-16, 2017.
2 - Analytical results from mobile lab used unless split with fixed lab. Fixed lab samples denoted with "*".
3 - Soil concentrations in milligrams per kilogram.
4 - Only soil results from 1-ft above water table depth varying between 2 and 6 ft bgs are shown.
5 - Residential and Industrial RSLs are based on risk of 1E-06 for carcinogens.
6 - No highlighting of symbol indicates TCE and PCE did not exceed the residential or industrial RSLs or SSL.
7 - If TCE/PCE not listed, they did not exceed any of the screening criteria.
8 - Samples from previous investigations collected at depths were below the current (May 2017) water table.

J - The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
PCE - Tetrachloroethene
TCE - Trichloroethene
RSL - Regional Screening Criteria (USEPA, May 2023)
SSL - Soil Screening Level (USEPA, May 2023)
ft bgs - Feet below ground surface
MCL - Maximum Contaminant Level

0 25 50 100 Feet
1 inch = 50 feet

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Lower Subsurface Soil Sample Results for TCE and PCE (1 Ft Above Water Table)

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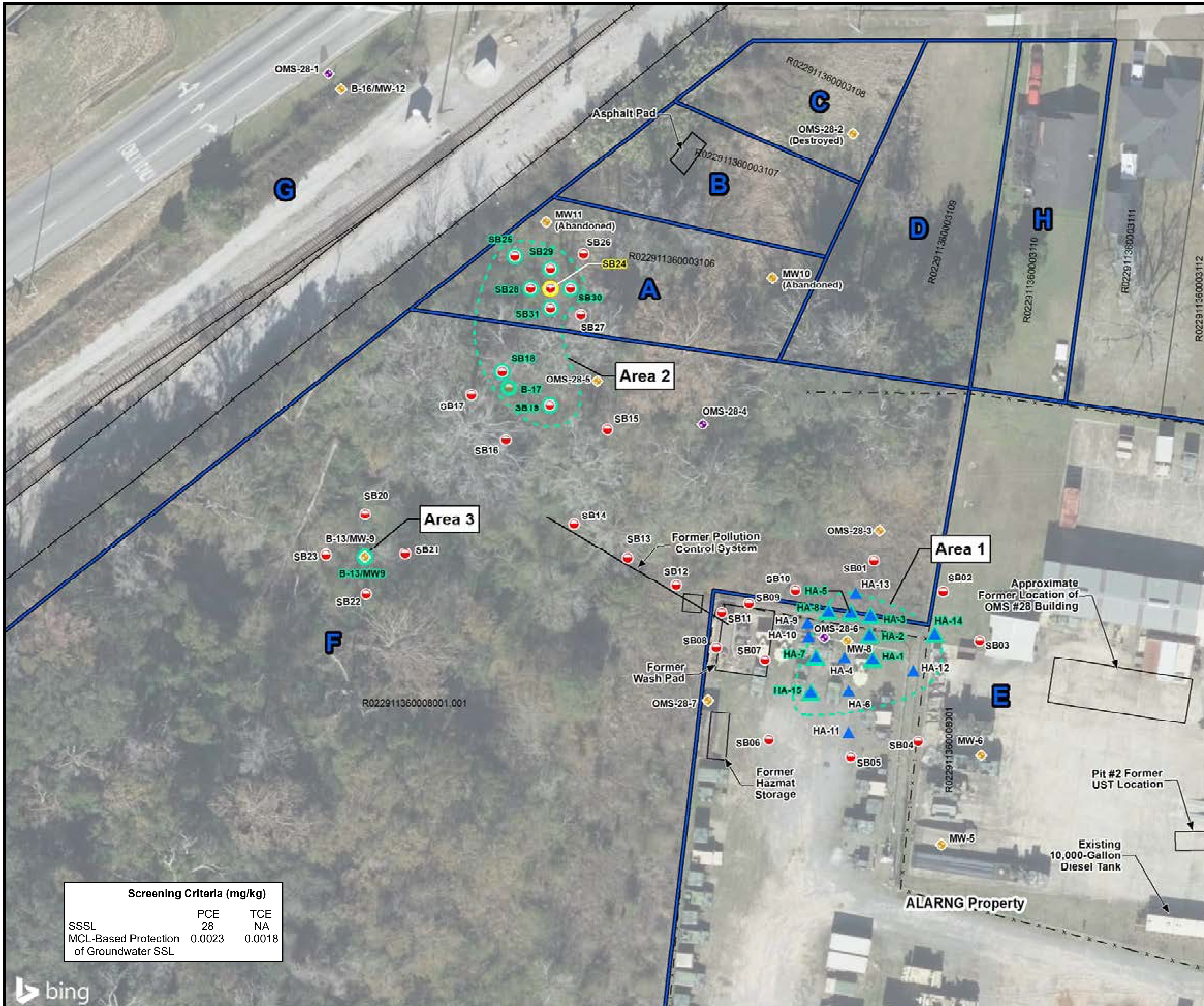
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/17/2023	Figure 1-8

Document Path: L:\Legacy\Group\earth\OMS 28\60439687\900-CADD-GIS\Brookley_GIS\Maps\FS Letter Report\20220505\Figure 1-8_Brookley_Lower Subsurface Soil Sample Results for TCE and PCE.mxd



Screening Criteria (mg/kg)

	PCE	TCE
SSSL	28	NA
MCL-Based Protection of Groundwater SSL	0.0023	0.0018

Site Location

Legend

- Hand Auger Samples Collected in 2006/2007
- Soil Boring Samples Collected in 2006/2007
- Soil Sample Locations Collected in 2017
- TCE and/or PCE Exceed MCL- Based Protection of Groundwater SSL
- PCE Exceeds SSSL
- Upper/Middle Surficial Monitoring Well Location
- Lower Surficial Monitoring Well Location
- Railroad
- Fenceline
- Approximate soil area exceeding MCL - Based Protection of Groundwater SSL
- Parcel Designation (A - H)
- Parcel Boundary

Notes:
ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
PCE - Tetrachloroethene
TCE - Trichloroethene
MCL - Maximum Contaminant Level
SSL - Soil Screening Level (USEPA, May 2023)
SSSL - Site Specific Screening Level (AECOM, March 2023)
NA - Not Applicable
FT - Feet

Wells MW-10 and MW-11 were abandoned in 2008 at the property owner's request.

Well OMS-28-2 was found destroyed during a site visit in December 2021.

0 25 50 100 Feet
1 inch = 50 feet

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Estimated Extent of Soil Impacts (From Ground Surface to 1 Ft Above Water Table)

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Mobile, Alabama

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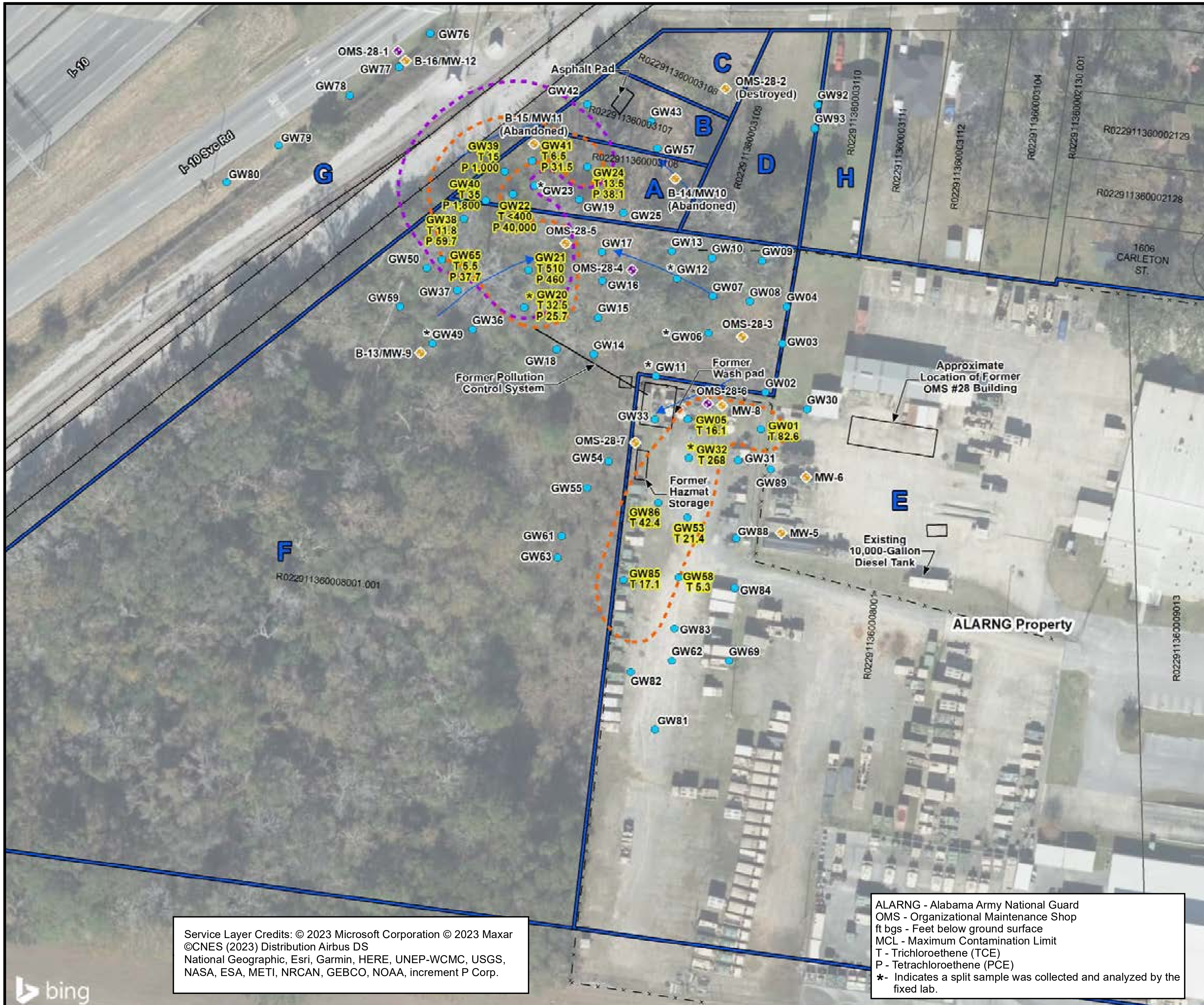
60666895	RJS	10/16/2023	Figure 1-9



Site Location

Legend

- Discrete Groundwater Sample Locations
- Upper/Middle Surficial Monitoring Well Location
- Lower Surficial Monitoring Well Location
- Apparent Groundwater Flow Direction - May 2017
- Fenceline
- Railroad
- Approximate extent of TCE Exceedance Above the MCL (5 µg/L)
- Approximate extent of PCE Exceedance Above the MCL (5 µg/L)
- Parcel Designation (A - H)
- Parcel Boundary
- Indicates PCE and/or TCE were detected above its respective MCL.

Notes:
1. Discrete groundwater investigation conducted in May 2017 (GW-01 through GW-72) and January/February 2018 (GW-73 through GW-93).
2. The laboratory analytical results from the mobile lab are used for the May 2017 results unless a split sample with the fixed lab is available.
The fixed lab results are used for the January/February 2018 samples.
3. Only groundwater results from discrete depths between 6 and 13 ft bgs are shown.
4. No highlighting of symbol indicates TCE and PCE did not exceed their respective MCLs.
5. If the TCE or PCE value is not listed, it did not exceed its respective screening criteria.
6. Wells MW-10 and MW--11 were abandoned in 2008 at the property owner's request.
7. Well OMS-28-2 was found destroyed during a site visit in December 2021.

0 40 80 160 Feet

1 inch = 80 feet

ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
ft bgs - Feet below ground surface
MCL - Maximum Contamination Limit
T - Trichloroethene (TCE)
P - Tetrachloroethene (PCE)
*- Indicates a split sample was collected and analyzed by the fixed lab.

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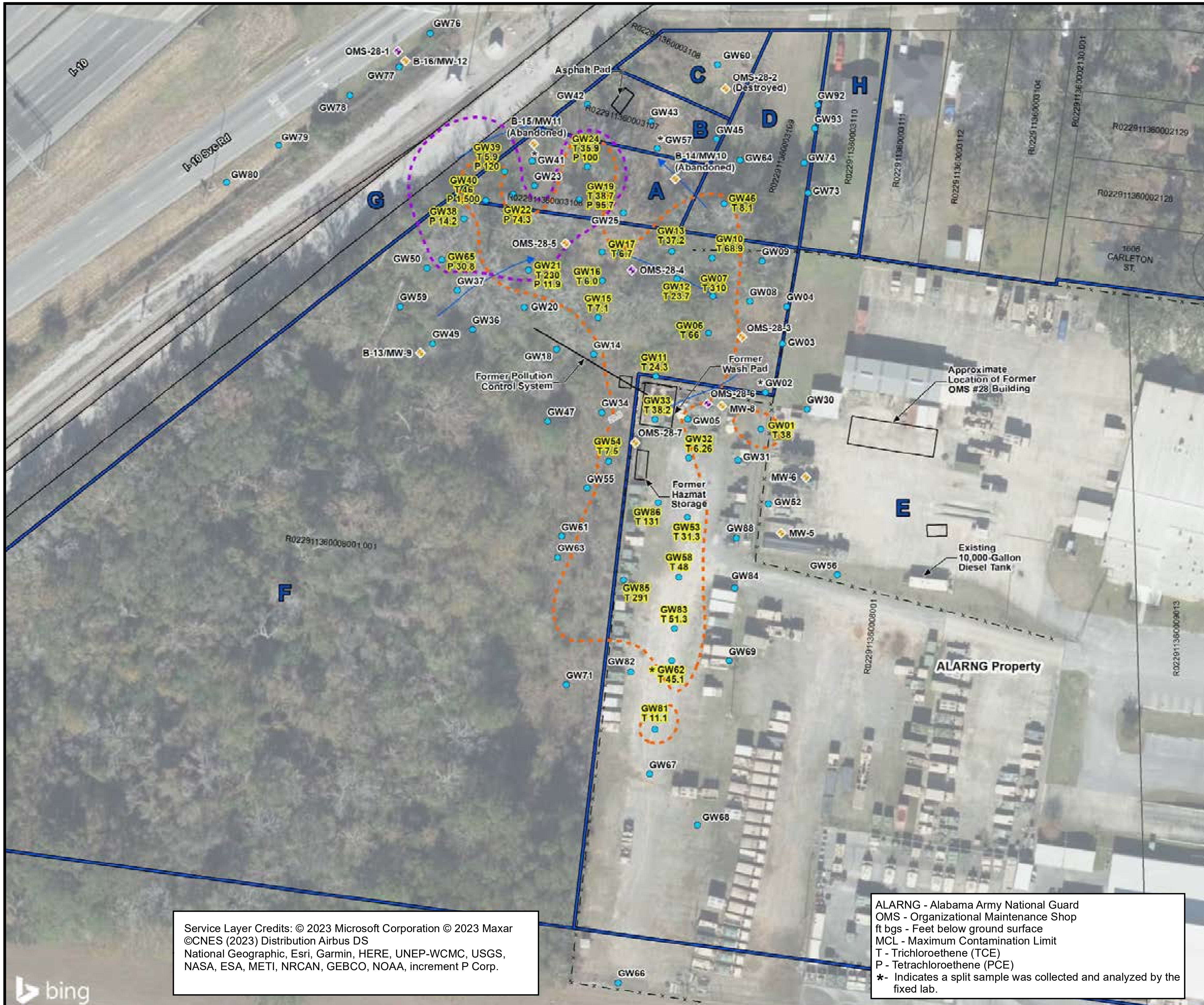
Discrete Groundwater Sampling Results for PCE & TCE - Upper Surficial (6 - 13 ft bgs)

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/16/2023	Figure 1-10



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ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
ft bgs - Feet below ground surface
MCL - Maximum Contamination Limit
T - Trichloroethene (TCE)
P - Tetrachloroethene (PCE)
*- Indicates a split sample was collected and analyzed by the fixed lab.

Legend

- Discrete Groundwater Sample Locations
- Upper/Middle Surficial Monitoring Well Location
- Lower Surficial Monitoring Well Location
- Approximate extent of PCE Exceedance Above the MCL (5 µg/L)
- Approximate extent of TCE Exceedance Above the MCL (5 µg/L)
- Apparent Groundwater Flow Direction - May 2017
- Fenceline
- Railroad
- Parcel Boundary
- Parcel Designation (A - H)
- Indicates TCE and/or PCE were detected above their respective MCL.

Notes:
1. Discrete groundwater investigation conducted in May 2017 (GW-01 through GW-72) and January/February 2018 (GW-73 through GW-93).
2. The laboratory analytical results from the mobile lab are used for the May 2017 results unless a split sample with the fixed lab is available.
The fixed lab results are used for the January/February 2018 samples.
3. Only groundwater results from discrete depths between 12 and 26 ft bgs are shown.
4. No highlighting of symbol indicates TCE and PCE did not exceed their respective MCLs.
5. If the TCE or PCE value is not listed, it did not exceed its respective screening criteria.
6. Wells MW-10 and MW--11 were abandoned in 2008 at the property owner's request.
7. Well OMS-28-2 was found destroyed during a site visit in December 2021.

0 40 80 160 Feet

1 inch = 80 feet

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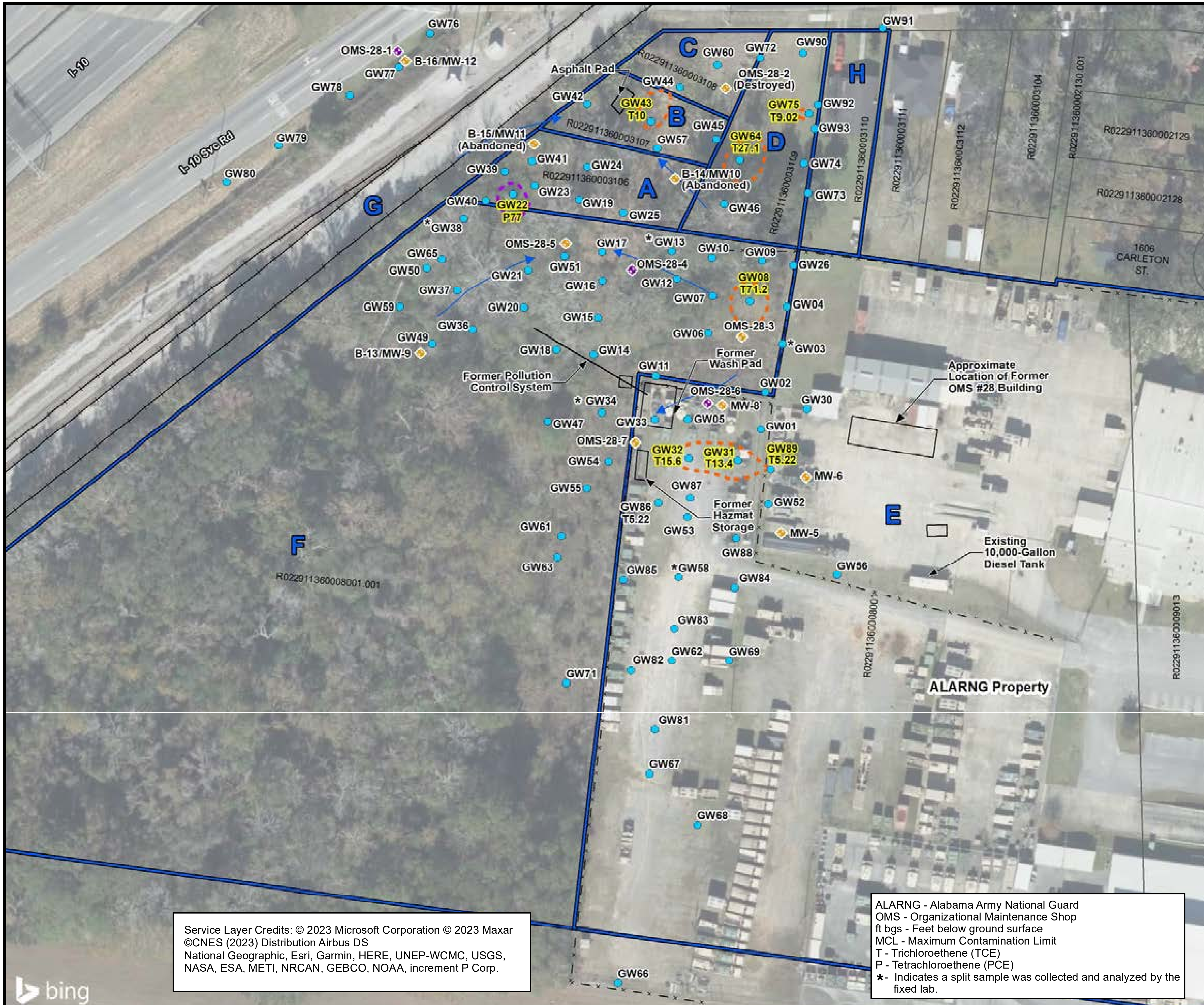
Discrete Groundwater Sampling Results for PCE & TCE - Middle Surficial (12 - 26 ft bgs)

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/16/2023	Figure 1-11

Document Path: L:\Legacy\Group\earth\OMS 28\60439687\900-CADD-GIS\Brookley_GIS\Maps\FS Letter Report\20220505\Figure 1-11_Brookley_Discrete Groundwater Sampling Results 12-26ft RJS.mxd



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ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
ft bgs - Feet below ground surface
MCL - Maximum Contamination Limit
T - Trichloroethene (TCE)
P - Tetrachloroethene (PCE)
*- Indicates a split sample was collected and analyzed by the fixed lab.

Site Location

Legend

- Discrete Groundwater Sample Locations
- Upper/Middle Surficial Monitoring Well Location
- Lower Surficial Monitoring Well Location
- Approximate extent of TCE Exceedance Above the MCL (5 µg/L)
- Approximate extent of PCE Exceedance Above the MCL (5 µg/L)
- Apparent Groundwater Flow Direction - May 2017
- Fenceline
- Railroad
- Parcel Designation (A - H)
- Parcel Boundary
- Indicates TCE and/or PCE were detected above their respective MCL.

Notes:
1. Discrete groundwater investigation conducted in May 2017 (GW-01 through GW-72) and January/February 2018 (GW-73 through GW-93).
2. The laboratory analytical results from the mobile lab are used for the May 2017 results unless a split sample with the fixed lab is available.
The fixed lab results are used for the January/February 2018 samples.
3. Only groundwater results from discrete depths deeper than 26 bgs are shown.
4. No highlighting of symbol indicates TCE and PCE did not exceed their respective MCLs.
5. If the TCE or PCE value is not listed, it did not exceed its respective screening criteria.
6. Wells MW-10 and MW--11 were abandoned in 2008 at the property owner's request.
7. Well OMS-28-2 was found destroyed during a site visit in December 2021.

0 40 80 160 Feet

1 inch = 80 feet

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Discrete Groundwater Sampling Results for PCE & TCE - Lower Surficial (Deeper than 26 ft bgs)

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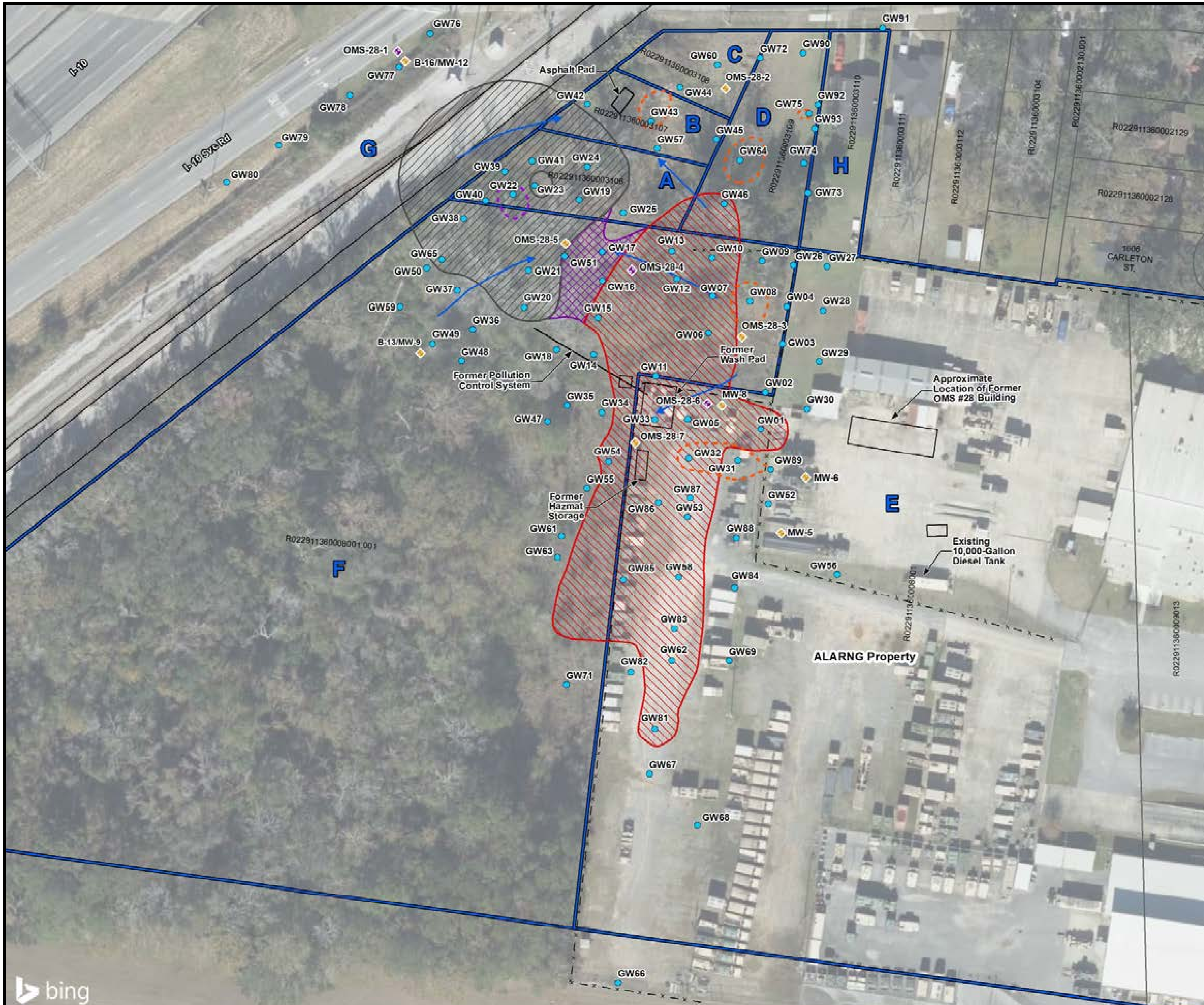
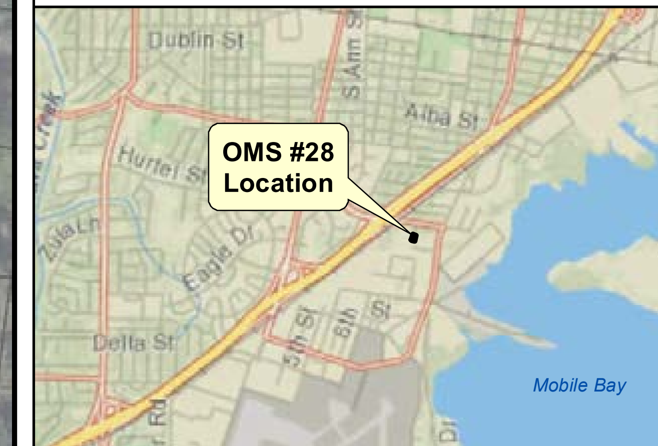
Document Path: L:\Legacy\Group\earth\OMS 28\60439687\900-CADD-GIS\Brookley_GIS\Maps\FS Letter Report\20220505\Figure 1-12_Brookley_Discrete Groundwater Sampling Results Deeper than 26ft RJS.mxd



Site Location



Legend

- Upper/Middle Surficial Monitoring Well
- Lower Surficial Monitoring Well Locations
- Discrete Groundwater Sample Locations
- Approximate Extent of PCE Exceedance Above the MCL (5 µg/L) in the Lower Surficial Aquifer
- Approximate Extent of TCE Exceedance Above the MCL (5 µg/L) in the Lower Surficial Aquifer
- Apparent Groundwater Flow Direction - May 2017
- Fenceline
- Railroad
- PCE Plume Related to Offsite PCE Spill on Parcel A
- TCE Plume Related to TCE Spill on Parcel E
- Area of Co-Mingled PCE from Parcel A and TCE from Parcel E
- Parcel Designation (A - H)
- Parcel Boundary

Note:
ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
PCE - Tetrachloroethene
TCE - Trichloroethene
MCL - Maximum Contaminant Level
µg/L - micrograms per liter

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0 40 80 160 Feet

1 inch = 80 feet

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Approximate Extent of PCE and TCE Groundwater Plumes

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Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
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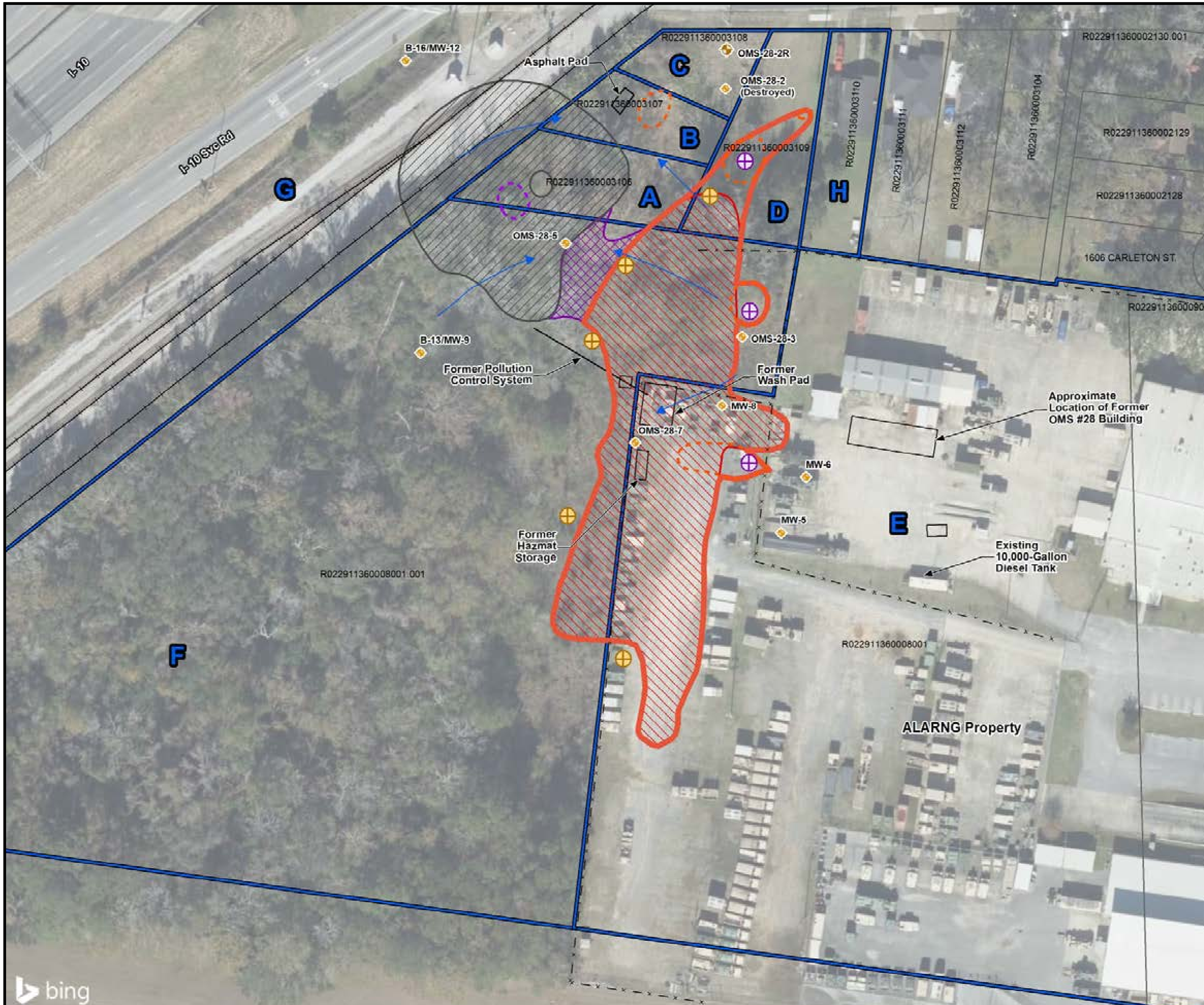
Document Path: L:\Legacy\Group\earth\OMS 28\60439687\900-CADD-GIS\Brookley_GIS\Maps\FS Letter Report\20220505\Figure 1-13_Brookley_Approx_Extent_PCE_TCE_and_Intermix_Plumes.mxd



Legend

- Proposed Replacement Well
- Proposed Upper/Middle Surficial Aquifer Monitoring Well Location
- Proposed Lower Surficial Aquifer Monitoring Well Location
- Existing Upper/Middle Surficial Aquifer Monitoring Well Locations
- Approximate Extent of PCE Exceedance Above the MCL (5 µg/L) in the Lower Surficial Aquifer
- Approximate Extent of TCE Exceedance Above the MCL (5 µg/L) in the Lower Surficial Aquifer
- Apparent Groundwater Flow Direction - May 2017
- Fenceline
- Railroad
- Proposed LUC Boundary
- PCE Plume Related to Offsite PCE Spill on Parcel A
- TCE Plume Related to TCE Spill on Parcel E
- Area of Co-Mingled PCE from Parcel A and TCE from Parcel E
- Parcel Designation (A - H)
- Parcel Boundary

ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
PCE - Tetrachloroethene
TCE - Trichloroethene
MCL - Maximum Contaminant Level
LUCs - Land Use Controls
µg/L - micrograms per liter

0 75 150 Feet

1 inch = 80 feet

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Alternative 2: LUCs with Periodic Monitoring

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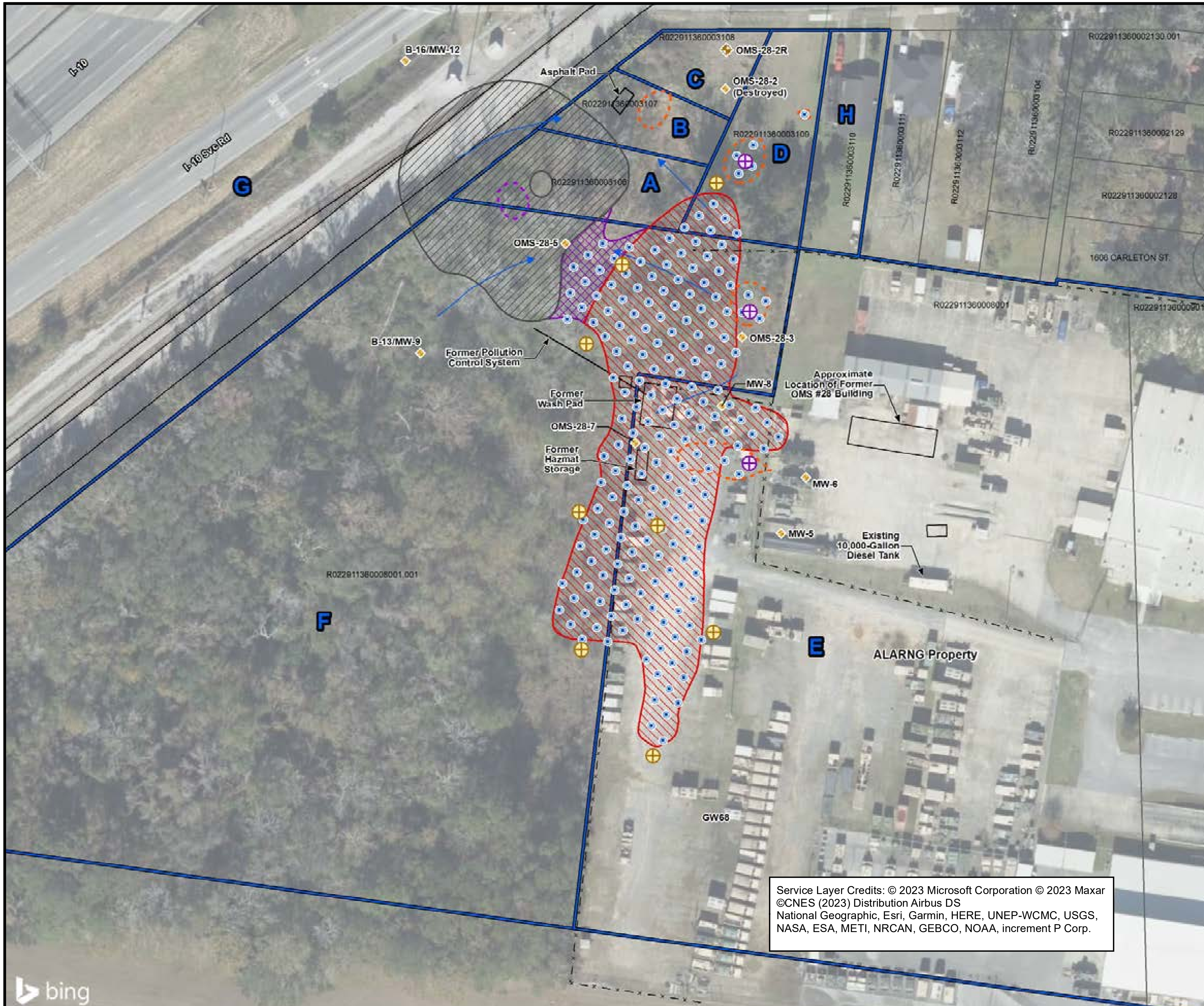
PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/17/2023	Figure 4-1



Site Location

Legend

- Temporary Injection Points (15 ft on center)
- Proposed Upper/Middle Surficial Aquifer Monitoring Well Location
- Proposed Lower Surficial Aquifer Monitoring Well
- Proposed Replacement Well
- Existing Upper/Middle Surficial Aquifer Monitoring Well Locations
- Approximate Extent of PCE Exceedance Above the MCL (5 µg/L) in the Lower Surficial Aquifer
- Approximate Extent of TCE Exceedance Above the MCL (5 µg/L) in the Lower Surficial Aquifer
- Apparent Groundwater Flow Direction - May 2017
- Fenceline
- Railroad
- Parcel Designation (A - H)
- Parcel Boundary
- PCE Plume Related to Offsite PCE Spill on Parcel A
- TCE Plume Related to TCE Spill on Parcel E
- Area of Co-Mingled PCE from Parcel A and TCE from Parcel

ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
PCE - Tetrachloroethene
TCE - Trichloroethene
MCL - Maximum Contaminant Level
ERD - Enhanced Reductive Dechlorination
ISCR - In Situ Chemical Reduction
MNA - Monitored Natural Attenuation
µg/L - micrograms per liter
ft - feet

0 40 80 160 Feet

1 inch = 80 feet

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Alternative 3:
ERD, ISCR, and Enhanced MNA

