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Supplemental Environmental Investigation Report Downtown Environmental Assessment Project, Montgomery, Alabama

Prepared for

Alabama Department of Environmental Management by the Downtown Environmental Alliance

April 2017

ch2m

PG and PE Certification

This Supplemental Environmental Investigation Report was prepared under the supervision of a Professional Geologist licensed by the Alabama Board of Licensure for Professional Geologists. It has also been prepared under the supervision of a Professional Engineer licensed by the Alabama Board of Licensure for Professional Engineers and Land Surveyors.

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Contents

PG and PE Certification

Acronyms and Abbreviations ..... **v**

Executive Summary **ES-1**
Site Characteristics ES-1
Summary of Objectives and Activities ES-1
Conceptual Site Model ES-2
Summary of Results ES-3
Preliminary Screening Evaluation ES-3

1 Introduction and Purpose **1-1**

2 Site Description **2-1**
2.1 Site-Related Chemicals 2-1
2.2 Land and Water Use 2-1
2.3 Geology/Hydrogeology 2-1
2.4 Surface Water Features 2-2

3 Environmental Investigation Activities **3-1**
3.1 Temporary Piezometer Installation 3-1
3.2 Groundwater Sampling 3-1
3.3 Soil Vapor and Geotechnical Investigation 3-1
3.3.1 Soil Vapor Sampling 3-1
3.3.2 Geotechnical Sampling 3-2
3.4 Cypress Creek Hydraulic Study 3-2
3.5 Bus Wash Sprayer Sampling 3-3
3.6 Surveying 3-3
3.7 Data Quality Evaluation Summary 3-3
3.8 Investigation Derived Waste Management 3-4

4 Investigation Results **4-1**
4.1 Groundwater Investigation 4-1
4.1.1 Nature and Extent 4-1
4.1.2 Natural Attenuation 4-2
4.2 Soil Vapor Investigation 4-2
4.3 Cypress Creek Hydraulic Study 4-3

5 Conceptual Site Model **5-1**
5.1 Source Areas and Release Mechanisms 5-1
5.2 Fate and Transport 5-1
5.2.1 Chemical Transport 5-1
5.2.2 Fate of Chemicals 5-2
5.3 Nature and Extent of Groundwater Contamination 5-2

6 Conclusions **6-1**

7 References **7-1**

Appendixes

A Soil Boring Logs and Well Completion Diagrams
B Groundwater and Soil Vapor Sample Logs
C Surveys
D Laboratory Reports and Data Quality Evaluation
E PCE Concentrations Time-Series Charts
F Mann-Kendall Trend Analysis

Tables

3-1 Well Construction Details
3-2 2016 Sampling Completed by Media
4-1 Groundwater Elevations – July 11, 2016
4-2 Groundwater Sampling Results
4-3 2016 Field Parameter Data
4-4 September 2016 Geotechnical Sampling Results
4-5 September 2016 Soil Vapor Sampling Results

Figures

ES-1 Site Map
ES-2 Conceptual Site Model
ES-3 PCE Groundwater Results – July 2016
1-1 Site Map
3-1 Investigation Locations
3-2 Cypress Creek Staff Gauge Schematic
4-1 July 2016 Shallow Potentiometric Surface
4-2 PCE Groundwater Results – July 2016
4-3 Soil Vapor Results
4-4 Cypress Creek Hydraulic Study Results
5-1 Conceptual Site Model
5-2 Extent of PCE Plume

Acronyms and Abbreviations

µg/L	micrograms per liter
AA/RA	alternatives analysis/risk assessment
ADEM	Alabama Department of Environmental Management
AG	Attorney General
AMS	AMS retract-a-tip
Annex	County Annex III
bgs	below ground surface
CH2M	CH2M HILL Engineers, Inc.
City	City of Montgomery
cm/s	centimeters per second
COPC	chemical of potential concern
CSM	conceptual site model
DEA	Downtown Environmental Alliance
DEAP	Downtown Environmental Assessment Project
EI	Environmental Investigation
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
ESC	Environmental Science Corporation
FD	field duplicate
GPS	global positioning system
HQ	hazard quotient
IDW	investigation derived waste
MCL	maximum contaminant level
MS	matrix spike
MSD	matrix spike duplicate
NPDES	National Pollutant Discharge Elimination System
PCE	tetrachloroethene
PPE	personal protective equipment
PRT	post-run-tubing
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
RSA	Retirement Systems of Alabama
RSL	Regional Screening Level

site	Montgomery DEAP site
TCE	trichloroethene
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
VC	vinyl chloride
VIMS	vapor intrusion monitoring system
VISL	vapor intrusion screening level
VOC	volatile organic compound
WQS	water quality standard

Executive Summary

This Supplemental Environmental Investigation (EI) report was prepared for the Alabama Department of Environmental Management (ADEM) by the Montgomery Downtown Environmental Alliance (DEA) to present the results of the EI activities completed at the Montgomery Downtown Environmental Alliance Project (DEAP) site (hereinafter known as the site). The site was identified initially by the detection of tetrachloroethene (PCE) at concentrations below the maximum contaminant level (MCL) in former public water supply well PW-9W in 1991, and in 1993, when PCE was identified in an excavation during the construction of the Retirement Systems of Alabama (RSA) Tower Energy Plant (hereinafter referred to as the RSA Energy Plant) located in downtown Montgomery, Alabama. The site includes these areas as well as groundwater surrounding and downgradient from the RSA Energy Plant (Figure ES-1). In addition to PCE, potential PCE degradation products such as trichloroethene (TCE), cis-1,2-dichloroethene (DCE), trans-1,2-DCE, and vinyl chloride were evaluated as part of the EI.

Site Characteristics

The DEAP site is composed of a mixture of predominantly commercial and industrial facilities, although there are residential-use buildings located within or near the site, they are outside of the areas impacted by PCE. All public water supply wells at the site were closed in 1991, following initial detection of PCE, and no private drinking water supply wells have been identified within the site boundaries. There is one commercial supply well located within the site boundary, which is used for commercial bus washing.

Surface water bodies in the site vicinity include the Alabama River and Cypress Creek, the latter of which comprises approximately a one-third mile portion of the northwestern site boundary and drains into the Alabama River. Surface water flow in Cypress Creek at the site boundary is partially restricted between two culverts (Figure ES-1).

Historical investigation results indicate that little to no residual mass remains in soil following the 1993 emergency removal action at the RSA Energy Plant. Based on historical findings and the results of the EI, the presence of PCE in groundwater is attributed to multiple historical releases from various sources within the downtown Montgomery study area. However, the historical soil and groundwater investigations concluded that there are no continuing sources of PCE to groundwater.

Summary of Objectives and Activities

The objective of the EI is to collect data in support of refining the conceptual site model (CSM), including the following:

- Assess the nature and extent of PCE in groundwater.
- Evaluate the potential for groundwater to impact surface water.
- Evaluate the vapor intrusion potential at the County Annex III (Annex) and Attorney General (AG) Buildings.
- Identify concentrations of soil vapor at locations where shallow groundwater concentrations exceeded U.S. Environmental Protection Agency (EPA) vapor intrusion screening levels (VISLs; EPA, 2016a).
- Provide sufficient data to evaluate potential exposure risk (to be presented in a separate deliverable).

The work conducted in support of this EI was completed between July 2016 and February 2017, and consisted of the following:

- Installation of temporary piezometer TMPZ-1 adjacent to Cypress Creek
- Groundwater sampling of TMPZ-1 and monitoring wells across the site
- A hydraulic study conducted in two separate month-long phases to evaluate the interaction between groundwater in TMPZ-1 and surface water in Cypress Creek and the Alabama River
- Soil vapor sampling adjacent to four wells where PCE concentrations were identified above the groundwater VISL during the July 2016 sampling, at an existing vapor intrusion monitoring system (VIMS), and adjacent to the AG and Annex Buildings
- Sampling of water from a commercial well located within the site boundary that pumps groundwater for bus washing

Conceptual Site Model

The results of the EI were used to refine the CSM presented on Figure ES-2, which is described below.

Two commingled PCE plumes were identified at the site. The source material contributing to the development of the PCE groundwater plume originating at the RSA Energy Plant was removed during an emergency action, and residual PCE in groundwater then migrated, toward Cypress Creek. North of the RSA Energy Plant, there is a second PCE plume, which originated from one or more separate sources in the vicinity of MW-12S.

Because the downgradient edge of the plumes is located adjacent to the downstream end of Cypress Creek at the Alabama River, a hydraulic study was conducted. The results of the study indicate PCE in the groundwater is impeded from further downgradient migration into Cypress Creek and the Alabama River. Cypress Creek is connected to the Alabama River through a culvert. Based on the elevation of the culvert and the close correlation in water levels between the creek and the river identified during the hydraulic study, backwater from the Alabama River is ponded in Cypress Creek. The nearby Alabama River acts as a hydraulic barrier between the leading edge of the PCE plume and Cypress Creek and limits the migration of the plume into the creek. The barrier effect caused by the Alabama River also may be a contributing factor to the higher PCE concentrations observed at downgradient well TMPZ-1 relative to other wells. Additionally, PCE in groundwater in this area commingles with the groundwater moving inland from the Alabama River, reducing concentrations prior to any potential discharge to surface water.

Although, geotechnical sampling results indicate similar physical soil properties across the site, variability in the PCE and TCE soil vapor concentrations relative to groundwater concentrations were noted. Concentrations of PCE detected in soil vapor were identified where elevated concentrations of PCE are in groundwater; therefore, the presence of PCE in soil vapor is attributed to volatilization of the plumes. Concentrations of TCE detected in soil vapor (such as MW-08S) are not associated with elevated groundwater concentrations (maximum concentration of 1.01 µg/L) and therefore, are likely related to separate releases to the vadose zone. The source of TCE in soil vapor may be related to historical releases from industrial areas that were not of sufficient quantity to migrate to the water table. At the VIMS, the following are noted for TCE concentrations in soil vapor: 1) they are upgradient of the PCE groundwater plume; 2) they are not co-located with TCE in groundwater; and 3) they were not detected at the Annex Building (less than 100 feet from the VIMS). Therefore, these TCE soil vapor concentrations are considered a separate, isolated occurrence originating from a separate source unrelated to the RSA Energy Plant.

Summary of Results

PCE and TCE were the only chemicals in groundwater that exceeded the lower of the maximum contaminant levels (MCLs) and EPA Regional Screening Levels (RSLs). Although TCE may be formed as PCE degrades, reported TCE concentrations were low (maximum 1.01 µg/L) and similar to the RSL of 0.49 µg/L but below the MCL. Therefore, the extents of the plumes are delineated based on PCE concentrations above the MCL of 5 µg/L, as shown on Figure ES-3.

The PCE plumes (originating from the RSA Energy Plant area and unknown sources from the industrialized area around MW-12S) extend northwest toward Cypress Creek (Figure ES-3), where the plumes commingle. The vertical extent of PCE in groundwater is limited to the shallow portion of the aquifer, as shown by low concentrations (below the MCL) and lack of detections in intermediate wells. The lateral extent of PCE in groundwater is delineated to Cypress Creek, where the influence of the Alabama River acts as a hydraulic barrier to impede further lateral migration and dilutes the leading edge of the commingled PCE plumes.

Preliminary Screening Evaluation

An initial screening of shallow groundwater analytical results indicates that PCE is present at concentrations above the MCL, as defined by the plume shown on Figure ES-3; however, groundwater in the downtown area is not used for drinking water. The soil vapor screening results indicate that two locations (MW-02S and MW-08S) exceed vapor intrusion screening levels (VISLs). for a residential scenario; however, no residential-use buildings are located near these locations (Figure ES-3). Samples collected from the VIMS exceeded the VISLs for a commercial scenario but samples collected adjacent to the Annex Building (less than 100 feet from the VIMS) did not exceed VISLs for a commercial scenario. Samples collected adjacent to the AG Building also did not exceed VISLs for a commercial scenario.

The shallow groundwater and shallow soil vapor results that exceed screening levels will be evaluated further as part of the alternatives analysis. In addition, the shallow soil vapor samples exceeding VISLs will be evaluated in the future risk assessment. The alternatives analysis and risk assessment will be presented together in the Risk Assessment/Alternatives Analysis Report, which will be prepared once the EI Report is finalized.

SECTION 1

Introduction and Purpose

This Supplemental Environmental Investigation (EI) Report is being submitted to the Alabama Department of Environmental Management (ADEM) by the Downtown Environmental Alliance (DEA) to document the results of the investigations conducted in accordance with the *Final Technical Work Plan – Downtown Environmental Assessment Project, Montgomery, Alabama* (CH2M HILL Engineers, Inc. [CH2M], 2016a) (hereinafter referred to as the Work Plan). The Work Plan was developed to meet the objective of further evaluating tetrachloroethene (PCE) in groundwater identified in former public water supply well PW-9W in 1991 and in 1993 during the construction of the Retirement Systems of Alabama (RSA) Tower Energy Plant (hereinafter referred to as the RSA Energy Plant). Figure 1-1 presents the site boundary.

This EI Report provides a summary of investigations completed at the Montgomery Downtown Environmental Alliance Project (DEAP), including groundwater, geotechnical, and soil vapor sampling, and a two-phase hydraulic study at Cypress Creek. The results of these investigations are evaluated to:

- Assess the current concentrations and trends of PCE in groundwater.
- Identify concentrations of PCE (and potential degradation products) in soil vapor within the site boundary where groundwater exceeds U.S. Environmental Protection Agency (EPA) residential vapor intrusion screening levels (VISLs; EPA, 2016a).
- Evaluate the potential for vapor intrusion in the vicinity of the current Alabama Attorney General (AG) Building and County Annex III (Annex) Building.
- Evaluate the potential for groundwater to impact surface water in Cypress Creek.

These data will be incorporated into a risk assessment for the DEAP and used to evaluate remedial alternatives. The risk and remedial alternative assessments will be provided in the Alternatives Analysis/Risk Assessment (AA/RA) Report to be submitted following approval of the Final EI.

SECTION 2

Site Description

The Montgomery DEAP site covers approximately 30 city blocks in downtown Montgomery, in Montgomery County, Alabama (Figure 1-1). The site boundary is defined based on the results of historical investigations by ADEM and EPA, and by the extent of PCE from the RSA Energy Plant area, other potential PCE sources from historical industrial activities and dry cleaning operations, and former public water supply well PW-9W. This EI evaluates PCE identified at these locations and the downgradient plume extent; the EI does not evaluate other urban contaminants from other sources in Montgomery.

