Remedial Investigation Report

Brenntag Mid-South, Inc.
Chemical Distribution Facility
2235 West Battlefield Road
Springfield, Missouri
EPA ID No. MOD0002325298

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Revised July 20, 2011

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Our Ref.:
OK001255.0036

Date:
September 28, 2007
(Revised July 20, 2011)

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Acronyms and Abbreviations

95UCL95th	percent upper confidence limit
ABS_{GI}	gastrointestinal absorption factor
amsl	above mean sea level
ARCADIS	ARCADIS U.S., Inc.
bgs	below ground surface
BTEX	benzene, toluene, ethyl-benzene and xylenes
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CII	Chemtech Industries, Inc.
CJE	C. Johnson Environmental
CLP	Contract Laboratory Program
cm/sec	centimeters per second
COC	chemicals of concern
COPC	chemical of potential concern
CSF	cancer slope factor
CSM	conceptual site model
CVOC	chlorinated volatile organic compound
DCA	dichlorethane
DCE	dichloroethene
DO	dissolved oxygen
ELCR	excess lifetime cancer risk
EPC	exposure point concentration
ERA	ecological risk assessment
ERD	enhanced reductive dechlorination
ESE	Environmental Science and Engineering, Inc.
ESIR	expanded site inspection report
F	fahrenheit
FS	feasibility study
FSP	field sampling plan
ft	feet
ft/day	feet per day
GP	Geoprobe™ (direct-push)
gpd	gallons per day

gpm	gallons per minute
HCE	Holland Chemical International
HHRA	human health risk assessment
HI	hazard index
HSP	Health and Safety Plan
HVE	high vacuum extraction
IDW	investigative derived waste
IRAP	Interim Removal Action Plan
IRIS	Integrated Risk Information System
LNAPL	light non-aqueous phase liquid
MCL	maximum contaminant level
MDL	method detection limit
MDNR	Missouri Department of Natural Resources
ug/L	micrograms per liter
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MIBK	methyl isobutyl ketone
MW	monitoring well
NAPL	non-aqueous phase liquid
NCEA	National Center for Environmental Assessment
NCP	National Contingency Plan
NGVD	National Geodetic Vertical Datum
NPDES	National Permit Discharge Elimination System
PA	Preliminary Assessment
PAH	Polycyclic Aromatic Hydrocarbons
PCE	tetrachloroethene or perchloroethene
PID	photo-ionization detector
POTW	public owned treatment works
ppb	parts per billion
ppm	parts per million
PRGs	USEPA Region 9 Preliminary Remediation Goals
PVC	polyvinyl chloride
QA	quality assurance
QAPP	quality assurance project plan

QC	quality control
RCRA	Resource Conservation and Restoration Act
RfD	reference dose
RI	remedial investigation
RME	reasonable maximum exposure
SARA	Superfund Amendments and Reauthorization Act
SAW	Springfield (Plateau) Aquifer Well
SOW	statements of work
SQL	sample quantitation limits
STL	Severn Trent Laboratory
SVOC	semi-volatile organic compound
SSVE	sub-slab vapor extraction
TA	Test America (formerly STL)
TCA	tetrachloroethane
TCE	trichloroethene
TO	total organic
TOC	total organic carbon
TPH	total petroleum hydrocarbons
UCL	upper confidence limit
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	underground storage tank
Versar	Versar, Inc.
VOC	volatile organic compound

1 Introduction

ARCADIS U.S., Inc. (ARCADIS) was retained by Brenntag Mid-South, Inc. (Brenntag) to conduct the Remedial Investigation (RI) for the Brenntag Chemical Distribution Facility located at 2235 West Battlefield Road in Springfield, Missouri (herein referred to as either the Brenntag site or Site). Brenntag voluntarily entered into an Administrative Order on Consent with the United States Environmental Protection Agency (USEPA) in September 2001 to complete the ongoing RI and Feasibility Study (FS) activities at the Site (Figure 1).

Brenntag purchased the facility from HCI-Chemtech Distribution, Inc. in December 2000 (Figure 2). Under the direction of the USEPA and Missouri Department of Natural Resources (MDNR), HCI-Chemtech and its consultant, C. Johnson Environmental (CJE) conducted initial RI tasks at the Site prior to the transfer of ownership. This report documents the results of recent RI activities conducted by Brenntag to address technical data gaps identified in the previous environmental and initial RI investigations. Site Maps are provided as Figures 3a and 3b which depict the resultant monitoring well network and the location of onsite utilities, respectively.

Results of previous investigations and the RI have assisted in the enhancement of the Interim Removal Action Plan (IRAP) implemented in accordance with the Compliance Agreement signed in November 1997. Brenntag voluntarily installed a dual-phase, high-vacuum extraction (HVE) system in July 1999. Operation of the HVE system was initiated in March 2000 to reduce the volatile organic compound (VOC) impacts in both the soil and groundwater at the Site (Figure 4).

1.1 Purpose

The overall purpose of the RI is to 1) update the comprehensive body of knowledge regarding the physical environment, contamination, and the fate and transport of the contamination at the Site presented in the previous investigation reports, and 2) address the technical data gaps identified in the previous investigations.

Results of previous environmental investigations (i.e., site characterization) were presented in the 1998 report prepared by CJE titled “Environmental Conditions at the HCI-Chemtech Springfield Site: A Summary Report” per the Compliance Agreement. Interim removal action activities and previous remedial investigation tasks were

conducted by CJE in 1999 and 2000. Recent RI activities conducted by Brenntag between 2002 and 2010 to address technical data gaps were designed specifically to:

- Complete the delineation of source areas in soil.
- Complete the vertical and horizontal delineation of the nature and extent of impacted groundwater.
- Define the hydrogeologic conditions at the Site.
- Determine a Conceptual Site Model (CSM).
- Conduct a Baseline Human Health Risk Assessment using all available site data.

This report has been prepared in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA), and the National Oil and Hazardous Substance Pollution Contingency Plan (NCP).

1.2 Report Organization

This RI report is divided into ten sections. A brief description of each section is presented below:

- Section 1, Introduction – Discusses the purpose of the investigation, organization of the report, regulatory history, and previous interim removal actions.
- Section 2, Site Background – Describes the site features, adjacent land use, site history, present and past operations, chemicals detected in soil and groundwater, reported releases, current and future land use and infrastructure, meteorology, and ecological setting.
- Section 3, Physical Characteristics of Study Area - Describes the surface features and drainage, soils, regional and site geology, and the regional and site hydrogeology.

- Section 4, Previous Investigations - Presents a summary of reports and findings for previous investigations, interim removal action plan activities, and a summary of findings for previous remedial investigations.

- Section 5, Scope of Remedial Investigation – Outlines the technical scope and rationale for additional investigation of the potential soil source areas, and provides a brief summary of the field methodologies used to collect data during the RI, including the soil boring investigation, monitoring well installation, groundwater sampling program, soil vapor survey, sub-slab vapor survey, sub-slab vapor extraction testing and system installation, and hydraulic testing.

- Section 6, Nature and Extent of Contamination – Describes the analytical results for soil and groundwater samples collected during the RI, soil source area and groundwater characterization, interim removal action plan activities, onsite soil vapor survey, sub-slab vapor survey, sub-slab vapor extraction testing and system installation, and hydraulic testing.

- Section 7, Baseline Risk Assessment – Summarizes the baseline human health risk assessment (HHRA).

- Section 8, Conceptual Site Model - Describes the physical setting, specific geology and hydrogeology, VOC source, occurrence and migration, and constituent fate and reductive dechlorination.

- Section 9, Summary – Summarizes the key findings of the RI.

- Section 10, Conclusions and Recommendations - Provides major conclusions and recommendations of the RI.

- Section 11, References - Includes citations for all documents used in the preparation of this report.

Eleven Appendices are attached to this RI Report. A brief description of each of the appendices is presented below:

- Appendix A, Geological Logs **–** The geological description for the former Dayco Products Inc. water supply well, each of the monitoring well borings installed during the RI. Those logs available from previous investigations are included.

- Appendix B, Summary of Fluid-Level Measurements **–** The historical fluid-level data for all wells.

- Appendix C, Well Construction Logs – Well construction logs for the former Dayco Products, Inc. water supply well, monitoring wells, extraction wells, and injection wells are provided. Missouri Department of Natural Resources well certification records are included.

- Appendix D, Historical Summary of Volatile Organic Compounds Detected in Groundwater – The cumulative groundwater analytical data for all wells.

- Appendix E, Geotechnical Testing Data – The laboratory reports for geotechnical soil samples collected during the recent RI activities.

- Appendix F, Laboratory Data Validation Reports (on CD) – The data validation reports for soil and groundwater analytical results obtained during the recent RI activities.

- Appendix G, Laboratory Reports for RI Soil Samples (on CD) – The laboratory reports for all soil samples collected during the recent RI activities. (Selected reports from previous investigations are included)

- Appendix H, Well Development Form – SAW-2 – The cumulative summary for monitoring of groundwater removal during the recent RI activities.

- Appendix I, Laboratory Reports for Groundwater Samples 2003-2010 (On CD) – The laboratory reports for RI groundwater monitoring events. (Selected reports from previous investigations are included)

- Appendix J, Laboratory Reports for Soil Vapor and Sub-slab Vapor Samples (On CD).

- Appendix K, Human Health Risk Assessment – A report of the baseline human health risk assessment results.

1.3 Regulatory Background

A Plea Agreement was signed in April 1997 that required Corporate and Compliance Monitoring Programs be adopted. The monitoring programs were defined in a Compliance Agreement finalized on November 7, 1997. An Administrative Order on

Consent was subsequently entered into voluntarily by the USEPA and Brenntag in September 2001. The Brenntag site regulatory history and previous interim removal actions are summarized in this discussion.

1.3.1 Regulatory History

The Brenntag site is regulated jointly by the USEPA Region 7 and the MDNR. Brenntag and the USEPA Region 7 signed an Administrative Order on Consent in September 2001, pursuant to Section 120(e) (1) of the CERCLA, as amended by the SARA of 1986. The general provisions of the Administrative Order on Consent addressed the following issues: (1) required that Brenntag conduct the removal action described in the Administrative Order on Consent to abate an imminent and substantial endangerment to the public health, welfare or the environment that may be presented by the actual or threatened release of hazardous substances, pollutants, or contaminants at or from the Site; (2) required Brenntag to conduct a Remedial Investigation/Feasibility Study; and (3) required the extent of the release of the hazardous substances, pollutants, or contaminants at or from the Site be determined.

Previous investigations and initial RI tasks conducted at the Site between 1992 and 2000 identified VOC impacts to both soil and groundwater. A description of the findings from previous environmental investigations and initial RI activities performed between 1992 and 2000 are presented in Section 4.

RI activities performed by Brenntag between 2002 and 2010 were in accordance with the May 2002 RI/FS Work Plan, and recommendations provided in the Remedial System Performance Evaluation – 2004 (ARCADIS, 2005). RI activities initiated by Brenntag in February 2007 were performed pursuant to the January 2007 Additional Site Characterization Work Plan and subsequent addendums. The most recent RI activities were initiated in April 2010 per the Data Gap Study Work Plan (February 2010). A description of the findings and data obtained during the 2007 - 2010 RI are presented in Section 6.

Actions under the IRAP were taken to mitigate VOC impacts to soil and groundwater at the Brenntag site. A chronology of these previous interim removal actions is provided in the following discussion.

1.3.2 Previous Interim Removal Actions

An IRAP was implemented with the installation of a dual-phase HVE system in July 1999. The HVE system consists of five major components: 1) four groups of HVE

wells referred herein as units; 2) dual phase HVE equipment; 3) a groundwater aeration treatment system; 4) a granular activated carbon polish, and 5) a permitted outfall to the publicly owned treatment works (POTW) via the sanitary sewer.

Presently, the interim remediation system is comprised of 57 dual-phase HVE wells (Figure 4). Each of the dual-phase HVE wells is constructed of two-inch diameter materials and was installed using a hollow stem auger. The four HVE well units have a trunk line to which each of the wells in that unit is connected via a shutoff valve. The HVE wells are constructed with a 1-inch drop tube fitted with a bleed valve at the surface. During operation, these bleed valves are partially opened to provide sufficient make up air so that the air flow velocity from the bottom of the drop pipe (bottom of each well) would keep groundwater entrained, lifting it to the surface and into the HVE well piping. Groundwater, vapors extracted from the subsurface, and bleed air from the surface is transported to the HVE system via the well groups trunk line.

Groundwater produced from the HVE wells enters the HVE system through two knockout tanks. The first knockout tank is located outside of the system equipment enclosure and was installed to remove sediment from the influent stream. The second knockout tank is used to separate liquid from vapors. The liquids are removed from the knockout tank using a level controlled progressive cavity transfer pump and pumped to a 550-gallon storage tank.

Vapors withdrawn from the top of the knockout tank pass through the liquid ring pumps, and then discharged to the atmosphere. The liquid ring pumps are oil sealed and require a second liquid/vapor knockout tank on the pump discharge. The seal fluid (hydraulic oil) is circulated through a heat exchanger prior to reentering the liquid ring pumps.

Groundwater is treated using an air stripper followed by carbon polishing prior to discharge. Water from the surge tank is pumped into the air stripper using a level controlled centrifugal pump. Following treatment in the air stripper, water is pumped through bag filters using a level controlled centrifugal pump, and then pumped through two-200 lb carbon vessels installed in series for final polishing. Groundwater is discharged to the POTW following treatment. Per the POTW permit guidelines, the outfall is sampled on a monthly basis to confirm treatment efficiency.

As designed, the HVE system induces a vacuum at the recovery wells to withdraw both soil vapors and groundwater from the subsurface. Volatile organic compounds (VOCs) are removed as a dissolved component in the groundwater, as vapors from the soil, and in the case of the petroleum based hydrocarbons, through in-situ biodegradation.

The objectives of this removal action are to 1) remove the VOCs from unsaturated soils and the dewatered smear zone through vapor extraction, 2) reduce the overall mass of VOCs from the groundwater by extraction and treatment, 3) to prohibit the vertical migration of VOCs, and 4) provide hydraulic control to mitigate impacted groundwater from migrating offsite. The extent to which each of these removal action objectives has been attained is provided in Section 6.4.2.

2 Site Background

The following sections present a site description and adjacent land use, site history, chemicals detected in soil and groundwater, reported releases, current and future land use, infrastructure, meteorology, and ecological setting.

2.1 Site Description and Adjacent Land Use

The Brenntag Mid-South, Inc. chemical distribution facility is located in the southwest side of Springfield on a 3.75 acre parcel within the Missouri Pacific Industrial Park (Figure 2). The geographic location of the Brenntag site is the SE ¼ of the SE ¼ of the NW ¼ of Section 3, Township 28 North, and Range 22 West (Figure 1).

The Facility is comprised of a 2,000 square foot office, a 12,000 square foot warehouse and loading dock, a 1,250 square-foot bag storage building, a covered 2,000 square foot acid drum storage area, a 700 square-foot storage shed, an inactive tank farm, and an inactive railcar spur. The rail spur enters the facility from the north along the eastern property boundary. There are currently 13 inactive above ground storage tanks on the Site (Figure 4).

A six-foot chain link fence surrounds the property with an electronic entry gate along the front that adjoins the office building. This gate is locked during non-business hours. The parking lot, loading dock, and rail spur are approximately five feet (ft) lower in elevation than the remaining portion of the facility (front lawn, office, warehouse, and northern portion of the Site).

Properties adjacent to the Brenntag facility are depicted on Figure 2. Two undeveloped land tracts located north of the Brenntag site are presently owned by the Back 3, LLC (western tract) and Battlefield Business Center, LLC (eastern tract). Dyke Lumber owns the tract immediately east of the Battlefield Business Center, LLC property. ACME Brick is located to the west of the facility. A light industrial business complex owned by Dennis Blake Properties is located east of the Site. The southern boundary of the Site is adjacent to West Battlefield Road. On the south side of West Battlefield Road are a residential trailer park and Foster Manufacturing, Inc.

2.2 Site History

Brenntag Mid-South owns and operates the chemical distribution facility that was acquired from Holland Chemical International (HCI) in December of 2000. Holland Chemical International (HCI) - Chemtech acquired the facility from Chemtech Industries, Inc. (CII) in 1992 and operated under the name HCI-Chemtech Distribution, Inc. CII initiated operations at the facility in 1975. The Site had been agricultural land used for farming and grazing until 1975.

2.2.1 Site Operations

Presently, the facility only stores and distributes pre-packaged chemical products. The facility also distributes dry chemicals including caustic, surfactants, desiccants, and pharmaceutical and food-grade chemicals. The facility never manufactured chemicals and the amount of chlorinated solvents stored at the facility has decreased considerably since bulk storage was discontinued.

Caustics, aromatic solvents, acids, ketones, alcohols, glycols, petroleum based hydrocarbons, and chlorinated solvents were handled and stored at the facility.

2.2.2 Previous Site Operations and Practices

Past practices of the facility included, bulk delivery of chemicals in railcars, railcar unloading, bulk storage of chemicals in above ground tanks, bulk loading of trucks for shipment, chemical blending, drum filling or repackaging in smaller containers, drum rinsing/painting (recycling), and storage of diesel fuel for company vehicles. Figure 5 depicts the facility structures and location where previous site operations were conducted. The previous operations and practices conducted at the facility include:

- When HCI purchased the Site in 1992, chemicals were stored in 38 aboveground storage tanks. The storage tanks were located north of the warehouse in tank farms which had earthen dikes and floors.

- The old tank farm was located adjacent to the rail spur. Decommission of the old tank arm was conducted in stages between 1992 and 1996. Reportedly, there was a manifold at the south end of the old tank farm similar to the existing manifold associated with the New Tank Farm. Several large conduits (12 to 16 inch-diameter) were located between the old tank farm manifold and the Former Drum Filling Room. These conduits contained product pipes that connected the designated, above-ground storage tanks with a manifold on the

outside wall of the warehouse. A transfer pump fitted with a valve, cam-lock connections, and flexible hose was located at the manifold for the purpose of transporting product into the Former Drum Filling Room.

- Piping between the old tank farm and the former drum filling room (located in the northwest corner of the warehouse) was removed during decommission of the old tank farm.

- A new tank farm (now inactive) with 13 above ground storage tanks, a concrete floor, and walls was constructed in 1996. Concrete walls within the tank farm separated chemicals that could be incompatible.

- Each tank in the new tank farm is individually plumbed to the manifold at the bulk tank truck loading area.

- Drum filling was conducted between 1996 and May 2001 in the covered area immediately west of the bulk tank truck loading area (at the east end of the covered full acid drum storage area).

- Bulk chemical storage in the new tank farm and bulk chemical handling at the drum filling area was discontinued in May 2001, soon after Brenntag acquired the facility.

- Only one chemical blend was prepared at the Site however, this operation was discontinued in June 2002. The blending was done in a portable polyethylene tank.

- The rinsing of solvent drums was conducted in the present bag storage building located in the northwest portion of the Site. This operation was ongoing between 1975 and the mid – 1980's. Methylene chloride was used to clean the solvent drums. The chemical was captured, reused, and when deemed spent it was properly disposed as a hazardous waste.

- A spray-paint booth operation was also located in the present bag storage building. This was the final step in the solvent drum reconditioning process.

- Acid and caustic drums were rinsed in a concrete neutralization tank or basin located in the northwest portion of the Site. Rinse water was neutralized and discharged under a permit to the municipal sewer. This operation was discontinued in the early 1990's.

- An underground pipe, that transported diesel fuel from the old tank farm to a dispenser, located at the southwest corner of the covered full acid drum storage area, was removed in the mid – 1990's.

- A previous report indicated that one underground storage tank (diesel) was used at the facility, but was removed in or around 1980. A later report disputed the existence of this tank. Discussions with site operations personnel indicate an above ground diesel tank was located in the old tank farm.

- Reportedly, above ground piping existed between the above ground diesel tank and the rail spur. A cam-lock connection and flexible hose was used to unload and transport diesel from the rail car. The practice of moving diesel between the old tank farm and the rail car loading area was abandoned in 1991. In contrast, a previous report indicates a 120-foot run of buried pipe carried diesel fuel between the old tank farm and the rail loading area. Diesel was dropped from the product list in 1992.

- Railcar unloading of chemicals was discontinued around 1983.

In general, the former operations and practices conducted at the facility fall within two areas;

1. The Former Drum Rinse Area - Includes both the Acid and Caustic Drum Rinse Area, and the Solvent Drum Rinse Area in the northwest portion of the Site.

2. The Former Bulk Chemical Handling Area – Includes the Blend Tank, Drum Filling Room (in the warehouse), Bulk Tank Truck Loading Area, and Drum Filling Area (near the new tank farm).

2.3 Chemicals Detected in Soil and Groundwater

The chemicals detected in soil and groundwater at the Site includes those chemicals detected above the laboratory reporting limit obtained during previous investigations and recent RI activities. Chemicals detected in soil and groundwater samples at the Brenntag site include VOCs (chlorinated, ketones, and aromatic hydrocarbons), and polynuclear aromatic hydrocarbons. A summary of the chemicals detected in soil samples at the Site between 1992 and 2010 are provided in Table 1. In addition, the chemicals detected in groundwater are summarized in Table 2.

Summaries of the screening levels for the determination of target chemicals of concern (COCs) at the Brenntag site are presented in the attached Human and Health Risk Assessment.

2.4 Reported Releases

Known or reported releases to the surface at the Brenntag Mid-South facility include the following:

- Three drums of nickel sulfamate were reported to have leaked on a truck on May 21, 1988. The location was not specified.

- Approximately 500 gallons of solvent (230 gallons of which was recovered) was released when a hose ruptured in the former bulk tank truck loading area in June 1986. This documented release is in a location consistent with historical and current groundwater impacts.

- The release of an unknown volume of off-specification chlorinated solvents near the northern end of the property in the mid - 1970's was reported in an assessment prepared in 1988. Chemtech stated in 1992 that they could not confirm the source of this information. This reported release is not directly associated with known source areas of soil or groundwater impacts. However, if there was a release, it may be in the general area of the acid/caustic and solvent drum rinsing and recycling operations.

The potential sources of an underground release of VOCs at the Site are;

- The handling of diesel fuel transferred between the old tank farm and the rail loading area.

- A former pipe that transported diesel fuel from the old tank farm to a former dispenser located at the southwest corner of the covered full acid drum storage area.

- The former piping located between the old tank farm and the former drum filling room located in the northwest corner of the warehouse.

Based on reported releases and historical soil and groundwater analytical data, the source areas evaluated during the previous source characterization activities include the following:

- The Bulk Chemical Handling Area located in the central portion of the Brenntag site (former bulk tank truck loading area, drum filling area, blend tank, and drum filling room). Chemicals detected in soil and groundwater samples from this area include VOCs (chlorinated, aromatics, and ketones) and polynuclear aromatic hydrocarbons.

- The Drum Rinse Area located in the northwest portion of the Brenntag site (former acid/caustic and solvent drum rinsing and recycling area). This process consisted of an acid/caustic drum rinsing basin located south of MW-1, and a solvent drum rinsing/painting area located in the present bag storage building. Chemicals detected in soil and groundwater samples from this area are primarily VOCs related to the historic practices of cleaning and recycling drums.

- The Rail Spur is located along the eastern Brenntag property boundary. Chemicals detected in soil and groundwater samples from this area include VOCs (chlorinated, aromatics, and ketones) and polynuclear aromatic hydrocarbons.

2.5 Current and Future Land Use

Current land use of the Brenntag site has been classified as industrial. Additional discussion of land use regarding the site-specific risk assessments will be presented in Section 7 of this report.

2.6 Infrastructure

This section describes the water supply, control of stormwater drainage, and transport and treatment of sanitary and industrial wastewater and sewage at the Brenntag site.

2.6.1 Water Supply

The City of Springfield, Missouri provides a potable water supply for the Brenntag site. Based on the results presented by the MDNR entitled “Expanded Site Inspection Report” (March, 2001), forty-six domestic wells and one non-community public well within four miles of the Site produce water from the Springfield Plateau Aquifer; however, none occur within one mile of the Brenntag site.

2.6.2 Storm Water Management

The Brenntag facility holds a National Pollution Discharge Elimination System (NPDES) storm water permit (#MOR23A087) for the management of storm water runoff from two outfalls. Outfall 001 includes the portion of the Brenntag site located north of the Former Drum Rinse Area which drains toward the open field located to the north. Outfall 002 includes the drainage area northeast and east of the inactive tank farm and at the inactive rail spur that is approximately five ft lower in elevation.

2.6.3 Wastewater Discharge Permit

The City of Springfield granted a wastewater permit in November 1996 for the discharge of treated groundwater from the remediation system. The permitted outfall to the public owned treatment works (POTW) via the sanitary sewer is located at the remediation system building.

2.7 Meteorology

Springfield, Greene County, Missouri has a temperate climate with cold winters and long, hot summers. In winter, the average temperature is 35 degrees Fahrenheit (F), with an average daily minimum temperature of 24 degrees F. In summer, the average temperature is 76 degrees F, with an average daily maximum temperature of 87 degrees F. The prevailing wind direction is from the southeast with an average speed of 12 miles per hour. Total annual precipitation is 41.47 inches. The 2-year, 24-hour rainfall is estimated at 3.5 inches (MDNR, 2001). Maximum precipitation occurs mainly in spring and early summer.

2.8 Ecological Setting

The Brenntag site is approximately 3.75 acres in size, and is located in the Missouri Pacific Industrial Park. Undeveloped properties with open fields border the Brenntag site to the north. These prospective commercial properties are grass covered and periodically mowed during warm weather months. Commercial properties border the east and west side of the Brenntag site. The southern border of the Brenntag site is fronted by Battlefield Road. Based on the results presented in the MDNR Expanded Site Inspection Report (ESIR) prepared in 2001, there are no sensitive environments on or within 200 ft of the Brenntag site.

3 Physical Characteristics of Study Area

The following sections discuss the surface features and drainage, soils, regional geology, site geology, and hydrogeology of the Site.

3.1 Surface Features and Drainage

According to the United States Geological Survey (USGS) Springfield, Missouri 7.5-minute quadrangle map (1996), the ground-surface elevation of the Site is approximately 1,280 ft above the National Geodetic Vertical Datum (NGVD) of 1929 (Figure 1). The USGS map indicates that the Site is located in an area of gently rolling hills, dissected by local streams that contribute to the James River, located south of Springfield. The general topographic gradient at the Site is to the north and south as the Site is located on a gentle east – west trending ridgeline. This ridgeline separates two westerly flowing drainage channels that represent the headwaters of South Creek. These westerly flowing channels appear approximately 3,000 ft north and 2,500 ft south of the Site. Several nearby wetlands were identified along the South Branch of South Creek.

In general, the surface water drainage system in the northern portion of the Brenntag site consists of overland flow to the north. Engineered drains in the southern portion of the facility direct surface water drainage to the storm sewer along West Battlefield Road.

3.2 Soils

3.2.1 Local Soils

According to the U.S. Department of Agriculture Soil Conservation Service (currently Natural Resources Conservation Service), the soils beneath the Site are classified as the Creldon silt loam (north unimproved area) and the Keeno and Eldon cherty silt loams (Brenntag site). The Creldon, Keeno, and Eldon soil types are found on uplands, formed in limestone residuum, and are typically well drained. These soils are characterized by brown to red silty clay loam and cherty silty clay loam with some sinkholes and surface blocks of bedrock.

3.2.2 Site Soils

Soil boring investigations determined that the Brenntag site is underlain by reddish-brown silt, clay, and residuum which overlays a hard, limestone bedrock. Geological logs with a description of the soil borings are provided in Appendix A. The reddish-brown silts and clays show localized variations throughout the Site. These variations include abundant chert bands in the upper four ft in the northeast area of the Site. Additionally, discontinuous thin lens of chert and white crystalline sands of varying thickness are present throughout the Site. The soil/residuum becomes firmer with depth, except in the area just above the limestone, where it is generally softer. In the western and southwest areas of the Site, a thin bed of oolites was reportedly present at the base of the predominantly silt, clay, and residuum.

3.3 Regional Geology

The Brenntag site lies within the Springfield Plateau sub-province of the Ozark Plateaus Province of the Interior Highlands Physiographic Province. The terrain is characterized as gently rolling in the divide areas with moderate relief along the rivers. This portion of the Springfield Plateau consists of broad uplands dissected by tributaries of the James River, located south of Springfield (Figure 1).

A review of available geologic literature was conducted as part of the RI activities to develop an understanding of the stratigraphy in the area of Springfield. The published reports included The Water Resources and Geology of the Springfield Area, Missouri (Emmett, 1978), and Major Geohydrologic Units in and adjacent to the Ozark Plateaus Province, Missouri Arkansas, Kansas, and Oklahoma (Imes, 1989). Based on a review of the information in these published geologic reports and the Expanded Site Inspection Report for the Brenntag site prepared by the MDNR (2001), the regional geology is characterized by the following observations:

- Soils at the surface are derived from loess, which was deposited as windblown silt during interglacial periods, and residuum that is derived from chemical weathering of the underlying carbonate bedrock.

- The area is underlain with predominantly carbonate rocks of Mississippian, Ordovician, and Cambrian-age. Sandstone, chert, and shale beds are present throughout these stratigraphic units.

- The top of bedrock is characterized as an eroded surface with weathered rock fragments, potential solution-enlarged joints and fractures separated by bedrock highs or “pinnacles”.

- A number of structural lineaments and normal faults are present.

- Numerous karst features including springs, caves, and closed depressions, which may be sinkholes, are documented.

- The Springfield Plateau Aquifer, Ozark Confining Unit, Ozark Aquifer, St. Francois Confining Unit, and St. Francois Aquifer comprise the major geohydrologic units in the region.

3.4 Site Geology

Two formations are exposed in the area: the Burlington-Keokuk Formation and the Elsey Formation. These formations are nearly horizontal with only very gentle dip to the west-southwest.

The Burlington-Keokuk is a light gray to white, coarsely to medium crystalline, crinoidal limestone. It is medium- to very thick-bedded limestone with common styolites. Chert occurs in elliptical white nodules, usually not more than 6 to 8 inches thick arranged in non-continuous layers. This formation rock is extremely susceptible to solution. A review of the USGS Springfield, Missouri 7.5-minute quadrangle map (1996) reveals the presence of ten closed depressions within one mile of the Site that may be sinkholes.

Beneath the Burlington-Keokuk limestone is the Elsey Formation, a dense light gray limestone containing 25 to 50 percent chert. The limestone is very finely crystalline and interbedded with nodular chert. The chert occurs in nodules or long lenses and beds from 6 inches to 2 ft thick. The chert has distinctive white to gray coloration with some mottling. The limestone dissolves easily where it contacts the chert. The chert tends to fracture easily and weather out of the formation leaving hollow spaces in outcrops. The formation weathers so easily that outcrops are difficult to find outside of road cuts.

The weathered limestone surface beneath the Site and surrounding area is very irregular. The depth to top of bedrock ranged between 11 ft and 32 ft below ground surface (bgs) in soil borings advanced during remedial investigations. This irregular bedrock topography is termed a “pinnacle” limestone in the area. A map depicting the

irregular top of the bedrock surface is shown as Figure 6. Hydrogeologic cross sections A-A' and B-B' depict the irregular limestone bedrock surface and the overlying cherty residuum and silt\clay soils. The cross sections are provided as Figures 7 and 8, respectively. In general, the topography of the undeveloped properties bordering the north side of the Brenntag site is reflective of the underlying geology. Both the ground surface and bedrock surface slope to the north.

3.5 Hydrogeology

The Springfield Plateau Aquifer, Ozark Confining Unit, Ozark Aquifer, St. Francois Confining Unit, and St. Francois Aquifer comprise the major geohydrologic units in the region.

3.5.1 Regional Hydrogeology

The Springfield Plateau Aquifer may be up to 285 ft thick in the Springfield area. It is comprised, in descending order, of the Burlington-Keokuk Limestone, Elsey Formation, Reeds Spring Formation, and Pierson Limestone of Mississippian age. This karst aquifer is unconfined and therefore is directly recharged by surface infiltration. The Springfield Plateau Aquifer is an important source of drinking water for both domestic and public water supply. Based on the results presented in the 2001 MDNR ESIR, forty-six domestic wells and one non-community public well within four miles of the Site produce water from the Springfield Plateau Aquifer; however, none occur within one mile of the Site.

The Ozark Confining Unit is leaky confining layer that underlies and separates the Springfield Plateau Aquifer from the Ozark Aquifer. The Ozark Confining Unit varies between 20 and 70 ft in thickness beneath the Springfield area. The Ozark Confining Unit is comprised of Mississippian age rocks (limestone, dolomite, sandstone siltstone, and shale). The uppermost geologic formation is the Northview Shale that is also the thickest formation of the confining unit. Beneath the Springfield area the Northview Shale ranges from less than 10 to about 40 ft in thickness.

The Ozark Aquifer is in excess of 1,400 ft thick in the Springfield area and is composed of rocks of Ordovician and Cambrian geologic formations of varying permeability. These formations are comprised predominantly of dolostone and sandstone. The Ozark Aquifer is the major source of groundwater in the Springfield area. A water supply well at the Carlisle Power Transmission Products (formerly Dayco Products, Inc.) facility , located approximately 0.4 miles west of the Brenntag site, is reported as 1,640 ft deep, with a static water level of 340 ft below ground surface (bgs). In 1999

the former Dayco (Carlisle) well was reportedly extracting approximately 60,000 gallons per day (gpd) from a depth of approximately 600 ft bgs (Figure 2). Other wells identified in the southwest area of Springfield, tend to be shallower, 400 to 600 ft deep, with static water levels in the range of 280 ft bgs.

3.5.2 Site Hydrogeology

A shallow unconfined water table is present in the soil/residuum and underlying limestone bedrock. Monitoring wells MW-1 through MW-13 are located on the Brenntag facility. These wells were drilled to the top of bedrock and completed with screens in the soil/residuum. Wells SAW-1 and SAW-3 are located on the Acme Brick and Brenntag facilities, respectively. These two wells are open-hole completions in the upper 20 ft of the shallow bedrock. In addition, onsite monitoring wells MW-28B through MW-31B are completed with screens in the upper bedrock.

A comparison of groundwater elevations measured in monitoring wells completed in the soil/residuum with those wells completed in the upper bedrock indicate the soil and bedrock act as one hydrologic unit. Figure 9a depicts the shallow groundwater elevations in the Springfield Plateau Aquifer beneath the northern portion of the site on November 1, 2010. The resultant drawdown due to HVE at upper bedrock extraction wells E42B, E45B, and E47B is apparent. Wells MW-2, MW-10, and MW-11 are completed with well screens positioned at or above the top of bedrock. The fluid level gauging data indicate each of these wells was dry during the gauging event and therefore the groundwater was below the top of bedrock. This observation is confirmed by the comparison of fluid level data observed on November 1, 2010 with the Approximate Top of Bedrock (Figure 6) elevations for each well. Measured groundwater elevation in monitoring wells completed in the upper bedrock (MW-28B through MW-31B) was also at or below the top of bedrock.

The upper bedrock is characterized as having localized solution voids within approximately the top 20 ft. Typically, a marked increase in drill rates occurs when the solution voids are encountered. Returned drill cuttings indicate the presence of a very fine-grained soil (clay and silt) in the voids and an increased production of groundwater. Soil boring logs indicate voids present in the upper bedrock extraction and monitoring wells installed in 2010.

Groundwater flow direction in the soil/residuum and upper bedrock appears to mimic the surface topography. The groundwater flow direction may also be influenced by the irregular elevation of the weathered bedrock surface. Secondary permeability pathways may occur locally such as chert zones in the soil/residuum, unconsolidated

sediment on the weathered bedrock surface, and bedding planes and solution features within the upper bedrock. The locations of site utilities (above ground and buried) are provided on Figure 3b. Buried utilities and piping associated with the HVE system are within the interval of surface to 5 ft bgs. Therefore, backfill materials associated with these trenches are not a likely influence on the shallow groundwater flow direction.

The groundwater flow direction in the deeper limestone bedrock may vary seasonally. Initial potentiometric surface data (3 wells) indicated the groundwater flow direction was generally to the west-southwest. The addition of three deep Springfield Plateau Aquifer wells in 2010 has resulted in an interpreted potentiometric surface and groundwater flow direction more similar to the shallow groundwater conditions. The deep Springfield Plateau Aquifer wells (SAW-2and SAW-4 through SAW-8) are characterized as; having a lack of observed fracturing or solution features in the bedrock borings, a slow rate of groundwater recovery, and a low hydraulic conductivity.

3.5.2.1 Groundwater Elevation

The following section presents the details and the results of the most recent fluid-level monitoring events. Fluid levels are measured from the top of casing that were surveyed and referenced to a benchmark datum. Measured fluid-levels are reported in ft above mean sea level (amsl). All groundwater elevation data, with the exception of SAW-2and SAW-4through SAW-8, are used to construct a shallow groundwater elevation map.

Groundwater withdrawal by means of the HVE system and variation in seasonal precipitation result in a broad range of depth to groundwater beneath the Brenntag facility. An observed rapid rise and markedly high groundwater elevations in wells indicate a high rate of groundwater recharge in the central portion of the Brenntag facility. Historical groundwater elevations range from approximately 3 ft to 21 ft bgs in monitoring wells located on the Brenntag facility. A summary of fluid level measurements collected at the Site between 1995 and 2010 is provided in Appendix B.

The site wide groundwater monitoring network for the unconfined, shallow groundwater surface was completed in April 2010. Shallow groundwater elevations are obtained from 35 monitoring points during the scheduled gauging events. Figure 9a through Figure 9c are groundwater elevation maps prepared for gauging events conducted in November 2010, August 2010, and May 2010, respectively. These recent groundwater elevation maps depict the calculated hydraulic gradient between onsite well MW-5 and offsite well MW-19 of approximately 0.03 ft per foot.

Groundwater elevations are obtained from six wells installed in the deep Springfield Plateau Aquifer monitoring network. These data were obtained from wells SAW-2and SAW-4through SAW-8 that are sealed from the intermediate and shallow groundwater zones in the Springfield Plateau Aquifer. Five of the deep SAW wells were constructed with screens 20 ft in length at a depth of approximately 200 ft bgs. SAW-7 was constructed with a screen 40 ft in length. Potentiometric surface maps prepared for gauging events conducted in December 2010 (Figures 10a and 10b), November 2010 (Figure 10c), and August 2010 (Figure 10d) These potentiometric surface maps of groundwater elevations in the deep portion of the Springfield Plateau Aquifer indicate an approximate gradient of 0.18 ft per foot.

A review of the historical groundwater elevations obtained for the unconfined, shallow groundwater table (MW-13) indicate a contrast with the lower elevations measured in the deep Springfield Plateau Aquifer (SAW-2) on the same date. This elevation contrast reflects the differential in hydrostatic head between the shallow unconfined aquifer and the potentiometric surface of groundwater from approximately 200 ft bgs.

3.5.2.2 Groundwater Flow

The flow direction for shallow groundwater at the Site is estimated from water levels measured in 28 monitoring points. Gradients are steeper beneath the Brenntag facility located in the upland area and relatively flat beneath the lower surface elevations located on adjacent properties to the north. Groundwater flow direction reflects the general surface topography in that it moves south, west, and north from the central portion of the Brenntag site (Figure 9a).

Monitoring wells SAW-2 and SAW-4 through SAW-8 are completed in the deep portion of the Springfield Plateau Aquifer. Potentiometric surface maps of the groundwater elevations in the deep portion of the Springfield Plateau Aquifer indicate that flow direction is generally to the west-northwest beneath the Site. The slow rate of groundwater recovery in the deep wells (SAW-2, SAW-4 through SAW-8), and the lack of fracturing or solution features (approximately 200 ft bgs) observed during deep well installation indicate hydraulic conductivity of the deeper limestone bedrock is low.

4 Previous Investigations

This section describes the data generated during previous assessments, audits, and environmental investigations completed at the Site between 1992 and 1998, a discussion of the activities conducted under the IRAP, and data obtained by CJE during previous remedial investigation tasks in 1999 and 2000. The data, conclusions, and recommendations provided in this section have been supplemented by the conclusions and recommendations of the RI conducted by Brenntag between 2002 and 2010.

Figure 11 shows the approximate location of each soil boring and monitoring well installed during previous investigations conducted between 1992 and 2000. Soil boring logs are included in Appendix A. Well construction details and MDNR well certification records are provided in Appendix C.

4.1 Previous Reports and Summary of Findings

Documentation of previous assessments, audits, and environmental investigations conducted at the Site between 1988 and 1998 are provided in the following reports:

4.1.1 August 1988 Pilko Environmental Risk Assessment

Pilko and Associates, Inc. (Pilko) prepared a report titled: “Environmental Risk Assessment of Chemtech Industries, Inc., Springfield, Missouri” on behalf of Chemtech. This report identified two environmental concerns at the Site, including:

- A one-time, unknown quantity of off-specification chlorinated solvents was reportedly released near the northern boundary of the Site in the mid – 1970’s. Chemtech later stated in 1992 that they were unable to determine the origin of the release information reported by Pilko.
- Approximately 500 gallons of solvents was released in the bulk tank truck loading area when a hose ruptured in June 1986. Recovery of 230 gallons of the spilled solvents was reported, resulting in a net loss of 270 gallons to the atmosphere and soil.

4.1.2 September 1991 ESE Limited Phase I Assessment

In September 1991, Environmental Science and Engineering, Inc. (ESE) prepared an assessment of the facility titled: "Limited Phase I Environmental Audit, Chemtech Industries, Inc., Springfield Distribution Branch". This report identified two environmental concerns at the Site, including:

- Three drums of nickel sulfamate reportedly leaked on a truck on May 21, 1988.
- Recommendations that 1) the tank farm be retrofitted with dikes and concrete floors and, 2) curbs should be installed to contain potential spills at the bulk tank truck loading area.

4.1.3 June 1992 CJE Preacquisition Environmental Assessment

In June 1992, CJE prepared a report titled "Preacquisition Environmental Assessment, Chemtech Industries, Inc." This initial subsurface investigation was conducted in May 1992. An objective of the investigation was to determine whether VOCs were present in soil and groundwater in the areas of reported releases or potential source areas related to previous site operations (Figure 5). The analytical results of soil samples from five boreholes and groundwater samples from three temporary monitoring wells are discussed. Wells were installed in three of the boreholes to assess potential impacts to groundwater based on the reported releases of VOCs at the Site (Figure 11).

Temporary monitoring well TMW-1 was located east of the former blend tank and immediately north of the former drum filling room located in the northwest corner of the warehouse. TMW-3 was located in the area where railcar unloading was conducted between the rail spur and the old tank farm. However, this temporary monitoring well location is not associated with a reported release. TMW-4 was located on the west side of the tank farm and south of the drum rinse area.

Boreholes B2 and B5 were drilled in the northwest portion of the Brenntag site. Borehole B2 was drilled near the area where used drums were returned, temporarily stockpiled, rinsed, and recycled. Solvent drums were rinsed and painted in the building (present bag storage building) located immediately south of Borehole B2. The acid and caustic drum rinse basin is located immediately east of Borehole B2. Borehole B5 was drilled in an area where a reported release of an unknown quantity of off-specification chlorinated solvents may have occurred.

4.1.3.1 Soil Analytical Data

Field analyses of soil samples from borehole B5 found no indication of VOC impacts. Therefore, no soil samples were submitted for laboratory analysis. Two soil samples were collected from the TMW-1 borehole at depths of 1 and 3 ft bgs (Figure 12). A soil sample was collected from the TMW-3 borehole, TMW-4 borehole, and borehole B-2. However, the depth which these boreholes were sampled is unknown. These three soil samples were selected on the basis of field observations and headspace analysis. Soil samples obtained during the May 1992 investigation were submitted for laboratory analyses of VOCs. The laboratory analytical results are summarized in Table 3.

A total VOC concentration value is provided at the bottom of Table 3. This value represents the cumulative concentration of all chemicals detected by the VOC laboratory method. In addition, a total chlorinated volatile organic compound (CVOC) concentration value and a total benzene, toluene, Ethylbenzene, and xylenes (BTEX) concentration is provided. These cumulative values provide a general comparison of concentrations for total CVOCs and total BTEX to the entire suite of VOCs detected in the sample. These cumulative values are provided in all subsequent analytical tables for soil and groundwater provided in this report.

The total CVOC and total BTEX concentrations detected in the May 1992 soil samples are provided on Figure 12. A total CVOC concentration of 87 micrograms per kilogram (ug/kg) and 2,027 ug/kg was detected in the Borehole B2 and TMW-4 soil samples, respectively. The presence of CVOCs in these samples may be associated with the nearby drum storage, rinsing, and recycling operations. The total BTEX concentration of 1,510 ug/kg detected in the TMW-3 soil sample indicated the presence of xylenes (1,400 ug/kg) near the rail spur.

Elevated concentrations of VOCs were detected in the TMW-1 soil sample collected 3 ft bgs. A total BTEX concentration of 604,000 ug/kg was detected in the TMW-1 soil sample. Ethylbenzene (64,000 ug/kg), toluene (150,000 ug/kg), and xylenes (390,000 ug/kg) were the highest detected analyte concentrations. No measurable concentration of benzene was detected. In addition, a total CVOC concentration of 83,737 ug/kg was detected. A partial list of the CVOCs detected include 1,1-dichloroethene (17,000 ug/kg), methylene chloride (15,000 ug/kg), tetrachloroethene (8,500 ug/kg), 1,1,1-trichloroethane (41,000 ug/kg), and trichloroethene (1,600 ug/kg). The elevated VOC concentrations detected at the TMW-1 location indicate a source area in the vicinity of the Former Bulk Chemical Handling Area (blend tank, drum filling room, and bulk tank truck loading operations).

4.1.3.2 Groundwater Analytical Data

A summary of groundwater analytical data for temporary wells TMW-1, TMW-3, and TMW-4 is provided in Table 4. VOCs were detected in groundwater samples from each of the temporary monitoring wells. The total VOC concentration detected in groundwater samples from TMW-1, TMW-3, and TMW-4 was 5,851,920 micrograms per liter (ug/L), 11,004 ug/L, and 4,181 ug/L, respectively.

Elevated concentrations of toluene (1,500,000 ug/L), ethylbenzene (610,000 ug/L), and xylenes (3,700,000 ug/L) dominate the analytical results of the TMW-1 groundwater sample. A total CVOC concentration of 41,920 ug/L was detected in the TMW-1 groundwater sample. The detected CVOCs include tetrachloroethene (PCE), 1,1,1–trichloroethane (TCA), trichloroethene (TCE) and degradation products of these chemicals. The elevated total BTEX and total CVOC concentrations detected in the TMW-1 groundwater sample indicate a source area is present in the proximity of the well location.

4.1.4 July 1995 Versar – Additional Investigation

Chemtech contracted Versar, Inc. (Versar) to more completely define the VOC impacts in soil and groundwater at the Site in 1995. The objective was to characterize the sources of VOCs identified during the pre-acquisition assessment conducted in May 1992. Results of the Versar site investigation were summarized in a subsequent CJE report prepared in 1998. These results were also discussed in the Remedial Investigation and Removal Action Workplan submitted by CJE in 1999.

Six monitoring wells (MW-1 through MW-6) were installed on May 31 and June 1, 1995 (Figure 11). Each of the wells were constructed with a stainless steel riser and well screen due to the high VOC concentrations detected in groundwater during the preliminary 1992 site investigation. A summary of well completion details for all wells at the Site is provided in Table 5.

Sixteen soil samples and six groundwater samples were collected and submitted for laboratory analysis of VOCs. Laboratory results and sample depth for soil samples collected from the well boreholes in May and June 1995 are provided in Table 6. Analytical results for the groundwater samples are included with the historical summary of VOCs detected in groundwater provided in Appendix D.

Well MW-1 was installed in the immediate vicinity of the former acid and caustic drum rinsing basin. Well MW-2 was installed in the northeast portion of the Site to delineate

the soil and groundwater impacts previously detected at temporary monitoring well TMW-4. Wells MW-3 and MW-4 are located along the former rail spur near temporary monitoring well TMW-3. Wells MW-5 and MW-6 were installed east of temporary monitoring well TMW-1 near the former blend tank and former drum filling room.

4.1.4.1 Soil Analytical Data

The sixteen well boring soil samples were collected at depths ranging from 4 ft and 21 ft bgs (Table 6). Groundwater elevation data collected subsequent to the installation of wells MW-1 through MW-6 indicate these samples represent either “smear zone” or saturated soil conditions. With the exception of one analyte, the results of the soil analytical data were consistent with those obtained from the 1992 investigation. However, acetone was detected in most samples at elevated concentrations that would not be explained as a possible laboratory contaminant.