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/17/2023	Figure 4-2

APPENDICES

APPENDIX A

Geologic Cross Sections

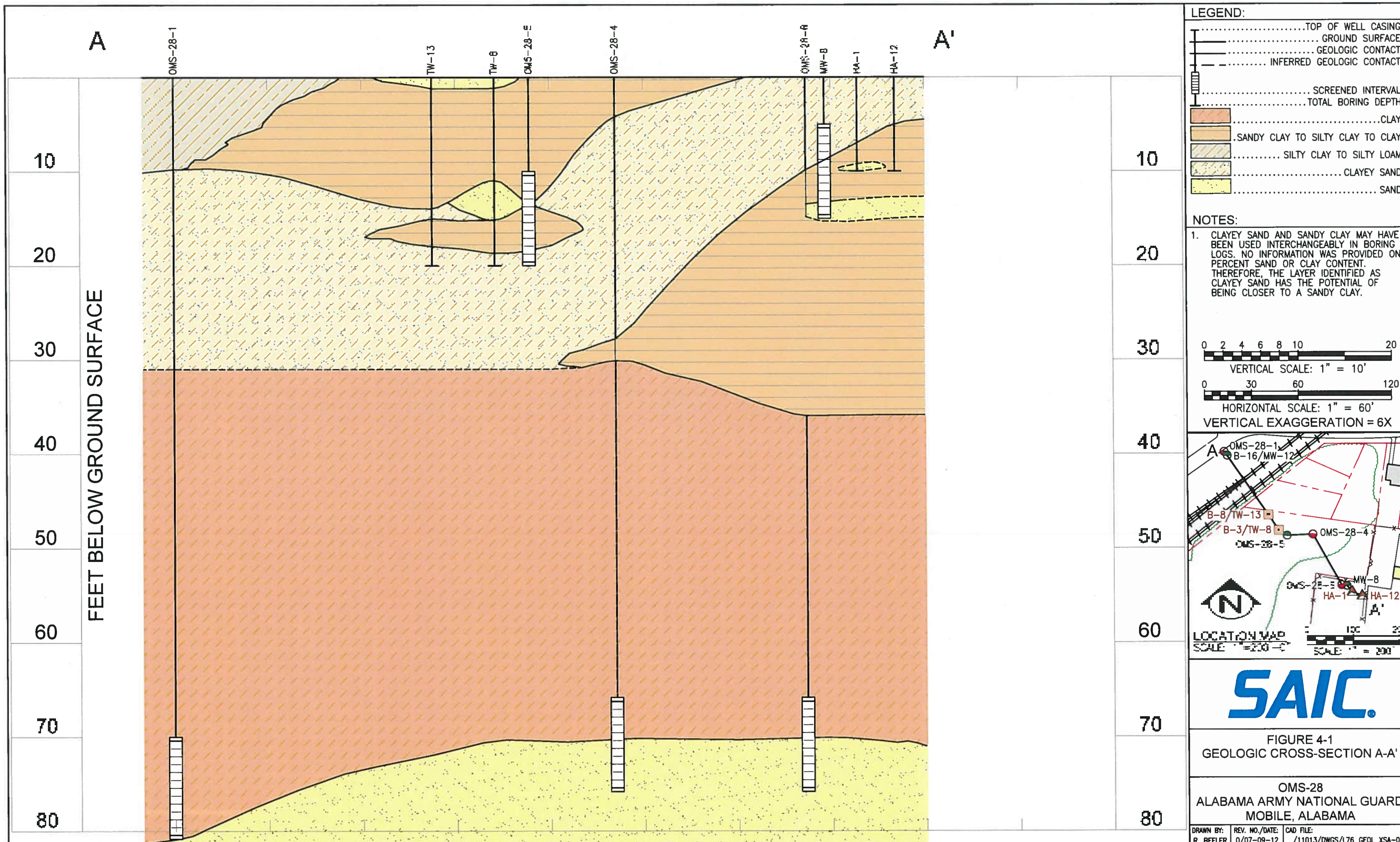
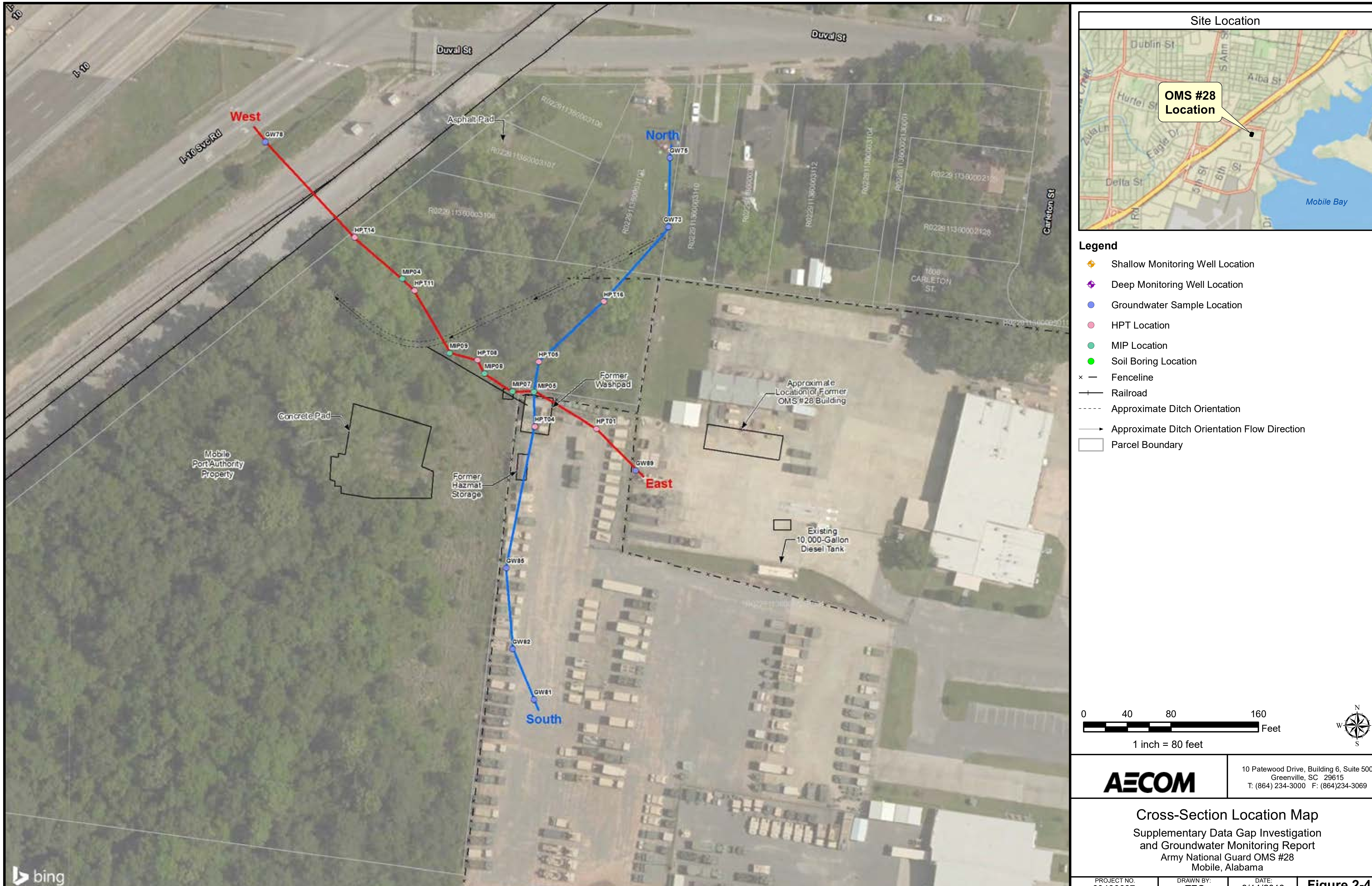


FIGURE 4-1
GEOLOGIC CROSS-SECTION A-A'



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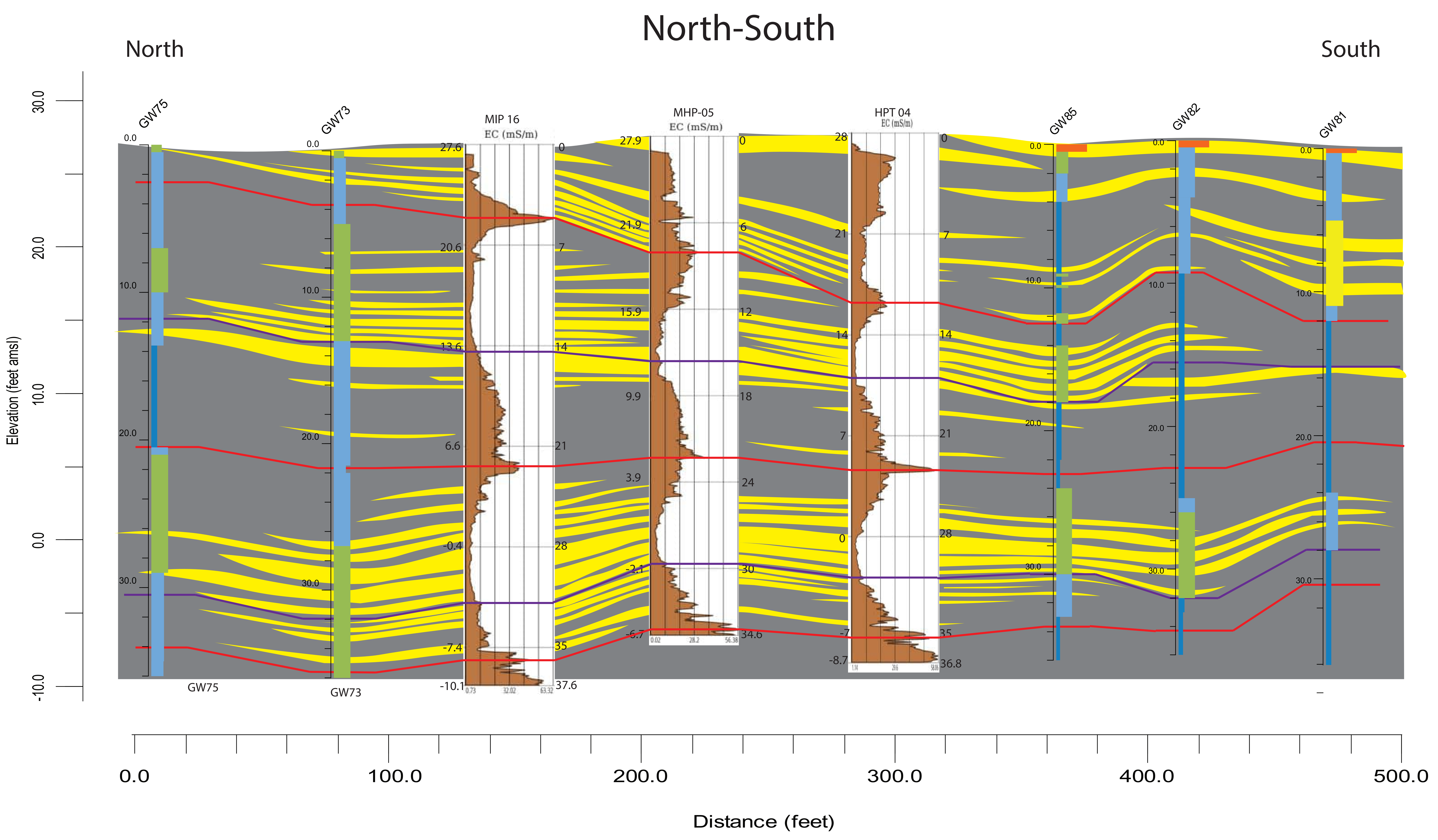
Cross-Section Location Map

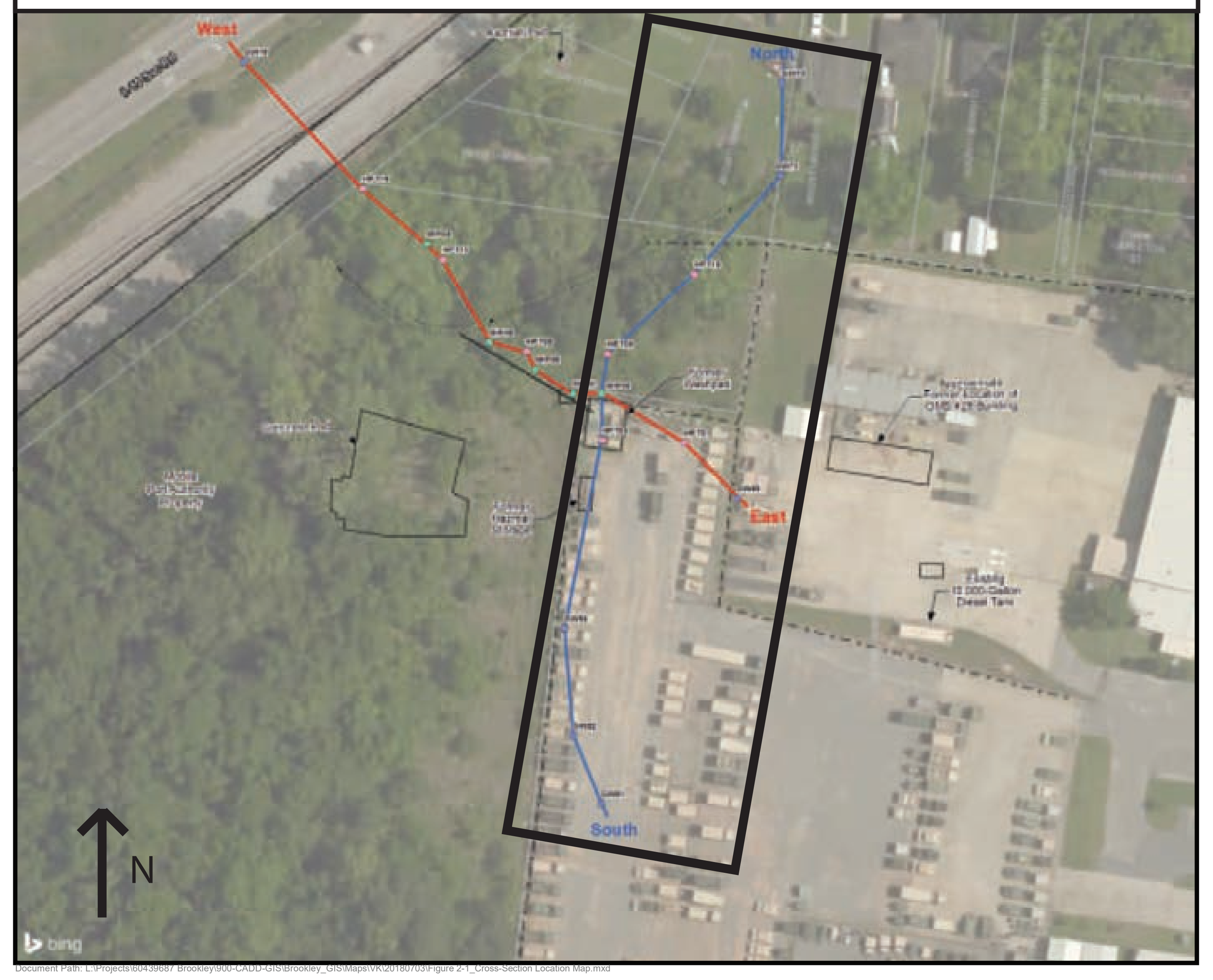
Supplementary Data Gap Investigation and Groundwater Monitoring Report
Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60439687	TEG	8/14/2018	Figure 2-4

Document Path: L:\Projects\60439687 Brookley\900-CADD-GIS\Brookley_GIS\Maps\VK\2018_08_09\Figure 2-4_Cross-Section Location Map.mxd



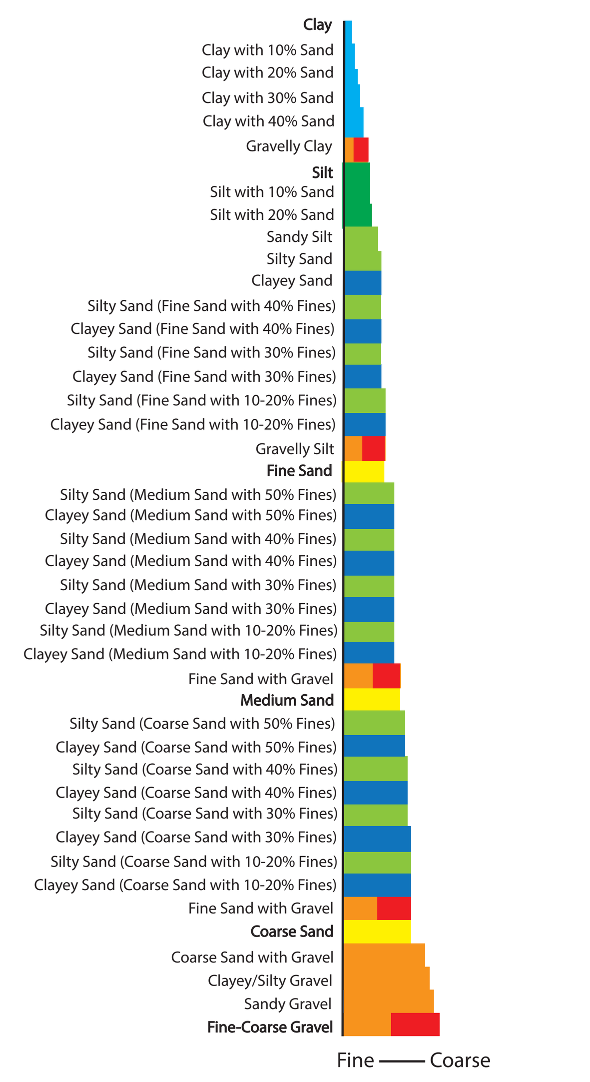
Cross Section Location



Legend

- Maximum Flooding Surface
- Sequence Boundary
- Mouth Bar Sands
- Tidal Clay

Grain Size Log



Notes:

GW75 - Discrete groundwater sampling location 75
MIP 16 - Membrane Interface Probe push location 16
HPT 04 - Hydraulic Profiling Tool push location 04
MHP-05 - Dual MIP/HPT push location 05
EC - Electrical conductivity
mS/m - miliSiemens per meter
amsl - above mean sea level

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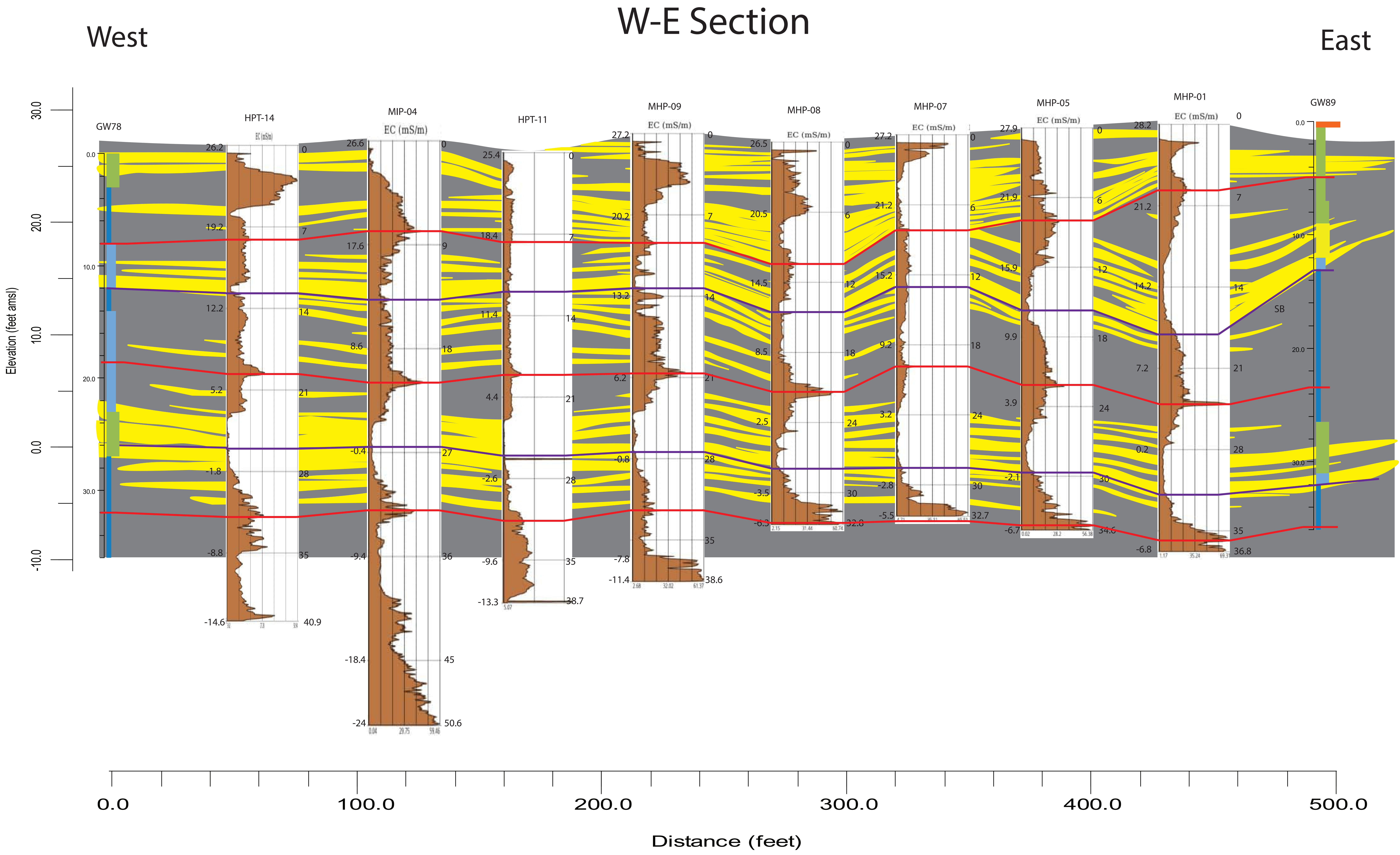
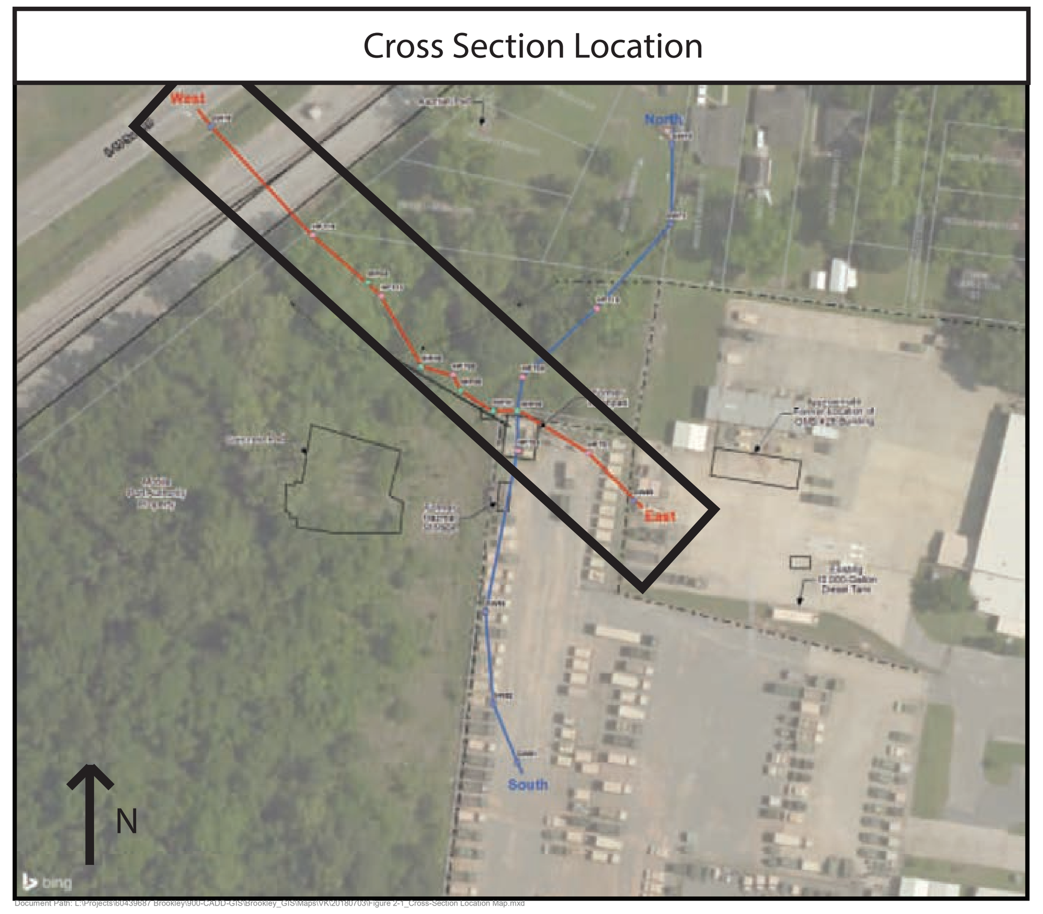
North - South Cross Section

Supplementary Data Gap Investigation and Groundwater Monitoring Report

Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60439687	RCS	7/5/2018	**Figure 2-5**

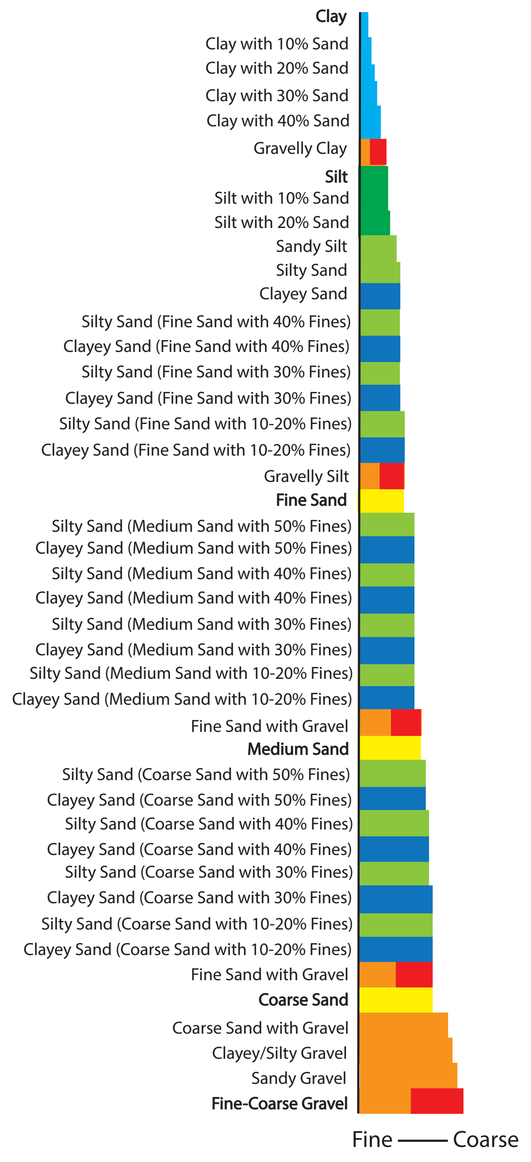




Legend

- Maximum Flooding Surface
- Sequence Boundary
- Mouth Bar Sands
- Tidal Clay

Grain Size Log



Notes:

GW89 - Discrete groundwater sampling location 89

MIP-04 - Membrane Interface Probe push location 04

HPT-11 - Hydraulic Profiling Tool push location 11

MHP-05 - Dual MIP/HPT push location 05

EC - Electrical conductivity

mS/m - miliSiemens per meter

amsl - above mean sea level

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West - East Cross Section

Supplmentary Data Gap Investigation
and Groundwater Monitoring Report

Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60439687	RCS	7/5/2018	**Figure 2-6**

APPENDIX B

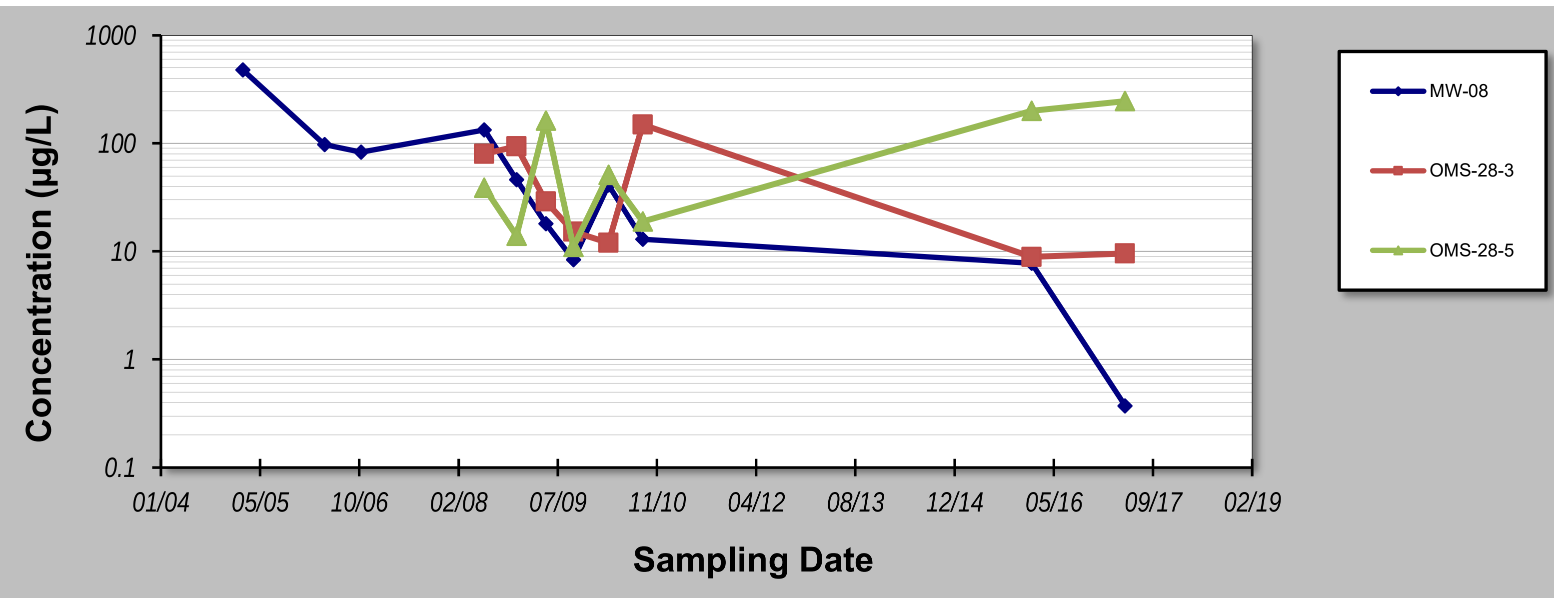
Mann-Kendall Toolkit Analysis

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **9-Feb-22**
Facility Name: **OMS #28**
Conducted By: **Timothy Renn**

Job ID: **60666895**
Constituent: **TCE - Upper Surficial aquifer**
Concentration Units: **µg/L**

Sampling Point ID:		**MW-08**	**OMS-28-3**	**OMS-28-5**				
Sampling Event	Sampling Date	TCE - UPPER SURFICIAL AQUIFER CONCENTRATION (µg/L)						
1	1-Mar-05	480						
2	18-Apr-06	97.9						
3	18-Oct-06	83						
4	1-Jul-08	133	80	39				
5	11-Dec-08	46	94	14				
6	8-May-09	18	29	162				
7	24-Sep-09	8.41	15.29	11				
8	19-Mar-10	41	12	51				
9	8-Sep-10	13	149	19				
10	20-Jan-16	7.8	8.92	200				
11	5-May-17	0.373	9.6	246				
12								
13								
14								
15								
16								
17								
18								
19								
20								
Coefficient of Variation:		**1.30**	**1.05**	**1.02**				
Mann-Kendall Statistic (S):		**-22**	**-14**	**12**				
Confidence Factor:		**99.8%**	**94.6%**	**91.1%**				
Concentration Trend:		Decreasing	Prob. Decreasing	Prob. Increasing				



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

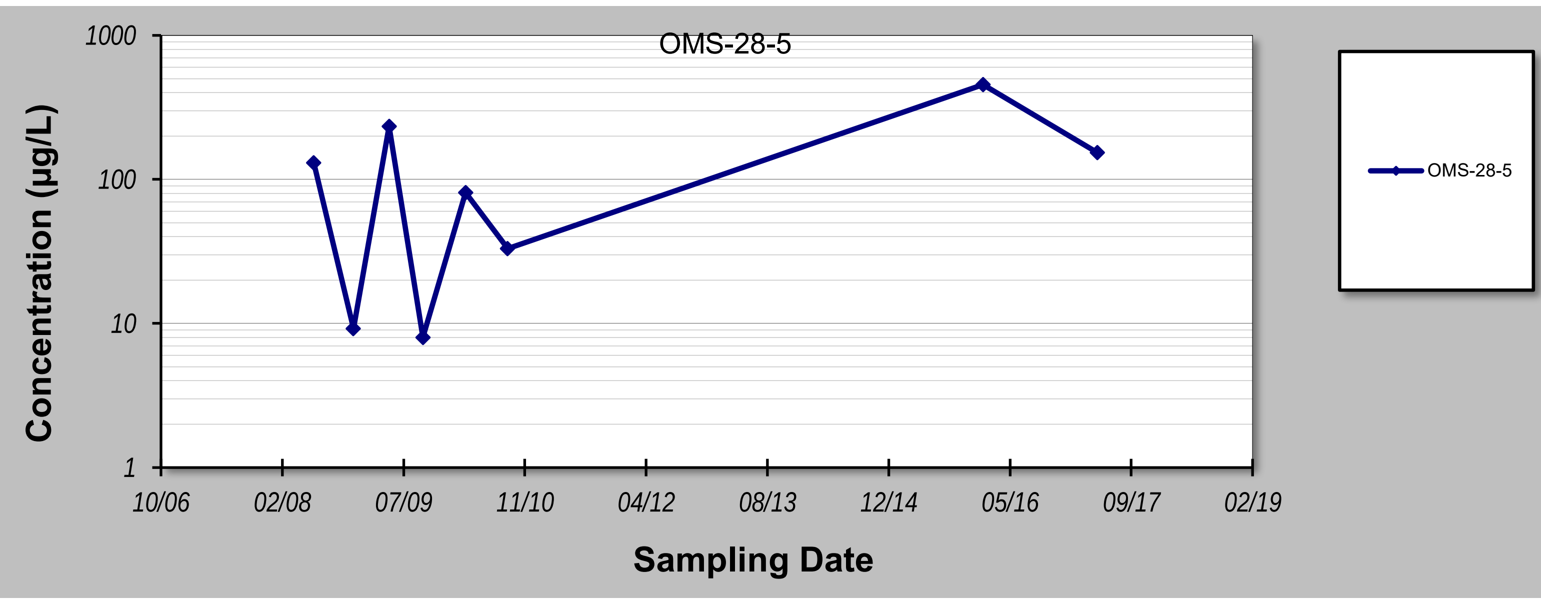
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **9-Feb-22**
Facility Name: **OMS #28**
Conducted By: **Timothy Renn**

Job ID: **60666895**
Constituent: **PCE - Upper Surficial aquifer**
Concentration Units: **µg/L**

Sampling Point ID: **OMS-28-5**

Sampling Event	Sampling Date	PCE - UPPER SURFICIAL AQUIFER CONCENTRATION (µg/L)						
		OMS-28-5						
1	1-Jul-08	130						
2	11-Dec-08	9.2						
3	8-May-09	234						
4	24-Sep-09	8.02						
5	19-Mar-10	81						
6	8-Sep-10	33						
7	20-Jan-16	455						
8	5-May-17	154						
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
	Coefficient of Variation:	1.09						
	Mann-Kendall Statistic (S):	6						
	Confidence Factor:	72.6%						
	Concentration Trend:	No Trend						



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

APPENDIX C

Exclusion of Responsibility for Offsite Tetrachloroethene (PCE) Contamination Documentation

APPENDIX C

Exclusion of Responsibility for Offsite Tetrachloroethene (PCE) Contamination Documentation
Organizational Maintenance Shop #28
Mobile County, Mobile, Alabama

INTRODUCTION

On September 10, 2020, the Army National Guard (ARNG) submitted to the Alabama Department of Environmental Management (ADEM) a letter (National Guard Bureau, 2020) that was based on the results of a Supplemental Data Gap Investigation (SDGI) and associated risk assessment that were conducted for Organization Maintenance Shop #28 (OMS #28) and the surrounding vicinity. **Figure C-1** shows OMS #28 and the surrounding vicinity. In this letter, the ARNG described a release of tetrachloroethene (PCE) into surface soil that was discovered during completion of SDGI activities on a privately owned undeveloped parcel (Parcel Identification (ID) R022911360003106 as shown on **Figure C-1 and C-2**) and located approximately 200 feet northwest of Alabama Army National Guard (ALARNG) property. Based on the SDGI results, the estimated extent of surface and subsurface soil impacted with PCE above the May 2023 United States Environmental Protection Agency (USEPA) Regional Screening Level (RSL) for residential soil is shown in plan view on **Figure C-2**, and groundwater impacted with PCE above the maximum contaminant level (MCL) is also shown on **Figure C-2**. A cross-section location map and two associated cross sections, which show the PCE contamination in offsite soil and groundwater with respect to the location of the ALARNG property, are presented as **Figures C-3 through C-5**.

ALARNG has had no known historical activities conducted on undeveloped Parcel ID R022911360003106. In addition, a commercially zoned parcel (Parcel ID R022911360008001.001 as shown on **Figure C-1 and C-2**) separates the ALARNG property from Parcel ID R022911360003106 where the PCE release occurred, which makes ALARNG involvement in the release even more unlikely. Note that the parcels identified in this document can viewed on the City of Mobile GIS City Map viewer at https://maps.cityofmobile.org/GIS/webmapping.aspx.

As a result of the SDGI, site risk assessment, and the determination that the ALARNG is not responsible for the offsite PCE release, the Feasibility Study (FS) for OMS #28, dated February 2014 and concurred with by ADEM on May 5, 2014, has been revised by the ARNG. The revised FS eliminates the evaluation of remedial alternatives for offsite PCE contamination in soil and groundwater located on Parcel IDs R022911360003106 and R022911360008001.001 and only provides remedial alternatives for chemicals of concern (COC) attributable to historical ALARNG operations conducted at OMS #28. The September 10, 2020 ARNG letter also stated that further justification for this revision would be provided in the revised FS. This document serves to provide the justification for this revision.

The ADEM Review and Response: *Responsibility for PCE Contamination* (ADEM, 2021), acknowledged receipt of the September 10, 2020 letter and the request by the ARNG to remove the offsite PCE contamination from their scope of responsibility. In this letter, ADEM requested that ARNG include all analytical data, lines of evidence, and rationale supporting the proposed removal of the offsite area contaminated with PCE from ARNG's scope of responsibility as part of the revised FS. This Exclusion of Responsibility for Offsite Tetrachloroethene (PCE) Contamination Documentation has been prepared in response to this request.

APPENDIX C

Exclusion of Responsibility for Offsite Tetrachloroethene (PCE) Contamination Documentation
Organizational Maintenance Shop #28
Mobile County, Mobile, Alabama

BACKGROUND

The OMS site has undergone numerous development, redevelopment, and organizational periods since initial development. The OMS #28 site was developed in the early 1950s, and the current OMS #28 building was constructed in 1978. The OMS site is located north of the former Brookley Air Force Base (BAFB). The Department of the Air Force officially declared BAFB excess property effective 30 June 1969. GSA completed the property disposal on 21 October 1969. BAFB maps were evaluated, and the property where the OMS is located is outside of the boundary of the former BAFB. The boundary of BAFB never extended north to the OMS #28 property or beyond the OMS #28 property to the west where the PCE soil contamination on Parcel A is located.

Various investigations were conducted at OMS #28 (the “site”) between 2005 and 2009. Following the detection of trichloroethene (TCE) at monitoring well (MW)-8 in March 2005, a comprehensive site investigation was initiated to determine the source of TCE in groundwater. A former wash pad that was in operation until 1978 and located approximately 40 feet to the west of MW-8 was identified as a potential source for the TCE and required further investigation. The wash pad was constructed as a concrete slab with no drainage system in place. Military vehicles were routinely washed in this area, and the associated wash water was allowed to flow freely onto the ground. The date of construction for the wash pad is unknown. Relevant historical site features are depicted on **Figure C-1**.

Subsequent site investigations confirmed two potential source areas for TCE groundwater contamination, one on ALARNG property and one on Parcel ID R022911360008001.001. A potential source of TCE in groundwater was confirmed on ALARNG property through soil sampling conducted in the vicinity of MW-8 between April 2006 and April 2007, where a number of surface (0 to 1 feet below ground surface [bgs]) and/or subsurface (8 to 10 feet bgs) samples exceeded the protection of groundwater soil screening level (SSL) of 0.0018 milligrams per kilogram (mg/kg) for TCE. In this area, PCE only slightly exceeded its SSL of 0.0023 mg/kg at three locations (estimated concentrations of 0.00252 mg/kg, 0.00253 mg/kg, and 0.00505 mg/kg at HA-5, HA-7, and HA-13, respectively; **Figure C-6**). A potential source of TCE in groundwater was also identified on Parcel ID R022911360008001.001 during the installation of MW-9 in October 2006, where the surface soil sample concentration (0.0171 mg/kg) exceeded the protection of groundwater SSL for TCE (**Figure C-6**).

One potential source of PCE groundwater contamination was also identified on Parcel ID R022911360008001.001 based on soil samples collected in March 2007. The potential source was identified at soil boring location B-17. In both the B-17 surface soil sample (0.933 mg/kg) and the subsurface soil sample (0.186 mg/kg) collected at B-17, PCE was detected above its protection of groundwater SSL (**Figure C-2**). B-17 was collected approximately 30 feet south of adjacent Parcel ID R022911360003106.

An SDGI was conducted at OMS #28 between April 2016 and February 2018. The objectives of the SDGI were to identify if other soil source areas were contributing to identified groundwater contamination and to improve the delineation of the known groundwater contaminant plumes. The SDGI consisted of four activities to meet these objectives:

- Sampling of existing site groundwater monitoring wells,
- Subsurface investigation using a membrane interface probe (MIP) and hydraulic profiling tool (HPT),
- Soil sampling via direct push technology (DPT), and
- Discrete groundwater sampling via DPT.

Figure C-7 shows all of the SDGI sample locations. The *Supplemental Data Gap Investigation and Groundwater Monitoring Report* (AECOM, 2019) documents SDGI activities and results. The SDGI was concurred with by ADEM on January 21, 2020 (ADEM, 2020). An overview of the significant findings from the SDGI is presented in the following four subsections.

JANUARY 2016 AND MAY 2017 SITE GROUNDWATER MONITORING WELL SAMPLING SUMMARY

During January 2016 and May 2017, eleven existing site monitoring wells were sampled for Target Compound List (TCL) Volatile Organic Compounds (VOC) by USEPA Method 8260B. **Figure C-1** shows the location of existing and abandoned site monitoring wells. During both sampling events, PCE was detected above the Maximum Contaminant Level (MCL) of 5 micrograms per liter (μg/L) in only one monitoring well, OMS-28-5. During the January 2016 groundwater sampling event, three monitoring wells (MW-8, OMS-28-3, and OMS-28-5) had detections of TCE above the MCL of 5 μg/L. During the May 2017 groundwater sampling event, TCE was detected above the MCL in OMS-28-3 and OMS-28-5; however, TCE at MW-8 was detected below the MCL at an estimated concentration of 0.373 μg/L. The January 2016 and May 2017 groundwater sampling results as well as older groundwater sampling results for site monitoring wells are presented in **Table C-1**.