Although not within the site boundary, additional investigation was historically conducted near two buildings based on previous odor/indoor air quality complaints during EPA's initial site work. The objective of the additional investigation by the DEA was to evaluate whether there was a potential for vapor intrusion. Those two buildings were:

- Annex Building
- AG Building

Based on the locations where PCE was discovered and data from multiple historical investigations in the area, the DEAP boundary is defined as shown on Figure 1-1.

2.1 Site-Related Chemicals

Although other chemicals that are commonly found in industrial or commercial areas were identified during the historical investigations, chemicals of potential concern (COPCs) investigated as part of the EI are limited to PCE, identified at the RSA Energy Plant and former public water supply well PW-9W, and associated degradation products: trichloroethene (TCE), cis-1,2-dichloroethene (DCE), trans-1,2-DCE, and vinyl chloride (VC).

2.2 Land and Water Use

The site is composed of a mixture of mainly commercial and industrial facilities. However, five residential properties, a daycare, and a school are located outside of the plume extent and along the boundaries of the site. With the exception of one well used for commercial bus washing, no groundwater extraction wells are present at the site. The North Well Field, which historically drew groundwater within the site boundary for public use, was closed in 1991 following initial detection of the PCE. The North Well Field was replaced with a new well field in southern Montgomery County. Most wells in the North Well Field were permanently abandoned (casing pulled and well grouted) in 2011; PW-9W was retained for environmental testing purposes only.

2.3 Geology/Hydrogeology

The geology beneath the DEAP consists of a thin soil layer on top of quaternary terrace deposits comprised of medium to coarse-grained sand, with interbedded clay and gravel lenses. Underlying these recent terrace deposits are Cretaceous sediments of the Eutaw, Gordo, and Coker formations. The Eutaw formation is an aquifer unit characterized by two thick layers of marine sands separated by a thin layer of marine clay (U.S. Geological Survey [USGS], 1987). The terrace deposits and Eutaw formation are combined to comprise the shallow aquifer. The Gordo and Coker aquifers consist of an estimated 500 feet of interbedded clay, sand, and gravel above crystalline bedrock.

The shallow aquifer is unconfined and 120 to 150 feet thick underneath the DEAP, but a localized low permeability zone may exist from approximately 35 to 50 feet below ground surface (bgs) (ADEM, 1995). Beneath the shallow aquifer, a low-permeability sandy clay unit effectively separates it from the underlying Gordo and Coker formations.

Water levels measured at the site in July 2016 range from approximately 25 to 57 feet bgs and groundwater generally flows west-northwest (toward Cypress Creek and the Alabama River). Based upon slug tests, hydraulic conductivity in the shallow aquifer has been estimated between 8.14×10^{-4} centimeters per second (cm/s) and 4.38×10^{-3} cm/s, with a geometric mean of 3.60×10^{-3} cm/s (Black & Veatch, 2002). The groundwater pore velocity in the shallow aquifer was calculated at 8.63×10^{-5} cm/s, based on the following equation:

$$v = Ki/n$$

Where:

K = geometric mean of the hydraulic conductivity slug test results (0.0036 cm/s)

n = geometric mean of the porosity values obtained from the Shelby tube samples in September 2016 (0.42)

i = hydraulic gradient between MW-10S and TMPZ-1 (calculated as 0.008 based on July 2016 groundwater elevation data

2.4 Surface Water Features

The northwestern portion of the site is located within the 100-year flood plain of the Alabama River (Office of Water Resources, 2017). Surface water features near the site include the Alabama River and Cypress Creek; the creek comprises approximately a one-third mile portion of the northwestern site boundary and drains directly into the Alabama River (Figure 1-1). Surface water contributions to Cypress Creek include overland flow during rainfall events as well as contributions from multiple industries located along upstream portions of the creek. In addition, treated groundwater discharges into Cypress Creek upstream of the site from the Coliseum Boulevard plume treatment system operated by the Alabama Department of Transportation under National Pollutant Discharge Elimination System (NPDES) permit AL0081167.

Surface water flow in Cypress Creek along the site boundary is partially restricted between two culverts (shown on Figure 1-1) that are at a higher elevation than the creek bed. The downstream culvert between the creek and the Alabama River restricts outflow, creating a ponded area immediately upstream.

SECTION 3

Environmental Investigation Activities

Groundwater, soil vapor, and geotechnical sampling were conducted between July and September 2016. A temporary piezometer (TMPZ-1) was installed near Cypress Creek to evaluate the interaction between groundwater and surface water along the segment where the PCE in groundwater was noted. This hydraulic study was conducted during a dry-weather season from July to August 2016 and wet-weather season in February 2017. In addition, a groundwater sample was collected from a commercial bus-washing facility located within the site boundary on February 20, 2017. Figure 3-1 shows the locations of these investigation activities.

3.1 Temporary Piezometer Installation

Temporary piezometer TMPZ-1 was installed adjacent to Cypress Creek near the northwestern site boundary (Figure 1-1) from July 18 to 20, 2016. TMPZ-1 was installed using a track-mounted sonic rig to a total depth of 48 feet bgs. Continuous soil core samples were collected from ground surface to the total depth and the lithology was logged by the CH2M field geologist. The soil boring log is included in Appendix A.

TMPZ-1 was constructed as a Type II monitoring well, in accordance with the Alabama Environmental Investigation and Remediation Guidelines (ADEM, 2008). The well completion diagram for TMPZ-1 is included in Appendix A. Table 3-1 includes a summary of well completion details for TMPZ-1, in addition to available completion details for other site monitoring wells.

3.2 Groundwater Sampling

On July 11, 2016, eight shallow and six intermediate monitoring wells were gauged using an electronic water level meter to an accuracy of 0.01 foot. It should be noted that MW-07S was classified previously as a shallow well because of its “S” designation; however, a review of the well installation log indicated that the well is screened from 85.0 to 94.7 feet bgs and therefore, MW-07S is reclassified as an intermediate well but retains the identification MW-07S. From July 11 through July 22, 2016, eight shallow and six intermediate (including MW-07S) monitoring wells were sampled for COPCs, as summarized in
Table 3-2.

Groundwater sampling was conducted using portable bladder pumps and the low-flow purge method. Specific conductance, pH, and turbidity measurements were allowed to stabilize for three consecutive readings while a steady water level was maintained prior to collecting the sample. Sample logs are included in Appendix B.

3.3 Soil Vapor and Geotechnical Investigation

Soil vapor probes were installed using both the GeoProbe post-run-tubing (PRT) and AMS retract-a-tip (AMS) methods, where appropriate, in accordance with Standard Operating Procedure for Installation of Temporary Soil Vapor Probes included in Appendix A of the Work Plan (CH2M, 2016a).

3.3.1 Soil Vapor Sampling

Soil vapor sample locations are shown on Figure 3-1 and summarized in Table 3-2. Three proposed samples were not collected as documented to ADEM in the October 4, 2016 *Request for Elimination of Soil Vapor Sampling Locations from Montgomery Downtown Environmental Assessment Project’s Technical Work Plan* (CH2M, 2016b). Per ADEM’s approval during a site visit on September 19, 2016, soil vapor samples were not collected from one proposed location at the AG Building and two proposed

locations at the Annex Building. Temporary soil vapor probes could not be installed west of the AG building or southwest of the Annex Building because of the density of underground utilities at each location. In addition, one probe could not be installed on the east side of the Annex Building because of the lack of safe access to external, ground-level sample locations.

Temporary soil vapor probes were installed using the AMS method on the north and east side of the AG Building and on the north and west side of the Annex Building (Figure 3-1). Probes were installed to a depth of 12 and 15 feet bgs adjacent to the AG Building to collect samples below the approximate depth of the sub-basement slab. Probes were installed to 12 feet bgs adjacent to the Annex Building to collect samples below the basement slab.

At MW-08S, MW-12S, and TMPZ-1, two temporary soil vapor probes were installed near each well using the PRT method. One shallow probe was installed to 8 feet bgs and the second, deep probe was installed to a depth approximately 3 to 5 feet above the water table (based on depth to water in the nearby well and available soil boring logs). At MW-02S, the shallow probe was installed using the AMS method after several attempts to install the probe using the PRT method failed to create a vapor tight seal. The deep probe at MW-02S was installed to 35 feet bgs using the PRT method.

Samples were shipped overnight to Environmental Science Corporation (ESC) in Mount Juliet, Tennessee for analysis of COPCs using EPA Method TO-15.

3.3.2 Geotechnical Sampling

Geotechnical samples were collected using Shelby tubes from boreholes adjacent to wells MW-02S, MW-08S, MW-12S, and TMPZ-1 (Table 3-2, Figure 3-1). Sample depths for the Shelby tubes were selected to target the various lithologies throughout the site as observed in monitoring well boring logs (Appendix A). Samples were shipped overnight to ESC and analyzed for bulk density, total porosity, saturated porosity, and fraction organic carbon.

3.4 Cypress Creek Hydraulic Study

A two-phase hydraulic study was conducted to evaluate groundwater/surface water interaction along the segment of Cypress Creek adjacent to the site. The first phase occurred during a dry-weather month and the second phase occurred during a wet-weather month to assess changes due to seasonal fluctuations. Phase I of the Cypress Creek hydraulic study was conducted from July 25 to August 26, 2016. Pressure transducers capable of recording the height of the water column above the transducer were installed in Cypress Creek and TMPZ-1. In addition, Alabama River levels recorded during the study period were downloaded from the USGS website from a staff gauge located approximately 0.69 mile upstream of the study area (Figure 3-1).

The Cypress Creek transducer was connected to a remote data transmitting device and installed inside a 4-inch polyvinyl chloride (PVC) pipe with a 5-foot screened interval at the bottom. The pipe was bolted to a signpost installed in Cypress Creek (Figure 3-2), such that the transducer tip hung 5.5 inches above the creek bed. The transducer in TMPZ-1 was installed inside the well with the tip at 1 foot above the bottom of the well. Both transducers were set to record the height of the water column every 15 minutes; however, on July 27, the creek transducer was set to record every 30 minutes to conserve battery.

The second phase of the Cypress Creek hydraulic study was proposed to be completed in December 2016. However, because of extreme drought in the Montgomery area, the second phase was postponed until February 2017 when sufficient rainfall had occurred. Based on the results of the July through August 2016 hydraulic study, which indicated no significant difference between Cypress Creek water elevations at the stream gauge location and Alabama River water elevations at the location of gauge USGS02419988 (approximately 0.69 mile upstream of the Cypress Creek gauge), the February 2017

hydraulic study compared the TMPZ-1 groundwater elevations with the Alabama River surface water elevations at gauge station USGS02419988. This change in study procedure was documented to ADEM in the September 6, 2016 Request for Modification (Martin, 2016, pers. comm.), and was subsequently approved.

3.5 Bus Wash Sprayer Sampling

A well was identified within the site boundary that pumps groundwater for commercial bus washing. To evaluate whether COPCs are present in groundwater from this well, facility personnel collected a water sample on February 20, 2017 from the location where pumped water is sprayed in the bus wash area.

3.6 Surveying

On July 26, 2016, Larry E. Speaks and Associates, Inc. performed a survey of the creek transducer elevation, and both horizontal coordinates and elevations of the ground surface and top of well casing at TMPZ-1. On October 5, 2016, Larry E. Speaks and Associates, Inc. performed a survey to establish horizontal coordinates and ground surface elevations of the soil vapor and geotechnical sampling locations. Surveying was conducted using global positioning system (GPS) equipment. The surveys are included in Appendix C.

3.7 Data Quality Evaluation Summary

Environmental data are subjected to a rigorous evaluation to assess whether the reported concentrations of possible chemicals are accurately representing the environmental conditions. A full assessment of the quality assurance/quality control (QA/QC) process to which the data were subjected is included in Appendix D, immediately following the laboratory reports. This section is a summary of the QA/QC review.

The analytical data presented for the 2016 groundwater, soil vapor, and soil sampling events and the 2017 bus wash sprayer sampling event were found to be usable and to accurately represent the environmental conditions at the site on the dates of sample collection. The samples were collected and transported to the laboratory in a timely manner and the samples arrived at the laboratory in good condition. The laboratory followed the EPA-approved methods for the analyses of the samples and most of the field and laboratory QA/QC samples were within criteria for the parameters analyzed.

Field, equipment, trip, and laboratory method blanks were used to monitor potential contamination introduced during field sampling, sample handling, and shipping activities, as well as sample preparation and analysis in the laboratory. Blanks analyzed for the 2016 and 2017 sampling events were reported as not detected for all target compounds.

Surrogate spike recoveries were used to monitor both laboratory performance and matrix interferences during volatile organic compound (VOC) analysis. Surrogate recoveries were reported within criteria for the VOC samples analyzed.

Matrix spike and matrix spike duplicate (MS/MSD) samples were prepared and analyzed to evaluate the effect of the sample matrix on the accuracy and precision of each analysis. Samples collected from groundwater monitoring well MW-09S were submitted to the laboratory for MS/MSD analysis during the July 2016 sampling event. Precision and accuracy criteria were met for all target compounds for the MS/MSD, along with the laboratory control sample/laboratory control sample duplicate.

Field duplicate (FD) samples were collected and analyzed to evaluate the precision of field sampling and the variability of the sample data. Groundwater monitoring wells MW-03S and MW-5I were selected for FD analysis during the July 2016 sampling event, soil vapor locations AMS-04-0916 and SV-MW12-22 were selected for FD analysis during the September 2016 sampling event, and a FD sample was collected

during the February 2017 bus wash sprayer sampling event. The native sample and FD sample results were compared and relative percent difference precision criteria were met with the exception of two VOCs. PCE and TCE results for SV-MW12-22 and SV-FD were “J” qualified to indicate the reported values are considered estimated concentrations because of the duplicate precision exceedances.

The data review of the field and laboratory QC samples concluded that the data set is usable as qualified and accurately represents the concentrations of the reported analytes.

3.8 Investigation Derived Waste Management

Investigation-derived waste (IDW) generated during the EI included purged groundwater, decontamination fluids, soil cuttings, personal protective equipment (PPE), and disposable sampling equipment. IDW was stored in labeled 55-gallon drums. Five soil drums and three groundwater/ decontamination fluid drums were used. Representative samples were collected from each drum for waste characterization. Soil IDW samples were submitted for toxicity characteristic leaching procedure VOC, Resource Conservation and Recovery Act metals, pH, and ignitability. Groundwater/ decontamination fluid IDW samples were submitted for VOC analysis.