The acetone concentrations detected in well boring soil samples from MW-3, MW-4, MW-5 and MW-6 dominated the analytical results for these well borings. However, an elevated concentration of tetrachloroethene or perchloroethene PCE was detected in saturated soil samples from the MW-1 well boring collected at 8.5 ft bgs (19,000 ug/kg) and 17 ft bgs (21,000 ug/kg). These PCE concentrations indicate a source area in the vicinity of the former drum rinsing and recycling operations. Total BTEX and total CVOC concentrations for soil samples collected from the six well borings installed in 1995 are provided on Figure 12.

4.1.4.2 Groundwater Analytical Data

Groundwater samples were collected from each of the six monitoring wells and submitted for laboratory analysis of VOCs. The June 1, 1995 groundwater analytical results for monitoring wells MW-1 through MW-6 are included with the historical summary provided in Appendix D. VOCs were detected in groundwater samples from each of the six monitoring wells.

The total VOC concentration detected in groundwater samples from MW-1 and MW-2 is 5,691ug/L, and 821ug/L, respectively. Although the total VOC concentration previously detected in the TMW-4 groundwater sample (May 1992) is consistent with MW-1, a marked contrast occurred in the analytes detected in these two wells. The detected PCE concentration in groundwater from MW-1 (1,300 ug/L) does not appear consistent with the elevated PCE concentrations in two soil samples from the MW-1 boring. However, the MW-1 groundwater analytical results confirm the presence of a

source area for PCE in the proximity of the former drum rinsing and recycling operations.

Analytical results of groundwater samples from MW-3 and MW-4 confirm the presence of toluene, ethylbenzene, and xylenes previously detected in TMW-3 (May 1992). However, the VOC impacts in groundwater detected along the rail spur may have migrated from the source area identified in the bulk chemical handling area (blend tank, drum filling area, and bulk tank truck loading area).

Wells MW-5 and MW-6 were drilled in the vicinity of the bulk chemical handling area. Toluene, ethylbenzene, and xylenes dominate the analytical results for the groundwater samples from these wells. However, CVOCs detected in the MW-6 groundwater sample include total 1,2-DCE (10,000 ug/l), methylene chloride (12,000 ug/l), PCE (430 ug/l), and 1,1,1-TCA (20,000 ug/l). The presence of these CVOCs in MW-6 groundwater sample, and elevated BTEX concentrations detected in groundwater samples from both MW-5 (7,530 ug/L) and MW-6 (71,690 ug/L) confirmed the impacts previously detected in TMW-4 (May 1992).

4.1.4.3 Hydraulic Testing

Four slug tests were conducted at wells MW-1 and MW-2 in 1995. These wells were completed in the soil/residuum. The reported test results indicate a range of hydraulic conductivities between $8x10^{-5}$ centimeters per second (cm/sec) and $3x10^{-6}$ cm/sec. Based on surface soils identified from the drilling borehole logs it is believed that the slug tests provide a reasonable estimate of the hydraulic conductivity. However, it is possible that these hydraulic conductivities are elevated, due to the presence of the thin sand and oolite layers observed in some of the borings.

4.1.5 January 1998 CJE Summary of Environmental Conditions

CJE prepared a report titled “Environmental Conditions at the HCI-Chemtech Springfield: A Summary Report” in January 1998. This report was prepared as part of the Compliance Agreement signed on November 7, 1997 to provide a complete summary of the reported releases, findings of previous environmental investigations, site background, and site operations.

The summary report included discussion of 2 water extraction wells and 14 vapor extraction wells installed in August 1995 (Figure 13). The wells were installed beneath the area where the concrete secondary containment was constructed for the (inactive) new tank farm. The water extraction wells were completed with six-inch diameter

materials and the vapor extraction wells were completed with four-inch diameter materials. The water extraction and vapor extraction wells are screened from 5 ft bgs to approximately 14 ft bgs or the top of bedrock. The water extraction wells (EW-1N and EW-2S) extend through the floor of the tank farm. The vapor extraction well casings are angled at 3 ft bgs and piped to the west edge of the tank where they surface in protective metal boxes.

In May 1996, CJE conducted a preliminary HVE pilot test utilizing the wells located beneath the new tank farm. CJE provided the conclusions derived from the HVE pilot test in the May 1999 Remedial Investigation and Removal Action Workplan that was required by the Compliance Agreement. The IRAP identified a remedy involving dual-phase HVE for source area soil and groundwater impacts, and a long-term groundwater monitoring program.

4.1.6 March 2000 MDNR Preliminary Assessment

The MDNR completed a Preliminary Assessment (PA) report for the Site on March 27, 2000. This report summarized the ownership, use, and regulatory history of the Site. It provided a summary of the characteristics of VOCs and SVOCs found in the soil and groundwater of the Site. The purpose of the PA was to:

- Assess the threat posed to human health and the environment.
- Determine the need for additional investigation under CERCLA/SARA or other authority.

The PA concluded that soil and groundwater impacts at the Site warranted further CERCLA action. However the IRAP had been implemented at the time of the PA investigation, therefore no further CERCLA action was needed unless the soil and groundwater remediation activities were discontinued prior to their completion. Interim removal action activities are discussed in section 4.2.

4.1.7 March 2001 MDNR Expanded Site Inspection Report

The MDNR completed a report titled “Expanded Site Inspection Report for the HCI Chemtech Springfield Site” on March 27, 2001. The purpose of this investigation was to assess the threat posed to human health and the environment and to determine the need for additional investigation under CERCLA/SARA or other authority. This report provides a comprehensive summary of findings presented in previous investigation

reports, discussion of the interim removal action activities, pathways for groundwater and surface water, soil exposure, and air pathways.

4.2 Interim Removal Action Plan Activities

In May 1999, CJE presented results of the 1996 HVE pilot test as a basis for the scope of work proposed in the Remedial Investigation and Removal Action Workplan.

In July 1999, CJE installed HVE wells EWA, EWB, EWC, EWD, and EWE in the former bulk tank truck loading area. The HVE wells were piped and connected to a vacuum pump in December 1999. A HVE pilot test was attempted in January 2000 however it was terminated due to extremely cold weather. Startup procedures were conducted in March 2000 to further evaluate the radius of influence and extraction rates of the system. A removal action was subsequently implemented to address impacted soil and groundwater in the central portion of the Brenntag site (Former Bulk Chemical Handling Area). These wells were the first of four groups of HVE wells (units) to be installed. This group of HVE wells would become part of the Central Unit that is located between the warehouse and the new tank farm (Figure 4).

CJE subsequently prepared and submitted a Work Plan for the Expansion of the Remediation System in November 2000. Modifications to the interim removal action plan included an equipment enclosure, expansion of the HVE system equipment, and the installation of 57 dual-phase HVE wells. Piping of the HVE wells was configured into four operable units, and start up operations of the expanded HVE system were conducted in December 2000. The HVE wells are segregated into the Central Unit, Loading Dock Unit, Rail Spur Unit, and Northwest Unit. ARCADIS was retained by Brenntag and continuous operation of the expanded HVE system was initiated in the spring of 2001.

The dual-phase HVE system operates most effectively when extracted groundwater is received from approximately twelve extraction wells. The quarterly performance data obtained for the HVE system in September 2010 indicate the following:

- Once the HVE Wells are dewatered the system discharges treated groundwater at an equilibrated flow rate of less than 1 gallon per minute (gpm).

- Treated cumulative groundwater volume is metered at the discharge to the sanitary sewer. Volume loss due to evaporation in the air stripper is not accounted for.

- Treated cumulative groundwater volume (March 2000 - September 2010) is 3,241,027 gallons.

As of September 2010, the influent groundwater VOC concentrations, air effluent VOC concentrations, system operational data, and discharge flow rates show the following cumulative VOC mass removal through the existing dual-phase HVE treatment system:

- Approximately 32 pounds of dissolved VOCs have been removed through groundwater extraction.

- Approximately 950 pounds of VOCs have been removed through vapor extraction.

- Approximately 982 cumulative pounds of VOCs have been removed from the dissolved and vapor phases by the interim HVE treatment system.

4.3 Previous Remedial Investigations

Based on the findings of previous environmental investigations conducted at the Site, CJE prepared a Remedial Investigation and Removal Action Workplan in May 1999 as required by the Compliance Agreement. CJE, on behalf of HCI Chemtech, conducted several initial RI tasks approved by the USEPA and MDNR between July 1999 and July 2000.

4.3.1 Scope of Previous Remedial Investigations

The RI scope of work conducted by CJE was designed to address technical data gaps identified from the previous environmental investigations. The components requiring additional investigation were: 1) source characterization of impacted soils, 2) impacted groundwater characterization, 3) assessment for potential migration of groundwater impacts to adjacent properties, 4) characterization of the upper portion of the Springfield Plateau Aquifer, and 5) characterization of the deep portion of the Springfield Plateau Aquifer.

4.3.2 July 1999 CJE Soil Investigation at the Old Tank Farm

A staged decommission of the old tank farm was conducted between 1992 and 1996. The new tank farm was built over portion of the old tank farm. CJE conducted an extensive soil characterization in the area of the old tank farm in July 1999 (Figure 13).

A soil sample was collected at a depth of 3 ft bgs from each of the fourteen shallow borings drilled in the old tank farm area. Geological logs were not provided for these shallow soil borings.

Fourteen soil samples (TF-1 through TF-14 and a duplicate were submitted for analysis of VOCs. Two soil samples (TF-4 and TF-14) were analyzed for semi-volatile organic compounds (SVOCs). Soil samples TF-2, TF-6, TF-12, and TF-13 were analyzed for Total Petroleum Hydrocarbons (TPH). The selected laboratory analyses were based upon the historical storage of chemicals in the old tank farm.

Laboratory analytical results for VOCs detected in the old tank farm soil samples (July 1999) are provided in Table 7. The total VOC concentrations detected in the 14 soil samples ranged between 12 ug/kg and 882 ug/kg. The chemicals detected at high concentrations in these samples were acetone and xylenes.

Analytical results for detected SVOCs and TPH are provided in Table 8. Nine SVOCs or Polycyclic Aromatic Hydrocarbons (PAHs) were detected in the tank farm soil sample TF-14-03 (3 ft bgs). The concentration of SVOCs detected in soil sample TF-14 ranged between 180 ug/kg and 10,000 ug/kg, respectively. TPH was detected in one of the four soil samples (TF-02-03) at a concentration of 35,700 ug/kg.

4.3.3 July 1999 CJE Soil Investigation at MW-1

In July 1999, CJE conducted five shallow soil borings in the immediate vicinity of monitoring well MW-1 (Figure 11). The objective was to determine the source of previously detected soil and groundwater impacts at this well location. These include one boring directly adjacent to MW-1 (BHW 1-C), and four boring locations 10 ft from MW-1 (BHW1-N, BHW1-S, BHW1-E, and BHW1-W). Soil samples were collected at a depth of 4 ft bgs and submitted for laboratory analysis of VOCs. A summary of the laboratory results for soils samples near MW-1 are provided in Table 9. The only detected chemicals were acetone and cis-1,2-dichloroethene (DCE). Acetone was detected in all of the soil samples at concentrations that ranged between 310 ug/kg and 9,300 ug/kg. A cis-1,2-DCE concentration of 190 ug/kg was detected in BHW1-C.

4.3.4 July 1999 CJE Onsite Soil and Groundwater Characterization

Monitoring wells MW-7 through MW-13 were installed on the Brenntag site in July 1999 (Figure 11). Expansion of the groundwater monitoring network also provided additional delineation of impacts in soils for the areas of reported and suspected releases on the Brenntag site. Figure 11 provides the location of monitoring wells installed during the

previous remedial investigations conducted by CJE between July 1999 and July 2000. Geological logs that provide a soil description of the borings and well construction details are provided in Appendix A and Appendix C, respectively.

Ten soil samples were collected from seven monitoring well borings and three soil samples were collected from an extraction well boring in July 1999. Extraction well EW-5 was installed for use in a HVE pilot test conducted in March 2000. A total of 13 well boring soil samples were collected at depths that range between 3 ft bgs and 8 ft bgs. The samples were submitted for laboratory analysis of VOCs. Analytical results of the July 1999 well boring soil samples are provided in Table 10. A comparison of total BTEX and total CVOC concentrations detected in the July 1999 well boring soil samples is provided on Figure 12.

Acetone was detected in all of the soil samples at concentrations that ranged between 130 ug/kg (MW-11) and 18,000 ug/kg (EW-5). No measurable concentration of benzene was detected in any of the eight well boring soil samples collected in July 1999.

Analytical results of soil samples from the EW-5 well boring are consistent with the VOC impacts previously detected in well borings located near the bulk chemical handling area (blend tank, drum filling room, and bulk tank truck loading area). An elevated total VOC concentration (167,840 ug/kg) was detected in the EW-5 soil sample collected 3 ft bgs. Ethylbenzene (4,000 ug/kg), toluene (17,000 ug/kg), xylenes (70,000 ug/kg), naphthalene (4,400 ug/kg), 1,2,4-trimethylbenzene (23,000 ug/kg), and 1,3,5-trimethylbenzene (23,000 ug/kg) were the highest detected analyte concentrations in this sample. A limited number of additional petroleum based hydrocarbons were detected in the EW-5 and MW-8 well borings.

Groundwater samples were collected in July 1999 from existing monitoring wells MW-1 through MW-6 and new monitoring wells MW-7 through MW-13. The samples were submitted for laboratory analysis of VOCs. Analytical results for monitoring wells MW-1 through MW-13 are included with the historical analytical summary for groundwater provided in Appendix D. VOCs were detected in groundwater samples from each of the 13 monitoring wells located on the Brenntag site. A total VOC concentration of 4,462 ug/L was detected in monitoring well MW-11 located at the northern boundary of the Site. The presence of PCE (41 ug/L), TCE (1,800 ug/L), and their degradation products in groundwater from MW-11 indicated that VOC impacts had migrated offsite to adjacent properties located north of the Brenntag site. Discussion of the offsite groundwater characterization is provided in the following section.

4.3.5 September – October 1999 CJE Offsite Groundwater Characterization

Based on the analytical results of the site wide groundwater sampling event conducted in July 1999, CJE conducted RI tasks to confirm the presence of VOC impacted groundwater beneath four adjacent properties.

Five Geoprobe™ (Geoprobe) or direct push borings were advanced in September 1999, and 18 boreholes were drilled in October 1999 to assess the potential migration of dissolved VOC impacts in groundwater (Figure 11). Direct push borings GP-4, GP-5, and GP-8 and boreholes BH12 and BH12A were advanced on the Battlefield Business Center property located north of the Site. Direct push boring GP-2 and boreholes BH-8, BH-9, BH-10, and BH-17 were installed on the Acme Brick facility located west of the Site. Boreholes BH-13 and BH-13A were drilled on the Dennis Blake Property located east of the Site. Boreholes BH-6 and BH-7 are located on the Foster Manufacturing property that is south-southwest of the Brenntag site. In addition, two direct push borings (GP-1 and GP-3) and two boreholes (BH-14 and BH15) were advanced in the southwest portion of the Brenntag site. Soil samples were not collected for laboratory analysis from any of the borings or boreholes advanced in September and October, 1999.

Groundwater was encountered and sampled from eleven of the soil borings/boreholes and submitted for analysis of VOCs. Laboratory analytical results for groundwater samples collected at four Geoprobe borings (GP) in September 1999 are provided in Table 11. Analytical data for groundwater samples collected from seven boreholes (BH) in October 1999 are provided in Table 12.

Analytical results for groundwater samples obtained from 13 onsite monitoring wells in July 1999, Geoprobe borings in September 1999, and boreholes in October 1999 were utilized in the preparation of composite concentration maps for total BTEX (Figure 14) and total CVOCs (Figure 15). These July – October 1999 composite maps were prepared to provide a baseline for groundwater quality prior to utilization of the HVE system in 2000.

4.3.6 July 2000 CJE Springfield Plateau Aquifer Groundwater Characterization

CJE drilled three borings into the subsurface bedrock and completed them as open-hole monitoring wells SAW-1, SAW-2, and SAW-3, in July 2000. SAW-1 was installed on the Acme Brick facility, whereas SAW-2 and SAW-3 were installed on the Brenntag facility (Figure 11).

In attempt to minimize the potential for shallow impacted groundwater to migrate vertically down into the boring, each of the open-hole wells were constructed with a steel surface casing set at approximately 30 ft bgs and below the top of bedrock. These wells were installed to determine the hydrogeologic conditions and water quality within the bedrock portion of the Springfield Plateau Aquifer.

4.3.6.1 Upper Bedrock - Springfield Plateau Aquifer Groundwater Characterization

The SAW-1 and SAW-3 wells were drilled to total depth of approximately 44 ft bgs. Bedrock was encountered in the SAW-1 and SAW-3 at approximately 16.5 and 19.5 ft bgs, respectively. SAW-1 was located west of the facility to evaluate the upper bedrock in an area interpreted as downgradient from the sources of impacts to soil and groundwater at the Brenntag site. SAW-3 was installed in the northeast corner of the Site and in the vicinity of monitoring well MW-12. The proximity of a monitoring well completed in the soil/residuum provided a comparison of groundwater elevation and quality between the soil residuum and underlying bedrock. These data established that the two media acted as a single hydrogeologic unit.

4.3.6.2 Deep Bedrock – Springfield Plateau Aquifer Groundwater Characterization

The SAW-2 open-hole monitoring well was installed in the southwest portion of the Brenntag site. The source of groundwater impacts in nearby Well MW-13 appeared to be the Former Bulk Chemical Handling Area. SAW-2 was drilled to a total depth of 208 ft bgs and completed as an open-hole well from 30 ft to 208 ft bgs. This did not provide an adequate test of the groundwater quality in the deep portion of the Springfield Plateau Aquifer.

Groundwater quality data obtained from the SAW-2 open-hole well indicated the presence of dissolved VOCs. The chemicals detected in SAW-2 were comparable to those seen in nearby Well MW-13 that was completed in the shallow soil/residuum. The potential that SAW-2 acted as a conduit for shallow groundwater to migrate vertically downward was evaluated in subsequent RI activities conducted in September 2002.

4.3.7 Groundwater Monitoring Program

Groundwater monitoring has been conducted on a quarterly basis at the Site since January 2000. Groundwater depths were collected quarterly from each available well (Figure 3a) and used with surveyed well data to construct groundwater elevation maps. Appendix B presents a summary of historical fluid-level measurements.

The groundwater samples were analyzed for VOCs using USEPA SW-846 Method 8260B. The target compound list of VOCs for analysis using this method is provided on Table 13. Appendix D presents the historical findings of VOC analysis for groundwater samples collected at the Site.

Chlorinated hydrocarbons (solvents) stored at the facility as well as degradation products derived from these solvents and petroleum based hydrocarbons (i.e. BTEX) have been routinely detected in the groundwater at the Site since groundwater monitoring was initiated.

4.3.7.1 Occurrence of Light Non-Aqueous Phase Liquids

In August 2001, light non-aqueous phase liquid (LNAPL) was observed for the first time in well MW-8. The recovered fluid had a petroleum based hydrocarbon odor. Monitoring well MW-8 is located in the Former Bulk Chemical Handling Area. The measured LNAPL thickness ranged from 0.93 ft in August 2001 and 0.01 ft in July 2006 (Appendix B). The first occurrence of LNAPL coincided with low groundwater levels due to the variation in seasonal precipitation and operation of the HVE system. The occurrence and apparent thickness of detected LNAPL has been subsequently addressed in the RI with the installation of additional HVE wells in the vicinity of MW-8.

5 Scope of Remedial Investigation

Based on the findings of the previous environmental investigations and the initial RI activities conducted by CJE, the recent RI scope of work was conducted to address data gaps identified in the previous investigations. The components requiring additional investigation were: 1) soil source area characterization and 2) additional groundwater characterization. The technical scope of work presented below outlines the strategies, sampling rationale, data collection methods, and analytical testing programs necessary to complete the overall objectives of the RI. Borings and wells installed by ARCADIS during RI activities conducted between 2002 and 2010 are provided on Figure 16.

This section discusses the objectives and details of RI activities completed by ARCADIS between 2002 and 2010. Details and results of the RI activities conducted by ARCADIS in September 2002 were previously provided in the following documents:

- ARCADIS G&M, Groundwater Monitoring Reports (Quarterly), Brenntag Mid-South, Inc., Brenntag HCI Chemtech Facility, Springfield, Missouri.

- ARCADIS G&M, January 2003 Site Characterization Report – September 2002, Brenntag Mid-South, Inc., Brenntag HCI Chemtech Facility, Springfield, Missouri.

The RI tasks completed by ARCADIS at the Brenntag site and adjacent properties were performed in accordance with the May 2002 RI / FS Work Plan, recommendations provided in the Remedial System Performance Evaluation – 2004, the January 2007 Additional Site Characterization Work Plan (and subsequent addendums to this plan), and the February 2010 Data Gap Study Work Plan.

5.1 Soil Source Area Characterization

A soil source area characterization program was developed and completed based on a review of historical Site operations and environmental data from previous investigations. The primary objective of the soil source characterization was to fully characterize potential source areas that were identified in previous environmental investigations and/or were areas where reported releases and historical Site operations may have resulted in a release of VOCs to the surface.

Based on a review of the previous environmental data, the impacted soil and groundwater areas are primarily located in the northwest and central portion of the Site. The following potential source areas (Figure 5) were identified and investigated during the RI activities:

- Former Drum Rinse Area – Includes the former acid and caustic drum rinsing area and the former solvent drum rinsing and recycling area.
- Former Bulk Chemical Handling Area – Includes the former blend tank, former drum filling room (warehouse), former bulk tank truck loading area, and the former drum filling area near the new tank farm.
- Rail Spur Area – Represented by the area between the old tank farm and the former rail car loading area.

5.1.1 Soil Borings

Well borings and direct push borings were used during the soil source area characterization portion of the RI. Direct push borings were advanced using a hydraulic and percussion probing unit. Borings installed by ARCADIS during RI activities conducted between 2002 and 2010 are shown on Figure 16.

Historical groundwater elevations range from approximately 3 ft to 21 ft bgs in monitoring wells located on the Brenntag facility. The highest historical groundwater elevation measured in each monitoring well was utilized to depict the unsaturated soil thickness shown on Figure 17. Soil samples from the source characterization borings were collected from depths of:

- The 0 ft to 2 ft bgs interval to assess potential surface releases.
- The 3 ft to 10 ft bgs interval to assess the relative concentrations of residual VOCs in the smear zone of the soil source areas.
- The 15 ft to 18 ft bgs interval to assess the relative concentrations of residual VOCs at the base of the soil/residuum.

Ten well borings and twelve direct push borings were installed in suspected soil source areas. Analysis of 38 soil samples collected from well borings (10) and direct push borings (12) comprise the data obtained during the soil source area characterization. These include soil samples collected from:

- Extraction well borings E51, E52, and E53 (April 2005).
- Injection well borings IW-3, IW-5 (April 2005), IW-6, IW-7, and IW-8 (January 2007).

- Direct push borings GP-22 through GP-32 advanced in February 2007.
- Monitoring well borings MW-27 and MW-28B (April 2010).

Soil cores from the well borings and direct push borings were evaluated in the field for the purpose of defining the geological classification of each sediment type and to describe the lithology underlying the Site. Soil samples were classified using the Unified Soil Classification System (USCS). Physical characteristics described in the field included the color, texture, sorting, moisture content, staining, and odor. The geological logs are provided in Appendix A.

Certification records documenting wells constructed during the RI were submitted to the MDNR Division of Environmental Quality, Wellhead Protection Section as required under the Missouri Well Construction Code. Copies of these records are provided in Appendix C.

The direct push borings were advanced with a continuous core sampler and acetate sleeve from surface to 10 ft bgs. A photo-ionization detector (PID) was used to measure total VOC concentrations directly from a hole drilled through the acetate sleeve and into the soil core. Soil samples from each direct push boring were collected for chemical characterization from the 0 to 2 ft bgs interval to assess potential surface releases. A second soil sample was collected from the 3 – 10 foot interval that exhibited the highest total VOC concentration measured with the PID. Upon completion of the direct push coring the boring was abandoned as a temporary monitoring well in accordance with 10 CSR 23-4.080 of the Missouri Well Construction Code.

All soil samples collected from the well borings and direct push borings were submitted to Brenntag Mid-South's contract laboratory, Severn Trent Laboratory (STL) in Arvada, Colorado (STL subsequently merged with Test America). Samples were analyzed to quantitatively assess soil quality conditions at potential source areas. The soil samples were analyzed for VOCs using SW-846 Method 8260B. The list of VOCs reported for this analytical method is provided on Table 13.

5.1.1.1 Former Drum Rinse Area

A distance of approximately 75 ft separates the former acid and caustic drum rinsing basin and the former solvent drum rinsing/recycling area (Figure 5). Because of the proximity of these two previous site operations they were investigated as one potential soil source area designated the Former Drum Rinse Area. The solvent drum rinsing

and recycling operation was discontinued in the mid – 1980's, and the acid/caustic drum rinsing operation was terminated in the early 1990's.

Six well borings and seven direct push borings were installed at the Former Drum Rinse Area between 2005 and 2010 (Figure 16). Analysis of 23 soil samples collected from well borings and direct push borings comprise the data obtained during the soil source area characterization. Analytical results of these soil samples supplement the data from twelve soil borings obtained between 1992 and 1999.

5.1.1.2 Former Bulk Chemical Handling Area

The Former Bulk Chemical Handling Area is comprised of four previous site operations that span a distance of approximately 100 ft (Figure 5). These former operations include the former blend tank, former drum filling room within the warehouse, former bulk tank truck loading area, and the former drum filling area near the new tank farm. Because of the proximity of these four previous site operations they were investigated as one potential soil source area. The blend tank is located within a concrete basin with walls approximately 3 ft in height. Only one chemical blend was prepared at the Site. This operation was discontinued in June 2002. Removal of the old tank farm and associated piping between the drum filling room were completed in 1996. Bulk chemical storage at the new tank farm and drum filling in the area immediately southwest of the new tank farm were discontinued in May 2001.

Three well borings and three direct push borings were installed at the Former Bulk Chemical Handling Area between 2005 and 2010 (Figure 16). Analysis of 9 soil samples collected from well borings and direct push borings comprise the data obtained during the soil source area characterization. Analytical results of these soil samples supplement the data from five soil borings obtained between 1992 and 1999.

5.1.1.3 Former Rail Spur Area

Rail car unloading was conducted along the railroad tracks located along the north half of the eastern boundary of the Site. Rail car unloading was discontinued around 1983.

Two direct push borings were installed at the Former Rail Spur Area in 2007. One well boring was installed on the Dennis Blake property (adjacent to the rail spur) in April 2010. Analytical results of 6 soil samples comprise the data obtained during the soil source area characterization. Analytical results of these soil samples supplement the data from four soil borings obtained between 1992 and 1999.

5.1.1.4 Geotechnical Sample Collection

Geotechnical samples were collected from soil boring GSB-1 and submitted for analyses. Unsaturated soil sample GSB1-5 was analyzed for liquid limit, plastic limit, plasticity index, moisture content, specific gravity, dry unit weight, and total organic carbon. GSB1-11 was analyzed for total organic carbon. The GSB1-5 and GSB1-11 samples were collected 5 ft and 11 ft bgs, respectively. The geotechnical analytical report is provided in Appendix E.

5.2 Expanded Monitoring Well Network

A work plan for expansion of the site wide shallow groundwater monitoring well network was based on:

- Determination that the hydraulic continuity between the soil/residuum and upper bedrock resulted in a single hydrologic unit.
- The soil/residuum and bedrock interface may be a preferential flow path for groundwater.
- Agreement that offsite monitoring wells should be constructed with a screen length sufficient to effectively evaluate groundwater in both the soil/residuum and upper bedrock.
- Agreement that additional onsite wells should be installed with a screen interval only in the upper bedrock to monitor the shallow Springfield Plateau Aquifer.
- Agreement that additional offsite wells should be installed with a total depth and screen interval similar to SAW-2 to monitor deep Springfield Plateau Aquifer.

In order to assess groundwater quality conditions at properties adjacent to the Site, the following groundwater characterization program was implemented between September 2002 and May 2010:

- Installation of eighteen shallow groundwater monitoring wells.
- Modification of the SAW-2 open-hole boring as a two-inch diameter monitoring well in the deep Springfield Plateau Aquifer bedrock, with a well screen 20 ft in length installed at total depth of 208 ft bgs.

- Installation of five monitoring wells in the deep Springfield Plateau Aquifer bedrock.

The technical scope and sampling rationale for the groundwater characterization program is presented in the following sections.

5.2.1. Monitoring Well Installation and Development

The site is located within a groundwater protection area that prevents construction of new drinking water wells in the Springfield Plateau Aquifer within Greene County and the northern half of Christian County. Missouri regulation 10 CSR 23-3.100(3), which is part of the Missouri Well Construction Code requires that well casing on new wells extend through the Northview Shale and that water produced comes from the Ozark Aquifer. This regulation has been in effect since 1987.

The new wells were constructed in accordance with industry guidelines and Missouri Well Construction Code (10 CSR 23 chapters 1-6 and sections 256.000-256.640 RSMo). The wells were completed using 2-inch diameter PVC casing and 0.010-inch mill-slotted screen. Well pads were constructed of 4-inch thick concrete with minimum dimensions of 2 ft by 2 ft. Wells were completed at grade, set in concrete, with steel well covers designed for the purpose. The well construction logs are included in Appendix C.

Following well completion activities, the well location, the top of each well casing elevation, and the land surface elevation adjacent to the well was obtained by a registered land surveyor (Heithous Engineering, Springfield, MO). The survey data for all wells (pre-existing and new) is based on the Missouri Coordinate System of 1983 (central zone). The wells were gauged and water levels were recorded to the nearest 0.01 ft using an electronic oil/water interface probe. Well development was conducted by either over-pumping or bailing.

5.2.2 Groundwater Sampling Program

Fluid-level and groundwater monitoring data were collected from all monitoring wells to confirm the hydrogeologic characteristics and assess groundwater quality. The new monitoring wells were incorporated with the ongoing quarterly groundwater sampling program as they were installed. After static fluid levels were gauged and recorded, each well was sampled using either low-flow sampling methods or with a bailer. Groundwater samples were submitted to Test America (TA) for analysis of VOCs using SW-846 Method 8260B.

Monitoring wells capable of maintaining sufficient yields were purged and sampled using low-flow protocol, and the remaining wells were purged and sampled using disposable bailers. The deep Springfield Plateau Aquifer wells were purged dry with dedicated tubing by means of a down-hole pump and then sampled.

5.2.3 Shallow Springfield Plateau Aquifer Monitoring Well Network

Monitoring wells were installed on six adjacent properties and within the City of Springfield right-of-way as part of the RI to supplement groundwater quality data collected during previous investigations and routine groundwater monitoring (Figure 16). The objectives of the shallow groundwater assessment were:

- Complete the delineation of the downgradient and cross-gradient extent of impacted shallow groundwater beneath the adjacent properties; and
- Evaluate the hydrologic continuity of the soil/residuum and upper bedrock.
- Evaluate the hydraulic characteristics of the upper bedrock interval beneath the Brenntag facility.

In order to achieve the above objectives, 18 monitoring wells were installed between September 2002 and April 2010 (Figure 16). The well completion details are provided in Table 5, and well construction logs are included in Appendix C.

In September 2002, ARCADIS installed five delineation monitoring wells on three adjacent properties. Monitoring wells MW-14 and MW-15 were installed on the ACME Brick property, Wells MW-16 and MW-17 were installed on the undeveloped Battlefield Business Center, LLC properties, and Well MW-18 was installed on the Dennis Blake Property.

In April 2005, monitoring wells MW-19 and MW-20 were installed in the City of Springfield right-of-way along the north side of Vista Street. In March 2007, ARCADIS installed two monitoring wells MW-21 and MW-22 on the Back 3, LLC property, located northwest of the Brenntag site (Figure 3a). Subsequently, monitoring wells MW-23 and MW-24 were installed in May 2007 on Battlefield Business Center, LLC properties located north of the Brenntag site. Well MW-24 was located north of all existing monitoring wells to delineate the downgradient extent of the impacted shallow groundwater plume.

Lastly, seven shallow groundwater monitoring wells were installed in April 2010. Wells MW-25 and MW-26 were installed on the Dyke Lumber property to confirm the lateral margin of the shallow groundwater plume at locations cross-gradient to MW-17. Well MW-27 was installed on the Dennis Blake property at a location adjacent to the Rail Spur and upgradient of the Brenntag facility. Wells MW-28B through MW-31B were installed near the northern boundary of the Brenntag facility to monitor the upper bedrock and facilitate hydraulic tests.

5.2.4 Deep Springfield Plateau Aquifer Assessment

Monitoring wells were installed on the Brenntag facility and three adjacent properties to delineate the vertical extent of VOC impacts in the Springfield Plateau Aquifer (Figure 16). Execution of this task was made contingent on the evaluation of results from the lateral delineation of shallow groundwater impacts beneath adjacent properties and completion of the open-hole SAW-2 as a two-inch diameter monitoring well.

SAW-2 was installed on the Brenntag facility during previous investigations in July 2000. It was completed as a deep Springfield Plateau Aquifer open-hole monitoring well to a total depth of 208 ft bgs. Originally constructed open hole with surface casing to a depth of 35 ft bgs, the well was modified in September 2002 due to concerns about the potential for shallow impacted groundwater to enter the open borehole. Two-inch diameter well materials were installed with the screen set from 188 to 208 ft bgs and a high-solids bentonite grout seal to the surface.

Pumping and bailing of the SAW-2 has been conducted periodically between September 2002 and August 2010 to evaluate the apparent downward vertical migration of shallow impacted groundwater in the open borehole prior to recompletion of the well. As of August 2010, approximately 3,044 cumulative gallons of impacted groundwater have been removed from the deep Springfield Plateau Aquifer at the SAW-2 location (Appendix H). The potential downward vertical migration of shallow impacted groundwater has been eliminated.

Five additional deep Springfield Plateau Aquifer wells were installed between March 2007 and July 2010 to delineate the lateral extent of VOC impacts detected in groundwater (SAW-2) beneath the Brenntag site (Figure 16). The SAW-4 was installed on the Back 3, LLC property located northwest of the Brenntag site. The SAW-5 and SAW-6 wells were installed on the Foster Manufacturing facility located south of the Brenntag property. The SAW-7 and SAW-8 wells were installed on the Acme Brick property located west of the Brenntag facility. Well completion details are provided in Table 5, and well construction logs are included in Appendix C.

Measured groundwater elevations were obtained to determine the potentiometric surface gradient and groundwater flow direction in the deep portion of the Springfield Plateau Aquifer.

5.3 Soil Vapor Survey

The primary objective of the soil vapor survey was to assess the potential existence of soil vapor at the exterior perimeter of the Brenntag warehouse and office buildings. Due to the proximity of the Bulk Chemical Handling Area, three soil vapor samples and a duplicate were collected at the northern perimeter of the Brenntag warehouse on April 2, 2007. In addition, a soil vapor sample was collected at the northern perimeter of the Brenntag office building. Soil vapor samples SV-1, SV-2, and SV-3 were collected at points located along the north exterior wall of the warehouse. Soil vapor sample SV-4 was collected at the north exterior wall of the office beneath the paved parking lot (Figure 18).

Soil vapor samples were collected by means of tubing inserted through hydraulic push probe rods driven to a depth of 5 ft bgs. The rods were pulled up to a depth of 4 ft bgs before the samples were collected. The soil vapor samples were submitted for laboratory analysis of selected VOCs by USEPA Method TO-15.

5.4 Sub-slab Vapor Survey

An addendum to the January 2007 work plan was submitted in June 2007 based on the laboratory analytical results of samples obtained during the soil vapor survey. The addendum presented tasks required to assess the potential for VOCs in vapor beneath the concrete slab floor in the northern portion of the Brenntag warehouse. Four sub-slab vapor samples and a duplicate were collected on June 15, 2007 in the vicinity of the warehouse office (SSV-5) and the former drum filling room (SSV-6, SSV-7, and SSV-8) located in the northwest corner of the warehouse (Figure 18).

Sub-slab vapor samples were collected by means of tubing inserted through a drilled hole in the concrete slab floor. The sub-slab vapor samples were submitted for laboratory analysis of selected VOCs by USEPA Method TO-15.

5.5 Sub-slab Vapor Extraction Testing and System Installation

Sub-slab vapor extraction testing was conducted at the Brenntag facility on January 15 and 16, 2008. Results of the sub-slab vapor extraction (SSVE) test were submitted in

a final report titled “Sub-slab Vapor Extraction Results” on September 9, 2009. The primary objective of the testing was to provide data necessary for the design and installation of a SSVE system in a portion of the facility warehouse. Based on the results of the vapor extraction pilot testing, a sub-slab venting system was proposed as an interim remedial measure. Implementation of a sub-slab vapor recovery system had two principle goals, 1) controlling migration of vapors from the below the slab in the area of principle concern (the warehouse office), and 2) removal of sub-slab vapors in the area with the highest VOC impacts (the west end of the warm room).

A SSVE system was installed and placed in operation on November 6, 2009. The SSVE system is located in the northwest portion of the warehouse and is independent of the soil and groundwater HVE system (Figure 19). A report titled “Sub-slab Vapor Extraction System Install Report” was submitted in April 2010. A summary of the SSVE system effluent sample analytical results and the estimated mass removal are provided in the quarterly monitoring report.

5.6 Hydraulic Testing

Four upper bedrock monitoring wells and one upper bedrock extraction well were installed at the northern property boundary of the Brenntag facility. An upper bedrock monitoring well (MW-28B) was completed at a location immediately north of MW-1. Three additional upper bedrock monitoring wells (MW-29B, MW-30B, and MW-31B) were completed at locations adjacent to the pre-existing upper bedrock extraction well E47B. The construction of these wells is similar to existing upper bedrock extraction wells E7B, E42B, and E47B. Hydraulic testing within the shallow unconsolidated soils and upper bedrock was conducted in May 2010 as proposed in the Data Gap Study Work Plan (February 2010). Details of the test results were submitted in a final report titled "Data Gap Study - Hydraulic Testing Report" dated January 4, 2011.

Testing was conducted to evaluate:

1) Hydraulic characteristics of the shallow unconsolidated soils and upper bedrock, and

2) The ability to achieve hydraulic control using groundwater extraction.

Hydraulic testing conducted as part of the Data Gap Study indicated that despite the relatively steep groundwater gradient at the site, groundwater extraction results in

overlapping capture zones, exerts hydraulic influence, and minimizes offsite migration of dissolved VOCs in the unconsolidated sediments and shallow bedrock.

5.7 Investigation Derived Waste Disposal

Investigation derived waste generated at the Site was transported and disposed subsequent to the final drilling activities. Brenntag is contracted with PSC Environmental Services (PSC) for the transport and disposal of their waste. Composite samples were collected as required by PSC and submitted for laboratory analysis. PSC transported 108 drums (55-gallon) of borehole cuttings to their Kansas City, Missouri facility between July 7, 2010 and August 4, 2010, and then profiled and disposed the investigation derived waste.

6 Nature and Extent of Contamination

6.1 Results of Data Usability Evaluation

All RI soil and groundwater samples were analyzed by TA, which in turn submitted analytical reports to ARCADIS. Evaluation of all laboratory analytical data from samples collected during the RI was completed by ARCADIS in accordance with the Quality Assurance Project Plan (QAPP) contained in Appendix B of the RI/FS Work Plan. The complete laboratory report package from TA is provided on readable compact disks in Adobe Acrobat file format. The ARCADIS data validation reports for soil and groundwater sampling events are included in Appendix F.

6.1.1 Quality Assurance/Data Validation Summary

Data validation is the procedure of reviewing data against a known set of criteria to verify data validity prior to its use. Data validation procedures have been developed by the USEPA to standardize the validation process for analytical results for both water-quality and soil-quality investigations and are documented in the USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (USEPA 1994a) and USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (USEPA 1994b). The Functional Guidelines are intended to be used as a guide for evaluation of data generated under statements of work (SOWs) for organic and inorganic analyses associated with the USEPA Contract Laboratory Program (CLP). The Functional Guidelines also provide general data validation guidelines that can be applied to data generated by non-CLP analytical methods.

6.1.2 Data Validation Reports

Analytical data for the RI, were validated in accordance with applicable USEPA SW-846 or Standard Method requirements, "USEPA Contract Laboratory Program National Functional Guidelines for Organic and Inorganic Data Review" (USEPA 1994a and b), and the QAPP.

Analytical data deficiencies pertaining to reports submitted by TA have been addressed in the "DATA VALIDATION CHECKLIST" which is a brief and concise report that summarizes the data reviewed. The checklists are provided in Appendix F. of this report. Within the data validation checklists, are tables listing the qualified

samples and the reasoning behind such qualification. The following items are explanations of data qualifier codes, as they pertain to Data Validation Checklists:

- The "B" data qualifier indicates an estimated value, positively identified, but at a concentration less than the reporting limit. The qualifier is used when the analyte is found in any associated blank, as well as the sample. This indicates that possible/probable blank contamination exists and warns the data user that this analyte may or may not be present in the sample(s) collected.
- The “UB” data qualifier indicates that the compound/analyte is considered non-detect at the listed value due to associated blank contamination.
- The “D” data qualifier indicates the value reported is from a secondary dilution.
- The “E” data qualifier indicates that the reported value exceeds calibration and is estimated due to matrix interference.
- The “G” data qualifier indicates an elevated reporting limit, due to matrix interference.
- The “J” data qualifier indicates an estimated value. This qualifier is used in organic data evaluation when mass spectral data indicate the presence of a compound that meets the identification criteria, but the result is less than the quantitation limit.
- The “UJ” data qualifier indicates that the analyte was detected above the reporting limit; however, the reported quantitation limit is approximate and may, or may not, represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
- The “L” data qualifier indicates that physical or chemical interferences are present due to serial dilution of a digestate in the analytical batch.
- The “M” data qualifier indicates that duplicate precision (relative percent difference) is not within control limits.
- The “N” data qualifier indicates that spike recovery is not within control limits.
- The “q” data qualifier indicates an elevated reporting limit, due to high analyte concentrations.
- The “R” data qualifier indicates the result is rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria; and the presence or absence of the analyte cannot be verified.

- The “X” data qualifier indicates elevated method detection limit due to matrix interference. This qualifier is used for organic data only.

6.1.2.1 RI Soil Samples

A summary of the major data validation findings from the Data Validation Checklists for soil samples are presented below:

- Seven (7) soil [E51-4 (4), E53-5 (5), E53-COMP, IW5-18 (18), GP-23-1.5 (1.5), GP-26-7 (7), and GP-29-2 (2)] samples contained selected analytes that exceeded the linear calibration limit of the instrument and were flagged “E” by the laboratory. These samples were rerun at greater dilutions to bring these concentrations within range. TA reported only those compounds from the greater dilution sample that exceeded on the lesser diluted sample. These results are acceptable, but the out of range results have been qualified as rejected “R.”

- Seven (7) method blanks (associated with data packages D5D290353, D5D300159, D7B280329, D7C140253, and D7C170181) contained low concentrations of analytes, including acetone, n-butylbenzene, 1,4-dichlorobenzene, methylene chloride, naphthalene, toluene, and 1,2,4-trimethylbenzene. These compounds were detected in associated field samples, which were flagged “B” by the laboratory. Where the detected concentrations exceeded five times the blank concentration (10 times for common laboratory contaminants acetone and methylene chloride), the sample results are considered usable and the “B” has been removed in the valid data tables.

- Surrogate recoveries for all field samples were within control limits, except two field samples associated with data package D7B280329. The recovery of surrogate toluene-*d8* exceeded control limits for samples GP-23-1.5 and GP-29-2. All positive detections were qualified as estimated “J.”

- Analytes detected from samples at concentrations below the PQL were flagged as estimated “J”.

- Field duplicates, equipment rinsate blanks, and trip blanks were not required for the soil sampling event.

6.1.2.2 RI Groundwater Samples

A summary of the major data validation findings from the Data Validation Checklists for groundwater samples are presented below:

- Numerous groundwater samples contained selected analytes that exceeded the linear calibration limit of the instrument and were flagged “E” by the laboratory. These samples were rerun at greater dilutions to bring these concentrations within range. TA reported only those compounds from the greater dilution sample that exceeded on the lesser diluted sample. These results are acceptable, but the out of range results have been qualified as rejected “R”.

- Seventy-two (72) method blanks (associated with data packages (May 2003 Data, July 2003 Data, November 2003 Data, May 2004 Data, July 2004 Data, October 2004 Data, February 2005 Data, D5H040377, D5K040333, D6B020262, D6E050322, D6H040335, D6K220224, D7C230374, D7F080325, D7I140380, D7K270159, D7K290359, D8B280294, D8E230237, D8E230334, D8H250171, D8K070230, D9B060219, D9E080274, D9H210307, D9H210312, D9K200368, D0B050624, 280-3534, and 280-6136) contained low concentrations of analytes, including acetone, chlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, hexachlorobutadiene, 2-hexanone, methylene chloride, 4-methyl-2-pentanone, naphthalene, tetrachloroethene, 1,2,3-trichlorobenzene, trichloroethene, m- + p-xylene, and total xylenes. These compounds were detected in associated field samples, which were flagged “B” by the laboratory. Where the detected concentrations exceeded five times the blank concentration (10 times for common laboratory contaminants acetone and methylene chloride), the sample results are considered usable and the “B” has been removed in the valid data tables.

- Surrogate recoveries for all field samples were within control limits, with the exception of twenty-one field samples. The affected field samples were MW-1 (D7K270159), MW-4 (D6B020262 and D9H210312), MW-6 (October 2004 Data), MW-8 (July 2004 Data, October 2004 Data, D5E120232, D5H040377, D6B020262, D6E050322, D6K220224, D7I140380, D8B280294, D8E230237, D8H250171, D8K070230, D9B060219, D9E080274, and D9K200368), TF-1N (D7K270159), and E7B (D9H210307). All positive detections were qualified as estimated “J.”

- Analytes detected from samples at concentrations below the PQL were flagged as estimated "J".

- With few exceptions, Field duplicates collected during groundwater sampling were determined to be representative duplicates. Selected compounds have been qualified as estimated in the field sample and duplicate sample, where RPDs exceeded control limits.

- Trip Blanks were determined to be acceptable. Several data packages Trip Blank samples were noted to contain certain detected compounds, which could possibly be due to common storage and handling of the samples in the field with samples collected containing high VOC concentrations.

- Equipment rinsate blanks were determined to be acceptable, with one exception. The equipment rinsate samples FBGW021505 and FBGW021605, associated with data package February 2005 Data, contained detectable concentrations of volatile organic compounds, including chloromethane, methylene chloride, naphthalene, n-propylbenzene, toluene, 1,3,5-trimethylbenzene, m- & p-xylene, o-xylene, and total xylenes. The presence of the detected compounds from the rinsate blanks indicate that is possible that cross-contamination between sampled wells may have occurred during this event.

Specific data validation and data usage information is included in the data validation checklists in Appendix F. Based on the data validation, the data has met the project's DQOs and the data is considered usable for the purposes of this RI, the baseline risk assessment, and future FS activities.

6.2 Soil Source Area Characterization

Maximum (highest) historical groundwater elevations measured in monitoring wells located on the Brenntag facility range from approximately 0.5 ft to 5 ft bgs. Withdrawal by the HVE system and variation in seasonal precipitation influence these data. Figure 17 provides the unsaturated soil thickness based on the highest measured historical fluid level measured in the monitoring wells. Joint review of this figure with USEPA and MDNR representatives concluded that soil samples from 0 ft to 2 ft bgs represented the unsaturated soil interval beneath the Site. As a result, only the samples from the unsaturated soil interval obtained during the RI were used for the risk screening process.

A total of 38 RI soil samples were collected between 2002 and 2010 from 22 borings advanced during the soil source characterization activities (Figure 20). The soil samples were submitted for laboratory analysis of VOCs in accordance with the USEPA approved RI/FS Work Plan. The number of soil samples obtained from the source characterization borings and the depth interval from which they were collected are as follows:

- 17 soil samples were collected from the 0 ft to 2 ft bgs interval to assess potential surface releases. For the purposes of the risk assessment, these soil samples represent the unsaturated soil interval (Figure 17)
- 19 soil samples were collected from the 3 ft to 10 ft bgs interval to assess the relative concentrations of residual VOCs in the smear zone of the soil source areas.
- 2 soil samples were collected from the 15 ft to 18 ft bgs interval to assess the relative concentrations of residual VOCs at the base of the soil/residuum.