MIP/HPT SUMMARY

MIP/HPT locations were investigated based on historical knowledge of site features that may have been potential sources of groundwater contamination. Specifically, the MIP/HPT borings were located in the vicinity of the former pollution control system and the former wash pad, shown on **Figure C-1**, and also within the plume boundary near soil boring B-17 (**Figure C-6**). No significant responses were identified within the MIP logs that indicated a soil source for groundwater in these areas.

DPT SOIL SAMPLING SUMMARY

Ninety-three (93) soil samples were collected from 31 locations and analyzed by an onsite mobile laboratory for PCE and TCE. As a quality check, split samples were collected at a frequency of 10 percent (%) of the total number of soil samples and sent to an offsite fixed laboratory for analysis of TCL VOCs by USEPA Method 8260B. The purpose of the soil sampling event was to refine the previous delineation of potential soil excavation areas identified in the February 2014 FS and to characterize any potential new soil source areas. Soil locations within the offsite vacant residential Parcel ID R022911360003106 were not originally planned as part of the DPT soil sampling event; however, these locations (OMS-28-SB24 through OMS-28-SB31) were added at the time field activities were being conducted based on the PCE and TCE results obtained at discrete groundwater sampling location OMS-28-GW22 (discussed in the DPT Groundwater Sampling Summary subsection).

The groundwater results for PCE and TCE at OMS-28-GW22 indicated that a possible soil source might be present near this location; therefore, additional soil samples were added to define the area around OMS-28-GW22. **Figures C-8 through C-10** show the DPT soil results, and **Tables C-2 and C-3** present the mobile and fixed lab soil sampling results, respectively. The onsite mobile laboratory analytical results and fixed laboratory results were screened against the industrial SSL, residential SSL, and the MCL-based protection of groundwater SSL as provided in the May 2018 United States Environmental Protection Agency (USEPA) Regional Screening Level (RSL) Table (USEPA, 2018a). The RSLs for PCE and TCE remain the same in the latest version of the USEPA RSL Table (USEPA, 2023).

A summary of the results for the DPT soil sampling activities include the following:

- Soil samples collected within the extent of the ALARNG facility's property boundaries and around SSL exceedances (primarily TCE) detected in 2006 and 2007 did not exhibit TCE or PCE results above the laboratory limits of detection (LOD).
- Samples collected along the former pollution control system did not exceed LODs for PCE or TCE.
- Surface and subsurface soil samples collected within the vicinity of location B-13/MW-9 (on Parcel ID R022911360008001.001) where the surface soil sample exceeded the MCL-based protection of groundwater SSL for TCE in October 2006 did not exceed LODs for TCE and PCE. Furthermore, the groundwater concentration for TCE at MW-9 has never exceeded the laboratory LOD. These results confirmed that a TCE source did not exist in this area.
- Two soil sample borings located near the northwest Parcel ID R022911360008001.001 boundary (OMS-28-SB18 and OMS-28–SB19) and completed near soil boring B-17, where PCE exceeded the MCL-based protection of groundwater SSL for PCE in March 2007 contained surface soil detections of PCE above the protection of groundwater SSL. PCE was detected in OMS-28-SB18 above the protection of groundwater SSL between 1.5 and 4 feet bgs. At OMS-28-SB19, PCE was detected above the protection of groundwater SSL at approximately 1 foot above the water table. TCE was also detected at slightly above its MCL-based SSL (0.0018 mg/kg) at this location.
- A new soil source area was identified on offsite vacant Parcel ID R022911360003106, which is located immediately north of Parcel ID R022911360008001.001. The origin for the source of PCE was unknown since there is no record of the ALARNG using PCE at the OMS #28 facility. The old ruins of a small shack were found within 15 feet of soil sample OMS-28-SB24, which had the highest concentration of PCE detected in all of the surface and subsurface samples that were collected during the SDGI. At this location, PCE was detected in both the mobile and fixed laboratory soil samples. In the fixed laboratory sample, PCE was detected above the industrial SSL of 39 mg/kg at a concentration of 329 mg/kg in surface soil and at a concentration of 53.7 mg/kg at 3 feet bgs. PCE was also detected above the residential SSL of 8.1 mg/kg at a concentration of 24.4 mg/kg at a depth of 1 foot above the water table (**Table C-3**). OMS-28-SB24 is located over 200 feet northwest of the fenced ALARNG property.

DPT Groundwater Sampling Summary

Between May 2017 and January/February 2018, 226 discrete groundwater samples were collected from 87 boring locations from the Upper, Middle, and Lower Surficial aquifer to profile PCE and TCE vertically in groundwater for the purposes of refining the conceptual site model. Similar to DPT soil sampling, split samples were collected as a quality check at a frequency of 10% of the total number of groundwater samples and sent to an offsite fixed laboratory for analysis of TCL VOCs by USEPA Method 8260B. **Figures C-11 through C-13** show the DPT groundwater results.

The onsite mobile laboratory analytical results for PCE, TCE, cis-1,2-dichloroethene (cis-1,2-DCE), and vinyl chloride (VC) from May 2017 were screened against the USEPA MCLs (USEPA, 2018b) and are presented in **Table C-4**. PCE, TCE, cis-1,2-DCE, and VC detections in the split samples, collected in May 2017 and analyzed by the fixed laboratory, were also screened against the USEPA MCLs (USEPA, 2018b) and are presented in **Table C-5**. PCE, TCE, cis-1,2-DCE, and VC detections for samples collected in January/February 2018 and analyzed by fixed laboratory were screened against the USEPA MCLs (USEPA, 2018b) and are presented in **Table C-6**. **Figure C-14** shows the approximate extent of the PCE and TCE impacts in the Upper/Middle Surficial aquifer and the Lower Surficial aquifer based on the data collected during the SDGI.

A summary of the results for the DPT groundwater sampling activities include the following:

- PCE was not detected in groundwater on the ALARNG property.
- PCE only exceeded the MCL on Parcel ID R022911360003106 and along the adjacent northwest boundary of Parcel ID R022911360008001.001. The highest concentration of PCE (40,000 µg/L) was detected in the Upper Surficial aquifer at groundwater DPT location OMS-28-GW22 on Parcel ID R022911360003106. OMS-28-GW22 is located in close proximity to where the highest concentration of PCE in soil (OMS-28-SB24) was subsequently detected. PCE from this area appears to have percolated down into subsurface soil and ultimately impacted the underlying groundwater.
- DPT groundwater analytical data indicated the PCE plume is partially degrading to TCE and creating a co-located plume in Upper Surficial groundwater that is centered around the identified PCE release.
- TCE in groundwater consists of two distinct plumes in the Upper Surficial aquifer that merge into one plume in the Middle Surficial aquifer as TCE migrates vertically. One distinct TCE groundwater plume exists in the Upper Surficial aquifer on ALARNG property. The second distinct plume of TCE is co-located with the PCE plume and the identified PCE surface spill area. TCE was detected in the Lower Surficial aquifer in isolated locations, outside of the footprint of the TCE plumes in the Upper and Middle Surficial aquifers. It is suspected that the TCE has migrated downward via sand lenses within the semi-confining unit separating the Middle Surficial aquifer from the Lower Surficial aquifer.

APPENDIX C

Exclusion of Responsibility for Offsite Tetrachloroethene (PCE) Contamination Documentation
Organizational Maintenance Shop #28
Mobile County, Mobile, Alabama

SUMMARY

Based on the information presented above, the following is a summary of why the ALARNG is not responsible for the remediation of the identified PCE release on offsite vacant Parcel ID R022911360003106 and also why PCE will not be addressed in the Revised FS.

- A PCE soil source area was identified on offsite vacant Parcel ID R022911360003106. PCE was also found in soil on the northwest portion of adjacent Parcel ID R022911360008001.001. The origin for the source of PCE is unknown. The old ruins of a small shack were found within 15 feet of soil sample OMS-28-SB24, which had the highest concentrations of PCE (329 mg/kg at 0-1 ft bgs) detected during the SDGI. PCE exceeded the industrial RSL in surface soil and shallow subsurface soil (3 feet bgs), and PCE exceeded the residential RSL in deeper subsurface soil (5 feet bgs or approximately 1 foot above the water table). OMS-28-SB24 is located over 200 feet northwest of the fenced ALARNG property and is within 60 feet of active railroad tracks that run parallel to Interstate 10. As such, the identified PCE surface spill is suggestive of offsite activity that was not the result of historical ALARNG activities associated with OMS #28.
- The heavily wooded Parcel ID R022911360008001.001 separates the ALARNG property from vacant Parcel ID R022911360003106where the PCE release occurred making ALARNG involvement in the release even more unlikely.
- Soil boring B-17, which was collected in March 2017, only contained PCE. B-17 was located in the northwest corner of Parcel ID R022911360008001.001 and approximately 30 feet south of Parcel ID R022911360003106 where the highest concentrations of PCE in soil were detected.
- PCE concentrations in groundwater only exceeded the MCL on vacant Parcel ID R022911360003106 and along the adjacent northwest boundary of Parcel ID R022911360008001.001. The highest concentration of PCE detected (40,000 µg/L) during the SDGI was found in the Upper Surficial aquifer at groundwater DPT location OMS-28-GW22, which is located on the Parcel ID R022911360003106. OMS-28-GW22 is located in close proximity to where the highest concentration of PCE in soil (OMS-28-SB24) was subsequently detected.
- PCE from the surface spill area has percolated into the subsurface soil and impacted the underlying groundwater. A PCE plume in groundwater is only present on the offsite vacant Parcel ID R022911360003106 and the adjacent northwest portion of Parcel ID R022911360008001.001. Analytical data indicates that the PCE plume is partially degrading to TCE and creating a co-located plume in Upper Surficial groundwater that is centered around the identified PCE release.
- PCE has only been detected in one site monitoring well (OMS-28-5), which is located on Parcel ID R022911360008001.001. OMS-28-5 is located approximately 30 feet south of the adjacent vacant Parcel ID R022911360003106 and approximately 50 feet southeast from where soil boring OMS-28-SB24 was collected.

- In January 2022, QuantArray®-Chlor analysis was conducted by Microbial Insights of Knoxville, Tennessee for three site monitoring wells (OMS-28-5, OMS-28-3, and MW-8). Bio-traps were deployed in these three wells for approximately one month between December 10, 2021 and January 13, 2022. A review of this report with regard to bacteria and enzymes responsible for reductive dechlorination indicates the presence of moderate concentrations of *Dehalobacter* spp. (DHBt) and *Desulfitobacterium* spp. (DSB) and a low concentration of *Dehalococcoides* (DHC) with no vinyl chloride reductases which are needed to degrade VC to ethene at OMS-28-5. DHBt and DSB are capable of using PCE and TCE as growth-supporting electron acceptors and can reduce PCE and TCE down to cis-1,2-DCE but no further. **Table C-1**, which presents results for OMS #28 monitoring wells, shows an elevated concentration of cis-1,2-DCE detected during the last sampling event conducted in May 2017 for OMS-28-5. The dissolved oxygen measurement in this well at that time was low at 0.17 milligrams per liter. The detection of elevated concentrations of TCE and cis-1,2-DCE in conjunction with low dissolved oxygen at OMS-28-5 suggests reductive dechlorination of PCE is occurring within the vicinity of this well and is the source of the co-located TCE plume in this area. The QuantArray results, provided in **Attachment 1**, do not indicate much in the way of reductive dechlorinating bacteria and no reductase enzymes at OMS-28-3 and MW-8.
- Two separate TCE plumes exist in the Upper Surficial aquifer. One distinct Upper Surficial TCE plume is located on ALARNG property and appears to be the result of a TCE release in a gravel-covered vehicle parking area used by the ALARNG. A review of older investigation results and the newer SDGI data shows that PCE has not been detected in groundwater on ALARNG property. The second distinct TCE plume is co-located with the PCE plume on vacant Parcel ID R022911360003106 and adjacent Parcel ID R022911360008001.001. The two Upper Surficial TCE plumes merge into one plume in the Middle Surficial aquifer as TCE migrates vertically.

REFERENCES

ADEM, 2020. Letter from Jason Wilson (Chief, ADEM Hazardous Waste Branch, Land Division) to David Connolly (Program Manager, Cleanup Branch Army National Guard), ADEM Review and Concurrence: Supplemental Data Gap Investigation and Groundwater Monitoring Report, dated January 2019, Mobile OMS-28, Mobile County Alabama, DSMOA ID: 535-223-0031, January 21.

ADEM, 2021. Electronically Transmitted letter from Jason Wilson (Chief, ADEM Hazardous Waste Branch, Land Division) to Queenie Mungin-Davis (Program Manager, Cleanup Branch Army National Guard), ADEM Review and Response: Responsibility for PCE Contamination, dated September 10, 2020, Mobile OMS-28, Mobile County Alabama, February 25.

AECOM, 2019. Supplemental Data Gap Investigation and Groundwater Monitoring Report, Organizational Maintenance Shop #28, January.

National Guard Bureau, 2020. Letter from Queenie Mungin-Davis (Program Manager, Cleanup Branch Army National Guard) to Colin Mitchell (Alabama Department of Environmental Management), Responsibility for PCE Contamination, September 10.

USEPA, 2018a. Regional Screening Levels Summary Table, Revised May.

USEPA, 2018b. 2018 Edition of the Drinking Water Standards and Health Advisories. EPA 822-F-18-001. March.

USEPA, 2023. Regional Screening Levels Summary Table, May.

TABLES

Table C-1
Groundwater COC Concentrations
Alabama Army National Guard, OMS #28
Mobile, Alabama

Well ID	Depth of Well (ft btoc)	Screened Interval (ft btoc)	Date	PCE	TCE	cis-1,2-DCE	Vinyl Chloride
Maximum Contaminant Level				5	5	70	2
Upper/Middle Surficial Monitoring Wells							
MW-5	12.6	3.3-13.3	10/18/2006	NA	0.27 U	NA	NA
			7/1/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/11/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/7/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/20/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/1/2017	0.5 U	0.5 U	0.5 U	0.5 U
MW-6	12.7	2.3-12.3	10/18/2006	NA	0.27 U	NA	NA
			7/1/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/11/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/7/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/20/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/1/2017	0.5 U	0.5 U	0.5 U	0.5 U
MW-8	15.2	4.8-14.8	3/__/05	NA	**480**	NA	NA
			4/18/2006	NA	**97.9**	NA	NA
			10/18/2006	NA	**83 J**	**NA**	NA
			7/1/2008	0.2 U	**133**	**3.97 J**	0.0538 U
			12/11/2008	0.153 U	**46**	**3.24 J**	0.155 U
			5/8/2009	0.0998 U	**18**	**0.812 J**	0.0767 U
			9/24/2009	0.0998 U	**8.41**	0.103 U	0.0767 U
			3/19/2010	0.121 U	**41**	**2.07 J**	0.093 U
			9/8/2010	0.121 U	**13**	0.0613 U	0.093 U
			1/22/2016	0.5 U	**7.8**	0.5 U	0.5 U
			5/1/2017	0.5 U	**0.373 J**	0.5 U	0.5 U
MW-9	17.4	7.4-17.4	11/22/2006	0.072 U	0.024 U	0.051 U	0.052 U
			7/1/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/10/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/8/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/20/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/5/2017	0.5 U	0.5 U	0.5 U	0.5 U
MW-10	17.6	7.6 - 17.6	11/22/2006	**4.9**	**11**	**5.8**	**1.5**
				Abandoned at request of property owner			
MW-11	16.6	6.6 - 16.6	11/22/2006	0.072 U	**63**	0.051 U	0.052 U
				Abandoned at request of property owner			
MW-12	15.6	5.6-15.6	11/22/2006	0.072 U	0.024 U	0.051 U	0.052 U
			7/1/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/10/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/7/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/21/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/1/2017	0.5 U	0.5 U	0.5 U	0.5 U

Table C-1
Groundwater COC Concentrations
Alabama Army National Guard, OMS #28
Mobile, Alabama

Well ID	Depth of Well (ft btoc)	Screened Interval (ft btoc)	Date	PCE	TCE	cis-1,2-DCE	Vinyl Chloride
Maximum Contaminant Level				5	5	70	2
Upper/Middle Surficial Monitoring Wells							
OMS-28-2	20.0	10-20	7/1/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/10/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	**2 J**	0.0613 U	0.093 U
			9/7/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/19/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/5/2017	0.5 U	0.5 U	0.5 U	0.5 U
OMS-28-3	20.0	10-20	7/1/2008	0.2 U	**80**	**6.26**	0.0538 U
			12/11/2008	0.153 U	**94**	**9.34**	0.155 U
			5/8/2009	0.0998 U	**29**	**9.55**	0.0767 U
			9/24/2009	0.0998 U	**15.29**	0.103 U	0.0767 U
			3/19/2010	0.121 U	**12**	**1.37 J**	0.093 U
			9/8/2010	0.121 U	**149**	**9.43**	0.093 U
			1/21/2016	0.5 U	**8.92**	**1.59**	0.5 U
			5/1/2017	0.5 U	**9.6**	**1.26**	0.5 U
OMS-28-5	20.0	10-20	7/1/2008	**130**	**39**	**12**	0.0538 U
			12/11/2008	**9.2**	**14**	**8.7**	0.155 U
			5/8/2009	**234**	**162**	**20**	0.0767 U
			9/24/2009	**8.02**	**11**	**9.12**	0.0767 U
			3/19/2010	**81**	**51**	**6.3**	0.093 U
			9/8/2010	**33**	**19**	**8.69**	0.093 U
			1/20/2016	**455**	**200**	**27.8**	2.5 U
			5/5/2017	**154**	**246**	**103**	1 U
OMS-28-7	20.0	10-20	7/1/2008	0.2 U	**1.73 J**	0.0745 U	0.0538 U
			12/10/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	**0.684 J**	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/8/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/20/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/1/2017	0.5 U	0.5 U	0.5 U	0.5 U
Lower Surficial Monitoring Wells							
OMS-28-1	80.0	70-80	7/8/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/11/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/7/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/20/2016	0.5 U	0.5 U	0.5 U	0.5 U
			5/1/2017	0.5 U	0.5 U	0.5 U	0.5 U
OMS-28-4	76.0	66-76	7/8/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/10/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/19/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/8/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			1/20/2016	**0.88 J**	0.5 U	0.5 U	0.5 U
			5/5/2017	0.5 U	0.5 U	0.5 U	0.5 U

Table C-1
Groundwater COC Concentrations
Alabama Army National Guard, OMS #28
Mobile, Alabama

Well ID	Depth of Well (ft btoc)	Screened Interval (ft btoc)	Date	PCE	TCE	cis-1,2-DCE	Vinyl Chloride
Maximum Contaminant Level				5	5	70	2
Lower Surficial Monitoring Wells							
OMS-28-6	76.0	66-76	7/8/2008	0.2 U	0.164 U	0.0745 U	0.0538 U
			12/10/2008	0.153 U	0.118 U	0.162 U	0.155 U
			5/8/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			9/24/2009	0.0998 U	0.0974 U	0.103 U	0.0767 U
			3/18/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
			9/8/2010	0.121 U	0.0618 U	0.0613 U	0.093 U
				Destroyed			

Definitions:
µg/L = micrograms per Liter (parts per billion [ppb])
cis-1,2-DCE = cis-1,2-dichloroethene
COC = chemical of concern
ft btoc = feet below top of casing
NA = Not Analyzed
PCE = tetrachloroethene
TCE = trichloroethene

Notes:
All concentrations in µg/L
Bold result indicates the analyte was detected.
Shading indicates the screening value is exceeded.

Data Qualifiers:
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
J = The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

Table C-2
Soil Analytical Results - Mobile Laboratory
Alabama Army National Guard, OMS #28
Mobile, Alabama

		Analytes	PCE	TCE
Soil Screening Criteria	**Residential SSL**		**8.1**	**0.41**
	Industrial SSL		**39**	**1.9**
	MCL-Based Protection of Groundwater SSL		**0.0023**	**0.0018**
Boring Location	**Sample Date**	**Sample Depth (feet)**		
OMS-28-SB01	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	2	< 0.002 (U)	< 0.002 (U)
	5/8/2017	3	< 0.002 (U)	< 0.002 (U)
OMS-28-SB02	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	3	< 0.002 (U)	< 0.002 (U)
	5/8/2017	5	< 0.002 (U)	< 0.002 (U)
OMS-28-SB03	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	3	< 0.002 (U)	< 0.002 (U)
	5/8/2017	5	< 0.002 (U)	< 0.002 (U)
OMS-28-SB04	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	2	< 0.002 (U)	< 0.002 (U)
	5/8/2017	5	< 0.002 (U)	< 0.002 (U)
OMS-28-SB05	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	2	< 0.002 (U)	< 0.002 (U)
	5/8/2017	5	< 0.002 (U)	< 0.002 (U)
OMS-28-SB06	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	3	< 0.002 (U)	< 0.002 (U)
	5/8/2017	6	< 0.002 (U)	< 0.002 (U)
OMS-28-SB07	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	3	< 0.002 (U)	< 0.002 (U)
	5/8/2017	6	< 0.002 (U)	< 0.002 (U)
OMS-28-SB08	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	3	< 0.002 (U)	< 0.002 (U)
	5/8/2017	6	< 0.002 (U)	< 0.002 (U)
OMS-28-SB09	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	2	< 0.002 (U)	< 0.002 (U)
	5/8/2017	3	< 0.002 (U)	< 0.002 (U)
OMS-28-SB10	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	2	< 0.002 (U)	< 0.002 (U)
	5/8/2017	3	< 0.002 (U)	< 0.002 (U)
OMS-28-SB11	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	4	< 0.002 (U)	< 0.002 (U)
	5/8/2017	6	< 0.002 (U)	< 0.002 (U)
OMS-28-SB12	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	3	< 0.002 (U)	< 0.002 (U)
	5/8/2017	5	< 0.002 (U)	< 0.002 (U)
OMS-28-SB13	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	3	< 0.002 (U)	< 0.002 (U)
	5/8/2017	5	< 0.002 (U)	< 0.002 (U)
OMS-28-SB14	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	3	< 0.002 (U)	< 0.002 (U)
	5/8/2017	5	< 0.002 (U)	< 0.002 (U)
OMS-28-SB15	5/8/2017	1	< 0.002 (U)	< 0.002 (U)
	5/8/2017	3	< 0.002 (U)	< 0.002 (U)
	5/8/2017	5	< 0.002 (U)	< 0.002 (U)

Table C-2
Soil Analytical Results - Mobile Laboratory
Alabama Army National Guard, OMS #28
Mobile, Alabama

		Analytes	PCE	TCE
Soil Screening Criteria	**Residential SSL**		**8.1**	**0.41**
	Industrial SSL		**39**	**1.9**
	MCL-Based Protection of Groundwater SSL		**0.0023**	**0.0018**
Boring Location	**Sample Date**	**Sample Depth (feet)**		
OMS-28-SB16	5/10/2017	1	< 0.002 (U)	< 0.002 (U)
	5/10/2017	2.5	< 0.002 (U)	< 0.002 (U)
	5/10/2017	4	< 0.002 (U)	< 0.002 (U)
OMS-28-SB17	5/10/2017	1	< 0.002 (U)	< 0.002 (U)
	5/10/2017	2.5	**0.0016 J**	< 0.002 (U)
	5/10/2017	5	< 0.002 (U)	< 0.002 (U)
OMS-28-SB18	5/10/2017	1	**0.0329**	< 0.002 (U)
	5/10/2017	2.5	**0.0226**	< 0.002 (U)
	5/10/2017	5	< 0.002 (U)	< 0.002 (U)
OMS-28-SB19	5/10/2017	1	**0.0568 J**	< 0.002 (U)
	5/10/2017	2.5	**0.0012 J**	< 0.002 (U)
	5/10/2017	5	**0.0264**	**0.0025**
OMS-28-SB20	5/10/2017	1	< 0.002 (U)	< 0.002 (U)
	5/10/2017	1.5	< 0.002 (U)	< 0.002 (U)
	5/10/2017	2	< 0.002 (U)	< 0.002 (U)
OMS-28-SB21	5/10/2017	1	< 0.002 (U)	< 0.002 (U)
	5/10/2017	1.5	< 0.002 (U)	< 0.002 (U)
	5/10/2017	2	< 0.002 (U)	< 0.002 (U)
OMS-28-SB22	5/10/2017	1	< 0.002 (U)	< 0.002 (U)
	5/10/2017	1.5	< 0.002 (U)	< 0.002 (U)
	5/10/2017	2	< 0.002 (U)	< 0.002 (U)
OMS-28-SB23	5/10/2017	1	< 0.002 (U)	< 0.002 (U)
	5/10/2017	1.5	< 0.002 (U)	< 0.002 (U)
	5/10/2017	2	< 0.002 (U)	< 0.002 (U)
OMS-28-SB24	5/10/2017	1	**180**	< 0.002 (U)
	5/10/2017	3	**23.1425**	< 0.002 (U)
	5/10/2017	5	**5.3593**	< 0.002 (U)
OMS-28-SB25	5/12/2017	1	**0.0211 J**	< 0.002 (U)
	5/12/2017	3	< 0.002 (U)	< 0.002 (U)
	5/12/2017	5	**0.0025**	< 0.002 (U)
OMS-28-SB26	5/12/2017	1	< 0.002 (U)	< 0.002 (U)
	5/12/2017	3	< 0.002 (U)	< 0.002 (U)
	5/12/2017	5	< 0.002 (U)	< 0.002 (U)
OMS-28-SB27	5/12/2017	1	**0.0012 J**	< 0.002 (U)
	5/12/2017	3	< 0.002 (U)	< 0.002 (U)
	5/12/2017	5	**0.0024**	< 0.002 (U)
OMS-28-SB28	5/16/2017	1	**5.8422**	< 0.002 (U)
	5/16/2017	3	**0.1491 J**	**0.0024**
	5/16/2017	5	**0.2377**	**0.0017**
OMS-28-SB29	5/16/2017	1	**16.3394**	**0.0137 J**
	5/16/2017	3	**0.1226**	**0.0086**
	5/16/2017	5	**0.088 J**	< 0.002 (UJ)
OMS-28-SB30	5/16/2017	1	**19.8493**	**0.0034 J**
	5/16/2017	3	**0.0533**	**0.0068**
	5/16/2017	5	**0.0459**	< 0.002 (U)

Table C-2
Soil Analytical Results - Mobile Laboratory
Alabama Army National Guard, OMS #28
Mobile, Alabama

		Analytes	PCE	TCE
Soil Screening Criteria	**Residential SSL**		**8.1**	**0.41**
	Industrial SSL		**39**	**1.9**
	MCL-Based Protection of Groundwater SSL		**0.0023**	**0.0018**
Boring Location	**Sample Date**	**Sample Depth (feet)**		
OMS-28-SB31	5/16/2017	1	**8.9034**	**0.0093 J**
	5/16/2017	3	**0.0423**	**0.0051**
	5/16/2017	5	**0.0887**	< 0.002 (U)

Notes:

Soil samples were analyzed utilizing a DOD certified mobile laboratory for TCE and PCE by Method 8260B.

Results are reported in mg/kg.

Soil Screening Criteria is based on the USEPA Regional Screening Level (RSL) Table for Residential, Industrial, and MCL-based Protection of Groundwater Soil Screening Levels (SSLs), based on a risk of 1E-06 for carcinogens and HQ 0.1 for noncarcinogens (USEPA, November 2021).

Bold results indicates the analyte was detected.

Shading indicates the respective screening value is exceeded.

Data Qualifiers:

< - the numeric value presented is the sample specific detection limit

U - The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.

J - The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

UJ -The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

Definitions:

mg/kg - milligrams per kilogram
DOD - Department of Defense
HQ - Hazard Quotient
MCL - Maximum Contaminant Level
PCE - Tetrachloroethene
SSL - Soil Screening Level
TCE - Trichloroethene
USEPA - United States Environmental Protection Agency

Table C-3
Split Soil Sample Results - Fixed Laboratory
Alabama Army National Guard, OMS #28
Mobile, Alabama

		Detected Analytes	2-Butanone	4-Methyl-2-pentanone	Acetone	Benzene	Cyclohexane	Methyl-cyclohexane	Methylene chloride	Styrene	PCE	Toluene	Xylenes (total)
Soil Screening Criteria	Residential		2,700	3,300	7,000	1.2	650	NS	35	600	8.1	490	58
	Industrial		19,000	14,000	110,000	5.1	2,700	NS	320	3,500	39	4,700	250
	MCL-Based Protection of Groundwater SSL		0.12*	0.14*	0.37*	0.0026	1.3*	NS	0.0013	0.11	0.0023	0.69	9.9
Boring ID	**Sample Date**	**Sample Depth (feet)**											
OMS-28-SB01	5/8/2017	2	< 0.00143 U	< 0.000358 U	**0.00980 J**	< 0.000358 U	< 0.000358 U	< 0.000358 U	**0.0113**	< 0.000358 U	< 0.000715 U	< 0.000358 U	< 0.00107 U
OMS-28-SB04	5/8/2017	1	< 0.00158 U	< 0.000395 U	**0.00437 J**	**0.000499 J**	**0.000698 J**	**0.00143 J**	**0.00314 J**	< 0.000395 U	< 0.00079 U	**0.00137 J**	**0.000862 J**
OMS-28-SB11	5/8/2017	6	< 0.00201 U	< 0.000502 U	< 0.00201 U	< 0.000502 U	< 0.000502 U	< 0.000502 U	**0.00909 J**	< 0.000502 U	< 0.001 U	< 0.000502 U	< 0.00151 U
OMS-28-SB14	5/8/2017	1	**0.00403 J**	**0.00139 J**	**0.083**	< 0.000443 U	< 0.000443 U	< 0.000443 U	**0.00192 J**	< 0.000443 U	< 0.000886 U	< 0.000443 U	< 0.00133 U
OMS-28-SB16	5/10/2017	4	< 0.00181 U	< 0.000453 U	< 0.00181 U	< 0.000453 U	< 0.000453 U	< 0.000453 U	**0.00273 J**	< 0.000453 U	< 0.000906 U	< 0.000453 U	< 0.00136 U
OMS-28-SB22	5/10/2017	2	< 0.00187 U	< 0.000468 U	**0.00616 J**	< 0.000468 U	< 0.000468 U	< 0.000468 U	**0.00418 J**	< 0.000468 U	< 0.000936 U	< 0.000468 U	< 0.0014 U
OMS-28-SB24	5/10/2017	1	< 12.3 U	< 3.07 U	< 12.3 U	< 3.07 U	< 3.07 U	< 3.07 U	< 12.3 U	< 3.07 U	**329**	< 3.07 U	< 9.22 U
OMS-28-SB24	5/10/2017	3	< 1.86 U	< 0.464 U	< 1.86 U	< 0.464 U	< 0.464 U	< 0.464 U	< 1.86 U	< 0.464 U	**53.7**	< 0.464 U	< 1.39 U
OMS-28-SB24	5/10/2017	5	< 0.92 U	< 0.23 U	< 0.92 U	< 0.23 U	< 0.23 U	< 0.23 U	< 0.92 U	< 0.23 U	**24.4**	< 0.23 U	< 0.69 U

Notes:
* - indicates the analyte is a noncarcinogen and the risk-based SSL is used as no MCL-Based Protection of Groundwater SSL is available.
Soil samples were analyzed in the field by GCAL Laboratory for a target compound list (TCL) of Volatile Organic Compounds via Method SW8260B. Only detected analytes are shown.
Results are reported in mg/kg.
Soil Screening Criteria is based on the USEPA Regional Screening Level (RSL) Table for Residential, Industrial, and MCL-based Protection of Groundwater Soil Screening Levels (SSLs), based on a risk of 1E-06 for carcinogens and HQ 0.1 for noncarcinogens (USEPA, November 2021).
Bold results indicates the analyte was detected.
Shading indicates the respective screening value is exceeded.

Data Qualifiers:
< - the numeric value presented is the sample specific detection limit
U - The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
J - The result is an estimated quality. The associated numerical value is the approximate concentration of the analyte in the sample.

Definitions:
HQ - Hazard Quotient
mg/kg - milligrams per kilogram
MCL - Maximum Contaminant Level
NS - No Standard
PCE - Tetrachloroethene
SSL - Soil Screening Level
TCE - Trichloroethene
USEPA - Environmental Protection Agency

Table C-4
Discrete Groundwater Results, May 2017 - Mobile Laboratory
Alabama Army National Guard, OMS #28
Mobile, Alabama

			Chemicals of Concern	PCE	TCE
Groundwater Screening Criteria	Maximum Contaminant Levels			5	5
Boring Location	Sample Depth (ft bgs)	Sample Zone	Sample Date		
OMS-28-GW01	6-10	Upper Surficial	5/2/2017	< 1 (U)	**82.16**
	15-19	Middle Surficial	5/2/2017	< 1 (U)	**38**
	28-32	Lower Surficial	5/2/2017	< 1 (U)	< 1 (U)
OMS-28-GW02	8-12	Upper Surficial	5/3/2017	< 1 (U)	**0.63 J**
	15-19	Middle Surficial	5/3/2017	< 1 (U)	< 1 (U)
	27-31	Lower Surficial	5/3/2017	< 1 (U)	< 1 (U)
OMS-28-GW03	8-12	Upper Surficial	5/4/2017	< 1 (U)	< 1 (U)
	16-20	Middle Surficial	5/4/2017	< 1 (U)	< 1 (U)
	30-34	Lower Surficial	5/4/2017	< 1 (U)	< 1 (U)
OMS-28-GW04	6-10	Upper Surficial	5/3/2017	< 1 (U)	**1.37**
	13-17	Middle Surficial	5/3/2017	< 1 (U)	< 1 (U)
	27-31	Lower Surficial	5/3/2017	< 1 (U)	< 1 (U)
OMS-28-GW05	7-11	Upper Surficial	5/2/2017	< 1 (U)	**16.1**
	15-19	Middle Surficial	5/2/2017	< 1 (U)	**3.14**
	29-33	Lower Surficial	5/2/2017	< 1 (U)	< 1 (U)
OMS-28-GW06	7-11	Upper Surficial	5/17/2017	< 1 (U)	**0.63 J**
	13-17	Middle Surficial	5/17/2017	< 1 (U)	**65.95**
	28-32	Lower Surficial	5/17/2017	< 1 (U)	< 1 (U)
OMS-28-GW07	7-11	Upper Surficial	5/19/2017	< 1 (U)	< 1 (U)
	14-18	Middle Surficial	5/19/2017	< 1 (U)	**310**
	27-31	Lower Surficial	5/19/2017	< 1 (U)	< 1 (U)
OMS-28-GW08	6-10	Upper Surficial	5/3/2017	< 1 (U)	< 1 (U)
	13-17	Middle Surficial	5/3/2017	< 1 (U)	< 1 (U)
	27-31	Lower Surficial	5/3/2017	< 1 (U)	**71.17**
OMS-28-GW09	6-10	Upper Surficial	5/3/2017	< 1 (U)	< 1 (U)
	12-16	Middle Surficial	5/3/2017	< 1 (U)	< 1 (U)
	29-33	Lower Surficial	5/3/2017	< 1 (U)	< 1 (U)
OMS-28-GW10	6-10	Upper Surficial	5/9/2017	< 1 (U)	< 1 (U)
	12-16	Middle Surficial	5/9/2017	< 1 (U)	**68.9**
	29-33	Lower Surficial	5/9/2017	< 1 (U)	< 1 (U)
OMS-28-GW11	7-11	Upper Surficial	5/13/2017	< 1 (U)	< 1 (U)
	15-19	Middle Surficial	5/13/2017	< 1 (U)	**24.3**
	26-30	Lower Surficial	5/13/2017	< 1 (U)	< 1 (U)
OMS-28-GW12	8-12	Upper Surficial	5/19/2017	< 1 (U)	< 1 (U)
	14-18	Middle Surficial	5/19/2017	< 1 (U)	**23.67**
	28-32	Lower Surficial	5/19/2017	< 1 (U)	< 1 (U)
OMS-28-GW13	8-12	Upper Surficial	5/9/2017	< 1 (U)	**1.5**
	14-18	Middle Surficial	5/9/2017	< 1 (U)	**37.2**
	28-32	Lower Surficial	5/9/2017	< 1 (U)	< 1 (U)
OMS-28-GW14	7-11	Upper Surficial	5/13/2017	< 1 (U)	< 1 (U)
	16-20	Middle Surficial	5/13/2017	< 1 (U)	**3.6**
	26-30	Lower Surficial	5/13/2017	< 1 (U)	< 1 (U)
OMS-28-GW15	8-12	Upper Surficial	5/5/2017	< 1 (U)	**2.77**
	15-19	Middle Surficial	5/5/2017	< 1 (U)	**7.11**
	26-30	Lower Surficial	5/5/2017	< 1 (U)	< 1 (U)

Table C-4
Discrete Groundwater Results, May 2017 - Mobile Laboratory
Alabama Army National Guard, OMS #28
Mobile, Alabama

			Chemicals of Concern	PCE	TCE
Groundwater Screening Criteria	**Maximum Contaminant Levels**			**5**	**5**
Boring Location	**Sample Depth (ft bgs)**	**Sample Zone**	**Sample Date**		
OMS-28-GW16	8-12	Upper Surficial	5/4/2017	< 1 (U)	**0.52 J**
	15-19	Middle Surficial	5/4/2017	< 1 (U)	**5.95**
	26-30	Lower Surficial	5/4/2017	< 1 (U)	< 1 (U)
OMS-28-GW17	8-12	Upper Surficial	5/4/2017	< 1 (U)	**1.59**
	15-19	Middle Surficial	5/4/2017	< 1 (U)	**6.7**
	24-28	Lower Surficial	5/4/2017	< 1 (U)	< 1 (U)
OMS-28-GW18	8-12	Upper Surficial	5/5/2017	< 1 (U)	**1.55**
	14-18	Middle Surficial	5/5/2017	< 1 (U)	**2.7**
	26-30	Lower Surficial	5/5/2017	< 1 (U)	< 1 (U)
OMS-28-GW19	8-12	Upper Surficial	5/9/2017	**2.2**	**3.3**
	15-19	Middle Surficial	5/9/2017	**95.7**	**38.7**
	26-30	Lower Surficial	5/9/2017	< 1 (U)	< 1 (U)
OMS-28-GW20	8-12	Upper Surficial	5/4/2017	**12.71**	**16.09**
	15-19	Middle Surficial	5/4/2017	< 1 (U)	< 1 (U)
	24-28	Lower Surficial	5/4/2017	< 1 (U)	< 1 (U)
OMS-28-GW21	8-12	Upper Surficial	5/5/2017	**460**	**510**
	14-18	Middle Surficial	5/5/2017	**11.85**	**230**
	26-30	Lower Surficial	5/5/2017	< 1 (U)	< 1 (U)
OMS-28-GW22	7-11	Upper Surficial	5/9/2017	**40,000**	< 1 (U)
	16-20	Middle Surficial	5/9/2017	**74.3**	**0.82 J**
	24-28	Lower Surficial	5/9/2017	**77**	**0.92 J**
OMS-28-GW23	8-12	Upper Surficial	5/10/2017	**0.72 J**	**0.63 J**
	16-20	Middle Surficial	5/10/2017	< 1 (U)	< 1 (U)
	24-28	Lower Surficial	5/10/2017	< 1 (U)	< 1 (U)
OMS-28-GW24	8-12	Upper Surficial	5/12/2017	**38.1**	**13.5**
	15-19	Middle Surficial	5/9/2017	**100**	**35.9**
	26-30	Lower Surficial	5/9/2017	**1.2**	< 1 (U)
OMS-28-GW25	8-12	Upper Surficial	5/16/2017	< 1 (U)	< 1 (U)
	15-19	Middle Surficial	5/9/2017	**1.4**	**0.8 J**
	24-28	Lower Surficial	5/9/2017	< 1 (U)	**0.89 J**
OMS-28-GW26	27-31	Lower Surficial	5/9/2017	< 1 (U)	< 1 (U)
OMS-28-GW30	6-11	Upper Surficial	5/4/2017	< 1 (U)	< 1 (U)
	16-20	Middle Surficial	5/4/2017	< 1 (U)	< 1 (U)
	29-33	Lower Surficial	5/4/2017	< 1 (U)	< 1 (U)
OMS-28-GW31	8-12	Upper Surficial	5/2/2017	< 1 (U)	< 1 (U)
	15-19	Middle Surficial	5/2/2017	< 1 (U)	< 1 (U)
	27-31	Lower Surficial	5/2/2017	< 1 (U)	**13.35**
OMS-28-GW32	8-12	Upper Surficial	5/2/2017	< 1 (U)	**140**
	15-19	Middle Surficial	5/2/2017	< 1 (U)	**6.26**
	27-31	Lower Surficial	5/2/2017	< 1 (U)	**15.6**
OMS-28-GW33	8-12	Upper Surficial	5/2/2017	< 1 (U)	< 1 (U)
	15-19	Middle Surficial	5/2/2017	< 1 (U)	**38.21**
	29-33	Lower Surficial	5/2/2017	< 1 (U)	< 1 (U)
OMS-28-GW34	15-19	Middle Surficial	5/17/2017	< 1 (U)	**2.56**
	28-32	Lower Surficial	5/17/2017	< 1 (U)	< 1 (U)