Analytical results (Appendix D) indicated that the IDW was not characterized as a hazardous waste. Therefore, soil cuttings, used PPE, and disposable sampling equipment were disposed at the North Montgomery Landfill, as approved by ADEM in letters dated September 20, 2016 and November 2, 2016. Groundwater and decontamination fluid IDW was discharged at the Econchate Wastewater Treatment Plant as authorized by the Montgomery Water Works and Sanitary Sewer Board.

SECTION 4

Investigation Results

The results of the 2016 and 2017 field investigation, including groundwater and soil vapor sampling, and the two-phase hydraulic study, are discussed in this section.

4.1 Groundwater Investigation

The results of the July 2016 gauging and sampling events are summarized in Tables 4-1 and 4-2, respectively. Results of the February 2017 commercial bus wash water sample analysis are presented in Table 4-2. The July 2016 field parameter data and potentiometric surface map for the shallow groundwater-bearing unit are presented on Table 4-3 and Figure 4-1, respectively.

4.1.1 Nature and Extent

To evaluate the results of the investigation, analytical data are compared to the lower of the EPA maximum contaminant levels (MCLs) and Regional Screening Levels (RSLs) for tap water (EPA, 2016b) in Table 4-2. Results indicate that PCE and TCE are present in groundwater above the respective criteria. However, TCE concentrations are generally low (1.01 micrograms per liter [µg/L] or less), slightly above the RSL of 0.49 µg/L and less than the MCL. Trans-1,2-DCE and VC were not detected, and cis-1,2-DCE was detected in only two samples but below its RSL and MCL. Because of the low concentrations of TCE, the potential for TCE to be formed as PCE degrades, and the identification of PCE at the RSA Energy Plant and former supply well PW-9W, groundwater impacts at the site are delineated based on PCE above the MCL of 5 µg/L, as shown on Figure 4-2.

The following observations can be made about the horizontal and vertical extent of PCE in groundwater:

- PCE has been laterally and vertically delineated.
- Concentrations exceeded the MCL in five shallow wells (MW-02S, MW-03S, MW-08S, MW-12S, and TMPZ-1).
- PCE in groundwater is composed of two distinct plumes with multiple sources:
  - From the historical RSA Energy Plant, a plume extends to the downstream end of Cypress Creek, adjacent to the Alabama River.
  - From the industrialized area around MW-12S, the second plume also extends toward Cypress Creek, where the two plumes comingle.
- PCE concentrations generally increase in the downgradient areas of the plumes (Figure 4-2), with the highest concentration reported at the farthest downgradient well, TMPZ-1.
- The vertical extent of PCE in groundwater is limited to the upper portion of the shallow aquifer, as confirmed by concentrations below the MCL or the lack of detection in intermediate monitoring wells.

As a conservative approach, to screen groundwater data for vapor intrusion potential, groundwater concentrations also were compared to residential VISLs (Table 4-2), based on a target excess lifetime cancer risk (ELCR) of 1×10^{-6} and a target hazard quotient (HQ) of 1. The data were used to select locations for the soil vapor sampling summarized in Section 4.2. PCE was identified at concentrations above the residential VISL in 4 of the 14 monitoring wells sampled. TCE concentrations in groundwater did not exceed the associated residential VISL.

4.1.2 Natural Attenuation

Multiple mechanisms can act to attenuate chemical concentrations in groundwater, such as degradation, dispersion, dilution, sorption, volatilization, and chemical or biological stabilization, transformation, or destruction. To evaluate whether PCE is attenuating at the site, statistical analysis of concentration trends at wells where sufficient data are available was performed. Time-series trend charts for wells sampled in July 2016 are presented in Appendix E. To statistically evaluate whether the PCE in groundwater is attenuating, the non-parametric Mann-Kendall analysis was performed on PCE concentrations for the six monitoring wells where the following criteria were met:

1. At least four data points exist.
2. PCE concentrations have exceeded the MCL at least once (MW-01S, MW-02S, MW-03S, MW-08S, MW-12S, and MW-05I).

Information regarding the underlying principles of the nonparametric Mann-Kendall analysis can be found in *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance* (EPA, 2009a).

The results of the Mann-Kendall trend analyses, presented in Appendix F, indicate that concentration trends in three wells located in the upgradient portions of the plumes are stable; two wells (MW-02S and MW-03S) from the upgradient portion of the plume related to the RSA Energy Plant and the third well (MW-12S) is located in the upgradient portion of the plume related to the historically industrial source area. No trend was identified in two wells (MW-01S and MW-08S); however, concentrations at MW-01S have been below the MCL for three consecutive sampling events since 2010 (historical results at this well were as high as 600 µg/L). MW-08S is located both within a historically industrial area where releases likely occurred (as indicated at MW-12S) and downgradient of the plume from the RSA Energy Plant. Although the MW-05I trend indicated that concentrations are probably increasing, PCE concentrations are nearly an order of magnitude below the MCL (Table 4-2).

4.2 Soil Vapor Investigation

The results of the September 2016 geotechnical and soil vapor sampling events are presented in Tables 4-4 and 4-5, respectively. Based on a target ELCR of 1×10^{-5} and target HQ of 1, soil vapor results collected adjacent to the Annex building and the north wing of the AG building were compared to the most recent version of EPA's commercial VISLs, and data from soil vapor samples collected at other locations were compared to the most recent version of EPA's residential VISLs. Locations where one or more COPCs exceeded a VISL are presented on Figure 4-3.

Soil vapor results indicate PCE and TCE concentrations were below the commercial VISLs at the AG and Annex Buildings. Although samples collected from the shallow interval soil vapor probes adjacent to two wells and the vapor intrusion monitoring system (VIMS) exceed the residential VISLs for PCE (MW-02S) and TCE (MW-08S and the VIMS) in soil vapor (Table 4-5), the exceedances are not located near residential-use buildings. Geotechnical sampling results (Table 4-4) show similar physical soil properties across the site and among the different lithologies sampled.

TCE concentrations in soil vapor at MW-08S and the VIMS are not considered to be related to the PCE plumes based on the following:

- TCE is present at very low concentrations (less than 1 µg/L) in groundwater at the VIMS and MW-08S.
- Shallow zone TCE concentrations in soil vapor at MW-08S are greater than deeper zone samples (collected directly above the water table), indicating that groundwater is not the likely source of the TCE in soil vapor in this area.

- TCE soil vapor concentrations at the VIMS are upgradient of the PCE groundwater plumes.
- The difference in PCE and TCE concentrations in soil vapor at the VIMS indicate that these chemicals are from different sources.

These data suggest that the vapors detected at these locations are not likely from groundwater but instead are related to historical releases of TCE from separate source areas that were likely limited to the vadose zone. Based on the lack of TCE detections or concentrations below the VISL in the soil vapor samples collected at the Annex building (less than 100 feet from the VIMS), the TCE exceedances at the VIMS appear localized.

4.3 Cypress Creek Hydraulic Study

The results of both Cypress Creek hydraulic studies are presented on Figure 4-4. Trends show that groundwater elevations in TMPZ-1 were consistently higher than surface water elevations in Cypress Creek and the Alabama River, which suggests that groundwater at TMPZ-1 may discharge at times to Cypress Creek. However, the diurnal water level fluctuations recorded in TMPZ-1 and the Alabama River during both study periods (and in Cypress Creek during the July to August 2016 study) are directly and strongly correlated. The average offset in the water levels of Cypress Creek and the Alabama River recorded during the July to August 2016 phase of the hydraulic study was very small (0.1 foot average over the study period). These data indicate the Alabama River communicates directly with and is the primary influence of the movement of water in the creek and groundwater at TMPZ-1. Therefore, the ponded area of Cypress Creek cannot be classified as either a gaining or losing stream, but instead is largely comprised of Alabama River water that has washed back through the downstream culvert and/or infiltrated through pore spaces in the subsurface.

Furthermore, the influence of the Alabama River noted at TMPZ-1 indicates that the river acts as a hydraulic barrier between the leading edge of the PCE plumes and Cypress Creek, limiting the migration of the plumes into the creek and diluting concentrations of PCE at the downgradient edge. This hydraulic barrier effect caused by the Alabama River also may be a contributing factor to the higher concentrations observed at TMPZ-1 relative to other wells by impeding migration.

SECTION 5

Conceptual Site Model

Figure 5-1 presents the conceptual site model (CSM) for the site. The CSM incorporates data gathered to date to identify source areas and release mechanisms, chemical fate and transport, nature and extent, and exposure pathways for the site.

5.1 Source Areas and Release Mechanisms

PCE was identified in former public water supply well PW-9W in 1991 and in soil during construction of the RSA Energy Plant in 1993. During a 1993 emergency removal action, impacted media were removed prior to construction of the RSA Energy Plant. Following the removal action, concentrations of PCE were not identified above the RSL in soil, indicating that little to no residual mass is present. Therefore, the RSA Energy Plant is not considered an ongoing source of PCE.

Multiple potential sources of PCE contamination exist within the site boundaries. Although the PCE identified during construction of the RSA Energy Plant contributed to PCE in groundwater, other historical releases within the site boundary likely also have occurred, as indicated by the plume that originates near MW-12S. This plume is not downgradient of the RSA Energy Plant and is located in an industrialized area. Based on historical review of records, several former dry cleaners and other industrial facilities were identified in downtown Montgomery.

5.2 Fate and Transport

5.2.1 Chemical Transport

To evaluate potential routes of migration, chemical transport mechanisms that may be acting on the groundwater plume are summarized in this section. Once dissolved in groundwater, three processes govern the transport of contaminants: advection, dispersion, and retardation. Advection is the most important transport process driving groundwater contaminant migration in the subsurface. Because of the lithology in the aquifer (primarily sand with thin gravel and silt/clay lenses), retardation is limited and not discussed further in this section.

5.2.1.1 Advection

Advection refers to the lateral movement of dissolved-phase contaminants caused by the flow of groundwater. Lateral migration at the site has resulted largely from natural hydraulic gradients to the northwest (Figures 4-1 and 4-2). The pattern of increasing contaminant concentrations in the downgradient flow direction is consistent with plume migration via advection.

5.2.1.2 Dispersion

Hydrodynamic dispersion is the process that spreads out contaminants in groundwater in three dimensions: parallel to the direction of migration (longitudinal), laterally (transverse), and vertically. The underlying processes are mechanical dispersion and molecular diffusion. The magnitude of mechanical dispersion is proportional to groundwater velocity, and the result is spreading and mixing at the plume edges. This results in reduced contaminant concentrations along the edges of the plume. The narrowness of the RSA Energy Plant plume moving in the downgradient direction indicates lateral dispersion is minimal and the lack of PCE exceedances/detections in the intermediate wells indicates vertical dispersion is limited to the shallow portion of the aquifer. At the downgradient edge of the plume, dispersion occurs as commingling with porewater from the Alabama River.

5.2.2 Fate of Chemicals

5.2.2.1 Volatility and Vapor Migration

The partitioning of a molecule from aqueous phase to the vapor phase is termed volatilization. Depending on the Henry's Law constant (a partitioning coefficient between adjacent water and air bodies), VOCs in groundwater can volatilize at the water table into the overlying soil. PCE and TCE easily partition into the vapor phase, where they can migrate through air-filled soil pores via primarily diffusion along a concentration gradient. The tendency for VOCs to diffuse through soil depends on the chemical and physical properties (diffusion coefficients in air and water), soil porosity (higher porosity encourages diffusion), and the soil moisture content (high moisture content may provide a barrier to vapor diffusion). Results of the geotechnical analysis indicate little variability in soil properties across the site.

The highest PCE concentrations in soil vapor were reported at MW-02S, downgradient of the RSA Energy Plant (one of the source areas), where PCE also is present in groundwater. Soil vapor TCE concentrations above VISLs were reported at MW-08S and the VIMS; however, TCE in soil vapor is not considered related to groundwater, based on lack of elevated dissolved TCE concentrations (maximum concentration 1.01 µg/L), and is likely due to historical releases that were limited to the vadose zone. The lateral extent of TCE in vapor at the VIMS, where soil vapor TCE concentrations are the highest, also is limited as it was not detected in the Annex Building samples collected less than 100 feet away from the VIMS.

5.2.2.2 Attenuation

Attenuation processes that act to reduce contaminant concentrations in groundwater include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater (EPA, 1999). These in situ processes include degradation, dispersion, dilution, sorption, volatilization, and chemical or biological stabilization, transformation, or destruction of contaminants.

Dispersion and dilution are the primary mechanisms acting to attenuate the plume, although the presence of PCE in soil vapor indicates that volatilization also is occurring.

5.3 Nature and Extent of Groundwater Contamination

PCE exceeded the MCL in groundwater during the investigation. The lateral extent of the PCE exceedances in groundwater is constrained to the east and west by nondetect historical grab sampling data (Black & Veatch, 2002) and to the south by detected concentrations below the MCL at MW-01S (Figure 5-2). The northern extent is delineated by Cypress Creek, where the Alabama River serves as a hydraulic barrier and groundwater commingles with river water in pore spaces near the creek. The vertical extent of the PCE exceedances in groundwater is delineated by a lack of detections above the MCL in intermediate wells.

SECTION 6

Conclusions

The results of the July 2016 groundwater sampling conducted at the site indicate the nature and extent of PCE in groundwater has been evaluated fully. During the July 2016 groundwater monitoring event, PCE was the only COPC detected above both its MCL and tap water RSL; TCE was the only other COPC detected above a screening level (above its tap water RSL but below its MCL). Cis-1,2-DCE also was detected at a few locations at low levels below its RSL and MCL; trans-1,2-DCE and VC were not detected. PCE in groundwater exists in two separate plumes; one plume originates from the area of the RSA Energy Plant and a separate plume originates in the industrial area near MW-12S. Overall, PCE exceedances in groundwater extend downgradient from historical source areas and commingle before migrating via advection toward Cypress Creek. The vertical extent of PCE in groundwater is limited to the shallow portion of the aquifer as it does not exceed the MCL in intermediate wells. At wells with sufficient historical data for time-series evaluation, PCE concentrations in groundwater are not increasing except where concentrations are an order of magnitude below the screening level (at MW-05I).

The results of the hydraulic study indicate that the influence of the Alabama River extends to TMPZ-1. The river acts as a hydraulic barrier at the leading edge of the comingled PCE plumes, impeding PCE migration toward Cypress Creek and mixing with the PCE in groundwater prior to any potential discharge to the creek. The hydraulic barrier effect caused by the Alabama River likely contributes to the higher concentrations at TMPZ-1 relative to other wells by limiting further migration. The results of the hydraulic study also indicate that the ponded area of Cypress Creek is neither a gaining nor losing stream, rather is composed of Alabama River water that has washed through the downstream culvert and/or infiltrated through pore spaces in the subsurface.