A discussion of the scope of work and sampling rationale is provided in Section 5.0. Findings from the RI soil investigation are presented below.

6.2.1 Soil Analytical Results

During the RI field investigations, 38 soil samples were collected for laboratory analysis from 22 source characterization borings (Figure 20). The primary objective of the soil source characterization was to fully characterize potential source areas that were identified in previous environmental investigations and/or were areas where reported releases and historical Site operations may have resulted in a release of VOCs to the surface.

The RI soil samples were collected from intervals of 0 to 2 ft bgs, 3 to 10 ft bgs, and 15 to 18 ft bgs and analyzed for VOCs using USEPA Method 8260B. Each of the soil samples were analyzed for the list of VOCs provided on Table 13. A summary of the VOCs detected in soil samples obtained from well borings and direct push borings conducted during the RI are provided in Table 14. The detected total BTEX and total CVOC concentrations in soil samples are depicted on Figure 20. A copy of the laboratory reports for RI soil samples are provided on a CD in Appendix G.

6.2.2 Comparison to Soil Screening Criteria

The detected concentrations of chemicals in the RI soil samples (2002 - 2010) from the 0 ft to 2 ft bgs were compared to the USEPA Regional Screening Levels (RSLs) as

part of the soil screening process. A list was derived to include each chemical that exceeds the soil screening criteria which is then identified as a chemical of potential concern (COPC). The identified COPCs in soil samples aid in the interpretation of potential soil source areas. Comparison of soil sample analytical results with the RSLs was to aid in the screening process and identification of COPCs and not to identify site remediation goals. The 0 ft to 2 ft bgs soil samples were screened to determine the risk to a future site worker, potential current offsite worker, and hypothetical future resident.

The following sections provide a discussion of RI soil samples from 0 ft to 2 ft bgs. The RI soil screening discussion also includes analytical results for historic soil samples obtained during previous site investigations as they relate to the soil source area characterization findings obtained during the RI soil investigation.

6.2.3 Volatile and Semi-Volatile Organic Compounds

A discussion of the VOCs and SVOCs detected in historic soil samples collected during the previous environmental investigations (1992 - 1999), and the VOCs detected in RI soil samples (2002 - 2010) is provided below.

6.2.3.1 Historic Soil Samples

Twenty-five VOCs were detected in historic soil samples collected and analyzed in 1992, 1995, and 1999 (see sections 4.1 and 4.3 for discussion). The detected VOCs, include the following: acetone, benzene, 2-butanone, chlorobenzene, chloroethane, chloroform, 1,1-DCA, 1,2-DCA, 1,1-DCE, cis-1,2-DCE, ethylbenzene, 2-hexanone, isopropylbenzene, p-isopropyltoluene, 4-methyl-2-pentanone, methylene chloride, naphthalene, n-propylbenzene, tetrachloroethene, toluene, 1,1,1-trichloroethane, TCE, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, , and xylenes. A summary of VOC concentrations detected in historic soil samples are provided in Tables 3, 6, 7, and 10. The historic soil boring locations are shown on Figure 12. The laboratory analytical reports for the historic soil samples are provided on a CD that is included in Appendix G.

Nine SVOCs were detected in historic soil samples collected in the area of the old tank farm and analyzed in July 1999 (see section 4.3.2 for discussion). The detected SVOCs, include the following: benzo(a)anthracene, benzo(a)pyrene, Benzo(g,h,i)perylene, Benzo(k)fluoranthene, chrysene, bis(2-ethylhexyl)phthalate, fluoranthene, indeno(1,2,3-cd)pyrene, and pyrene. A summary of the SVOCs detected

in historic soil samples from the area of the old tank farm is provided in Table 8. The historic soil boring locations in the area of the old tank farm are shown on Figure 13.

6.2.3.2 RI Soil Samples

A total of 24 VOCs were detected in the unsaturated soil samples (0 ft to 2 ft bgs) analyzed during the RI between 2007 and 2010. A summary of the VOCs detected in all RI soil samples is provided in Table 14. The distribution of total BTEX and total CVOCs in RI soil samples is shown on Figure 20. None of the soil samples collected during the RI was analyzed for SVOCs. The laboratory analytical reports for the RI soil samples are provided on a CD that is included in Appendix G.

Of the 24 VOCs detected in RI soil samples, three chemicals were detected in concentrations that exceed the RSL screening criteria. Those three chemicals include: ethylbenzene, tetrachloroethene,and 1,2,4-trimethylbenzene.

6.2.4 Chemicals of Potential Concern in Soil

Based on the RI analytical data comparison to RSLs, 3 VOCs (ethylbenzene, PCE, and 1,2,4-trimethylbenzene) are considered chemicals of potential concern (COPCs) for the purpose of this RI screening process.

Provided in the table below are; the 3 VOCs detected in RI soil samples that exceed the RSL criteria. In addition to the COPCs provided in the table are a ratio of the number of detects per analyte and the total number of soil samples analyzed, the number of soil samples exceeding the RSLs, and the range of detected concentrations.

Summary of VOCs in RI Soil Samples Exceeding Screening Criteria (COPCs)

Analyte Detected	Number of Detects/ Number of Samples	Samples Exceeding Residential RSLs	Range of Detected Concentrations (µg/kg)	
			Minimum	Maximum
Ethylbenzene	3/17	1	5.4	88,000
Tetrachloroethene (PCE)	13/17	1	0.73	3,400
1,2,4-Trimethylbenzene	7/17	1	0.64J	520,000

RSL = Residential Regional Screening Level .

6.2.5 Delineation of Soil Source Areas

The primary objective of the soil source characterization was to fully delineate potential source areas that were identified in previous environmental investigations and/or were areas where reported releases and previous Site operations may have resulted in a release of VOCs to the surface (Figure 5). Residual VOCs in the unsaturated zone, smear zone, and saturated zone are responsible for the dissolved impacts in groundwater beneath the Site. All historic and RI soil samples collected at depths between 0 and 10 ft bgs were utilized for the purpose of preparing the soil source area characterization maps. Five soil samples collected at depths greater than 10 ft bgs were not included for this purpose. The following potential source areas (Figure 5) were investigated during the source area characterization:

- Former Drum Rinse Area – Includes the former acid and caustic drum rinsing area and the former solvent drum rinsing and recycling area.

- Former Bulk Chemical Handling Area – Includes the former blend tank, former drum filling room (warehouse), former bulk tank truck loading area, and the former drum filling area near the new tank farm.

- Rail Spur Area – Represented by the area between the old tank farm and the former rail car loading area.

The results of the historic soil samples and RI soil samples collected during the soil source characterization are described below. Note that several source characterization borings were used to investigate more than one source area due to the close proximity of potential source areas. Soil boring and well boring locations installed during previous investigations and RI activities are shown on Figure 11 and Figure 16, respectively.

Total BTEX and Total CVOC concentrations for historic and RI soil samples were utilized to illustrate the soil source area characterization. Figures 21a and 21b provide soil concentrations detected in samples from the surface to 5 ft bgs for Total BTEX and Total CVOC's, respectively. In general, the Total BTEX and Total CVOC's concentration figures for the surface to 5 ft bgs interval represent the unsaturated soil interval. This assessment is based on the Unsaturated Soil Thickness Map (Figure 17). The figure was derived from the highest recorded water levels obtained from the Site monitoring wells.

Figures 21c (Total BTEX) and 21d (Total CVOC) depict detected concentrations for soil samples collected from the interval of 6 ft to 10 ft bgs. This interval represents a transition between the smear zone and saturated soil interval. The smear zone is

influenced by seasonal groundwater level fluctuations and groundwater withdrawal by the dual-phase HVE system. Therefore, the detected chemicals in soil samples from this interval represent residual VOC concentrations derived from the overlying source area.

6.2.5.1 Former Drum Rinse Area

The Former Drum Rinse Area is located between the bag storage building to the west and the inactive new tank farm to the east. The historic borings with soil samples in the Former Drum Rinse Area include; B-2, TMW-4, MW-1, MW-9, and MW-10 (Figure 11). Note the TMW-4 soil sample was collected in 1992 at an unknown depth. However, the TMW-4 soil sample represents the interval where the highest PID value was detected in the field.

RI boring samples IW-3, IW-5 through IW-8, GP-22 through GP 27, GP-33, and MW-28B (Figure 16) were installed in the Former Drum Rinse Area. Boring IW-6 is located in the area where returned used drums were temporarily stockpiled prior to rinsing. Boring GP-23 is located at the bag storage building where the former solvent drum rinsing operation was conducted. Boring GP-26 is located adjacent to the former acid/caustic drum rinsing basin (neutralization tank). Only the GP-23 (1.5 ft bgs) soil sample had detected concentrations for chemicals that exceeded the RSLs (Figures 21a and 21b).

The Former Drum Rinse Area is considered a probable historic source area. It is noted that VOCs detected in Boring GP-23 were from soil samples collected below the concrete pavement. This soil source area was adequately identified during the RI for the purpose of conducting a FS.

6.2.5.2 Former Bulk Chemical Handling Area

Borings E-51, E-52, E-53, GP-28, GP-29, and GP-30 (Figure 16) were installed during the RI in the Former Bulk Chemical Handling Area located between the warehouse building to the south and the inactive new tank farm to the north. Only soil samples collected at depths between 0 and 2 ft bgs were utilized for the purpose of the soil screening. However both historic and RI soil boring data were included in the source area characterization Figures 21a (Total BTEX) and 21b (Total CVOC).

The historic borings with soil samples in the Former Bulk Chemical Handling Area include; TMW-1 (3 ft bgs), MW-5, MW-6, MW-8, and EW-5. Note the TMW-1 soil sample was collected in 1992.

Three direct-push borings (GP-28, GP-29, and GP-30) were installed in the Bulk Chemical Handling Area during the RI. Unsaturated soil samples from these borings were included in the risk screening. None of the detected analyte concentrations exceeded the RSLs. Boring GP-29 is located adjacent to the former bulk tank truck loading/unloading manifold. It is noted that VOCs detected in Boring GP-29 from a 0 to 2 ft interval samples that was collected below the concrete pavement.

The Former Bulk Chemical Handling Area is considered a probable historic source area. This soil source area was adequately identified during the RI for the purpose of conducting a FS.

As discussed in Section 6.5, subsequent RI activities (soil vapor sampling) indicate a probable historic source area may also be located in the Bulk Chemical Handling Area in the vicinity of the former blend tank. This is the area where piping from the old tank farm terminated at a manifold and transfer pump located outside of the Former Drum Filling Room. High VOC concentrations were detected in soil vapor sample SV-1 collected at the northwest corner of the warehouse, adjacent to the former drum filling room, and south of Boring GP-28.

6.2.5.3 Rail Spur Area

Borings GP-31, GP-32, and MW-27 (Figure 16) were installed in the rail spur area during the RI. Soil samples from these borings contained analyte concentrations that confirmed similar results of historic soil samples from borings MW-2 located to the northwest, MW-3 located to the north, MW-4 located between the rail spur and old tank farm, and the 14 shallow borings in the area of the old tank farm. Potential source area characterization of the area east of the rail spur was obtained with the soil sample from MW-27, located on the adjacent property east of the Site. The TMW-3 soil sample was collected in 1992 at an unknown depth. However, the TMW-3 soil sample represents the interval where the highest PID value was detected in the field.

The concentration of VOCs detected in historic and RI soil samples collected from 0 ft to 5 ft bgs were generally non-detect or at low levels, which indicates the rail spur area is not a source of VOCs from soil to groundwater. These data also indicate that the VOCs detected in soil samples collected at depths greater than 10 ft bgs (MW-3 and MW-4) probably migrated to the rail spur area from the Bulk Chemical Handling Area (Figure 20). The rail spur area is not considered a probable soil source area.

6.2.6 Source Area Confirmation

Based on the soil analytical results and the soil screening process results, two probable soil source areas were identified and delineated. These include the Former Drum Rinse Area and the Former Bulk Chemical Handling Area. Each of the probable soil source areas is associated with historical site operations and/or operational structures. The probable source areas and the COPCs in soil at each source area are summarized below.

Probable Soil Source Areas		**Chemicals of Potential Concern**
Former Drum Rinse Area (combined)	Acid/Caustic and solvent drum rinsing operations	Ethylbenzene, tetrachloroethene (PCE), and 1,2,4-trimethylbenzene
Former Bulk Chemical Handling Area	Blend Tank, Drum Filling Room, Bulk Tank Truck Loading/Unloading, and Drum Filling Area. Includes the underground piping connections outside the drum filling room (associated with the old tank farm)	Ethylbenzene, tetrachloroethene (PCE), and 1,2,4-trimethylbenzene

The two probable soil source areas are in close proximity and have similar COPCs. Therefore, they will be treated as one co-mingled source area for the purposes of discussing groundwater characterization and risk assessment in the following sections. It is noted that the Former Drum Rinse Area and the Former Bulk Chemical Handling Area are considered historical sources.

The primary objective of the soil source characterization was to adequately identify potential source areas that were identified in previous environmental investigations and/or were areas where reported releases and historical Site operations may have resulted in a release of VOCs to the surface. This objective has been met to the extent possible considering access issues associated with an active facility, such as buildings, tanks, and piping. Therefore, the soil sampling objectives have been achieved and the soil impacts have been adequately identified (Figures 21a and 21b).

6.3 Groundwater Characterization

To characterize and delineate the extent of chemicals in the Springfield Plateau Aquifer, samples were collected from 35 shallow and six deep monitoring wells during the RI. The shallow wells include 18 monitoring wells and two former HVE pilot test wells (within the new tank farm) that are located on the Brenntag facility, and 15

monitoring wells located on the adjacent properties (Figure 3a). Two of the shallow monitoring wells (SAW-1 and SAW-3) are open-hole completions in the upper bedrock (Table 5). Monitoring wells SAW-2 and SAW-4 through SAW-8 are completed in the deep portion of the Springfield Plateau Aquifer.

Groundwater analytical data obtained between November 2008 and August 2010 (8 quarters) were utilized in the attached Human Health Risk Assessment (Appendix K). These eight quarterly analytical reports represent the RI groundwater analytical data set utilized in the HHRA to identify the COPCs in groundwater that are referenced in the following discussion.

The shallow groundwater and deep groundwater characterization samples were analyzed for VOCs using SW-846 Method 8260B. Laboratory results for the recent August 2010 sampling event are provided in Table 15 (shallow groundwater) and Table 16 (deep groundwater), respectively. A summary of the historical analytical results for groundwater samples collected at the Site is provided in Appendix D.

6.3.1 Comparison to Groundwater Quality Standards

The detected concentrations of VOCs in the RI groundwater samples were compared to the USEPA RSLs for tap water and the federal primary Maximum Contaminant Levels (MCLs) for drinking water. Comparison of groundwater analytical results with the RSLs and the federal primary MCLs was to aid in the screening process and identification of COPCs used to establish delineation criteria, and not to identify site remediation goals.

The following sections provide a screening level comparison of the RI groundwater sample concentrations to the RSLs for tap water. The shallow and deep groundwater data obtained in August 2010 are summarized in Tables 15 and 16, respectively. The analytical summary tables include the RSLs for comparison and are the data set referenced in the following groundwater characterization discussion. Findings from the RI groundwater investigation and groundwater screening process are presented below. In addition, groundwater analytical results from previous site investigations are also briefly discussed.

6.3.2 Shallow Springfield Plateau Aquifer Groundwater

During the RI and previous groundwater sampling events, VOCs were detected at the highest concentrations within the shallow portion of the Springfield Plateau Aquifer (Appendix D). Shallow groundwater monitoring results from 1992 through 2000 indicate similar detected VOCs in comparable patterns as those detected during the

RI. However, concentrations of VOCs have generally decreased since 2000 which reflects the influence of the interim dual-phase HVE system.

The presence of daughter products associated with some of the chlorinated COPC's indicates that chlorinated compounds are undergoing reductive dechlorination. In addition, there are other data that indicate groundwater removal has been a significant factor. Most notably, a simultaneous decline in the concentration of petroleum based hydrocarbon compounds and an increased rate of decline where additional extraction wells were added. The relative roles of reductive dechlorination and the HVE system operation in reducing contaminant concentrations are unclear.

Additional offsite monitoring wells were added to the shallow groundwater monitoring network between 2002 and 2010 providing better definition of the impacted groundwater plume. Therefore, the following section focuses on the most recent shallow groundwater data obtained in August 2010. Figures 22 through 31 are August 2010 groundwater concentration maps for selected VOCs. These figures include data from all wells in the current monitoring well network.

6.3.2.1 Shallow Springfield Plateau Aquifer Monitoring Well Network Results

The shallow Springfield Plateau Aquifer monitoring well network consists of open boreholes and wells less than 45 ft in total depth with screens of varying lengths that are completed across:

- Only the overlying soil/residuum from approximately 13 to 23 ft bgs (Onsite Wells MW-1 through MW-13, EW-1N, and EW-2S).
- The soil/residuum and the upper bedrock sequence from approximately 19 to 44 ft bgs (Offsite Wells MW-14 through MW-27).
- Only the upper bedrock sequence from approximately 20 to 45 ft bgs (Open Boreholes SAW-1 and SAW-3, and Wells MW-28B through MW-31B).

Groundwater samples collected from the shallow monitoring wells in August 2010 were analyzed for VOCs. A summary of the VOCs detected in these groundwater samples is provided in Table 15. The distribution of total BTEX and total CVOCs in shallow groundwater is shown on Figure 22 and Figure 23, respectively. The laboratory analytical report is provided on a CD that is included in Appendix I.

6.3.2.2 Shallow Springfield Plateau Aquifer Screening Results

A total of 48 chemicals were detected in the groundwater samples collected from shallow monitoring wells during the RI (2008 – 2010). Of the 48 chemicals detected in shallow groundwater samples, 27 chemicals were detected in concentrations that exceed the RSLs for tap water. However, only ten chemicals were detected in concentrations that exceed their applicable federal primary MCLs. Based on the RI analytical data (2008 – 2010) comparison to RSL tap water values, 27 chemicals are considered COPCs in the shallow groundwater samples.

The number of COPCs detected in RI groundwater samples from the shallow Springfield Plateau Aquifer, the number of samples with concentrations that exceed the RSLs for tap water and the minimum and maximum concentrations detected for each COPC are provided below.

Summary of COPCs in RI Groundwater Samples from Shallow Springfield Plateau Aquifer Monitoring Wells					
Analyte Detected	**Number of Detects/ Number of Samples**	**Samples Exceeding RSLs Tap Water**	**Samples Exceeding Federal MCLs**	**Range of Detected Concentrations (µg/L)**	
				Minimum	**Maximum**
Benzene	107/235	103	56	0.26	36
Bromodichloromethane	3/235	3	0	0.35	4.90
n-Butylbenzene	43/235	26	NA	0.21	110
sec-Butylbenzene	64/235	26	NA	0.22	33
tert-Butylbenzene	21/235	3	NA	0.16	2.40
Carbon Tetrachloride	3/235	1	0	0.22	0.55
Chloroform	52/235	52	1	0.20	180
1,4-Dichlorobenzene	18/235	5	0	0.16	0.64
1,1-Dichloroethane	184/235	115	NA	0.17	120
1,2-Dichloroethane	52/235	52	16	0.17	9.50

(Cont.)

Summary of COPCs in RI Groundwater Samples from Shallow Springfield Plateau Aquifer Monitoring Wells					
Analyte Detected	**Number of Detects/ Number of Samples**	**Samples Exceeding RSLs Tap Water**	**Samples Exceeding Federal MCLs**	**Range of Detected Concentrations (µg/L)**	
				Minimum	**Maximum**
cis-1,2-Dichloroethene	156/235	33	34	0.16	3200
1,2-Dichloropropane	4/235	2	0	0.16	1.70
Ethylbenzene	94/235	65	0	0.18	600
2-Hexanone	6/235	2	NA	5.40	110
Methylene Chloride	20/235	6	6	0.34	170
Naphthalene	83/235	83	NA	0.23	52
1,1,1,2-Tetrachloroethane	4/235	4	NA	37	56
1,1,2,2-Tetrachloroethane	3/235	3	NA	0.21	3
Tetrachloroethene (PCE)	74/235	74	20	0.21	93000
Toluene	84/235	7	8	0.17	8000
1,1,2-Trichloroethane	20/235	20	10	0.38	110
Trichloroethene (TCE)	112/235	47	39	0.17	8300
1,2,3-Trichloropropane	1/235	1	NA	1.20	1.20
1,2,4-Trimethylbenzene	93/235	42	NA	0.15	1300
1,3,5-Trimethylbenzene	64/235	18	NA	0.20	4000
Vinyl Chloride	67/235	67	56	0.41	1100
Xylenes (total)	101/235	33	0	0.24	7200

NA = No Assigned MCL; RSL = Regional Screening Level

6.3.3 Deep Springfield Plateau Aquifer Groundwater

Groundwater samples were collected from six monitoring wells screened in the deep portion of the Springfield Plateau Aquifer and were analyzed for VOCs. A summary of the VOCs detected in these groundwater samples is provided in Table 16. The laboratory analytical report is provided on a CD that is included in Appendix I.

6.3.3.1 Deep Springfield Plateau Aquifer Monitoring Well Network Results

Groundwater samples were collected in August 2010 from six monitoring wells screened in the deep portion of the Springfield Plateau Aquifer. These monitoring wells include SAW-2 and SAW-4 through SAW-8. With the exception of SAW-7, the deep SAW wells are completed with screens 20 ft in length at a depth of approximately 200 ft bgs. The exception is SAW-7 that was completed with a screen length of 40 ft.

The distribution of Total BTEX and Total Chlorinated VOCs in groundwater samples from the deep Springfield Plateau Aquifer is shown on Figure 22 and Figure 23, respectively. Analytical results for the deep Springfield Plateau Aquifer groundwater samples from monitoring wells are provided below.

6.3.3.2 Deep Springfield Plateau Aquifer Screening Results

A total of 17 VOCs were detected in the groundwater samples collected from the deep Springfield Plateau Aquifer during the RI. Of the 17 VOCs detected, 12 chemicals were detected in concentrations that exceed the RSLs for tap water. However, only five chemicals were detected in concentrations that exceed the federal MCLs. Based on the RI analytical data comparison to RSL tap water values, 12 VOCs are considered COPCs in the deep Springfield Plateau Aquifer groundwater.

Each of the 12 COPCs with concentrations that exceed RSLs for tap water were detected in the SAW-2 groundwater samples. Surrounding deep Springfield Plateau Aquifer Wells (SAW-4 through SAW-8) generally reported VOC concentrations below the sample detection limit (i.e. non-detect) or were detected at concentrations below applicable screening levels. Note that 11 of the 12 COPCs identified in the SAW-2 groundwater sample collected during the RI were also identified as COPCs in the shallow Springfield Plateau Aquifer groundwater samples (MW-13). One additional VOC (1,2-dibromo-3-chloropropane) was detected in the deep portion of the Springfield Plateau Aquifer. A discussion of the probable vertical migration of VOCs down the SAW-2 open borehole prior to recompletion is provided in Section 5.2.4.

The number of COPCs detected in RI groundwater samples from the deep Springfield Plateau Aquifer, the number of samples with concentrations that exceed the RSLs for tap water and the minimum and maximum concentrations detected for each COPC are provided below.

Summary of COPCs in RI Groundwater Samples from Deep Springfield Plateau Aquifer Monitoring Wells					
Analyte Detected	**Number of Detects/ Number of Samples**	**Samples Exceeding RSLs Tap Water**	**Samples Exceeding Federal MCLs**	**Range of Detected Concentrations (µg/L)**	
				Minimum	**Maximum**
Benzene	11/44	9	8	0.18	40
1,2-Dibromo-3-chloropropane	1/44	1	1	4.3	4.3
1,4-Dichlorobenzene	3/44	2	0	0.17	1.4
1,1-Dichloroethane	10/44	8	NA	0.19	16
1,2-Dichloroethane	2/44	2	0	1.3	1.9
cis-1,2-Dichloroethene	23/44	7	7	0.21	980
Ethylbenzene	12/44	10	0	0.34	170
Methylene Chloride	1/44	1	1	2.9	6.7
Naphthalene	9/44	9	NA	0.32	37
1,2,4-Trimethylbenzene	3/44	8	NA	0.15	81
Vinyl Chloride	9/44	9	9	3.9	810
Xylenes (total)	16/44	8	0	0.31	790

NA = No Assigned MCL; RSL = Regional Screening Level

6.3.4 Chemicals of Potential Concern in Groundwater

VOCs were detected at the highest concentrations during the RI within the shallow portion of the Springfield Plateau Aquifer. A total of 49 VOCs were detected in one or more groundwater samples from the shallow and deep portions of the Springfield Plateau Aquifer. Only one additional VOC (1,2-dibromo-3-chloropropane) was detected in the deep portion of the Springfield Plateau Aquifer. A cumulative 28 of the 49 VOCs were detected at concentrations which exceed the RSLs for tap water, the federal MCLs, or both. As a result of the comparison of shallow and deep groundwater analytical results to the screening criteria of RSLs in tap water and MCLs, 28 VOCs were considered to be COPCs and are summarized below.

Summary of COPCs in RI Groundwater Samples from Springfield Plateau Aquifer Monitoring Wells				
	Shallow		Deep	
Analyte Detected	Exceeds RSLs Tap Water	Exceeds MCLs	Exceeds RSLs Tap Water	Exceeds MCLs
Benzene	X	X	X	X
Bromodichloromethane	X			
n-Butylbenzene	X	NA		
sec-Butylbenzene	X	NA		
tert-Butylbenzene	X	NA		
Carbon Tetrachloride	X			
Chloroform	X	X		
1,2-Dibromo-3-chloropropane			X	X
1,4-Dichlorobenzene	X		X	
1,1-Dichloroethane	X	NA	X	NA
1,2-Dichloroethane	X	X	X	
cis-1,2-Dichloroethene	X	X	X	X
1,2-Dichloropropane	X			
Ethylbenzene	X		X	
2-Hexanone	X	NA		
Methylene Chloride	X	X	X	X
Naphthalene	X	NA	X	NA
1,1,1,2-Tetrachloroethane	X	NA		
1,1,2,2-Tetrachloroethane	X	NA		
Tetrachloroethene (PCE)	X	X		
Toluene	X	X		
1,1,2-Trichlorethane	X	X		
Trichloroethene (TCE)	X	X		
1,2,3-Trichlorpropane	X	NA		
1,2,4-Trimethylbenzene	X	NA	X	NA
1,3,5-Trimethylbenzene	X	NA		
Vinyl Chloride	X	X	X	X
Xylenes *(total)*	X		X	

NA = No assigned MCL; RSL = Regional Screening Level

Figures 24 through 31 depict groundwater concentration contours for selected COPCs utilizing the August 2010 analytical results. With the exception of 2-hexanone, the COPCs identified in shallow and deep groundwater samples collected during the RI generally fall into one of the two following categories:

- **Petroleum Based Hydrocarbons**: Ten COPCs were identified including benzene, n-butylbenzene, sec-butylbenzene, tert-butylbenzene, ethylbenzene, naphthalene, toluene, 1,2,4-trimethylbenzene (Figure 24), 1,3,5-trimethylbenzene (Figure 25), and xylenes. The total BTEX concentrations detected in shallow and deep groundwater samples are shown on Figure 22.

Chlorinated Solvents and Degradation Products: Seventeen COPCs were identified including tetrachloroethene (Figure 26), trichloroethene (Figure 27) carbon tetrachloride, chloroform, 1,1-dichloroethane (Figure 29), 1,2-dichlorethane (Figure 30), cis-1,2-dichloroethene (Figure 28), methylene chloride, 1,1,1,2-tetrachloroethane, 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, and vinyl chloride (Figure 31). Other detected chlorinated COPCs include bromodichloromethane, 1,2-dibromo-3-chloropropane, 1,4-dichlorobenzne, 1,2-dichloropropane, and 1,2,3-trichloropropane.

Also present are ketones, widely used as commercial solvents, volatile, and aerobically degradable.

6.3.5 Delineation of Groundwater Impacts

As discussed above, two primary groups of COPCs (petroleum based hydrocarbons and chlorinated solvents and their associated degradation products) have been identified in groundwater at the Site. Concentrations of the COPCs vary between the shallow and deep groundwater in the Springfield Plateau Aquifer underlying the Site. Based on the results of the groundwater screening process, the highest concentrations of COPCs were detected in the shallow groundwater zone. The VOCs detected in the deep Springfield Plateau Aquifer have migrated vertically down the SAW-2 open hole prior to recompletion of the well. Therefore, the section below primarily addresses the delineation and the extent of migration for COPCs in groundwater within the shallow Springfield Plateau Aquifer.

6.3.5.1 Shallow Springfield Plateau Aquifer

The highest concentrations of COPCs in groundwater have been reported within the shallow groundwater of the Springfield Plateau Aquifer beneath and directly downgradient of identified soil source areas. For the purpose of the RI, the extent of COPCs in the shallow groundwater has been delineated.

A qualitative evaluation of groundwater impacts in extraction wells located in the Northwest Unit of the HVE system was conducted in February 2010. The analytical results were deemed qualitative due to the contrast in screen lengths and relative placement of the screens in the unconsolidated soil. Therefore, these data were submitted to the USEPA and MDNR in draft form and it was agreed that it not be included in the RI data set. However, the analytical results of samples from the extraction wells confirmed the interpreted plume geometry based on historical monitoring well data. In addition, the qualitative extraction well data assisted in the determination of proposed locations for an expanded upper bedrock monitoring well network (Wells MW-28B through MW-31B) and recompletion of a shallow HVE well (E45) into the upper bedrock. Analytical results of groundwater samples obtained from the upper bedrock wells in August 2010 further defined the groundwater plume geometry at the northern boundary of the Brenntag facility.

Concentrations of COPCs decrease significantly away from the source areas to the northern property boundary. Impacted groundwater within the shallow Springfield Plateau Aquifer has migrated offsite to the north as indicated by the presence of VOCs in Well MW-17. The following sections discuss the impacted shallow groundwater plume found onsite and the extent it has migrated primarily toward the north.

Two areas with dissolved phase COPCs exceeding the RSLs for tap water were identified onsite. These areas include the Former Drum Rinse Area and the Former Bulk Chemical Handling Area. Impacted shallow groundwater beneath these two source areas, which are in close proximity to each other, have co-mingled**.**

Petroleum Based Hydrocarbons

The highest concentrations of petroleum based hydrocarbons (i.e. toluene, xylenes, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene) were reported in groundwater samples collected from locations near the Former Bulk Chemical Handling Area.). Additional petroleum based hydrocarbons detected in shallow groundwater samples with detected concentrations that exceed the RSLs for tap water include: benzene, n-butylbenzene, sec-butylbenzene, tert-butylbenzene, , ethylbenzene, and naphthalene,

In general, samples with the highest historical concentrations of petroleum based hydrocarbons were observed in the Former Bulk Chemical Handling Area (Wells MW-6 and MW-8).

Figure 20 indicates a marked absence of BTEX impacts in shallow soil samples (both historic and RI) from borings located in the Former Rail Spur. An exception is the soil sample collected from an unknown depth at temporary monitoring well TMW-3. It is assumed that this sample was collected from the discrete interval with the highest TVOC concentration obtained during field screening with a PID. Ostensibly, the TMW-3 soil sample was obtained from the saturated soil interval. As a result, analytical data for the TMW-3 soil sample was included in the soil source area delineation figures for the 6 to 10 ft bgs interval which represent saturated soils. Therefore, it appears that the presence of petroleum based hydrocarbons in RI groundwater samples from the soil/residuum (MW-4) and the upper bedrock (E7B) have likely migrated from the nearby Former Bulk Chemical Handling Area to the Former Rail Spur.

As indicated on Figure 22 (Total BTEX), the extent of petroleum based hydrocarbons in the shallow groundwater decreases significantly from the documented soil source in the Former Bulk Chemical Handling Area to the downgradient (i.e., north) property boundary. Analysis of BTEX concentrations in shallow groundwater samples from onsite Wells MW-2, EW-1N, MW-9, MW-10, MW-11, , MW-12, and SAW-3 were either non-detect or slightly exceeded the laboratory reporting limit. However, petroleum based hydrocarbons that were identified as COPCs with concentrations that exceeded the RSLs for tap water, were detected in the recently installed upper bedrock wells MW-28B through MW-30B and the upper bedrock extraction well E45B. These wells are located at the northern property boundary of the Site and immediately downgradient of the Former Drum Rinse Area that appears to be the source area for these petroleum based hydrocarbons.

The northward migration of petroleum based hydrocarbons to an adjacent property appears to have occurred near the interface of the soil/residuum and the weathered bedrock surface. The benzene, ethylbenzene, toluene, xylenes (Figure 22), 1,2,4-trimethylbenzene (Figure 24), 1,3,5-trimethylbenzene (Figure 25), and naphthalene concentrations detected in the downgradient monitoring well MW-17 exceed the RSLs for tap water. It appears that the Former Drum Rinse Area was the source of the petroleum based hydrocarbons present in MW-17.

Relative to the groundwater impacts at offsite Well MW-17, petroleum based hydrocarbons in groundwater have been adequately defined in the cross-gradient (MW-16, MW-23, MW-25 and MW-26) and downgradient (MW-19, MW-20, and MW-

24) direction. The benzene, ethylbenzene, toluene, xylenes, (Figure 22) 1,2,4-trimethylbenzene (Figure 24), 1,3,5-trimethylbenzene (Figure 25), and naphthalene concentrations did not exceed the RSLs for tap water in these wells. For the purpose of the RI, petroleum based hydrocarbons in shallow groundwater have been adequately defined in the downgradient direction. Relative to the Site, petroleum based hydrocarbons have been delineated to the east (MW-27 and MW-18), southwest (MW-14), and south (MW-7). Well MW-15 is located downgradient and west of the Site. Concentrations for two petroleum based hydrocarbon compounds (benzene and naphthalene) exceed the RSLs at Well MW-15. Also, benzene concentrations detected in MW-15 exceeds its MCL (5 ug/L). Although possibly unrelated, a former UST was located in the vicinity of Well MW-15 located on the Acme Brick facility. This report assumes that the benzene detected in MW-15 is related to the dissolved petroleum hydrocarbons released at the Site. The range of benzene concentrations detected in historical samples from MW-15 is between 1.1 ug/L and 21 ug/L. Continued reduction of dissolved petroleum hydrocarbons by ongoing HVE operation and proposed source area remedies will enhance the attenuation of benzene in the vicinity of MW-15 at the western boundary of the dissolved plume. No further delineation of dissolved benzene in groundwater in the vicinity of MW-15 is warranted.

Chlorinated Solvents and Degradation Products

The highest concentrations of chlorinated solvents were reported in groundwater samples collected from wells in the Former Drum Rinse Area. Tetrachloroethene concentrations detected in Well MW-1 are the highest of any chlorinated solvent detected in shallow groundwater samples (Figure 26). The tetrachloroethene concentrations in Well MW-1 fluctuate due to seasonal precipitation events and influence of the dual-phase HVE system. Seasonal precipitation events may result in high groundwater table conditions (within 3 ft bgs) in the vicinity of Well MW-1. As a result, a historical release of tetrachloroethene at the surface has been smeared throughout the soil/residuum column.

High concentrations of tetrachloroethene and trichloroethene (Figure 27) were detected in groundwater samples from the shallow soil/residuum (MW-1) and the upper bedrock (MW-28B). The immediate area surrounding these two wells defines the Former Drum Rinse as a source area for chlorinated solvents (Figure 26). Figure 27 depicts an area with elevated trichloroethene concentrations in shallow groundwater that includes Well MW-28B and extends to the northern property boundary (E45B, MW-29B through MW-31B, and MW-11).

As shown on Figures 26 and 27, the areal extent of elevated tetrachloroethene and trichloroethene concentrations in the shallow groundwater of the Springfield Plateau Aquifer decreases significantly from the Former Drum Rinse Area to the downgradient (i.e., north) properties. This is evident in shallow groundwater samples from downgradient wells (MW-21, MW-16. MW-17, and MW-23) and crossgradient wells (SAW-1, MW-10, MW-2, SAW-3 and MW-12). However, concentrations of Trichloroethene that exceed the RSL (but less than 10 ppb) were detected in Wells MW-19, MW-20, and MW-22 near the downgradient terminus of the chlorinated VOC groundwater plume. Detected concentrations of trichloroethene did not exceed the RSL in surrounding Wells MW-16, MW-24, MW-20 and MW-25. Therefore both of these chlorinated solvents are adequately delineated in the shallow groundwater.

Degradation products derived from chlorinated solvents were detected in shallow groundwater samples at concentrations that exceed the RSLs for tap water. These chlorinated VOCs include; carbon tetrachloride, chloroform, 1,1-DCA, 1,2-DCA, cis-1,2-dichloroethene, methylene chloride, and vinyl chloride. Two of the degradation products are characterized as having elevated detected concentrations in shallow groundwater. Cis-1,2-dichloroethene (Figure 28) and vinyl chloride (Figure 31) are present in shallow groundwater samples collected from wells near each of the identified soil source areas.

Remaining chlorinated VOCs identified as COPCs in the RI shallow Springfield Plateau Aquifer groundwater include; bromodichloromethane, 1,4-dichlorobenzene, 1,2-dichloropropane, 1,1,1,2-tetrachloroethane, 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, and 1,2,3-trichloropropane. Elevated concentrations of chlorinated VOC degradation products in groundwater occur in the Bulk Chemical Handling Area (Well MW-5), extend downgradient (Wells EW-2S and MW-9), and north to the Former Drum Rinse Area (Wells MW-1, MW-28B through MW-31B, E45B, E47B, and MW-11).

Chlorinated VOC degradation products identified as COPCs in offsite groundwater monitoring wells to the north include; 1,1-dichloroethane (MW-17, MW-21, and MW-22), 1,2-dichloroethane (MW-21 and MW-22), cis-1,2-dichloroethene (MW-19 and MW-22), and vinyl chloride (MW-21 and MW-22). Shallow groundwater samples from downgradient Wells MW-23, MW-16, MW-24, MW-20, MW-25, and MW-26 did not detect chlorinated VOCs (solvents and their degradation products) at concentrations that exceeded the RSLs for tap water.

For the purpose of the RI, the extent of chlorinated VOC degradation products in the shallow groundwater of the Springfield Plateau Aquifer has been adequately delineated downgradient (north) of the Site.

The isopleth contours on Figure 23 depict the presence of Total Chlorinated VOCs downgradient (east) of the Brenntag site at the adjacent Acme Brick property. However, none of the detected CVOCs in RI samples for the last 6 quarters from Well MW-15 exceeded their respective RSLs.

6.3.5.2 Deep Springfield Plateau Aquifer

During the RI, detected concentrations of five petroleum based hydrocarbons and seven chlorinated VOC degradation products were observed in the deep Springfield Plateau Aquifer groundwater.

Petroleum Based Hydrocarbons

Five petroleum based hydrocarbons were identified as COPCs in the deep portion of the Springfield Plateau Aquifer at concentrations that exceed the RSLs for tap water. The five petroleum based hydrocarbon COPCs were detected only in the SAW-2 groundwater sample. The identified COPCs include; benzene, ethylbenzene, naphthalene, 1,2,4-trimethylbenzene, and xylenes. Benzene is the only petroleum based hydrocarbon COPC detected in the deep Springfield Plateau Aquifer in concentrations that exceed the federal MCL. None of the petroleum based hydrocarbon concentrations detected in the new delineation wells SAW-4 through SAW-8 exceed the RSLs for tap water. Therefore, the lateral extent of petroleum based hydrocarbons in the deep Springfield Plateau Aquifer has been adequately delineated for the purpose of the RI.

Chlorinated Solvents and Degradation Products

Neither of the two chlorinated solvents that were identified as COPCs in shallow groundwater of the Springfield Plateau Aquifer (tetrachloroethene and trichloroethene) were identified as COPCs in the deep Springfield Plateau Aquifer groundwater samples.

Chlorinated VOC degradation products detected in groundwater samples from the deep Springfield Plateau Aquifer that were detected in concentrations that exceed the RSLs for tap water include: 1,1-dichloroethane (Figure 29), 1,2-dichloroethane (Figure 30), cis-1,2-dichloroethene (Figure 28), methylene chloride, and vinyl chloride (Figure 31). These COPCs were detected only in the SAW-2 groundwater sample with the exceptions of 1,1-dichloroethane (SAW-6) and cis-1-2-dichloroethene (SAW-6 and SAW-7). However, the detected concentrations of these two COPCs in SAW-6 and SAW-7 did not exceed the RSL.

Remaining chlorinated VOCs identified as COPCs in the deep groundwater (SAW-2) include; 1,2-dibromo-3-dichloropropane and 1,4-dichlorobenzeneChlorinated VOCs detected in the deep Springfield Plateau Aquifer groundwater samples in concentrations that exceeded the federal MCLs include; 1,2-dibromo-3-dichloropropane, cis-1-2-dichloroethene, methylene chloride, and vinyl chloride. The analyte 1,2-dibromo-3-dichloropropane was not identified as a COPC in the shallow groundwater samples.

None of the chlorinated VOCs detected in the deep Springfield Plateau Aquifer delineation wells SAW-4 through SAW-8 exceeded the RSLs for tap water. For the purpose of the RI, the chlorinated COPCs identified in the deep Springfield Plateau Aquifer have been adequately delineated.

6.4 Interim Removal Action Plan Activities

As discussed in Section 1.3.2, an IRAP was implemented in July 1999. ARCADIS conducted additional activities based on results of IRAP system monitoring results. Presently, the interim HVE system is comprised of 57 dual-phase HVE wells (Figure 4). The additional IRAP activities included:

- The recompletion of select HVE wells.
- Installation of new HVE wells.
- Operation of the HVE system to mitigate offsite migration of impacted groundwater.
- The implementation of an Enhanced Reductive Dechlorination (ERD) pilot test.

6.4.1 Expansion of HVE Well Network

As part of the additional IRAP activities, four shallow extraction wells (E7, E42, E45, and E47) were recompleted in the upper bedrock between January 2004 and April 2010. These wells had been initially completed on bedrock highs with very short screen lengths and were not effectively providing hydraulic control. The casing and screens were pulled and the well borings were drilled to a total depth of approximately 40 to 45 ft bgs. Each of the bedrock extraction wells (E7B, E42B, E45B, and E47B) was completed with screens in the upper bedrock between approximately 20 ft and 45 ft bgs. These upper bedrock extraction wells were connected to the HVE system to establish hydraulic control in the upper bedrock aquifer.

Wells E47B, E45B, and E42B are located near monitoring wells completed in the overlying soil/residuum with historical high VOC concentrations in groundwater. Wells E45B and E47B are located with the intent to capture groundwater in the upper bedrock and mitigate the downgradient migration of VOCs at the northern boundary of the Brenntag site.

As discussed in section 6.3.5.1, a qualitative evaluation of groundwater concentrations in HVE wells located in the Northwest Unit of the HVE system was conducted in February 2010. The analytical results were deemed qualitative due to the contrast in screen lengths and relative placement of the screens in the unconsolidated soil. Therefore, these data were submitted to the USEPA and MDNR in draft form and it was agreed that it not be included in the RI data set. However, the analytical results of groundwater samples from the HVE wells confirmed the interpreted VOC plume geometry based on historical monitoring well data. Most importantly, the qualitative HVE well data assisted in the determination of proposed locations for the upper bedrock monitoring well network (Wells MW-28B through MW-31B) and recompletion of a shallow HVE well (H45) in the upper bedrock. These wells were installed in April 2010. Groundwater analytical results were obtained from the upper bedrock wells in May and August 2010. These data further defined the groundwater plume geometry at the northern boundary of the Brenntag facility.

Figure 9a depicts shallow groundwater elevations obtained on November 1, 2010 after the installation and operation of E45B in the Northwest Unit of the HVE system. The apparent overlapping radius of influence with Wells E42B (south) and E47B (north) have resulted in a marked depression in groundwater elevations in nearby monitoring wells. When compared to the Approximate Top of Bedrock elevations (Figure 6) the measured groundwater elevations at the northern property boundary are below the top of bedrock. This response is consistent with conclusions derived from the July 2010 hydraulic tests that were conducted in the upper bedrock at the northern property boundary in May 2010.

Well E7B is an upper bedrock extraction well located in the Rail Spur. A marked reduction in petroleum hydrocarbon based VOCs in groundwater at Wells MW-3 and MW-4 has resulted since the installation of Well E7B in 2004.

HVE wells E51, E52, and E53 were installed in the Central Unit in April 2005 to enhance the removal of VOC impacts in soil and groundwater in the Former Bulk Chemical Handling Area. HVE wells E51 and E52 were completed with screens across the soil/residuum and upper bedrock. Soil and groundwater samples were collected and submitted for VOC analysis. A substantial reduction of VOC

concentrations in Wells MW-5, MW-6 and MW-8 are the result of the increased density of extraction wells.

6.4.2 HVE System Removal Action Objectives

Interim remediation activities conducted since January 2000 (consisting primarily of the installation and operation of the HVE system) has had a significant impact on the constituent fate at the site. The objectives of the previously stated (Section 1.3.2) HVE system removal action are to 1) remove the VOCs from unsaturated soils and the dewatered smear zone through vapor extraction, 2) reduce the overall mass of VOCs from the groundwater by extraction and treatment, 3) to prohibit the vertical migration of VOCs, and 4) provide hydraulic control to mitigate impacted groundwater from migrating offsite. Briefly stated, the extent to which each removal action objective has been attained is;

- A significant mass (approximately 950 lbs) of VOCs have been removed from the unsaturated zone via SVE as confirmed through periodic vapor monitoring of the HVE system.

- With the exception of the elevated VOC concentrations at MW-1, there has been both a large reduction in the footprint of the dissolved VOC plume (Figures 14 and 15) and the VOC concentration in groundwater (Figures 22 and 23) collected from site monitoring wells as noted in Table 2.

- Reconstruction of SAW-2 eliminated the only identified vertical pathway for dissolved VOCs from the shallow groundwater into the deeper bedrock.

- Reduction of dissolved VOC impacts in offsite wells as indicated in Table 15 and Table 16 is consistent with the HVE system reducing offsite migration. The results of the hydraulic testing during the Data Gaps Study confirmed that as currently configured, the HVE system is capable of exerting hydraulic control and preventing off site migration of dissolved VOCs from the Former Drum Rinsing Area.

6.4.3 Enhanced Reductive Dechlorination Pilot Test Activities

An enhanced reductive dechlorination (ERD) pilot test was conducted in 2005 in the vicinity of MW-1 (Figure 4). Injection wells IW-1 through IW-5 were installed between monitoring well MW-1 and HVE well E42B in April 2005. Laboratory analytical results for soils and groundwater are provided in Table 14 and Appendix D, respectively.

These injection wells were used to conduct an initial ERD pilot test between August 2005 and January 2006.

The objective of the initial ERD pilot test was to assess the feasibility of enhancing the ongoing reductive dechlorination of VOCs in the vicinity of the Former Drum Rinse Area. In general, the results of the pilot test indicated that the ongoing reductive dechlorination could be effectively enhanced through the injection of a carbon source. As a result, an expanded ERD pilot test was proposed and approved and additional injection wells IW-6, IW-7, and IW-8 were installed in January 2007.

The expanded ERD pilot test activities were initiated on March 5, 2007 and continued through March of 2008. Based on the results of pilot testing, several conclusions were drawn regarding the implementation of ERD to address site impacts of chlorinated VOCs in groundwater:

- Results indicate that the ongoing reductive dechlorination can be further enhanced through the addition of a carbon source.

- The presence of dissolved gases in groundwater, such as methane, ethene, and ethane, which are the final reductive dechlorination products of chlorinated VOCs, are consistent with the reductive process being driven to completion.

- Due to the presence of secondary permeability pathways, mainly bedding planes, chert zones, and solution features, uniform delivery of carbon through the use of traditional vertical wells will be problematic.

- The results of the pilot test indicate distribution of organic carbon and accompanying reductive dechlorination does occur in the subsurface once the carbon source is injected.

- Enhancing and sustaining an accelerated rate of dechlorination will be dependent upon designing and implementing a carbon delivery method that will uniformly distribute carbon in the impacted areas.

- Based on the results of the long term pilot test, ERD is an appropriate approach to remediate dissolved CVOCs at the Site, however, delivery systems other than vertical injection wells will be evaluated prior to full-scale implementation.

6.5 Soil Vapor Survey

Three soil vapor samples and a duplicate were collected at the northern perimeter of the Brenntag warehouse on April 2, 2007. In addition, a soil vapor sample was collected at the northern perimeter of the Brenntag office building. Soil vapor samples SV-1, SV-2, and SV-3 were collected at points located along the north exterior wall of the warehouse. Soil vapor sample SV-4 was collected at the north exterior wall of the office beneath the paved parking lot (Figure 18).