Table C-4
Discrete Groundwater Results, May 2017 - Mobile Laboratory
Alabama Army National Guard, OMS #28
Mobile, Alabama

			Chemicals of Concern	PCE	TCE
Groundwater Screening Criteria	**Maximum Contaminant Levels**			**5**	**5**
Boring Location	**Sample Depth (ft bgs)**	**Sample Zone**	**Sample Date**		
OMS-28-GW36	8-12	Upper Surficial	5/11/2017	< 1 (U)	< 1 (U)
	14-18	Middle Surficial	5/11/2017	< 1 (U)	< 1 (U)
	25-29	Lower Surficial	5/11/2017	< 1 (U)	< 1 (U)
OMS-28-GW37	8-12	Upper Surficial	5/11/2017	< 1 (U)	< 1 (U)
	15-19	Middle Surficial	5/11/2017	< 1 (U)	< 1 (U)
	24-28	Lower Surficial	5/11/2017	< 1 (U)	< 1 (U)
OMS-28-GW38	8-12	Upper Surficial	5/11/2017	**59.7**	**11.8**
	14-18	Middle Surficial	5/11/2017	**14.2**	**1.5**
	26-30	Lower Surficial	5/11/2017	< 1 (U)	< 1 (U)
OMS-28-GW39	9-13	Upper Surficial	5/10/2017	**1,000**	**15**
	16-20	Middle Surficial	5/10/2017	**120**	**5.9**
	24-28	Lower Surficial	5/10/2017	< 1 (U)	< 1 (U)
OMS-28-GW40	9-13	Upper Surficial	5/11/2017	**1,800**	**35**
	16-20	Middle Surficial	5/11/2017	**1,500**	**46**
	24-28	Lower Surficial	5/11/2017	< 1 (U)	< 1 (U)
OMS-28-GW41	8-12	Upper Surficial	5/11/2017	**31.5**	**6.5**
	16-20	Middle Surficial	5/11/2017	**0.61 J**	< 1 (U)
	24-28	Lower Surficial	5/11/2017	< 1 (U)	< 1 (U)
OMS-28-GW42	8-12	Upper Surficial	5/10/2017	**3.6**	**1.7**
	16-20	Middle Surficial	5/10/2017	**1.6**	**1.8**
	24-28	Lower Surficial	5/10/2017	**1.3**	< 1 (U)
OMS-28-GW43	8-12	Upper Surficial	5/12/2017	**0.56 J**	< 1 (U)
	16-20	Middle Surficial	5/12/2017	< 1 (U)	< 1 (U)
	24-28	Lower Surficial	5/12/2017	< 1 (U)	**10**
OMS-28-GW44	24-28	Lower Surficial	5/16/2017	< 1 (U)	**4.43**
OMS-28-GW45	14-18	Middle Surficial	5/12/2017	< 1 (U)	**1**
	28-32	Lower Surficial	5/12/2017	< 1 (U)	**0.62 J**
OMS-28-GW46	12-16	Middle Surficial	5/12/2017	< 1 (U)	**8.1**
	29-33	Lower Surficial	5/12/2017	< 1 (U)	**1.3**
OMS-28-GW47	15-19	Middle Surficial	5/17/2017	< 1 (U)	**3.32**
	28-32	Lower Surficial	5/17/2017	< 1 (U)	< 1 (U)
OMS-28-GW49	8-12	Upper Surficial	5/15/2017	< 1 (U)	< 1 (U)
	14-18	Middle Surficial	5/15/2017	< 1 (U)	< 1 (U)
	26-30	Lower Surficial	5/15/2017	< 1 (U)	< 1 (U)
OMS-28-GW50	9-13	Upper Surficial	5/15/2017	< 1 (U)	< 1 (U)
	14-18	Middle Surficial	5/15/2017	< 1 (U)	< 1 (U)
	26-30	Lower Surficial	5/15/2017	< 1 (U)	< 1 (U)
OMS-28-GW51	26-30	Lower Surficial	5/13/2017	< 1 (U)	< 1 (U)
OMS-28-GW52	15-19	Middle Surficial	5/15/2017	< 1 (U)	< 1 (U)
	27-31	Lower Surficial	5/13/2017	< 1 (U)	< 1 (U)
OMS-28-GW53	8-12	Upper Surficial	5/13/2017	< 1 (U)	**21.4**
	15-19	Middle Surficial	5/13/2017	< 1 (U)	**31.3**
	27-31	Lower Surficial	5/13/2017	< 1 (U)	< 1 (U)

Table C-4
Discrete Groundwater Results, May 2017 - Mobile Laboratory
Alabama Army National Guard, OMS #28
Mobile, Alabama

			Chemicals of Concern	PCE	TCE
Groundwater Screening Criteria	Maximum Contaminant Levels			5	5
Boring Location	Sample Depth (ft bgs)	Sample Zone	Sample Date		
OMS-28-GW54	8-12	Upper Surficial	5/13/2017	< 1 (U)	< 1 (U)
	15-19	Middle Surficial	5/13/2017	< 1 (U)	**7.5**
	28-32	Lower Surficial	5/13/2017	< 1 (U)	< 1 (U)
OMS-28-GW55	8-12	Upper Surficial	5/13/2017	< 1 (U)	**0.65 J**
	15-19	Middle Surficial	5/13/2017	< 1 (U)	**2.9**
	28-32	Lower Surficial	5/13/2017	< 1 (U)	< 1 (U)
OMS-28-GW56	14-18	Middle Surficial	5/15/2017	< 1 (U)	< 1 (U)
	27-31	Lower Surficial	5/15/2017	< 1 (U)	< 1 (U)
OMS-28-GW57	8-12	Upper Surficial	5/17/2017	< 1 (U)	< 1 (U)
	12-16	Middle Surficial	5/12/2017	< 1 (U)	< 1 (U)
	29-33	Lower Surficial	5/12/2017	< 1 (U)	< 1 (U)
OMS-28-GW58	8-12	Upper Surficial	5/15/2017	< 1 (U)	**5.34**
	15-19	Middle Surficial	5/15/2017	< 1 (U)	**48.02**
	27-31	Lower Surficial	5/15/2017	< 1 (U)	< 1 (U)
OMS-28-GW59	8-12	Upper Surficial	5/16/2017	**1.86**	< 1 (U)
	14-18	Middle Surficial	5/16/2017	< 1 (U)	< 1 (U)
	26-30	Lower Surficial	5/16/2017	< 1 (U)	< 1 (U)
OMS-28-GW60	29-33	Lower Surficial	5/16/2017	< 1 (U)	< 1 (U)
OMS-28-GW61	8-12	Upper Surficial	5/17/2017	< 1 (U)	< 1 (U)
	15-19	Middle Surficial	5/17/2017	< 1 (U)	**2.01**
	27-31	Lower Surficial	5/17/2017	< 1 (U)	< 1 (U)
OMS-28-GW62	8-12	Upper Surficial	5/16/2017	< 1 (U)	**3.47**
	15-19	Middle Surficial	5/16/2017	< 1 (U)	**20.45**
	26-30	Lower Surficial	5/16/2017	< 1 (U)	< 1 (U)
OMS-28-GW63	8-12	Upper Surficial	5/17/2017	< 1 (U)	< 1 (U)
	15-19	Middle Surficial	5/17/2017	< 1 (U)	**2.41**
	26-30	Lower Surficial	5/17/2017	< 1 (U)	< 1 (U)
OMS-28-GW64	12-16	Middle Surficial	5/17/2017	< 1 (U)	< 1 (U)
	29-33	Lower Surficial	5/17/2017	< 1 (U)	**27.1**
OMS-28-GW65	8-12	Upper Surficial	5/17/2017	**37.71**	**5.49**
	15-19	Middle Surficial	5/17/2017	**30.75**	**2.02**
	25-29	Lower Surficial	5/17/2017	< 1 (U)	< 1 (U)
OMS-28-GW66	22-26	Middle Surficial	5/18/2017	< 1 (U)	< 1 (U)
	45-49	Lower Surficial	5/18/2017	< 1 (U)	< 1 (U)
OMS-28-GW67	22-26	Middle Surficial	5/18/2017	< 1 (U)	**0.91 J**
	48-52	Lower Surficial	5/18/2017	< 1 (U)	< 1 (U)
OMS-28-GW68	22-26	Middle Surficial	5/18/2017	< 1 (U)	< 1 (U)
	53-57	Lower Surficial	5/18/2017	< 1 (U)	< 1 (U)
OMS-28-GW69	22-26	Middle Surficial	5/18/2017	< 1 (U)	< 1 (U)
	45-49	Lower Surficial	5/19/2017	< 1 (U)	< 1 (U)
OMS-28-GW71	15-19	Middle Surficial	5/19/2017	< 1 (U)	**4.7**
	29-33	Lower Surficial	5/19/2017	< 1 (U)	< 1 (U)

Table C-4
Discrete Groundwater Results, May 2017 - Mobile Laboratory
Alabama Army National Guard, OMS #28
Mobile, Alabama

			Chemicals of Concern	PCE	TCE
Groundwater Screening Criteria	**Maximum Contaminant Levels**			**5**	**5**
Boring Location	**Sample Depth (ft bgs)**	**Sample Zone**	**Sample Date**		
OMS-28-GW72	29-33	Lower Surficial	5/19/2017	< 1 (U)	< 1 (U)

Notes:
Groundwater samples were analyzed in the field by Columbia Technology's mobile laboratory for TCE and PCE via Method SW8260B.
The Screening Criteria is based on the USEPA Maximum Contamination Limit.
Results are reported in (μg/L).
Bold results indicates the analyte was detected.
Shading indicates the screening value was exceeded.
Sample Depth is reported as feet below ground surface (ft bgs).

Data Qualifiers:
< - the numeric value presented is the sample specific detection limit.
U - The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
J - The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

Definitions:
μg/L - microgram per liter
MCL - Maximum Contaminant Level
PCE - Tetrachloroethene
TCE - Trichloroethene
USEPA - United States Environmental Protection Agency

Table C-5
Split Groundwater Sample Results - May 2017
Alabama Army National Guard, OSM # 28
Mobile, Alabama

Sample ID	MCL	OMS-28-GW02	OMS-28-GW03	OMS-28-GW06	OMS-28-GW11
Sample Depth (ft bgs)		15-19	30-34	7-11	7-11
Sample Date		5/3/2017	5/4/2017	5/17/2017	5/13/2017
TCL Volatile Organic Compounds Method SW8260B (µg/L)					
cis-1,2-Dichloroethene	70	< 0.5 (U)	< 0.5 (U)	< 0.5 (U)	< 0.5 (U)
Tetrachloroethene	5	< 0.5 (U)	< 0.5 (U)	< 0.5 (U)	< 0.5 (U)
Trichloroethene	5	< 0.5 (U)	< 0.5 (U)	**1.07**	< 0.5 (U)
Vinyl Chloride SW8260 SIM (µg/L)					
Vinyl chloride	2	**0.011 J**	< 0.015 (U)	< 0.015 (U)	< 0.015 (U)

Sample ID	MCL	OMS-28-GW12	OMS-28-GW13	OMS-28-GW20	OMS-28-GW23
Sample Depth (ft bgs)		8-12	28-32	8-12	8-12
Sample Date		5/19/2017	5/9/2017	5/5/2017	5/10/2017
TCL Volatile Organic Compounds Method SW8260B (µg/L)					
cis-1,2-Dichloroethene	70	< 0.5 (U)	< 0.5 (U)	**0.927 J**	< 0.5 (U)
Tetrachloroethene	5	< 0.5 (U)	< 0.5 (U)	**25.7**	**0.863 J**
Trichloroethene	5	< 0.5 (U)	< 0.5 (U)	**32.5**	**0.751 J**
Vinyl Chloride SW8260 SIM (µg/L)					
Vinyl chloride	2	NA	< 0.015 (U)	**0.024**	< 0.015 (U)

Sample ID	MCL	OMS-28-GW32	OMS-28-GW34	OMS-28-GW38	OMS-28-GW41
Sample Depth (ft bgs)		8-12	27-31	26-30	16-20
Sample Date		5/2/2017	5/17/2017	5/11/2017	5/11/2017
TCL Volatile Organic Compounds Method SW8260B (µg/L)					
cis-1,2-Dichloroethene	70	**3.71**	< 0.5 (U)	< 0.5 (U)	< 0.5 (U)
Tetrachloroethene	5	< 1 (U)	< 0.5 (U)	< 0.5 (U)	< 0.5 (U)
Trichloroethene	5	**268**	< 0.5 (U)	< 0.5 (U)	< 0.5 (U)
Vinyl Chloride SW8260 SIM (µg/L)					
Vinyl chloride	2	**0.022**	< 0.015 (U)	< 0.015 (U)	**0.0063**

Sample ID	MCL	OMS-28-GW49	OMS-28-GW57	OMS-28-GW58	OMS-28-GW62
Sample Depth (ft bgs)		8-12	12-16	27-31	15-19
Sample Date		5/15/2017	5/12/2017	5/15/2017	5/16/2017
TCL Volatile Organic Compounds Method SW8260B (µg/L)					
cis-1,2-Dichloroethene	70	< 0.5 (U)	< 0.5 (U)	< 0.5 (U)	**3.41**
Tetrachloroethene	5	< 0.5 (U)	< 0.5 (U)	< 0.5 (U)	< 0.5 (U)
Trichloroethene	5	< 0.5 (U)	< 0.5 (U)	< 0.5 (U)	**45.1**
Vinyl Chloride SW8260 SIM (µg/L)					
Vinyl chloride	2	< 0.015 (U)	< 0.015 (U)	< 0.015 (U)	**0.008 J**

Notes:

Groundwater samples were analyzed by GCAL for TCL VOCs by Method 8260B except vinyl chloride.
Vinyl chloride analyzed by ALS Environmental by Method 8260SIM.

Results are reported in µg/L.

The groundwater screening criteria is based on the USEPA Maximum Contamination Limit (MCL).

Bold text indicates analyte concentration detected above the limit of detection (LOD).

Gray shading and bold text indicates the analyte was detected in exceedance of its respective screening value.

Data Qualifiers:

J - Estimated value detected below the limit of detection.

U - Indicates not detected at the limit of detection indicated.

Definitions:

µg/L - micrograms per liter

ft bgs - feet below ground surface

LOD - Limit of Detection

MCL - Maximum Contamination Level

SIM - Select Ion Method

TCL - target compound list

USEPA - United States Environmental Protection Agency

Table C-6
Groundwater Summary Results, January/February 2018
Alabama Army National Guard, OMS #28
Mobile, Alabama

Sample ID	MCL	OMS-28-GW73	OMS-28-GW73	OMS-28-GW74	OMS-28-GW74	OMS-28-GW75	OMS-28-GW76	OMS-28-GW76
Sample Depth (ft bgs)		12-16	29-33	11-15	29-33	25-29	9-13	16-20
Sample Date		1/29/2018	1/29/2018	1/30/2018	1/30/2018	1/30/2018	1/31/2018	1/31/2018
Select Volatile Organic Compounds Method SW8260B (µg/L)								
cis-1,2-Dichloroethene	70	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)
Tetrachloroethene	5	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)
Trichloroethene	5	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	**9.02**	< 0.500 (U)	< 0.500 (U)
Vinyl Chloride SW8260 SIM (µg/L)								
Vinyl Chloride	2	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)

Sample ID	MCL	OMS-28-GW76	OMS-28-GW77	OMS-28-GW77	OMS-28-GW77	OMS-28-GW78	OMS-28-GW78	OMS-28-GW78
Sample Depth (ft bgs)		24-28	8-12	16-20	23-27	8-12	16-20	23-27
Sample Date		1/31/2018	2/1/2018	2/1/2018	2/2/2018	1/31/2018	1/31/2018	2/1/2018
Select Volatile Organic Compounds Method SW8260B (µg/L)								
cis-1,2-Dichloroethene	70	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)
Tetrachloroethene	5	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)
Trichloroethene	5	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)
Vinyl Chloride SW8260 SIM (µg/L)								
Vinyl Chloride	2	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)

Sample ID	MCL	OMS-28-GW79	OMS-28-GW79	OMS-28-GW79	OMS-28-GW80	OMS-28-GW80	OMS-28-GW80	OMS-28-GW81
Sample Depth (ft bgs)		7-11	13-17	23-27	7-11	13-17	23-27	14-18
Sample Date		2/1/2018	2/1/2018	2/1/2018	2/1/2018	2/2/2018	2/2/2018	1/30/2018
Select Volatile Organic Compounds Method SW8260B (µg/L)								
cis-1,2-Dichloroethene	70	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	**1.29**
Tetrachloroethene	5	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)
Trichloroethene	5	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	**11.1**
Vinyl Chloride SW8260 SIM (µg/L)								
Vinyl Chloride	2	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)

Table C-6
Groundwater Summary Results, January/February 2018
Alabama Army National Guard, OMS #28
Mobile, Alabama

Sample ID	MCL	OMS-28-GW81	OMS-28-GW82	OMS-28-GW82	OMS-28-GW83	OMS-28-GW83	OMS-28-GW83	OMS-28-GW84
Sample Depth (ft bgs)		24-28	15-19	27-31	8-12	12-16	27-31	8-12
Sample Date		1/31/2018	2/2/2018	2/2/2018	2/2/2018	2/2/2018	2/2/2018	2/5/2018
Select Volatile Organic Compounds Method SW8260B (µg/L)								
cis-1,2-Dichloroethene	70	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	**1.28**	< 0.500 (U)	< 0.500 (U)
Tetrachloroethene	5	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)
Trichloroethene	5	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	**3.59**	**51.3**	**0.644 J**	< 0.500 (U)
Vinyl Chloride SW8260 SIM (µg/L)								
Vinyl Chloride	2	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)

Sample ID	MCL	OMS-28-GW84	OMS-28-GW84	OMS-28-GW85	OMS-28-GW85	OMS-28-GW85	OMS-28-GW86	OMS-28-GW86
Sample Depth (ft bgs)		13-17	27-31	9-13	15-19	27-31	8-12	12-16
Sample Date		2/5/2018	2/5/2018	2/2/2018	2/2/2018	2/2/2018	2/3/2018	2/3/2018
Select Volatile Organic Compounds Method SW8260B (µg/L)								
cis-1,2-Dichloroethene	70	< 0.500 (U)	< 0.500 (U)	**0.521 J**	**7.56**	< 0.500 (U)	**2.9**	**4.34**
Tetrachloroethene	5	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 1.00 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)
Trichloroethene	5	< 0.500 (U)	< 0.500 (U)	**17.1**	**291**	< 0.500 (U)	**42.4**	**131**
Vinyl Chloride SW8260 SIM (µg/L)								
Vinyl Chloride	2	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	**0.028 J**	< 0.050 (U)	< 0.050 (U)	**0.034 J**

Sample ID	MCL	OMS-28-GW86	OMS-28-GW87	OMS-28-GW88	OMS-28-GW88	OMS-28-GW88	OMS-28-GW89	OMS-28-GW90
Sample Depth (ft bgs)		27-31	27-31	8-12	13-17	27-31	27-31	29-33
Sample Date		2/3/2018	2/3/2018	2/5/2018	2/5/2018	2/5/2018	1/30/2018	2/5/2018
Select Volatile Organic Compounds Method SW8260B (µg/L)								
cis-1,2-Dichloroethene	70	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	**1.03**	< 0.500 (U)
Tetrachloroethene	5	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)
Trichloroethene	5	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	**0.894 J**	**5.22**	**1.28**
Vinyl Chloride SW8260 SIM (µg/L)								
Vinyl Chloride	2	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)

Table C-6
Groundwater Summary Results, January/February 2018
Alabama Army National Guard, OMS #28
Mobile, Alabama

Sample ID	**MCL**	**OMS-28-GW91**	**OMS-28-GW92**	**OMS-28-GW92**	**OMS-28-GW92**	**OMS-28-GW93**	**OMS-28-GW93**	**OMS-28-GW93**
Sample Depth		**29-33**	**8-12**	**12-16**	**29-33**	**8-12**	**12-16**	**29-33**
Sample Date		**2/6/2018**	**2/6/2018**	**2/6/2018**	**2/6/2018**	**2/6/2018**	**2/6/2018**	**2/6/2018**
Select Volatile Organic Compounds Method SW8260B (µg/L)								
cis-1,2-Dichloroethene	70	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)
Tetrachloroethene	5	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)
Trichloroethene	5	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	< 0.500 (U)	**0.584 J**
Vinyl Chloride SW8260 SIM (µg/L)								
Vinyl Chloride	2	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)	< 0.050 (U)

Notes:

Groundwater samples were analyzed by GCAL for TCL VOCs by Method 8260B except vinyl chloride.
Vinyl chloride analyzed by ALS Environmental by Method 8260SIM.
Results are reported in µg/L.
The groundwater screening criteria is based on the USEPA Maximum Contamination Limit (MCL).
Bold text indicates analyte concentration detected above the limit of detection (LOD).
Gray shading and bold text indicates the analyte was detected in exceedance of its respective screening value.

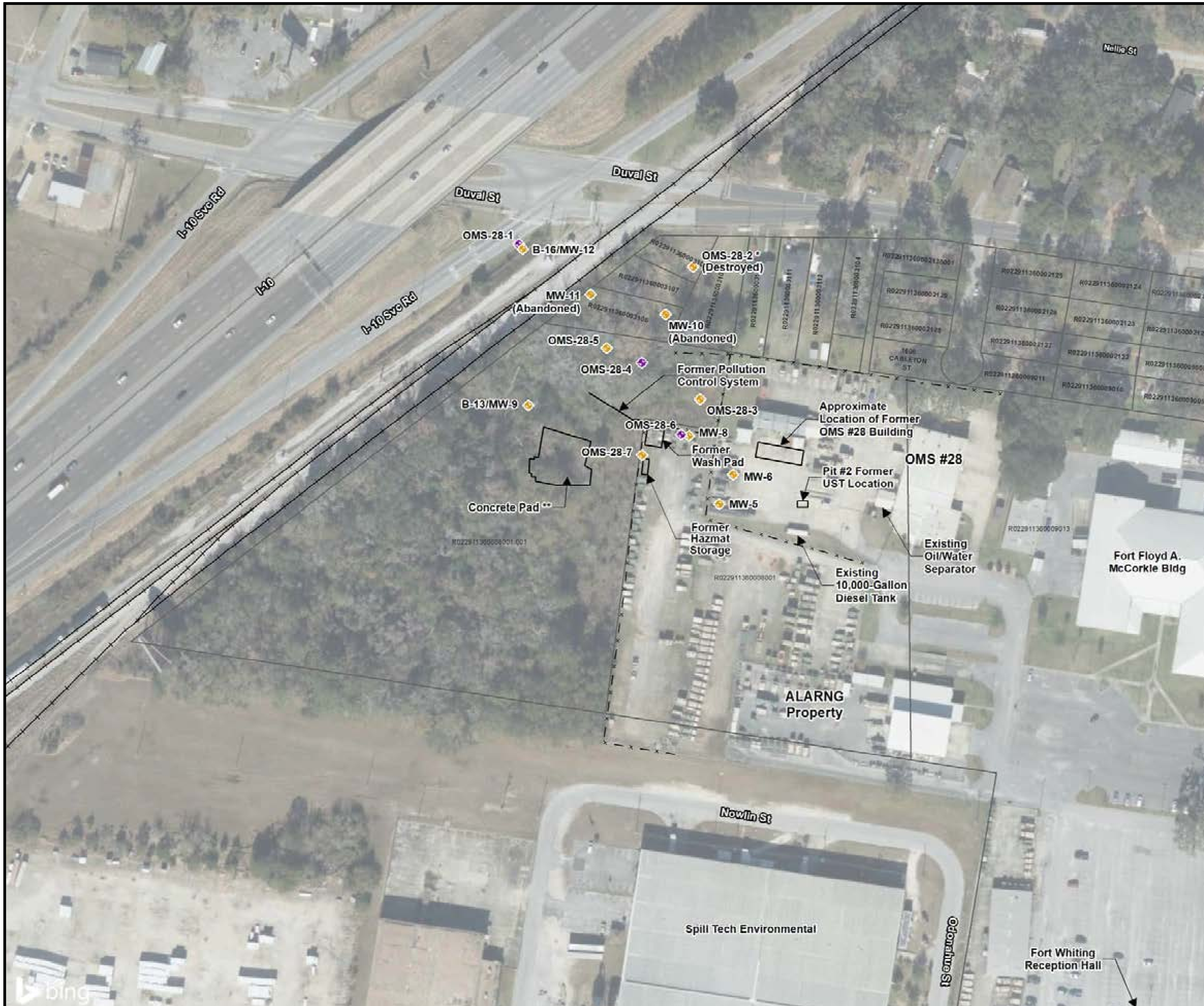
Data Qualifiers:

J - Estimated value detected below the limit of detection.
U - Indicates not detected at the limit of detection indicated.

Definitions:

µg/L - micrograms per liter
ft bgs - feet below ground surface
LOD - Limit of Detection
MCL - Maximum Contamination Level
TCL - target compound list
USEPA - United States Environmental Protection Agency

FIGURES



Site Location

Legend

- Upper/Middle Surficial Monitoring Well Location
- Lower Surficial Monitoring Well Location
- Railroad
- Fenceline
- Parcel Boundary

Notes:
Wells MW-10 and MW-11 were abandoned in 2008 at the property owner's request and have not been replaced.

* Wells OMS-28-2 was found destroyed during a site visit in December 2021.

** Concrete pad is the likely remnant foundation of Mollison Hall (recreational hall for soldiers before and after World War II) that was demolished between 1972 and 1974.

ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop

0 75 150 300 Feet

1 inch = 150 feet

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Facility Site Location Map

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/12/2023	**Figure C-1**

Document Path: L:\Legacy\Group\earth\OMS 28\60439687\900-CADD-GIS\Brookley_GIS\Maps\FS Letter Report\20220505\Figure 1-2_Facility Site Location Map.mxd

Screening Criteria

	PCE
Residential RSL	8.1 mg/kg
MCL	5 µg/L

Site Location

Legend

- Discrete Groundwater Sample Locations
- Discrete Soil Boring Location
- Upper/Middle Surficial Monitoring Well Location
- Lower Surficial Monitoring Well Location
- Railroad
- PCE Exceeds Residential Soil RSL
- PCE Plume Related to Offsite PCE Spill on Parcel A
- Fenceline
- Parcel Boundary

Notes:

Wells MW-10 and MW-11 were abandoned in 2008 at the property owner's request and have not been replaced.

* Well OMS-28-2 was found destroyed during a site visit conducted in December 2021.

ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
PCE - Tetrachloroethene
MCL - Maximum Contaminant Level
RSL - Residential Screening Level (USEPA, May 2023)
mg/kg - milligrams per kilogram
mg/L - milligrams per liter

Service Layer Credits: © 2023 Microsoft Corporation © 2023 Maxar ©CNES (2023) Distribution Airbus DS
National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

0 30 60 120 Feet

1 inch = 60 feet

N W E S

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Plan View of Offsite PCE Contamination in Soil and Groundwater

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/12/2023	Figure C-2

Document Path: L:\Legacy\Group\earth\OMS 28\60439687\900-CADD-GIS\Brookley_GIS\Maps\FS Letter Report\20220505\Figure C-2_Plan View Off-Site PCE in Soil and Groundwater.mxd

Site Location

Legend

- Upper/Middle Surficial Monitoring Well Location
- Lower Surficial Monitoring Well Location
- Discrete Groundwater Sample Location
- HPT Location
- MIP Location
- Soil Boring Location
- Cross-Section A-A'
- Cross-Section B-B'
- Fenceline
- Railroad
- Parcel Designation (A - H)
- Parcel Boundary

Note:

* Well OMS-28-2 was found destroyed during a site visit conducted in December 2021.

ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop

HPT - Hydraulic Profiling Tool

MIP - Membrane Interface Probe

Service Layer Credits: © 2023 Microsoft Corporation © 2023 Maxar ©CNES (2023) Distribution Airbus DS
National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

0 40 80 160 Feet

1 inch = 80 feet

N S E W

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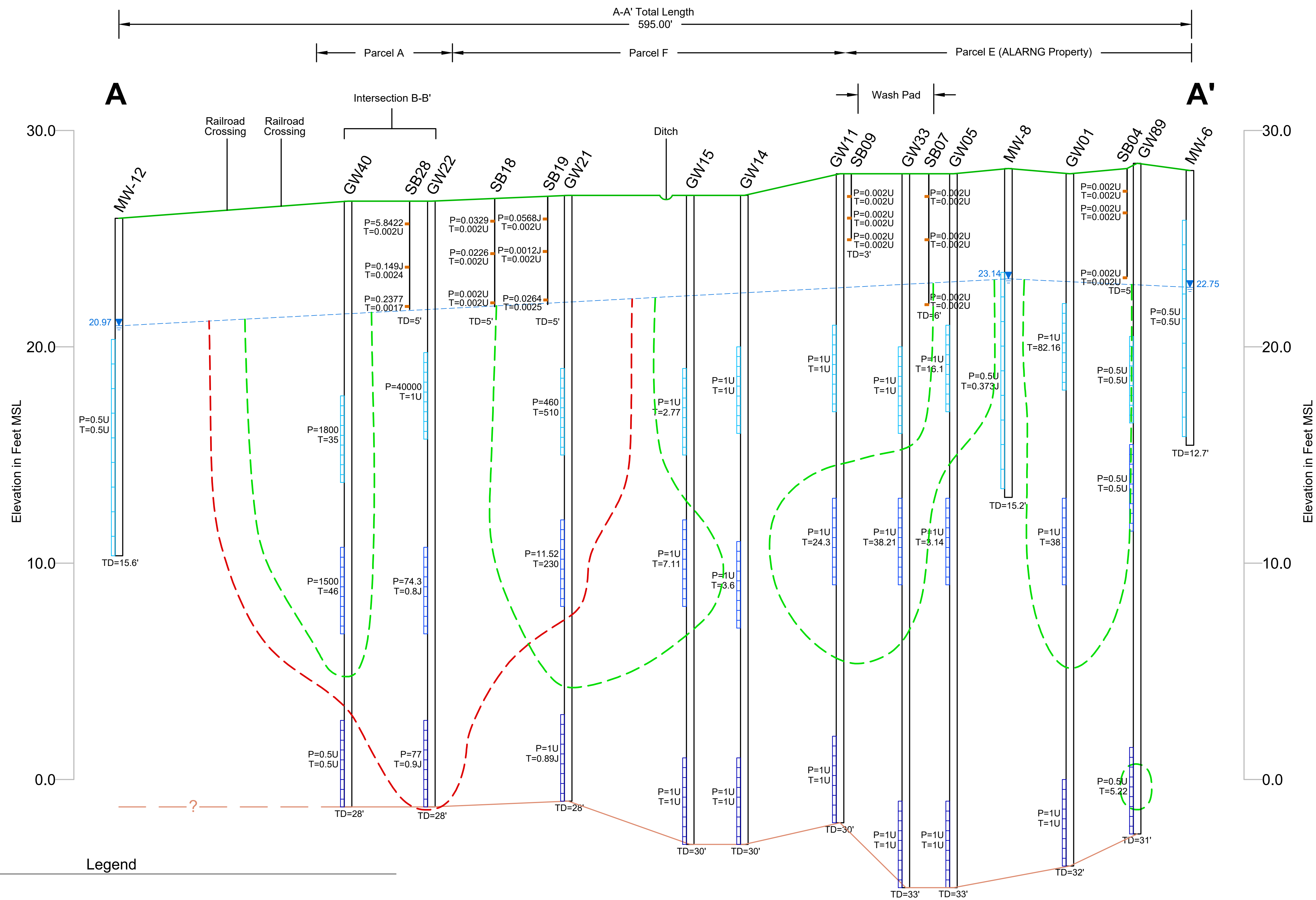
Cross-Section Location Map

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/11/2023	Figure C-3



Legend

GW40	Location Name		Shallow Well Screen		Extent of PCE in Groundwater
	Well		Middle Well Screen		Extent of TCE in Groundwater
	Soil Boring		Lower Well Screen	P=74.3	PCE Concentration (µg/L)
		20.97	Groundwater Elevation (ft msl)	T=0.8J	TCE Concentration (µg/L)
	Soil Sample		Groundwater Surface	TD=28'	Total Depth (ft bgs)
			Impervious Clay Layer		

Notes:
Soil boring results are reported in milligrams per kilogram (mg/kg).
ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
PCE - Tetrachloroethene
TCE - Trichloroethene
µg/L - micrograms per liter
µg/kg - micrograms per kilogram
ft bgs - feet below ground surface
ft msl - feet mean sea level
J - The result is an estimated quantity.
U - The analyte was analysed for, but it was not detected above the level of the reported quantitation limit.

0 30 60 120 180
HORIZONTAL SCALE IN FEET

0 2.5 5 10 15
VERTICAL SCALE IN FEET
Vertical Exaggeration = 12

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Cross Section A-A'

Alabama Army National Gaurd OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	5/20/2022	Figure C-4

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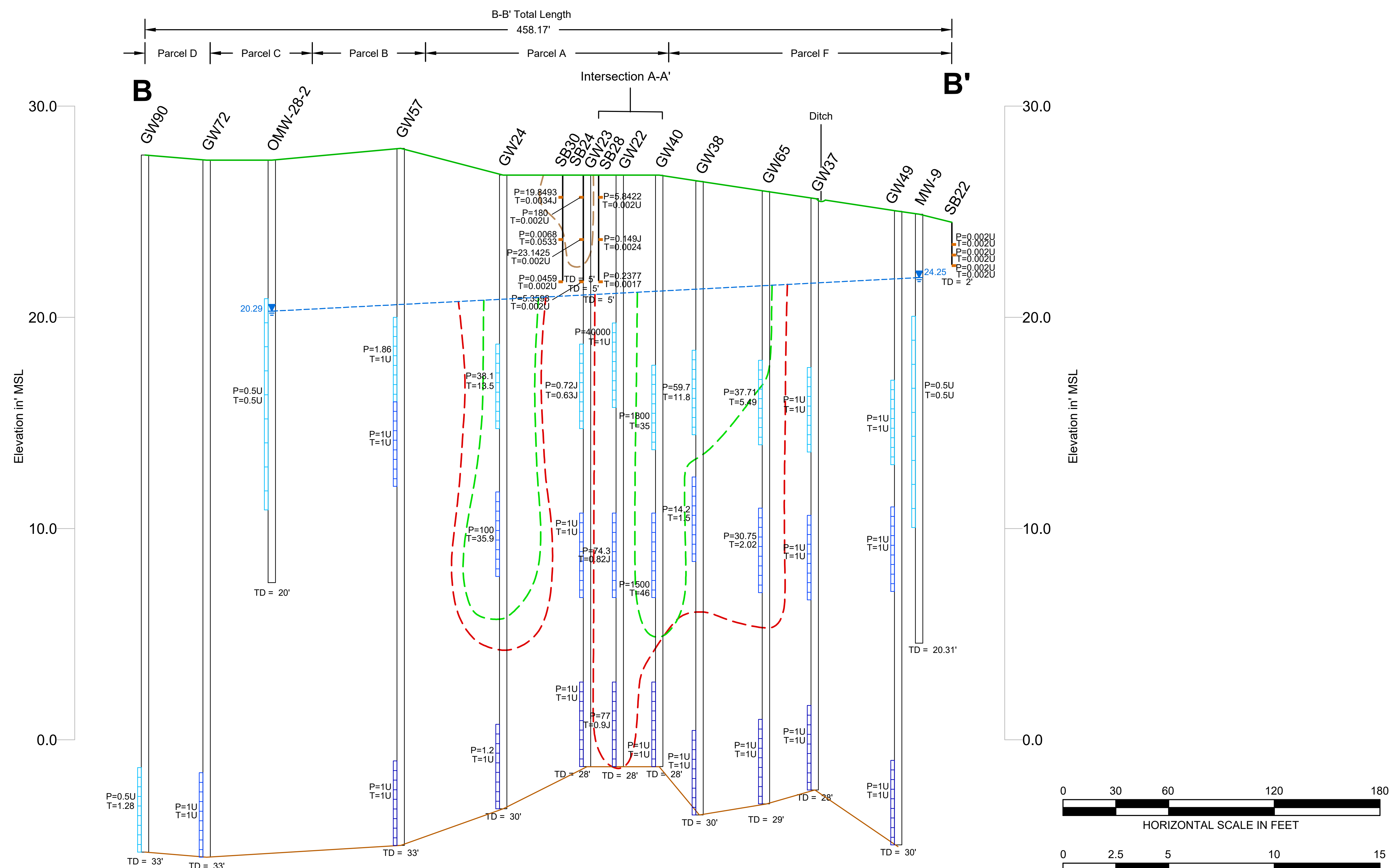

Legend

GW57 Location Name	Shallow Well Screen	Extent of PCE in Soil (Residential RSL 8.1 mg/kg)
Well	Middle Well Screen	Extent of PCE in Groundwater (5 µg/L)
Soil Boring	Lower Well Screen	Extent of TCE in Groundwater (5 µg/L)
	20.29 Groundwater Elevation (ft msl)	P=38.1 PCE Concentration (µg/L)
Soil Sample	Groundwater Surface	T=13.5 TCE Concentration (µg/L)
	Impervious Clay Layer	TD=33' Total Depth (ft bgs)

Notes:
Soil boring results are reported in milligrams per kilogram (mg/kg).
ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
PCE - Tetrachloroethene
TCE - Trichloroethene
µg/L - micrograms per liter
µg/kg - micrograms per kilogram
ft bgs - feet below ground surface
ft msl - feet mean sea level
J - The result is an estimated quantity.
U - The analyte was analysed for, but it was not detected above the level of the reported quantitation limit.