PCE concentrations in soil vapor indicate that some volatilization of PCE from groundwater is occurring. PCE is present in soil vapor at concentrations above the residential VISL in one well, MW-02S. TCE soil vapor concentrations also exceed the residential VISL at the shallow interval of MW-08S. However, these PCE and TCE exceedances are not located in residential areas. Furthermore, because TCE is not present at concentrations above the MCL in groundwater, it is likely related to separate historical releases into the vadose zone in limited quantities that did not impact groundwater, and does not appear to be related to the PCE plumes. These releases may be related to past industrial activities at both MW-08S and the VIMS. The highest TCE concentrations in soil vapor (reported at the VIMS) are upgradient of the PCE plumes and also are limited laterally based on the low concentrations or lack of TCE detections in soil vapor samples collected adjacent to the Annex building, less than 100 feet from the VIMS.

Groundwater and soil vapor concentrations will be evaluated as part of the risk assessment, which will be documented in the AA/RA Report. This evaluation will include discussion of current and future land use, potential exposure pathways, receptors, and risk estimates for the locations where groundwater is extracted for commercial bus washing or soil vapor concentrations exceed VISLs.

SECTION 7

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Tables

TABLE 3-1

Well Construction Details

Environmental Investigation Report--DEAP, Montgomery, Alabama

Station	TOC Elevation (ft amsl)	Northing	Easting	Total Well Depth (ft bgs)	Screen Length (ft)	Top of Screen (ft bgs)	Bottom of Screen (ft bgs)	Bentonite Seal Depth (ft bgs)	Sandpack Interval (ft bgs)	Screen/Riser Material
MW-01S	189.37	683943.95	510596.75	51.96	9.7	40.2	49.9	35.5 - 38.0	38 - 57	stainless steel
MW-02S*	188.59	684303.83	510637.81	59.87	20	40	60	NA	37 - 60	stainless steel
MW-03S*	206.18	684381.71	511066.14	59.32	20	40	60	NA	37 - 60	stainless steel
MW-07S**	179.65	684401.46	510402.04	96.71	9.7	85	94.7	81 - 83	83 - 97	stainless steel
MW-08S	173.46	685008.22	510169.10	51.77	9.7	40	49.7	35 - 37	37 - 53	stainless steel
MW-09S	213.41	682890.15	510287.11	71.76	9.7	60	69.7	55 - 57	57 - 73	stainless steel
MW-10S	212.67	683543.56	510867.66	71.91	9.7	60.2	69.9	56 - 58	58 - 77	stainless steel
MW-12S*	157.58	685782.50	510116.69	41.88	9.6	29.37	38.95	NA	22.8 - 43.2	stainless steel
TMPZ-1	158.90	685647.08	509234.13	48.00	9.7	37.5	47.2	30 - 34	34 - 48	polyvinyl chloride
MW-01I	190.00	683944.63	510601.89	141.76	9.7	130	139.7	126 - 128	128 - 147	stainless steel
MW-05I	159.37	684113.92	511233.31	159.37	9.7	147.6	157.3	135.6 - 143.6	143.6 - 167.0	stainless steel
MW-07I	179.76	684392.88	510402.76	128.85	9.7	117.1	126.8	110.9 - 113.9	113.9 - 130.0	stainless steel
MW-08I	173.42	685003.15	510168.99	119.73	9.7	108.0	117.7	103 - 106	106 - 127	stainless steel
MW-12I*	157.82	685786.15	510111.71	104.69	9.7	92.18	101.85	NA	84.5 - 110	stainless steel

Notes:

Top of casing elevations based on National Geodetic Vertical Datum of 1929 (NGVD 1929).

Wells completed as flush mounts with 2-inch inner diameter well casings.

Well construction details based on well construction diagrams unless otherwise noted. Top of casing elevations and location coordinates details based on 2002 RI Report Table 4-8 (TMPZ-1 coordinates and TOC elevation based on July 2016 survey).

*Well construction details based on 2002 RI Report Table 4-8; well construction diagrams not available

** Although previously identified as a shallow well (S designation), MW-07S is classified as intermediate based on the depth of the screen interval.

NA = original construction diagram not available

TOC = top of casing

ft bgs = feet below ground surface

ft amsl = feet above mean sea level

TABLE 3-2

2016 Sampling Completed by Media

Environmental Investigation Report--DEAP, Montgomery, Alabama

Location ID	Number of Samples	Sample Depth (ft bgs)	Analyses	Method
Shallow Groundwater				
MW-01S	1	NA	tetrachloroethene trichloroethene cis-1,2-dichloroethene trans-1,2-dichloroethene vinyl chloride (chemicals of potential concern [COPCs])	SW8260B
MW-02S	1	NA		
MW-03S	2*	NA		
MW-08S	1	NA		
MW-09S	3**	NA		
MW-10S	1	NA		
MW-12S	1	NA		
TMPZ-1	1	NA		
Intermediate Groundwater				
MW-01I	1	NA	COPCs	SW8260B
MW-05I	2*	NA		
MW-07I	1	NA		
MW-07S	1	NA		
MW-08I	1	NA		
MW-12I	1	NA		
Soil - Shelby tube				
MW-02S	1	5 - 7	bulk density	ASTM D7263-09
MW-08S	1	28 - 30	total porosity	ASTM D7263-09
MW-12S	2	4 - 6; 22- 24	saturated porosity	ASTM D7263-09
TMPZ-1	2	9 - 11; 18 - 20	fraction organic carbon	Walkley Black Method
Soil Vapor Samples				
MW-02S	2	7.8 - 8; 34 - 35	COPCs	TO-15
MW-08S	2	7 - 8; 29 - 30		
MW-12S	3*	7 - 8; 21 - 22*		
TMPZ-1	2	7 - 8; 26 - 27		
VIMS-10	1	10		
VIMS-50	1	50		
Alabama AG's Building***	3*	14.8 - 15; 11.8 - 12*		
County Annex III Building***	2	11.8 - 12; 11.8 -12		

Notes:

* Includes field duplicate sample

** Includes matrix spike/matrix spike duplicate sample

*** Due to access restrictions and dense underground utility networks, fewer soil vapor samples than proposed in the Work Plan were collected around the AG (originally 3 proposed) and County Annex III (originally 4 proposed) Buildings.

ft bgs = feet below ground surface

AG = Attorney General

ASTM = ASTM International

DEAP = Downtown Environmental Assessment Project

NA = not applicable

SW = SW-846 Test Methods for Evaluating Solid Waste Physical/Chemical Methods

VIMS = vapor intrusion monitoring system

TABLE 4-1

Groundwater Elevations - July 11, 2016

Environmental Investigation Report--DEAP, Montgomery, Alabama

Well	TOC Elevation	DTW	Groundwater Elevation
Shallow Interval Wells			
MW-01S	189.37	38.44	150.93
MW-02S	188.59	40.45	148.14
MW-03S	206.18	55.91	150.27
MW-08S	173.46	35.38	138.08
MW-09S	213.41	54.71	158.70
MW-10S	212.67	56.42	156.25
MW-12S	157.58	25.73	131.85
TMPZ-1[1]	158.90	30.09	128.81
Intermediate Interval Wells			
MW-01I	190.00	39.54	150.46
MW-05I	210.98	57.39	153.59
MW-07I	179.76	35.38	144.38
MW-07S	179.65	34.86	144.79
MW-08I	173.42	36.28	137.14
MW-12I	157.82	25.70	132.12

Notes:

DEAP = Downtown Environmental Assessment Project

DTW = depth to water in feet below TOC

TOC = top of casing in feet above mean sea level

Elevation reported in feet above mean sea level.

[1]TMPZ-1 was gauged on July 22, 2016.

TABLE 4-2

Groundwater Sampling Results

Environmental Investigation Report--DEAP, Montgomery, Alabama

Station ID	Date Sampled	PCE VISL: 15 MCL: 5 RSL: 11	TCE VISL: 1.2 MCL: 5 RSL: 0.49	cis-1,2-DCE VISL: NA MCL: 70 RSL: 36	trans-1,2-DCE VISL: NA MCL: 100 RSL: 360	VC VISL: 0.15 MCL: 2 RSL: 0.019
Shallow Interval Wells						
MW-01S	7/12/2016	1.56	0.398 U	0.260 U	0.396 U	0.259 U
MW-02S	7/13/2016	**34.1**	0.398 U	0.260 U	0.396 U	0.259 U
MW-03S	7/13/2016	**6.27**	**0.566 J**	0.260 U	0.396 U	0.259 U
MW-03S FDUP	7/13/2016	**6.02**	0.442 J	0.260 U	0.396 U	0.259 U
MW-08S	7/13/2016	**78.4**	**0.599 J**	0.260 U	0.396 U	0.259 U
MW-09S	7/11/2016	0.372 U	**0.567 J**	0.260 U	0.396 U	0.259 U
MW-10S	7/12/2016	0.372 U	0.398 U	0.260 U	0.396 U	0.259 U
MW-12S	7/13/2016	**58.9**	0.414 J	0.268 J	0.396 U	0.259 U
TMPZ-1	7/22/2016	**174**	**1.01**	0.874 J	0.396 U	0.259 U
Intermediate Interval Wells						
MW-01I	7/12/2016	0.372 U	0.398 U	0.260 U	0.396 U	0.259 U
MW-05I	7/14/2016	0.595 J	0.398 U	0.260 U	0.396 U	0.259 U
MW-05I FDUP	7/14/2016	0.573 J	0.398 U	0.260 U	0.396 U	0.259 U
MW-07I	7/12/2016	0.372 U	0.398 U	0.260 U	0.396 U	0.259 U
MW-07S	7/12/2016	0.372 U	0.398 U	0.260 U	0.396 U	0.259 U
MW-08I	7/13/2016	0.372 U	0.398 U	0.260 U	0.396 U	0.259 U
MW-12I	7/13/2016	0.372 U	0.398 U	0.260 U	0.396 U	0.259 U
Commercial Bus Washing Station						
BSW-0217	2/20/2017	0.372 U	0.398 U	0.260 U	0.396 U	0.259 U

Notes:

Concentrations presented in micrograms per liter (µg/L).

Bold text indicates concentration exceeds the lower of the MCL/RSL.

Shaded cell indicate shallow interval well concentration exceeds the EPA VISL.

PCE = tetrachloroethene

TCE = trichloroethene

DCE = dichloroethene

VC = vinyl chloride

FDUP = field duplicate

MCL = U.S. Environmental Protection Agency (EPA) Maximum Contaminant Level

RSL = EPA Regional Screening Level (tap water; based on a target risk = 1×10^{-6} and target hazard quotient = 1), May 2016

VISL = vapor intrusion screening level (based on a residential scenario, target risk = 1×10^{-6}, target hazard quotient = 1, default groundwater temperature), May 2016

NA = no VISL available

DEAP = Downtown Environmental Assessment Project

J = concentration is estimated

U = analyte was not detected

TABLE 4-3

2016 Field Parameter Data

Environmental Investigation Report--DEAP, Montgomery, Alabama

Station	Date Collected	pH (standard unit)	Conductivity (µS/cm)	Temperature (°C)	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	Turbidity[1] (NTU)
MW-01S	7/12/2016	5.73	790	22.54	4.73	195.1	1.7
MW-02S	7/13/2016	5.23	378	23.17	6.83	267.0	8.9
MW-03S	7/13/2016	5.52	309	21.82	5.30	229.7	-2.2
MW-07S[2]	7/12/2016	5.13	356	23.00	7.33	225.2	18.8
MW-08S	7/13/2016	5.04	370	22.53	5.88	266.4	-2.9
MW-09S	7/11/2016	5.03	350	22.82	6.51	264.4	0.0
MW-10S	7/12/2016	4.94	417	22.74	5.83	259.8	-2.1
MW-12S	7/13/2016	5.34	307	21.76	4.64	178.7	45.4
TMPZ-1	7/22/2016	5.61	372	21.47	3.46	132.8	5.5
MW-05I	7/14/2016	5.73	70	24.40	4.23	176.0	39.8
MW-01I	7/12/2016	5.56	104	22.00	5.99	237.5	1.7
MW-07I	7/12/2016	5.66	124	22.11	3.13	158.2	8.2
MW-08I	7/13/2016	5.59	68	23.04	8.47	228.7	-0.9
MW-12I	7/13/2016	6.86	283	22.63	1.11	-95.9	4.5

Notes:

[1] Negative turbidity readings due to probe malfunction. Water in collected samples was visibly clear of sediment.

[2] MW-07S is screened as an intermediate well.

µS/cm = microsiemens per centimeter

°C = degrees Celsius

mg/L = milligrams per liter

mV = millivolts

NTU = nephelometric turbidity units

DEAP = Downtown Environmental Assessment Project

Field parameters were not collected at BSW-0217.

TABLE 4-4

September 2016 Geotechnical Sampling Results

Downtown Environmental Assessment Project, Montgomery, Alabama

	Station ID	TMPZ-1		MW-12S		MW-08S	MW-02S
	Sample Depth (ft bgs)	9-11	18-20	4-6	22-24	28-30	5-7
Analyte	**Unit**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
Saturated Porosity*	%	34	45	44	41	29	33
Total Soil Porosity	cm^3/cm^3-soil	0.37	0.48	0.47	0.44	0.36	0.4
Soil Dry Bulk Density	g/cm^3	1.73	1.46	1.46	1.53	1.71	1.6
Fraction Organic Carbon	%	0.51	0.11	0.15	0.08	0.11	0.16

Notes:

* Saturated porosity was calculated from total porosity.