Soil vapor samples were collected by means of tubing inserted through hydraulic push probe rods driven to a depth of 5 ft bgs. The rods were pulled up to a depth of 4 ft bgs before the samples were collected. The soil vapor samples were submitted for laboratory analysis of selected VOCs by USEPA Method TO-15. A summary of the laboratory analytical results for the soil vapor samples is provided on Table 17. A copy of the laboratory analytical report is provided on CD that is included in Appendix J,

Reportedly, historical site operations included utilization of a transfer pump in the vicinity of soil vapor sample SV-1. The pump transported chemical between the tank farm and the former drum filling room located in the northwest corner of the warehouse. High concentrations of toluene were detected in soil vapor sample SV1-5 and a duplicate from the same location. Additional VOCs were detected in these samples (Table 17). Based on the analytical results of soil vapor sample SV-1, four sub-slab vapor samples were proposed in an Addendum – Additional Site Characterization Work Plan submitted in June 2007.

6.6 Sub-slab Vapor Survey

Based on the analytical results of the onsite soil vapor survey a potential for VOCs in sub-slab vapor was investigated in the northern portion of the Brenntag warehouse. Four sub-slab vapor samples and a duplicate were collected on June 15, 2007. These samples include SSV-5 located in the vicinity of the warehouse office and SSV-6, SSV-7, and SSV-8 located in the vicinity of the former drum filling room at the northwest corner of the warehouse (Figure 18).

The sub-slab vapor samples and a duplicate were submitted for laboratory analysis of selected VOCs by USEPA Method TO-15. Laboratory analytical results are provided in Table 18. Included in Table 18 is the U.S. Environmental Protection Agency (USEPA) target shallow soil gas concentrations based on a 1×10^{-6} target risk level. Also presented in the table are the USEPA target shallow soil gas concentrations based on a 1×10^{-4} target risk level. These two concentrations are included in the table

because they represent the range of concentrations typically considered by USEPA to be within their acceptable or target risk range. A copy of the laboratory analytical report is provided on CD that is included in Appendix J.

With the exception of trichloroethene, 1,3,5-trimethylbenzene and 1,2,4-trimethylbenzene detected in SSV-7, all constituent concentrations detected in the five sub-slab vapor samples are less than the 1×10^{-4} target risk level, indicating acceptable risk. The sub-slab vapor concentrations of 1,3,5-trimethylbenzene and 1,2,4-trimethylbenzene exceed the screening levels. However, even though these concentrations exceed the screening levels, it does not mean that there is a potential risk to workers in the building. Although chemicals are detected in the sub-slab vapor samples, it is unlikely that ambient air quality in the warehouse would be impacted. The visible building slab appears to be intact with no apparent cracks or floor drains that could act as a conduit for sub-slab vapors to migrate into the building. Also, there are large loading dock access doors open most of the year and circulation of ambient air with indoor air is likely to be significant, thereby reducing the concentrations of potential vapor that might migrate into the warehouse.

The potential does exist for vapors from impacted groundwater to migrate vertically and accumulate beneath the warehouse slab. Therefore, as an interim remedial measure, a permanent sub-slab venting system was installed to mitigate any potential vapor migration to the building slab from the underlying groundwater.

6.7 Sub-slab Vapor Extraction Testing and System Installation

A sub-slab vapor extraction pilot test was conducted in January 2008. Results of the test were utilized for the design and installation of a vacuum extraction system to address the presence of VOCs detected in sub-slab vapor as an interim remedial measure.

Implementation of a sub-slab vapor recovery system would achieve two principle goals, 1) control the potential migration of vapors from the below the building slab in the area of principle concern (the warehouse office), and 2) removal of sub-slab vapors in the area with the highest VOC impacts (the west end of the warm room. Exposure to VOC vapors migrating into the warehouse from underlying impacted media is considered an incomplete pathway. However, to remove the vapor concentration beneath the northwestern portion of the slab, an Interim Measure Vacuum Extraction System was installed in November 2009.

The SSVE system is located in the northwest portion of the warehouse and is independent of the soil and groundwater HVE system (Figure 19). Details of the sub-slab system installation were provided in a report that was submitted to the USEPA and MDNR on April 7, 2010.

The SSVE system consists of nine extraction points located in the facility warehouse. These extraction points are configured as follows: three vapor extraction points (VE-1, VE-4 and VE-9) in the Former Drum Filling Room, three vapor extraction points (VE-2, VE-3 and VE-5) in the Warm Room and three vapor extraction points (VE-6, VE-7 and VE-8) in the Main Warehouse near the Warehouse Office. A 3.5 horsepower (hp) regenerative blower is used to apply the vacuum to the extraction points via collection piping. Extracted vapors are discharged above the roof line via a 2-inch steel exhaust stack.

A summary of the SSVE system effluent sample analytical results and the estimated mass removal are provided in the quarterly monitoring report. As of August 2010, the SSVE system had operated approximately 95% of the time since start up. Approximately 125 grams of Total VOCs have been removed via sub-slab vapor extraction during this period.

6.8 Hydraulic Testing

Four upper bedrock monitoring wells and one upper bedrock extraction were installed at the northern property boundary of the Brenntag facility. An upper bedrock monitoring well (MW-28B) was completed at a location immediately north of MW-1. Three additional upper bedrock monitoring wells (MW-29B, MW-30B, and MW-31B) were completed at locations adjacent to the pre-existing upper bedrock extraction well E47B. The construction of these wells is similar to existing upper bedrock extraction wells E7B, E42B, and E47B. Hydraulic testing within the shallow unconsolidated soils and upper bedrock was conducted in May 2010 as proposed in the Data Gap Study Work Plan (February 2010). Testing was conducted to evaluate 1) hydraulic characteristics of the shallow unconsolidated soils and upper bedrock, and 2) the ability to achieve hydraulic control using groundwater extraction.

Conclusions based on the hydraulic test results indicate the Site is hydrogeologically complex due to the variability of the bedrock surface and the presence of secondary permeability features (sediment filled solution voids, bedding planes, etc.). In addition, the hydraulic testing was conducted in a manner to maximize hydraulic response in order evaluate the effectiveness of a hydraulic control strategy. The empirical results of the hydraulic testing indicate the following:

- The E47B distance drawdown analysis indicated a hydraulic conductivity of approximately 5 x 10^{-4} centimeters per second (cm/sec). This is higher than previously estimated hydraulic conductivity based on historical water production rates from the interim remedial system and previously conducted slug tests.

- The observed area of hydraulic response coupled with the relatively modest pumping rates indicates a storativity of 0.001. This is a low value for an unconsolidated formation, but is consistent with the conceptual site model (CSM) developed on the basis of previous field observations. While a storativity of 0.001 would be very low for a water table aquifer in unconsolidated soils, it is consistent with the properties of secondary permeability associated with the upper bedrock.

- The similarity in hydraulic response between wells completed in the shallow unconsolidated soils and the upper bedrock indicate that they are hydraulically interconnected, as anticipated.

- The voids observed during the installation of MW-29B and MW-30B coupled with the strong hydraulic response noted at these same wells indicates that these voids are interconnected at the E47B location. However, the rapid hydraulic response, the relatively low sustained pumping rate, and the presence of sediment within the voids indicate a relatively small volume within the voids available for storage.

- While a hydraulic response was noted at distances exceeding 100 ft, the capture zone is likely somewhat limited by the strong hydraulic gradient (0.083 ft/foot). Calculations indicate that a capture width for E47B exceeds 100 ft. These results indicate that the existing spacing of remediation wells at the downgradient property boundary is adequate to achieve hydraulic control. However, it is recommended that additional boundary control wells be completed into the upper bedrock to 1) maximize drawdown and 2) maximize the potential for intersecting secondary permeability features.

7 Risk Assessment

The following sections present a summary of the Human Health Risk Assessment (HHRA) that was prepared for the Brenntag/HCI-Chemtech Facility in Springfield, Missouri. An ecological assessment was also conducted for the Site. Based on the presence of active commercial operations, the lack of ecological habitat, and the absence of complete exposure pathways for wildlife at the site, additional ecological assessment of the Site is not required. The detailed discussion, calculations, and results for the HHRA are presented in Appendix K of this RI report.

7.1 Human Health Risk Assessment

The HHRA for the Site was prepared consistent with USEPA guidance. The HHRA quantified potential risks and hazards associated with chemicals detected soil, and groundwater at the Site. In addition, potential exposure to indoor air via vapor intrusion from groundwater was also evaluated using the USEPA vapor intrusion model and site-specific soil vapor and sub-slab vapor data. The entire HHRA report is in Appendix K of this RI report.

7.1.1 Summary of Chemicals of Potential Concern

One of the first steps in selecting COPCs for the purposes of the HHRA was to evaluate the sample data collected at the Site. Sample collection, analysis, and validation aspects of the data collection were reviewed to ensure data were valid for use in the risk assessment following USEPA guidance. The sample screening process and samples used to determine the COPCs in each medium are briefly discussed below:

- A total of 17 surface soil samples were collected at the Site to investigate potential impacts to soil (Appendix K, Figure 3). These samples are discussed in Section 3.2 of Appendix K. For the purpose of the HHRA, soil samples collected between 0 and 2 ft bgs were considered to be surface soil samples. The surface soil data set consists of 8 soil samples collected from 0 to 1 foot bgs in 2007 and 2010, 6 soil samples collected between 0 to 1.5 ft bgs in 2007, and 3 soil samples collected from 0 to 2 ft bgs in 2007. Surface samples were analyzed for VOCs. The surface soil data set is used to evaluate both current and future exposures. The surface soil samples listed on Table 3-1 of Appendix K were evaluated in the HHRA.

- The vadose zone for the Site is defined as the depth interval from 0 to 2 ft bgs. Therefore, a subsurface data set was not evaluated in the HHRA (Appendix K) because the 0 to 2 ft bgs depth interval represents both the surface soil and the vadose zone interval.

- Groundwater samples have been collected from the Site and on adjacent properties from monitoring wells and Springfield Plateau Aquifer wells, since 1995. These samples are discussed in Section 3.4 of Appendix K. Groundwater monitoring data collected during the fourth quarter of 2008, the first, second, third, and fourth quarters of 2009, and the first, second, and third quarters of 2010 (i.e., the most recent 8 quarters) are considered representative of current conditions at the Site and were included in the groundwater data set for the HHRA (Appendix K).

The second step in the COPC selection process was to compare the maximum detected chemical concentrations in each medium to health-based screening levels. USEPA Regional Screening Levels (RSLs) for tap water and residential soil (USEPA, 2010a) were used as the screening levels for groundwater and soil, respectively. Chemicals detected at concentrations greater than the RSLs were identified as COPCs. (One-tenth of the RSLs based on non-cancer effects were used as screening values to account for potential cumulative effects. The RSLs based on carcinogenic effects [using a target cancer risk of 10^{-6}] were used at the listed value.) The following COPCs were identified:

- Surface Soil under a current scenario: there are no identified COPCs in surface soil;

- Surface Soil under a hypothetical future scenario (which includes soil samples that are currently covered by concrete/pavement): ethylbenzene, tetrachloroethene, and 1,2,4-trimethylbenzene;

- Groundwater: benzene, bromodichloromethane, n-butylbenzene, sec-butylbenzene, tert-butylbenzene, carbon tetrachloride, chloroform, 1,4-dichlorobenzene, 1,1-dichloroethane, 1,2-dichloroethane, cis-1,2-dichloroethene, 1,2-dichloropropane, ethylbenzene, 2-hexanone, methylene chloride, naphthalene, 1,1,1,2-tetrachloroethane, 1,1,2,2-tetrachloroethane, tetrachloroethene, toluene, 1,1,2-trichloroethane, trichloroethene, 1,2,3-trichloropropane, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, vinyl chloride, and xylenes (total).

7.1.2 Exposure Assessment

The assessment of exposure includes characterization of the physical environment, identification of exposure pathways (including migration pathways, exposure points, and exposure routes), and identification of potentially exposed individuals and populations. A conceptual site model was developed which identified potential receptors as well as characterized potentially complete or incomplete exposure pathways.

Brenntag owns and operates the chemical distribution facility, located on the southwest side of Springfield. The encompassing approximately 3.75 acres, is located within the Missouri Pacific Industrial Park. Past practices of the facility included chemical storage, chemical blending, railcar unloading, drum recycling/reconditioning, and a paint spray booth operation. Caustics, aromatic solvents, acids, ketones, alcohols, glycols, petroleum based hydrocarbons, and chlorinated solvents were handled and stored at the facility. The facility never manufactured chemicals and the amount of chlorinated solvents stored at the Site has decreased considerably since bulk storage was discontinued.

Presently, the facility only stores and distributes pre-packaged chemical products. The facility also distributes dry chemicals including caustic, surfactants, desiccants, and pharmaceutical and food-grade chemicals. A fence currently surrounds the facility and the perimeter is regularly patrolled. Access by authorized personnel is limited to guarded entrances and public access is restricted.

Current land use of the Brenntag facility is classified as commercial/industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA. Based on past, present, and anticipated future land use for the Site, the Brenntag property is expected to remain in commercial/industrial use for the foreseeable future. However, for purposes of a baseline risk assessment, future unrestricted land use must be assessed. Therefore, a residential scenario is also evaluated in the HHRA based on the possibility, although unlikely, that the Site will be redeveloped for residential use.

Based on the current and future land uses, the following complete or potentially complete exposure pathways and receptors were identified:

- Future site workers may be exposed to COPCs in surface soil via incidental ingestion, dermal contact and inhalation of wind-blown fugitive

dust and VOCs. Future site workers may also be exposed via inhalation to volatile COPCs in groundwater migrating to indoor air.

- Future site workers may also be exposed to COPCs in groundwater via inhalation and ingestion of groundwater used as potable water and dermal contact while washing hands.

- Current offsite workers may be exposed via inhalation to volatile COPCs in groundwater migrating to indoor air.

- Hypothetical future residents may be exposed to COPCs in surface soil via incidental ingestion, dermal contact and inhalation of wind-blown fugitive dust and VOCs. Hypothetical future residents may also be exposed to COPCs in soil and groundwater via inhalation of VOCs migrating to indoor air.

- Hypothetical future residents may also be exposed to COPCs in groundwater via ingestion of groundwater used as potable water, dermal contact while washing hands and showering, and inhalation of VOCs released to indoor air during household use of groundwater.

The next step of the exposure assessment was to assemble exposure factors for each of the exposure scenarios developed and calculate the exposure point concentration (EPC). Exposure factors representing the reasonable maximum exposure were used in this HHRA. The EPC is the lower of the 95th percent upper confidence limit on the mean (UCL) or the maximum detected concentration. The USEPA (1989) defines the EPC as “the arithmetic average of the concentration that is contacted over the exposure period.” To ensure that the estimate of the average (or mean) is conservative and not underestimated, USEPA (1989, 1992c) recommends using the UCL as an estimate for the EPC for each exposure area of a site. Statistical software provided by USEPA (i.e., ProUCL) has, to some extent, automated the process of calculating UCLs and selecting the most representative statistic based on characteristics of the data set such as sample size, and measures of variance. USEPA’s ProUCL 4.00.05 statistical software (USEPA 2010b) was utilized to calculate EPCs for each exposure scenario evaluated.

7.1.3 Toxicity Assessment

The human toxicity assessment was performed in order to identify numerical toxicity criteria with which to assess human health exposures. In accordance with the

USEPA's toxicity value hierarchy (USEPA 2003) quantitative dose-response data were compiled from USEPA's IRIS (USEPA, 2010c), USEPA Provisional Peer Reviewed Toxicity Values (PPRTVs), HEAST (USEPA 1997), the California EPA (2009), and the Agency for Toxic Substances and Disease Registry (ATSDR 2010).

For non-cancer health effects, chemical-specific reference doses (RfDs) were compiled. Chronic RfDs were used to assess long-term exposures ranging from 7 years to a lifetime.

For cancer endpoints, chemical-specific cancer slope factors (CSFs) and weight-of-evidence classifications were compiled.

Whenever possible, route-specific toxicity values have been used. However, toxicity values for dermal exposures have not yet been developed by USEPA; therefore, the oral toxicity values and the gastrointestinal absorption efficiency (ABS_{GI}) were used to derive adjusted toxicity values (adjusted to the absorbed dose) for use in assessing dermal exposure (USEPA, 2004b).

7.1.4 Risk Characterization

Using the human exposure and toxicity information, potential human health risks for each COPC and selected exposure pathway were evaluated. Upper-bound excess lifetime cancer risks and non-cancer hazards were quantified. In addition, cumulative risks and hazard indices were estimated by summing the upper-bound excess lifetime cancer risks or hazards across exposure pathways for individual receptors.

The following summarizes the cumulative excess lifetime cancer risk (ELCR) and hazard indices (HIs) for each of the receptors evaluated in this HHRA. The risks and hazards shown below are cumulative for each exposure scenario, summed across all COPCs, media, and exposure routes.

Receptor	Exposure Media	ELCR	HI
Future Site Worker	Surface soil, groundwater, indoor air	3×10^{-2}	128
Potential Current Offsite Worker	Indoor air	1×10^{-6}	0.2

Receptor	Exposure Media	ELCR	HI
Hypothetical Future Resident	Surface soil, groundwater, indoor air	2×10^{-1}	1063

ELCR Excess lifetime cancer risk; HI Hazard index.

The potential ELCR for the potential current offsite worker receptor is within the USEPA target risk range and the potential cumulative HIs is less than 1. USEPA (1991) guidance on the *Role of Risk Assessment in Superfund Remedy Selection Decisions* states that, "where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4} and the non-carcinogenic hazard quotient is less than 1, action generally is not warranted unless there are adverse environmental impacts."

The calculated ELCRs for future site worker (ELCR = 3×10^{-2}) and future resident (ELCR = 2×10^{-1}) exposure to soil and groundwater are greater than the USEPA target risk of 10^{-4} prescribed by the National Contingency Plan (NCP). In addition, the cumulative HIs for a future site worker (HI = 128), and a future resident (HI = 1063) are greater than the benchmark of 1. Because USEPA benchmarks for acceptable risks/hazards were exceeded, COCs are identified in the following section.

7.1.5 Chemicals of Concern

The calculated ELCRs for a future site worker and future child resident are greater than the USEPA target risk range of 1×10^{-6} to 1×10^{-4} prescribed by the NCP (USEPA, 1991). In addition, the cumulative HIs for a future site worker and future adult and child resident are greater than the benchmark of 1. Therefore, COCs are identified for each medium of concern. For exposure pathways with a calculated ELCR greater than the USEPA target risk range or a cumulative HI greater than 1, the COCs are identified as individual COPCs resulting in an excess lifetime cancer risk exceeding the 10^{-6} level and for non-cancer endpoints, chemicals contributing to the hazard index greater than 1. The following COCs have been identified by medium:

- Soil: 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene.

- Groundwater: benzene, bromodichloromethane, carbon tetrachloride, chloroform, 1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichloroethane, cis-1,2-dichloroethene, 1,2-dichloropropane, ethylbenzene, methylene chloride, naphthalene, 1,1,1,2-tetrachloroethane, 1,1,2,2-tetrachloroethane, tetrachloroethene, toluene, 1,1,2-trichloroethane, trichloroethene, 1,2,3-

trichloropropane, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, vinyl chloride, and xylenes (total).These COCs will be evaluated further in the FS.

8 Conceptual Site Model

This section presents the Conceptual Site Model and provides a description of the VOC occurrence, distribution, and migration at the Site based on the current data. The conceptual site model developed from the recent and historical site data is summarized in Figure 32 and discussed below.

8.1 Physical Setting

The Brenntag site is an active chemical distribution facility located on a 3.75 acre site in Springfield, Missouri. The area impacted by releases includes the facility, undeveloped land tracts north of the Brenntag site, a light industrial business complex to the east, and the ACME brick facility to the west. The facility includes a 2,000 square foot office, a 12,000 square foot warehouse and loading dock, a 1,250 square foot bag storage building, a 2,000 square foot covered acid drum storage area, a 700 square foot storage shed, an inactive tank farm, and an inactive railcar spur. The rail spur enters the site from the north along the eastern property boundary. Past practices of the facility included chemical storage, chemical blending, railcar unloading, drum recycling/reconditioning, and a paint spray booth operation. Caustics, aromatic solvents, acids, ketones, alcohols, glycols, petroleum based hydrocarbons, and chlorinated solvents were handled and stored at the facility. In May 2001, the facility discontinued bulk storage. Presently, the facility only stores and distributes pre-packaged chemical products.

The Brenntag site is located on a topographic high, most of the site slopes gently to the north, with the southernmost portion of the site sloping gently to the south (Figure 1).

8.1.1 Geology

The site is underlain by reddish-brown silts, clays, and residuum which overlay weathered limestone bedrock (Figure 32). The reddish-brown silts and clays show localized variations throughout the site. Discontinuous thin lenses of chert and white crystalline sands of varying thickness are present throughout the site. The soil/residuum becomes firmer with depth, except in the interval immediately above the limestone, where it is weathered and less firm. The soil/residuum thickness varies from approximately 12 to 24 ft on site and up to approximately 30 ft off site to the north, depending on the depth to the irregular limestone bedrock surface.

The Springfield Plateau Aquifer, comprised mostly of fractured, medium crystalline, hard limestone may be up to 285 ft thick in the Springfield area. The Ozark Confining Unit underlies and separates the Springfield Plateau Aquifer from the Ozark Aquifer. The Ozark Confining Unit is leaky confining layer that varies between 20 and 70 ft in thickness beneath the Springfield area. The uppermost geologic formation is the Northview Shale that is also the thickest formation of the confining unit. Beneath the Springfield area the Northview Shale ranges from less than 10 to about 40 ft in thickness.

8.1.2 Hydrogeology

A shallow unconfined water table is present in the soil/residuum and underlying upper limestone bedrock. The groundwater elevations vary seasonally and respond quickly during periods of precipitation. The maximum (highest) groundwater elevations beneath the Brenntag facility range from approximately 0.5 to 5 ft bgs and are as deep as 25 ft bgs in offsite wells to the north. Water levels in the upper bedrock are similar to the water levels in adjacent wells completed in the soil/residuum and indicate that there is no significant vertical gradient between the soil/residuum and the upper bedrock.

The shallow groundwater flow direction beneath the site is generally to the west-northwest reflecting the east-west trending ridge at the surface. The groundwater flow direction may also be influenced by the irregular subsurface bedrock elevation and secondary permeability pathways such as fractures, bedding planes and minor solution features as indicated on the Conceptual Site Model (Figure 32). The locations of site utilities (above ground and buried) are provided on Figure 3b. Buried utilities and piping associated with the HVE system are within the interval of surface to 5 ft bgs. Therefore, backfill materials associated with these trenches are not a likely influence on the shallow groundwater flow direction.

Overall, it appears the permeability within the fine grained soil/residuum and upper bedrock is low, but that secondary features allow flow velocities and VOC travel times significantly higher than anticipated from the lithologic descriptions and hydraulic testing. The weathered upper bedrock is characterized as having localized solution voids within approximately the top 20 ft. Typically, markedly increased drill rates occur when the solution voids are encountered. Returned drill cuttings indicate the presence of a very fine-grained soil (clay and silt) in the voids and an increased production of groundwater. Soil boring logs indicate voids present in the upper bedrock extraction and monitoring wells installed in 2010.

The groundwater flow direction in the deeper limestone bedrock may vary seasonally. Initial potentiometric surface data (3 wells) indicated the groundwater flow direction was generally to the west-southwest. The addition of three deep Springfield Plateau Aquifer wells in 2010 has resulted in an interpreted potentiometric surface and groundwater flow direction more similar to the shallow groundwater conditions. The slow rate of groundwater recovery in the deep wells (SAW-2, and SAW-4 through SAW-8), and the minimal evidence of fracturing or solution voids during deep well installation indicate the hydraulic conductivity of the deeper limestone bedrock is low.

8.2 VOC Source, Occurrence, and Migration

The primary objective of the source characterization was to determine the location of soil source areas in the vadose zone, which are or could have been responsible for the dissolved VOC concentrations in groundwater beneath the Site. Based on the RI activities, two probable soil source areas were identified and delineated. Each of the probable source areas is associated with historic operations and includes:

- Former Bulk Chemical Handling area located between the new tank farm and the warehouse.
- Former Drum Rinse Area located in the area of monitoring well MW-1.

There are two primary classes of VOCs detected at the Site, 1) chlorinated hydrocarbons, typically used as degreasers and resistant to aerobic degradation, and their degradation products and 2) petroleum based hydrocarbons consisting primarily of toluene, ethylbenzene, and xylenes. Also present are ketones, widely used as commercial solvents, volatile, and aerobically degradable.

Concentrations of dissolved VOCs were detected in most site monitoring wells; however, the highest concentrations of VOCs were detected in three primary areas, the Former Bulk Chemical Handling Area, the Former Drum Rinse Area, and an offsite portion of the groundwater plume near MW-17.

As Figure 32 illustrates, chemicals released in the source areas have moved generally vertically by gravity though the soil/residuum until groundwater was encountered. Chemicals dissolved in the groundwater then migrate laterally through the soil/residuum and weathered bedrock zone. Over time, releases of mixed petroleum products and chlorinated solvent have co-mingled into a single groundwater plume that has migrated offsite to the north-northwest approximately 700 ft. The groundwater analytical data suggests that a significant reduction of BTEX and CVOCs has occurred

as a result of the continued operation of the HVE system in conjunction with ongoing active reductive dechlorination.

Dissolved VOCs were detected in deep monitoring well SAW-2. As initially constructed, SAW-2 acted as a conduit for shallow groundwater to migrate vertically downward. Based on the reduction in VOC concentrations observed in SAW-2 since the modification of the well, it is concluded that the VOCs present in SAW-2 migrated vertically via the previously uncased well bore, driven by the downward hydraulic gradient. Thus the vertical transport method at the site has likely been eliminated. Lack of vertical transport of VOCs is further indicated by the trend of decreasing concentrations of total BTEX and total CVOCs detected in the SAW-2 well. The detection of trace VOC concentrations in the SAW-4 through SAW-8 wells also indicate that the influx of shallow groundwater and vertical migration has been eliminated.

9 Summary

A summary of the results obtained during the RI is provided below.

9.1 Site Geology and Hydrogeology

Brenntag operates an active chemical distribution facility that occupies approximately 3.75 acres located on a topographic high area.

The unsaturated zone is comprised of fine grained soil/residuum that is primarily reddish-brown silts and clays with thin lenses of interbedded chert.

The saturated zone is characterized as an unconfined water table present in the soil/residuum and underlying limestone bedrock. Groundwater flow direction in the soil/residuum and upper bedrock appears to mimic the surface topography. The groundwater flow direction may also be influenced by the irregular elevation of the weathered bedrock surface. Secondary permeability pathways may occur locally such as chert zones in the soil/residuum, unconsolidated sediment on the weathered bedrock surface, and bedding planes and solution features within the upper bedrock.

Groundwater withdrawal by means of the HVE system and variation in seasonal precipitation result in a broad range of depth to groundwater beneath the Brenntag facility. An observed rapid rise and markedly high groundwater elevations in wells indicate a high rate of groundwater recharge in the central portion of the facility. Historical groundwater elevations range from approximately 3 ft to 21 ft bgs in this area of the facility. Groundwater elevations measured in both the monitoring wells completed in the soil/residuum and the upper bedrock wells indicate one hydrologic unit exists beneath the site.

The hydraulic gradient of shallow groundwater beneath the Brenntag facility (located in the upland area) is steep and becomes relatively flat beneath the lower surface elevations located on adjacent properties to the north. The predominant groundwater flow direction reflects the general surface topography in that it moves north, west, and south from the central portion of the Brenntag site.

The potentiometric surface for groundwater in the deep portion of the Springfield Plateau Aquifer has an approximate hydraulic gradient of 0.18 ft per foot. The groundwater flow direction is to the west-southwest. The slow rate of groundwater

recovery in the deep Springfield Plateau Aquifer wells, and the lack of fracturing or solution features observed during the well installation indicate the hydraulic conductivity is low.

9.2 Data Usability and Data Limitations

All soil and groundwater samples were analyzed by TA, which in turn submitted analytical reports to ARCADIS. Evaluation of all laboratory analytical data from samples collected during the RI was completed by ARCADIS in accordance with the QAPP. Based on the data validation review, the data has met the project's DQOs and the data is considered usable for the purposes of this RI, the baseline risk assessment, and future FS activities.

9.3 Nature and Extent of Contamination

9.3.1 Soil Source Area Characterization

During the RI field investigations, 38 soil samples were collected for laboratory analysis from 22 source characterization borings. The primary objective of the soil source characterization was to fully characterize potential source areas that were identified in previous environmental investigations and/or were areas where reported releases and historical Site operations may have resulted in a release of VOCs to the surface.

Maximum (highest) historical groundwater elevations measured in monitoring wells located on the Brenntag facility range from approximately 0.5 ft to 5 ft bgs (Figure 17). The RI soil samples were collected from intervals of 0 to 2 ft bgs, 3 to 10 ft bgs, and 15 to 18 ft bgs. Therefore only soil samples from the 0 ft to 2 ft bgs interval represent unsaturated soil.

The detected concentrations of chemicals in the RI soil samples (2002 - 2010) were compared to the USEPA RSLs for tap water. A list was derived to include each chemical that exceeds the soil screening criteria which is then identified as a COPC. The identified COPCs in soil samples aid in the interpretation of potential soil source areas. Comparison of soil sample analytical results with the RSLs was to aid in the screening process and identification of COPCs and not to identify site remediation goals.

Of the 25 VOCs detected in RI soil samples analyzed between 2002 and 2010, three chemicals were detected in concentrations that exceed the RSLs for tap water..

Therefore, for the purpose of the RI screening process, 3 VOCs (ethylbenzene, tetrachloroethene, and 1,2,4-trimethylbenzene) are considered COPCs.

Based on the RI soil sampling results and the soil screening process results, two probable historic soil source areas were identified and delineated. Each of the probable source areas is associated with historic site operation, and/or operational structures. The identified probable soil source areas are the Former Drum Rinse Area and the Former Bulk Chemical Handling Area. The probable source areas and the COPCs at each source area are summarized below:

Probable Soil Source Areas		Chemicals of Potential Concern
Former Drum Rinse Area (combined)	Acid/Caustic and solvent drum rinsing operations	Ethylbenzene, tetrachloroethene (PCE), and 1,2,4-trimethylbenzene
Former Bulk Chemical Handling Area	Blend Tank, Drum Filling Room, Bulk Tank Truck Loading/Unloading, and Drum Filling Area. Includes the underground piping connections outside the drum filling room (associated with the old tank farm)	Ethylbenzene, tetrachloroethene (PCE), and 1,2,4-trimethylbenzene

The two probable soil source areas are in close proximity and have similar COPCs. Therefore, they will be treated as one co-mingled source area for the purpose of discussing groundwater characterization.

9.3.2 Groundwater Characterization

To characterize and delineate the extent of VOCs in the shallow Springfield Plateau Aquifer, samples were collected from 35 shallow monitoring wells during the RI. These include 18 monitoring wells and two former HVE pilot test wells (within the new tank farm) that are located on the Brenntag facility, and 15 monitoring wells located on the adjacent properties. Two of the shallow monitoring wells (SAW-1 and SAW-3) are open-hole completions in the upper bedrock (Table 5).

Monitoring wells SAW-2 and SAW-4 through SAW-8 are completed in the deep portion of the Springfield Plateau Aquifer.

The RI samples collected from the shallow and deep groundwater monitoring wells were analyzed for VOCs. Detected concentrations of VOCs in the RI groundwater samples were compared to the USEPA RSLs for tap water and the federal primary Maximum Contaminant Levels (MCLs) for drinking water. It should be noted that the purpose of comparing groundwater analytical results with the RSLs and MCLs was to aid in the screening process and identification of COPCs used to establish delineation criteria, and not to identify site remediation goals.

The shallow groundwater monitoring well network consists of open boreholes and wells completed to a total depth less than 45 ft bgs with screens of varying lengths that are completed across:

- Only the overlying soil/residuum from approximately 13 to 23 ft bgs (Onsite Wells MW-1 through MW-13, EW-1N, and EW-2S).
- The soil/residuum and the upper bedrock sequence from approximately 19 to 44 ft bgs (Offsite Wells MW-14 through MW-27).
- Only the upper bedrock sequence from approximately 20 to 45 ft bgs (Open Boreholes SAW-1 and SAW-3, and Wells MW-28B through MW-31B).

Analytical results obtained during the RI groundwater sampling events indicate the highest COPC concentrations were detected within the shallow portion of the Springfield Plateau Aquifer. A total of 48 VOCs were detected in the shallow groundwater samples collected from monitoring wells during the RI (2008 – 2010). Of the 48 VOCs detected in shallow groundwater samples, 27 chemicals were detected in concentrations that exceed the RSLs for tap water. However, only 10 chemicals were detected in concentrations that exceed their applicable federal primary MCLs. Based on the RI analytical data comparison to RSL tap water values, 27 chemicals are considered COPCs in the shallow groundwater samples.

Groundwater samples were collected from six monitoring wells screened in the deep portion of the Springfield Plateau Aquifer. A total of 17 VOCs were detected in the groundwater samples collected from the deep Springfield Plateau Aquifer during the RI. Twelve of the VOCs were detected in concentrations that exceed the RSLs tap water. However, only five chemicals were detected in concentrations that exceed the Federal MCLs. Based on the RI analytical data comparison to RSL tap water values, 12 VOCs are considered COPCs in the deep Springfield Plateau Aquifer groundwater.

Each of the 12 COPCs with concentrations that exceed RSLs for tap water were detected in the SAW-2 groundwater samples. Surrounding deep Springfield Plateau

Aquifer Wells (SAW-4 through SAW-9) generally reported VOC concentrations below the sample detection limit (i.e. non-detect) or were detected at concentrations below applicable screening levels. Note that 11 of the 12 COPCs identified in the SAW-2 groundwater sample collected during the RI were also identified as COPCs in the Shallow Springfield Plateau Aquifer groundwater samples. One additional VOC (1,2-dibrom-3-chloropropane) was detected in the deep portion of the Springfield Plateau Aquifer.

As a result of the comparison of the shallow and deep groundwater results to the screening criteria of RSLs in tap water and MCLs, 28 VOCs were considered to be COPCs and are summarized below.

Summary of COPCs in RI Groundwater Samples				
	Shallow		Deep	
Analyte Detected	Exceeds RSLs Tap Water	Exceeds MCLs	Exceeds RSLs Tap Water	Exceeds MCLs
Benzene	X	X	X	X
Bromodichloromethane	X		X	
n-Butylbenzene	X	NA		
sec-Butylbenzene	X	NA		
tert-Butylbenzene	X	NA		
Carbon Tetrachloride	X			
Chloroform	X	X		
1,2-Dibromo-3-chloropropane			X	X
1,4-Dichlorobenzene			X	
1,1-Dichloroethane	X	NA	X	NA
1,2-Dichloroethane	X	X	X	
cis-1,2-Dicchloroethene	X	X		
1,2-Dichloropropane	X			
Ethylbenzene	X		X	
2-Hexanone	X	NA		
Methylene Chloride	X	X		

(Cont.)

Summary of COPCs in RI Groundwater Samples				
	Shallow		Deep	
Analyte Detected	**Exceeds RSLs Tap Water**	**Exceeds MCLs**	**Exceeds RSLs Tap Water**	**Exceeds MCLs**
Naphthalene	X		X	
1,1,1,2-Tetrachloroethane	X			
1,1,2,2-Tetrachloroethane	X	NA		
Tetrachloroethene (PCE)	X	X		
Toluene	X	X		
1,1,2-Trichlorethane	X	X		
Trichloroethene (TCE)	X	X		
1,2,3-Trichlorpropane	X	NA		
1,2,4-Trimethylbenzene	X	NA	X	NA
1,3,5-Trimethylbenzene	X	NA	X	
Vinyl Chloride	X	X	X	X
Xylenes, *(total)*	X		X	

NA = No Assigned MCL; RSL = Regional Screening Level

With the exception of 2-hexanone, the COPCs identified in shallow and deep groundwater samples collected during the RI fall into one of the two following categories:

- **Petroleum Based Hydrocarbons**: Ten COPCs were identified including benzene, n-butylbenzene, sec-butylbenzene, tert-butylbenzene, ethylbenzene, naphthalene, toluene, 1,2,4-trimethylbenzene (Figure 24), 1,3,5-trimethylbenzene (Figure 25), and xylenes. The total BTEX concentrations detected in shallow and deep groundwater samples are shown on Figure 22.

- **Chlorinated Solvents and Degradation Products**: Seventeen COPCs were identified including tetrachloroethene (Figure 26), trichloroethene (Figure 27) carbon tetrachloride, chloroform, 1,1-dichloroethane (Figure 29), 1,2-dichlorethane (Figure 30), cis-1,2-dichloroethene (Figure 28), methylene chloride, 1,1,1,2-tetrachloroethane, 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, and vinyl chloride (Figure 31). Other detected chlorinated COPCs include bromodichloromethane, 1,2-dibromo-3-chloropropane, 1,4-dichlorobenzne, 1,2-dichloropropane, and 1,2,3-trichloropropane.

Two areas were identified onsite with elevated concentrations of dissolved phase VOCs in groundwater. These areas include the Former Drum Rinse Area and the Former Bulk Chemical Handling Area. These areas of impacted shallow groundwater are in close proximity to each other and have co-mingled. Concentrations of COPCs decrease significantly away from the soil source areas to the adjacent property north of the Brenntag facility. Impacted groundwater within the shallow Springfield Plateau Aquifer has migrated offsite to the north as indicated by the presence of VOCs in Well MW-17. Dissolved VOCs have migrated downgradient (north) from the soil source areas a distance of approximately 700 ft.

9.3.3 Interim Removal Action Plan Activities

An IRAP was implemented with the installation of a dual-phase HVE system in July 1999. The HVE system consists of five major components: 1) four groups of HVE wells referred herein as units; 2) dual phase HVE equipment; 3) a groundwater aeration treatment system; 4) a granular activated carbon polish, and 5) a permitted outfall to the publicly owned treatment works (POTW) via the sanitary sewer.

Additional RI activities were conducted based on results of the IRAP system monitoring results. Presently, the interim HVE system is comprised of 57 dual-phase HVE wells. These additional activities included the recompletion of select HVE wells in the upper bedrock, installation of new HVE wells, the implementation of an Enhanced Reductive Dechlorination (ERD) pilot test, and installation of upper bedrock monitoring wells.

Pumping and bailing of the SAW-2 has been conducted between 2002 and 2010 to evaluate the apparent downward vertical migration of shallow impacted groundwater in the open borehole prior to recompletion of the well. As of August 2010, approximately 3,044 gallons of impacted groundwater have been removed from the deep Springfield Plateau Aquifer at the SAW-2 location.

The objective of the initial ERD pilot test in 2005 was to assess the feasibility of enhancing the ongoing reductive dechlorination of VOCs in the vicinity of the Former Drum Rinse Area. In general, the results of the pilot test indicated that the ongoing reductive dechlorination could be effectively enhanced through the injection of a carbon source. As a result, an expanded ERD pilot test was initiated in March 2007 and conducted through March of 2008. Based on the results of pilot testing, conclusions were drawn regarding the implementation of ERD to address site impacts of chlorinated VOCs in groundwater:

- Results indicate that the ongoing reductive dechlorination can be further enhanced through the addition of a carbon source.

- The presence of dissolved gases in groundwater, such as methane, ethene, and ethane, which are the final reductive dechlorination products of chlorinated VOCs, are consistent with the reductive process being driven to completion.

- Due to the presence of secondary permeability pathways, mainly bedding planes, chert zones, and solution features, uniform delivery of carbon through the use of traditional vertical wells will be problematic.

- The results of the pilot test indicate distribution of organic carbon and accompanying reductive dechlorination does occur in the subsurface once the carbon source is injected.

- Enhancing and sustaining an accelerated rate of dechlorination will be dependent upon designing and implementing a more carbon delivery method that will uniformly distribute carbon in the impacted areas.

- Based on the results of the long term pilot test, ERD is an appropriate approach to remediate dissolved CVOCs at the Site, however, delivery systems other than vertical injection wells will be evaluated prior to full-scale implementation.

9.3.4 Soil Vapor Survey

A soil vapor survey was conducted at the northern exterior walls of the Brenntag warehouse and the office building in April 2007. Soil vapor samples were collected by means of tubing inserted through hydraulic push probe rods driven to a depth of 5 ft bgs. The rods were pulled up to a depth of 4 ft bgs before the samples were collected. The soil vapor samples were submitted for laboratory analysis of selected VOCs by USEPA Method TO-15.

Reportedly, historical site operations included utilization of a transfer pump that was located outside at the northwest corner of the warehouse. The pump transported chemical between the tank farm and the former drum filling room located within the northwest corner of the warehouse. A high concentration of toluene was detected in a soil vapor sample obtained from the same location of the former transfer pump. Based on the analytical results of the soil vapor survey, four sub-slab vapor samples were proposed at locations within the warehouse.

9.3.5 Sub-slab Vapor Survey

The potential for VOCs in sub-slab vapor was investigated in June 2007. Four sub-slab vapor samples were collected in the vicinity of the warehouse office and the former drum filling room at the northwest corner of the warehouse. The sub-slab vapor samples and a duplicate were submitted for laboratory analysis of selected VOCs by USEPA Method TO-15.

With the exception of trichloroethene, 1,3,5-trimethylbenzene and 1,2,4-trimethylbenzene detected in SSV-7, all constituent concentrations detected in the five sub-slab vapor samples were less than the 1×10^{-4} target risk level, indicating acceptable risk. The sub-slab vapor concentrations of 1,3,5-trimethylbenzene and 1,2,4-trimethylbenzene exceed the screening levels. However, even though these concentrations exceed the screening levels, it does not mean that there is a potential risk to workers in the building. Although chemicals were detected in the sub-slab vapor samples, it is unlikely that ambient air quality in the warehouse would be impacted. The visible building slab appears to be intact with no apparent cracks or floor drains that could act as a conduit for sub-slab vapors to migrate into the building. Also, there are large loading dock access doors open most of the year and circulation of ambient air with indoor air is likely to be significant, thereby reducing the potential sub-slab vapors to migrate into the warehouse.

9.3.6 Sub-slab Vapor Extraction Testing and System Installation

Based on the results of the soil vapor survey, the potential does exist for vapors from impacted groundwater to migrate vertically and accumulate beneath the warehouse slab. Therefore, as an interim remedial measure, a permanent sub-slab venting system was installed to mitigate any potential vapor migration to the building slab from the underlying groundwater. A sub-slab vapor extraction pilot test was conducted in January 2008. Results of the test were utilized for the design and installation of a vacuum extraction system to address the presence of VOCs detected in sub-slab vapor as an interim remedial measure.

Implementation of a SSVE system in November 2009 achieved two principle goals, 1) control the potential migration of vapors from the below the building slab in the area of principle concern (the warehouse office), and 2) removal of sub-slab vapors in the area with the highest VOC impacts (the west end of the warm room). The SSVE system is located in the northwest portion of the warehouse and is independent of the soil and groundwater HVE system (Figure 19). As a result of the SSVE system installation,

exposure to VOC vapors migrating into the warehouse from underlying impacted media is considered an incomplete pathway.

9.3.7 Hydraulic Testing

Conclusions based on the hydraulic test results indicate the Site is hydrogeologically complex due to the variability of the bedrock surface and the presence of secondary permeability features (sediment filled solution voids, bedding planes, etc.). In addition, the hydraulic testing was conducted in a manner to maximize hydraulic response in order evaluate the effectiveness of a hydraulic control strategy. Calculations indicate that a capture width for E47B exceeds 100 ft. These results indicate that the existing spacing of remediation wells at the downgradient property boundary is adequate to achieve hydraulic control. However, it is recommended that additional boundary control wells be completed into the upper bedrock to 1) maximize drawdown and 2) maximize the potential for intersecting secondary permeability features.

9.4 Risk Assessment

The HHRA quantified potential risks and hazards associated with chemicals detected in soil and groundwater at the Site. In addition, potential exposure to indoor air via vapor intrusion from groundwater was also evaluated using the vapor intrusion model and site-specific soil-gas and sub-slab vapor data.

For the purposes of the HHRA, the COPCs were selected by: 1) evaluating the sample data collected at the Site, and 2) comparing the maximum detected chemical concentrations in each medium to health-based screening levels. USEPA Regional Screening Levels for tap water and residential soil were used as the screening levels for groundwater and soil, respectively. Chemicals detected at concentrations greater than the RSLs were identified as COPCs.

A conceptual site exposure model was then developed which identified potential receptors as well as characterization of potentially complete or incomplete exposure pathways. The next step of the exposure assessment was to assemble exposure factors for each of the exposure scenarios developed and calculate the exposure point concentration. Exposure factors representing the reasonable maximum exposure were used in the HHRA.

The human toxicity assessment was performed in order to identify numerical toxicity criteria with which to assess human health exposures. Using the human exposure and toxicity information, potential human health risks for each COPC and selected

exposure pathway were then evaluated. Upper-bound excess lifetime cancer risks and non-cancer hazards were quantified. In addition, cumulative risks and hazard indices were estimated by summing the upper-bound excess lifetime cancer risks or hazards across exposure pathways for individual receptors.

The following summarizes the cumulative ELCR and HIs for each of the receptors evaluated in the HHRA. The risks and hazards shown below are cumulative for each exposure scenario, summed across all COPCs, media, and exposure routes.

Receptor	Exposure Media	ELCR	HI
Future Site Worker	Surface soil, groundwater, indoor air	3×10^{-2}	128
Potential Current Offsite Worker	Indoor air	1×10^{-6}	0.2
Hypothetical Future Resident	Surface soil, groundwater, indoor air	2×10^{-1}	1063

ELCR Excess lifetime cancer risk; HI Hazard index.

ELCR for the potential current offsite worker receptor is within the USEPA target risk range and the calculated cumulative HI is less than 1. USEPA (1991a) guidance on the Role of Risk Assessment in Superfund Remedy Selection Decisions states that, “where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4} and the non-carcinogenic hazard quotient is less than 1, action generally is not warranted unless there are adverse environmental impacts.”

The calculated ELCRs for future site worker (ELCR = 3×10^{-2}) and future resident (ELCR = 2×10^{-1}) exposure to soil and groundwater are greater than the USEPA target risk of $10^{-4.}$ In addition, the cumulative HIs for a future site worker (HI = 128), and a future resident (HI = 1063) are greater than the benchmark of 1.

Therefore, COCs are identified for each medium of concern. For exposure pathways with a calculated ELCR greater than the USEPA target risk range or a cumulative HI greater than 1, the COCs are identified as individual COPCs resulting in an ELCR exceeding the 10^{-6} level and for non-cancer endpoints, chemicals contributing to the HI greater than 1. The following COCs have been identified by medium:

- Soil: 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene.

- Groundwater: benzene, bromodichloromethane, carbon tetrachloride, chloroform, 1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichloroethane, cis-1,2-dichloroethene, 1,2-dichloropropane, ethylbenzene, methylene chloride, naphthalene, 1,1,1,2-tetrachloroethane, 1,1,2,2-tetrachloroethane, tetrachloroethene, toluene, 1,1,2-trichloroethane, trichloroethene, 1,2,3-trichloropropane, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, vinyl chloride, and xylenes (total).

9.5 Conceptual Site Model

Based on the historical and RI data, a Conceptual Site Model was developed to characterize the source, occurrence, distribution, and migration path of VOCs at the Site (Figure 32).

Two probable soil source areas were identified and delineated. Each of the probable source areas is associated with historic operations and includes:

- Former Bulk Chemical Handling area located between the new tank farm and the warehouse;
- Former Drum Rinse Area located in the area of monitoring well MW-1.

There are primarily two classes of VOCs detected at the Site, 1) chlorinated hydrocarbons, typically used as degreasers and resistant to aerobic degradation, and their degradation products, and 2) petroleum based hydrocarbons consisting primarily of toluene, ethylbenzene, and xylenes. Also present are ketones, widely used as commercial solvents, volatile and aerobically degradable,

VOCs released from the source areas have moved generally vertically by gravity though the soil/residuum until groundwater was encountered. Chemicals are then dissolved in the groundwater and migrate laterally through the soil/residuum and weathered bedrock zone. Over time, releases of mixed petroleum products and chlorinated solvent have co-mingled into a single groundwater plume that has migrated offsite to the north-northwest approximately 700 ft. The groundwater analytical data suggests that a significant reduction of BTEX and CVOCs has occurred as a result of the continued operation of the HVE system in conjunction with ongoing active reductive dechlorination.