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Cross Section B-B'

Alabama Army National Gaurd OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	5/20/2022	Figure C-5

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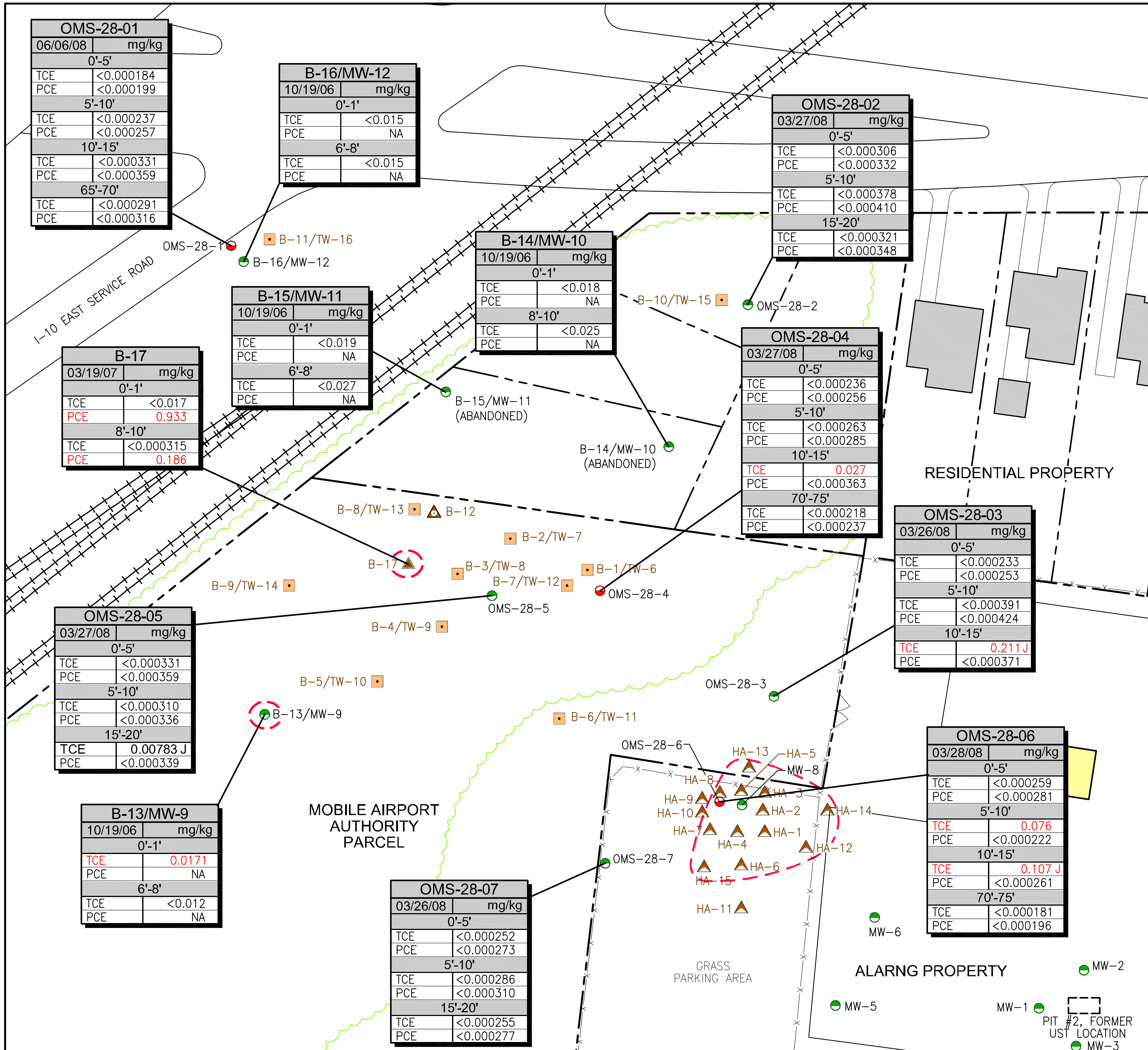


HA-1	
04/19/06	mg/kg
0'-1'	
TCE	0.00311 J
PCE	0.00121 J
6'-8'	
TCE	0.017
PCE	0.000822 J

HA-2	
04/19/06	mg/kg
0'-1'	
TCE	0.241 J
PCE	<0.011
8'-10'	
TCE	0.027
PCE	<0.000191

HA-3	
04/19/06	mg/kg
0'-1'	
TCE	0.019 J
PCE	<0.000476
8'-10'	
TCE	0.00353 J
PCE	<0.000137

HA-4	
04/19/06	mg/kg
0'-1'	
TCE	<0.000249
PCE	<0.000271
7'-9'	
TCE	<0.000211
PCE	<0.000229

HA-5	
04/19/06	mg/kg
0'-1'	
TCE	<0.000429
PCE	0.00252 J
7'-9'	
TCE	<0.00944
PCE	<0.010

HA-6	
04/19/06	mg/kg
0'-1'	
TCE	<0.000207
PCE	<0.000225
8'-10'	
TCE	0.15
PCE	<0.000203

HA-7	
04/19/06	mg/kg
0'-1'	
TCE	<0.000437
PCE	0.00253 J
8'-10'	
TCE	0.069 J
PCE	<0.00711

HA-8	
04/19/06	mg/kg
0'-1'	
TCE	0.00286 J
PCE	<0.00266
8'-10'	
TCE	<0.00998
PCE	<0.011

HA-9	
04/19/06	mg/kg
0'-1'	
TCE	<0.000359
PCE	<0.000389
8'-10'	
TCE	<0.012
PCE	<0.013

HA-10	
04/19/06	mg/kg
0'-1'	
TCE	<0.000267
PCE	0.00154 J
8'-10'	
TCE	<0.000146
PCE	<0.000159

HA-11	
05/11/06	mg/kg
0'-1'	
NOT SAMPLED	
8'-10'	
TCE	<0.000169
PCE	<0.000184

HA-12	
05/11/06	mg/kg
0'-1'	
NOT SAMPLED	
8'-10'	
TCE	0.00353 J
PCE	0.00191 J

HA-13	
05/11/06	mg/kg
0'-1'	
NOT SAMPLED	
8'-10'	
TCE	<0.000451
PCE	0.00505 J

HA-14	
03/19/07	mg/kg
0'-1'	
TCE	0.017
PCE	<0.000243
8'-10'	
TCE	0.00962
PCE	<0.000332

HA-15	
03/19/07	mg/kg
0'-1'	
TCE	0.586
PCE	<0.015
8'-10'	
TCE	0.132 J
PCE	<0.000326

LEGEND:

- RESIDENTIAL BUILDING
- COMMERCIAL BUILDING
- ASPHALT ROAD
- RAILROAD TRACKS
- CHAIN LINK FENCE
- PROPERTY BOUNDARY
- TREE LINE
- SOIL BORING (2006–2007)
- TEMPORARY WELL (2006–2007)
- HAND AUGER BORING (2006–2007)
- FLUTE LINER BORING (2006)
- SHALLOW MONITORING WELL
- DEEP MONITORING WELL
- XXXX CONTAMINATION EXCEEDING SSL
- CONTAMINATION EXCEEDING RSL
- EXCEEDS SSL

NOTES:

1. HISTORICAL LOCATIONS DIGITIZED FROM BASE MAP PROVIDED BY AEROSTAR ENVIRONMENTAL SERVICES INC. (AEROSTAR 2007).
2. MONITORING WELL LOCATIONS DATA PROVIDED BY AEROSTAR ENVIRONMENTAL SERVICES INC. (AEROSTAR 2008).
3. EPA RSLs DATED MAY 2012 ARE BEING USED IN LIEU OF AL PSVs PUBLISHED IN THE ALABAMA RISK-BASED CORRECTIVE ACTION GUIDANCE MANUAL (2008) AS PER APRIL 2, 2012 EMAIL CORRESPONDENCE BETWEEN ADEM AND ALARNG.

	PROTECTION OF GROUNDWATER SSL (mg/Kg)	RESIDENTIAL SOIL EPA RSL (mg/Kg)
TCE	0.0018	0.41
PCE	0.0023	8.1

ALABAMA STATE PLANE NAD 83 WEST ZONE

0 30 60 120

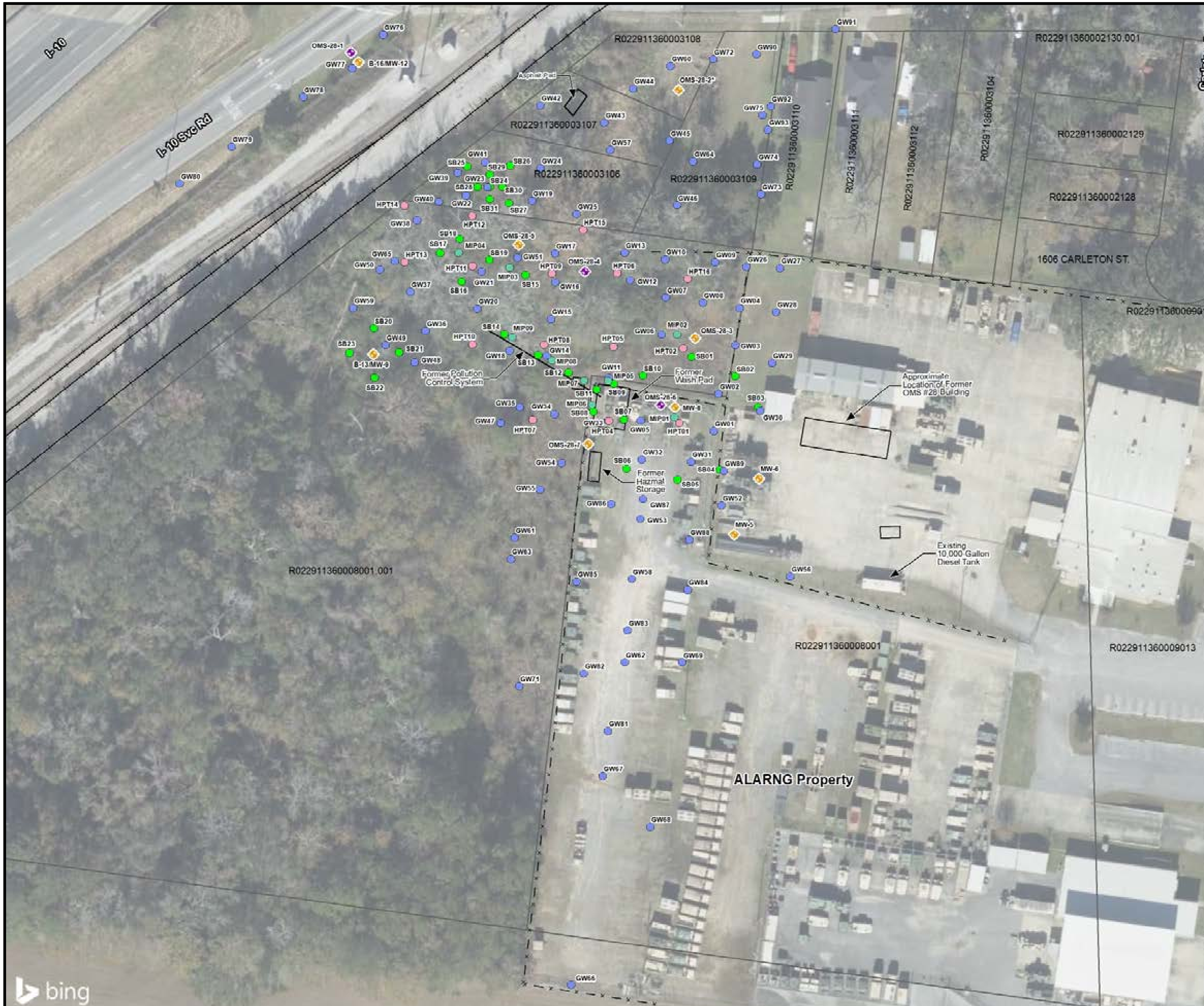
SCALE: 1" = 60'

AECOM

FIGURE C-6
DISTRIBUTION OF COCs IN SOIL

OMS #28
ALABAMA ARMY NATIONAL GUARD
MOBILE, ALABAMA

Source:
SAIC, 2013, *RI Report for the ALARNG OMS #28*



Site Location

Legend

- Upper/Middle Surficial Monitoring Well Location
- Lower Surficial Monitoring Well Location
- Discrete Groundwater Sample Location
- HPT Location
- MIP Location
- Soil Boring Location
- Fenceline
- Railroad
- Parcel Boundary

Note:

* Well OMS-28-2 was found to be destroyed during a site visit conducted in December 2021.

ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
HPT - Hydraulic Profiling Tool
MIP - Membrane Interface Probe

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0 40 80 160 Feet

1 inch = 80 feet

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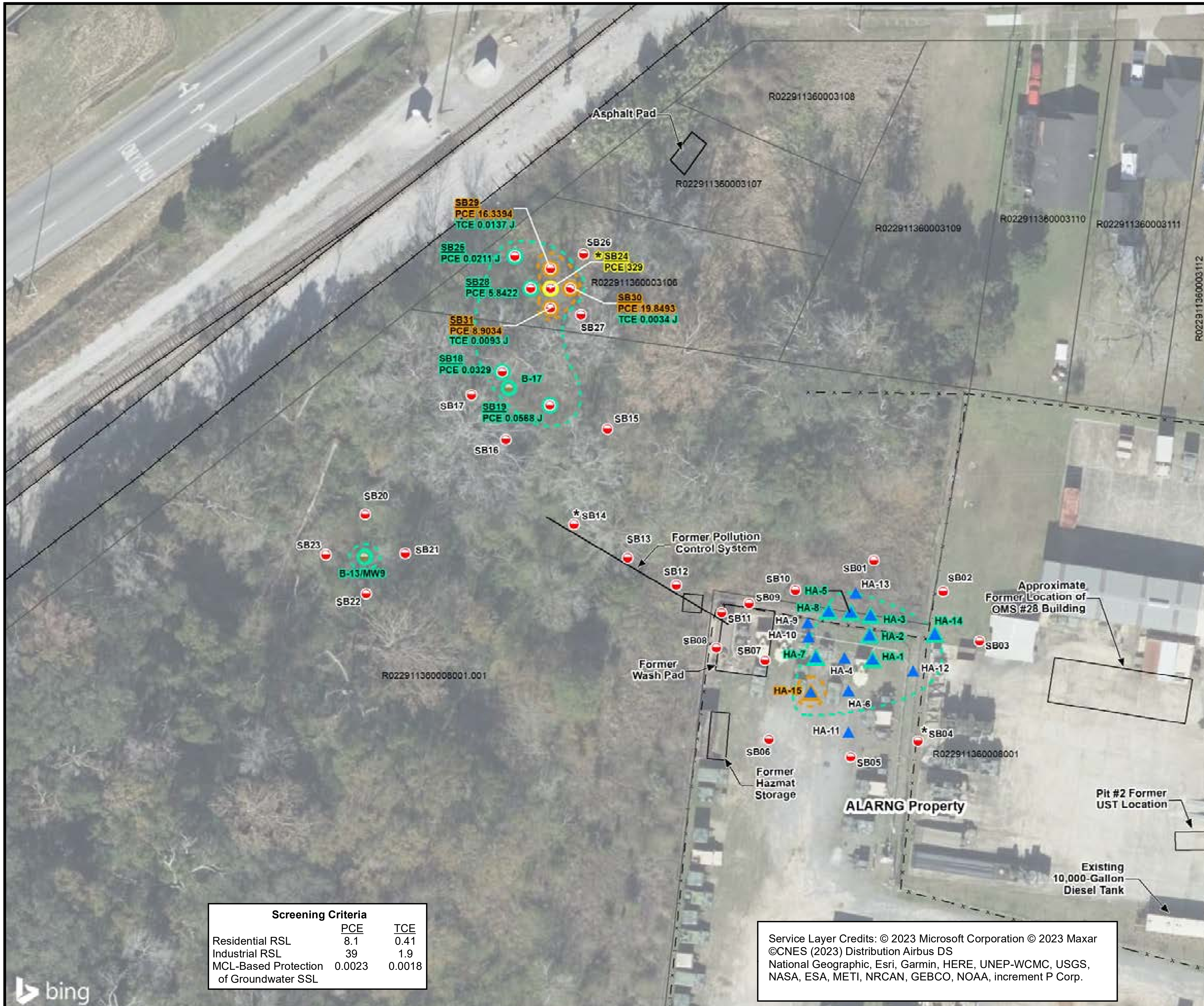
Supplemental Data Gap Investigation Sample Location Map

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/12/2023	Figure C-7

Document Path: L:\Legacy\Group\earth\OMS 28\60439687\900-CADD-GIS\Brookley_GIS\Maps\FS Letter Report\20220505\Figure C-7_Discrete GW Sample_MWs_SBs_MIP_HPT.mxd



Screening Criteria

	PCE	TCE
Residential RSL	8.1	0.41
Industrial RSL	39	1.9
MCL-Based Protection of Groundwater SSL	0.0023	0.0018

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Site Location

Legend

- Hand Auger Samples Collected in 2006/2007
- Soil Boring Samples Collected in 2006/2007
- Soil Sample Locations Collected in 2017
- TCE and/or PCE Exceeded MCL- Based Protection of Groundwater SSL
- TCE or PCE Exceeded Residential RSL
- PCE Exceeded Industrial RSL
- Approximate soil area exceeding MCL - Based Protection of Groundwater SSL
- Approximate soil area exceeding Residential and/or Industrial RSL
- Railroad
- Fenceline
- Parcel Boundary

Notes:
1 - Soil Samples collected between May 8-16, 2017.
2 - Analytical results from mobile lab used unless split with fixed lab. Fixed lab samples denoted with "*".
3 - Soil concentrations in milligrams per kilogram.
4 - All samples collected from bottom of 0-1 ft bgs interval and analyzed by Method 8260.
5 - Residential and Industrial RSLs are based on risk of 1E-06 for carcinogens.
6 - No highlighting of symbol indicates TCE and PCE did not exceed any RSLs or SSL.
7 - If TCE/PCE not listed, they did not exceed any of the screening criteria.
8 - Analytical results for samples collected in 2006/2007 can be found in the TCE Comprehensive Investigation Report (Aerostar, April 2007).

ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
PCE - Tetrachloroethene
TCE - Trichloroethene
MCL - Maximum Contaminant Level
ft bgs - Feet below ground surface
RSL - Regional Screening Criteria (USEPA, May 2023)
SSL - Soil Screening Level (USEPA, May 2023)
J - The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

0 25 50 100 Feet
1 inch = 50 feet

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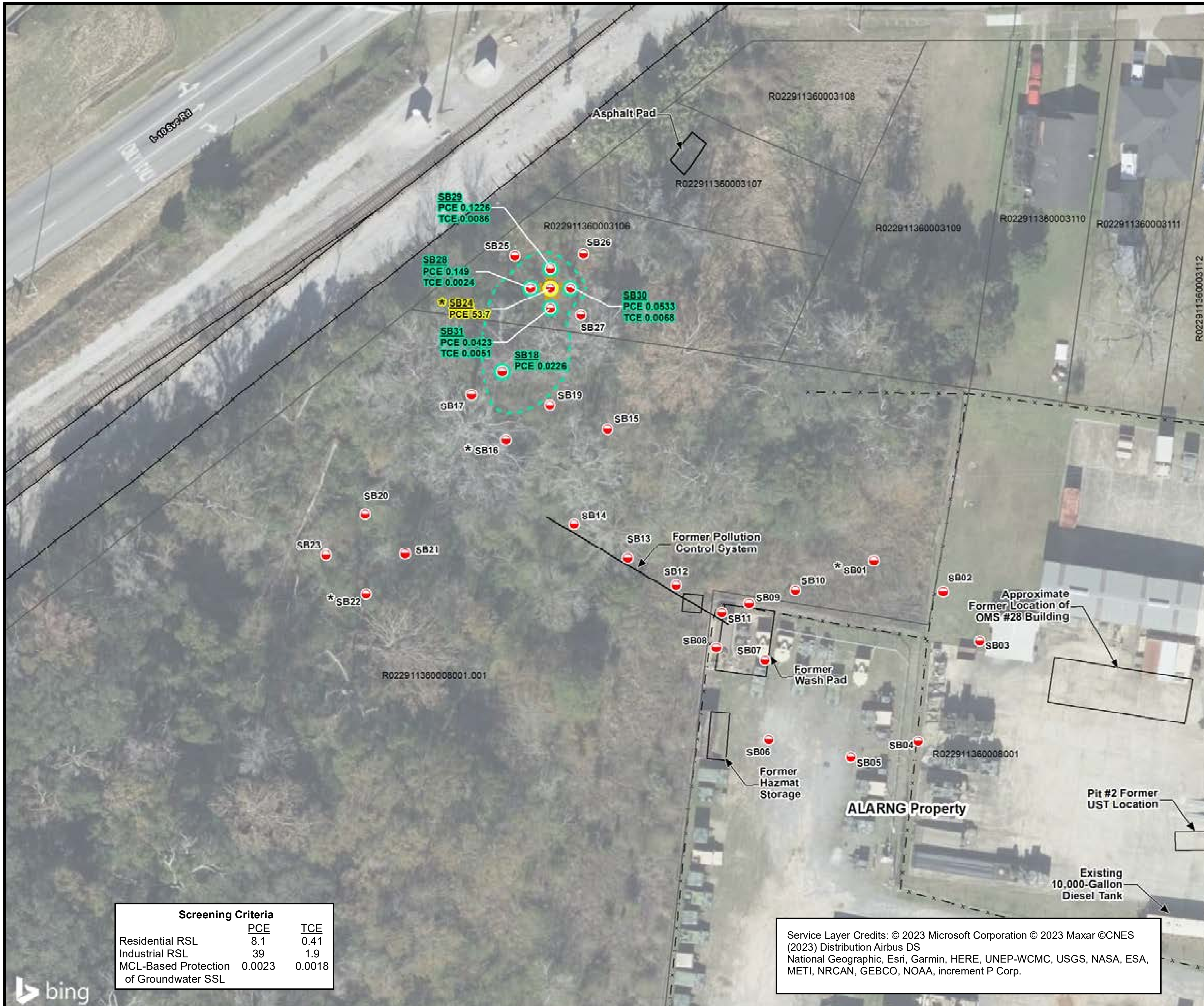
Surface Soil Sample Results - PCE and TCE (0 - 1 ft bgs)

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/19/2023	Figure C-8

Document Path: L:\Legacy\Group\earth\OMS 28\60439687\900-CADD-GIS\Brookley_GIS\Maps\FS Letter Report\20220505\Figure C-8_Brookley_Surface Soil Sample Results TCE and PCE - May 2017.mxd



Screening Criteria

	PCE	TCE
Residential RSL	8.1	0.41
Industrial RSL	39	1.9
MCL-Based Protection of Groundwater SSL	0.0023	0.0018

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Site Location

Legend

- Soil Sample Locations
- PCE Exceeded Residential RSL
- TCE and/or PCE Exceeded MCL-Based Protection of Groundwater SSL
- Railroad
- Parcel Boundary
- Fenceline
- Approximate soil area exceeding MCL - Based Protection of Groundwater SSL
- Approximate soil area exceeding Residential RSL

Notes:
1 - Soil Samples collected between May 8-16, 2017.
2 - Analytical results from mobile lab used unless split with fixed lab. Fixed lab samples denoted with "*".
3 - Soil concentrations in milligrams per kilogram.
4 - Only soil results from depths between 1.5 and 4 ft bgs are shown Interval selected based on PID or MIP result. If no response from either PID or MIP, the sample was collected from the midpoint between the surface sample and the top of water table sample.
5 - Residential and Industrial RSLs are based on risk of 1E-06 for carcinogens.
6 - No highlighting of symbol indicates TCE and PCE did not exceed any RSLs or SSL.
7 - If TCE/PCE not listed, they did not exceed any of the screening criteria.
8 - Samples from previous investigations are not within this depth interval.

ft bgs - Feet below ground surface
ALARNG - Alabama Army National Guard
MIP - Membrane Interface probe
OMS - Organizational Maintenance Shop
PCE - Tetrachloroethene
TCE - Trichloroethene
PID - Photo Ionization Detector
MCL - Maximum Continant Level
RSL - Regional Screening Criteria (USEPA, May 2023)
SSL - Soil Screening Level (USEPA, May 2023)

0 25 50 100 Feet

1 inch = 50 feet

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Upper Subsurface Soil Sample Results for PCE and TCE (1.5 - 4 ft bgs)

Alabama Army National Guard OMS #28
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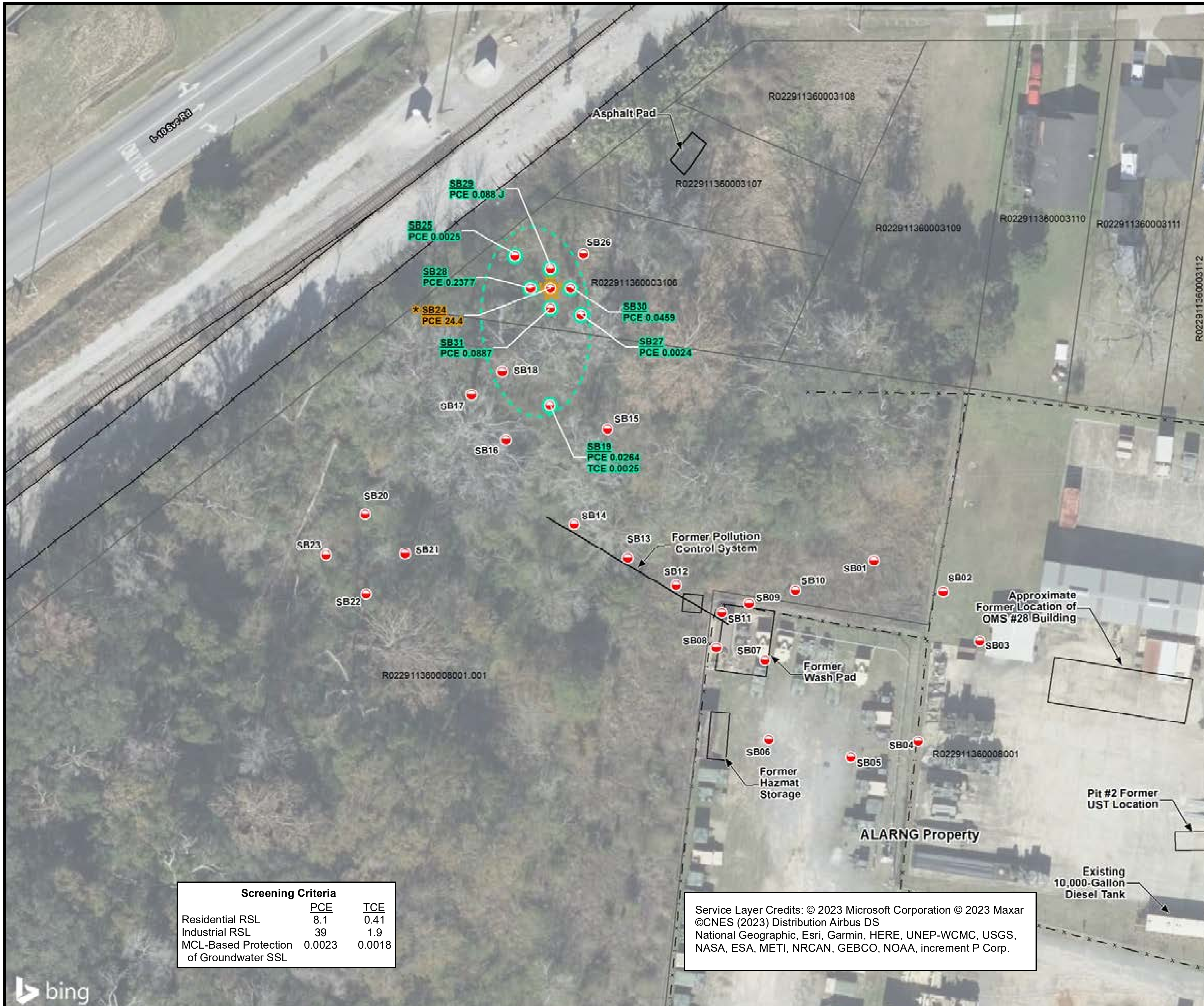
PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/19/2023	Figure C-9

Document Path: L:\Legacy\Group\earth\OMS 28\60439687\900-CADD-GIS\Brookley_GIS\Maps\FS Letter Report\20220505\Figure C-9_Brookley_Upper Subsurface Soil Sample Results for TCE and PCE.mxd



Screening Criteria

	PCE	TCE
Residential RSL	8.1	0.41
Industrial RSL	39	1.9
MCL-Based Protection of Groundwater SSL	0.0023	0.0018

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Site Location

Legend

- Soil Sample Locations
- PCE Exceeded Residential RSL
- TCE and/or PCE Exceed MCL - Based Protection of Groundwater SSL
- Railroad
- Parcel Boundary
- Fenceline
- Approximate soil area exceeding MCL - Based Protection ofGroundwater SSL
- Approximate soil area exceeding Residential RSL

Notes:
1 - Soil Samples collected between May 8-16, 2017.
2 - Analytical results from mobile lab used unless split with fixed lab. Fixed lab samples denoted with "*".
3 - Soil concentrations in milligrams per kilogram.
4 - Only soil results from 1-ft above water table depth varying between 2 and 6 ft bgs are shown.
5 - Residential and Industrial RSLs are based on risk of 1E-06 for carcinogens.
6 - No highlighting of symbol indicates TCE and PCE did not exceed the residential or industrial RSLs or SSL.
7 - If TCE/PCE not listed, they did not exceed any of the screening criteria.
8 - Samples from previous investigations collected at depths were below the current (May 2017) water table.

J - The result of an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
ft bgs - Feet Below Ground Surface
ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
PCE - Tetrachloroethene
TCE - Trichloroethene
MCL - Maximum Contaminant Level
RSL - Regional Screening Criteria (USEPA, May 2023)
SSL - Soil Screening Level (USEPA, May 2023)

0 25 50 100 Feet

1 inch = 50 feet

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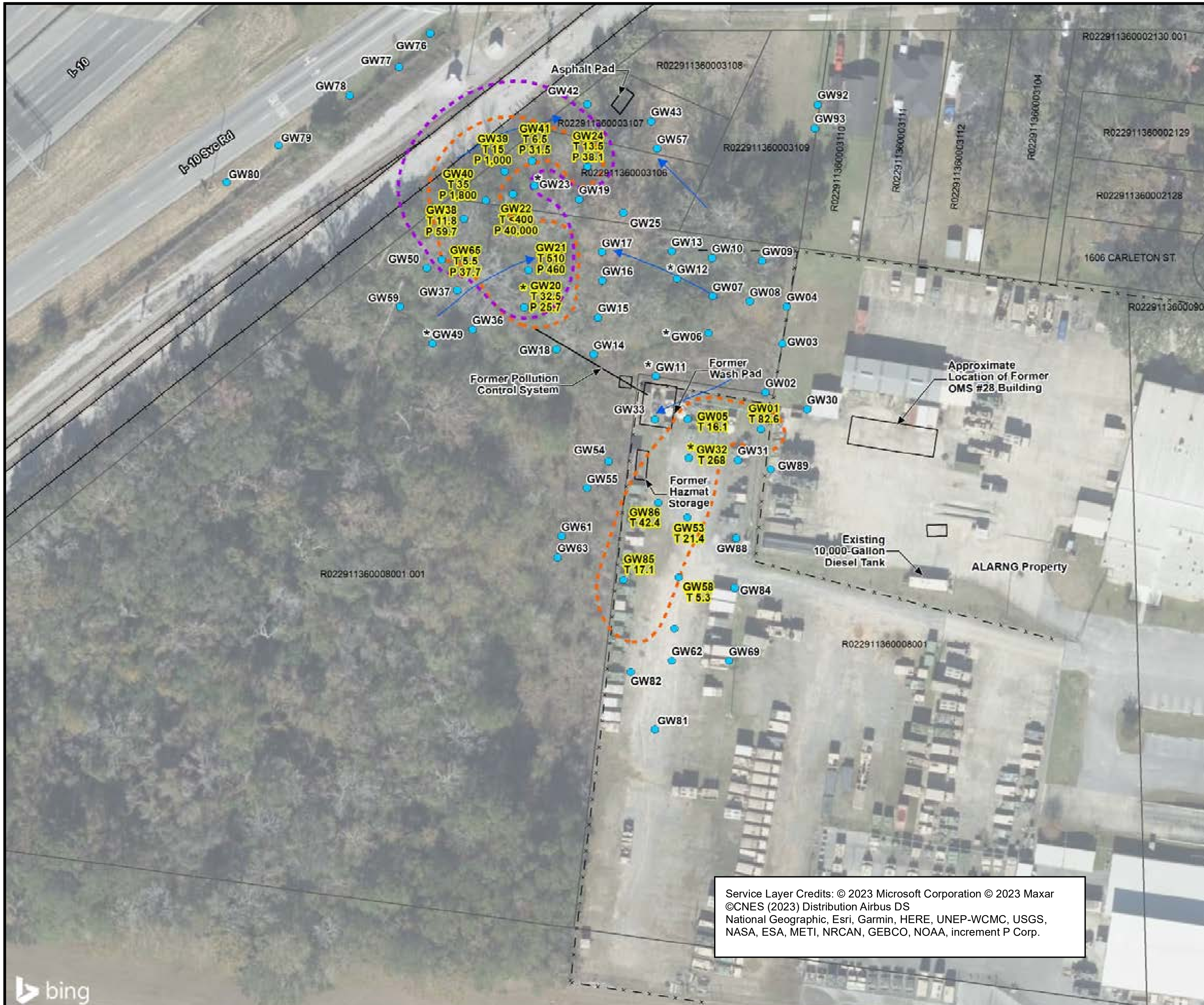
Lower Subsurface Soil Sample Results for PCE and TCE (1 Ft Above Water Table)

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/19/2023	Figure C-10



Site Location

Legend

- Discrete Groundwater Sample Locations
- Apparent Groundwater Flow Direction - May 2017
- Fenceline
- Railroad
- Approximate extent of TCE Exceedance Above the MCL (5 µg/L)
- Approximate extent of PCE Exceedance Above the MCL (5 µg/L)
- Parcel Boundary
- Indicates PCE and/or TCE were detected above its respective MCL.

Notes:
1. Discrete groundwater investigation conducted in May 2017 (GW-01 through GW-72) and January/February 2018 (GW-73 through GW-93).
2. The laboratory analytical results from the mobile lab are used for the May 2017 results unless a split sample with the fixed lab is available. The fixed lab results are used for the January/February 2018 samples.
3. Only groundwater results from discrete depths between 6 and 13 ft bgs are shown.
4. No highlighting of symbol indicates TCE and PCE did not exceed their respective MCLs.
5. If the TCE or PCE value is not listed, it did not exceed its MCL.

ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
ft bgs = Feet below ground surface
MCL = Maximum Contamination Limit
T - Trichloroethene (TCE)
P - Tetrachloroethene (PCE)
* - Indicates a split sample was collected and analyzed by the fixed lab.

0 40 80 160 Feet

1 inch = 80 feet

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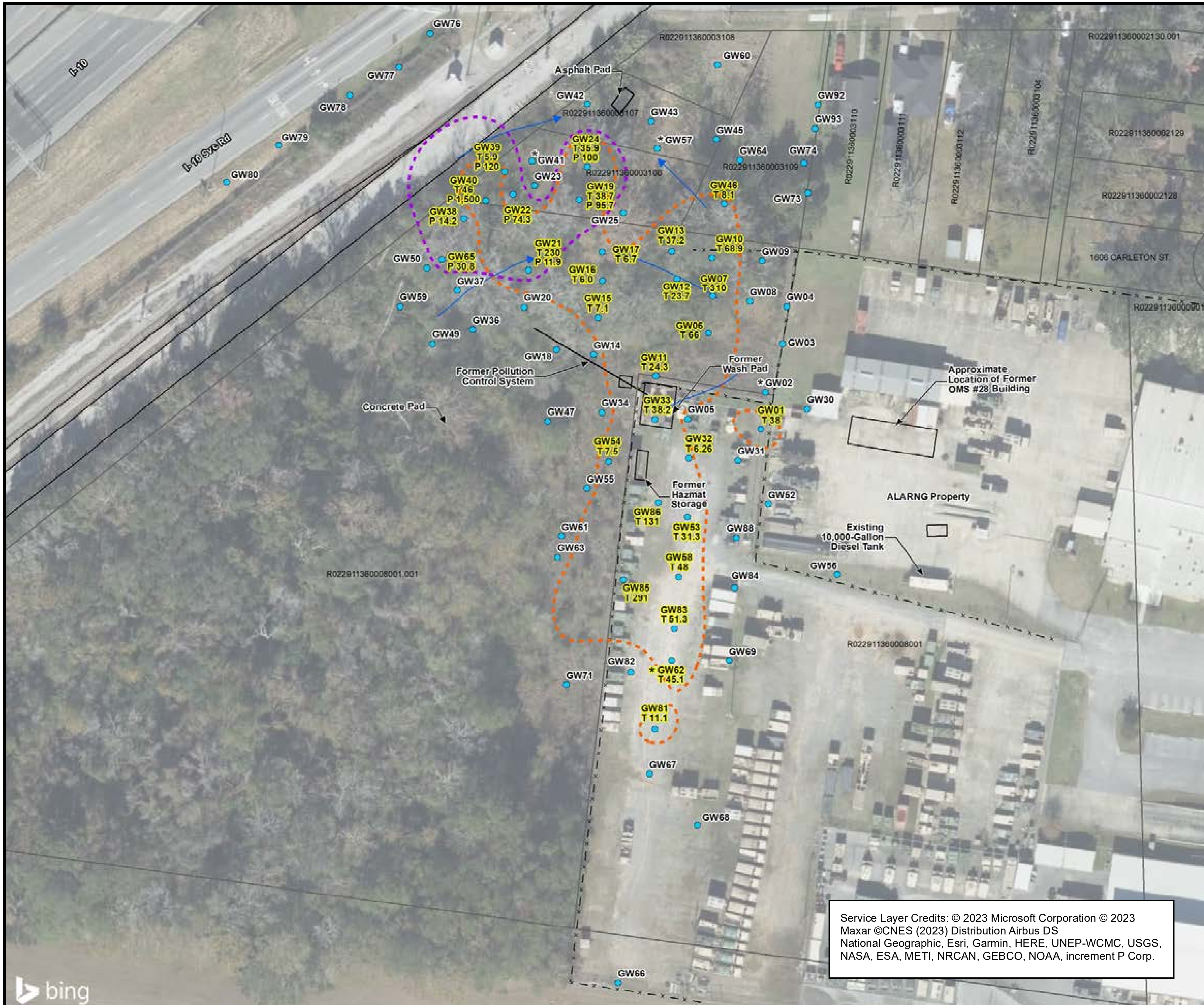
Discrete Groundwater Sampling Results for PCE & TCE - Upper Surficial (6 - 13 ft bgs)

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/19/2023	Figure C-11

Document Path: L:\Legacy\Group\earth\OMS 28\60439687\900-CADD-GIS\Brookley_GIS\Maps\FS Letter Report\20220505\Figure C-11_Brookley_Discrete Groundwater Sampling Results 6-13ft RJS.mxd



Site Location

Legend

- Discrete Groundwater Sample Locations
- Apparent Groundwater Flow Direction - May 2017
- Fenceline
- Railroad
- Approximate extent of TCE Exceedance Above the MCL (5 μg/L)
- Approximate extent of PCE Exceedance Above the MCL (5 μg/L)
- Parcel Boundary
- Indicates TCE and/or PCE were detected above their respective MCL.

Notes:
1. Discrete groundwater investigation conducted in May 2017 (GW-01 through GW-72) and January/February 2018 (GW-73 through GW-93).
2. The laboratory analytical results from the mobile lab are used for the May 2017 results unless a split sample with the fixed lab is available. The fixed lab results are used for the January/February 2018 samples.
3. Only groundwater results from discrete depths between 12 and 26 ft bgs are shown.
4. No highlighting of symbol indicates TCE and PCE did not exceed their respective MCLs.
5. If the TCE or PCE value is not listed, it did not exceed its MCL.

ft bgs= Feet below ground surface
ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
MCL = Maximum Contamination Limit
T - Trichloroethene (TCE)
P - Tetrachloroethene (PCE)
*- Indicates a split sample was collected and analyzed by the fixed lab.

0 40 80 160 Feet

1 inch = 80 feet

N W E S

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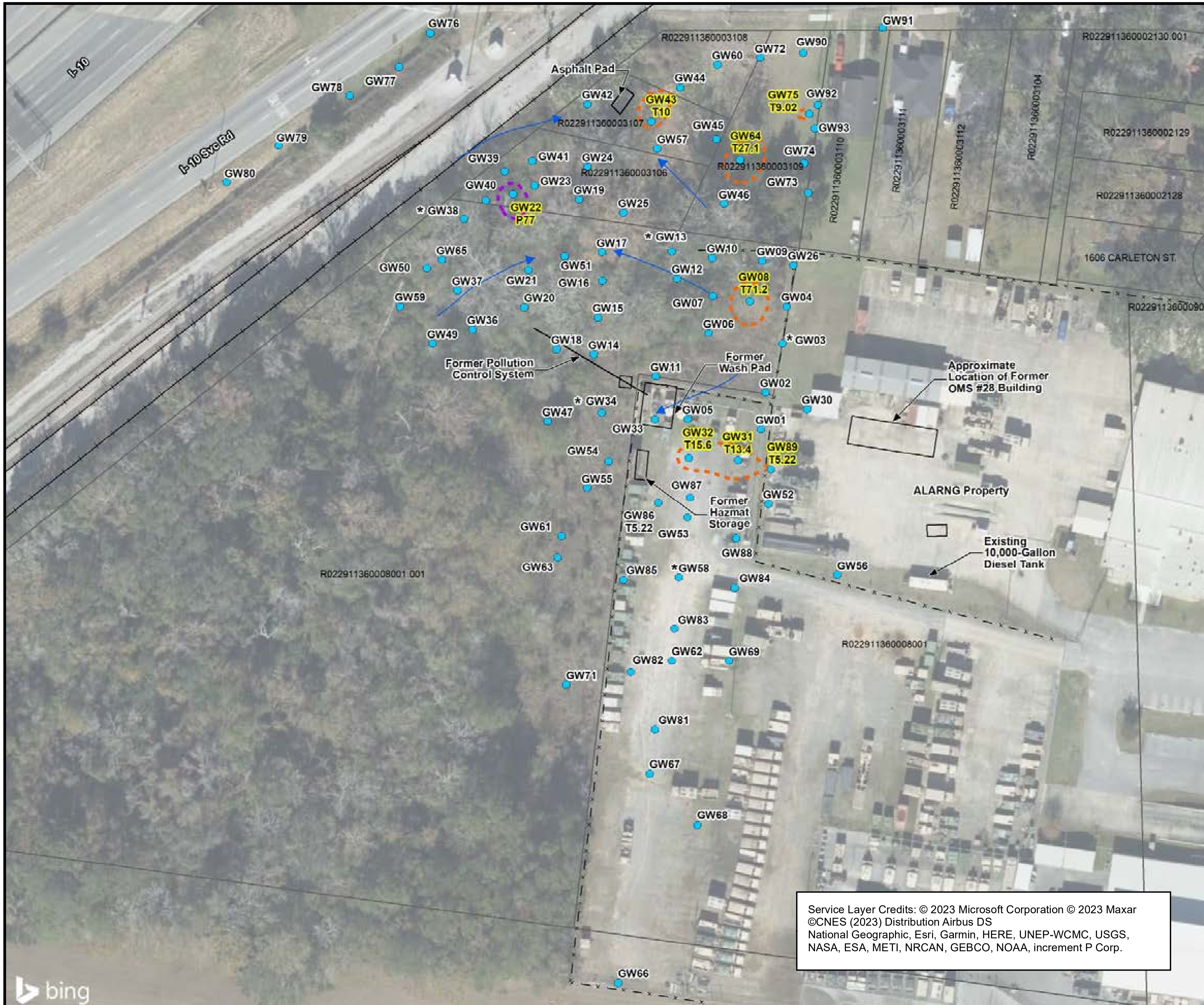
Discrete Groundwater Sampling Results for PCE & TCE - Middle Surficial (12 - 26 ft bgs)

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/19/2023	Figure C-12



Site Location

Legend

- Discrete Groundwater Sample Locations
- Apparent Groundwater Flow Direction - May 2017
- Fenceline
- Railroad
- Approximate extent of PCE Exceedance Above the MCL (5 µg/L)
- Approximate extent of TCE Exceedance Above the MCL (5 µg/L)
- Parcel Boundary
- Indicates TCE and/or PCE were detected above their respective MCL.