% = percent

g/cm^3 = grams per centimeter cubed

cm^3/cm^3 = centimeters cubed per centimeters cubed

ft bgs = feet below ground surface

DEAP = Downtown Environmental Assessment Project

TABLE 4-5

September 2016 Soil Vapor Sampling Results

Environmental Investigation Report--DEAP, Montgomery, Alabama

Station ID	Sample Depth (ft bgs)	Date Sampled	PCE Residential VISL: 1,400	TCE Residential VISL: 70	cis-1,2-DCE Residential VISL: NA	trans-1,2-DCE Residential VISL: NA	VC Residential VISL: 56
Plume Area							
MW-02S	7.8 - 8	09/23/2016	**4,940**	3.21	1.59 U	1.59 U	1.02 U
	34 - 35	09/22/2016	**5,280**	34.5	1.59 U	1.59 U	1.02 U
MW-08S	7 - 8	09/22/2016	493	**336**	1.59 U	1.59 U	1.02 U
	29 - 30	09/22/2016	361	27.8	1.59 U	1.59 U	1.02 U
MW-12S	7 - 8	09/21/2016	23.3	3.56	1.59 U	1.59 U	1.02 U
	21 - 22	09/21/2016	4.36 J	42.3 J	1.59 UJ	1.59 U	1.02 U
	21 - 22 (FD)	09/21/2016	6.41 J	64.6 J	5.67 J	1.59 U	1.02 U
TMPZ-1	7 - 8	09/21/2016	3.49	2.14 U	1.59 U	1.59 U	1.02 U
	26 - 27	09/21/2016	1,240	10	1.59 U	1.59 U	1.02 U
Vapor Intrusion Monitoring System							
VIMS-10	10	09/21/2016	99.6	**13,100**	88.6	2.55	1.02 U
VIMS-50	50	09/22/2016	286	**98,800**	873	19.1	4.09 U

Station ID	Sample Depth (ft bgs)	Date Sampled	PCE Commercial VISL: 5,800	TCE Commercial VISL: 290	cis-1,2-DCE Commercial VISL: NA	trans-1,2-DCE Commercial VISL: NA	VC Commercial VISL: 930
County Annex III Building							
AMS-01	11.8 - 12	09/19/2016	14.2	2.14 U	1.59 U	1.59 U	1.02 U
AMS-02	11.8 - 12	09/19/2016	6.28	6.67	1.59 U	1.59 U	1.02 U
Alabama Attorney General's Building							
AMS-03	14.8 - 15	09/20/2016	9.68	2.14 U	1.59 U	1.59 U	1.02 U
AMS-04	11.8 - 12	09/20/2016	9.37	2.14 U	1.59 U	1.59 U	1.02 U
	11.8 - 12 (FD)	09/20/2016	9.18	2.14 U	1.59 U	1.59 U	1.02 U

Notes:

Concentrations presented in micrograms per meter cubed ($\mu g/m^3$).

Bold text indicates concentration exceeds EPA residential VISL.

ft bgs = feet below ground surface

PCE = tetrachloroethene

TCE = trichloroethene

DCE = dichloroethene

VC = vinyl chloride

FD = field duplicate

VISL = EPA Vapor Intrusion Screening Level (based on target risk of 1×10^{-5} and target hazard quotient of 1), May 2016.

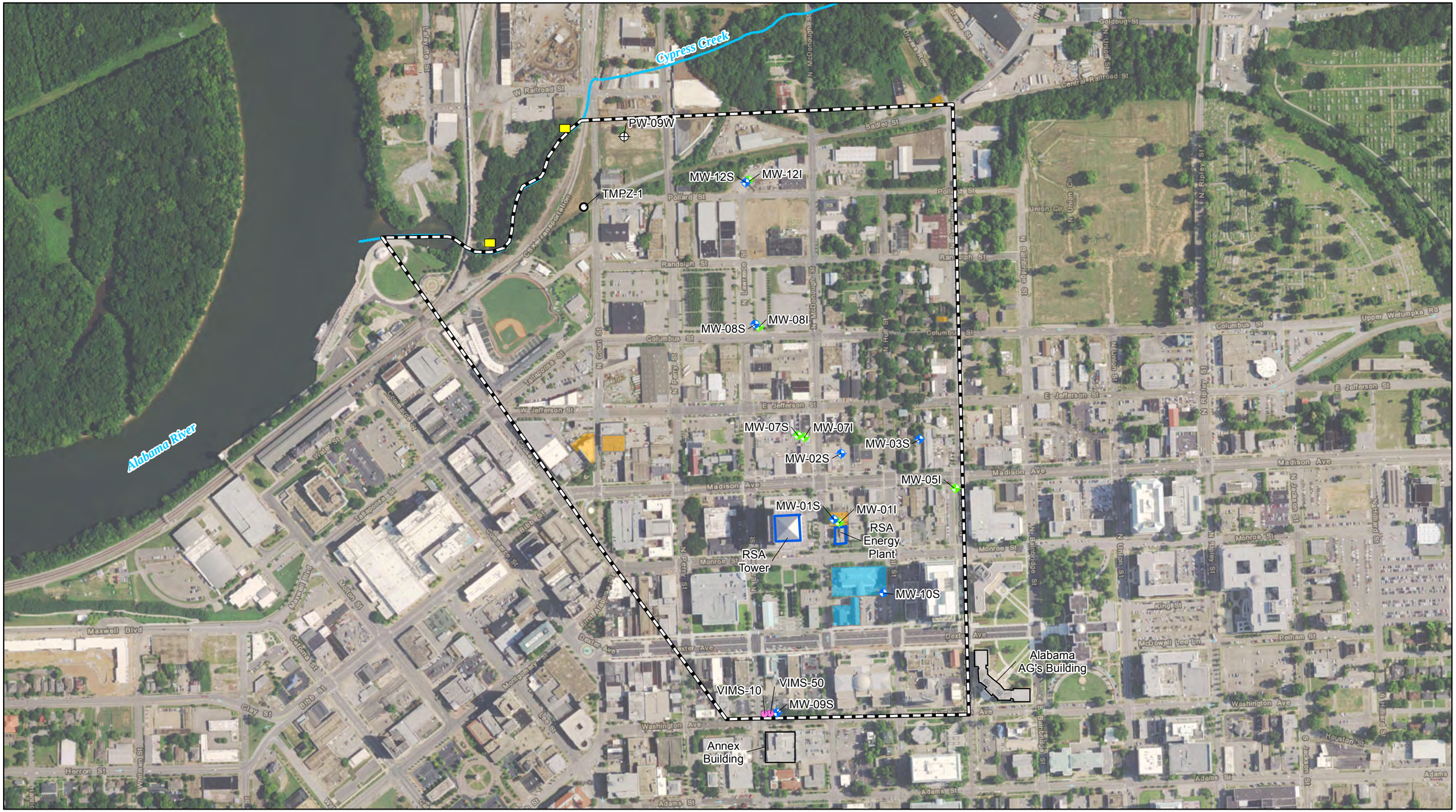
NA = no VISL available

DEAP = Downtown Environmental Assessment Project

J = concentration is estimated

U = analyte was not detected

Figures



LEGEND

- Shallow Monitoring Well
- Intermediate Monitoring Well
- Former City Water Supply Well
- Temporary Piezometer
- Approximate Culvert Location
- VIMS
- RSA Building
- Site Boundary
- Residential Property
- School/Daycare Property

Notes:
1. AG - Attorney General
2. RSA - Retirement Systems of Alabama
3. VIMS - Vapor Intrusion Monitoring System

N

0 250 500
Feet

FIGURE ES-1
Site Map
Environmental Investigation Report
Downtown Environmental Assessment Project
Montgomery, AL

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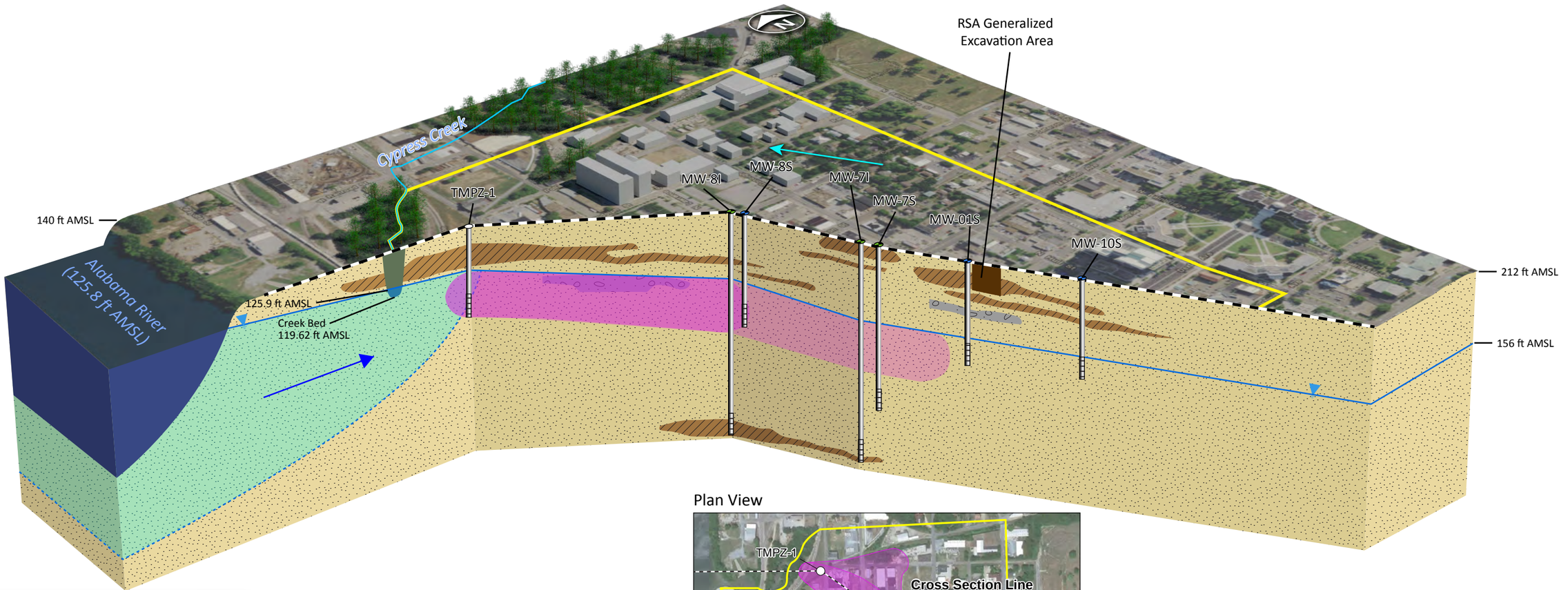

LEGEND

- Site Boundary
- Shallow Monitoring Well
- Intermediate Monitoring Well
- Temporary Piezometer
- PCE Plume
- Approximate Extent of Alabama River Influence
- Sand
- Silt and Clay
- Sandy Gravel
- Groundwater Level
- Flow Direction

Notes:

1. Not to scale
2. Below surface elements vertically exaggerated for clarity
3. Darker purple color indicates commingled plumes
4. PCE = tetrachloroethene
5. ft AMSL = feet above mean sea level

Plan View

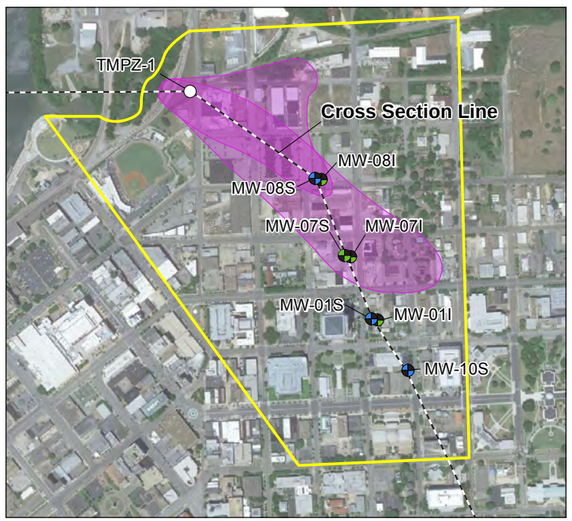

Figure ES-2
Conceptual Site Model
Environmental Investigation Report
Downtown Environmental Assessment Project
Montgomery, Alabama

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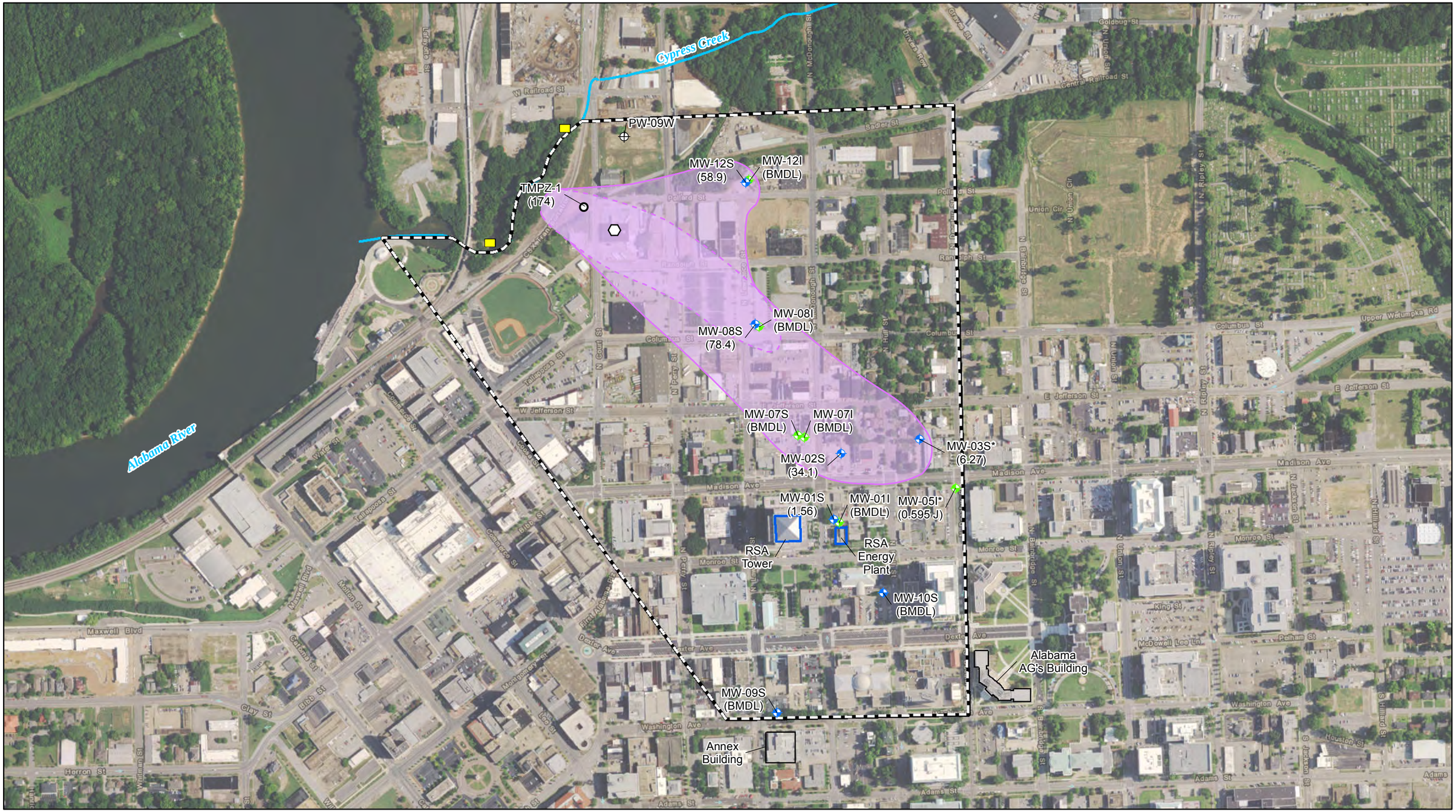