As initially constructed, SAW-2 acted as a conduit for shallow groundwater to migrate vertically downward. Based on the reduction in VOC concentrations observed in SAW-2 since the recompletion of the well, it is concluded that the VOCs present in SAW-2

migrated vertically via the previously uncased well bore, driven by the downward hydraulic gradient. Thus the vertical transport method for the VOC's has been eliminated. The detection of only trace VOC concentrations in Wells SAW-4 through SAW-8 is further evidence that the influx of impacted shallow groundwater and vertical migration has been eliminated.

10 Conclusions and Recommendations

Based on the findings of the RI, the following major conclusions and associated recommendations can be made:

1. The objectives of addressing data gaps from previous investigations and completing the delineation of impacted soil and groundwater have been achieved for this RI. Therefore, the RI is considered complete and further characterization is not deemed necessary.

2. The soil source areas have been adequately identified for the purpose of conducting a FS.

3. The shallow and deep groundwater COPCs have been adequately delineated for the purpose of conducting a FS.

4. Groundwater data provides strong evidence that anaerobic degradation and reductive dechlorination of VOCs is occurring within the groundwater plume beneath the Site. In addition, ERD pilot test results indicate that the ongoing reductive dechlorination can be further enhanced through the injection of carbon.

5. The objectives of the interim removal measures were to 1) remove the VOCs from unsaturated soils and the dewatered smear zone through vapor extraction, 2) reduce the overall mass of VOCs from the groundwater by extraction and treatment, 3) to prohibit the vertical migration of VOCs, and 4) provide hydraulic control to mitigate impacted groundwater from migrating offsite. In general, the objectives of the interim removal action have been achieved. Modifications to the dual-phase HVE system will be evaluated in the FS.

6. The results of the Human Health Risk Assessment indicated that no unacceptable risk to any current exposure scenarios exists. However, unacceptable risks for the hypothetical future resident and hypothetical future site worker scenarios were identified. Although, it is highly unlikely that the Site will be used for residential purposes in the future.

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Table 1. Summary of Chemicals Detected in Soil Samples, 2007- 2010,
Brenntag HCI/Chemtech, 2235 W. Battlefield Rd., Springfield, Missouri.

Chemical Name	Minimum Detected Value (mg/kg)	Maximum Detected Value (mg/kg)	Sample ID of Maximum Detected Value	Frequency of Detection
Acetone	0.052	0.32	GP-29-2(2/26/2007)	5/17
Benzene	0.0036	0.0036	GP-29-2(2/26/2007)	1/17
2-Butanone	0.0066	0.013	GP-28-1(2/26/2007)	2/17
n-Butylbenzene	1.1	1.1	GP-29-2(2/26/2007)	1/17
Chloroform	0.00034	0.0011	GP-33-1(2/26/2007)	2/17
1,2-Dichlorobenzene	0.016	0.016	GP-29-2(2/26/2007)	1/17
1,1-Dichloroethane	0.00024	0.22	GP-29-2(2/26/2007)	2/17
1,1-Dichloroethene	0.0036	0.0036	GP-29-2(2/26/2007)	1/17
cis-1,2-Dichloroethene	0.00072	0.13	GP-29-2(2/26/2007)	5/17
1,2-Dichloropropane	0.032	0.032	GP-29-2(2/26/2007)	1/17
Ethylbenzene	0.0054	88	GP-23-1.5(2/26/2007)	3/17
Isopropylbenzene (Cumene)	0.02	63	GP-23-1.5(2/26/2007)	3/17
p-Isopropyltoluene	0.0025	0.22	GP-29-2(2/26/2007)	3/17
Naphthalene	0.00065	1.7	GP-29-2(2/26/2007)	5/17
n-Propylbenzene	0.038	140	GP-23-1.5(2/26/2007)	3/17
Tetrachloroethene (PCE)	0.00073	3.4	GP-23-1.5(2/26/2007)	13/17
Toluene	0.00093	120	GP-23-1.5(2/26/2007)	4/17
1,1,1-Trichloroethane	0.29	0.29	GP-29-2(2/26/2007)	1/17
Trichloroethene (TCE)	0.00024	0.22	GP-23-1.5(2/26/2007)	8/17
1,2,4-Trimethylbenzene	0.00064	520	GP-23-1.5(2/26/2007)	7/17
1,3,5-Trimethylbenzene	0.029	340	GP-23-1.5(2/26/2007)	3/17
m&p-Xylene	0.001	420	GP-23-1.5(2/26/2007)	8/17
o-Xylene	0.004	110	GP-23-1.5(2/26/2007)	3/17
Xylenes (total)	0.00062	520	GP-23-1.5(2/26/2007)	10/17

mg/kg – milligrams per kilogram

Table 2. Summary of Chemicals Detected in Groundwater Samples, 2008 - 2010,
Brenntag HCI/Chemtech, 2235 W. Battlefield Rd., Springfield, Missouri.

Chemical Name	Minimum Detected Value (mg/L)	Maximum Detected Value (mg/L)	Sample ID of Maximum Detected Value	Frequency of Detection
Volatile Organic Compounds				
Acetone	0.0024	0.16	MW-4(2/2/2010)	22/219
Benzene	0.00026	0.036	SAW-1(2/4/2010)	99/219
Bromodichloromethane	0.00035	0.0049	MW-27(5/12/2010)	3/219
2-Butanone	0.0019	0.014	SAW-1(2/4/2010)	5/219
n-Butylbenzene	0.00021	0.11	MW-3(2/3/2009)	40/219
sec-Butylbenzene	0.00022	0.033	MW-4(8/18/2009)	58/219
tert-Butylbenzene	0.00016	0.0024	MW-9(8/5/2010)	21/219
Carbon Tetrachloride	0.00022	0.00055	MW-8(2/4/2009)	3/219
Chlorobenzene	0.00018	0.0004	MW-9(11/5/2008)	7/219
Chloroethane	0.00052	0.31	MW-17(11/5/2008)	94/219
Chloroform	0.0002	0.18	MW-27(5/12/2010)	44/219
Chloromethane	0.00032	0.00032	MW-12(2/2/2010)	1/219
1,2-Dichlorobenzene	0.00015	0.0045	SAW-1(8/5/2010)	36/219
1,3-Dichlorobenzene	0.00056	0.00056	SAW-1(5/12/2010)	1/219
1,4-Dichlorobenzene	0.00016	0.00064	SAW-1(8/5/2010)	18/219
1,1-Dichloroethane	0.00017	0.12	MW-5(11/17/2009;2/3/2010)	168/219
1,2-Dichloroethane	0.00017	0.0095	MW-5(2/3/2010)	51/219
1,1-Dichloroethene	0.00015	0.11	MW-28B(5/12/2010)	61/219
cis-1,2-Dichloroethene	0.00016	3.2	MW-28B(5/12/2010)	149/219
trans-1,2-Dichloroethene	0.00019	0.037	SAW-1(5/6/2009)	65/219
1,2-Dichloropropane	0.00016	0.0017	MW-6(2/3/2010)	4/219
trans-1,3-Dichloropropene	0.00043	0.00043	MW-6(2/4/2009)	1/219
Ethylbenzene	0.00018	0.6	MW-17(11/5/2008)	87/219
2-Hexanone	0.0054	0.11	MW-17(5/5/2009)	6/219
Isopropylbenzene (Cumene)	0.00023	0.36	MW-4(2/3/2009)	100/219
p-Isopropyltoluene	0.00019	0.056	MW-4(2/2/2010)	35/219
4-Methyl-2-pentanone (MIBK)	0.0031	0.0031	MW-6(2/4/2009)	1/219
Methylene Chloride	0.00034	0.17	MW-1(11/17/2009)	20/219
Naphthalene	0.00023	0.052	MW-17(11/5/2008)	75/219
n-Propylbenzene	0.00017	0.55	MW-4(2/3/2009)	70/219
Styrene	0.00022	0.026	MW-17(2/4/2009)	12/219
1,1,1,2-Tetrachloroethane	0.037	0.056	MW-1(8/18/2009)	4/219
1,1,2,2-Tetrachloroethane	0.00021	0.003	MW-8(5/7/2009)	3/219
Tetrachloroethene (PCE)	0.00021	93	MW-1(5/12/2010)	73/219
Toluene	0.00017	8	MW-17(8/4/2010)	78/219
1,2,3-Trichlorobenzene	0.00018	0.00091	MW-4(2/3/2009)	3/219
1,2,4-Trichlorobenzene	0.00039	0.0017	MW-4(2/3/2009)	2/219
1,1,1-Trichloroethane	0.00025	0.0018	MW-6(2/4/2009)	3/219
1,1,2-Trichloroethane	0.00038	0.11	MW-1(2/2/2010)	20/219
Trichloroethene (TCE)	0.00017	8.3	MW-31B(5/12/2010)	106/219
Trichlorofluoromethane	0.00029	0.00037	MW-14(2/4/2009)	2/219
1,2,3-Trichloropropane	0.0012	0.0012	MW-13(5/13/2010)	1/219
1,2,4-Trimethylbenzene	0.00015	1.3	MW-4(2/3/2009)	85/219
1,3,5-Trimethylbenzene	0.0002	4	MW-4(5/6/2009)	61/219
Vinyl Chloride	0.00041	1.1	MW-1(5/6/2009)	67/219
m&p-Xylene	0.00036	5.4	MW-17(11/5/2008)	81/219
o-Xylene	0.00023	1.8	MW-17(11/5/2008)	67/219
Xylenes (total)	0.00024	7.2	MW-17(11/5/2008)	93/219

mg/L - milligrams per liter

Table 3. Summary of VOCs Detected in Soil Samples, May 1992,
Brenntag HCI/Chemtech, 2235 W. Battlefield Rd., Springfield, Missouri.

Well / Boring Name	TMW1-1	TMW1-3	B-2	TMW-3	TMW-4
Sample Depth ft bgs	1	3			
Sample Date	5/1/92	5/1/92	5/1/92	5/1/92	5/1/92
	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Acetone					
Benzene					
Bromobenzene					
Bromochloromethane					
Bromodichloromethane					
Bromoform					
Bromomethane					
2-Butanone (MEK)					
n-Butylbenzene					
sec-Butylbenzene					
tert-Butylbenzene					
Carbon Tetrachloride					
Chlorobenzene					
Chloroethane					
Chloroform					
Chloromethane					
2-Chlorotoluene					
4-Chlorotoluene					
Dibromochloromethane					
1,2-Dibromo-3-chloropropane					
1,2-Dibromoethane (EDB)					
Dibromomethane					
1,2-Dichlorobenzene					
1,3-Dichlorobenzene					
1,4-Dichlorobenzene					
Dichlorodifluoromethane					
1,1-Dichloroethane	**130**	**250**	<	<	<
1,2-Dichloroethane	<	**87**	<	<	<
1,1-Dichloroethene	**44**	**17000**	<	<	<
cis-1,2-Dichloroethene					
trans-1,2-Dichloroethene					
1,2-Dichloroethene (total)					
1,2-Dichloropropane					
1,3-Dichloropropane					
2,2-Dichloropropane					
1,1-Dichloropropene					
cis-1,3-Dichloropropene					
trans-1,3-Dichloropropene					
Ethylbenzene	**660**	**64000**	<	**110**	<
Hexachlorobutadiene					
2-Hexanone					
Isopropylbenzene (Cumene)					
p-Isopropyltoluene					
4-Methyl-2-pentanone (MIBK)					
Methylene Chloride	**5600**	**15000**	**62**	**26**	**27**
Naphthalene					
n-Propylbenzene					
Styrene					
1,1,1,2-Tetrachloroethane					
1,1,2,2-Tetrachloroethane					
Tetrachloroethene (PCE)	**17**	**8500**	<	<	<
Toluene	**1100**	**150000**	<	<	<
1,2,3-Trichlorobenzene					
1,2,4-Trichlorobenzene					
1,1,1-Trichloroethane	**930**	**41000**	**25**	**17**	<
1,1,2-Trichloroethane					
Trichloroethene (TCE)	**49**	**1600**	<	<	**2000**
Trichlorofluoromethane					
1,2,3-Trichloropropane					
1,2,4-Trimethylbenzene					
1,3,5-Trimethylbenzene					
Vinyl Chloride					
m&p-Xylene					
o-Xylene					
Xylenes (total)	**4600**	**390000**	<	**1400**	<
Total VOCs	**13,130**	**687,437**	**87**	**1,553**	**2,027**
Total Chlorinated VOCs	**6,770**	**83,437**	**87**	**43**	**2,027**
Total BTEX	**6,360**	**604,000**	0	**1,510**	0

Table 4. Summary of VOCs Detected in Groundwater Samples Collected from Temporary Monitoring Wells, May 1992, Brenntag HCI/Chemtech, 2235 W. Battlefield Rd., Springfield, Missouri

Sample Name Boring Location Sample Date	CALM (ug/L)	MCLs (ug/L)	TMW-1 Near MW-6 5/1/92 (ug/L)	TMW-3 Near MW-4 5/1/92 (ug/L)	TMW-4 Near MW-9 5/1/92 (ug/L)
Acetone	4,000	-			
Benzene	5	5			
Bromobenzene	-	-			
Bromochloromethane	-	-			
Bromodichloromethane	80	-			
Bromoform	-	-			
Bromomethane	-	-			
2-Butanone (MEK)	-	-			
n-Butylbenzene	-	-			
sec-Butylbenzene	-	-			
tert-Butylbenzene	-	-			
Carbon Tetrachloride	-	5			
Chlorobenzene	100	100			
Chloroethane	-	-			
Chloroform	80				
Chloromethane	-	-			
2-Chlorotoluene	-	-			
4-Chlorotoluene	-	-			
Dibromochloromethane	-	-			
1,2-Dibromo-3-chloropropane	-	-			
1,2-Dibromoethane (EDB)	-	-			
Dibromomethane	-	5			
1,2-Dichlorobenzene	600	600			
1,3-Dichlorobenzene	-	-			
1,4-Dichlorobenzene	75	75			
Dichlorodifluoromethane	-	-			
1,1-Dichloroethane	-	-	**1300**	**200**	**18**
1,2-Dichloroethane	5	5	**670**	<10	**34**
1,1-Dichloroethene	7	7	**12000**	**100**	<
cis-1,2-Dichloroethene	70	70			
trans-1,2-Dichloroethene	100	100			
1,2-Dichloroethene (total)	-	-			
1,2-Dichloropropane	5	5			
1,3-Dichloropropane	-	-			
2,2-Dichloropropane	-	-			
1,1-Dichloropropene	-	-			
cis-1,3-Dichloropropene	-	-			
trans-1,3-Dichloropropene	-	-			
Ethylbenzene	700	700	**610,000**	**620**	**580**
Hexachlorobutadiene	-	-			
2-Hexanone	-	-			
Isopropylbenzene (Cumene)	-	-			
p-Isopropyltoluene	-	-			
4-Methyl-2-pentanone (MIBK)	-	-			
Methylene Chloride	5	5			
Naphthalene	20	-			
n-Propylbenzene	-	-			
Styrene	-	100			
1,1,1,2-Tetrachloroethane	-	-			
1,1,2,2-Tetrachloroethane	-	-			
Tetrachloroethene (PCE)	5	5	**430**	<	**1.5**
Toluene	150	1,000	**1,500,000**	**4700**	**1800**
1,2,3-Trichlorobenzene	-	-			
1,2,4-Trichlorobenzene	-	70			
1,1,1-Trichloroethane	200	200	**27,000**	**84**	**7.6**
1,1,2-Trichloroethane	-	5			
Trichloroethene (TCE)	5	5	**520**	<	**640**
Trichlorofluoromethane	-	-			
1,2,3-Trichloropropane	-	-			
1,2,4-Trimethylbenzene	-	-			
1,3,5-Trimethylbenzene	-	-			
Vinyl Chloride	2	2			
m&p-Xylene	-	-			
o-Xylene	-	-			
Xylenes (total)	320	1,000	**3,700,000**	**5300**	**1100**
Total VOCs			**5,851,920**	**11,004**	**4,181**
Total Chlorinated VOCs			**41,920**	**384**	**701**
Total BTEX			**5,810,000**	**10,620**	**3,480**

Table 5. Well Completion Summary,
Brenntag/HCI Chemtech, 2235 W. Battlefield Rd., Springfield, Missouri.

Well Name	Date Installed	Well Material	Top of Vault/Ground (ft amsl)	Top of Casing (ft amsl)	Well Diameter (inches)	Bentonite Interval (ft bgs)	Top of Screen (ft bgs)	Bottom of Screen (ft bgs)	Top of Screen (ft amsl)	Bottom of Screen (ft amsl)	Screen Size (inches)	Borehole Diameter (inches)	Boring Depth (ft bgs)	Top of Bedrock (ft bgs)	Top of Bedrock (ft amsl)
Shallow Springfield Plateau Aquifer Monitoring Wells															
MW-1	5/31/95	SS	1289.26	1288.84	2	7-10	12.2	22.2	1277.06	1267.06	0.010	6	22.5	22.5	1266.8
MW-2	5/31/95	SS	1288.91	1288.39	2	4-6.2	8.2	18.2	1280.71	1270.71	0.010	6	19.5	19.5	1269.4
MW-3	6/1/95	SS	1288.58	1287.85	2	2-4.7	6.7	16.7	1281.88	1271.88	0.010	6	17	17.3	1271.3
MW-4	6/1/95	SS	1287.78	1288.29	2	1-3.5	4.6	14.6	1283.18	1273.18	0.010	6	14.9	14.3	1273.5
MW-5	6/1/95	SS	1289.22	1288.49	2	3.5-6.5	8.5	18.5	1280.72	1270.72	0.010	6	18.8	18.8	1270.4
MW-6	6/1/95	SS	1288.97	1288.73	2	0.5-3.5	5	15	1283.97	1273.97	0.010	6	15.3	15.3	1273.7
MW-7	7/15/99	PVC	1289.02	1291.96	2	2.5-4	5	20	1284.02	1269.02	0.020	8	20	19.7	1269.3
MW-8	7/14/99	PVC	1288.89	1288.56	2	1.25-2.5	3.5	16	1285.39	1272.89	0.020	8	16	15.6	1273.3
MW-9	7/15/99	PVC	1288.89	1288.39	2	3-6.5	8	23	1280.89	1265.89	0.020	8	23.5	23	1265.9
MW-10	7/15/99	PVC	1288.59	1288.07	2	2.5-4	5	20	1283.59	1268.59	0.020	8	20	20	1268.6
MW-11	7/14/99	PVC	1288.09	1290.79	2	2.5-4	4	19	1284.09	1269.09	0.020	8	19	19	1269.1
MW-12	7/14/99	PVC	1287.92	1291.03	2	2.5-4	4.75	19.75	1283.17	1268.17	0.020	8	19	19.75	1268.2
MW-13	7/15/99	PVC	1284.23	1283.63	2	1.25-2.25	3	13	1281.23	1271.23	0.020	8	13	12	1272.2
MW-14	9/10/02	PVC	1286.01	1285.63	2	5-8	10	45	1276.01	1241.01	0.020	6	45.5	21	1265.0
MW-15	9/10/02	PVC	1288.55	1287.93	2	7-10	8.5	43.5	1280.05	1245.05	0.020	6	45.5	12.5	1276.1
MW-16	9/11/02	PVC	1277.69	1277.17	2	7-10	9.5	44.5	1268.19	1233.19	0.020	6	45	28.5	1249.2
MW-17	9/11/02	PVC	1277.38	1276.89	2	7-10	10	45	1267.38	1232.38	0.020	6	45	29	1248.4
MW-18	9/11/02	PVC	1287.72	1287.71	2	7-10	10	45	1277.72	1242.72	0.020	6	45.6	14.5	1273.2
MW-19	4/28/05	PVC	1275.56	1275.35	2	2-12	15	45	1260.56	1230.56	0.010	6	45.5	27.5	1248.1
MW-20	4/28/05	PVC	1276.82	1276.41	2	2-19	20.5	40.5	1256.32	1236.32	0.010	6	41	29	1247.8
MW-21	3/15/07	PVC	1285.08	1284.74	2	1-13	14.8	44.8	1270.28	1240.28	0.010	6	44.8	23	1262.1
MW-22	3/16/07	PVC	1272.67	1272.14	2	1-9	10.5	40.5	1262.17	1232.17	0.010	6	40.5	7	1265.7
MW-23	5/21/07	PVC	1282.86	1282.59	2	1-11	14.2	44.2	1268.66	1238.66	0.010	6	45	20	1262.9
MW-24	5/22/07	PVC	1265.81	1265.20	2	1-9	10.5	40.5	1255.31	1225.31	0.010	6	40.5	20	1245.8
MW-25	4/26/10	PVC	1277.97	1277.54	2	2-8	10	40	1267.97	1237.97	0.010	6	40.5	13	1265.0
MW-26	4/23/10	PVC	1280.84	1280.25	2	2-12.5	15	45	1265.84	1235.84	0.010	6	45.5	23	1257.8
MW-27	4/20/10	PVC	1287.80	1287.41	2	3-8	10	45	1277.80	1242.80	0.010	6	46	13	1274.8
MW-28B	4/27/10	PVC	1289.54	1288.08	2	2-22	24	44	1265.54	1245.54	0.010	6	45	19	1270.5
MW-29B	4/25/10	PVC	1288.10	1287.70	2	2-18	20	45	1268.10	1243.10	0.010	6	45.5	16	1272.1
MW-30B	4/25/10	PVC	1288.32	1286.79	2	3-18	20	45	1268.32	1243.32	0.010	6	45.5	19.5	1268.8
MW-31B	4/25/10	PVC	1288.00	1287.14	2	3-18	20	45	1268.00	1243.00	0.010	6	45.5	19	1269.0

Table 5. Well Completion Summary,
Brenntag/HCI Chemtech, 2235 W. Battlefield Rd., Springfield, Missouri.

Well Name	Date Installed	Well Material	Top of Vault/Ground (ft amsl)	Top of Casing (ft amsl)	Well Diameter (inches)	Bentonite Interval (ft bgs)	Top of Screen (ft bgs)	Bottom of Screen (ft bgs)	Top of Screen (ft amsl)	Bottom of Screen (ft amsl)	Screen Size (inches)	Borehole Diameter (inches)	Boring Depth (ft bgs)	Top of Bedrock (ft bgs)	Top of Bedrock (ft amsl)
Shallow Springfield Plateau Aquifer Monitoring Wells (cont.)															
SAW-1	7/25/00	S\OH	1288.97	1288.61	6.25\@30'	OH	30	42.5	*1258.97*	*1246.47*	OH	10\5.6	42.5	16.5	1272.5
SAW-3	7/26/00	S\OH	*1288.67*	1288.30	6.25\@30'	OH	30	44	1258.67	1244.67	OH	10\5.6	44	19.5	1269.2
Former HVE Pilot Test Wells - New Tank Farm															
EW-1N	8/1/95	PVC/SS	1291.52	1290.72	6		*5*	*23.55*	*1285.72*	*1267.17*					
EW-2S	8/1/95	PVC/SS	1291.67	1292.41	6		*5*	*20.80*	*1287.41*	*1271.61*					
Deep Springfield Plateau Aquifer Monitoring Wells															
(SAW-2)	*7/25/00*	*S\OH*	*1277.94*	*1277.41*	*6.25\@25'*	*OH*	*25*	*208*	*1252.94*	*1069.94*	*OH*	*10\5.6*	*208*	*13.9*	
SAW-2	9/11/02	S80 PVC	1283.91	1283.52	2	177.6-182	188	208	1095.91	1075.91	0.020	10\5.6	208	13.9	1270.0
SAW-4	3/15/07	S80 PVC	1285.11	1284.74	6"@60' 2"	176-180	190	210	1095.11	1075.11	0.020	10\6	210	15	1270.1
SAW-5	3/13/07	S80 PVC	1279.16	1278.86	6"@60' 2"	168-173	185	205	1094.16	1074.16	0.020	10\6	205	13	1266.2
SAW-6	4/22/10	S80 PVC	1285.01	1284.70	6"@59' 2"	178-183	185	205	1100.01	1080.01	0.010	10\6	206	14	1271.0
SAW-7	4/24/10	S80 PVC	1288.61	1288.41	6"@59' 2"	165-170	172	212	1116.61	1076.61	0.010	10\6	213	16	1272.6
SAW-8	7/17/10	S80 PVC	*1286.83*	1286.35	6"@59' 2"	177-182	185	205	1101.83	1081.83	0.010	10\6	206	21	1265.8
ERD Pilot Test - Injection Wells (NW Unit)															
IW-1	4/28/05	PVC/SS	1289.00	1288.50	2	8.5-10.5	11.5	21.5	1277.90	1267.90	0.010	6	22	16.5	1272.5
IW-2	4/28/05	PVC/SS	1289.09	1288.56	2	8-11	12	22	1277.09	1267.09	0.010	6	22	N.E.	
IW-3	4/28/05	PVC/SS	1289.27	1288.83	2	9-11	12	22	1277.27	1267.27	0.010	6	22	N.E.	
IW-4	4/28/05	PVC/SS	1290.21	1289.64	2	9-11	12	22	1278.21	1268.21	0.010	6	22	N.E.	
IW-5	4/28/05	PVC/SS	1290.15	1289.72	2	9-11	12	22	1278.15	1268.15	0.010	6	22	20	1270.2
IW-6	1/24/07	PVC/SS	1288.71	1288.33	2	3-7.4	9.5	19.5	1279.21	1269.21	0.010	8	19.5	18.5	1270.2
IW-7	1/29/07	PVC/SS	1289.41	1289.08	2	2-8	10	20	1279.41	1269.41	0.010	6	20	N.E.	
IW-8	1/29/07	PVC/SS	1289.72	1289.42	2	2-8	10	20	1279.72	1269.72	0.010	6	20	N.E.	

Table 5. Well Completion Summary,
Brenntag/HCI Chemtech, 2235 W. Battlefield Rd., Springfield, Missouri.

Well Name	Date Installed	Well Material	Top of Vault/Ground (ft amsl)	Top of Casing (ft amsl)	Well Diameter (inches)	Bentonite Interval (ft bgs)	Top of Screen (ft bgs)	Bottom of Screen (ft bgs)	Top of Screen (ft amsl)	Bottom of Screen (ft amsl)	Screen Size (inches)	Borehole Diameter (inches)	Boring Depth (ft bgs)	Top of Bedrock (ft bgs)	Top of Bedrock (ft amsl)
Extraction Wells - Northwest Unit															
E36		PVC	1288.31	*1287.05*			8.5	18.5	1279.81	1269.81			18.5		1269.8
E37		PVC	1288.08	*1286.76*			8.5	18.5	1279.58	1269.58			18.5		1269.6
E38			1287.33	*1286.00*	2		8.5	15.5	1278.83	1271.83			15.5		1271.8
E39			1287.54	*1286.31*			9.5	14.5	1278.04	1273.04			14.5		1273.0
E40			1288.52	*1286.90*	2		10.5	20.5	1278.02	1268.02			20.5		1268.0
E41			1288.90	*1287.55*			9	19	1279.90	1269.90			19.0		1269.9
E42	Pulled						8.5	12.5					12.5	Chert?	
E42B	1/13/04	PVC	1289.08	*1288.21*	2	2.5 - 18	19.5 btoc	44.5 btoc	1268.71	1243.71	0.010	6	45.0	17.00	1272.1
E43			1288.53	*1287.19*			9.5	14.5	1279.03	1274.03			14.5		1274.0
E44			1288.84	*1287.62*	2		9	19	1279.84	1269.84			19.0		1269.8
E45	Pulled						8.5	10.5					10.5		
E45B	4/26/10	PVC	1287.59	*1286.23*	2	3-18	20	40	1266.23	1246.23	0.010	6	42.0	10	1277.6
E46			1289.71	*1288.67*			9	17	1280.71	1272.71			17.0		1272.7
E47	Pulled						9	17					17.0		
E47B	1/13/04	PVC	1288.53	*1287.54*	2	3 - 19	19.25 btoc	44.25 btoc			0.010	6	45.0	17.00	1271.5
E48			1289.83	*1288.68*	2		8.5	18.5	1281.33	1271.33			18.5		1271.3
E49			1289.97	*1288.81*			8.5	12.5	1281.47	1277.47			12.5		1277.5
E50			1288.60	*1287.54*			8.5	10.5	1280.10	1278.10			10.5		1278.1
Extraction Wells - Central Unit															
EW4		SS	1288.77		2	3-5.5	7	22	1281.77	1266.77		8	22	16.00	1272.8
EW5	7/16/99	SS	1289.51		2	2-3.5	4	19	1285.51	1270.51		8	19	19.00	1270.5
EW7"D"	7/16/99	SS	1289.95		2	3-6	9	19	1280.95	1270.95		8	19	19.00	1271.0
EW8"C"	7/16/99	SS	1288.78		2	2.25-3.5	3.5	13.5	1285.28	1275.28		8	13.5	13.50	1275.3
EW9"B"	7/16/99	SS	1289.53		2	2.25-3.5	6.5	16.5	1283.03	1273.03		8	19.5	16.50	1273.0
E11		SS	1288.61				6.5	9	1282.11	1279.61			9.0		1279.6
E12		SS	1288.48				8	18	1280.48	1270.48			18.0		1270.5
E13		SS	1288.57				7.5	9	1281.07	1279.57			9.0		1279.6
E14"A"	7/16/99	SS	1288.79				9.5	19.5	1279.29	1269.29			19.5		1269.3
E32"E"	7/16/99	SS	1289.42				13	23	1276.42	1266.42			23.0		1266.4
E51	4/25/05	PVC	1288.83		2	2-5	6	26	1282.83	1262.83	0.010	6	26	16.5	1272.3
E52	4/27/05	PVC	1288.98		2	3-6	8	23	1280.98	1265.98	0.010	6	26	17	1272.0
E53	4/27/05	PVC	1289.55		2	3-6	7	17	1282.55	1272.55	0.010	6	22	17	1272.6

Table 5. Well Completion Summary,
Brenntag/HCI Chemtech, 2235 W. Battlefield Rd., Springfield, Missouri.

Well Name	Date Installed	Well Material	Top of Vault/Ground (ft amsl)	Top of Casing (ft amsl)	Well Diameter (inches)	Bentonite Interval (ft bgs)	Top of Screen (ft bgs)	Bottom of Screen (ft bgs)	Top of Screen (ft amsl)	Bottom of Screen (ft amsl)	Screen Size (inches)	Borehole Diameter (inches)	Boring Depth (ft bgs)	Top of Bedrock (ft bgs)	Top of Bedrock (ft amsl)
Extraction Wells - Rail Spur Unit															
E4		PVC	1285.04				10	20	1275.04	1265.04			20.0		1265.0
E5		PVC	1285.20				9.5	19.5	1275.70	1265.70			19.5		1265.7
E6		PVC	1285.14				9.5	14.5	1275.64	1270.64			14.5		1270.6
E7	Pulled	PVC					9.5	14.5					14.5		
E7B	1/13/04	PVC	1286.00	*1285.31*	2	3 * 19	19.5 btoc	44.5 btoc	1265.81	1240.81	0.010	6	45.0	17.00	1269.0
E8		PVC	1285.10				9.5	19.5	1275.60	1265.60			19.5		1265.6
E9		PVC	1285.08				9	11.5	1276.08	1273.58			11.5		1273.6
E10		PVC	1285.24				7.5	8.5	1277.74	1276.74			8.5		1276.7
E33		PVC	1289.69				10.5	20.5	1279.19	1269.19			20.5		1269.2
E34		PVC	1289.51				8.5	13.5	1281.01	1276.01			13.5		1276.0
Extraction Wells - Loading Dock															
E1		PVC	1285.45				8.5	18.5	1276.95	1266.95			18.5		1267.0
E2		PVC	1285.10				7	8	1278.10	1277.10			8.0		1277.1
E3		PVC	1285.64				8	17	1277.64	1268.64			17.0		1268.6
E15		SS	1289.31				8.5	13.5	1280.81	1275.81			13.5		1275.8
E16		SS	1288.85				9.5	17	1279.35	1271.85			17.0		1271.9
E17		PVC	1289.02				10	17.5	1279.02	1271.52			17.5		1271.5
E18		PVC	1284.82				11	21	1273.82	1263.82			21.0		1263.8
E19		PVC	1284.62				8	17	1276.62	1267.62			17.0		1267.6
E20		PVC	1284.52				7.5	12.5	1277.02	1272.02			12.5		1272.0
E21		PVC	1284.18				8	15	1276.18	1269.18			15.0		1269.2
E22		PVC	1284.67				9.5	16.5	1275.17	1268.17			16.5		1268.2
E23		PVC	1284.32				9	17	1275.32	1267.32			17.0		1267.3
E24		PVC	1284.55				8	12.5	1276.55	1272.05			12.5		1272.1
E25		PVC	1284.70				9.5	15.5	1275.20	1269.20			15.5		1269.2
E26		PVC	1284.68				8.5	13.5	1276.18	1271.18			13.5		1271.2
E27		PVC	1284.84				9.5	19.5	1275.34	1265.34			19.5		1265.3
E28		PVC	1284.51				8.5	10.5	1276.01	1274.01			10.5		1274.0
E29		PVC	1284.97				8.5	9.5	1276.47	1275.47			9.5		1275.5
E30		PVC	1283.90				13.5	23.5	1270.40	1260.40			23.5		1260.4
E31		PVC	1284.03				8	13	1276.03	1271.03			13.0		1271.0

Table 5. Well Completion Summary,
Brenntag/HCI Chemtech, 2235 W. Battlefield Rd., Springfield, Missouri.

Well Name	Date Installed	Well Material	Top of Vault/Ground (ft amsl)	Top of Casing (ft amsl)	Well Diameter (inches)	Bentonite Interval (ft bgs)	Top of Screen (ft bgs)	Bottom of Screen (ft bgs)	Top of Screen (ft amsl)	Bottom of Screen (ft amsl)	Screen Size (inches)	Borehole Diameter (inches)	Boring Depth (ft bgs)	Top of Bedrock (ft bgs)	Top of Bedrock (ft amsl)

Notes:

Top of Casing Elevation, Top of Vault Elevation, and Location for all Monitoring Wells Were Obtained by Heithous Engineering in May and July 2010.

Top of Vault Elevation and Location for all (57) Extraction Wells Were Obtained on May 5, 2010.

New Survey is Tied to the Missouri DNR Survey Monument: Seminole, Elevation 1274.31

Bearings Based on Grid North as Established by Missouri Coordinate System of 1983, Central Zone.

Top of Casing Elevation for Extraction Wells in NW Unit (in italics) were obtained by ARCADIS in January 2010.

OH = Open Hole N.E. = Not Encountered SS = Stainless Steel PVC = Poly Vinyl Chloride S = Steel

Groundwater Monitoring Well Network - Screen Interval

Shallow Soil (residuum)	15 wells	MWs 1 - 13, EW-1N, and EW-2S (onsite)
Shallow Soil and Upper Bedrock	14 wells	MWs 14 - 27 (offsite)
Upper Bedrock	6 wells	SAW-1, SAW-3, and MWs 28B - 31B (onsite)
Deep Bedrock	6 wells	SAW-2 (onsite) and SAW-4 through SAW-8 (offsite)

21 monitoring wells are located on the Brenntag facility. 20 monitoring wells are located on the adjacent properties.

Extraction Well Network Summary (57 total)

Shallow Extraction Wells (51 total) are completed within the soil/residuum and bottom of screen is at or near the top of bedrock.
Extraction Wells E51 and E52 are completed with screens across the soil/residuum and upper bedrock.
Extraction Wells E7B, E42B, E45B, and E47B are completed with screens within the upper bedrock (below bedrock surface).

Table 6. Summary of VOCs Detected in Well Boring Soil Samples, May - June 1995,
Brenntag HCI/Chemtech, 2235 W. Battlefield Rd., Springfield, Missouri.

Well Name Sample Depth ft bgs Sample Date	MW-1 8.5 5/31/95 (ug/kg)	MW-1 17 5/31/95 (ug/kg)	MW-1 21 5/31/95 (ug/kg)	MW-2 11 5/31/95 (ug/kg)	MW-2 14.5 5/31/95 (ug/kg)	MW-2 19 5/31/95 (ug/kg)	MW-3 9 6/1/95 (ug/kg)	MW-3 12 6/1/95 (ug/kg)	MW-3 16 6/1/95 (ug/kg)
Acetone	**6800 E**	**250**	**13 J**	**23**	<	**89**	<	**18**	**10000 E**
Benzene									
Bromobenzene									
Bromochloromethane									
Bromodichloromethane									
Bromoform									
Bromomethane									
2-Butanone (MEK)	**22 J**	<	<	<	<	<	<	<	**350**
n-Butylbenzene									
sec-Butylbenzene									
tert-Butylbenzene									
Carbon Tetrachloride									
Chlorobenzene	**8 J**	**10 J**	<	<	<	<	<	<	<
Chloroethane									
Chloroform									
Chloromethane									
2-Chlorotoluene									
4-Chlorotoluene									
Dibromochloromethane									
1,2-Dibromo-3-chloropropane									
1,2-Dibromoethane (EDB)									
Dibromomethane									
1,2-Dichlorobenzene									
1,3-Dichlorobenzene									
1,4-Dichlorobenzene									
Dichlorodifluoromethane									
1,1-Dichloroethane	<	<	<	<	**2 J**	**3 J**	<	<	<
1,2-Dichloroethane									
1,1-Dichloroethene									
cis-1,2-Dichloroethene									
trans-1,2-Dichloroethene									
1,2-Dichloroethene (total)	**21 J**	**46**	**68**	<	<	<	<	<	<
1,2-Dichloropropane									
1,3-Dichloropropane									
2,2-Dichloropropane									
1,1-Dichloropropene									
cis-1,3-Dichloropropene									
trans-1,3-Dichloropropene									
Ethylbenzene	**15 J**	**18 J**	**2 J**	<	<	<	<	<	**140**
Hexachlorobutadiene									
2-Hexanone									
Isopropylbenzene (Cumene)									
p-Isopropyltoluene									
4-Methyl-2-pentanone (MIBK)	**22 J**	<	**<**	<	<	<	<	<	<
Methylene Chloride	**36**	**100**	<	**5 J**	**4 J**	<	<	<	<
Naphthalene									
n-Propylbenzene									
Styrene									
1,1,1,2-Tetrachloroethane									
1,1,2,2-Tetrachloroethane									
Tetrachloroethene (PCE)	**19000 E**	**21000 E**	**17**	<	**2 J**	<	<	**13**	<
Toluene	<	**8 J**	<	<	<	<	<	<	**2100**
1,2,3-Trichlorobenzene									
1,2,4-Trichlorobenzene									
1,1,1-Trichloroethane									
1,1,2-Trichloroethane									
Trichloroethene (TCE)	**18 J**	**22 J**	**4 J**	<	<	<	<	<	<
Trichlorofluoromethane									
1,2,3-Trichloropropane									
1,2,4-Trimethylbenzene									
1,3,5-Trimethylbenzene									
Vinyl Chloride									
m&p-Xylene									
o-Xylene									
Xylenes (total)	**66**	**81**	<	<	<	**23**	<	<	**1800**
Total VOCs	**26,008**	**21,535**	**104**	**28**	**8**	**115**	0	**31**	**14,390**
Total Chlorinated VOCs	**19,075**	**21,168**	**89**	**5**	**8**	**3**	0	**13**	0
Total BTEX	**81**	**107**	**2**	0	0	**23**	0	0	**4,040**

Table 6. Summary of VOCs Detected in Well Boring Soil Samples, May - June 1995,
Brenntag HCI/Chemtech, 2235 W. Battlefield Rd., Springfield, Missouri.

Well Name Sample Depth ft bgs Sample Date	MW-4 6 6/1/95 (ug/kg)	MW-4 9 6/1/95 (ug/kg)	MW-4 14 6/1/95 (ug/kg)	MW-5 4 6/1/95 (ug/kg)	MW-5 9 6/1/95 (ug/kg)	MW-6 7 6/1/95 (ug/kg)	MW-6 10 6/1/95 (ug/kg)
Acetone	**12000 E**	**2100 E**	**660**	**28000**	**36000 E**	**29000**	**25000**
Benzene							
Bromobenzene							
Bromochloromethane							
Bromodichloromethane							
Bromoform							
Bromomethane							
2-Butanone (MEK)	**1100 E**	**160**	**54 J**	**6700**	**11000**	**5000**	**3700**
n-Butylbenzene							
sec-Butylbenzene							
tert-Butylbenzene							
Carbon Tetrachloride							
Chlorobenzene							
Chloroethane							
Chloroform							
Chloromethane							
2-Chlorotoluene							
4-Chlorotoluene							
Dibromochloromethane							
1,2-Dibromo-3-chloropropane							
1,2-Dibromoethane (EDB)							
Dibromomethane							
1,2-Dichlorobenzene							
1,3-Dichlorobenzene							
1,4-Dichlorobenzene							
Dichlorodifluoromethane							
1,1-Dichloroethane	<	<	**25 J**	<	**1100**	**220 J**	**370 J**
1,2-Dichloroethane							
1,1-Dichloroethene							
cis-1,2-Dichloroethene							
trans-1,2-Dichloroethene							
1,2-Dichloroethene (total)	<	<	**35 J**	<	**260 J**	<	**100**
1,2-Dichloropropane							
1,3-Dichloropropane							
2,2-Dichloropropane							
1,1-Dichloropropene							
cis-1,3-Dichloropropene							
trans-1,3-Dichloropropene							
Ethylbenzene	<	<	**170**	<	**1200**	<	**700 J**
Hexachlorobutadiene							
2-Hexanone	**2 J**	<	<	<	<	<	<
Isopropylbenzene (Cumene)							
p-Isopropyltoluene							
4-Methyl-2-pentanone (MIBK)	**36**	<	<	**2800**	**1700 J**	**2300**	**2700**
Methylene Chloride	<	<	<	<	<	<	**9000**
Naphthalene							
n-Propylbenzene							
Styrene							
1,1,1,2-Tetrachloroethane							
1,1,2,2-Tetrachloroethane							
Tetrachloroethene (PCE)							
Toluene	**13**	<	**26** J	**630** J	**3800**	**680** J	**4500**
1,2,3-Trichlorobenzene							
1,2,4-Trichlorobenzene							
1,1,1-Trichloroethane							
1,1,2-Trichloroethane							
Trichloroethene (TCE)							
Trichlorofluoromethane							
1,2,3-Trichloropropane							
1,2,4-Trimethylbenzene							
1,3,5-Trimethylbenzene							
Vinyl Chloride							
m&p-Xylene							
o-Xylene							
Xylenes (total)	**14**	<	**710**	**490 J**	**6500**	**880 J**	**4100**
Total VOCs	**13,165**	**2,260**	**1,680**	**38,620**	**61,560**	**38,080**	**50,170**
Total Chlorinated VOCs	0	0	60	0	**1,360**	**220**	**9,470**
Total BTEX	**27**	0	**906**	**1,120**	**11,500**	**1,560**	**9,300**

Table 7. Summary of VOCs Detected in Old Tank Farm Soil Samples, July 1999,
Brenntag HCl/Chemtech, 2235 W. Battlefield Rd., Springfield, Missouri.

Well / Boring Name Sample Depth ft bgs Sample Date	TF-01-03 3 7/1/99 (ug/kg)	TF-02-03 3 7/1/99 (ug/kg)	TF-03-03 3 7/1/99 (ug/kg)	TF-04-03 3 7/1/99 (ug/kg)	TF-05-03 3 7/1/99 (ug/kg)	TF-06-03 3 7/1/99 (ug/kg)	TF-07-03 3 7/1/99 (ug/kg)	TF-08-03 3 7/1/99 (ug/kg)
Acetone	NA	**120**	**220**	NA	**680**	**170**	**170**	NA
Alcohols	<10000	NA	NA	NA	<10000	<10000	NA	<10000
Benzene	NA	<5	<5	NA	<5	<5	<5	NA
Bromobenzene								
Bromochloromethane								
Bromodichloromethane								
Bromoform								
Bromomethane								
2-Butanone (MEK)	NA	<100	<100	NA	<100	<100	<100	NA
n-Butylbenzene								
sec-Butylbenzene	NA	<5	<5	NA	<5	<5	<5	NA
tert-Butylbenzene								
Carbon Tetrachloride								
Chlorobenzene								
Chloroethane	NA	<5	<5	NA	<5	<5	<5	NA
Chloroform	NA	<5	<5	NA	<5	<5	<5	NA
Chloromethane								
2-Chlorotoluene								
4-Chlorotoluene								
Dibromochloromethane								
1,2-Dibromo-3-chloropropane								
1,2-Dibromoethane (EDB)								
Dibromomethane								
1,2-Dichlorobenzene								
1,3-Dichlorobenzene								
1,4-Dichlorobenzene								
Dichlorodifluoromethane								
1,1-Dichloroethane	NA	<5	<5	NA	<5	<5	<5	NA
1,2-Dichloroethane	NA	<5	<5	NA	<5	<5	<5	NA
1,1-Dichloroethene	NA	<5	<5	NA	<5	<5	<5	NA
cis-1,2-Dichloroethene	NA	<5	<5	NA	<5	<5	<5	NA
trans-1,2-Dichloroethene								
1,2-Dichloroethene (total)								
1,2-Dichloropropane								
1,3-Dichloropropane								
2,2-Dichloropropane								
1,1-Dichloropropene								
cis-1,3-Dichloropropene								
trans-1,3-Dichloropropene								
Ethylbenzene	NA	<5	**7**	NA	<5	<5	<5	NA
Hexachlorobutadiene								
2-Hexanone								
Isopropylbenzene (Cumene)	NA	<5	<5	NA	<5	<5	<5	NA
p-Isopropyltoluene	NA	<5	<5	NA	<5	<5	<5	NA
4-Methyl-2-pentanone (MIBK)	NA	<50	<50	NA	<50	<50	<50	NA
Methylene Chloride	NA	<20	<20	NA	<20	<20	<20	NA
Naphthalene	NA	<5	<5	NA	<5	<5	<5	NA
n-Propylbenzene	NA	<5	<5	NA	<5	<5	<5	NA
Styrene								
1,1,1,2-Tetrachloroethane								
1,1,2,2-Tetrachloroethane								
Tetrachloroethene (PCE)	NA	<5	<5	NA	<5	<5	<5	NA
Toluene	NA	<5	<5	NA	<5	<5	<5	NA
1,2,3-Trichlorobenzene								
1,2,4-Trichlorobenzene								
1,1,1-Trichloroethane								
1,1,2-Trichloroethane								
Trichloroethene (TCE)	NA	<5	<5	NA	<5	<5	<5	NA
Trichlorofluoromethane								
1,2,3-Trichloropropane								
1,2,4-Trimethylbenzene	NA	<5	**6**	NA	<5	<5	<5	NA
1,3,5-Trimethylbenzene	NA	<5	**5.2**	NA	<5	<5	<5	NA
Vinyl Chloride								
m&p-Xylene	NA	<5	**29**	NA	<5	<5	<5	NA
o-Xylene	NA	<5	**12**	NA	<5	<5	<5	NA
Xylenes (total)								
Total VOCs	NA	**120**	**279**	NA	**680**	**170**	**170**	NA
Total Chlorinated VOCs	NA	<20	<20	NA	<20	<20	<20	NA
Total BTEX	NA	<5	**48**	NA	<5	<5	<5	NA

Table 7. Summary of VOCs Detected in Old Tank Farm Soil Samples, July 1999,
Brenntag HCl/Chemtech, 2235 W. Battlefield Rd., Springfield, Missouri.