Notes:

1. Discrete groundwater investigation conducted in May 2017 (GW-01 through GW-72) and January/February 2018 (GW-73 through GW-93).
2. The laboratory analytical results from the mobile lab are used for the May 2017 results unless a split sample with the fixed lab is available. The fixed lab results are used for the January/February 2018 samples.
3. Only groundwater results from discrete depths deeper than 26 bgs are shown.
4. No highlighting of symbol indicates TCE and PCE did not exceed their respective MCLs.
5. If the TCE or PCE value is not listed, it did not exceed its MCL.

ft bgs = Feet below ground surface
ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
MCL = Maximum Contamination Limit
T - Trichloroethene (TCE)
P - Tetrachloroethene (PCE)
* - Indicates a split sample was collected and analyzed by the fixed lab.

0 40 80 160 Feet

1 inch = 80 feet

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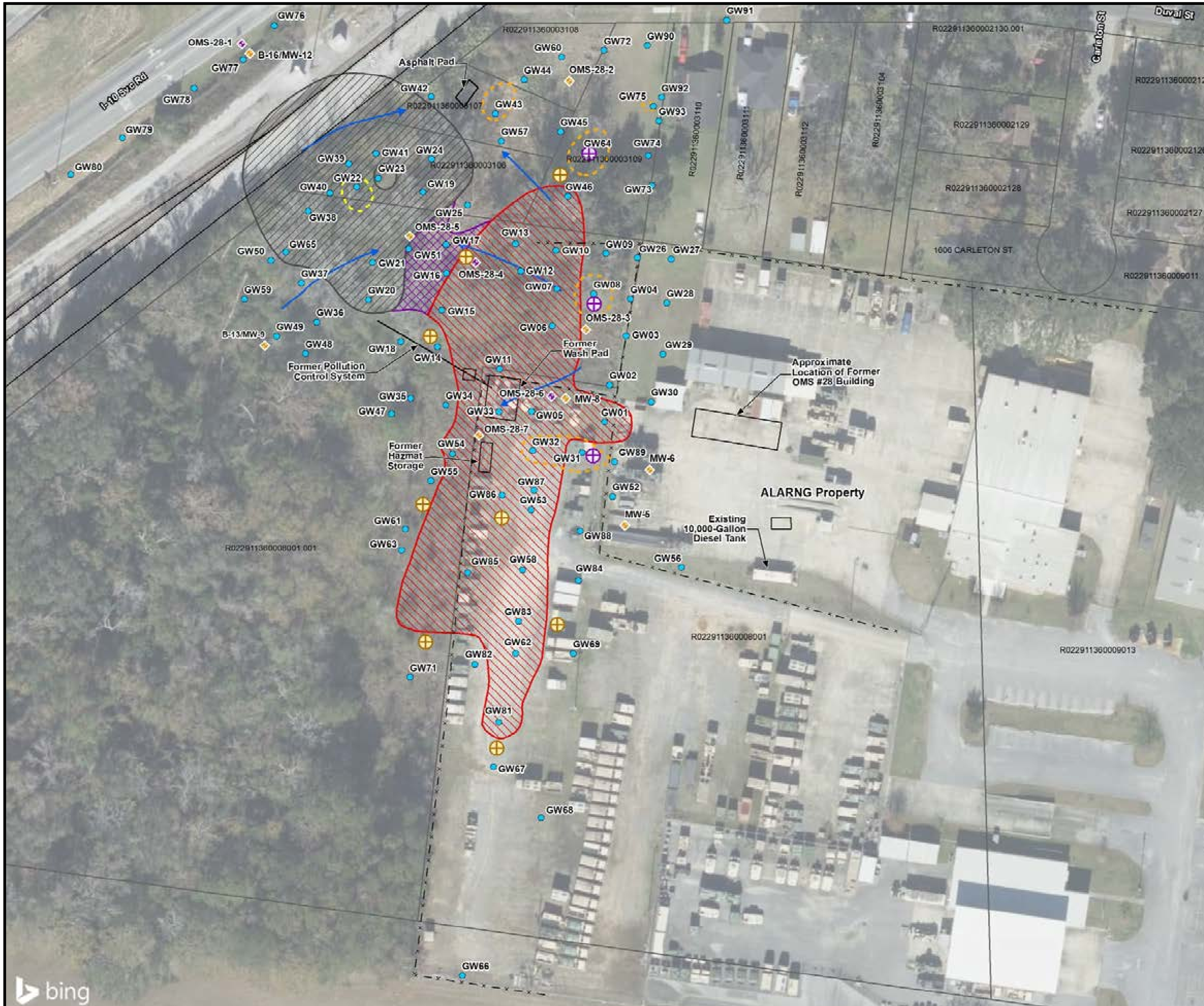
Discrete Groundwater Sampling Results for PCE & TCE - Lower Surficial (Deeper Than 26 ft bgs)

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
60666895	RJS	10/19/2023	Figure C-13



Site Location

Legend

- Proposed Upper/Middle Surficial Aquifer Monitoring Well Location
- Proposed Lower Surficial Aquifer Monitoring Well Location
- Upper/Middle Surficial Monitoring Well Location
- Lower Surficial Monitoring Well Location
- Discrete Groundwater Sample Locations
- Approximate Extent of PCE Exceedance of the MCL (5 µg/L) in the Lower Surficial Aquifer
- Approximate Extent of TCE Exceedance of the MCL (5 µg/L) in the Lower Surficial Aquifer
- Fenceline
- Railroad
- PCE Plume Related to Offsite PCE Spill on Parcel A
- TCE Plume related to TCE Spill on Parcel E
- Area of Co-Mingled PCE from Parcel A and TCE from Parcel E
- Parcel Boundary

ALARNG - Alabama Army National Guard
OMS - Organizational Maintenance Shop
PCE - Tetrachloroethene
TCE - Trichloroethene
MCL - Maximum Contaminant Level
µg/L - micrograms per liter

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0 40 80 160 Feet

1 inch = 80 feet

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Approximate Extent of PCE and TCE Groundwater Plumes

Alabama Army National Guard OMS #28
Mobile, Alabama

PROJECT NO.	DRAWN BY:	DATE:	
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Document Path: L:\Legacy\Group\earth\OMS 28\60439687\900-CADD-GIS\Brookley_GIS\Maps\FS Letter Report\20220505\Figure C-14_Brookley_Approx_Extent_PCE_TCE_Plumes in GW.mxd

ATTACHMENT 1

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Fax: 865.573.8133
Web: www.microbe.com

SITE LOGIC Report

QuantArray®-Chlor Study

Contact: Tim Renn

Phone: 864-234-3053

Address: AECOM
10 Patewood Drive
Bldg VI, STE 500
Greenville, SC 29615

Email: timothy.renn@aecom.com

MI Identifier: **031TA**

Report Date: 01/25/2022

Project: OMS 28, 60666895.2
Comments:

The QuantArray®-Chlor Approach

Quantification of *Dehalococcoides*, the only known bacterial group capable of complete reductive dechlorination of PCE and TCE to ethene, has become an indispensable component of assessment, remedy selection, and performance monitoring at sites impacted by chlorinated solvents. While undeniably a key group of halorespiring bacteria, *Dehalococcoides* are not the only bacteria of interest in the subsurface because reductive dechlorination is not the only potential biodegradation pathway operative at contaminated sites, and chlorinated ethenes are not always the primary contaminants of concern. The QuantArray®-Chlor not only includes a variety of halorespiring bacteria (*Dehalococcoides*, *Dehalobacter*, *Dehalogenimonas*, etc.) to assess the potential for reductive dechlorination of chloroethenes, chloroethanes, chlorobenzenes, chlorophenols, and chloroform, but also provides quantification of functional genes involved in aerobic (co)metabolic pathways for biodegradation of chlorinated solvents and even competing biological processes. Thus, the QuantArray®-Chlor will give site managers the ability to simultaneously yet economically evaluate the potential for biodegradation of a spectrum of common chlorinated contaminants through a multitude of anaerobic and aerobic (co) metabolic pathways to give a much more clear and comprehensive view of contaminant biodegradation.

The QuantArray®-Chlor is used to quantify specific microorganisms and functional genes to evaluate the following:

Anaerobic Reductive Dechlorination	Quantification of important halorespiring bacteria (e.g. *Dehalococcoides*, *Dehalobacter*, *Dehalogenimonas*, *Desulfitobacterium* spp.) and key functional genes (e.g. vinyl chloride reductases, TCE reductase, chloroform reductase) responsible for reductive dechlorination of a broad spectrum of chlorinated solvents.
Aerobic Cometabolism	Several different types of bacteria including methanotrophs and some toluene/phenol utilizing bacteria can co-oxidize TCE, DCE, and vinyl chloride. The QuantArray®-Chlor quantifies functional genes like soluble methane monooxygenase encoding enzymes capable of co-oxidation of chlorinated ethenes.
Aerobic (Co)metabolism of Vinyl Chloride	Ethene oxidizing bacteria are capable of cometabolism of vinyl chloride. In some cases, ethenotrophs can also utilize vinyl chloride as a growth supporting substrate. The QuantArray®-Chlor targets key functional genes in ethene metabolism.

How do QuantArrays® work?

The QuantArray®-Chlor in many respects is a hybrid technology combining the highly parallel detection of microarrays with the accurate and precise quantification provided by qPCR into a single platform. The key to highly parallel qPCR reactions is the nanoliter fluidics platform for low volume, solution phase qPCR reactions.

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How are QuantArray® results reported?

One of the primary advantages of the QuantArray®-Chlor is the simultaneous quantification of a broad spectrum of different microorganisms and key functional genes involved in a variety of pathways for chlorinated hydrocarbon biodegradation. However, highly parallel quantification combined with the various metabolic and cometabolic capabilities of different target organisms can complicate data presentation. Therefore, in addition to Summary Tables, QuantArray® results will be presented as Microbial Population Summary and Comparison Figures to aid in data interpretation and subsequent evaluation of site management activities.

Types of Tables and Figures:

Microbial Population Summary	Figure presenting the concentrations of QuantArray®-Chlor target populations (e.g. *Dehalococcoides*) and functional genes (e.g. vinyl chloride reductase) relative to typically observed values.
Summary Tables	Tables of target population concentrations grouped by biodegradation pathway and contaminant type.
Comparison Figures	Depending on the project, sample results can be presented to compare changes over time or examine differences in microbial populations along a transect of the dissolved plume.

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Results

Table 1: Summary of the QuantArray®-Chlor results obtained for samples OMS-28-5, OMS-28-3, and MW-8.

Sample Name Sample Date	OMS-28-5 01/13/2022	OMS-28-3 01/13/2022	MW-8 01/13/2022
Reductive Dechlorination	cells/bead	cells/bead	cells/bead
Dehalococcoides (DHC)	**2.92E+01**	<2.50E+01	<2.50E+01
tceA Reductase (TCE)	<2.50E+01	<2.50E+01	<2.50E+01
BAV1 Vinyl Chloride Reductase (BVC)	<2.50E+01	<2.50E+01	<2.50E+01
Vinyl Chloride Reductase (VCR)	<2.50E+01	<2.50E+01	<2.50E+01
Dehalobacter spp. (DHBt)	**7.27E+04**	<2.50E+02	<2.50E+02
Dehalobacter DCM (DCM)	<2.50E+02	<2.50E+02	<2.50E+02
Dehalogenimonas spp. (DHG)	<2.50E+02	<2.50E+02	**9.37E+03**
cerA Reductase (CER)	<2.50E+02	<2.50E+02	<2.50E+02
trans-1,2-DCE Reductase (TDR)	<2.50E+02	<2.50E+02	<2.50E+02
Desulfitobacterium spp. (DSB)	**8.99E+04**	<2.50E+02	<2.50E+02
Dehalobium chlorocoercia (DECO)	<2.50E+02	<2.50E+02	<2.50E+02
Desulfuromonas spp. (DSM)	<2.50E+02	**2.20E+03**	<2.50E+02
PCE Reductase (PCE-1)	<2.50E+02	<2.50E+02	<2.50E+02
PCE Reductase (PCE-2)	<2.50E+02	<2.50E+02	<2.50E+02
Chloroform Reductase (CFR)	<2.50E+02	<2.50E+02	<2.50E+02
1,1 DCA Reductase (DCA)	<2.50E+02	<2.50E+02	<2.50E+02
1,2 DCA Reductase (DCAR)	<2.50E+02	<2.50E+02	<2.50E+02
Aerobic (Co)Metabolic			
Soluble Methane Monooxygenase (SMMO)	<2.50E+02	**2.84E+03**	<2.50E+02
Toluene Dioxygenase (TOD)	<2.50E+02	**3.48E+02**	**2.88E+02**
Phenol Hydroxylase (PHE)	**7.21E+03**	**7.47E+01 (J)**	**3.30E+04**
Trichlorobenzene Dioxygenase (TCBO)	<2.50E+02	<2.50E+02	<2.50E+02
Toluene Monooxygenase 2 (RDEG)	<2.50E+02	<2.50E+02	**4.27E+04**
Toluene Monooxygenase (RMO)	**7.01E+02**	**7.52E+01 (J)**	<2.50E+02
Ethene Monooxygenase (EtnC)	<2.50E+02	<2.50E+02	<2.50E+02
Epoxyalkane Transferase (EtnE)	<2.50E+02	<2.50E+02	**3.04E+03**
Dichloromethane Dehalogenase (DCMA)	<2.50E+02	<2.50E+02	<2.50E+02
Other			
Total Eubacteria (EBAC)	**5.67E+06**	**1.10E+07**	**7.99E+06**
Sulfate Reducing Bacteria (APS)	**9.12E+04**	**3.13E+03**	**2.60E+02**
Methanogens (MGN)	**4.21E+01 (J)**	**1.70E+01 (J)**	**9.70E+00 (J)**

Legend:

NA = Not Analyzed
NS = Not Sampled
J = Estimated Gene Copies Below PQL but Above LQL
I = Inhibited
< = Result Not Detected

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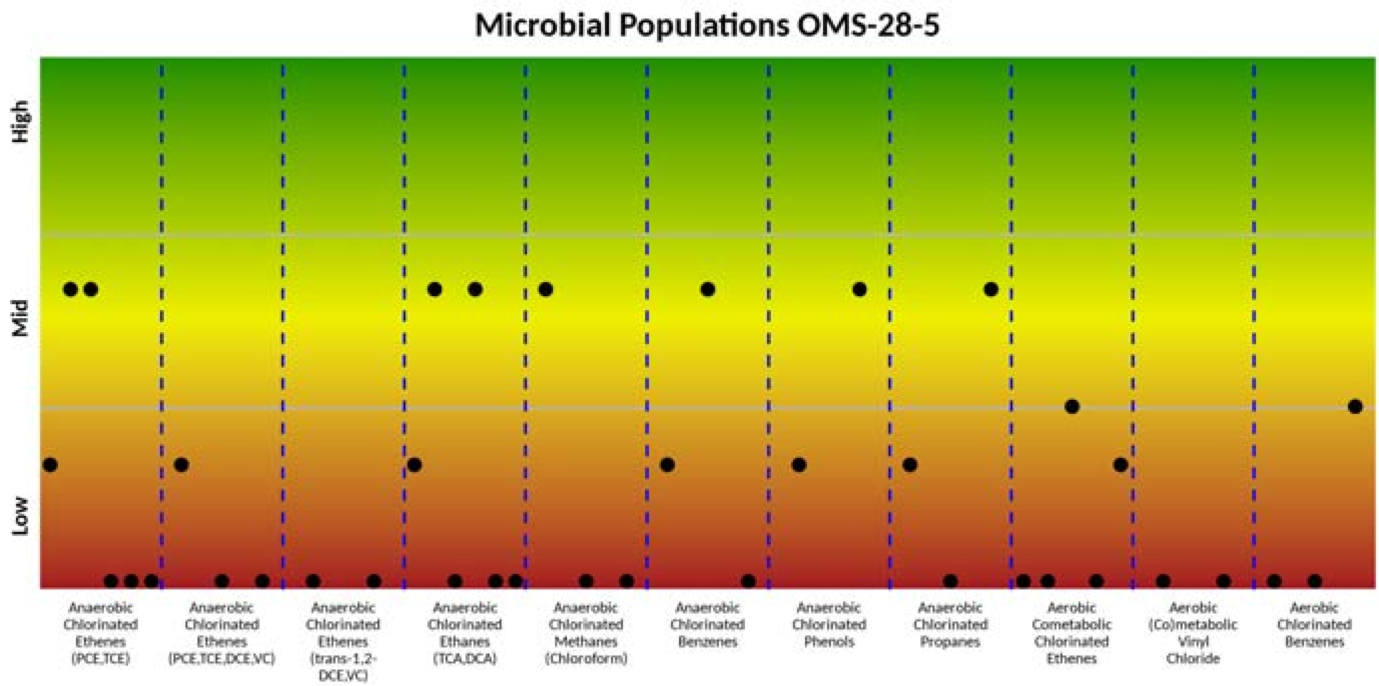

Figure 1: Microbial population summary to aid in evaluating potential pathways and biodegradation of specific contaminants.

Anaerobic - Reductive Dechlorination or Dichloroelimination		Aerobic - (Co)metabolism	
Chlorinated Ethenes (PCE, TCE)	DHC, DHBt, DSB, DSM, PCE-1, PCE-2	Chlorinated Ethenes (TCE,DCE,VC)	sMMO, TOD, PHE, RDEG, RMO
Chlorinated Ethenes (PCE, TCE, DCE, VC)	DHC, BVC, VCR	(Co)metabolic Vinyl Chloride	etnC, etnE
Chlorinated Ethenes (trans-1,2-DCE, VC)	TDR, CER	Chlorinated Benzenes	TOD, TCBO, PHE
Chlorinated Ethanes (TCA and 1,2-DCA)	DHC, DHBt, DHG, DSB[1], DCA, DCAR		
Chlorinated Methanes (Chloroform)	DHBt, DCM, CFR		
Chlorinated Benzenes	DHC, DHBt[2], DECO		
Chlorinated Phenols	DHC, DSB		
Chlorinated Propanes	DHC, DHG, DSB[1]		

[1]*Desulfitobacterium dichloroeliminans* DCA1. [2]Implicated in reductive dechlorination of dichlorobenzene and potentially chlorobenzene.

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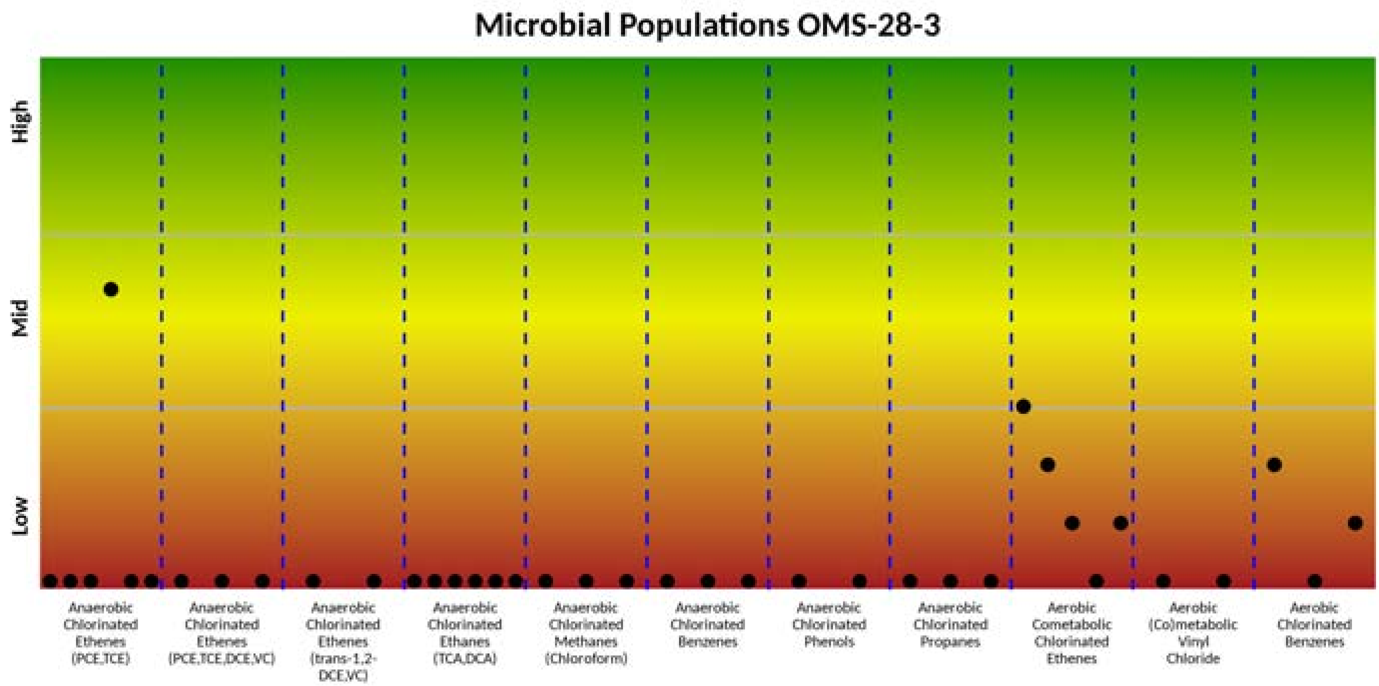

Figure 2: Microbial population summary to aid in evaluating potential pathways and biodegradation of specific contaminants.

Anaerobic - Reductive Dechlorination or Dichloroelimination		Aerobic - (Co)metabolism	
Chlorinated Ethenes (PCE, TCE)	DHC, DHBt, DSB, DSM, PCE-1, PCE-2	Chlorinated Ethenes (TCE,DCE,VC)	sMMO, TOD, PHE, RDEG, RMO
Chlorinated Ethenes (PCE, TCE, DCE, VC)	DHC, BVC, VCR	(Co)metabolic Vinyl Chloride	etnC, etnE
Chlorinated Ethenes (trans-1,2-DCE, VC)	TDR, CER	Chlorinated Benzenes	TOD, TCBO, PHE
Chlorinated Ethanes (TCA and 1,2-DCA)	DHC, DHBt, DHG, DSB[1], DCA, DCAR		
Chlorinated Methanes (Chloroform)	DHBt, DCM, CFR		
Chlorinated Benzenes	DHC, DHBt[2], DECO		
Chlorinated Phenols	DHC, DSB		
Chlorinated Propanes	DHC, DHG, DSB[1]		

[1]*Desulfitobacterium dichloroeliminans* DCA1. [2]Implicated in reductive dechlorination of dichlorobenzene and potentially chlorobenzene.

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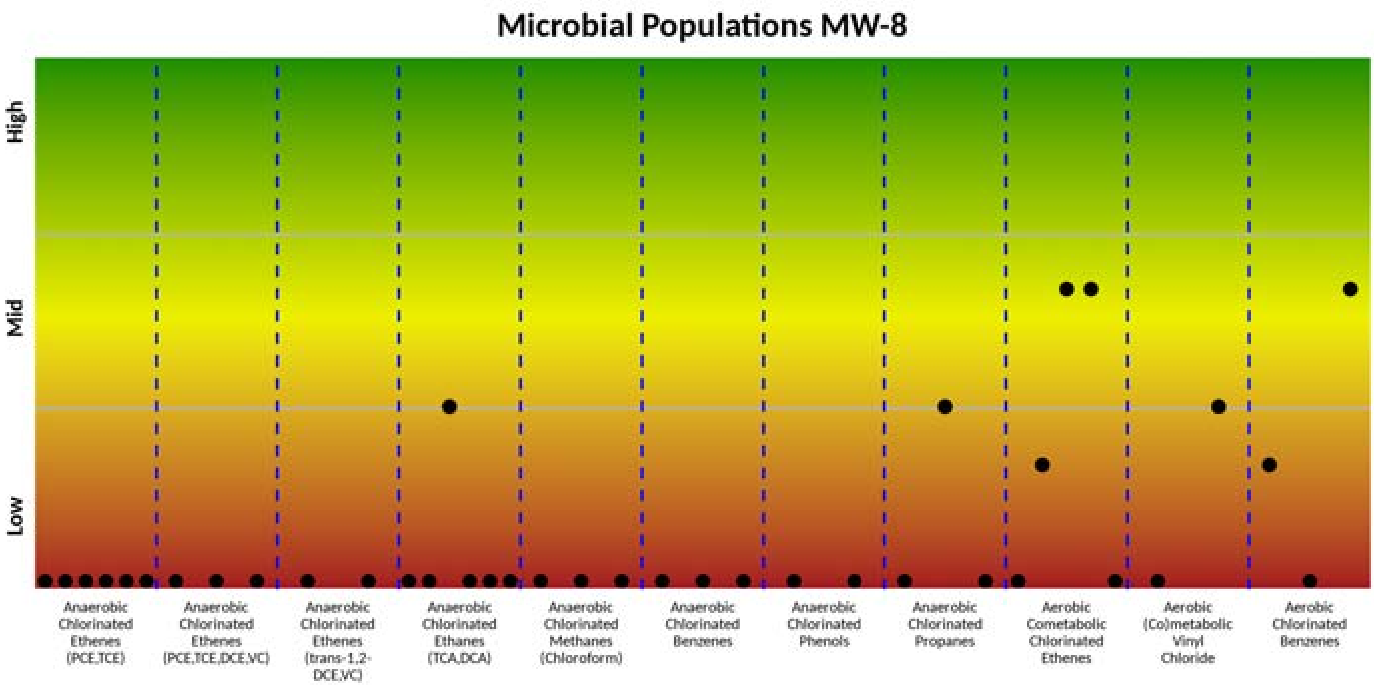

Figure 3: Microbial population summary to aid in evaluating potential pathways and biodegradation of specific contaminants.

Anaerobic - Reductive Dechlorination or Dichloroelimination		Aerobic - (Co)metabolism	
Chlorinated Ethenes (PCE, TCE)	DHC, DHBt, DSB, DSM, PCE-1, PCE-2	Chlorinated Ethenes (TCE,DCE,VC)	sMMO, TOD, PHE, RDEG, RMO
Chlorinated Ethenes (PCE, TCE, DCE, VC)	DHC, BVC, VCR	(Co)metabolic Vinyl Chloride	etnC, etnE
Chlorinated Ethenes (trans-1,2-DCE, VC)	TDR, CER	Chlorinated Benzenes	TOD, TCBO, PHE
Chlorinated Ethanes (TCA and 1,2-DCA)	DHC, DHBt, DHG, DSB[1], DCA, DCAR		
Chlorinated Methanes (Chloroform)	DHBt, DCM, CFR		
Chlorinated Benzenes	DHC, DHBt[2], DECO		
Chlorinated Phenols	DHC, DSB		
Chlorinated Propanes	DHC, DHG, DSB[1]		

[1] *Desulfitobacterium dichloroeliminans* DCA1. [2] Implicated in reductive dechlorination of dichlorobenzene and potentially chlorobenzene.

Table 2: Summary of the QuantArray®-Chlor results for microorganisms responsible for reductive dechlorination for samples OMS-28-5, OMS-28-3, and MW-8.

Sample Name Sample Date	OMS-28-5 01/13/2022	OMS-28-3 01/13/2022	MW-8 01/13/2022
Reductive Dechlorination	cells/bead	cells/bead	cells/bead
Dehalococcoides (DHC)	**2.92E+01**	<2.50E+01	<2.50E+01
tceA Reductase (TCE)	<2.50E+01	<2.50E+01	<2.50E+01
BAV1 Vinyl Chloride Reductase (BVC)	<2.50E+01	<2.50E+01	<2.50E+01
Vinyl Chloride Reductase (VCR)	<2.50E+01	<2.50E+01	<2.50E+01
Dehalobacter spp. (DHBt)	**7.27E+04**	<2.50E+02	<2.50E+02
Dehalobacter DCM (DCM)	<2.50E+02	<2.50E+02	<2.50E+02
Dehalogenimonas spp. (DHG)	<2.50E+02	<2.50E+02	**9.37E+03**
Desulfitobacterium spp. (DSB)	**8.99E+04**	<2.50E+02	<2.50E+02
Dehalobium chlorocoercia (DECO)	<2.50E+02	<2.50E+02	<2.50E+02
Desulfuromonas spp. (DSM)	<2.50E+02	**2.20E+03**	<2.50E+02

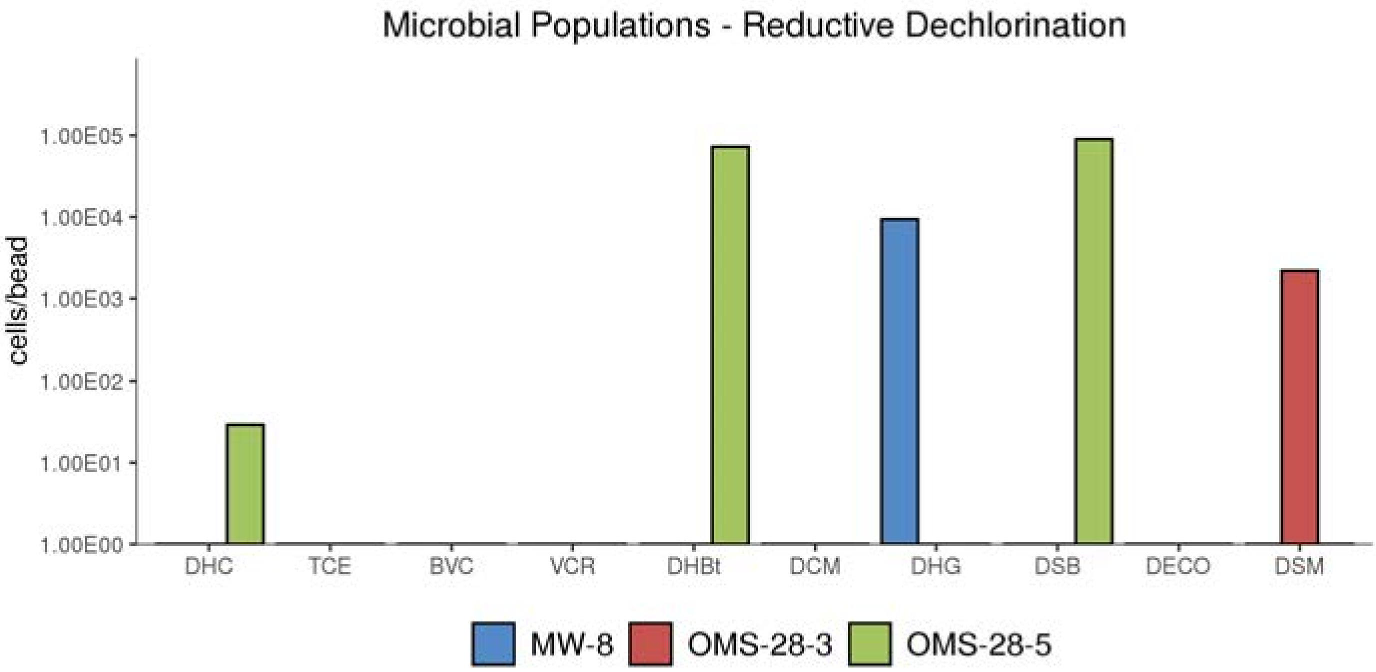

Figure 4: Comparison - microbial populations involved in reductive dechlorination.

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Table 3: Summary of the QuantArray®-Chlor results for microorganisms responsible for reductive dechlorination for samples OMS-28-5, OMS-28-3, and MW-8.

Sample Name Sample Date	OMS-28-5 01/13/2022	OMS-28-3 01/13/2022	MW-8 01/13/2022
Reductive Dechlorination	cells/bead	cells/bead	cells/bead
Chloroform Reductase (CFR)	<2.50E+02	<2.50E+02	<2.50E+02
1,1 DCA Reductase (DCA)	<2.50E+02	<2.50E+02	<2.50E+02
1,2 DCA Reductase (DCAR)	<2.50E+02	<2.50E+02	<2.50E+02
PCE Reductase (PCE-1)	<2.50E+02	<2.50E+02	<2.50E+02
PCE Reductase (PCE-2)	<2.50E+02	<2.50E+02	<2.50E+02
Dehalogenimonas trans-1,2-DCE Reductase (TDR)	<2.50E+02	<2.50E+02	<2.50E+02
Dehalogenimonas cerA Reductase (CER)	<2.50E+02	<2.50E+02	<2.50E+02

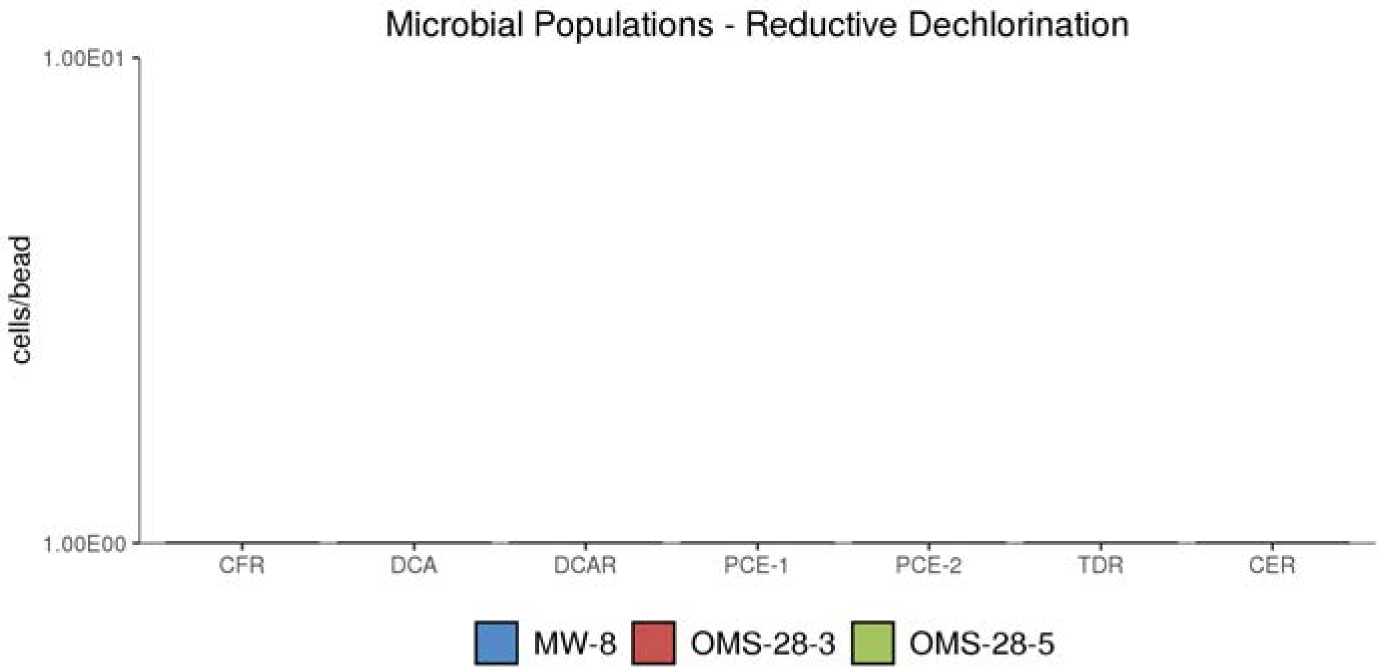

Figure 5: Comparison - microbial populations involved in reductive dechlorination.

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Table 4: Summary of the QuantArray®-Chlor results for microorganisms responsible for aerobic (co)metabolism for samples OMS-28-5, OMS-28-3, and MW-8.

Sample Name **Sample Date**	**OMS-28-5** **01/13/2022**	**OMS-28-3** **01/13/2022**	**MW-8** **01/13/2022**
Aerobic (Co)Metabolic	cells/bead	cells/bead	cells/bead
Soluble Methane Monooxygenase (SMMO)	<2.50E+02	**2.84E+03**	<2.50E+02
Toluene Dioxygenase (TOD)	<2.50E+02	**3.48E+02**	**2.88E+02**
Phenol Hydroxylase (PHE)	**7.21E+03**	**7.47E+01 (J)**	**3.30E+04**
Trichlorobenzene Dioxygenase (TCBO)	<2.50E+02	<2.50E+02	<2.50E+02
Toluene Monooxygenase 2 (RDEG)	<2.50E+02	<2.50E+02	**4.27E+04**
Toluene Monooxygenase (RMO)	**7.01E+02**	**7.52E+01 (J)**	<2.50E+02
Ethene Monooxygenase (EtnC)	<2.50E+02	<2.50E+02	<2.50E+02
Epoxyalkane Transferase (EtnE)	<2.50E+02	<2.50E+02	**3.04E+03**
Dichloromethane Dehalogenase (DCMA)	<2.50E+02	<2.50E+02	<2.50E+02

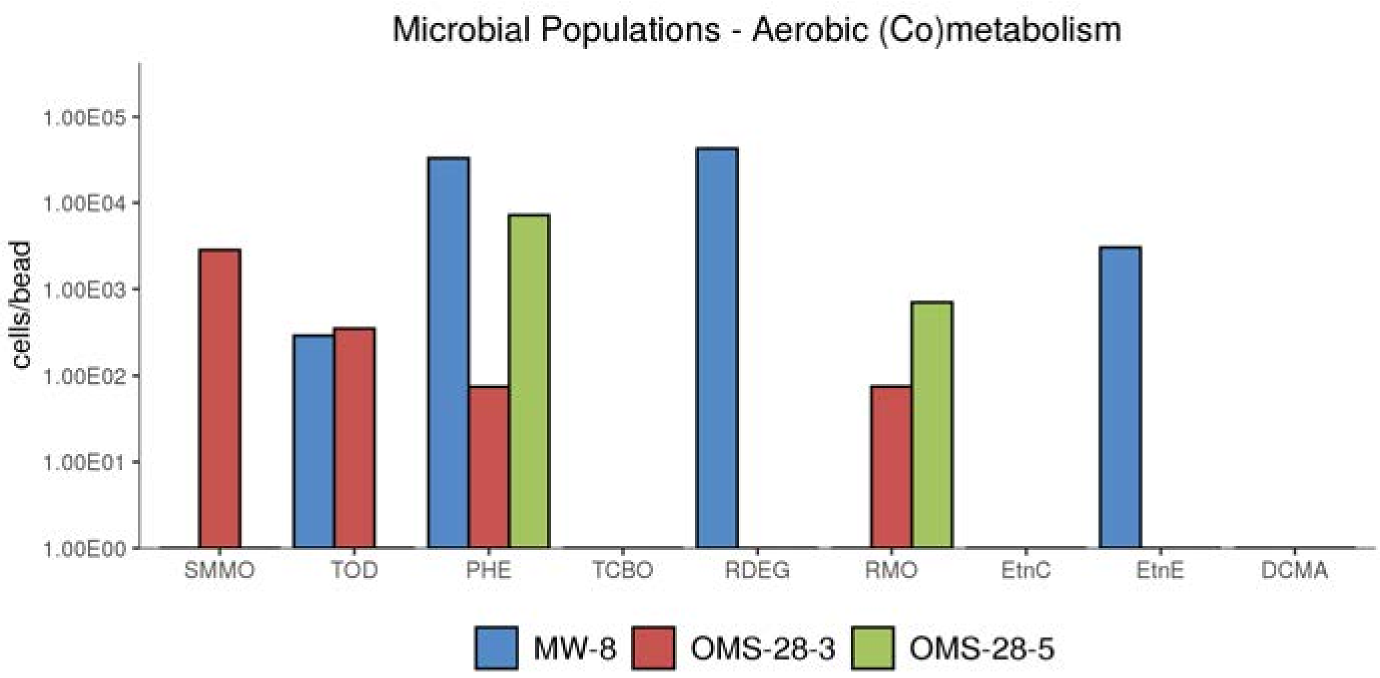

Figure 6: Comparison - microbial populations involved in aerobic (co)metabolism.

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Table 5: Summary of the QuantArray® results for total bacteria and other populations for samples OMS-28-5, OMS-28-3, and MW-8.