LEGEND

- Shallow Monitoring Well
- Intermediate Monitoring Well
- Former City Water Supply Well
- Temporary Piezometer
- Approximate Culvert Location
- Commercial Bus-Washing Station
- Approximate Extent of PCE > 5 µg/L
- RSA Building
- Site Boundary

Notes:
1. AG = Attorney General
2. BMDL = below method detection limit
3. J = concentration is estimated
4. PCE = tetrachloroethene
5. RSA = Retirement Systems of Alabama
6. µg/L = micrograms per liter
7. * = field duplicate sample location, highest result presented
8. (34.1) = PCE concentration in groundwater in µg/L

N

0 250 500
Feet

FIGURE ES-3
PCE Groundwater Results - July 2016
Environmental Investigation Report
Downtown Environmental Assessment Project
Montgomery, AL

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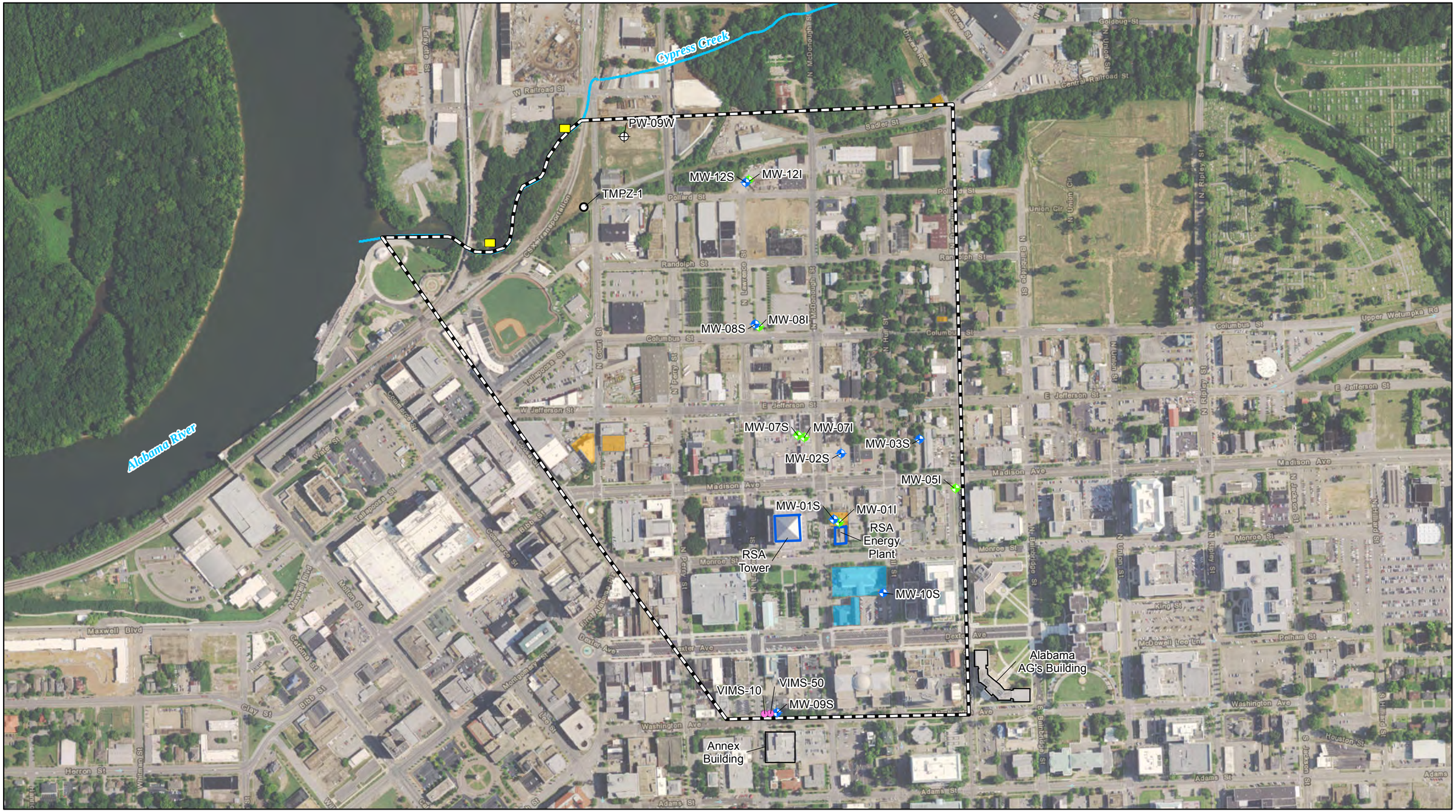

LEGEND

- Shallow Monitoring Well
- Intermediate Monitoring Well
- Former City Water Supply Well
- Temporary Piezometer
- Approximate Culvert Location
- VIMS
- RSA Building
- Site Boundary
- Residential Property
- School/Daycare Property

Notes:
1. AG - Attorney General
2. RSA - Retirement Systems of Alabama
3. VIMS - Vapor Intrusion Monitoring System

N

0 250 500
Feet

FIGURE 1-1
Site Map
Environmental Investigation Report
Downtown Environmental Assessment Project
Montgomery, AL

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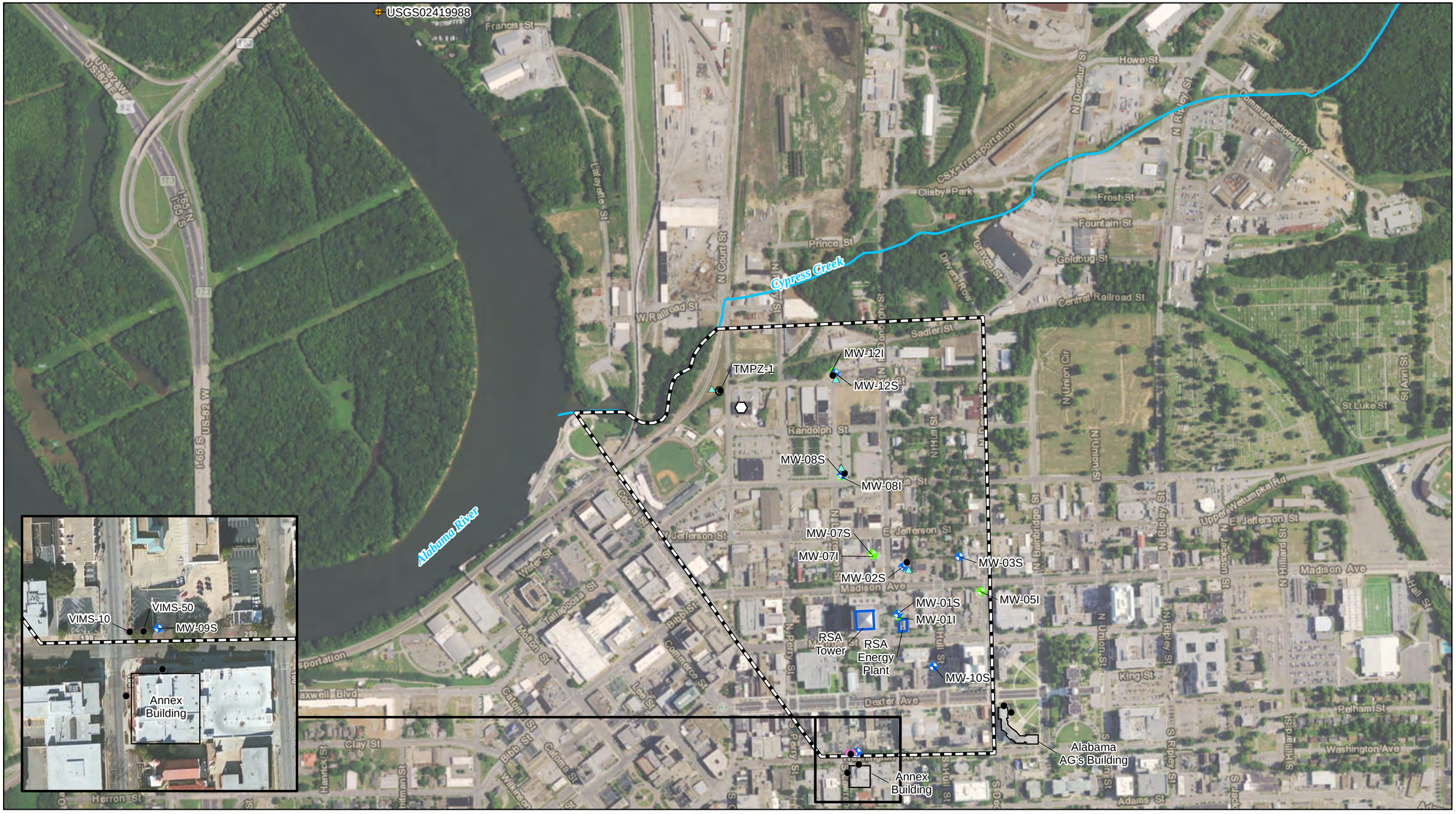

LEGEND

- Shallow Monitoring Well
- Intermediate Monitoring Well
- Temporary Piezometer
- VIMS
- Soil Vapor Sampling Location
- Geotechnical Sampling Location
- Alabama River Gauge Station
- Commercial Bus-Washing Station
- RSA Building
- Site Boundary

Notes:
1. AG = Attorney General
2. RSA = Retirement Systems of Alabama
3. VIMS = Vapor Intrusion Monitoring System

N

0 350 700
Feet

FIGURE 3-1
Investigation Locations
Environmental Investigation Report
Downtown Environmental Assessment Project
Montgomery, AL

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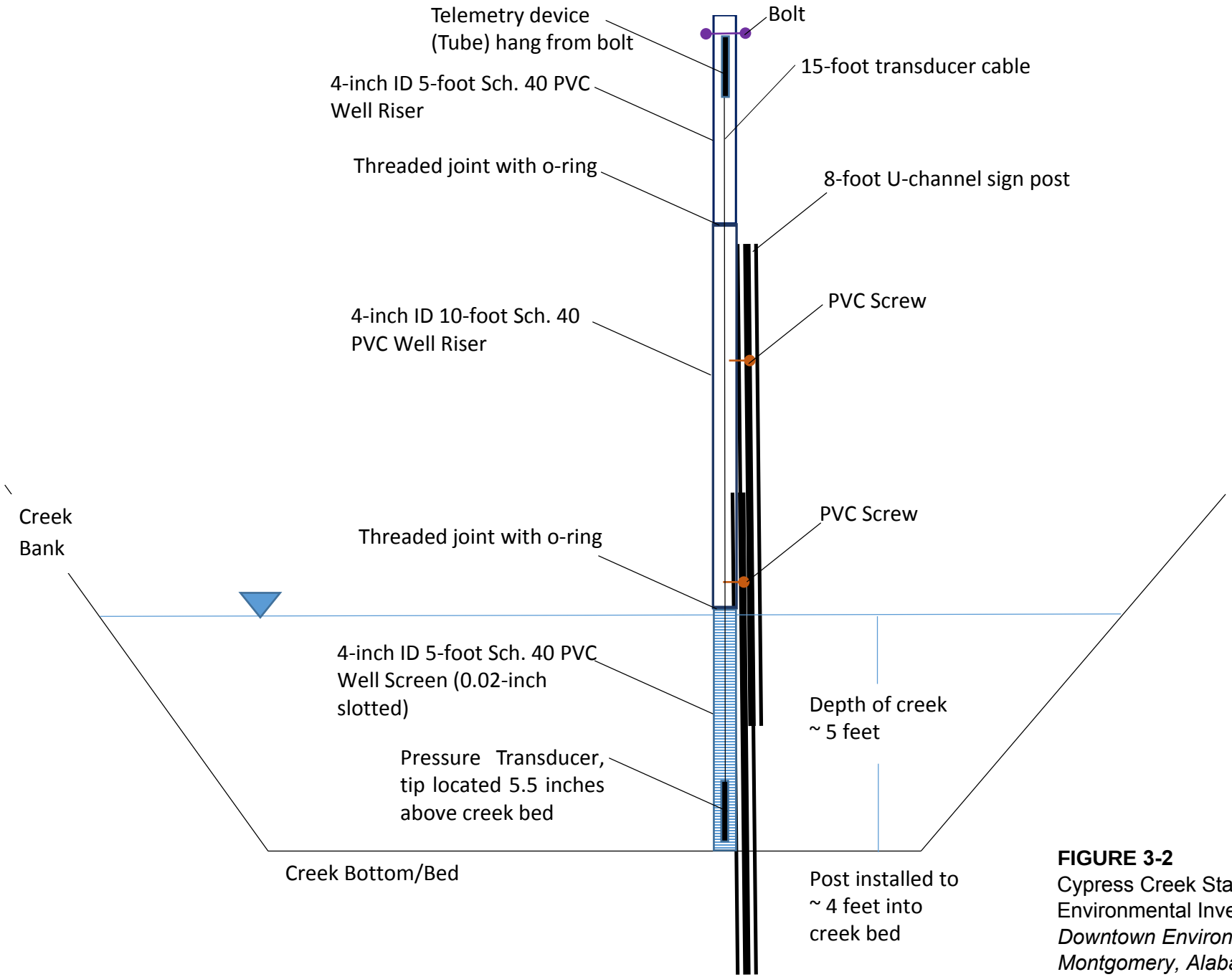
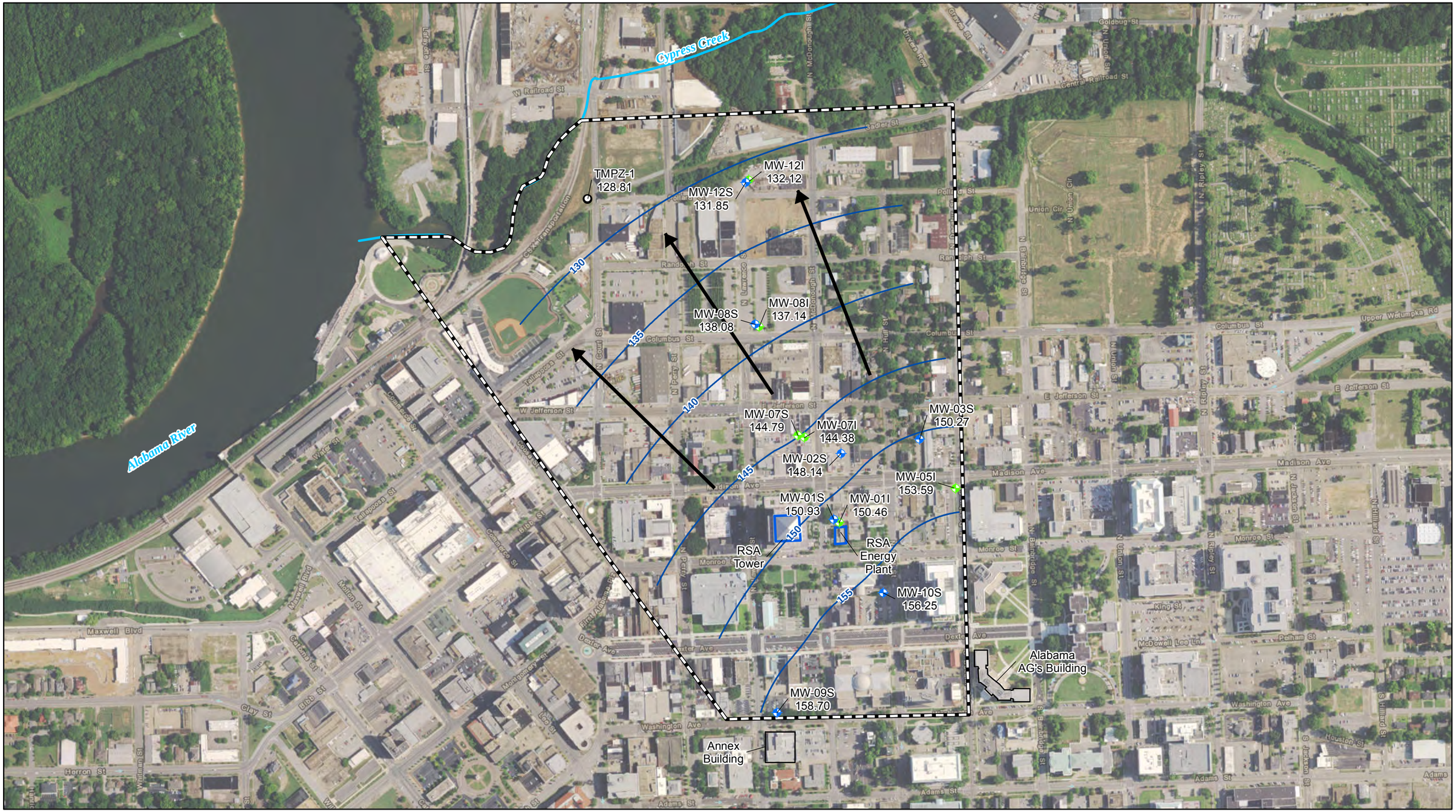