Well / Boring Name Sample Depth ft bgs Sample Date	TF-09-03 3 7/1/99 (ug/kg)	Dup #1 (TF-09-03) 7/1/99 (ug/kg)	TF-10-03 3 7/1/99 (ug/kg)	TF-11-03 3 7/1/99 (ug/kg)	TF-12-03 3 7/1/99 (ug/kg)	TF-13-03 3 7/1/99 (ug/kg)	TF-14-03 3 7/1/99 (ug/kg)
Acetone	**240**	<100	**290**	**280**	**240**	**430**	**390**
Alcohols	NA	NA	NA	NA	NA	NA	NA
Benzene	<5	<5	<5	<5	<5	<5	<5
Bromobenzene							
Bromochloromethane							
Bromodichloromethane							
Bromoform							
Bromomethane							
2-Butanone (MEK)	<100	<100	<100	<100	<100	<100	<100
n-Butylbenzene							
sec-Butylbenzene	<5	<5	<5	<5	<5	<5	<5
tert-Butylbenzene							
Carbon Tetrachloride							
Chlorobenzene							
Chloroethane	<5	<5	<5	<5	<5	<5	<5
Chloroform	<5	<5	<5	<5	<5	<5	<5
Chloromethane							
2-Chlorotoluene							
4-Chlorotoluene							
Dibromochloromethane							
1,2-Dibromo-3-chloropropane							
1,2-Dibromoethane (EDB)							
Dibromomethane							
1,2-Dichlorobenzene							
1,3-Dichlorobenzene							
1,4-Dichlorobenzene							
Dichlorodifluoromethane							
1,1-Dichloroethane	<5	<5	<5	<5	<5	<5	<5
1,2-Dichloroethane	<5	<5	<5	<5	<5	<5	<5
1,1-Dichloroethene	<5	<5	<5	<5	<5	<5	<5
cis-1,2-Dichloroethene	<5	<5	<5	<5	<5	<5	<5
trans-1,2-Dichloroethene							
1,2-Dichloroethene (total)							
1,2-Dichloropropane							
1,3-Dichloropropane							
2,2-Dichloropropane							
1,1-Dichloropropene							
cis-1,3-Dichloropropene							
trans-1,3-Dichloropropene							
Ethylbenzene	<5	<5	<5	**5.7**	<5	<5	<5
Hexachlorobutadiene							
2-Hexanone							
Isopropylbenzene (Cumene)	<5	<5	<5	<5	<5	<5	<5
p-Isopropyltoluene	<5	<5	<5	<5	<5	<5	<5
4-Methyl-2-pentanone (MIBK)	<50	<50	<50	<50	<50	<50	<50
Methylene Chloride	<20	<20	<20	<20	<20	<20	<20
Naphthalene	<5	<5	<5	<5	<5	<5	<5
n-Propylbenzene	**6.1**	<5	<5	<5	<5	<5	<5
Styrene							
1,1,1,2-Tetrachloroethane							
1,1,2,2-Tetrachloroethane							
Tetrachloroethene (PCE)	<5	<5	<5	<5	<5	<5	<5
Toluene	<5	<5	<5	**16**	<5	<5	<5
1,2,3-Trichlorobenzene							
1,2,4-Trichlorobenzene							
1,1,1-Trichloroethane							
1,1,2-Trichloroethane							
Trichloroethene (TCE)	<5	<5	<5	<5	<5	<5	<5
Trichlorofluoromethane							
1,2,3-Trichloropropane							
1,2,4-Trimethylbenzene	**41**	<5	<5	<5	<5	<5	<5
1,3,5-Trimethylbenzene	**45**	**12**	<5	<5	<5	<5	<5
Vinyl Chloride							
m&p-Xylene	<5	<5	<5	**320**	<5	<5	<5
o-Xylene	<5	<5	<5	**260**	<5	<5	<5
Xylenes (total)							
Total VOCs	**332**	**12**	**290**	**882**	**240**	**430**	**390**
Total Chlorinated VOCs	<20	<20	<20	<20	<20	<20	<20
Total BTEX	<5	<5	<5	**602**	<5	<5	<5

Table 8. Summary of Semi-Volatile Organic Compounds Detected in Old Tank Farm Soil Samples, July 1999,
Brenntag HCI/Chemtech, 2235 W. Battlefield Rd., Springfield, Missouri.

Well / Boring Name Sample Depth ft bgs Sample Date	TF-01- 3 7/1/99 (ug/kg)	TF-02-03 3 7/1/99 (ug/kg)	TF-03- 3 7/1/99 (ug/kg)	TF-04- 3 7/1/99 (ug/kg)	TF-05- 3 7/1/99 (ug/kg)	TF-06- 3 7/1/99 (ug/kg)	TF-07- 3 7/1/99 (ug/kg)	TF-08- 3 7/1/99 (ug/kg)	TF-09- 3 7/1/99 (ug/kg)	Dup #1 (TF-09- 7/1/99 (ug/kg)	TF-10- 3 7/1/99 (ug/kg)	TF-11-03 3 7/1/99 (ug/kg)	TF-12-03 3 7/1/99 (ug/kg)	TF-13-03 3 7/1/99 (ug/kg)	TF-14-03 3 7/1/99 (ug/kg)
Benz (a) anthracene	NA	NA	NA	<401	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**180 J**
Benzo (a) pyrene	NA	NA	NA	<401	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**280 J**
Benzo (g,h,i) perylene	NA	NA	NA	<401	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**270 J**
Benzo (k) fluoranthene	NA	NA	NA	<401	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**310 J**
Benzoic acid	NA	NA	NA	<401	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**<1899**
Butyl-benzyl phthalate	NA	NA	NA	<401	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**<1899**
Chrysene	NA	NA	NA	<401	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**290 J**
Di-n-butyl-phthalate	NA	NA	NA	<401	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**<1899**
bis(s-Ethylhexyl)phthalate	NA	NA	NA	**480**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**10000**
Fluoranthene	NA	NA	NA	**35 J**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**340 J**
Ideno (1,2,3-cd) pyrene	NA	NA	NA	<401	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**240 J**
Phenol	NA	NA	NA	<401	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**<1899**
Pyrene	NA	NA	NA	**33 J**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**300 J**
Total Semi-VOCs	NA	NA	NA	**548**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**12,210**

Total Petroleum Hydrocarbons	NA	**35700**	NA	NA	NA	<6250	NA	NA	NA	NA	NA	NA	<6540	<6200	NA

Table 9. Summary of VOCs Detected in Soil Samples Near MW-1, July 1999,
Brenntag HCI/Chemtech, 2235 W. Battlefield Rd., Springfield, Missouri.

Boring Name Sample Depth ft bgs Sample Date	BHW1-C-4 4 7/15/99 (ug/kg)	BHW1-W-4 4 7/15/99 (ug/kg)	BHW1-N-4 4 7/15/99 (ug/kg)	BHW1-S-4 4 7/15/99 (ug/kg)	BHW1-E-4 4 7/15/99 (ug/kg)
Acetone	**9300**	**310**	**570**	**980**	**340**
Benzene	<5	<5	<5	<5	<5
Bromobenzene					
Bromochloromethane					
Bromodichloromethane					
Bromoform					
Bromomethane					
2-Butanone (MEK)	<100	<100	<100	<100	<100
n-Butylbenzene					
sec-Butylbenzene	<5	<5	<5	<5	<5
tert-Butylbenzene					
Carbon Tetrachloride					
Chlorobenzene					
Chloroethane	<5	<5	<5	<5	<5
Chloroform	<5	<5	<5	<5	<5
Chloromethane					
2-Chlorotoluene					
4-Chlorotoluene					
Dibromochloromethane					
1,2-Dibromo-3-chloropropane					
1,2-Dibromoethane (EDB)					
Dibromomethane					
1,2-Dichlorobenzene					
1,3-Dichlorobenzene					
1,4-Dichlorobenzene					
Dichlorodifluoromethane					
1,1-Dichloroethane	<5	<5	<5	<5	<5
1,2-Dichloroethane	<5	<5	<5	<5	<5
1,1-Dichloroethene	<5	<5	<5	<5	<5
cis-1,2-Dichloroethene	**190**	<5	<5	<5	<5
trans-1,2-Dichloroethene					
1,2-Dichloroethene (total)					
1,2-Dichloropropane					
1,3-Dichloropropane					
2,2-Dichloropropane					
1,1-Dichloropropene					
cis-1,3-Dichloropropene					
trans-1,3-Dichloropropene					
Ethylbenzene	<5	<5	<5	<5	<5
Hexachlorobutadiene					
2-Hexanone					
Isopropylbenzene (Cumene)	<5	<5	<5	<5	<5
p-Isopropyltoluene	<5	<5	<5	<5	<5
4-Methyl-2-pentanone (MIBK)	<50	<50	<50	<50	<50
Methylene Chloride	<20	<20	<20	<20	<20
Naphthalene	<5	<5	<5	<5	<5
n-Propylbenzene	<5	<5	<5	<5	<5
Styrene					
1,1,1,2-Tetrachloroethane					
1,1,2,2-Tetrachloroethane					
Tetrachloroethene (PCE)	**23**	<5	<5	<5	<5
Toluene	<5	<5	<5	<5	<5
1,2,3-Trichlorobenzene					
1,2,4-Trichlorobenzene					
1,1,1-Trichloroethane					
1,1,2-Trichloroethane					
Trichloroethene (TCE)	<5	<5	<5	<5	<5
Trichlorofluoromethane					
1,2,3-Trichloropropane					
1,2,4-Trimethylbenzene	<5	<5	<5	<5	<5
1,3,5-Trimethylbenzene	<5	<5	<5	<5	<5
Vinyl Chloride					
m&p-Xylene	<5	<5	<5	<5	<5
o-Xylene	<5	<5	<5	<5	<5
Xylenes (total)					
Total VOCs	**9,513**	**310**	**570**	**980**	**340**
Total Chlorinated VOCs	**213**	<20	<20	<20	<20
Total BTEX	<5	<5	<5	<5	<5

Table 10. Summary of VOCs Detected in Well Boring Soil Samples, July 1999,
Brenntag HCI/Chemtech, 2235 W. Battlefield Rd., Springfield, Missouri.

Well Name Sample Depth ft bgs Sample Date	MW-7 3 7/15/99 (ug/kg)	MW-7 8 7/15/99 (ug/kg)	MW-8 3 7/14/99 (ug/kg)	MW-8 7 7/14/99 (ug/kg)	MW-9 3 7/15/99 (ug/kg)	MW-9 Dup 3 7/15/99 (ug/kg)	MW-10 5 7/15/99 (ug/kg)
Acetone	**280**	**490**	**400**	**9200**	**170**	**17000**	**21000**
Benzene	<5	<5	<5	**20**	<5	<5	<5
Bromobenzene							
Bromochloromethane							
Bromodichloromethane							
Bromoform							
Bromomethane							
2-Butanone (MEK)	<100	<100	<100	**4600**	<100	<100	<100
n-Butylbenzene							
sec-Butylbenzene	<5	<5	<5	<5	<5	<5	<5
tert-Butylbenzene							
Carbon Tetrachloride							
Chlorobenzene							
Chloroethane	<5	<5	<5	**170**	<5	<5	<5
Chloroform	<5	<5	**13**	<5	<5	<5	<5
Chloromethane							
2-Chlorotoluene							
4-Chlorotoluene							
Dibromochloromethane							
1,2-Dibromo-3-chloropropane							
1,2-Dibromoethane (EDB)							
Dibromomethane							
1,2-Dichlorobenzene							
1,3-Dichlorobenzene							
1,4-Dichlorobenzene							
Dichlorodifluoromethane							
1,1-Dichloroethane	<5	<5	**23**	**230**	<5	<5	<5
1,2-Dichloroethane	<5	<5	**8.2**	**120**	<5	<5	<5
1,1-Dichloroethene	<5	<5	<5	**19**	<5	<5	<5
cis-1,2-Dichloroethene	<5	<5	**69**	**690**	<5	<5	<5
trans-1,2-Dichloroethene							
1,2-Dichloroethene (total)							
1,2-Dichloropropane							
1,3-Dichloropropane							
2,2-Dichloropropane							
1,1-Dichloropropene							
cis-1,3-Dichloropropene							
trans-1,3-Dichloropropene							
Ethylbenzene	<5	<5	**63**	**39**	<5	<5	<5
Hexachlorobutadiene							
2-Hexanone							
Isopropylbenzene (Cumene)	<5	<5	**9.7**	<5	<5	<5	<5
p-Isopropyltoluene	<5	<5	**5.4**	<5	<5	<5	<5
4-Methyl-2-pentanone (MIBK)	<50	<50	<50	**1800**	<50	<50	<50
Methylene Chloride	<20	<20	<20	**33**	<20	**37**	<20
Naphthalene	<5	<5	**29**	**12**	<5	<5	<5
n-Propylbenzene	<5	<5	**18**	<5	<5	<5	<5
Styrene							
1,1,1,2-Tetrachloroethane							
1,1,2,2-Tetrachloroethane							
Tetrachloroethene (PCE)	<5	<5	<5	<5	<5	<5	<5
Toluene	<5	<5	**430**	**700**	<5	<5	<5
1,2,3-Trichlorobenzene							
1,2,4-Trichlorobenzene							
1,1,1-Trichloroethane							
1,1,2-Trichloroethane							
Trichloroethene (TCE)	<5	<5	<5	<5	<5	<5	<5
Trichlorofluoromethane							
1,2,3-Trichloropropane							
1,2,4-Trimethylbenzene	<5	<5	**59**	**15**	<5	<5	<5
1,3,5-Trimethylbenzene	<5	<5	**34**	**7.6**	<5	<5	<5
Vinyl Chloride							
m&p-Xylene	<5	<5	**180**	**110**	<5	<5	<5
o-Xylene	<5	<5	**72**	**60**	<5	<5	<5
Xylenes (total)							
Total VOCs	**280**	**490**	**1,413**	**17,826**	**170**	**17,037**	**21,000**
Total Chlorinated VOCs	<20	<20	**113**	**1,262**	<20	**37**	<20
Total BTEX	<5	<5	**745**	**929**	<5	<5	<5

Table 10. Summary of VOCs Detected in Well Boring Soil Samples, July 1999,
Brenntag HCI/Chemtech, 2235 W. Battlefield Rd., Springfield, Missouri.

Well Name Sample Depth ft bgs Sample Date	MW-11 3 7/14/99 (ug/kg)	MW-11 5 7/14/99 (ug/kg)	MW-12 5 7/14/99 (ug/kg)	MW-13 3 7/15/99 (ug/kg)	EW-5 3 7/16/99 (ug/kg)	EW-5 5 7/16/99 (ug/kg)	EW-5 7 7/16/99 (ug/kg)
Acetone	**130**	**180**	**270**	**420**	**18000**	**9000**	**17000**
Benzene	<5	<5	<5	<5	<500	<130	<130
Bromobenzene							
Bromochloromethane							
Bromodichloromethane							
Bromoform							
Bromomethane							
2-Butanone (MEK)	<100	<100	<100	<100	<10000	<2500	<2500
n-Butylbenzene							
sec-Butylbenzene	<5	<5	<5	<5	**840**	<130	<130
tert-Butylbenzene							
Carbon Tetrachloride							
Chlorobenzene							
Chloroethane	<5	<5	<5	<5	<500	<130	<130
Chloroform	<5	<5	<5	<5	<500	<130	<130
Chloromethane							
2-Chlorotoluene							
4-Chlorotoluene							
Dibromochloromethane							
1,2-Dibromo-3-chloropropane							
1,2-Dibromoethane (EDB)							
Dibromomethane							
1,2-Dichlorobenzene							
1,3-Dichlorobenzene							
1,4-Dichlorobenzene							
Dichlorodifluoromethane							
1,1-Dichloroethane	<5	<5	<5	<5	<500	<130	<130
1,2-Dichloroethane	<5	<5	<5	<5	<500	<130	<130
1,1-Dichloroethene	<5	<5	<5	<5	<500	<130	<130
cis-1,2-Dichloroethene	<5	<5	<5	<5	<500	<130	<130
trans-1,2-Dichloroethene							
1,2-Dichloroethene (total)							
1,2-Dichloropropane							
1,3-Dichloropropane							
2,2-Dichloropropane							
1,1-Dichloropropene							
cis-1,3-Dichloropropene							
trans-1,3-Dichloropropene							
Ethylbenzene	<5	<5	<5	**37**	**4000**	**560**	**400**
Hexachlorobutadiene							
2-Hexanone							
Isopropylbenzene (Cumene)	<5	<5	<5	**9.8**	**1900**	**140**	**220**
p-Isopropyltoluene	<5	<5	<5	**8.6**	**3400**	**240**	**320**
4-Methyl-2-pentanone (MIBK)	<50	<50	<50	<50	<5000	<1300	<1300
Methylene Chloride	<20	<20	<20	<20	<2000	<500	<500
Naphthalene	<5	<5	<5	**76**	**4400**	<130	**900**
n-Propylbenzene	<5	<5	<5	**18**	**2300**	**260**	**530**
Styrene							
1,1,1,2-Tetrachloroethane							
1,1,2,2-Tetrachloroethane							
Tetrachloroethene (PCE)	<5	<5	<5	<5	<500	**160**	<130
Toluene	<5	<5	<5	**49**	**17000**	**1600**	**190**
1,2,3-Trichlorobenzene							
1,2,4-Trichlorobenzene							
1,1,1-Trichloroethane							
1,1,2-Trichloroethane							
Trichloroethene (TCE)	<5	<5	<5	<5	<500	**440**	<130
Trichlorofluoromethane							
1,2,3-Trichloropropane							
1,2,4-Trimethylbenzene	<5	<5	<5	**73**	**23000**	**950**	**1800**
1,3,5-Trimethylbenzene	<5	<5	<5	**38**	**23000**	**950**	**1100**
Vinyl Chloride							
m&p-Xylene	<5	<5	<5	**98**	**49000**	**2700**	**1900**
o-Xylene	<5	<5	<5	**32**	**21000**	**1100**	**550**
Xylenes (total)							
Total VOCs	**130**	**180**	**270**	**859**	**167,840**	**18,100**	**24,910**
Total Chlorinated VOCs	<20	<20	<20	<20	<2000	**600**	<500
Total BTEX	<5	<5	<5	**216**	**91,000**	**5,960**	**3,040**

Table 11. Summary of VOCs Detected in Geoprobe Groundwater Samples, September 1999,
Brenntag HCI/Chemtech, 2235 W. Battlefield Rd., Springfield, Missouri.

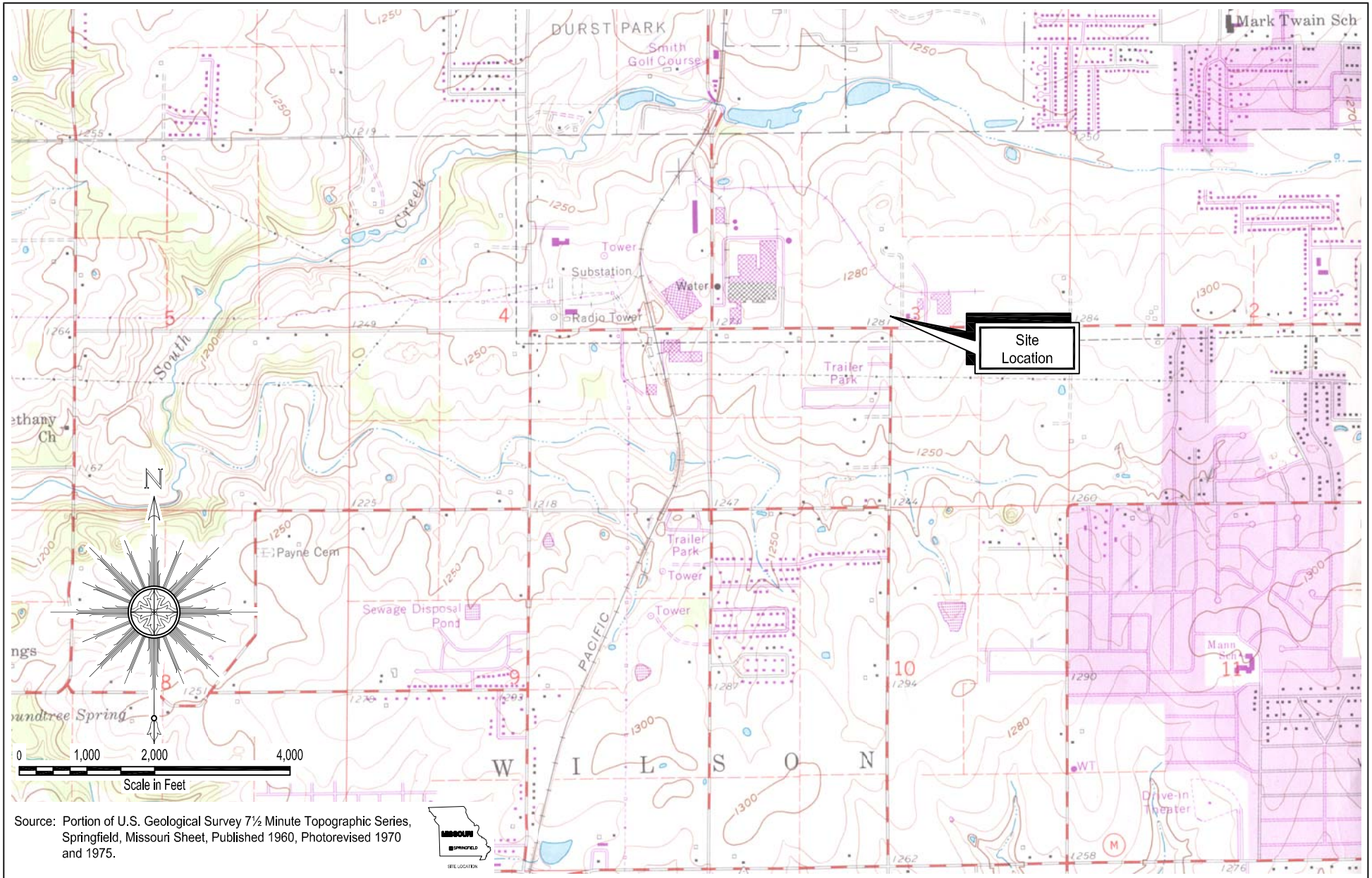
Sample Name Sample Date	CALM (ug/L)	MCLs (ug/L)	GP-1 9/15/99 (ug/L)	GP-2 9/15/99 (ug/L)	GP-2 Dup 9/15/99 (ug/L)	GP-3 9/15/99 (ug/L)	GP-5 9/16/99 (ug/L)	Blank 9/15/99 (ug/L)	Blank 9/15/99 (ug/L)
Acetone	4,000	-							
Benzene	5	5	**11**	**74**	**69**	<10	<10	<10	<10
Bromobenzene	-	-							
Bromochloromethane	-	-							
Bromodichloromethane	80	-							
Bromoform	-	-							
Bromomethane	-	-							
2-Butanone (MEK)	-	-							
n-Butylbenzene	-	-							
sec-Butylbenzene	-	-							
tert-Butylbenzene	-	-							
Carbon Tetrachloride	-	5							
Chlorobenzene	100	100							
Chloroethane	-	-	**25**	**216**	**218**	<10	<10	<10	<10
Chloroform	80		<10	<10	<10	<10	<10	<10	<10
Chloromethane	-	-							
2-Chlorotoluene	-	-							
4-Chlorotoluene	-	-							
Dibromochloromethane	-	-							
1,2-Dibromo-3-chloropropane	-	-							
1,2-Dibromoethane (EDB)	-	-							
Dibromomethane	-	5							
1,2-Dichlorobenzene	600	600	<10	<10	<10	<10	<10	<10	<10
1,3-Dichlorobenzene	-	-							
1,4-Dichlorobenzene	75	75							
Dichlorodifluoromethane	-	-							
1,1-Dichloroethane	-	-	**35**	<10	<10	**19**	**28**	<10	<10
1,2-Dichloroethane	5	5							
1,1-Dichloroethene	7	7	<10	<10	<10	<10	<10	<10	<10
cis-1,2-Dichloroethene	70	70	<10	<10	<10	<10	**147**	<10	<10
trans-1,2-Dichloroethene	100	100							
1,2-Dichloroethene (total)	-	-							
1,2-Dichloropropane	5	5							
1,3-Dichloropropane	-	-							
2,2-Dichloropropane	-	-							
1,1-Dichloropropene	-	-							
cis-1,3-Dichloropropene	-	-							
trans-1,3-Dichloropropene	-	-							
Ethylbenzene	700	700	<10	**38**	**37**	<10	<10	<10	<10
Hexachlorobutadiene	-	-							
2-Hexanone	-	-							
Isopropylbenzene (Cumene)	-	-							
p-Isopropyltoluene	-	-							
4-Methyl-2-pentanone (MIBK)	-	-							
Methylene Chloride	5	5							
Naphthalene	20	-							
n-Propylbenzene	-	-							
Styrene	-	100							
1,1,1,2-Tetrachloroethane	-	-							
1,1,2,2-Tetrachloroethane	-	-							
Tetrachloroethene (PCE)	5	5	<10	<10	<10	<10	<10	<10	<10
Toluene	150	1,000	<10	**352**	**557**	<10	<10	<10	<10
1,2,3-Trichlorobenzene	-	-							
1,2,4-Trichlorobenzene	-	70							
1,1,1-Trichloroethane	200	200	<10	<10	<10	<10	<10	<10	<10
1,1,2-Trichloroethane	-	5							
Trichloroethene (TCE)	5	5	<10	<10	<10	<10	**23**	<10	<10
Trichlorofluoromethane	-	-							
1,2,3-Trichloropropane	-	-							
1,2,4-Trimethylbenzene	-	-	<10	<10	<10	<10	<10	<10	<10
1,3,5-Trimethylbenzene	-	-	<10	<10	<10	<10	<10	<10	<10
Vinyl Chloride	2	2	<10	<10	<10	<10	**147**	<10	<10
m&p-Xylene	-	-	<10	**78**	**76**	<10	<10	<10	<10
o-Xylene	-	-	<10	**18**	**17**	<10	<10	<10	<10
Xylenes (total)	320	1,000							
Total VOCs			**71**	**776**	**974**	**19**	**345**	<10	<10
Total Chlorinated VOCs			**60**	**216**	**218**	**19**	**345**	<10	<10
Total BTEX			**11**	**560**	**756**	<10	<10	<10	<10

Table 12. Summary of VOCs Detected in Borehole Groundwater Samples, October 1999,
Brenntag HCl/Chemtech, 2235 W. Battlefield Rd., Springfield, Missouri.

Sample Name	CALM	MCLs	BH-6	BH-6 Dup	BH-11	BH-14	BH-15	BH-16	BH-17	BH-19	Blank
Sample Date	(ug/L)	(ug/L)	10/7/99 (ug/L)	10/7/99 (ug/L)	10/7/99 (ug/L)	10/7/99 (ug/L)	10/7/99 (ug/L)	10/7/99 (ug/L)	10/7/99 (ug/L)	10/7/99 (ug/L)	10/7/99 (ug/L)
Acetone	4,000	-									
Benzene	5	5	<5	<5	<5	**190**	**131**	<5	<5	<5	<5
Bromobenzene	-	-									
Bromochloromethane	-	-									
Bromodichloromethane	80	-									
Bromoform	-	-									
Bromomethane	-	-									
2-Butanone (MEK)	-	-									
n-Butylbenzene	-	-	<5	<5	<5	<5	**1600**	<5	<5	<5	<5
sec-Butylbenzene	-	-									
tert-Butylbenzene	-	-									
Carbon Tetrachloride	-	5									
Chlorobenzene	100	100									
Chloroethane	-	-	<5	<5	<5	**1600**	<100	<5	<5	<5	<5
Chloroform	80		<5	<5	**160**	<5	<100	**6**	<5	**139**	<5
Chloromethane	-	-									
2-Chlorotoluene	-	-									
4-Chlorotoluene	-	-									
Dibromochloromethane	-	-									
1,2-Dibromo-3-chloropropane	-	-									
1,2-Dibromoethane (EDB)	-	-									
Dibromomethane	-	5									
1,2-Dichlorobenzene	600	600									
1,3-Dichlorobenzene	-	-									
1,4-Dichlorobenzene	75	75									
Dichlorodifluoromethane	-	-									
1,1-Dichloroethane	-	-	<5	<5	**6**	**34**	**3530**	**32**	**32**	**6**	<5
1,2-Dichloroethane	5	5	<5	<5	<5	**45**	**380**	**19**	<5	**11**	<5
1,1-Dichloroethene	7	7	<5	<5	<5	<5	**460**	<5	<5	<5	<5
cis-1,2-Dichloroethene	70	70	<5	<5	**160**	<5	**16480**	**6**	<5	**139**	<5
trans-1,2-Dichloroethene	100	100									
1,2-Dichloroethene (total)	-	-									
1,2-Dichloropropane	5	5									
1,3-Dichloropropane	-	-									
2,2-Dichloropropane	-	-									
1,1-Dichloropropene	-	-									
cis-1,3-Dichloropropene	-	-									
trans-1,3-Dichloropropene	-	-									
Ethylbenzene	700	700	<5	<5	<5	**3280**	**11000 >**	**36**	<5	**5**	<5
Hexachlorobutadiene	-	-									
2-Hexanone	-	-									
Isopropylbenzene (Cumene)	-	-									
p-Isopropyltoluene	-	-									
4-Methyl-2-pentanone (MIBK)	-	-									
Methylene Chloride	5	5									
Naphthalene	20	-	<5	<5	<5	<5	**2980**	<5	<5	<5	<5
n-Propylbenzene	-	-	<5	<5	<5	**110**	**2560**	<5	<5	<5	<5
Styrene	-	100									
1,1,1,2-Tetrachloroethane	-	-									
1,1,2,2-Tetrachloroethane	-	-									
Tetrachloroethene (PCE)	5	5	<5	<5	<5	<5	**730**	**11**	<5	**7**	<5
Toluene	150	1,000	<5	<5	<5	**20150**	**27000 >**	<5	<5	<5	<5
1,2,3-Trichlorobenzene	-	-									
1,2,4-Trichlorobenzene	-	70									
1,1,1-Trichloroethane	200	200	<5	<5	<5	<5	**1750**	<5	<5	<5	<5
1,1,2-Trichloroethane	-	5									
Trichloroethene (TCE)	5	5	<5	<5	**10**	<5	**171**	<5	<5	<5	<5
Trichlorofluoromethane	-	-									
1,2,3-Trichloropropane	-	-									
1,2,4-Trimethylbenzene	-	-	<5	<5	<5	**420**	**4260**	<5	<5	<5	<5
1,3,5-Trimethylbenzene	-	-	<5	<5	<5	**210**	**2670**	<5	<5	<5	<5
Vinyl Chloride	2	2	<5	<5	**9**	<5	**200**	**82**	<5	<5	<5
m&p-Xylene	-	-	<5	<5	<5	**8810**	**17000 >**	**13**	<5	**9**	<5
o-Xylene	-	-	<5	<5	<5	**2990**	**10000 >**	**12**	<5	<5	<5
Xylenes (total)	320	1,000									
Total VOCs			<5	<5	**345**	**37,839**	**102,902**	**217**	**32**	**316**	<5
Total Chlorinated VOCs			<5	<5	**345**	**1,679**	**23,701**	**156**	**32**	**302**	<5
Total BTEX			<5	<5	<5	**35,420**	**65,131**	**61**	<5	**14**	<5

Table 13. Target Compound List of VOCs for Analysis Using USEPA SW-846 Method 8260B, Brenntag/HCI Chemtech, 2235 W. Battlefield Rd., Springfield, Missouri.

Analytes	CAS Reference No.
Acetone	67-64-1
Benzene	71-43-2
Bromobenzene	108-86-1
Bromochloromethane	74-97-5
Bromodichloromethane	75-27-4
Bromoform	75-25-2
Bromomethane	74-83-9
2-Butanone (MEK)	78-93-3
n-Butylbenzene	104-51-8
sec-Butylbenzene	135-98-8
tert-Butylbenzene	98-54-4
Carbon tetrachloride	56-23-5
Chlorobenzene	108-90-7
Chloroethane	75-00-3
Chloroform	67-66-3
Chloromethane	74-87-3
2-Chlorotoluene	95-49-8
4-Chlorotoluene	106-43-4
Dibromochloromethane	124-48-1
1,2-Dibromo-3-chloropropane	96-12-8
1,2-Dibromoethane (EDB)	106-93-4
Dibromomethane	74-95-3
1,2-Dichlorobenzene	95-50-1
1,3-Dichlorobenzene	541-73-1
1,4-Dichlorobenzene	106-46-7
Dichlorodifluoromethane	75-71-8
1,1-Dichloroethane	75-34-3
1,2-Dichloroethane	107-06-2
1,1-Dichloroethene	75-35-4
cis-1,2-Dichloroethene	156-59-2
trans-1,2-Dichloroethene	156-60-5
1,2-Dichloropropane	78-87-5
1,3-Dichloropropane	143-28-9
2,2-Dichloropropane	594-20-7
1,1-Dichloropropene	563-58-6
cis-1,3-Dichloropropene	10061-01-5
trans-1,3-Dichloropropene	10061-02-6
Ethylbenzene	100-41-4
Hexachlorobutadiene	87-68-3
2-Hexanone	591-78-6
Isopropylbenzene (cumene)	98-82-8
p-Isopropyltoluene	99-86-5
4-Methyl-2-pentanone (MIBK)	108-10-1
Methylene chloride	75-09-2
Naphthalene	91-20-3
n-Propylbenzene	103-65-1
Styrene	100-42-5
1,1,1,2-Tetrachloroethane	630-20-6
1,1,2,2-Tetrachloroethane	79-34-5
Tetrachloroethene (PCE)	127-18-4
Toluene	108-88-3
1,2,3-Trichlorobenzene	87-61-6
1,2,4-Trichlorobenzene	120-82-1
1,1,1-Trichloroethane	71-55-6
1,1,2-Trichloroethane	79-00-5
Trichloroethene (TCE)	79-01-6
Trichlorofluoromethane	75-69-4
1,2,3-Trichloropropane	96-18-4
1,2,4-Trimethylbenzene	95-63-6
1,3,5-Trimethylbenzene	79-34-5
Vinyl chloride	75-01-4
m-Xylene	108-38-3
p-Xylene	106-42-3
o-Xylene	95-47-6



Source: Portion of U.S. Geological Survey 7½ Minute Topographic Series, Springfield, Missouri Sheet, Published 1960, Photorevised 1970 and 1975.

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Brenntag/HCI Chemtech
2235 W. Battlefield Rd.

Site Location - Topographic Map

Springfield, Missouri

Project Number	OK001255.0036
Drawing Date	21 June 2007
Figure	1

BRENNTAG/HCI Chemtech
2235 W. Battlefield Rd.
Springfield, Missouri

Vicinity Map - Aerial Photo

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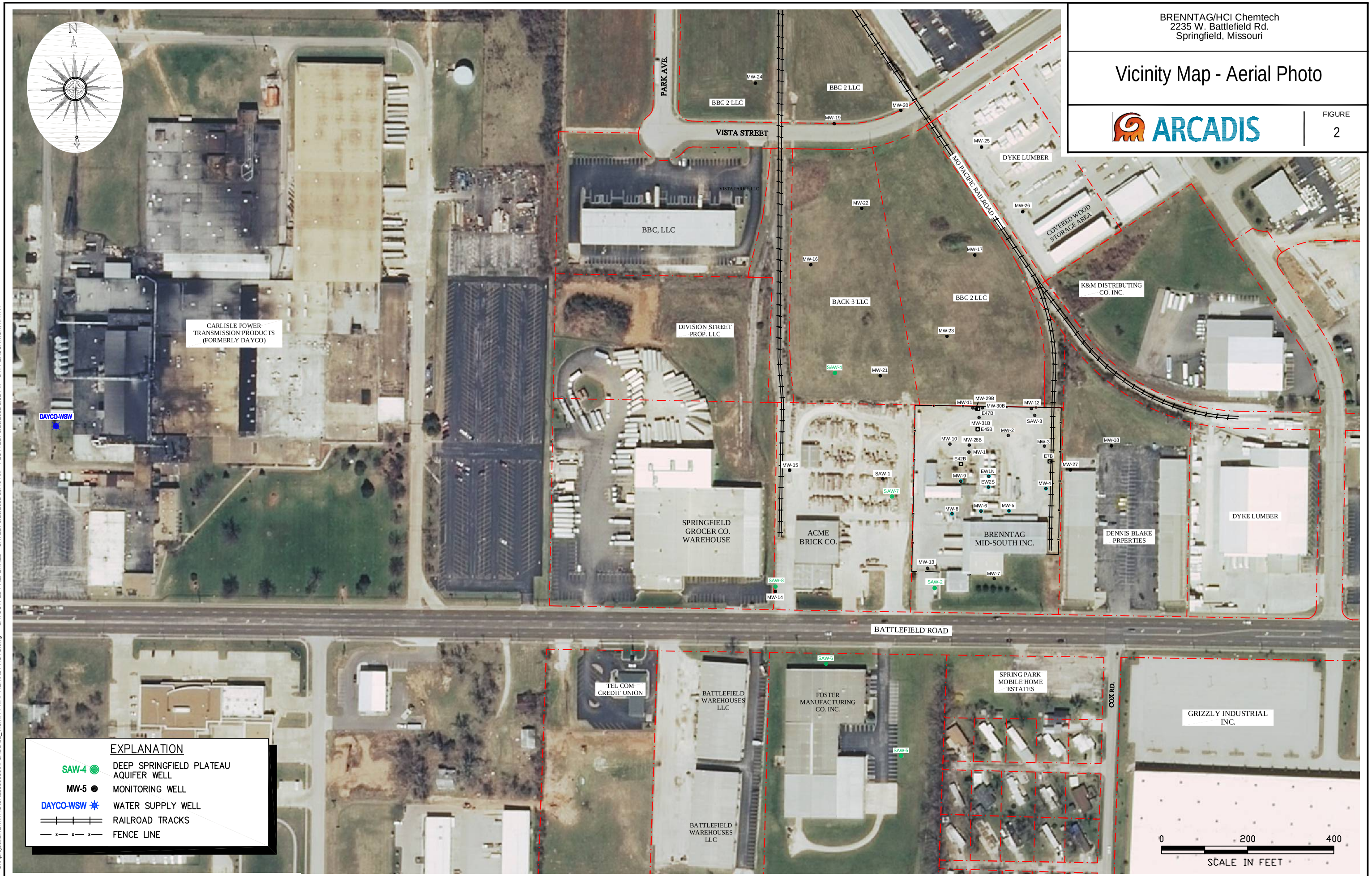
FIGURE
2



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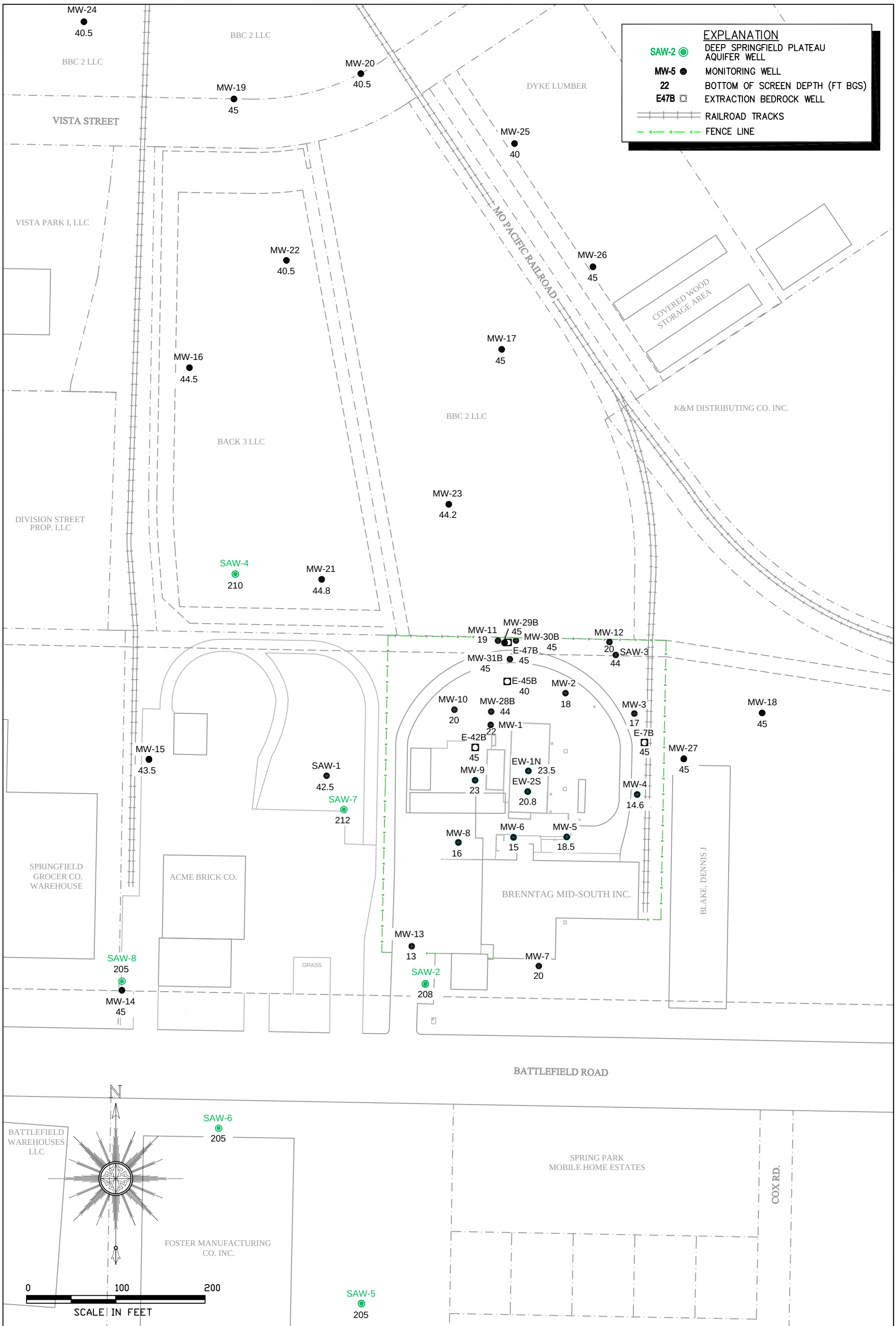

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Project Number: OK001255.0036
Drawing Date: 8-03-10
Figure: 3a

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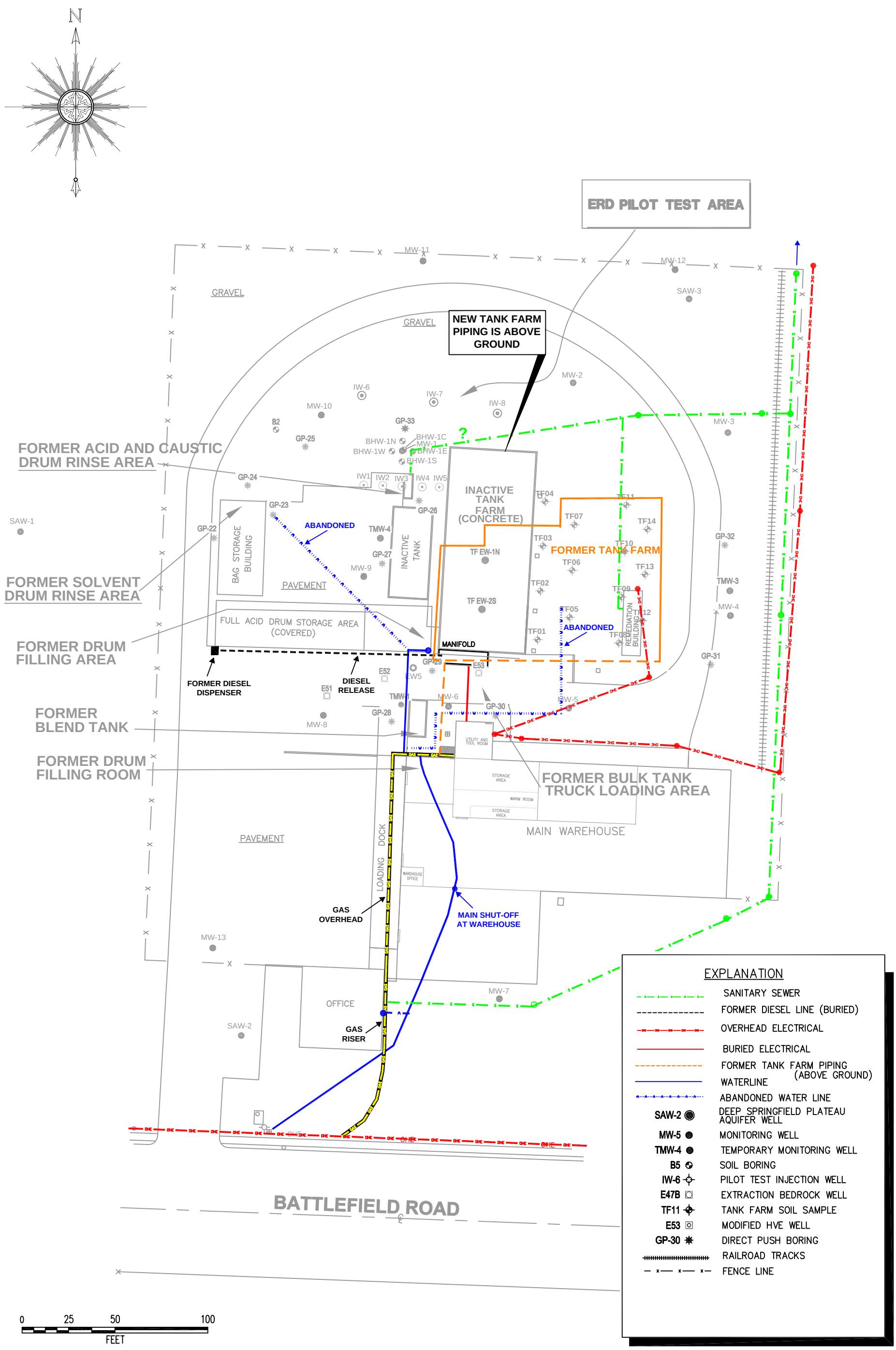

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Brenntag/HCl Chemtech
2235 W. Battlefield Rd.