Sample Name Sample Date	OMS-28-5 01/13/2022	OMS-28-3 01/13/2022	MW-8 01/13/2022
Other	cells/bead	cells/bead	cells/bead
Total Eubacteria (EBAC)	**5.67E+06**	**1.10E+07**	**7.99E+06**
Sulfate Reducing Bacteria (APS)	**9.12E+04**	**3.13E+03**	**2.60E+02**
Methanogens (MGN)	**4.21E+01 (J)**	**1.70E+01 (J)**	**9.70E+00 (J)**

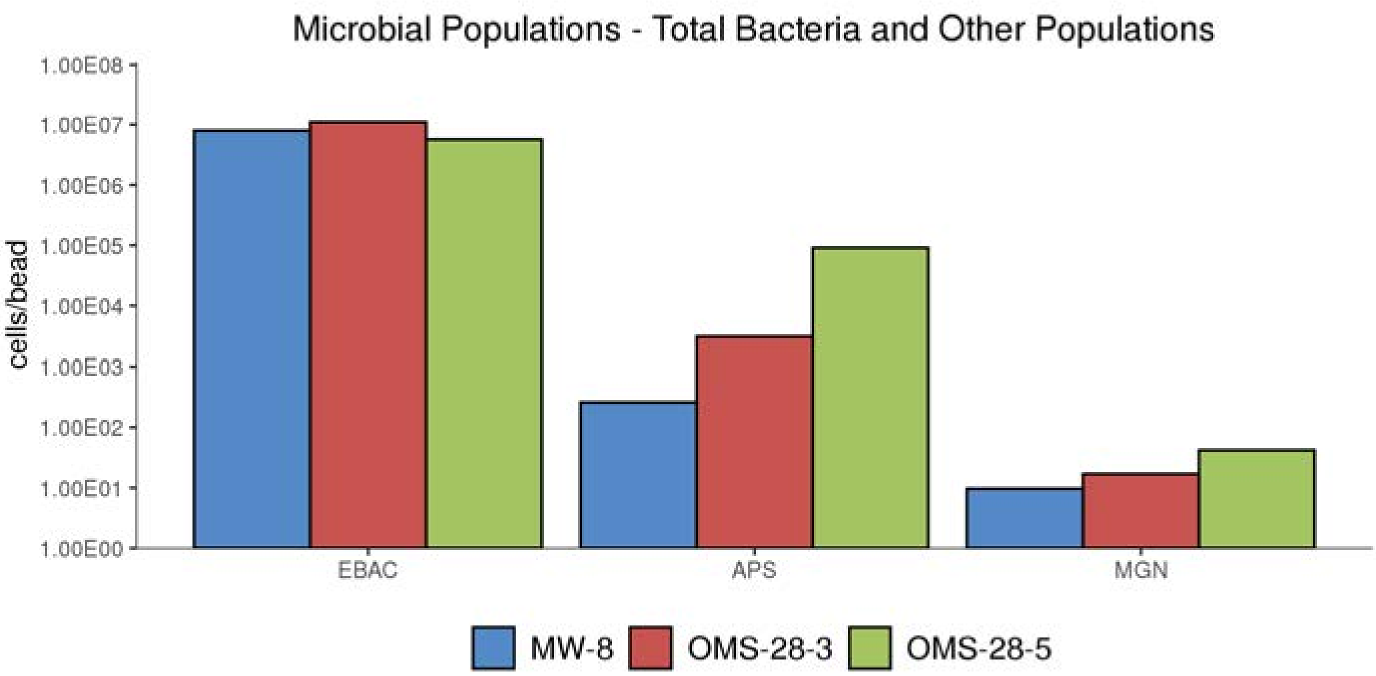

Figure 7: Comparison - microbial populations.

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Interpretation

The overall purpose of the QuantArray®-Chlor is to give site managers the ability to simultaneously yet economically evaluate the potential for biodegradation of a spectrum of common chlorinated contaminants through a multitude of anaerobic and aerobic (co)metabolic pathways in order to provide a clearer and more comprehensive view of contaminant biodegradation. The following discussion describes the interpretation of results in general terms and is meant to serve as a guide.

Reductive Dechlorination - Chlorinated Ethenes: While a number of bacterial cultures including *Dehalococcoides*, *Dehalobacter*, *Desulfitobacterium*, and *Desulfuromonas* spp. capable of utilizing PCE and TCE as growth-supporting electron acceptors have been isolated [1–5], *Dehalococcoides* may be the most important because they are the only bacterial group that has been isolated to date which is capable of complete reductive dechlorination of PCE to ethene [6]. In fact, the presence of *Dehalococcoides* has been associated with complete reductive dechlorination to ethene at sites across North America and Europe [7], and Lu et al. [8] have proposed using a *Dehalococcoides* concentration of 1×10^4 cells/mL as a screening criterion to identify sites where biological reductive dechlorination is predicted to proceed at "generally useful" rates.

At chlorinated ethene sites, any "stall" leading to the accumulation of daughter products, especially vinyl chloride, would be a substantial concern. While *Dehalococcoides* concentrations greater than 1×10^4 cells/mL correspond to ethene production and useful rates of dechlorination, the range of chlorinated ethenes degraded varies by strain within the *Dehalococcoides* genus [6, 9], and the presence of co-contaminants and competitors can have complex impacts on the halorespiring microbial community [10–15]. Therefore, QuantArray®-Chlor also provides quantification of a suite of reductive dehalogenase genes (PCE, TCE, BVC, VCR, CER, and TDR) to more definitively confirm the potential for reductive dechlorination of all chlorinated ethene compounds including vinyl chloride.

Perhaps most importantly, QuantArray®-Chlor quantifies TCE reductase (TCE) and both known vinyl chloride reductase genes (BVC, VCR) from *Dehalococcoides* to conclusively evaluate the potential for complete reductive dechlorination of chlorinated ethenes to non-toxic ethene [16–18]. In addition, the analysis also includes quantification of reductive dehalogenase genes from *Dehalogenimonas* spp. capable of reductive dechlorination of chlorinated ethenes. More specifically, these are the trans-1,2-DCE dehalogenase gene (TDR) from strain WBC-2 [19] and the vinyl chloride reductase gene (CER) from GP, the only known organisms other than *Dehalococcoides* capable of vinyl chloride reduction [20]. Finally, PCE reductase genes responsible for sequential reductive dechlorination of PCE to *cis*-DCE by *Sulfurospirillum* and *Geobacter* spp. are also quantified. In mixed cultures, evidence increasingly suggests that partial dechlorinators like *Sulfurospirillum* and *Geobacter* may be responsible for the majority of reductive dechlorination of PCE to TCE and *cis*-DCE while *Dehalococcoides* functions more as *cis*-DCE and vinyl chloride reducing specialists [10, 21].

Reductive Dechlorination - Chlorinated Ethanes: Under anaerobic conditions, chlorinated ethanes are susceptible to reductive dechlorination by several groups of halorespiring bacteria including *Dehalobacter*, *Dehalogenimonas*, and *Dehalococcoides*. While the reported range of chlorinated ethanes utilized varies by genus, species, and sometimes at the strain level, several general observations can be made regarding biodegradation pathways and daughter product formation. *Dehalobacter* spp. have been isolated that are capable of sequential reductive dechlorination of 1,1,1-TCA through 1,1-DCA to chloroethane [13]. Biodegradation of 1,1,2-TCA by several halorespiring bacteria including *Dehalobacter* and *Dehalogenimonas* spp. proceeds via dichloroelimination producing vinyl chloride [22–24]. Similarly, 1,2-DCA biodegradation by *Dehalobacter*, *Dehalogenimonas*, and *Dehalococcoides* occurs via dichloroelimination producing ethene. While not utilized by many *Desulfitobacterium* isolates, at least one strain, *Desulfitobacterium dichloroeliminans* strain DCA1, is also capable of dichloroelimination of 1,2-DCA [25]. The 1,2-dichloroethane reductive dehalogenase gene (DCAR) from members of *Desulfitobacterium* and *Dehalobacter* is known to dechlorinate 1,2-DCA to ethene, while the 1,1-dichloroethane reductive dehalogenase (DCA) targets the gene responsible for 1,1-DCA dechlorination in some strains of *Dehalobacter*. In addition to chloroform,chloroform reductase (CFR) has also been shown to be responsible for reductivedechlorination of 1,1,1-TCA [26].

Reductive Dechlorination - Chlorinated Methanes: Chloroform is a common co-contaminant at chlorinated solvent sites and can inhibit reductive dechlorination of chlorinated ethenes. Grostern et al. demonstrated that a *Dehalobacter* population was capable of reductive dechlorination of chloroform to produce dichloromethane [27]. The *cfrA* gene encodes the reductase which catalyzes this initial step in chloroform biodegradation [26]. Justicia-Leon et al. have since shown that dichloromethane can support growth of a distinct group of *Dehalobacter* strains via fermentation [28]. The *Dehalobacter* DCM assay targets the 16S rRNA gene of these strains.

Reductive Dechlorination - Chlorinated Benzenes: Chlorinated benzenes are an important class of industrial solvents and chemical intermediates in the production of drugs, dyes, herbicides, and insecticides. The physical-chemical properties of chlorinated benzenes as well as susceptibility to biodegradation are functions of their degree of chlorination and the positions of chlorine substituents. Under anaerobic conditions, reductive dechlorination of higher chlorinated benzenes including hexachlorobenzene (HCB),

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pentachlorobenzene (PeCB), tetrachlorobenzene (TeCB) isomers, and trichlorobenzene (TCB) isomers has been well documented [29], although biodegradation of individual compounds and isomers varies between isolates. For example, *Dehalococcoides* strain CBDB1 reductively dechlorinats HCB, PeCB, all three TeCB isomers, 1,2,3-TCB, and 1,2,4-TCB [9, 30]. *Dehalobium chlorocoercia* DF-1 has been shown to be capable of reductive dechlorination of HCB, PeCB, and 1,2,3,5-TeCB [31]. The dichlorobenzene (DCB) isomers and chlorobenzene (CB) were considered relatively recalcitrant under anaerobic conditions. However, new evidence has demonstrated reductive dechlorination of DCBs to CB and CB to benzene [32] with corresponding increases in concentrations of *Dehalobacter* spp. [33].

Reductive Dechlorination - Chlorinated Phenols: Pentachlorophenol (PCP) was one of the most widely used biocides in the U.S. and despite residential use restrictions, is still extensively used industrially as a wood preservative. Along with PCP, the tetrachlorophenol and trichlorophenol isomers were also used as fungicides in wood preserving formulations. 2,4-Dichlorophenol and 2,4,5-TCP were used as chemical intermediates in herbicide production (e.g. 2,4-D) and chlorophenols are known byproducts of chlorine bleaching in the pulp and paper industry. While the range of compounds utilized varies by strain, some *Dehalococcoides* isolates are capable of reductive dechlorination of PCP and other chlorinated phenols. For example, *Dehalococcoides* strain CBDB1 is capable of utilizing PCP, all three tetrachlorophenol (TeCP) congeners, all six trichlorophenol (TCP) congeners, and 2,3-dichlorophenol (2,3-DCP). PCP dechlorination by strain CBDB1 produces a mixture of 3,5-DCP, 3,4-DCP, 2,4-DCP, 3-CP, and 4-CP [34]. In the same study, however, *Dehalococcoides* strain 195 dechlorinated a more narrow spectrum of chlorophenols which included 2,3-DCP, 2,3,4-TCP, and 2,3,6-TCP, but no other TCPs or PCP. Similar to *Dehalococcoides*, some species and strains of *Desulfitobacterium* are capable of utilizing PCP and other chlorinated phenols. *Desulfitobacterium hafniense* PCP-1 is capable of reductive dechlorination of PCP to 3-CP [35]. However, the ability to biodegrade PCP is not universal among *Desulfitobacterium* isolates. *Desulfitobacterium* sp. strain PCE1 and *D. chlororespirans* strain Co23, for example, can utilize some TCP and DCP isomers, but not PCP for growth [2, 36].

Reductive Dechlorination - Chlorinated Propanes: *Dehalogenimonas* is a recently described bacterial genus of the phylum Chloroflexi which also includes the well-known chloroethene-respiring *Dehalococcoides* [23]. The *Dehalogenimonas* isolates characterized to date are also halorespiring bacteria, but utilize a rather unique range of chlorinated compounds as electron acceptors including chlorinated propanes (1,2,3-TCP and 1,2-DCP) and a variety of other vicinally chlorinated alkanes including 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, and 1,2-dichloroethane [23].

Aerobic - Chlorinated Ethene Cometabolism: Under aerobic conditions, several different types of bacteria including methane-oxidizing bacteria (methanotrophs), and many benzene, toluene, ethylbenzene, xylene, and (BTEX)-utilizing bacteria can cometabolize or co-oxidize TCE, DCE, and vinyl chloride [37]. In general, cometabolism of chlorinated ethenes is mediated by monooxygenase enzymes with “relaxed’ specificity that oxidize a primary (growth supporting) substrate (*e.g.* methane) and co-oxidize the chlorinated compound (*e.g.*TCE). QuantArray®-Chlor provides quantification of a suite of genes encoding oxygenase enzymes capable of co-oxidation of chlorinated ethenes including soluble methane monooxygenase (sMMO). Soluble methane monooxygenases co-oxidize a broad range of chlorinated compounds [38–41] including TCE, *cis*-DCE, and vinyl chloride. Furthermore, soluble methane monooxygenases are generally believed to support greater rates of aerobic cometabolism [40]. QuantArray®-Chlor also quantifies aromatic oxygenase genes encoding ring hydroxylating toluene monooxygenase genes (RMO, RDEG), toluene dioxygenase (TOD) and phenol hydroxylases (PHE) capable of TCE co-oxidation [42–46]. TCE or a degradation product has been shown to induce expression of toluene monooxygenases in some laboratory studies [43, 47] raising the possibility of TCE cometabolism with an alternative (non-aromatic) growth substrate. Moreover, while a number of additional factors must be considered, recent research under ESTCP Project 201584 has shown positive correlations between concentrations of monooxygenase genes (soluble methane monooxygenase, ring hydroxylating monooxygenases, and phenol hydroxylase) and the rate of TCE degradation [48].

Aerobic - Chlorinated Ethane Cometabolism: While less widely studied than cometabolism of chlorinated ethenes, some chlorinated ethanes are also susceptible to co-oxidation. As mentioned previously, soluble methane monooxygenases (sMMO) exhibit very relaxed specificity. In laboratory studies, sMMO has been shown to co-oxidize a number of chlorinated ethanes including 1,1,1-TCA and 1,2-DCA [38, 40].

Aerobic - Vinyl Chloride Cometabolism: Beginning in the early 1990s, numerous microcosm studies demonstrated aerobic oxidation of vinyl chloride under MNA conditions without the addition of exogenous primary substrates. Since then, strains of

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Mycobacterium, *Nocardioides*, *Pseudomonas*, *Ochrobactrum*, and *Ralstonia* species have been isolated which are capable of aerobic growth on both ethene and vinyl chloride (see Mattes et al. [49] for a review). The initial steps in the pathway are the monooxygenase (*etn*ABCD) catalyzed conversion of ethene and vinyl chloride to their respective epoxyalkanes (epoxyethane and chlorooxirane), followed by epoxyalkane:CoM transferase (*etn*E) mediated conjugation and breaking of the epoxide [50].

Aerobic - Chlorinated Benzenes: In general, chlorobenzenes with four or less chlorine groups are susceptible to aerobic biodegradation and can serve as growth-supporting substrates. Toluene dioxygenase (TOD) has a relatively relaxed substrate specificity and mediates the incorporation of both atoms of oxygen into the aromatic ring of benzene and substituted benzenes (toluene and chlorobenzene). Comparison of TOD levels in background and source zone samples from a CB-impacted site suggested that CBs promoted growth of TOD-containing bacteria [51]. In addition, aerobic biodegradation of some trichlorobenzene and even tetrachlorobenzene isomers is initiated by a group of related trichlorobenzene dioxygenase genes (TCBO). Finally, phenol hydroxylases catalyze the continued oxidation and in some cases, the initial oxidation of a variety of monoaromatic compounds. In an independent study, significant increases in numbers of bacteria containing PHE genes corresponded to increases in biodegradation of DCB isomers [51].

Aerobic - Chlorinated Methanes: Many aerobic methylotrophic bacteria, belonging to diverse genera (*Hyphomicrobium*, *Methylobacterium*, *Methylophilus*, *Pseudomonas*, *Paracoccus*, and *Alibacter*) have been isolated which are capable of utilizing dichloromethane (DCM) as a growth substrate. The DCM metabolic pathway in methylotrophic bacteria is initiated by a dichloromethane dehalogenase (DCMA) gene. DCMA is responsible for aerobic biodegradation of dichloromethane by methylotrophs by first producing formaldehyde which is then further oxidized [52]. As discussed in previous sections, soluble methane monooxygenase (sMMO) exhibits relaxed specificity and co-oxidizes a broad spectrum of chlorinated hydrocarbons. In addition to chlorinated ethenes, sMMO has been shown to co-oxidize chloroform in laboratory studies [38, 41].

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APPENDIX D

Detailed Remedial Alternatives Cost Estimates

Table D-1
Cost Estimate for Alternative 2, Land Use Controls with Periodic Groundwater Monitoring
OMS #28
Alabama Army National Guard - Mobile, Alabama

COST ESTIMATE WORKSHEET SUMMARY

Alternative 2		Site:	OMS #28
Land Use Controls with		Location:	ALARNG, Mobile, AL
Periodic Groundwater Monitoring		Phase:	Feasilbility Study
		Base Year:	2023

Labor Rates:

Project Manager	$171.65	**Travel:**		
Env. Engineer - Senior	$166.40	Per Diem	$59.00	/day
Geologist - Senior	$148.29	Lodging	$100.00	/day
Env. Engineer - Mid	$125.27	Mileage	$0.655	/mile
Geologist - Mid	$110.73	Rental Car	$85.00	/day
Env. Engineer - Junior	$87.00	Adm Assist/Clerical - Mid	$72.73	
Geologist - Junior	$75.71	Risk Assessor	$144.06	
GIS/CADD - Mid	$95.50	CIH/Safety Manager - Mid	$129.69	
Contracts/Admin/Procurement - Mid	$111.98	Chemist - Mid	$117.02	
		Database Manager	$82.17	

LUC Implentation - Year 1

Includes:
1. Prepare Draft, Draft Final, and Final LUCIP.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor (LUCIP generation):					
Project Manager	19	$171.65	/hr	$3,227.02	
Env. Engineer - Senior	50	$166.40	/hr	$8,320.00	
Env. Engineer - Junior	80	$87.00	/hr	$6,960.00	
GIS/CADD - Mid	24	$95.50	/hr	$2,292.00	
Adm Assist/Clerical - Mid	24	$72.73	/hr	$1,745.52	
Materials (LUCIP):					
Document Repro/Ship (D, DF, F)	3	$500.00	/ea	$1,500.00	
Travel:					
Per Diem	1	$59.00	/day	$59.00	
Lodging	0	$100.00	/day	$0.00	
Milage	200	$0.655	/mile	$131.00	Destin to Mobile (~100 mi.)
			Year 1 LUC Cost Subtotal	$24,234.54	
			Total LUC Capital Cost Year 1 (Rounded)	**$24,200**	

Draft RD/RA Work Plan - Year 1

Includes:
1. Complete Draft RD/RA Workplan to install 5 new Shallow/Middle Surficial Aquifer monitoring wells, 1 replacement for well OMS-28-2, and 3 Lower Surficial Aquifer monitoring wells.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	12	$171.65	/hr	$2,128.46	
Env. Engineer - Senior	20	$166.40	/hr	$3,328.00	
Env. Engineer - Junior	80	$87.00	/hr	$6,960.00	
GIS/CADD - Mid	16	$95.50	/hr	$1,528.00	
Adm Assist/Clerical - Mid	8	$72.73	/hr	$581.84	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
			Year 1 Draft RD/RA Work Plan Subtotal	$15,026.30	
			Year 1 Draft RD/RA Work Plan Subtotal (Rounded)	**$15,000**	

Draft Final RD/RA Work Plan/Health & Safety Plan - Year 1

Includes:
1. Complete Draft RD/RA Workplan to install 5 new Shallow/Middle Surficial Aquifer monitoring wells, 1 replacement for well OMS-28-2, and 3 Lower Surficial Aquifer monitoring wells.
2. Prepare HASP.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	9	$171.65	/hr	$1,476.19	
Env. Engineer - Senior	12	$166.40	/hr	$1,996.80	
Env. Engineer - Junior	50	$87.00	/hr	$4,350.00	
GIS/CADD - Mid	16	$95.50	/hr	$1,528.00	
Adm Assist/Clerical - Mid	8	$72.73	/hr	$581.84	
CIH/Safety Manager - Mid	4	$129.69	/hr	$518.76	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
			Year 1 Draft Final RA/RD Work Plan/HASP Cost Subtotal	$10,951.59	
			Year 1 Draft Final RA/RD Work Plan/HASP Cost Subtotal (Rounded)	**$11,000**	

Table D-1
Cost Estimate for Alternative 2, Land Use Controls with Periodic Groundwater Monitoring
OMS #28
Alabama Army National Guard - Mobile, Alabama

Final RD/RA Work Plan - Year 1

Includes:

1. Complete Draft RD/RA Workplan to install 5 new Shallow/Middle Surficial Aquifer monitoring wells, 1 replacement for well OMS-28-2, and 3 Lower Surficial Aquifer monitoring wells.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	5	$171.65	/hr	$926.91	
Env. Engineer - Senior	8	$166.40	/hr	$1,331.20	
Env. Engineer - Junior	30	$87.00	/hr	$2,610.00	
GIS/CADD - Mid	8	$95.50	/hr	$764.00	
Adm Assist/Clerical - Mid	8	$72.73	/hr	$581.84	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
Year 1 Final RA/RD Work Plan/HASP Cost Subtotal				$6,713.95	
Year 1 Final RA/RD Work Plan/HASP Cost Subtotal (Rounded)				**$6,700**	

Site Prep/Clearing/Monitoring Well Installation and Development - Year 1

Includes:

1. Private utility locate.
2. Clearing of the locations for 4 new monitoring wells that will be located in heavily wooded area on Parcel F.
3. Install and develop 5 new Shallow/Middle Surficial Aquifer monitoring wells, 1 replacement for well OMS-28-2, and 3 new Lower Surficial Aquifer monitoring wells.
4. Build crush and run rock road to the 4 new monitoring wells on Parcel F to provide continued access to the wells for duration of Alternative 2.
5. Oversight provided by one mid-level geologist.

Assumptions:

1. 1 new shallow replacement monitoring well located on Parcel C.
2. 1 new shallow surficial and 1 new lower surficial monitoring well located on Parcel D.
3. 1 new shallow surfiical and 1 new deep surficial monitoring well located on Parcel E.
4. 3 new shallow surficial and 1 new deep surficial monitoring well located on Parcel F.
5. Total of 9 new monitoring wells to be installed.

Total field days (12 hour work days [M - F]) = 4

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	10	$171.65	/hr	$1,647.84	Fieldwork coordination
Env. Engineer - Senior	12	$166.40	/hr	$1,996.80	Fieldwork coordination
Geologist - Mid	64	$110.73	/hr	$7,086.72	Oversight
Contracts/Admin/Procurement - Mid	16	$111.98	/hr	$1,791.68	Procure subcontractors
CIH/Safety Manager - Mid	4	$129.69	/hr	$518.76	Safety Review
Services:					
Private utility clearance	1	$1,600.00	/day	$1,600.00	Daily Rate
Mobilization/Demobilization	1	$750.00	LS	$750.00	WHE Quote - 6/21/2023
Site Clearing for 4 Wells on Parcel F	1	$2,500.00	LS	$2,500.00	WHE Quote - 6/21/2023
Crush and Run Road for Parcel F Wells	1	$4,000.00	LS	$4,000.00	WHE Quote - 6/21/2023
DPT Rig & Crew for Well Installation	4	$3,200.00	/day	$12,800.00	WHE Quote - 6/21/2023
Per Diem	4	$600.00	/day	$2,400.00	WHE Quote - 6/21/2023
2-inch PVC Well Materials	241	$22.00	/ft	$5,302.00	WHE Quote - 6/21/2023
Decontamination Pad	1	$350.00	/ea	$350.00	WHE Quote - 6/21/2023
Surface Completion	9	$600.00	/ea	$5,400.00	WHE Quote - 6/21/2023
Bollards	27	$75.00	/ea	$2,025.00	WHE Quote - 6/21/2023
55-Gal Drums for Soil & Development Water	18	$95.00	/ea	$1,710.00	WHE Quote - 6/21/2023
Well Development	9	$250.00	/ea	$2,250.00	WHE Quote - 6/21/2023
Transportation of Drums for Disposal	1	$1,000.00	/ea	$1,000.00	WHE Quote - 6/21/2023
Disposal of Drums	18	$150.00	/ea	$2,700.00	WHE Quote - 6/21/2023
Analytical:					
TCLP VOCs	1	$150.00	/ea	$150	Waste Characterization
Travel (AECOM):					
Per Diem	4	$59.00	/day	$236.00	
Lodging	4	$100.00	/day	$400.00	
Mileage	220	$0.655	/mile	$144.10	Destin, FL to Mobile (~100 mi.)
Year 1 Site Prep/Clearing/Monitoring Well Installation and Development Subtotal				$58,758.90	
Year 1 Site Prep/Clearing/Monitoring Well Installation and Development (Rounded)				**$58,800**	

Table D-1
Cost Estimate for Alternative 2, Land Use Controls with Periodic Groundwater Monitoring
OMS #28
Alabama Army National Guard - Mobile, Alabama

Periodic Groundwater Monitoring & Reporting - Baseline (Year 1), Year 2, Year 4, and Years 6, 11, & 16

Includes:

1. Cost presented is for the individual sampling event (Baseline, Year 5, Year 10, and Year 15).
2. Sample 8 new wells, 1 replacement well OMS-28-2R, and 8 existing wells.
3. Data verification and evaluation.

4. Number of wells sampled =	17	wells	
5. Field crew =	2	personnel	
6. Sampling Duration =	2	days	(10 hr day)
7. Total VOC Samples =	21	samples	(17 wells + 10% FD + 5%MS/MSD + 10% TB)
10. Total events =	1	event	
11. Total prep/mobe/demobe time (per person) =	8	hrs	
12. Total field time with prep/mobe/demobe (per person) =	28	hrs	(10 hr days)

Data Management and QA/QC Assumptions:

Geologist - Junior	1 hr/sample
Chemist - Mid	0.75 hr/sample
Database Manager	1.5 hr/sample
Env. Engineer - Senior	0.175 hr/sample

Service/Materials	Unit	Unit Cost	Cost	Notes
Report Labor:				
Project Manager	21	$171.65 /hr	$3,604.65	
Env. Engineer - Senior	40	$166.40 /hr	$6,656.00	
Geologist - Mid	60	$110.73 /hr	$6,643.80	
Env. Engineer - Junior	40	$87.00 /hr	$3,480.00	
GIS/CADD - Mid	30	$95.50 /hr	$2,865.00	
Adm Assist/Clerical - Mid	40	$72.73 /hr	$2,909.20	
Materials:				
Document Repro/Ship (D, DF, F)	3	$500.00 /ea	$1,500.00	
Data Management Labor:				
Geologist - Junior	21	$75.71 /hr	$1,589.91	
Chemist - Mid	16	$117.02 /hr	$1,872.32	
Database Manager	32	$82.17 /hr	$2,629.44	
Env. Engineer - Senior	4	$166.40 /hr	$665.60	
Procurement:				
Contracts/Admin/Procurement - Mid	12	$111.98 /hr	$1,343.76	Procure Lab and IDW Disposal
Office Oversight:				
Project Manager	6	$171.65 /hr	$1,029.90	
Env. Engineer - Senior	4	$166.40 /hr	$665.60	
Sampling Field Labor:				
Env. Engineer - Junior	28	$87.00 /hr	$2,436.00	
Geologist - Junior	28	$75.71 /hr	$2,119.88	
Materials:				
Sampling Equipment	2	$189.75 /ea	$379.50	AECOM Equip. Rental Rate
Drums	1	$95.00 /ea	$95.00	Based on WHE Quote
IDW Transporation	1	$1000.00 /ea	$1,000.00	Based on WHE Quote
IDW Disposal	1	$150.00 /ea	$150.00	Based on WHE Quote
Analytical:				
VOCs (8260D)	21	$50.00 /ea	$1,062.50	Pace Analytical Cost
Daily Shipping	2	$100.00 /ea	$200.00	Fed Ex Cost
Travel:				
Per Diem	4	$59.00 /day	$236.00	
Lodging	4	$100.00 /day	$400.00	
Mileage	400	$0.655 /mile	$262.00	Destin, FL to Mobile (~100 mi.)
Periodic Groundwater Monitoring/Reporting Cost Subtotal(single event)			$45,796	
Periodic Groundwater Monitoring/Reporting Cost Subtotal (single event) (Rounded)			$45,800	
Periodic Groundwater Monitoring/Reporting Cost Subtotal (four events) (Rounded)			**$274,800**	

Table D-1
Cost Estimate for Alternative 2, Land Use Controls with Periodic Groundwater Monitoring
OMS #28
Alabama Army National Guard - Mobile, Alabama

Periodic LUC Surveillance/Five-Year Review - Years 6, 11, & 16

Includes:
1. One site visit for one person.
2. Assume 2 hours for mobe, 4 hours on site, and 2 hours for demobe for one junior geologist.
3. Draft, Draft-Final, and Final 5-Year Review

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	29	$171.65	/hr	$4,977.85	
Env. Engineer - Senior	60	$166.40	/hr	$9,984.00	
Env. Engineer - Mid	120	$125.27	/hr	$15,032.40	
Geologist - Junior	32	$75.71	/hr	$2,422.72	
GIS/CADD - Mid	40	$95.50	/hr	$3,820.00	
Adm Assist/Clerical - Mid	40	$72.73	/hr	$2,909.20	
Materials:					
Document Repro/Ship (D, DF, F)	3	$500.00	/ea	$1,500.00	
Travel:					
Per Diem	1	$59.00	/day	$59.00	
Lodging	0	$100.00	/day	$0.00	
Mileage	200	$0.655	/mile	$131.00	Destin, FL to Mobile (~100 mi.)
Periodic LUC Surveillance/Five-Year Review Cost Subtotal (Single Event)				$40,836.17	
Periodic LUC Surveillance/Five-Year Review Cost Subtotal (Single Event) (Rounded)				$40,800.00	
Periodic LUC Surveillance/Five-Year Review Cost Subtotal (Three Events) (Rounded)				**$122,400**	

Alternative 2 Total Cost (Rounded)	**$512,900**
Alternative 2 Total Net Present Worth Cost (Rounded)	**$403,600**
Total Contingency (20%)	**$80,700**
Alternative 2 Total Net Present Worth Cost (Rounded)	**$484,300**

Table D-1
Cost Estimate for Alternative 2
Land Use Controls with Periodic Groundwater Monitoring
OMS #28
Alabama Army National Guard - Mobile, Alabama

PRESENT WORTH SUMMARY

Alternative 2	Site:	OMS #28
Land Use Controls with	Location:	ALARNG, Mobile, AL
Periodic Monitoring	Phase:	Feasilbility Study
	Base Year:	2023

Present Value Analysis

30-year discount rate 4.2% (OMB Circular A-94 Appendix C) - Revised December 12, 2022

Year	Capital Cost	Annual O&M	Periodic Costs	Total Costs	Present Worth
0	$0	-	-	$0	$0
1	$115,700	$45,800	-	$161,500	$154,990
2	-	$45,800	-	$45,800	$42,182
3	-	-	-	$0	$0
4	-	$45,800	-	$45,800	$38,850
5	-	-	-	$0	$0
6	-	$45,800	$40,800	$86,600	$67,657
7	-	-	-	$0	$0
8	-	-	-	$0	$0
9	-	-	-	$0	$0
10	-	-	-	$0	$0
11	-	$45,800	$40,800	$86,600	$55,077
12	-	-	-	$0	$0
13	-	-	-	$0	$0
14	-	-	-	$0	$0
15	-	-	-	$0	$0
16	-	$45,800	$40,800	$86,600	$44,837
17	-	-	-	$0	$0
18	-	-	-	$0	$0
19	-	-	-	$0	$0
20	-	-	-	$0	$0
21	-	-	-	$0	$0
22	-	-	-	$0	$0
23	-	-	-	$0	$0
24	-	-	-	$0	$0
25	-	-	-	$0	$0
26	-	-	-	$0	$0
27	-	-	-	$0	$0
28	-	-	-	$0	$0
29	-	-	-	$0	$0
30	-	-	-	$0	$0
TOTALS	**$115,700**	**$274,800**	**$122,400**	**$512,900**	**$403,594**

Table D-2
Cost Estimate for Alternative 3, ERD, ISCR, and Enhanced MNA
OMS #28
Alabama Army National Guard - Mobile, Alabama

COST ESTIMATE WORKSHEET SUMMARY

Alternative 3
ERD, ISCR, and Enhanced MNA

Site: OMS #28
Location: ALARNG, Mobile, AL
Phase: Feasilbility Study
Base Year: 2023

Labor Rates:

Project Manager	$171.65	Per Diem	$59.00	/day
Env. Engineer - Senior	$166.40	Lodging	$100.00	/day
Geologist - Senior	$148.29	Mileage	$0.655	/mile
Env. Engineer - Mid	$125.27	Rental Car	$85.00	/day
Geologist - Mid	$110.73			
Env. Engineer - Junior	$87.00	Adm Assist/Clerical - Mid	$72.73	
Geologist - Junior	$75.71	Risk Assessor	$144.06	
GIS/CADD - Mid	$95.50	CIH/Safety Manager - Mid	$129.69	
Contracts/Admin/Procurement - Mid	$111.98	Chemist - Mid	$117.02	
		Database Manager	$82.17	

(Travel: column heading above Per Diem through Rental Car.)

Draft RD/RA Work Plan - Year 1

Includes:
1. Complete Draft RD/RA Workplan for ERD, ISCR, and Enhanced MNA.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	28	$171.65	/hr	$4,806.20	
Env. Engineer - Junior	120	$87.00	/hr	$10,440.00	
Env. Engineer - Senior	80	$166.40	/hr	$13,312.00	
GIS/CADD - Mid	40	$95.50	/hr	$3,820.00	
Adm Assist/Clerical - Mid	40	$72.73	/hr	$2,909.20	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
Year 1 Draft RD/RA Work Plan Subtotal				$35,787.40	
Year 1 Draft RD/RA Work Plan Subtotal (Rounded)				**$35,800**	

Draft Final RD/RA Work Plan/Health & Safety Plan - Year 1

Includes:
1. Complete Draft Final RD/RA Workplan for ERD, ISCR, and Enhanced MNA.
2. Prepare HASP.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	20	$171.65	/hr	$3,501.66	
Env. Engineer - Junior	80	$87.00	/hr	$6,960.00	
Env. Engineer - Senior	40	$166.40	/hr	$6,656.00	
Geologist - Junior	40	$75.71	/hr	$3,028.40	
GIS/CADD - Mid	20	$95.50	/hr	$1,910.00	
Adm Assist/Clerical - Mid	20	$72.73	/hr	$1,454.60	
CIH/Safety Manager - Mid	4	$129.69	/hr	$518.76	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
Year 1 Draft Final RD/RA Work Plan/Health & Safety Plan Subtotal				$24,529.42	
Year 1 Draft Final RD/RA Work Plan/Health & Safety Plan Subtotal (Rounded)				**$24,500**	

Final RD/RA Work Plan - Year 1

Includes:
1. Complete Final RD/RA Workplan for ERD, ISCR, and Enhanced MNA.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	14	$171.65	/hr	$2,403.10	
Env. Engineer - Junior	60	$87.00	/hr	$5,220.00	
Env. Engineer - Senior	40	$166.40	/hr	$6,656.00	
GIS/CADD - Mid	20	$95.50	/hr	$1,910.00	
Adm Assist/Clerical - Mid	20	$72.73	/hr	$1,454.60	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
Year 1 Final RA/RD Work Plan Cost Subtotal				$18,143.70	
Year 1 Final RA/RD Work Plan Cost Subtotal				**$18,100**	

Table D-2
Cost Estimate for Alternative 3, ERD, ISCR, and Enhanced MNA
OMS #28
Alabama Army National Guard - Mobile, Alabama

Request for Proposal Preparation (RFP) and Contractor Selection - Year 1

Includes:
1. Prepare and issue an RFP with a standardized rate sheet for site clearing and groundwater injection activities.
2. Evaluate proposals, select contractors, and establish contracts.
3. Conduct site walk for subcontracotors. Assume 2 hours mobe, 4 hours on site, and 2 hours demobe (Florida Panhandle to Mobile, AL and back).

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	12	$171.65	/hr	$1,991.14	
Env. Engineer - Senior	60	$166.40	/hr	$9,984.00	
Env. Engineer - Junior	48	$87.00	/hr	$4,176.00	
GIS/CADD - Mid	8	$95.50	/hr	$764.00	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
Travel:					
Per Diem	1	$59.00	/day	$59.00	
Mileage	200	$0.655	/mile	$131.00	Destin to Mobile (~100 mi.)
Year 1 RFP and Contractor Selection Subtotal				$17,605.14	
Year 1 RFP and Contractor Selection Subtotal (Rounded)				**$17,600**	

Site Prep/Clearing/Monitoring Well Installation and Development - Year 1

Includes:

1. Private utility locate.
2. Clearing of the locations for 5 new monitoring wells that will be located in heavily wooded area on Parcel F.
3. Install and develop 8 new Shallow/Middle Surficial Aquifer monitoring wells, 1 replacement for well OMS-28-2, and 3 new Lower Surficial Aquifer monitoring wells.
4. Build crush and run rock road to the 5 new monitoring wells on Parcel F to provide continued access to the wells for duration of Alternative 3.
5. Oversight provided by one mid-level geologist.

Assumptions:

1. Approximate Parcel F area to be cleared and grubbed (acres) = 0.43
2. 1 new shallow replacement monitoring well located on Parcel C.
3. 1 new shallow surficial and 1 new lower surficial monitoring well located on Parcel D.
4. 3 new shallow surfiical and 1 new deep surficial monitoring well located on Parcel E.
5. 4 new shallow surficial and 1 new deep surficial monitoring well located on Parcel F.
6. Total of 12 new monitoring wells to be installed.

Total field days (12 hour work days [M - F]) = 7

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	15	$171.65	/hr	$2,540.42	Fieldwork coordination
Env. Engineer - Senior	20	$166.40	/hr	$3,328.00	Fieldwork coordination
Geologist - Mid	100	$110.73	/hr	$11,073.00	Oversight
Contracts/Admin/Procurement - Mid	24	$111.98	/hr	$2,687.52	Procure subcontractors
CIH/Safety Manager - Mid	4	$129.69	/hr	$518.76	Safety Review
Services:					
Private utility clearance	1	$1,600.00	/day	$1,600.00	Daily Rate
Mobilization/Demobilization	1	$750.00	/LS	$750.00	WHE Quote - 6/21/2023
Site Clearing for Injection Area on Parcel F	1	$7,500.00	LS	$7,500.00	WHE Quote - 6/21/2023
Crush and Run Road for Parcel F Wells	1	$4,500.00	LS	$4,500.00	WHE Quote - 6/21/2023
DPT Rig & Crew for Well Installation	7	$3,200.00	/day	$22,400.00	WHE Quote - 6/21/2023
Per Diem	7	$600.00	/day	$4,200.00	WHE Quote - 6/21/2023
2-inch PVC Well Materials	316	$22.00	/ft	$6,952.00	WHE Quote - 6/21/2023
Decontamination Pad	1	$350.00	/ea	$350.00	WHE Quote - 6/21/2023
Surface Completion	12	$600.00	/ea	$7,200.00	WHE Quote - 6/21/2023
Bollards	36	$75.00	/ea	$2,700.00	WHE Quote - 6/21/2023
55-Gal Drums for Soil & Development Water	24	$95.00	/ea	$2,280.00	WHE Quote - 6/21/2023
Well Development	12	$250.00	/ea	$3,000.00	WHE Quote - 6/21/2023
Transportation of Drums for Disposal	1	$1,000.00	/ea	$1,000.00	WHE Quote - 6/21/2023
Disposal of Drums	24.00	$150.00	/ea	$3,600.00	WHE Quote - 6/21/2023
Analytical:					
TCLP VOCs	2	$150.00	/ea	$300	Waste Characterization
Travel:					
Per Diem	7	$59.00	/day	$413.00	
Lodging	7	$100.00	/day	$700.00	
Mileage	270	$0.655	/mile	$176.85	Destin to Mobile (~100 mi.)
Year 1 Site Prep/Clearing/Monitoring Well Installation and Development Subtotal				$89,769.55	
Year 1 Site Prep/Clearing/Monitoring Well Installation and Development (Rounded)				**$89,800**	

Table D-2
Cost Estimate for Alternative 3, ERD, ISCR, and Enhanced MNA
OMS #28
Alabama Army National Guard - Mobile, Alabama

Baseline Sampling Event - Year 1

Includes:

1. Baseline GW monitoring event for VOCs for 20 wells.
2. Baseline GW monitoring event for MNA for 6 wells and for qPCR for 4 wells.
3. Data verification and evaluation (baseline results reported in RA Report).