Notes:
1) Drawing not to scale
2) ID = inner diameter
3) Sch. 40 = schedule 40
4) PVC = polyvinyl chloride

FIGURE 3-2
Cypress Creek Staff Gauge Schematic
Environmental Investigation Report
Downtown Environmental Assessment Project
Montgomery, Alabama



LEGEND

- Shallow Monitoring Well
- Intermediate Monitoring Well
- Temporary Piezometer
- Shallow Potentiometric Contour
- Generalized Groundwater Flow Direction
- RSA Building
- Site Boundary

Notes:
1. AG - Attorney General
2. RSA - Retirement Systems of Alabama
3. Intermediate wells not used in contouring.
4. Groundwater elevations presented in feet above mean sea level. .

N

0 250 500
Feet

FIGURE 4-1
July 2016 Shallow Potentiometric Surface
Environmental Investigation Report
Downtown Environmental Assessment Project
Montgomery, AL

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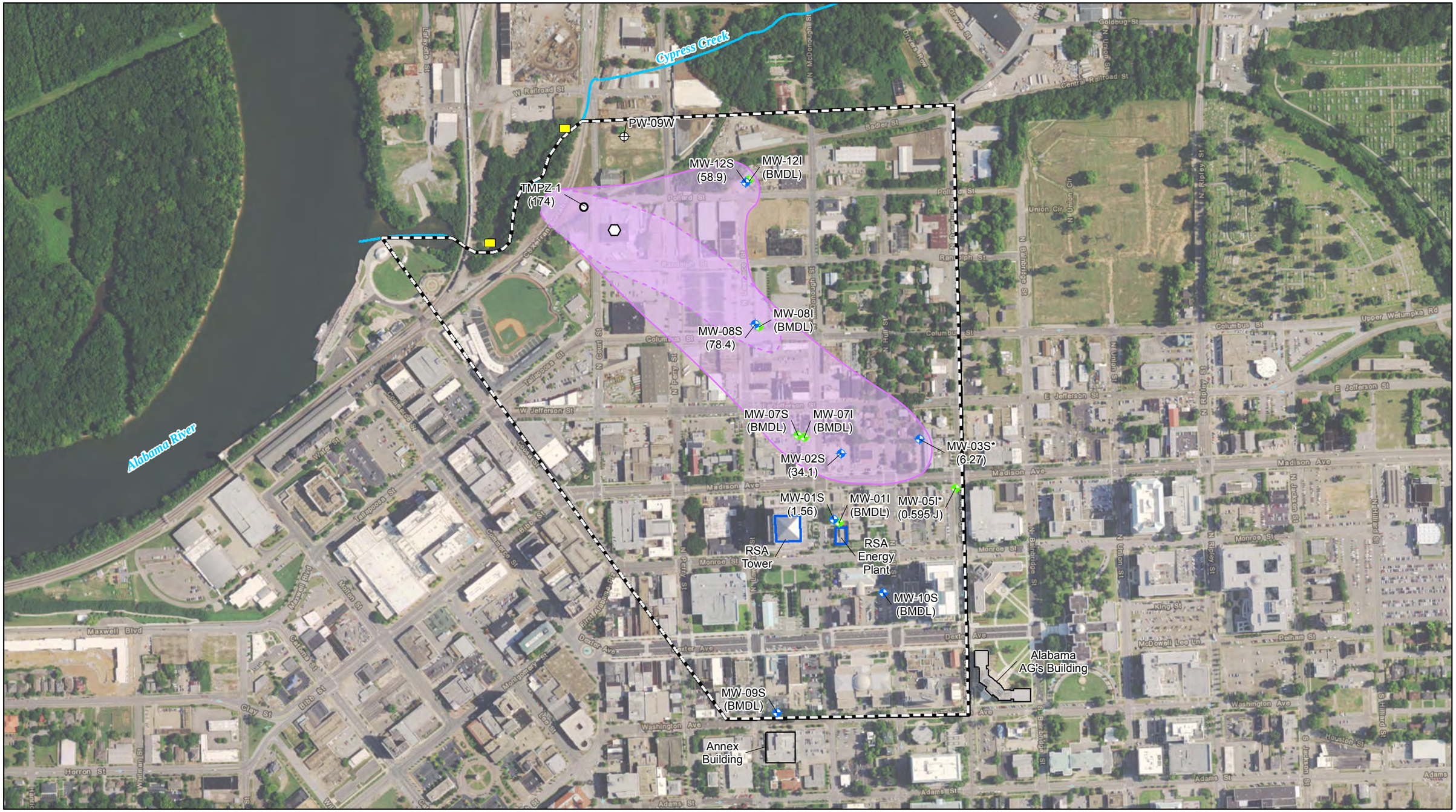

LEGEND

- Shallow Monitoring Well
- Intermediate Monitoring Well
- Former City Water Supply Well
- Temporary Piezometer
- Approximate Culvert Location
- Commercial Bus-Washing Station
- Approximate Extent of PCE > 5 µg/L
- RSA Building
- Site Boundary

Notes:
1. AG = Attorney General
2. BMDL = below method detection limit
3. J = concentration is estimated
4. PCE = tetrachloroethene
5. RSA = Retirement Systems of Alabama
6. µg/L = micrograms per liter
7. * = field duplicate sample location, highest result presented
8. (34.1) = PCE concentration in groundwater in µg/L

N

0 250 500
Feet

FIGURE 4-2
PCE Groundwater Results - July 2016
Environmental Investigation Report
Downtown Environmental Assessment Project
Montgomery, AL

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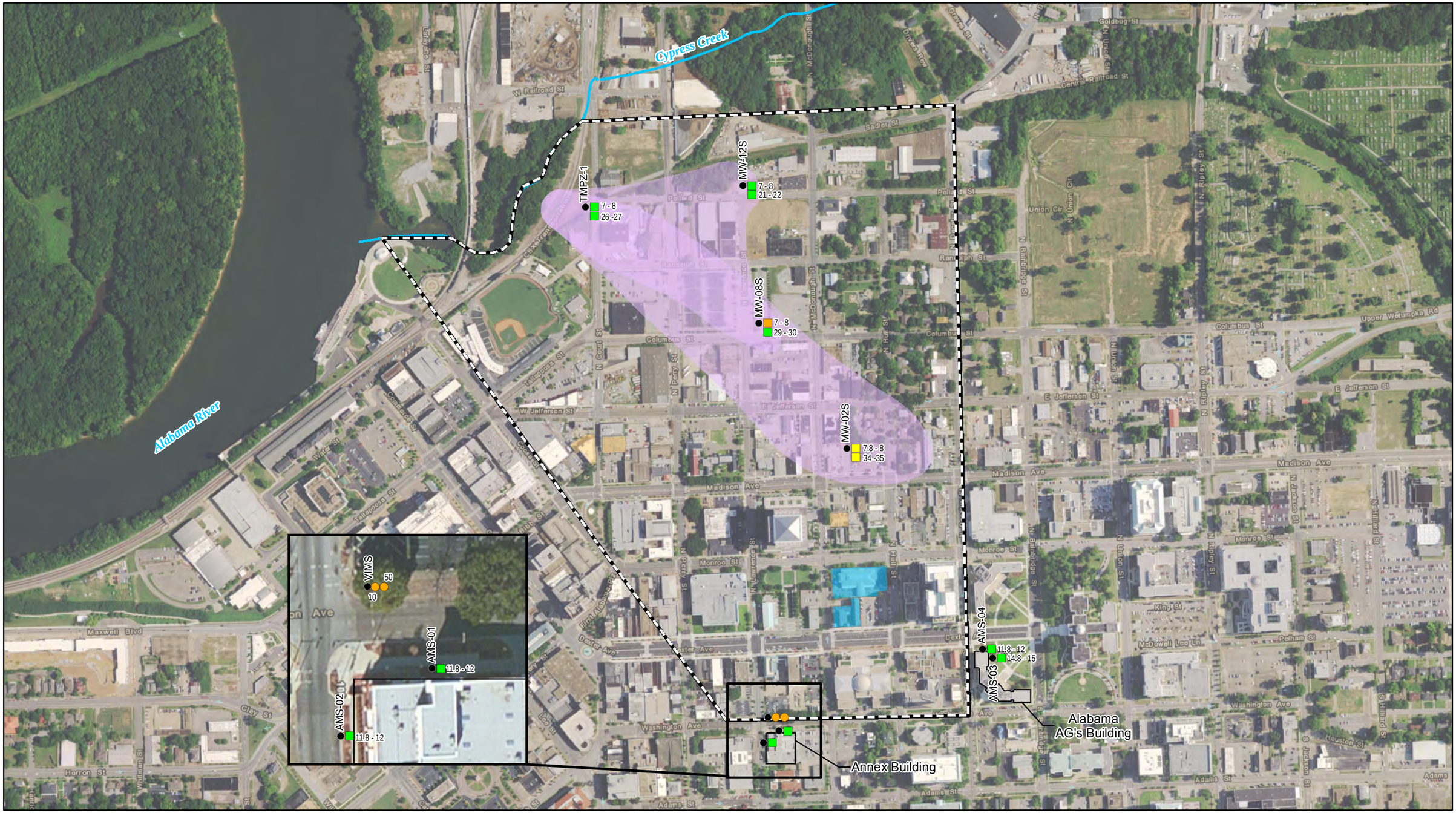

Soil Vapor VISL Screening Results

- Result does not exceed VISL
- Result exceeds residential VISL for PCE
- Result exceeds residential VISL for TCE
- Result exceeds commercial VISL for TCE

- Soil Vapor Sample Location
- Building
- Site Boundary
- Residential Property
- School/Daycare Property
- Approximate Extent of PCE > 5 µg/L

Notes:
VISL = EPA vapor intrusion screening level
(based on target risk of $1x10^{-5}$ and target hazard quotient of 1) (EPA, 2016)
µg/L = micrograms per liter
PCE = tetrachloroethene
TCE = trichloroethene
# - # = the depth interval in feet below ground surface.
Soil vapor results collected adjacent to the Annex and AG's Buildings were compared to commercial VISLs, results from all other locations were compared to residential VISLs.

N

0 250 500
Feet

FIGURE 4-3
Soil Vapor Results
Downtown Environmental Assessment Project
Montgomery, Alabama

ch2m.