Site Map - Utilities

Springfield, Missouri

Project Number	OK001255.0036
Drawing Date	17 November 2009
Figure	3b

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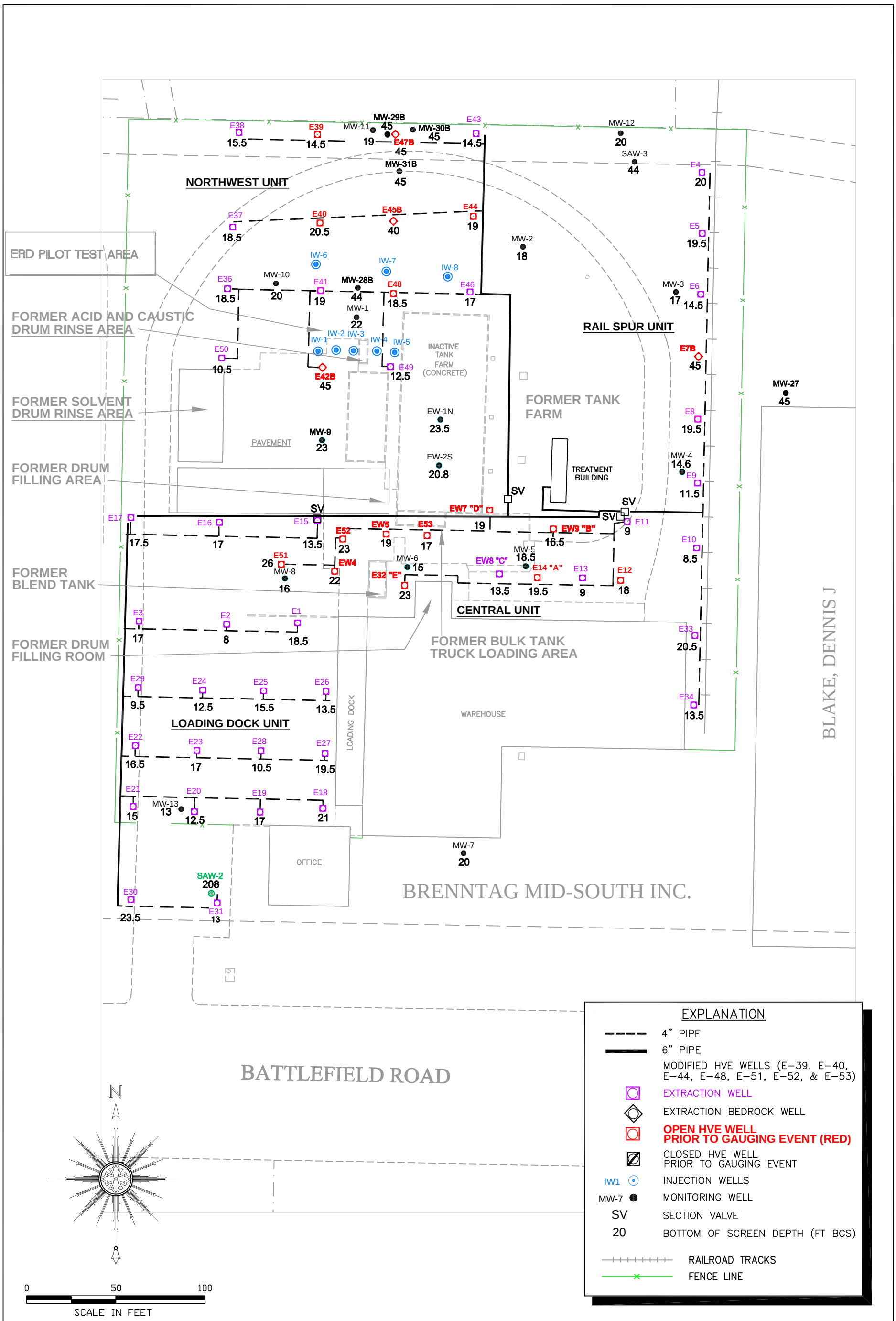

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Project Manager: W._FRENCH			Drawing Date: 6-16-10
Task Manager: W._FRENCH			Figure: 4
Technical Review: W._FRENCH			

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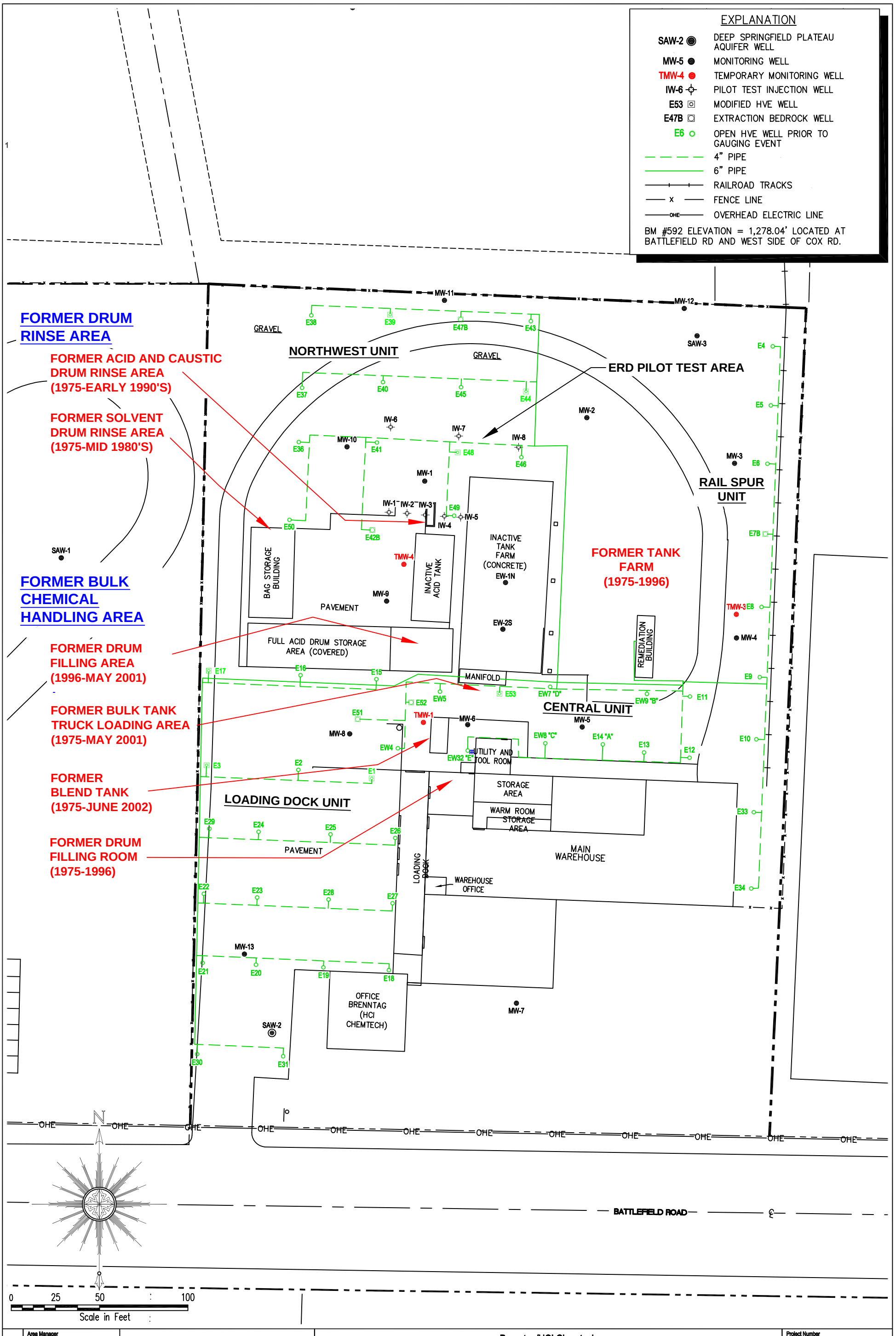

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Brenntag/HCI Chemtech
2235 W. Battlefield Rd.

Previous Site Operations

Springfield, Missouri

Project Number	OK001255.0036
Drawing Date	26 June 2007
Figure	5

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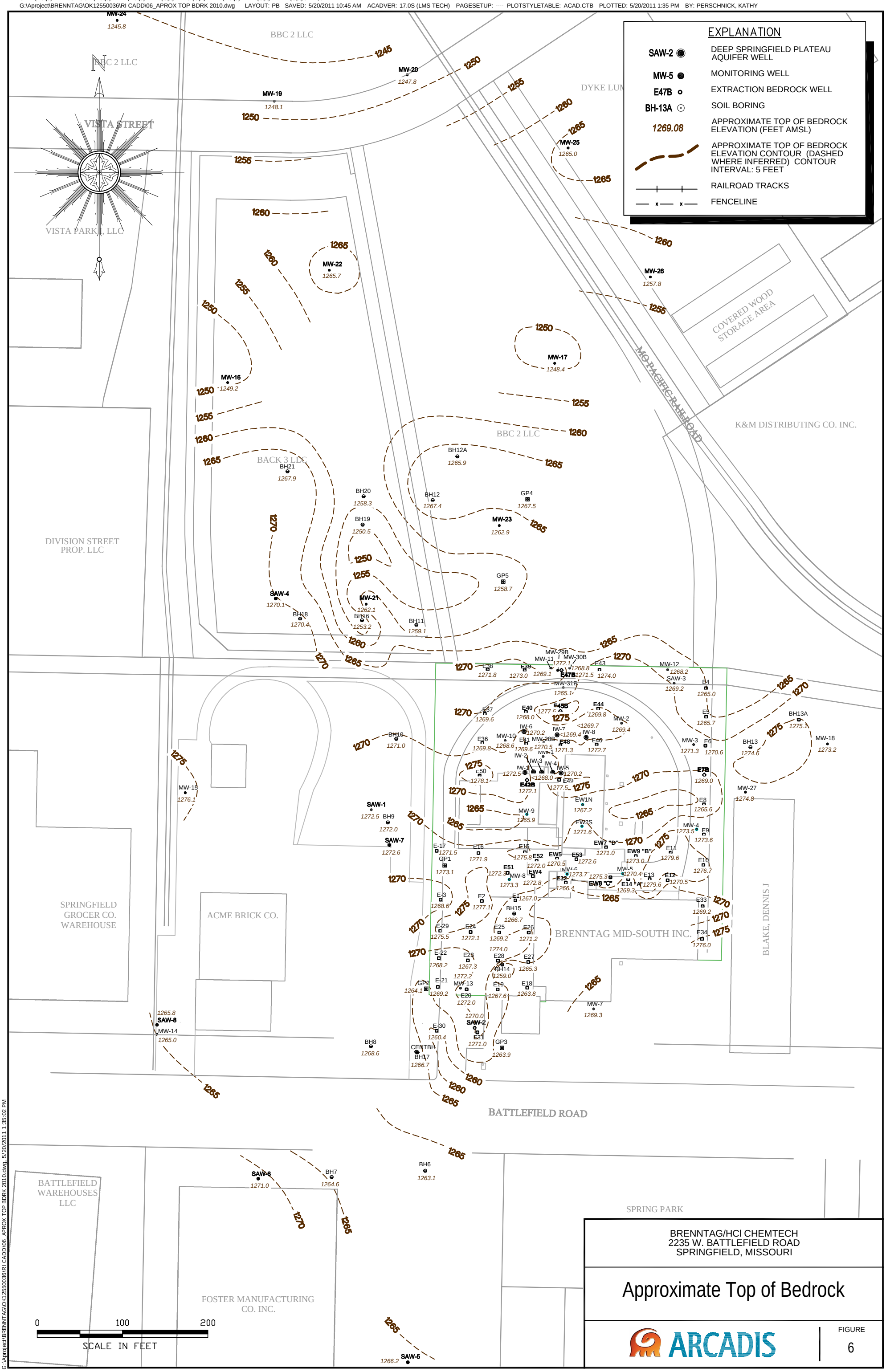

BRENNTAG/HCI CHEMTECH
2235 W. BATTLEFIELD ROAD
SPRINGFIELD, MISSOURI

Approximate Top of Bedrock

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FIGURE
6

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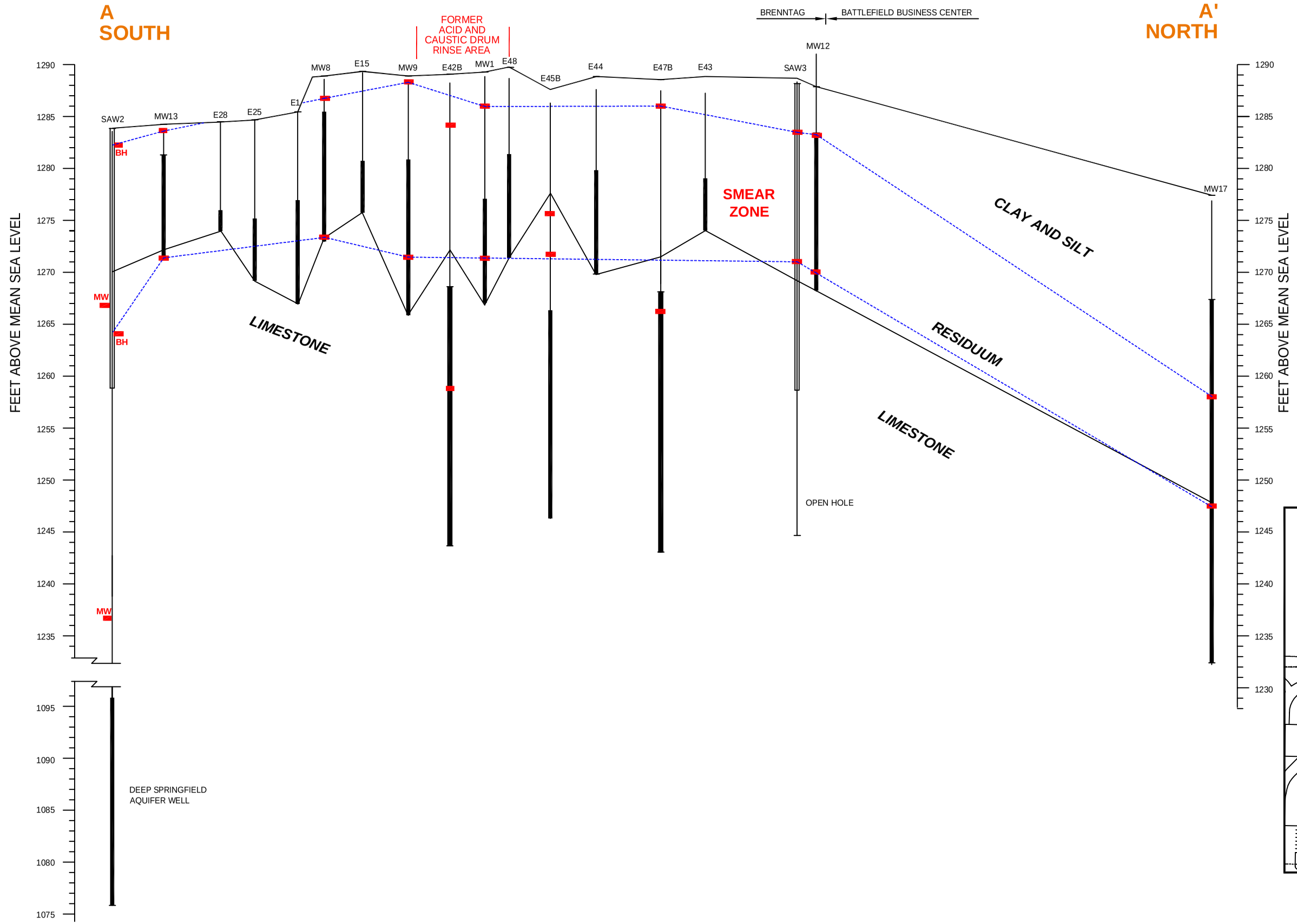


KEY TO SYMBOLS

APPROXIMATE RANGE-WATER ELEVATIONS

CASING

SCREEN

SURFACE CASING

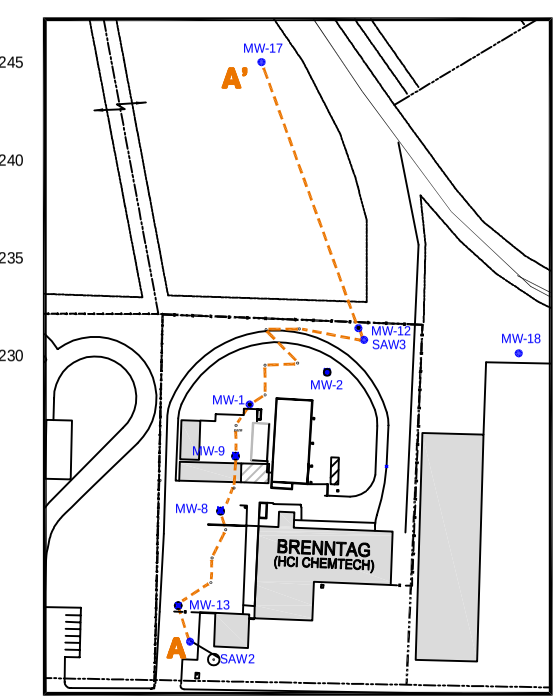
OPEN HOLE

10

0

100

GRAPHICS SCALE (FEET)



CROSS SECTION TRACE

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2235 W. Battlefield Rd.

Hydrogeologic Cross Section A - A'

Springfield, Missouri

Project Number	OK001255.0036
Drawing Date	3 December 2010
Figure	7

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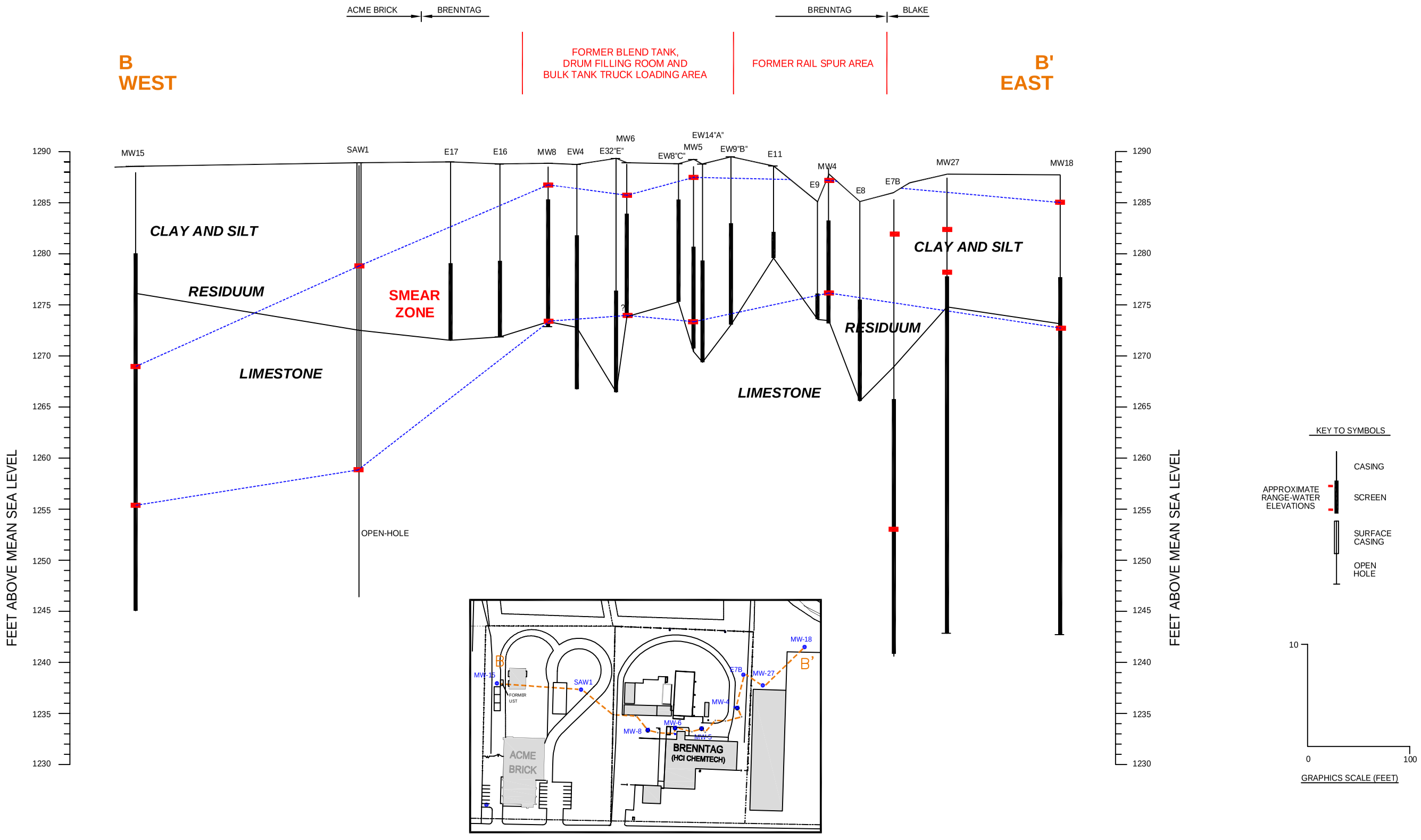

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Hydrogeologic Cross Section B - B'

Springfield, Missouri

Project Number	
Drawing Date	12 December 2010
Figure	8

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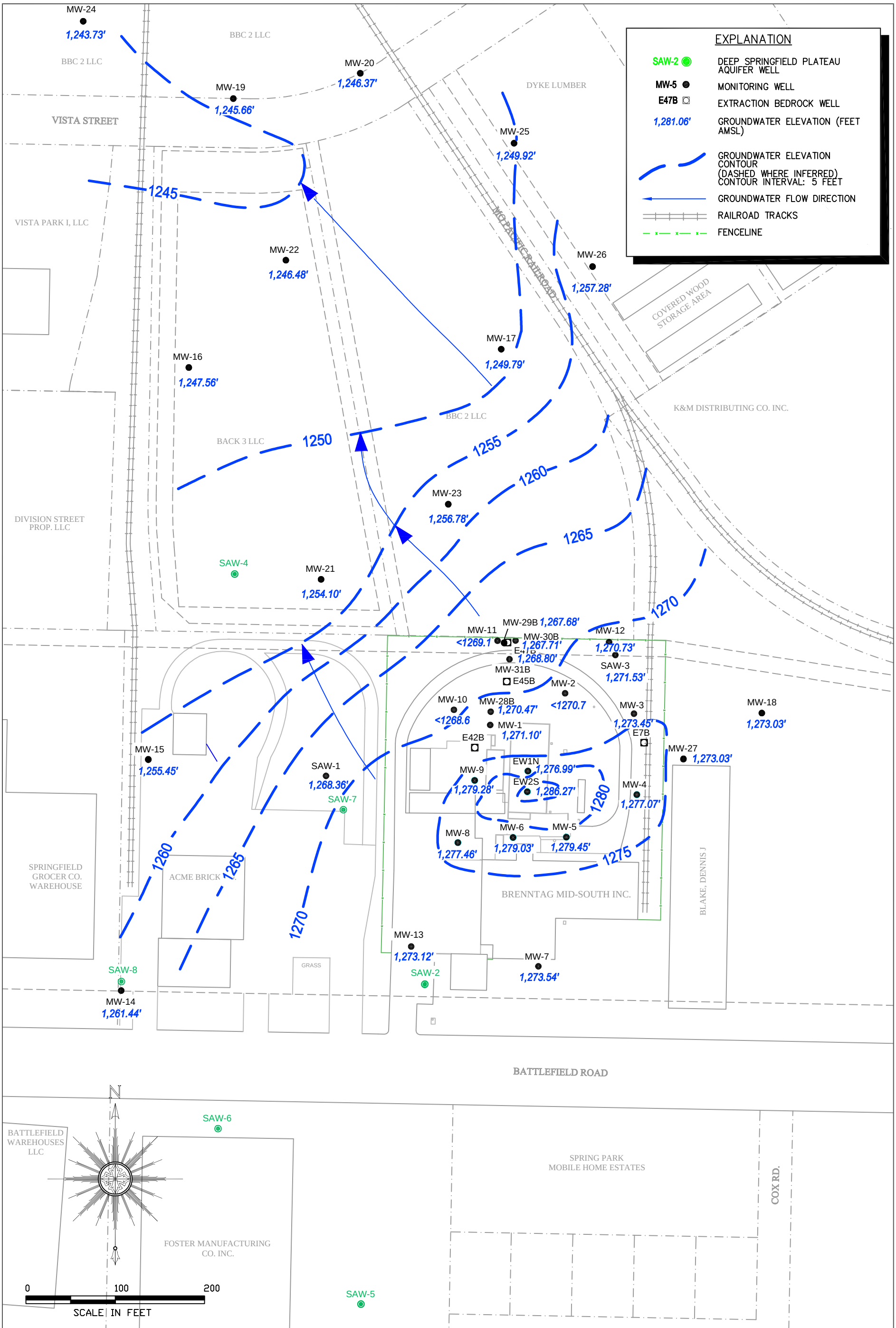

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Project Manager	W._FRENCH
Task Manager	W._FRENCH
Technical Review	W._FRENCH

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Brenntag/HCI Chemtech
2235 W. Battlefield Rd.

Groundwater Elevation Map
November 1, 2010

Springfield, Missouri

Project Number	OK001255.0036
Drawing Date	4-6-11
Figure	9a

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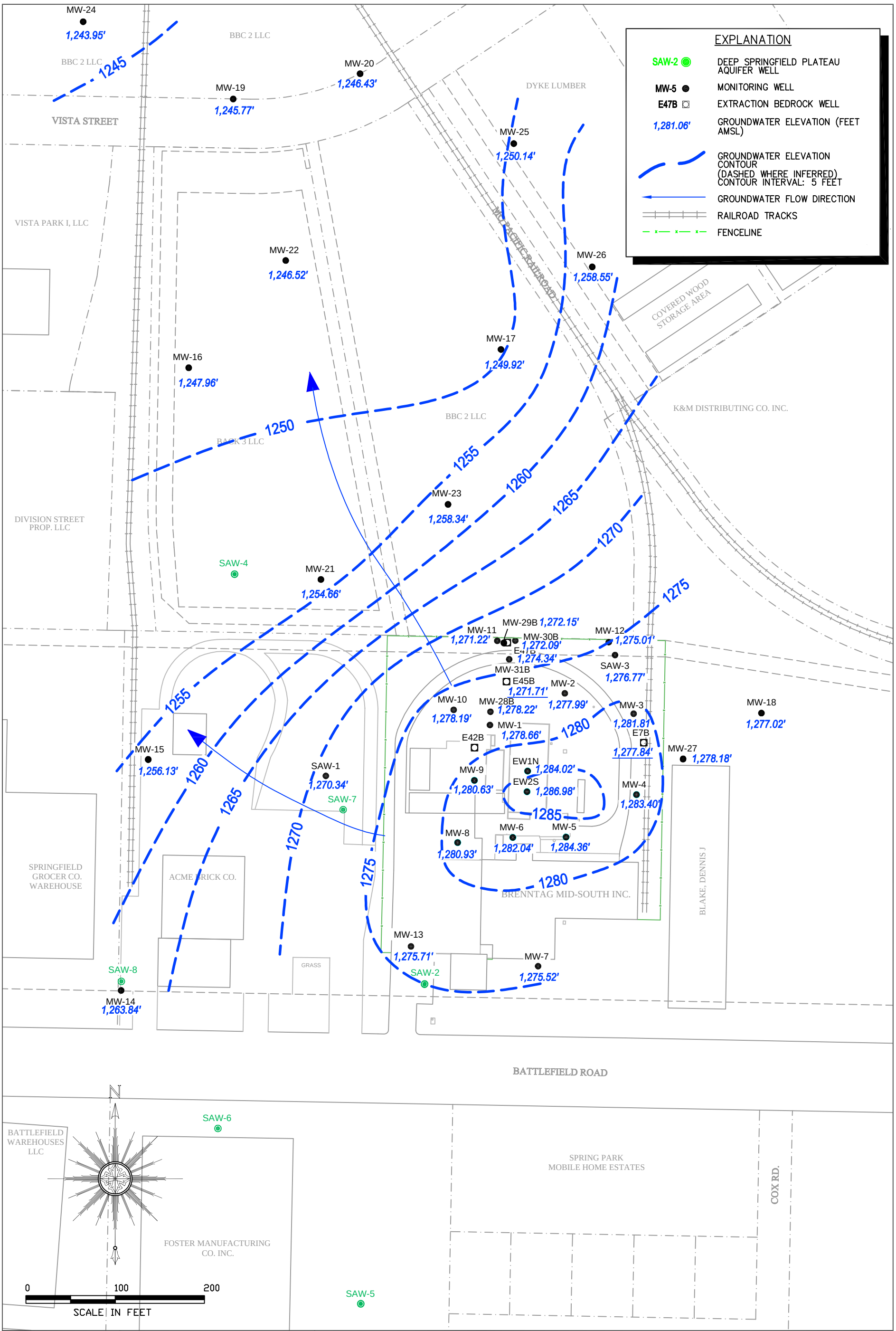

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Groundwater Elevation Map
August 2, 2010

Springfield, Missouri

Project Number	OK001255.0036
Drawing Date	9-9-10
Figure	9b

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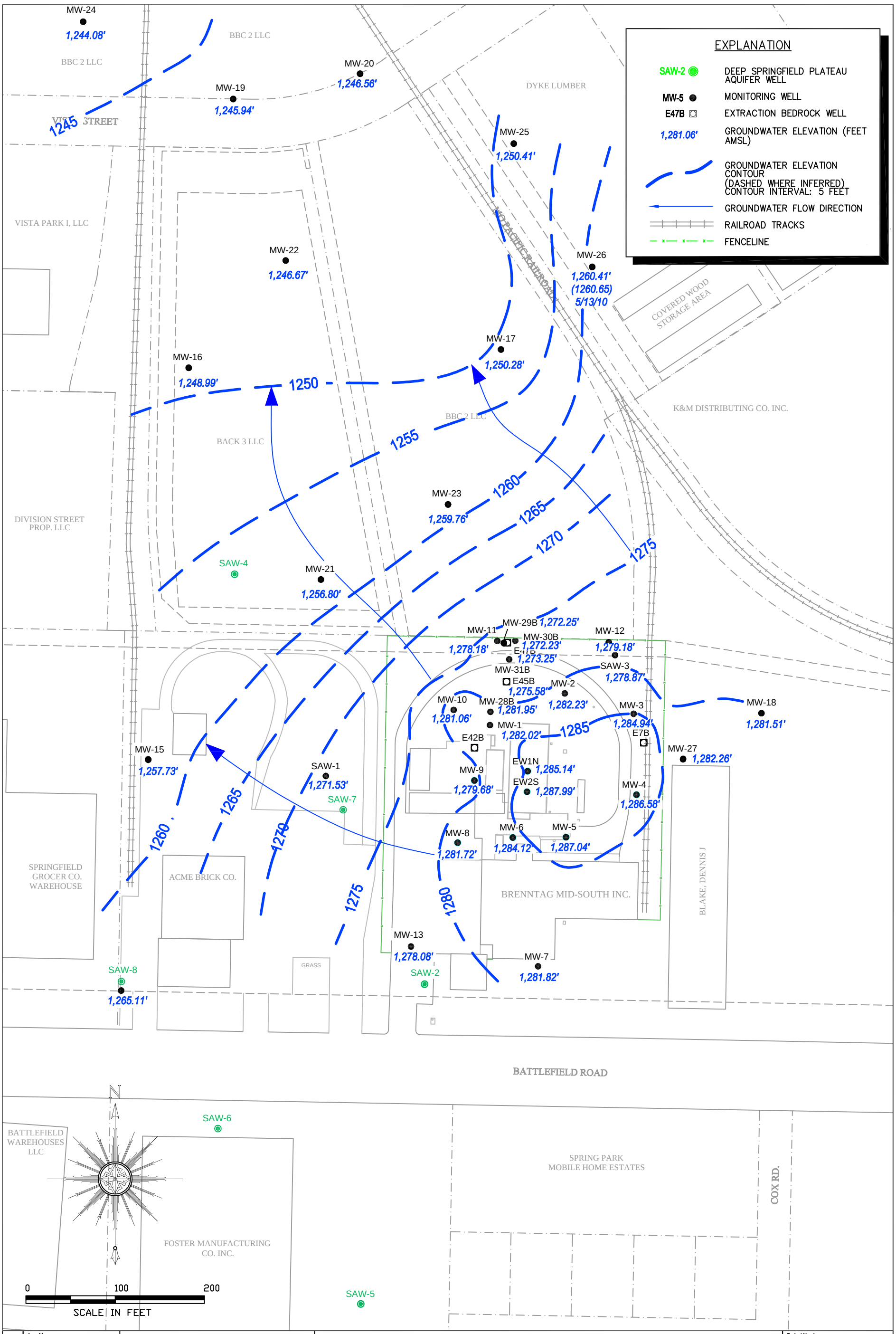

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Groundwater Elevation Map
May 10, 2010

Springfield, Missouri

Project Number	OK001255.0036
Drawing Date	6-10-10
Figure	9c

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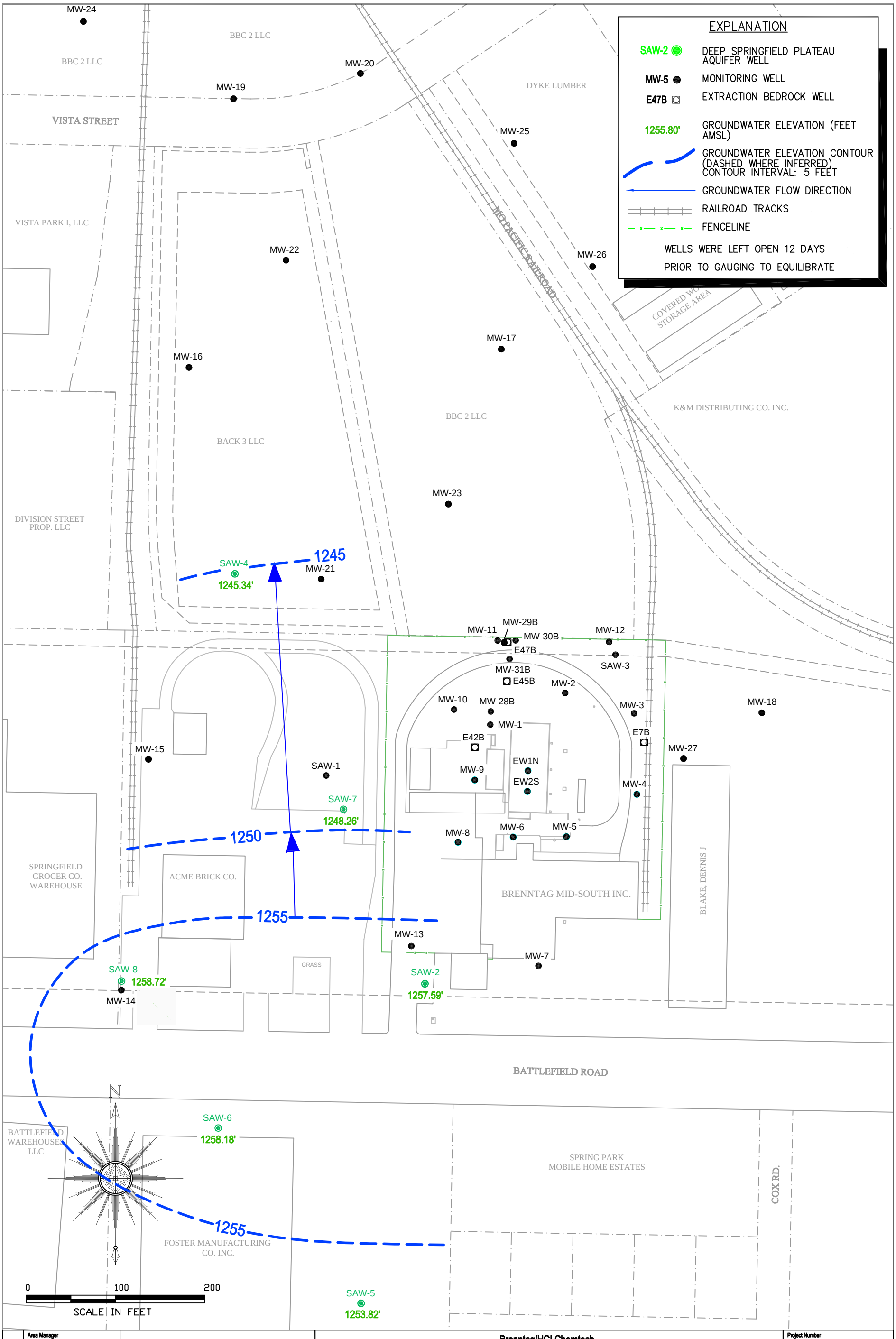

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Potentiometric Surface Map
Deep Springfield Plateau Aquifer
December 13, 2010

Springfield, Missouri

Project Number	OK001255.0036
Drawing Date	11-8-10
Figure	10a

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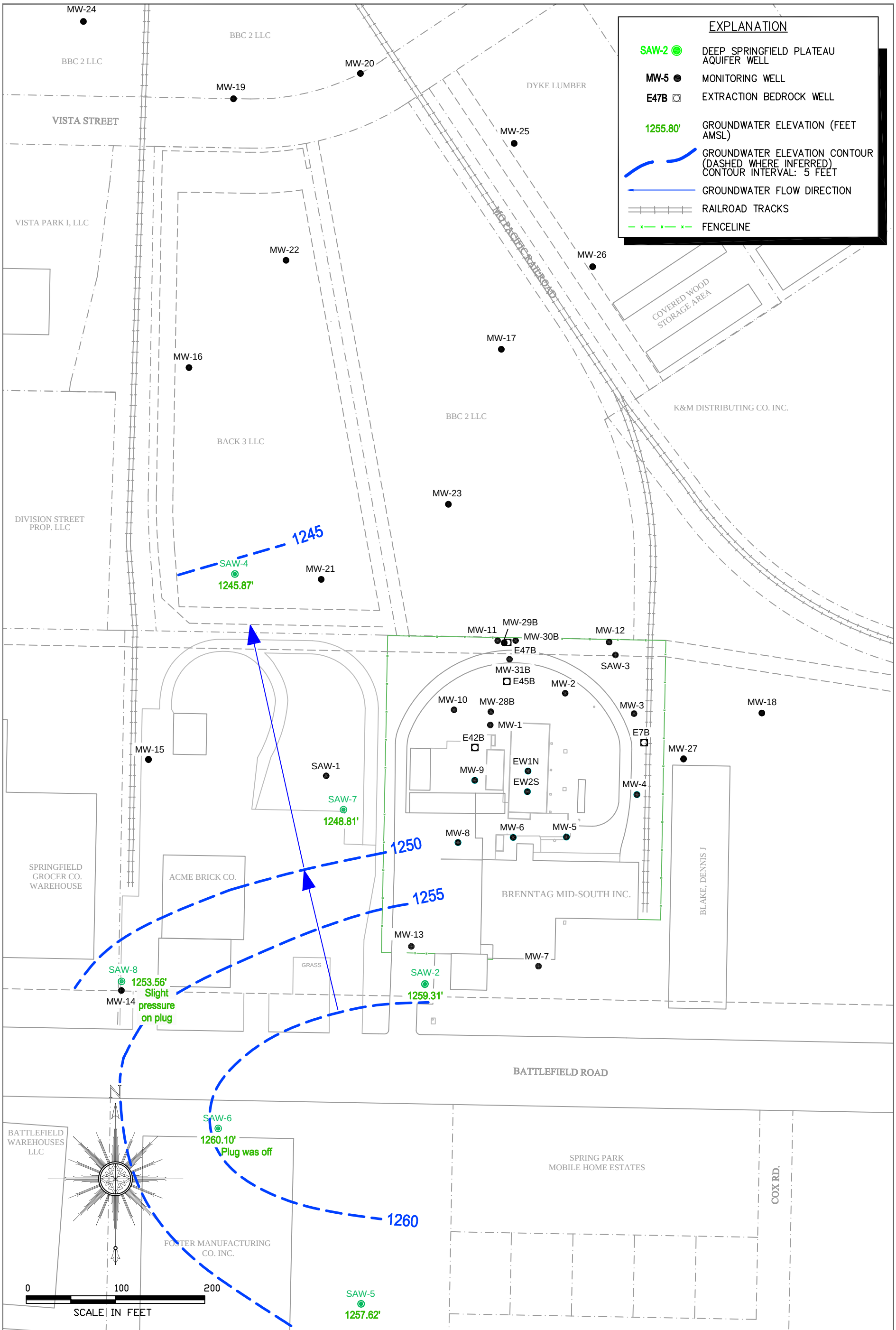

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Potentiometric Surface Map
Deep Springfield Plateau Aquifer
December 1, 2010

Springfield, Missouri

Project Number	OK001255.0036
Drawing Date	11-8-10
Figure	10b

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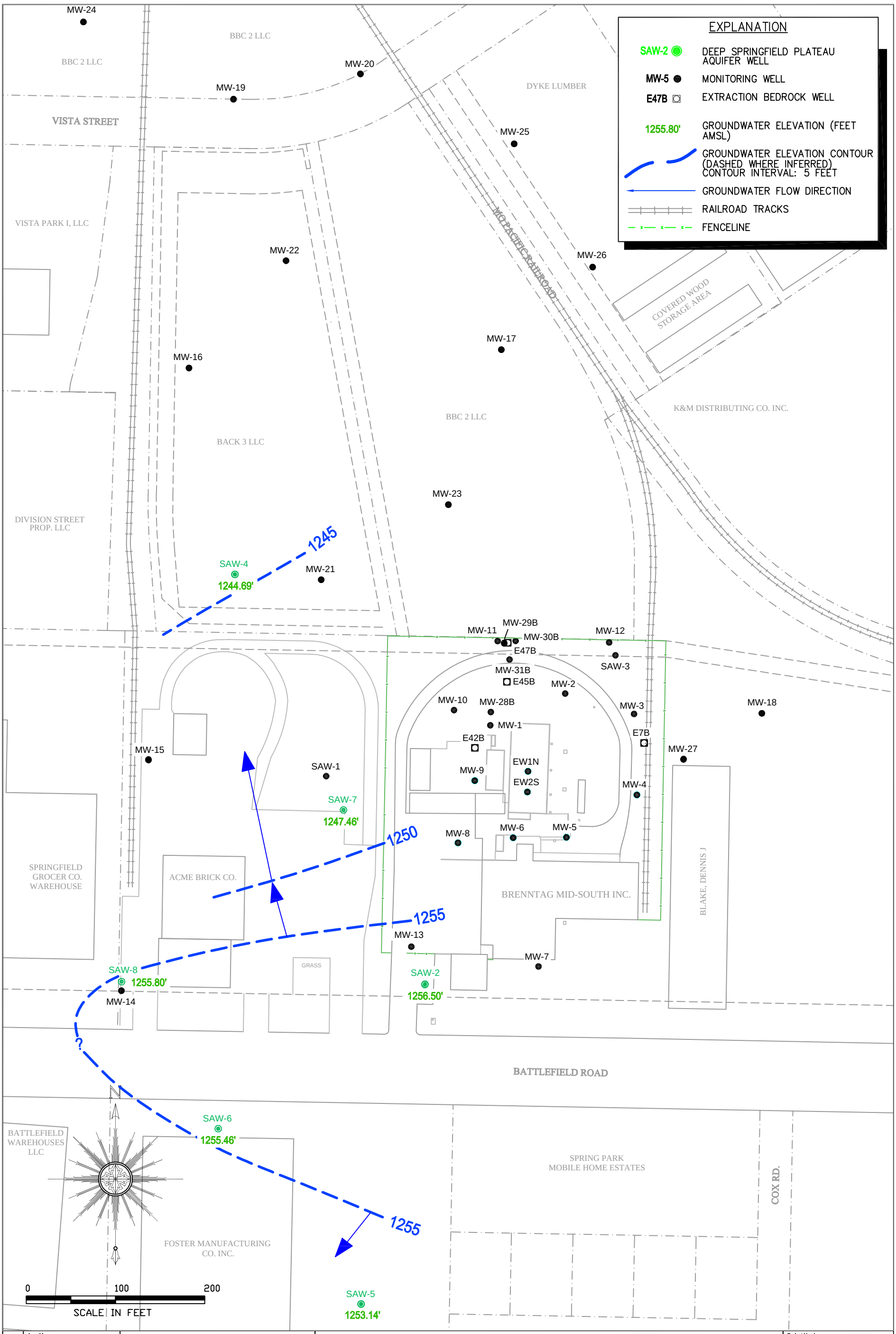

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Project Number: OK001255.0036
Drawing Date: 11-8-10
Figure: 10c

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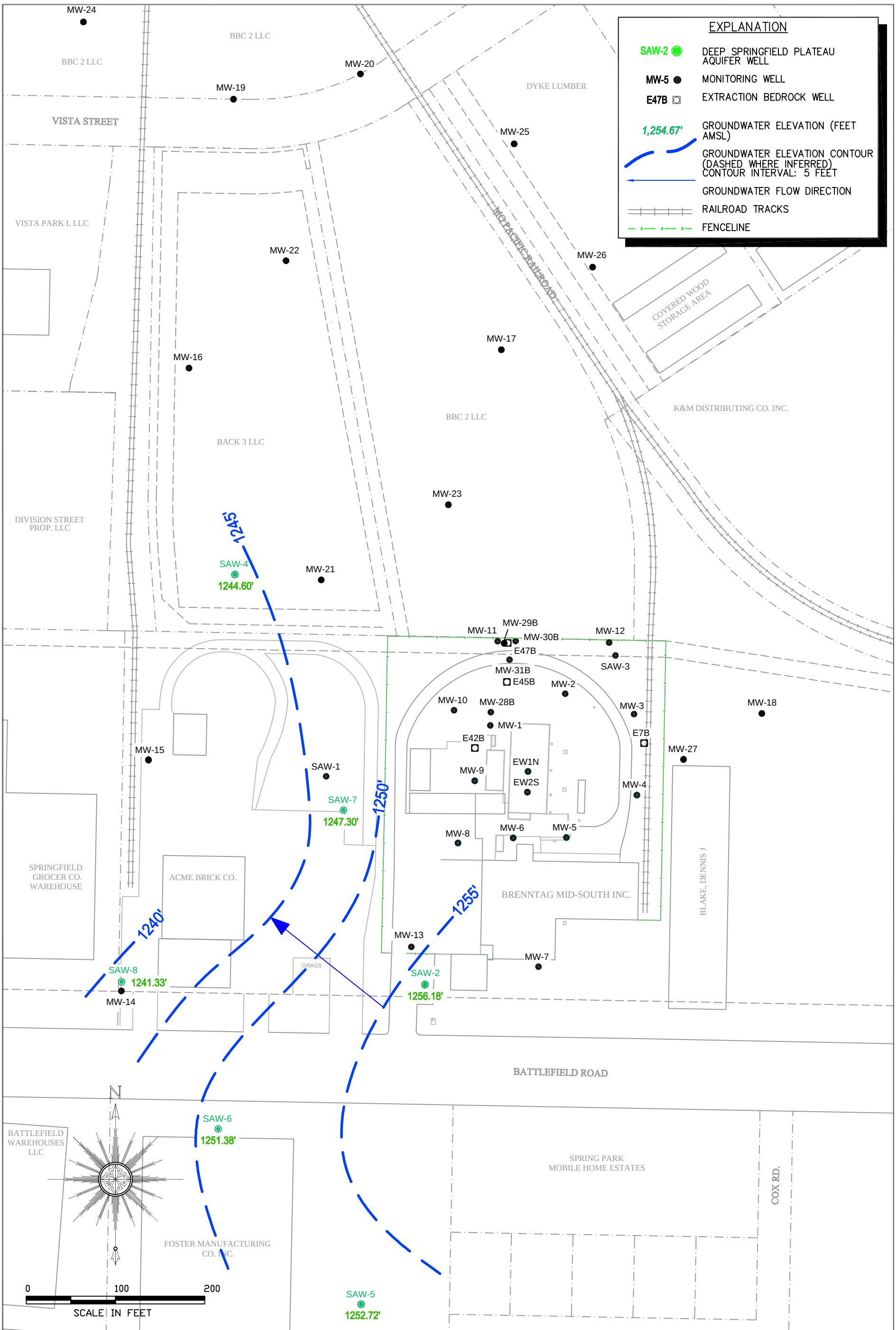

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Potentiometric Surface Map
Deep Springfield Plateau Aquifer
August 27, 2010

Springfield, Missouri

Project Number	OK001255.0036
Drawing Date	11-8-10
Figure	10d

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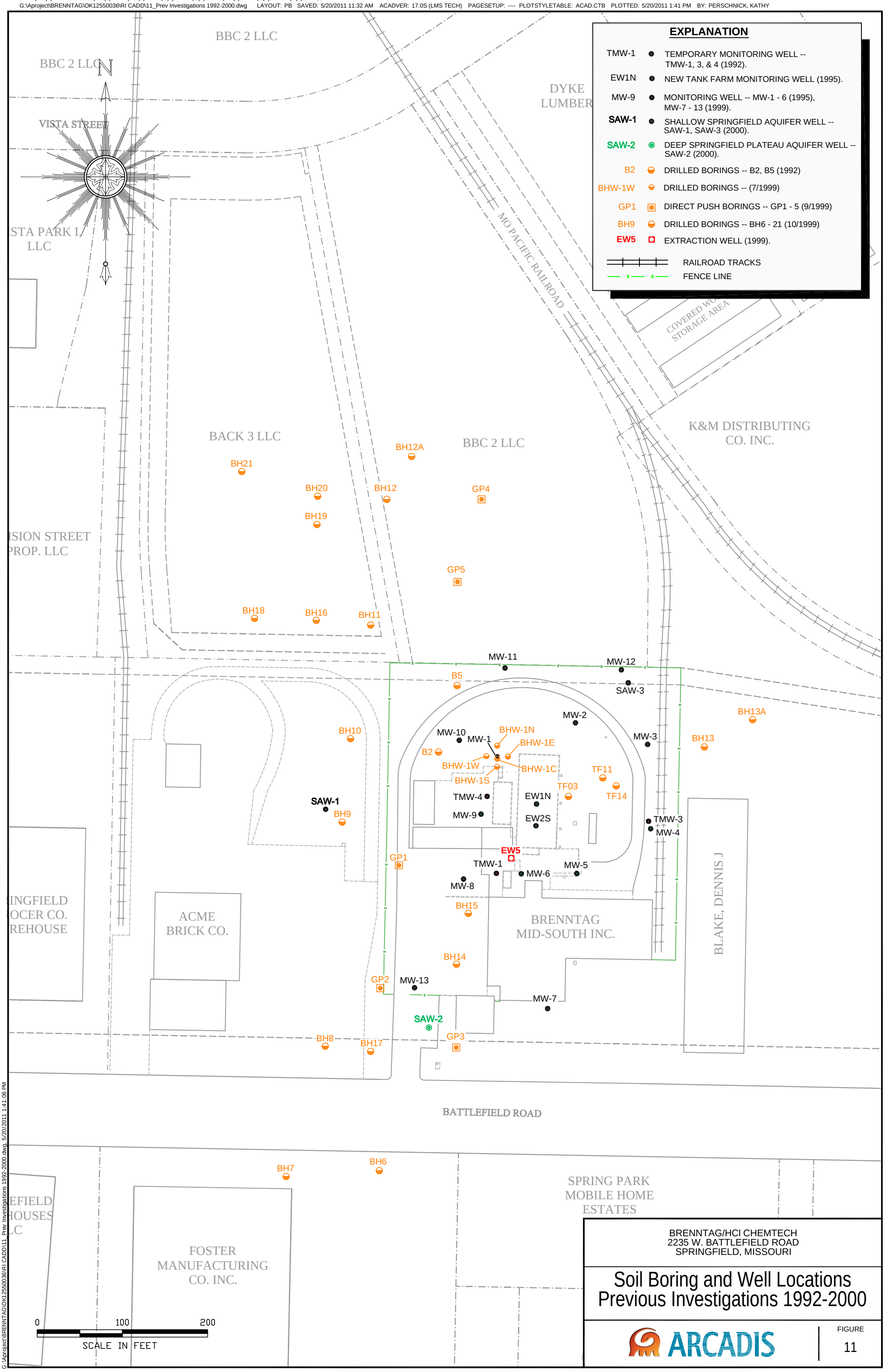

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2235 W. BATTLEFIELD ROAD
SPRINGFIELD, MISSOURI

Soil Boring and Well Locations Previous Investigations 1992-2000

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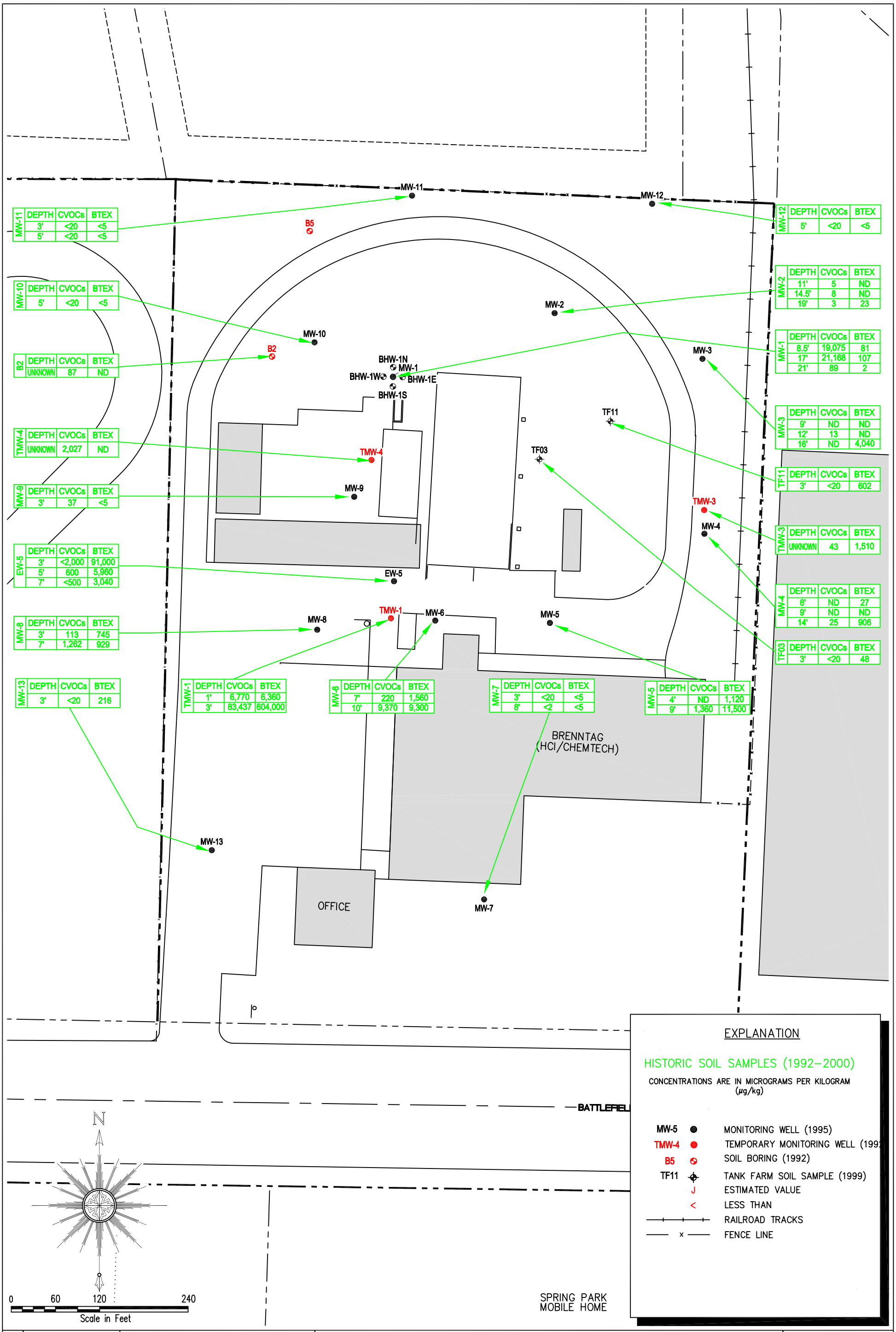
FIGURE
11

G:\Aproject\BRENNTAG\OK12550036\RI CADD\11_Prev Investigations 1992-2000.dwg, 5/20/2011 1:41:06 PM



MW-11	DEPTH	CVOCs	BTEX
	3'	<20	<5
	5'	<20	<5

MW-10	DEPTH	CVOCs	BTEX
	5'	<20	<5

B2	DEPTH	CVOCs	BTEX
	UNKNOWN	87	ND

TMW-4	DEPTH	CVOCs	BTEX
	UNKNOWN	2,027	ND

MW-9	DEPTH	CVOCs	BTEX
	3'	37	<5

EW-5	DEPTH	CVOCs	BTEX
	3'	<2,000	91,000
	5'	600	5,960
	7'	<500	3,040

MW-8	DEPTH	CVOCs	BTEX
	3'	113	745
	7'	1,262	929

MW-13	DEPTH	CVOCs	BTEX
	3'	<20	216

TMW-1	DEPTH	CVOCs	BTEX
	1'	6,770	6,360
	3'	83,437	604,000

MW-6	DEPTH	CVOCs	BTEX
	7'	220	1,560
	10'	9,370	9,300

MW-7	DEPTH	CVOCs	BTEX
	3'	<20	<5
	8'	<2	<5

MW-5	DEPTH	CVOCs	BTEX
	4'	ND	1,120
	9'	1,360	11,500

MW-12	DEPTH	CVOCs	BTEX
	5'	<20	<5

MW-2	DEPTH	CVOCs	BTEX
	11'	5	ND
	14.5'	8	ND
	19'	3	23

MW-1	DEPTH	CVOCs	BTEX
	8.5'	19,075	81
	17'	21,168	107
	21'	89	2

MW-3	DEPTH	CVOCs	BTEX
	9'	ND	ND
	12'	13	ND
	16'	ND	4,040

TF11	DEPTH	CVOCs	BTEX
	3'	<20	602

TMW-3	DEPTH	CVOCs	BTEX
	UNKNOWN	43	1,510

MW-4	DEPTH	CVOCs	BTEX
	6'	ND	27
	9'	ND	ND
	14'	25	906

TF03	DEPTH	CVOCs	BTEX
	3'	<20	48

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Brenntag/HCI Chemtech
2235 W. Battlefield Rd.