4. Number of wells sampled =	20	wells	
5. Field crew =	2	personnel	
6. Sampling Duration =	2.5	days	(10 hr days)
7. Total VOC Samples =	25	samples	(20 wells + 10% FD + 5%MS/MSD + 10% TB)
8. Total MNA Samples =	6	samples	(6 wells with no FDs or TBs)
9. Total qPCR Samples =	4	samples	(4 wells with no FDs or TBs)
10. Total events =	1	event	
11. Total prep/mobe/demobe time (per person) =	8	hrs	
12. Total field time with prep/mobe/demobe (per person) =	33	hrs	(10 hr days)

Data Management and QA/QC Assumptions:

Geologist - Junior	1	hr/sample
Chemist - Mid	0.75	hr/sample
Database Manager	1.5	hr/sample
Env. Engineer - Senior	0.175	hr/sample

Service/Materials	Unit	Unit Cost		Cost	Notes
Data Management Labor:					
Geologist - Junior	31	$75.71	/hr	$2,347.01	
Chemist - Mid	24	$117.02	/hr	$2,808.48	
Database Manager	47	$82.17	/hr	$3,861.99	
Env. Engineer - Senior	6	$166.40	/hr	$998.40	
Procurement:					
Contracts/Admin/Procurement - Mid	12	$111.98	/hr	$1,343.76	Procure Lab and IDW Disposal
Office Oversight:					
Project Manager	7	$171.65	/hr	$1,201.55	
Env. Engineer - Senior	4	$166.40	/hr	$665.60	
Sampling Field Labor:					
Env. Engineer - Junior	33	$87.00	/hr	$2,871.00	
Geologist - Junior	33	$75.71	/hr	$2,498.43	
Materials:					
Sampling Equipment	2	$182.93	/ea	$365.86	AECOM Equip. Rental Rate
Drums	2	$95.00	/ea	$190.00	Based on WHE Quote
IDW Management:					
IDW Transporation	1	$1000.00	/ea	$1,000.00	Based on WHE Quote
IDW Disposal	1	$150.00	/ea	$150.00	Based on WHE Quote
Analytical:					
VOCs (8260D)	25	$50.00	/ea	$1,250.00	Pace Analytical Cost
Dissolved Iron	6	$15.00	/ea	$90.00	Pace Analytical Cost
Total Iron	6	$15.00	/ea	$90.00	Pace Analytical Cost
Methane, Ethane, Ethene	6	$65.00	/ea	$390.00	Pace Analytical Cost
Total Organic Carbon	6	$25.00	/ea	$150.00	Pace Analytical Cost
Total Alkalinity	6	$15.00	/ea	$90.00	Pace Analytical Cost
DHC/DHB	4	$375.00	/ea	$1,500.00	Microbial Insights cost
Daily Shipping	3	$100.00	/ea	$300.00	Fed Ex cost
Travel:					
Per Diem	5	$59.00		$295.00	
Lodging	5	$100.00		$500.00	
Mileage	420	$0.655		$275.10	Destin, FL to Mobile (~100 mi.)
		Year 1 Baseline Sampling Cost Subtotal		$25,232.18	
		Year 1 Baseline Sampling Cost Subtotal (Rounded)		**$25,200**	

Table D-2
Cost Estimate for Alternative 3, ERD, ISCR, and Enhanced MNA
OMS #28
Alabama Army National Guard - Mobile, Alabama

First ERD/ICSR Injection Event - Year 2

Includes:

1. One injection event with 201 injection points based on 15-foot spacing between the points.
2. Injection intervals (60 points between 6 and 14 ft bgs, 127 points between 14 and 26 ft bgs, 14 points between 27 and 31 ft bgs).
3. Individual injections are conducted every 2 vertical feet apart over the entire injection interval in a bottom-to-top approach.
4. 100 lbs ABC+Ole, 10 lbs magnesium oxide, 2 lbs guar, 0.25 liters RTB-1, and 0.025 lbs sodium sulfite in approximately 50 gallons of water per injection interval.
5. Estimated injection total of 1,600 gallons per day.
6. Estimate of 49 days to complete. 44 days of injection and 5 days of mobe/set up/demobe. Three injection crew members with oversight by Mid-level Engineer.

Service/Materials	Unit	Unit Cost		Cost	Notes
Office Labor:					
Project Manager	4	$171.65	/hr	$686.60	
Env. Engineer - Senior	40	$166.40	/hr	$6,656.00	Coordination for field work
Contracts/Admin/Procurement - Mid	4	$111.98	/hr	$447.92	Finalize procurement
Field Labor:					
Env. Engineer - Mid	490	$125.27	/hr	$61,382.30	10 hour days for 49 days
Travel:					
Per Diem	49	$59.00	/day	$2,891.00	
Lodging	49	$100.00	/day	$4,900.00	
Mileage	850	$0.655	/mile	$556.75	Destin, FL to Mobile (~100 mi.)
Injection Subcontractor:					
Project Management	1	$2,500.00	/LS	$2,500.00	Redox Tech, LLC quote
Mobe/Demobe	5	$3,500.00	/day	$17,500.00	Redox Tech, LLC quote
DPT Injection (3-person crew)	44	$5,500.00	/day	$242,000.00	Redox Tech, LLC quote
Materials:					
ABC+Ole	139,000	$1.50	/lb	$208,500.00	Redox Tech, LLC quote
Magnesium Oxide (pH buffer)	13,900	$0.75	/lb	$10,425.00	Redox Tech, LLC quote
Guar	2,780	$2.75	/lb	$7,645.00	Redox Tech, LLC quote
RTB-1	347.5	$140.00	/liter	$48,650.00	Redox Tech, LLC quote
Sodium Sulfite	35	$2.00	/lb	$70.00	Redox Tech, LLC quote
		Year 2 First Injection Event Cost Subtotal		$614,810.57	
		Year 2 First Injection Event Cost Subtotal (Rounded)		**$614,800**	

Post-First Injection Quarterly Performance Monitoring - Year 2

Assumptions:
1. Four quarterly performance monitoring events conducted by two staff.
2. The same 20 wells sampled during the baseline sampling event will be sampled for the same parameters with the same assumptions.
3. Cost will be the same as the baseline sampling event multiplied by four sampling events.

Year 2 Post-Injection Quarterly Monitoring Event Cost Subtotal	$100,928.74
Year 2 Post-Injection Quarterly Monitoring Event Cost Subtotal (Rounded)	**$100,900**

Draft RA Report - Year 2

Includes:
1. Complete Draft RA Report that summarizes the baseline sampling event and the first ERD/ISCR event.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	26	$171.65	/hr	$4,462.90	
Env. Engineer - Senior	60	$166.40	/hr	$9,984.00	
Env. Engineer - Mid	120	$125.27	/hr	$15,032.40	
GIS/CADD - Mid	40	$95.50	/hr	$3,820.00	
Adm Assist/Clerical - Mid	40	$72.73	/hr	$2,909.20	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
		Year 2 Draft RA Report Cost Subtotal		$36,708.50	
		Year 2 Draft RA Report Cost Subtotal (Rounded)		**$36,700**	

Draft Final RA Report - Year 2

Includes:
1. Complete Draft Final RA Report that summarizes the baseline sampling event and the first ERD/ISCR event.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	13	$171.65	/hr	$2,231.45	
Env. Engineer - Senior	30	$166.40	/hr	$4,992.00	
Env. Engineer - Mid	60	$125.27	/hr	$7,516.20	
GIS/CADD - Mid	20	$95.50	/hr	$1,910.00	
Adm Assist/Clerical - Mid	20	$72.73	/hr	$1,454.60	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
		Year 2 Draft Final RA Report Cost Subtotal		$18,604.25	
		Year 2 Draft Final RA Report Cost Subtotal (Rounded)		**$18,600**	

Table D-2
Cost Estimate for Alternative 3, ERD, ISCR, and Enhanced MNA
OMS #28
Alabama Army National Guard - Mobile, Alabama

Final RA Report - Year 2

Includes:
1. Complete Final RA Report that summarizes the baseline sampling event and the first ERD/ISCR event.

Service/Materials	Unit	Unit Cost		Cost
Labor:				
Project Manager	10	$171.65	/hr	$1,716.50
Env. Engineer - Senior	40	$166.40	/hr	$6,656.00
Env. Engineer - Mid	40	$125.27	/hr	$5,010.80
GIS/CADD - Mid	20	$95.50	/hr	$1,910.00
Adm Assist/Clerical - Mid	20	$72.73	/hr	$1,454.60
Materials:				
Document Reproduction	1	$500.000	/ea	$500.00
		Year 2 Final RA Report Cost Subtotal		$17,247.90
		Year 2 Final RA Report Cost Subtotal (Rounded)		**$17,200**

Post-First Injection Semi-Annual Performance Monitoring - Year 3

Assumptions:
1. Two semi-annual performance monitoring events conducted by two staff.
2. The same 20 wells sampled during the baseline sampling event will be sampled for the same parameters with the same assumptions.
3. Cost will be the same as the baseline sampling event multiplied by two sampling events.

Year 3 Post-Injection Semi-Annual Monitoring Event Cost Subtotal	$50,464.37
Year 3 Post-Injection Semi-Annual Monitoring Event Cost Subtotal (Rounded)	**$50,500**

Draft RA-O Report - Year 3

Includes:
1. Complete Draft RA-O Report.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	26	$171.65	/hr	$4,462.90	
Env. Engineer - Senior	60	$166.40	/hr	$9,984.00	
Env. Engineer - Mid	120	$125.27	/hr	$15,032.40	
GIS/CADD - Mid	40	$95.50	/hr	$3,820.00	
Adm Assist/Clerical - Mid	40	$72.73	/hr	$2,909.20	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
		Year 3 Draft RA-O Report Cost Subtotal		$36,708.50	
		Year 3 Draft RA-O Report Cost Subtotal (Rounded)		**$36,700**	

Draft Final RA-O Report - Year 3

Includes:
1. Complete Draft Final RA-O Report.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	13	$171.65	/hr	$2,231.45	
Env. Engineer - Senior	30	$166.40	/hr	$4,992.00	
Env. Engineer - Mid	60	$125.27	/hr	$7,516.20	
GIS/CADD - Mid	20	$95.50	/hr	$1,910.00	
Adm Assist/Clerical - Mid	20	$72.73	/hr	$1,454.60	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
		Year 3 Draft Final RA-O Report Cost Subtotal		$18,604.25	
		Year 3 Draft Final RA-O Report Cost Subtotal (Rounded)		**$18,600**	

Final RA-O Report - Year 3

Includes:
1. Complete Final RA-O Report.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	10	$171.65	/hr	$1,716.50	
Env. Engineer - Senior	40	$166.40	/hr	$6,656.00	
Env. Engineer - Mid	40	$125.27	/hr	$5,010.80	
GIS/CADD - Mid	20	$95.50	/hr	$1,910.00	
Adm Assist/Clerical - Mid	20	$72.73	/hr	$1,454.60	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
		Year 3 Final RA-O Report Cost Subtotal		$17,247.90	
		Year 3 Final RA-O Report Cost Subtotal (Rounded)		**$17,200**	

Table D-2
Cost Estimate for Alternative 3, ERD, ISCR, and Enhanced MNA
OMS #28
Alabama Army National Guard - Mobile, Alabama

Post-First Injection Annual Performance Monitoring - Year 4

Assumptions:
1. One annual performance monitoring event conducted by two staff.
2. The same 20 wells sampled during the baseline sampling event will be sampled for the same parameters with the same assumptions.
3. Cost will be the same as the baseline sampling event.
4. RA-O report will provide details for a second ERD/ISCR injection event and the associated monitoring details.

Year 4 Post-Injection Annual Monitoring Event Cost Subtotal	$25,232.18
Year 4 Post-Injection Annual Monitoring Event Cost Subtotal (Rounded)	**$25,200**

Draft RA-O Report - Year 4

Includes:
1. Complete Draft RA-O Report.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	26	$171.65	/hr	$4,462.90	
Env. Engineer - Senior	60	$166.40	/hr	$9,984.00	
Env. Engineer - Mid	120	$125.27	/hr	$15,032.40	
GIS/CADD - Mid	40	$95.50	/hr	$3,820.00	
Adm Assist/Clerical - Mid	40	$72.73	/hr	$2,909.20	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
Year 4 Draft RA-O Report Cost Subtotal				$36,708.50	
Year 4 Draft RA-O Report Cost Subtotal (Rounded)				**$36,700**	

Draft Final RA-O Report - Year 4

Includes:
1. Complete Draft Final RA-O Report.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	13	$171.65	/hr	$2,231.45	
Env. Engineer - Senior	30	$166.40	/hr	$4,992.00	
Env. Engineer - Mid	60	$125.27	/hr	$7,516.20	
GIS/CADD - Mid	20	$95.50	/hr	$1,910.00	
Adm Assist/Clerical - Mid	20	$72.73	/hr	$1,454.60	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
Year 4 Draft Final RA-O Report Cost Subtotal				$18,604.25	
Year 4 Draft Final RA-O Report Cost Subtotal (Rounded)				**$18,600**	

Final RA-O Report - Year 4

Includes:
1. Complete Final RA-O Report.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	10	$171.65	/hr	$1,716.50	
Env. Engineer - Senior	40	$166.40	/hr	$6,656.00	
Env. Engineer - Mid	40	$125.27	/hr	$5,010.80	
GIS/CADD - Mid	20	$95.50	/hr	$1,910.00	
Adm Assist/Clerical - Mid	20	$72.73	/hr	$1,454.60	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
Year 4 Final RA-O Report Cost Subtotal				$17,247.90	
Year 4 Draft RA-O Report Cost Subtotal (Rounded)				**$17,200**	

Table D-2
Cost Estimate for Alternative 3, ERD, ISCR, and Enhanced MNA
OMS #28
Alabama Army National Guard - Mobile, Alabama

Second ERD/ICSR Injection Event - Year 5

Includes:

1. One injection event with 100 injection points based on 15-foot spacing between the points.
2. Injection intervals (30 points between 6 and 14 ft bgs, 62 points between 14 and 26 ft bgs, 8 points between 27 and 31 ft bgs).
3. Individual injections are conducted every 2 vertical feet apart over the entire injection interval in a bottom-to-top approach.
4. 100 lbs ABC+Ole, 10 lbs magnesium oxide, 2 lbs guar, 0.25 liters RTB-1, and 0.025 lbs sodium sulfite in approximately 50 gallons of water per injection interval.
5. Estimated completion of 1,600 gallons of injectate per day
6. Estimate 25 days to complete. 23 days of field work and 2 days of mobe/demobe. Three injection crew members with oversight by Jr. Engineer.

Service/Materials	Unit	Unit Cost		Cost	Notes
Office Labor:					
Project Manager	5	$171.65	/hr	$858.25	
Env. Engineer - Senior	40	$166.40	/hr	$6,656.00	Coordination for field work
Contracts/Admin/Procurement - Mid	8	$111.98	/hr	$895.84	Finalize procurement
Field Labor:					
Env. Engineer - Junior	250	$87.00	/hr	$21,750.00	10 hour days for 25 days
Travel:					
Per Diem	25	$59.00	/day	$1,475.00	
Lodging	25	$100.00	/day	$2,500.00	
Mileage	430	$0.655	/mile	$281.65	Destin, FL to Mobile (~100 mi.)
Injection Subcontractor:					
Project Management	1	$2,500.00	/LS	$2,500.00	Based on Redox Tech quote
Mobe/Demobe	2	$3,500.00	/day	$7,000.00	Based on Redox Tech quote
DPT Injection (3-person crew)	23	$5,500.00	/day	$126,500.00	Based on Redox Tech quote
Materials:					
ABC+Ole	68,800	$1.50	/lb	$103,200.00	Based on Redox Tech quote
Magnesium Oxide (pH buffer)	6,880	$0.75	/lb	$5,160.00	Based on Redox Tech quote
Guar	1,376	$2.75	/lb	$3,784.00	Based on Redox Tech quote
RTB-1	172	$140.00	/liter	$24,080.00	Based on Redox Tech quote
Sodium Sulfite	17	$2.00	/lb	$34.00	Based on Redox Tech quote
	Year 5 Second Injection Event Cost Subtotal			$306,674.74	
	Year 5 Second Injection Event Cost Subtotal (Rounded)			**$306,700**	

Table D-2
Cost Estimate for Alternative 3, ERD, ISCR, and Enhanced MNA
OMS #28
Alabama Army National Guard - Mobile, Alabama

Post Second-Injection Quarterly Sampling Event - Year 5

Includes:

1. GW monitoring event for VOCs for 12 wells.
2. GW monitoring event for MNA for 4 wells and for qPCR for 2 wells.
3. Data verification and evaluation (results reported in RA-O Report).

4. Number of wells sampled =	12	wells	
5. Field crew =	2	personnel	
6. Sampling Duration =	1.5	days	(10 hr days)
7. Total VOC Samples =	15	samples	(12 wells + 10% FD + 5%MS/MSD + 10% TB)
8. Total MNA Samples =	4	samples	(4 wells with no FDs or TBs)
9. Total qPCR Samples =	2	samples	(2 wells with no FDs or TBs)
10. Total event =	1	events	
11. Total prep/mobe/demobe time =	8	hrs	
12. Total field time with prep/mobe/demobe =	23	hrs	(10 hr days)

Data Management and QA/QC Assumptions:

Geologist - Junior	1	hr/sample
Chemist - Mid	0.75	hr/sample
Database Manager	1.5	hr/sample
Env. Engineer - Senior	0.175	hr/sample

Service/Materials	Unit	Unit Cost		Cost	Notes
Data Management Labor:					
Geologist - Junior	19	$75.71	/hr	$1,438.49	
Chemist - Mid	15	$117.02	/hr	$1,755.30	
Database Manager	29	$82.17	/hr	$2,382.93	
Env. Engineer - Senior	4	$166.40	/hr	$665.60	
Procurement:					
Contracts/Admin/Procurement - Mid	6	$111.98	/hr	$671.88	Procure Lab and IDW Disposal
Office Oversight:					
Project Manager	5	$171.65	/hr	$858.25	
Env. Engineer - Senior	4	$166.40	/hr	$665.60	
Sampling Field Labor:					
Env. Engineer - Junior	23	$87.00	/hr	$2,001.00	
Geologist - Junior	23	$75.71	/hr	$1,741.33	
Materials:					
Sampling Equipment	2	$179.57	/ea	$359.14	AECOM Equip. Rental Rate
Drums	1	$95.00	/ea	$95.00	Based on WHE Quote
IDW Management:					
IDW Transporation	1	$1000.00	/ea	$1,000.00	Based on WHE Quote
IDW Disposal	1	$150.00	/ea	$150.00	Based on WHE Quote
Analytical:					
VOCs	15	$50.00	/ea	$750.00	Based on Pace Analytical
Dissolved Iron	4	$15.00	/ea	$60.00	Based on Pace Analytical
Total Iron	4	$15.00	/ea	$60.00	Based on Pace Analytical
Methane, Ethane, Ethene	4	$65.00	/ea	$260.00	Based on Pace Analytical
Total Organic Carbon	4	$25.00	/ea	$100.00	Based on Pace Analytical
Total Alkalinity	4	$15.00	/ea	$60.00	Based on Pace Analytical
DHC/DHB	2	$375.00	/ea	$750.00	Based on Pace Analytical
Daily Shipping	2	$100.00	/ea	$200.00	Fed Ex Cost
Travel:					
Per Diem	4	$59.00		$236.00	
Lodging	4	$100.00		$400.00	
Mileage	210	$0.655		$137.55	
Year 5 Post-Second Injection Event Quarterly Sampling Cost Subtotal (1 event)				$16,798.07	
Year 5 Post-Second Injection Event Sampling Cost Subtotal (4 events)				$67,192.30	
Year 5 Post-Second Injection Event Sampling Cost Subtotal (4 events) (Rounded)				**$67,200**	

RA-O Report - Year 5

Assumptions:

1. Cost of Draft, Draft Final, and Final RA-O Report together.
2. 75% of the total cost ($72,500) to do the Draft, Draft Final, and Final RA-O Reports following the first injection event.

Year 5 RA-O Report Subtotal (Rounded) **$54,375**

Table D-2
Cost Estimate for Alternative 3, ERD, ISCR, and Enhanced MNA
OMS #28
Alabama Army National Guard - Mobile, Alabama

CERCLA Five-Year Review - Year 5

Includes:
1. One site visit for one person.
2. Assume 2 hours for mobe, 4 hours on site, 2 hours demobe for site visit.
3. Draft, Draft-Final, and Final 5-Year Review

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	27	$171.65	/hr	$4,634.55	
Env. Engineer - Junior	120	$87.00	/hr	$10,440.00	
Env. Engineer - Mid	60	$125.27	/hr	$7,516.20	
Geologist - Junior	8	$75.71	/hr	$605.68	
GIS/CADD - Mid	30	$95.50	/hr	$2,865.00	
Adm Assist/Clerical - Mid	40	$72.73	/hr	$2,909.20	
Materials:					
Document Repro/Ship (D, DF, F)	3	$500.00	/ea	$1,500.00	
Travel:					
Per Diem	1	$59.00	/day	$59.00	
Lodging	0	$100.00	/day	$0.00	
Mileage	200	$0.655	/mile	$131.00	Destin, FL to Mobile, AL
CERCLA Five-Year Review Cost Subtotal				$30,660.63	
CERCLA Five-Year Review Cost Subtotal (Rounded)				**$30,700**	

Post Second-Injection Semi-Annual Sampling Event - Year 6

Assumptions:
1. Two semi-annual performance monitoring events conducted by two staff.
2. The same 12 wells sampled during the Year 5 sampling events will be sampled for the same parameters with the same assumptions.
3. Cost will be the same as one Year 5 quarterly sampling event multiplied by two sampling events.

Year 6 Post-Injection Semi-Annual Monitoring Event Cost Subtotal $33,596.15

Year 6 Post-Injection Semi-Annual Monitoring Event Cost Subtotal (Rounded) $33,600

RA-O Report - Year 6

Assumptions:

1. Rolls cost of Draft, Draft Final, and Final RA-O Report together.
2. 75% of the total cost ($72,500) to do the Draft, Draft Final, and Final RA-O Reports following the first injection event.

Year 6 RA-O Report Subtotal (Rounded) $54,375

Post Second-Injection Annual Sampling Event - Year 7

Assumptions:
1. One annual performance monitoring events conducted by two staff.
2. The same 12 wells sampled during the Year 5 & 6 sampling events will be sampled for the same parameters with the same assumptions.
3. Cost will be the same as one Year 5 quarterly sampling event.

Year 7 Post-Injection Semi-Annual Monitoring Event Cost Subtotal $16,798.07

Year 7 Post-Injection Semi-Annual Monitoring Event Cost Subtotal (Rounded) $16,800

Draft RA Completion Report - Year 7

Includes:
1. Complete Draft RA Completion Report.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	28	$171.65	/hr	$4,806.20	
Env. Engineer - Senior	80	$166.40	/hr	$13,312.00	
Env. Engineer - Mid	120	$125.27	/hr	$15,032.40	
GIS/CADD - Mid	40	$95.50	/hr	$3,820.00	
Adm Assist/Clerical - Mid	40	$72.73	/hr	$2,909.20	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
Year 7 Draft RA Completion Report Cost Subtotal				$40,379.80	
Year 7 Draft RA Completion Report Cost Subtotal (Rounded)				**$40,400**	

Table D-2
Cost Estimate for Alternative 3, ERD, ISCR, and Enhanced MNA
OMS #28
Alabama Army National Guard - Mobile, Alabama

Draft Final RA Completion Report - Year 7

Includes:
1. Complete Draft Final RA Completion Report.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	14	$171.65	/hr	$2,403.10	
Env. Engineer - Senior	40	$166.40	/hr	$6,656.00	
Env. Engineer - Mid	60	$125.27	/hr	$7,516.20	
GIS/CADD - Mid	20	$95.50	/hr	$1,910.00	
Adm Assist/Clerical - Mid	20	$72.73	/hr	$1,454.60	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
Year 7 Draft Final RA Completion Report Cost Subtotal				$20,439.90	
Year 7 Draft Final RA Completion Report Cost Subtotal (Rounded)				**$20,400**	

Final RA Completion Report - Year 7

Includes:
1. Complete Final RA Completion Report.

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor:					
Project Manager	10	$171.65	/hr	$1,716.50	
Env. Engineer - Senior	40	$166.40	/hr	$6,656.00	
Env. Engineer - Mid	40	$125.27	/hr	$5,010.80	
GIS/CADD - Mid	20	$95.50	/hr	$1,910.00	
Adm Assist/Clerical - Mid	20	$72.73	/hr	$1,454.60	
Materials:					
Document Reproduction	1	$500.000	/ea	$500.00	
Year 7 Final RA Completion Report Cost Subtotal				$17,247.90	
Year 7 Final RA Completion Report Cost Subtotal (Rounded)				**$17,200**	

Monitoring Well Abandonment - Year 7

Includes:
1. Abandonment of all site monitoring wells (22 total). Includes 2 deep wells that are not part of the proposed monitoring program.
2. Well abandonment (2 days with consultant oversight).
3. Oversight of disposal of 2 drums of non-hazardous water (1 day).

Service/Materials	Unit	Unit Cost		Cost	Notes
Labor (Well Abandonment):					
Project Manager	4	$171.65	/hr	$686.60	
Geologist - Junior	28	$75.71	/hr	$2,119.88	Well abandon & IDW oversight
Contracts/Admin/Procurement - Mid	8	$111.98	/hr	$895.84	Subcontractor produrment
Travel:					
Per Diem	3	$59.00	/day	$177.00	
Lodging	1	$100.00	/day	$100.00	
Mileage	400	$0.66	/mile	$262.00	Destin, FL to Mobile, AL
Drilling Subcontractor Services:					
Project Mobe/Demobe	1	$750.00	/ea	$750.00	WHE Quote - 6/21/2023
Well Abanonment	607	$5.00	/LF	$3,032.50	
Decontamination Pad	1	$350.00	LS	$350.00	WHE Quote - 6/21/2023
Per Diem	2	$600.00	/day	$1,200.00	WHE Quote - 6/21/2023
55-Gal Drums for Soil & Water	2	$95.00	/ea	$190.00	WHE Quote - 6/21/2023
Transportation of Drums for Disposal	1	$1,000.00	/ea	$1,000.00	WHE Quote - 6/21/2023
Disposal of Drums	2	$150.00	/ea	$300.00	WHE Quote - 6/21/2023
Analytical:					
TCLP VOCs	1	$150.00	/ea	$150	Waste Characterization
Year 7 Monitoring Well Abandonment Subtotal				$11,213.82	
Year 7 Monitoring Well Abandonment Subtotal (Rounded)				**$11,200**	

Table D-2
Cost Estimate for Alternative 3, ERD, ISCR, and Enhanced MNA
OMS #28
Alabama Army National Guard - Mobile, Alabama

Owner Cost

Includes:
1. Initiate
2. Contract
3. Oversee
4. Direct
5. Implement
6. Closeout
7. One quarter of total Owner Cost applied as Periodic Cost in Year 0, Year 2, Year 4, and Year 7 of the Present Worth Value cost spreadsheet.

Owner Cost (11% of total alternative cost)	$206,013.50
Owner Cost (Rounded)	**$206,000**

Alternative 3 Total Cost (Rounded)	**$2,078,900**
Alternative 3 Total Net Present Worth (Rounded)	**$1,823,100**
Total Contingency (20%)	**$364,600**
Alternative 3 Total Net Present Worth Cost (Rounded)	**$2,187,700**

Table D-2
Cost Estimate for Alternative 3
ERD, ISCR, and Enhanced MNA
OMS #28
Alabama Army National Guard - Mobile, Alabama

PRESENT WORTH SUMMARY

Alternative 3	Site:	OMS #28
ERD, ISCR, and	Location:	ALARNG, Mobile, AL
Enhanced MNA	Phase:	Feasilbility Study
	Base Year:	2023

Present Value Analysis

30-year discount rate (i) 4.2% (OMB Circular A-94 Appendix C) - Revised December 12, 2022

Year	Capital Cost	Annual O&M	Periodic Costs	Total Costs	Present Worth
0	$0	-	$51,500	$51,500	$51,500
1	$211,000	-	-	$211,000	$202,495
2	$614,800	$173,400	$51,500	$839,700	$773,372
3		$123,000	-	$123,000	$108,718
4	-	$97,700	$51,500	$149,200	$126,560
5	$306,700	$121,575	$30,700	$458,975	$373,637
6	-	$87,975	-	$87,975	$68,731
7	-	$94,800	$62,700	$157,500	$118,088
TOTALS	**$1,132,500**	**$698,450**	**$247,900**	**$2,078,850**	**$1,823,103**

APPENDIX E

Groundwater COC Degradation Rate Estimates

Groundwater TCE Degradation Rate Estimates

OMS #28

Contract No.: W91278-20-D-0020
Delivery Order/Call No. W91278-20-D-0020

Prepared for:
United States Army Corps of Engineers, Mobile District
United States Army National Guard

United States Army National Guard
111 S. George Mason Dr.
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June 2022

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LIST OF ATTACHMENTS

ATTACHMENT	TITLE
1	First-Order Decay Rate Estimates
2	Literature-Derived Decay Rate Estimates

LIST OF ABBREVIATIONS AND ACRONYMS

µg/L	micrograms per liter
ALARNG	Alabama Army National Guard
cis-1,2-DCE	cis-1,2-dichloroethene
COC	Chemicals of Concern
ERD	Enhanced Reductive Dechlorination
FS	Feasibility Study
ISCR	In Situ Chemical Reduction
MCL	Maximum Contaminant Level
MNA	Monitored Natural Attenuation
MW	Monitoring Well
OMS #28	Organizational Maintenance Shop # 28
PCE	Tetrachloroethene
RGs	Remedial Goals
TCE	Trichloroethene
VC	Vinyl Chloride

1.0 INTRODUCTION

In the Feasibility Study (FS) for Operational Maintenance Shop # 28 (OMS #28), Alternative 3 (Enhanced Reductive Dechlorination [ERD], In Situ Chemical Reduction [ISCR] and Enhanced Monitored Natural Attenuation [MNA]) actively addresses site-specific groundwater chemicals of concern (COCs) associated with historical activities conducted by Alabama Army National Guard (ALARNG) at OMS #28 (Parcel E). These COCs include trichloroethene (TCE) and its associated breakdown products cis-1,2-dichloroethene (cis-1,2-DCE) and vinyl chloride (VC). An estimated time to meet the remedial goals (RGs) established in the FS for TCE in groundwater is developed in the following subsections. Note that cis-1,2-DCE and VC have never been detected in groundwater impacted by historical ALARNG activities conducted at OMS #28.

1.1 First-Order Decay Rate Calculation Method

Based on site investigative work completed prior to 2015, the potential source area for the TCE plume that emanates from ALARNG property appears to be the gravel parking area located within the vicinity of monitoring well (MW)-8. For Alternative 3, a site-specific degradation rate was first calculated using the first-order decay rate calculation method based upon analytical data collected from OMS-28-3, which is located approximately 50 feet north of the TCE source area.

Only two other wells have TCE in them besides OMS-28-3. MW-08, which is located in the TCE source area on ALARNG property, had TCE detected at a concentration (0.373 micrograms per liter [µg/L]) that was less than the maximum contaminant level (MCL) of 5 µg/L the last time it was sampled in May 2017. As a result, MW-08 has already met the RG for groundwater, and a degradation rate calculation is unnecessary. OMS-28-5 has consistently had tetrachloroethene (PCE), TCE, and cis-1,2-DCE detected in it; however, as explained in **Appendix C**, PCE and its breakdown products including TCE and cis-1,2-DCE are related to an offsite PCE spill that is not related to historical ALARNG activities conducted at OMS #28. Therefore, a first-order decay rate was also not developed for this monitoring well.

The results of the evaluation for OMS-28-3 indicated a slightly decreasing degradation trend for TCE. Because the concentration (9.6 µg/L) of TCE detected in this well in May 2017 was only slightly above the MCL, the estimated time to clean up was 3.1 years. However, a review of the concentrations of TCE in source area groundwater detected during the Supplemental Data Gap Investigation via direct push technology sampling indicated that the highest concentration of TCE near the ALARNG property source area was detected at OMS-28-GW07 at a concentration of 310 µg/L. Using this concentration, the estimated time to reach the MCL for TCE was 19.6 years. **Attachment 1** contains the first-order decay rate calculations for OMS-28-3.

Upon further review of these results, it can be seen that the regression line R-squared value calculated for TCE was poor (0.4018). The R-squared value is a statistical measure of how close the data fits to the plotted COC degradation regression line. As a result, the predicted time to reach the RG of the MCL for TCE in site groundwater is highly uncertain based on the groundwater results for OMS-28-3. As such, another method to estimate the time for TCE to meet the MCL was evaluated.

1.2 LITERATURE-BASED ESTIMATION METHOD

The site-specific first-order decay rate calculation result described in Section 1.1 appears to be artificially high and suspect due to the large scatter in the data. A slower degradation rate would be expected based on the characteristics of the TCE groundwater plume, which include being oxidative and also somewhat acidic. For highly oxidized compounds such as TCE, natural attenuation under these conditions would be expected to be slow. Natural attenuation of this plume would primarily be a function of non-destructive mechanisms such as mechanical dispersion, advection, and dilution rather than destructive biological processes, which would be inhibited by the ambient site groundwater conditions. The length of time that the site-related groundwater COCs have remained in groundwater at OMS #28 is also indicative of a lack of ongoing destructive biological degradation. As a result, an estimate for the rate of degradation of the TCE plume was calculated based on using the most conservative (i.e., longest) published half-lives available for this compound, which were found in the *Handbook of Environmental Degradation Rates* (Howard et al., 1991).

For TCE, its half-life in groundwater ranged between 10.7 months and 4.5 years. The highest concentration of TCE detected for the plume that emanates from the ALARNG property was observed at temporary groundwater sampling location OMS-28-GW07 in May 2017. Conservatively using the longest half-life for TCE, it was estimated that it would take almost 27 years, starting in June 2017, to reach the RG of 5 µg/L for TCE in the year 2044 (**Attachment 2**). Assuming that the FS, Proposed Plan, and Decision Document are all concurred with by the end of 2025, it is estimated that it would take a little over 18 years to achieve the RG for TCE. It should be noted that these estimated time frames assume that there is not an ongoing contributing source of these COCs to the impacted groundwater, and they do not take into account the effects of potential matrix back diffusion.

Based upon a subsequent literature review, a degradation rate for TCE via the proposed ERD, ISCR, and Enhanced MNA remedial alternative was also estimated. In the article *Enhanced Bioremediation Field Experience: Using Observed Half Lives in Design and Prediction* (Moreno et. al., 2015), it was observed that degradation half-lives were approximately ten times faster when using zero valent iron than without it. As such, the degradation half-live for TCE was increased by 10 times for this alternative. The predicted time for TCE to reach its RG assuming that the first injection event would occur in 2027 was a little over 2.5 years (**Attachment 2**). This allows for one year after the approval of the Decision Document at the end of 2025 in order to prepare a Remedial Design/Remedial Action Work Plan for the proposed injection work. This estimated timeframe assumes that contact between the injected ERD/ISCR project and the targeted TCE plume can be adequately achieved. To be conservative, at least two ERD/ISCR injection events are recommended.

In total, the duration of Alternative 3 (ERD, ISCR, and Enhanced MNA) is expected to be approximately 7 years.

2.0 REFERENCES

Howard et al., 1991. Handbook of Environmental Degradation Rates, Lewis Publishers, Chelsea, Michigan.

Moreno et. al., 2015. Enhanced Bioremediation Field Experience: Using Observed Half Lives in Design and Prediction ..\..\Moreno et al_Using Observed Half Lives in Design and Prediction.pdf

Attachments

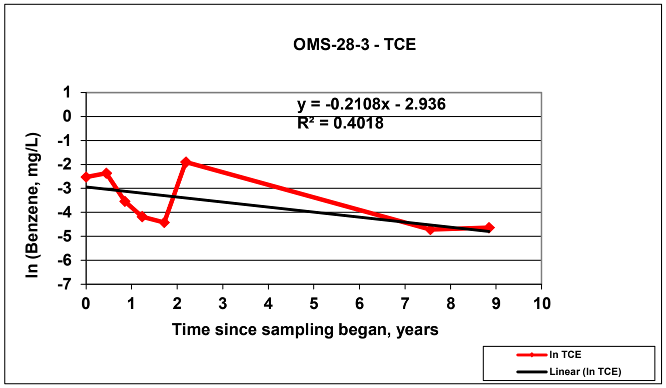
Attachment 1
First-Order Decay Rate Estimates

Attachment 1
First-Order Decay Rate Calculation for TCE in OMS-28-3
OMS #28
Alabama Army National Guard, Mobile, Alabama

Facility Name: **OMS #28**

Well ID: **OMS-28-3, OMS-GW32**

Sampling Date	Depth to Ground Water feet	TCE OMS-28-3 mg/L	TCE OMS-28-3 ug/L	ln TCE OMS-28-3 mg/L	Elapsed time since 7/1/08 years
1-Jul-08		0.0800	80	-2.526	0.00
11-Dec-08		0.0940	94	-2.364	0.45
8-May-09		0.0290	29	-3.540	0.85
24-Sep-09		0.0153	15.29	-4.181	1.23
19-Mar-10		0.0120	12	-4.423	1.72
8-Sep-10		0.1490	149	-1.904	2.19
20-Jan-16		0.0089	8.92	-4.719	7.56
5-May-17		0.0096	9.6	-4.646	8.85
MCL		***0.005***	***5***	***-5.298317367***	



Formula

$t = -[\ln(C_{CL}/C_o)] / k_{point}$

where:

t = Time to achieve cleanup levels, years
C_{CL} = Cleanup level for contaminant of concern, mg/L
C_o = Initial concentration of contaminant of concern, mg/L
k_{point} = First-order decay rate constant at one monitoring point, years^{-1}
= slope of the trend line, y

Solutions - Note: R2 value indicates data is not a good fit; use predictions with caution

OMS-28-3, TCE			
Enter C_{CL}	⟹	**0.005**	
Enter C_o	⟹	**0.0096**	
Enter k_{point}	⟹	**0.2108**	
Estimated time to reach cleanup level		**3.1**	**years**

Solutions - Note: R2 value indicates data is not a good fit; use predictions with caution

OMS-28-GW07, TCE			
Enter C_{CL}	⟹	**0.005**	
Enter C_o	⟹	**0.31**	
Enter k_{point}	⟹	**0.2108**	
Estimated time to reach cleanup level		**19.6**	**years**

Attachment 2
Literature-Derived Decay Rate Estimates

Attachment 2
Literature-specific TCE Degradation Rate Set Up Table
OMS #28
Alabama Army National Guard, Mobile, Alabama

Context	k_{point} (day^{-1})	$t_{1/2}$ (days)	Molecular Weight	Reference
TCE Natural Attenuation	0.00042	1643	131.39	Howard et. al.
TCE ERD (w/iron)	0.00422	164	131.39	Moreno et. al.

ERD - Enhanced Reductive Dechlorination
k_{point} - First-order decay rate constant
$t_{1/2}$ - Half life
TCE - Trichlorethene

Attachment 2
TCE Degradation Rate Calculation - Natural Attenuation
OMS #28
Alabama Army National Guard, Mobile, Alabama

Site ID	**OMS #28**
Start (Calendar Year)	**2017.6**
Lag time (months)	**0**
	TCE NA
Half Life $t_{1/2}$ (days)	1643
Degradation Rate k_{point} (day-1)	0.00042
Goal	**5**
$[Contaminant]_0$ - ppb*	**310**
Molecular weight	131.39

***Based on groundwater sample result from OMS-28-GW07 collected on 5/19/2017.**

		TCE		
Year	**Days**	**TCE Goal**	**[TCE]**	**[TCE] mol**
2017.6	0	5.0	310.0	2.36E-06
2018.0	150	5.0	291.0	2.21E-06
2019.0	510	5.0	250.0	1.90E-06
2020.0	870	5.0	214.8	1.63E-06
2021.0	1230	5.0	184.5	1.40E-06
2022.0	1590	5.0	158.5	1.21E-06
2023.0	1980	5.0	134.5	1.02E-06
2024.0	2340	5.0	115.5	8.79E-07
2025.0	2700	5.0	99.2	7.55E-07
2026.0	3060	5.0	85.3	6.49E-07
2027.0	3420	5.0	73.2	5.57E-07
2028.0	3780	5.0	62.9	4.79E-07
2028.0	3810	5.0	62.1	4.73E-07
2028.1	3840	5.0	61.3	4.67E-07
2029.0	4170	5.0	53.4	4.06E-07
2030.0	4530	5.0	45.9	3.49E-07
2032.0	5250	5.0	33.8	2.58E-07
2033.0	5610	5.0	29.1	2.21E-07
2034.0	6000	5.0	24.7	1.88E-07
2035.0	6360	5.0	21.2	1.61E-07
2036.0	6720	5.0	18.2	1.39E-07
2037.0	7080	5.0	15.6	1.19E-07
2038.0	7440	5.0	13.4	1.02E-07
2039.0	7800	5.0	11.5	8.78E-08
2040.0	8160	5.0	9.9	7.55E-08
2041.0	8550	5.0	8.4	6.40E-08
2042.0	8910	5.0	7.2	5.50E-08
2043.0	9270	5.0	6.2	4.72E-08
2044.0	9630	5.0	5.3	4.06E-08
2044.4	9780	5.0	**5.0**	3.81E-08

Attachment 2
TCE Degradation Rate Calculation With Zero Valent Iron Enhancement
OMS #28
Alabama Army National Guard, Mobile, Alabama

Site ID	**OMS #28**	
Start (Calendar Year)	**2027**	
Lag time (months)	**0**	
	TCE (w/ ZVI)	
Half Life $t_{1/2}$ (days)	164	
Degradation Rate k_{point} (day-1)	0.00422	
Remedial Goal (RG)	**5**	
$[Contaminant]_0$ - ppb	**310**	*** Based on groundwater sampling results**
Molecular weight	131.39	**for OMS-28-GW07 collected on 5/19/2017.**

		TCE		
Year	**Days**	**TCE Goal**	**[TCE]**	**[TCE] mol**
2027.0	0	5.0	310.0	2.36E-06
2027.5	180	5.0	145.1	1.10E-06
2028.5	540	5.0	31.8	2.42E-07
2029.5	930	5.0	6.1	4.67E-08
2029.6	960	5.0	5.4	4.11E-08
2029.7	990	5.0	**4.8**	3.62E-08