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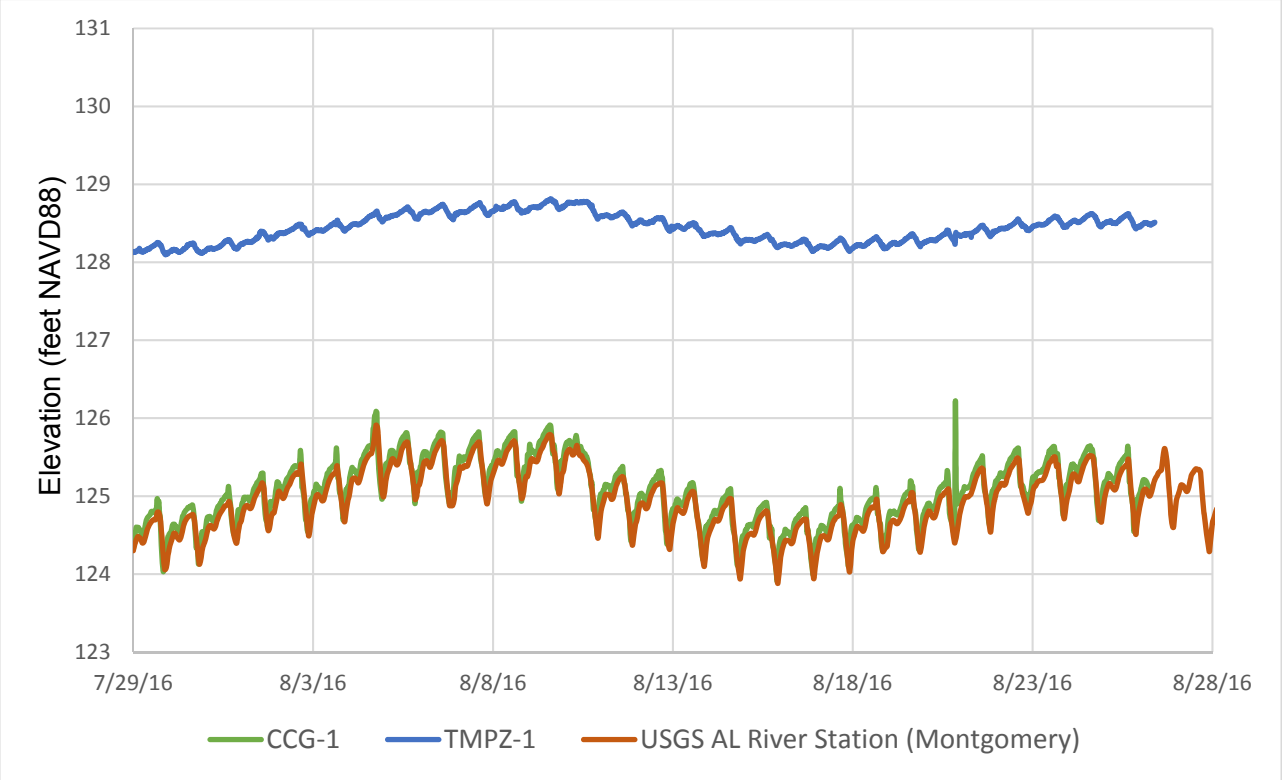
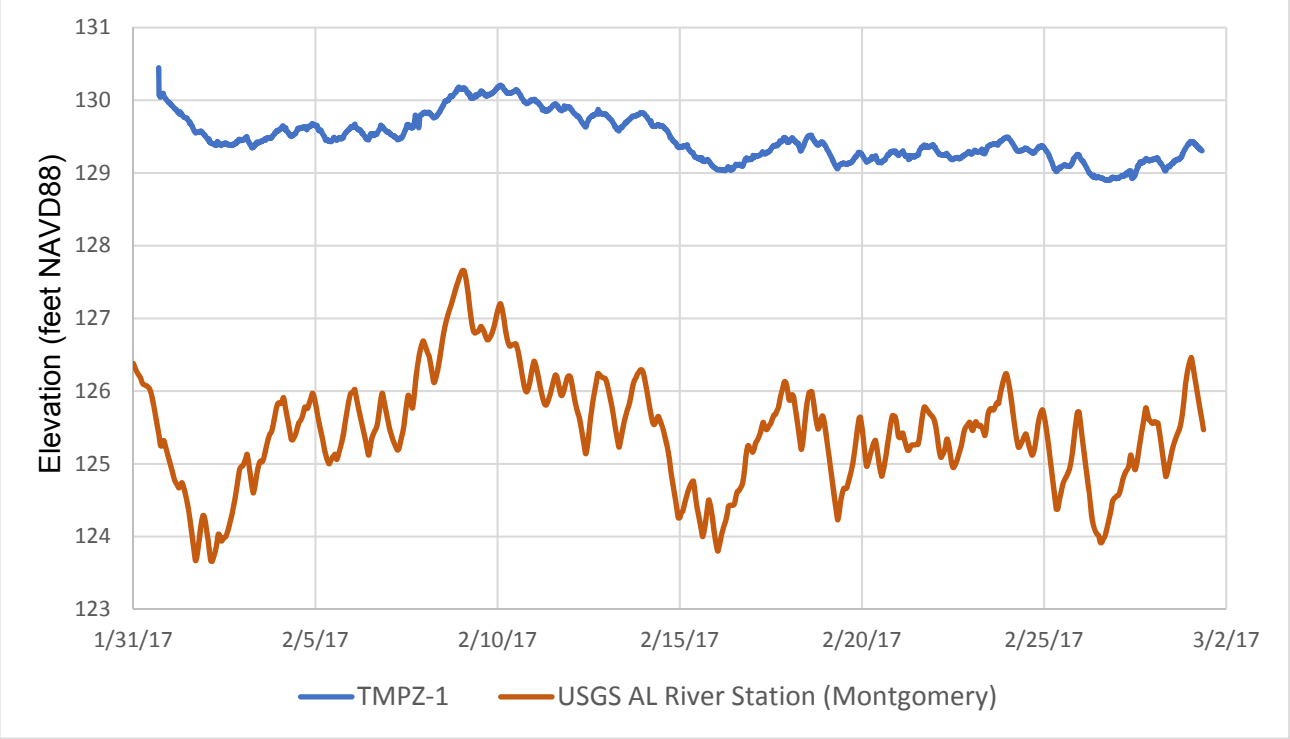
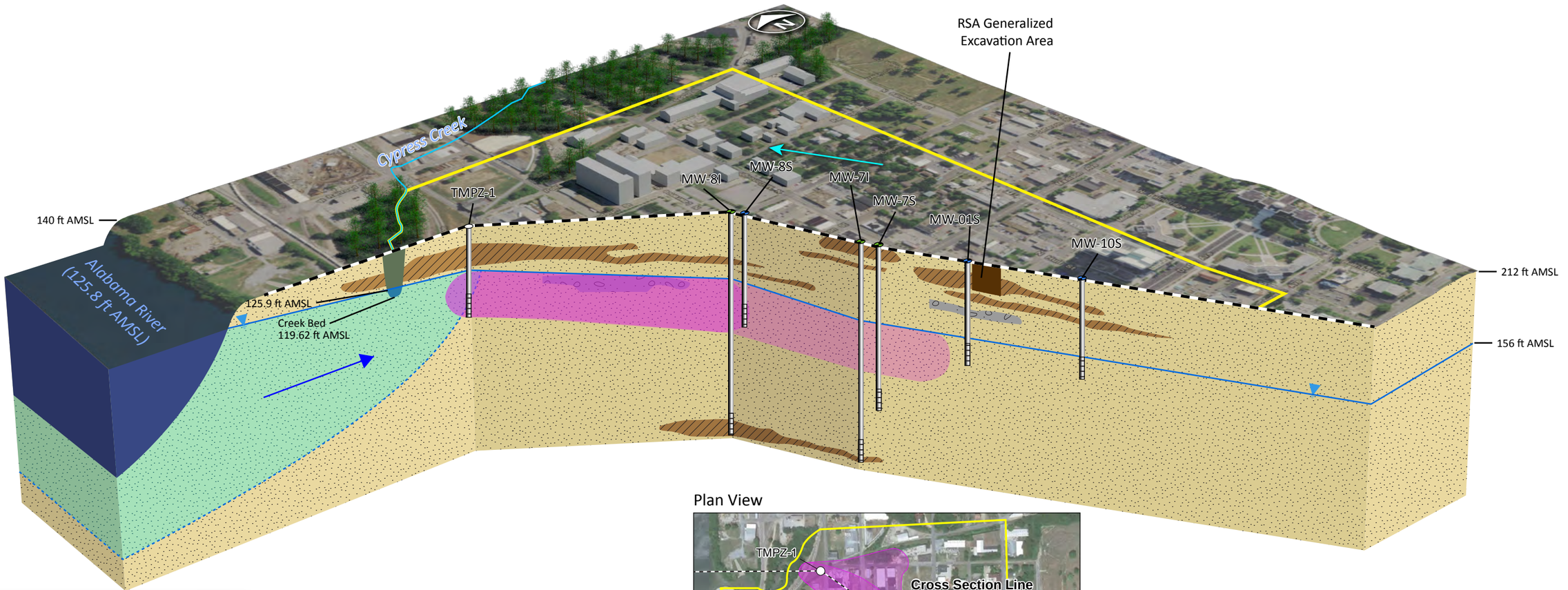




Notes:
CCG-1 = Cypress Creek Gauge
USGS AL River Station = United States Geological Society Alabama River Gauge 02419988
NAVD88 = North American Vertical Datum of 1988

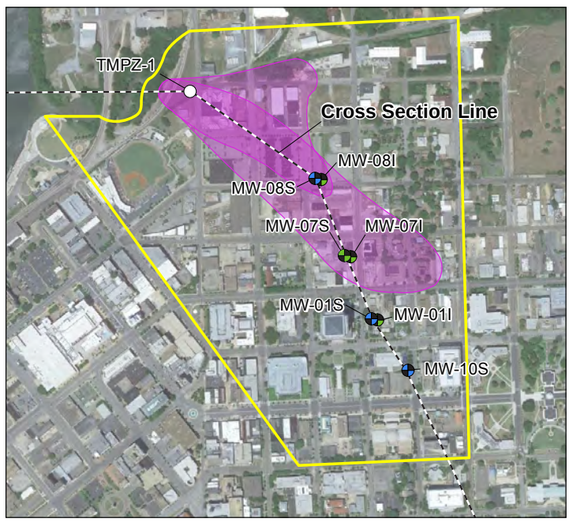
Figure 4-4
Cypress Creek Hydraulic Study Results
Environmental Investigation Report
Downtown Environmental Assessment Project
Montgomery, AL



LEGEND

- Site Boundary
- Shallow Monitoring Well
- Intermediate Monitoring Well
- Temporary Piezometer
- PCE Plume
- Approximate Extent of Alabama River Influence
- Sand
- Silt and Clay
- Sandy Gravel
- Groundwater Level
- Flow Direction

Plan View

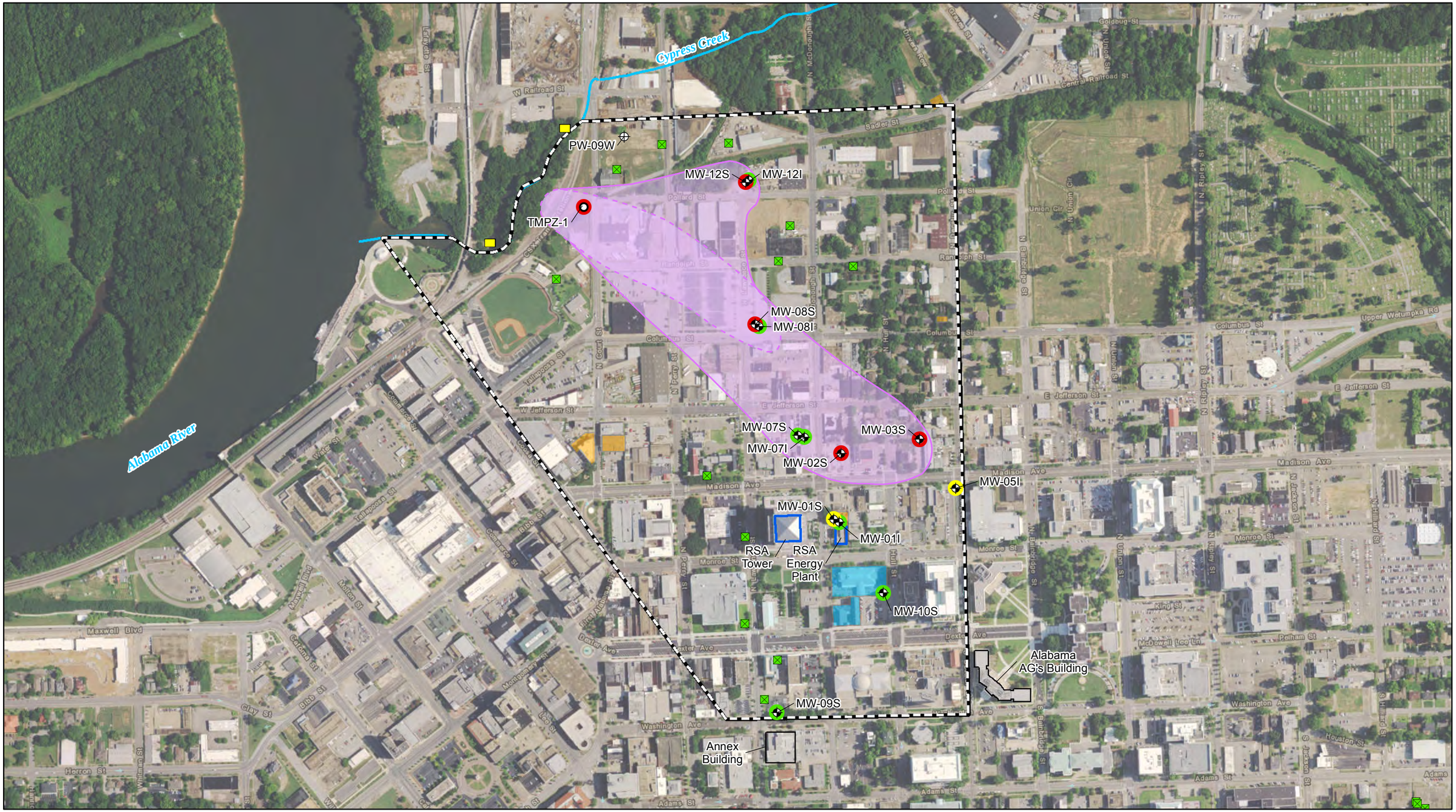


Notes:

1. Not to scale
2. Below surface elements vertically exaggerated for clarity
3. Darker purple color indicates commingled plumes
4. PCE = tetrachloroethene
5. ft AMSL = feet above mean sea level

Figure 5-1
Conceptual Site Model
Environmental Investigation Report
Downtown Environmental Assessment Project
Montgomery, Alabama

ch2m.



LEGEND

- Monitoring Well
- Former City Water Supply Well
- Temporary Piezometer
- Approximate Culvert Location
- 2003 Grab Sample Data Used for Plume Delineation

PCE Groundwater Results - July 2016

- Not Detected
- Detected, Not Exceeded
- Exceeded

- RSA Building
- Site Boundary
- Approximate Extent of PCE > 5 µg/L
- Residential Property
- School/Daycare Property

Notes:
1. AG = Attorney General
2. PCE = tetrachloroethene
3. RSA = Retirement Systems of Alabama
4. µg/L = micrograms per liter

N

0 250 500
Feet

FIGURE 5-2
Extent of PCE Plume
Environmental Investigation Report
Downtown Environmental Assessment Project
Montgomery, AL

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Appendixes A through F

Due to file size limitations, appendices are not included in this version of the report. Should you need a copy of the appendices, please contact Kim Fehl at 334-265-2091, Glen Davis at 334-215-9016, or access the full version of the report through the ADEM e-File system.