Total BTEX and Total CVOC Concentrations Historic Soil Samples 1992-2000

Springfield, Missouri

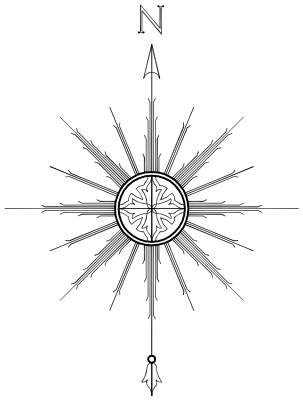
Project Number: OK001255.0036
Drawing Date: 6 September 2007
Figure: 12

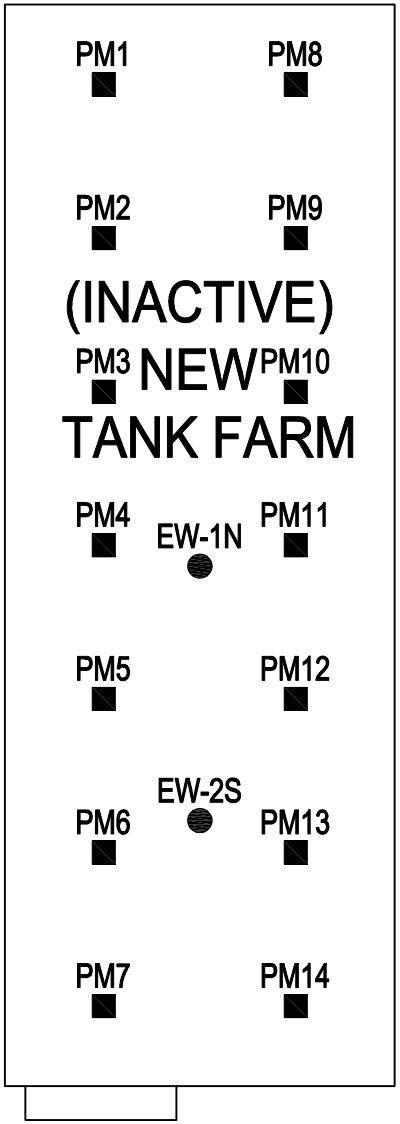
G:\Aproject\BRENNTAG\OK12550036\RI CADD\12_1992-2000 BTEX CVOC SOIL.dwg, 5/20/2011 1:41:30 PM

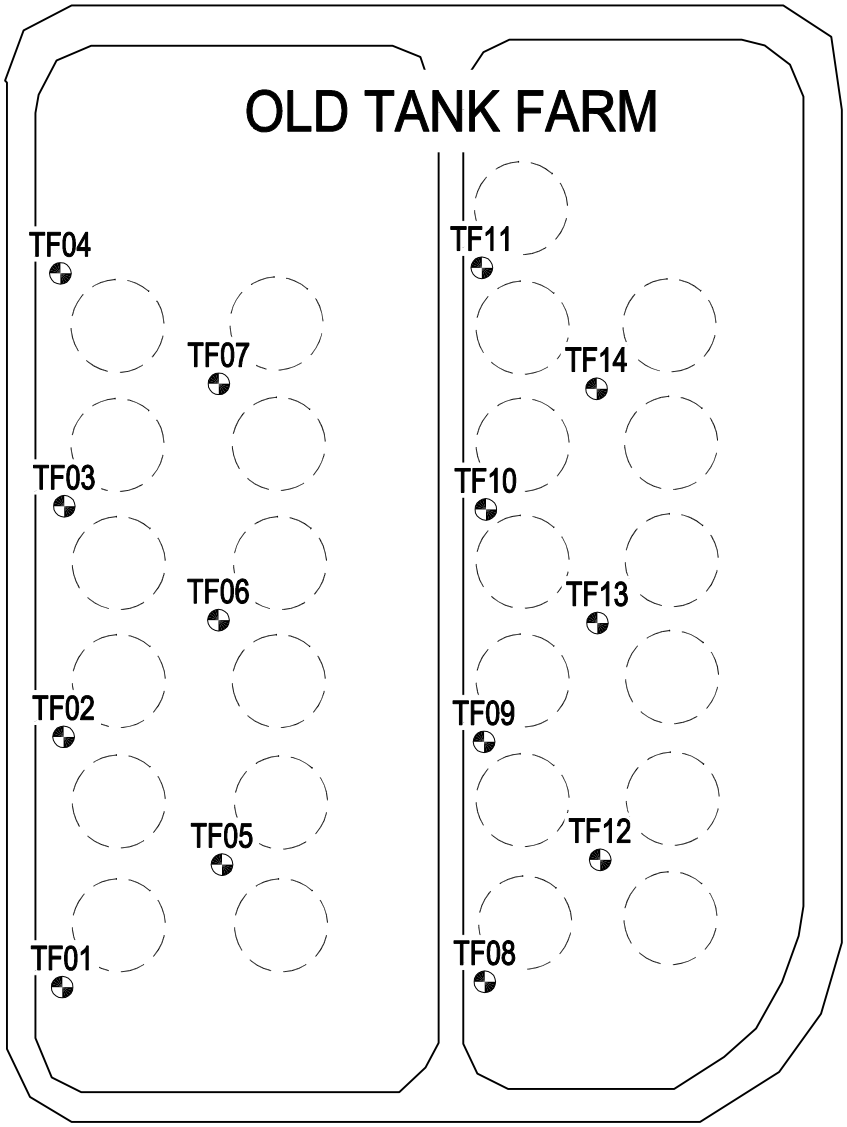
EXPLANATION

TF11 SOIL BORING
EW-1N EXTRACTION/MONITORING WELL
PM1 PRESSURE MONITORING WELL
NOT TO SCALE (APPROXIMATELY 1" = 20')

PRELIMINARY HVE PILOT TEST WELL LOCATIONS MAY 1996







Source: Source Map Prepared by CJ Environmental

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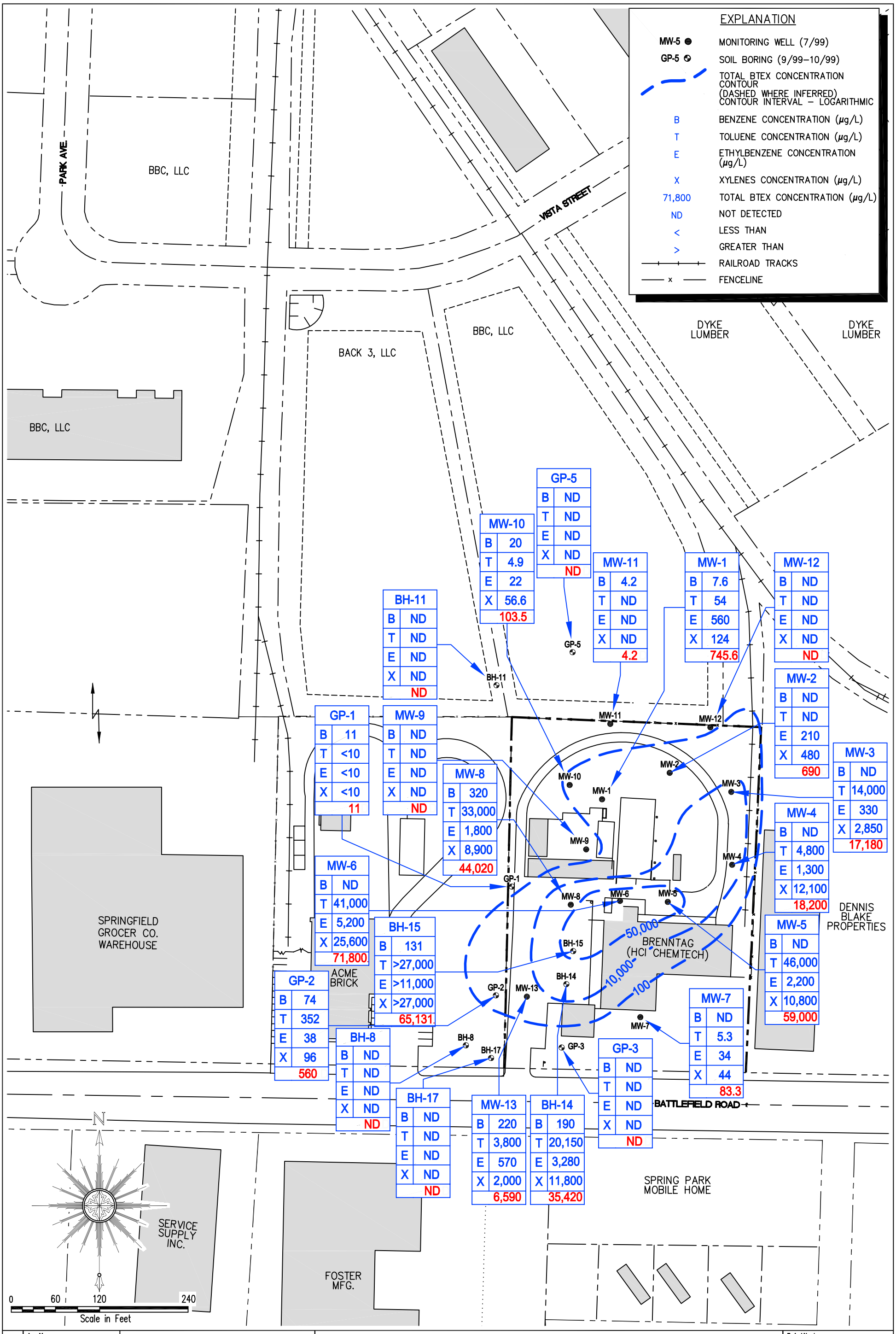
Brenntag/HCI Chemtech
2235 W. Battlefield Rd.

Old Tank Farm Soil Borings, July 1999

Springfield, Missouri

Project Number	OK001255.0036
Drawing Date	9 July 2007
Figure	13

G:\Aproject\BRENNTAG\OK12550036\RI CADD\13_1999JULY-OLD TANK FARM SOIL.dwg, 5/20/2011 1:41:47 PM



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Brenntag/HCI Chemtech
2235 W. Battlefield Rd.

Total BTEX Concentrations in Groundwater July - October, 1999

Springfield, Missouri

Project Number	OK001255.0036
Drawing Date	6 July 2007
Figure	14

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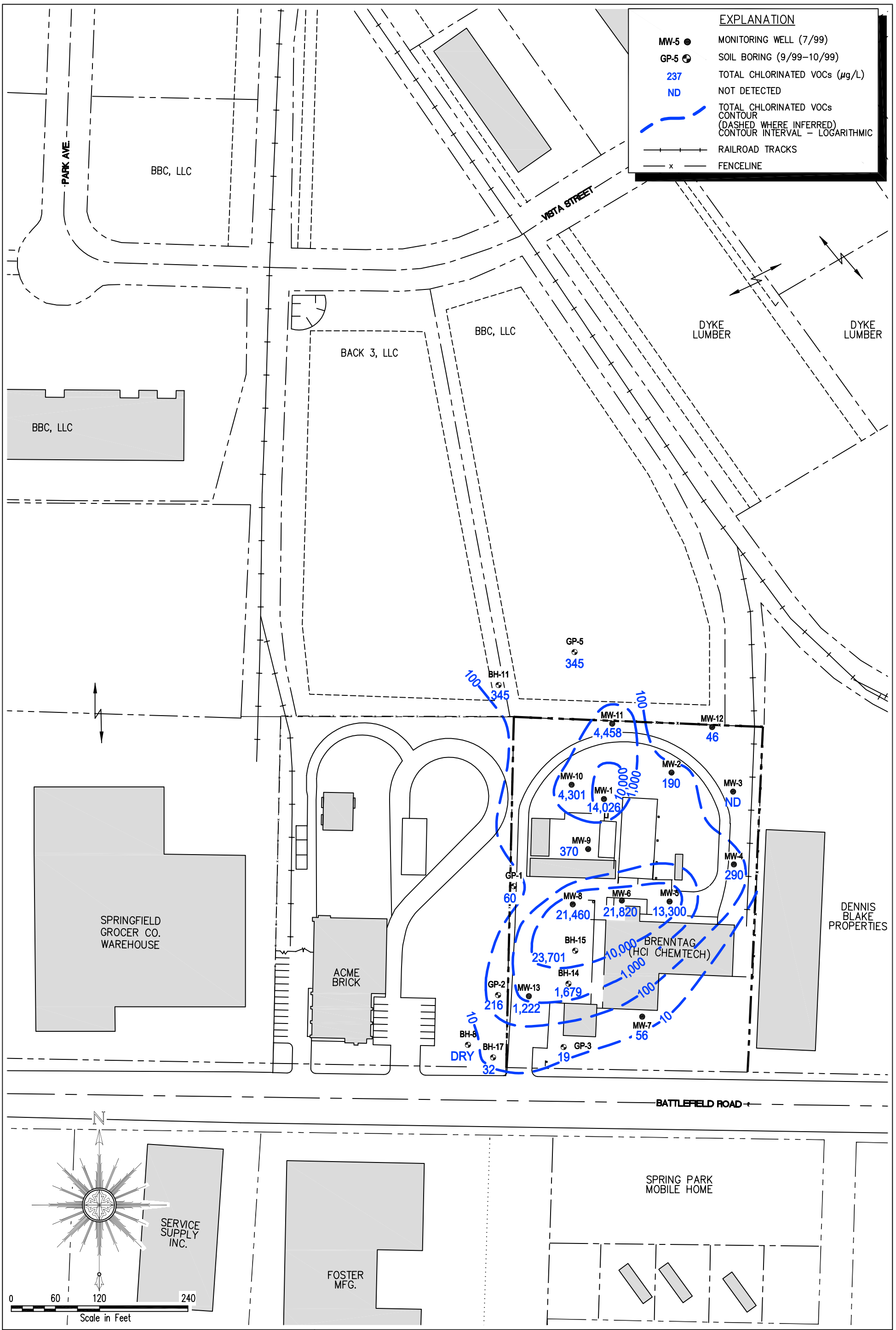

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Brenntag/HCl Chemtech
2235 W. Battlefield Rd.

Total Chlorinated VOC Concentrations in Groundwater July - October, 1999

Springfield, Missouri

Project Number	OK001255.0036
Drawing Date	6 July 2007
Figure	15

G:\Aproject\BRENNTAG\OK125500036\RI CADD\15_1999JULY-CVOC GW.dwg, 5/20/2011 1:42:31 PM

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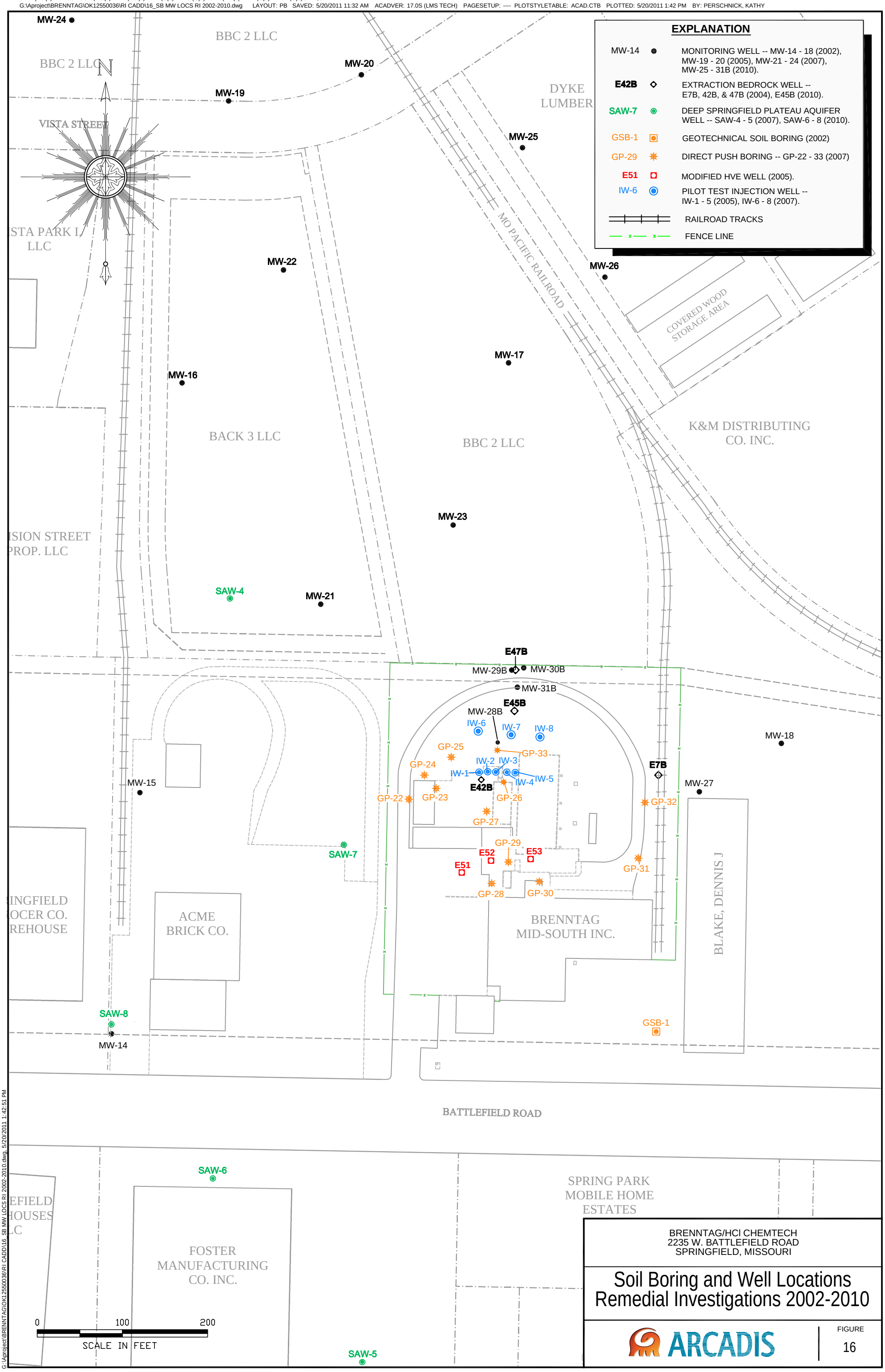

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2235 W. BATTLEFIELD ROAD
SPRINGFIELD, MISSOURI

Soil Boring and Well Locations Remedial Investigations 2002-2010

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FIGURE
16

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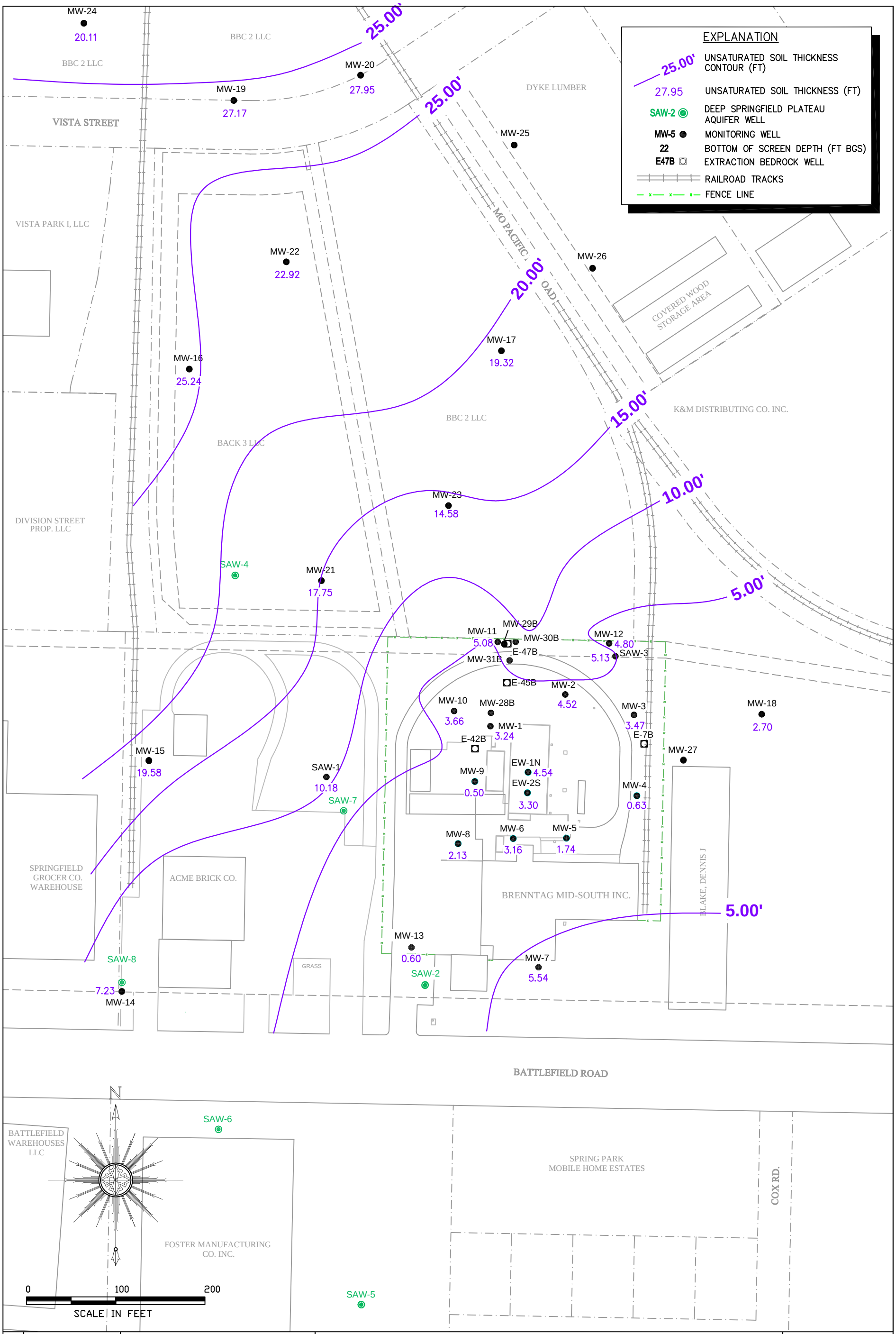

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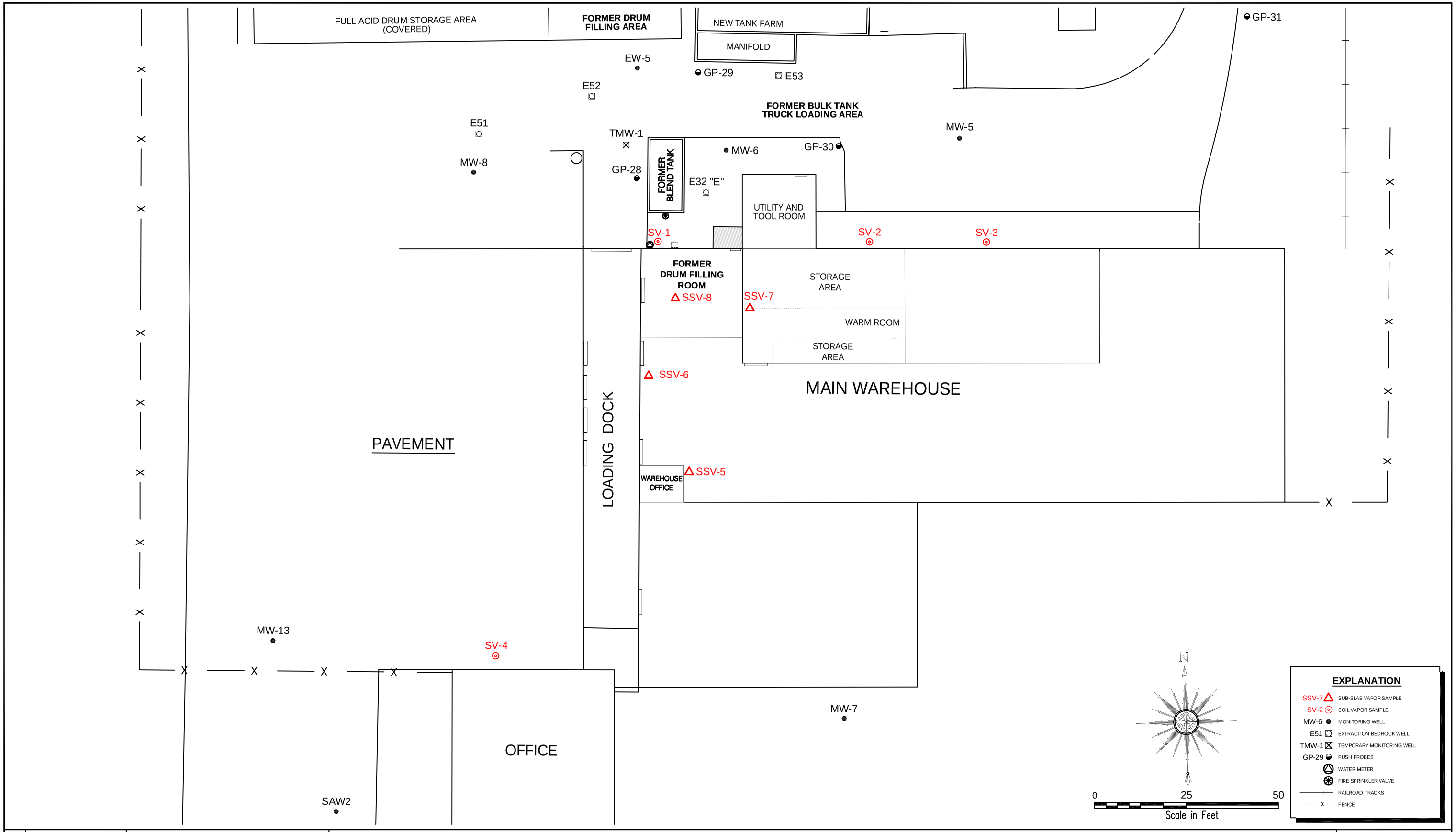
G:\Aproject\BRENNTAG\OK1255003\6\RI CADD\17_UNSAT SOIL THICK MAP.dwg, 5/20/2011 1:43:11 PM



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Soil and Sub-slab Vapor Survey Sample Locations

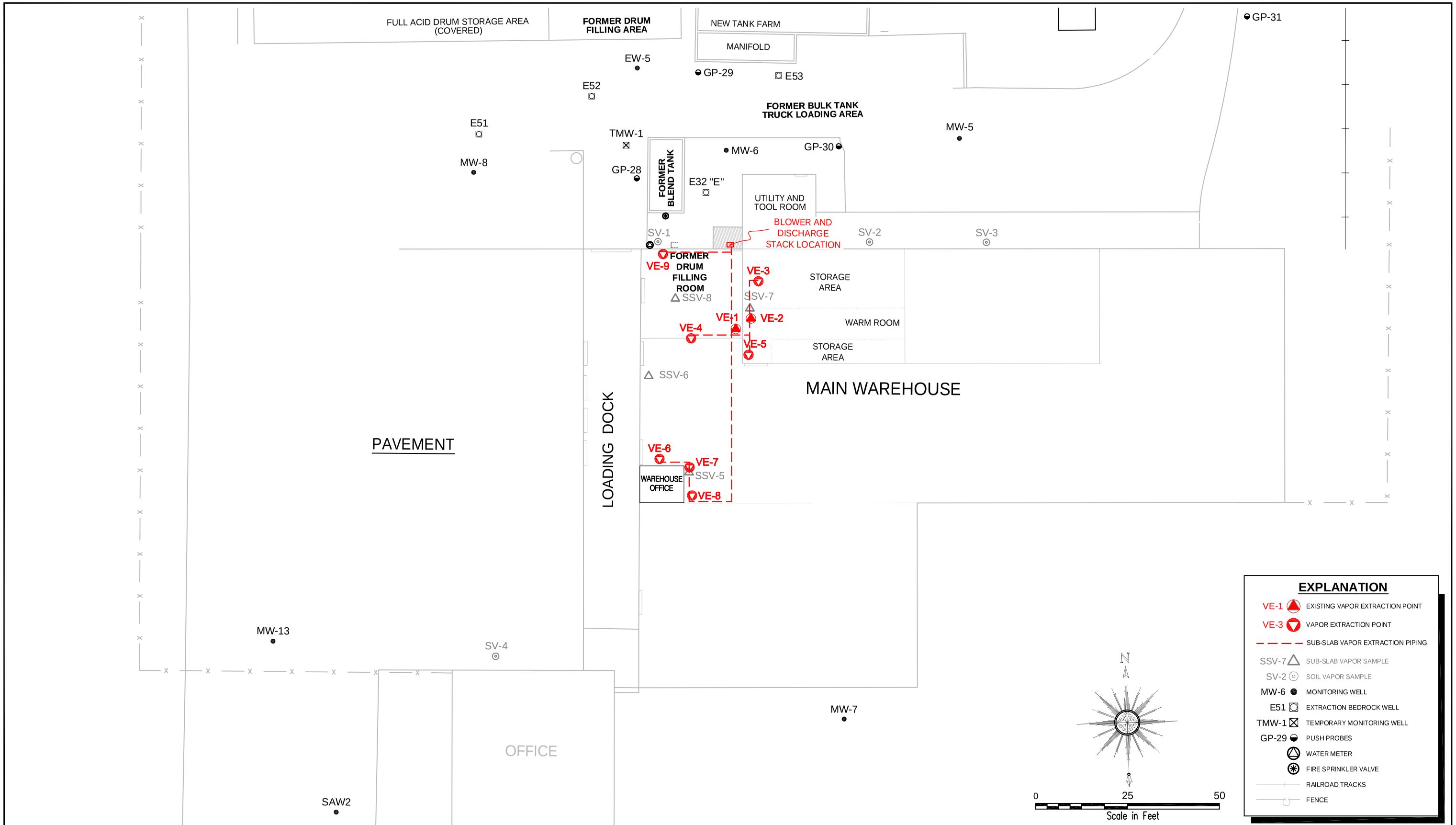
Springfield, Missouri

Project Number
OK001255.0036

Drawing Date
26 June 2007

Figure
18

G:\Aproject\BRENNTAG\OK125500361RI CADD\18_SV-SSV SURV SMPL LOCS.dwg, 5/20/2011 1:43:29 PM



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2235 W. Battlefield Rd.

Sub-slab Vapor Extraction System

Springfield, Missouri

Project Number
OK001255.0036

Drawing Date
3 March 2010

Figure
19

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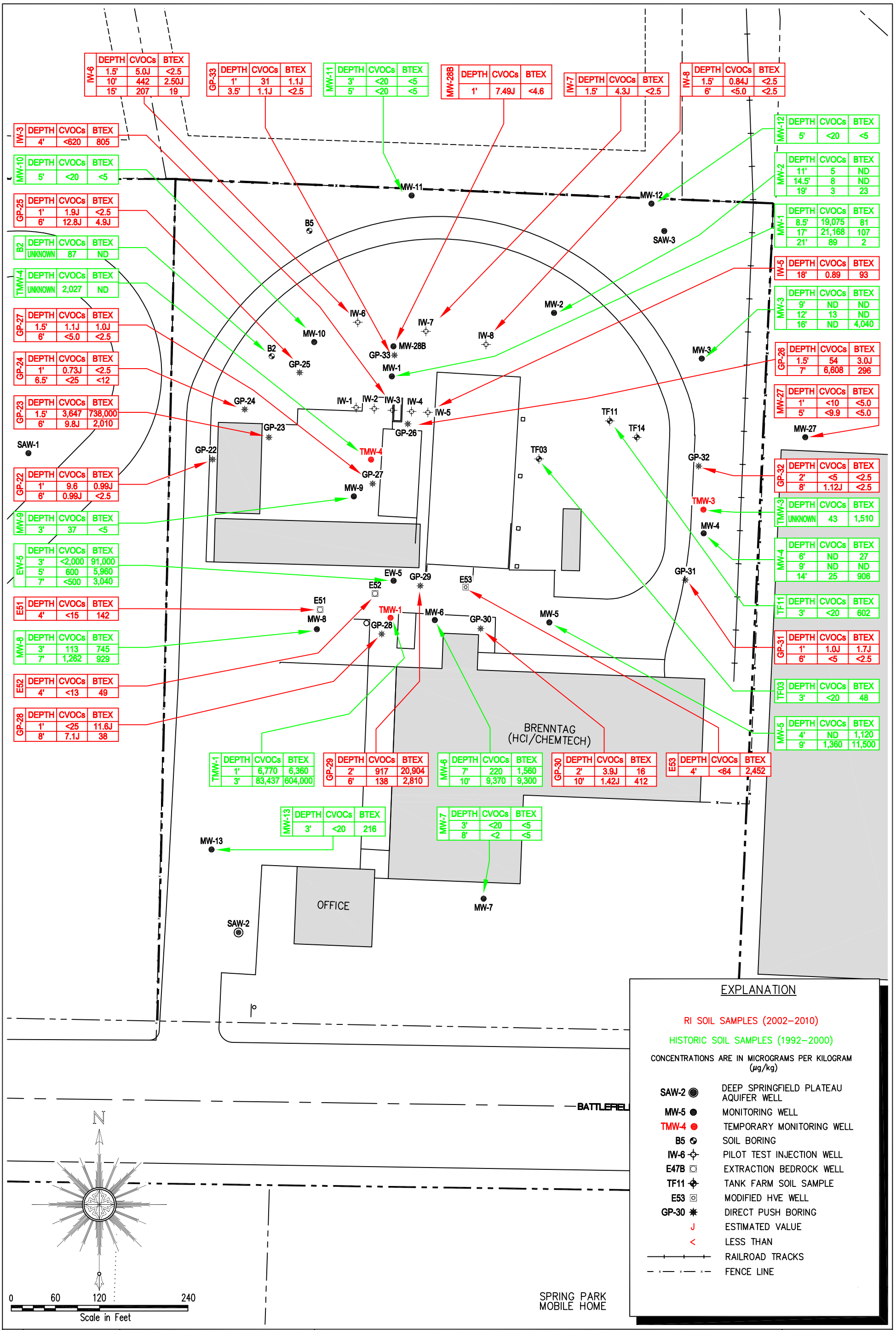

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2235 W. Battlefield Rd.

Total BTEX and Total CVOC Concentrations Historic and RI Soil Samples 1992-2010

Springfield, Missouri

Project Number	OK001255.0036
Drawing Date	10 November 2010
Figure	20

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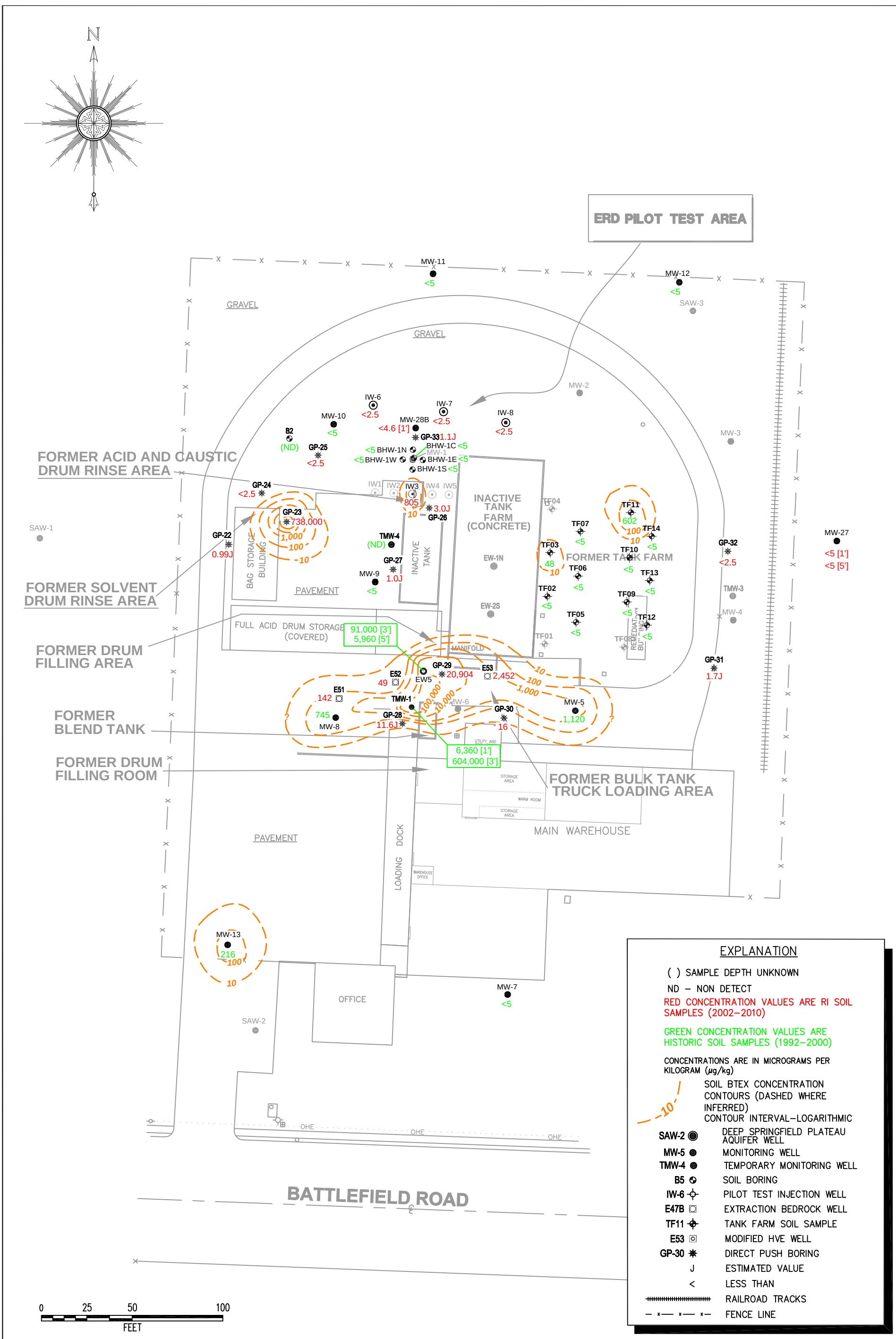

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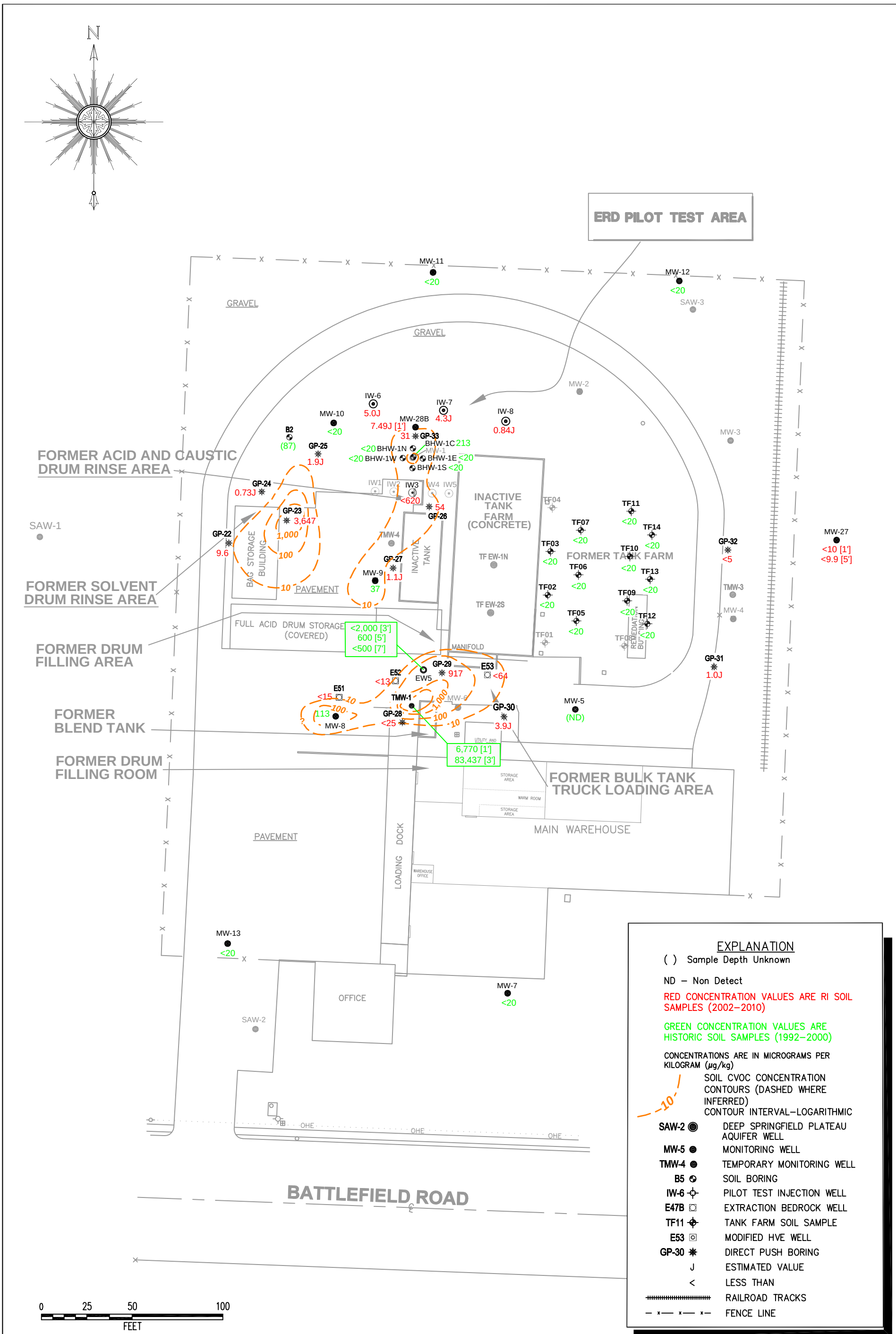
2235 W. Battlefield Rd.

Soil Source Areas
Total BTEX Concentrations 0-5' BGS
(Historic and RI Soil Samples 1992-2010)

Springfield, Missouri

Project Number	OK001255.0036
Drawing Date	10 November 2010
Figure	21a

G:\Aproject\BRENNTAG\OK\1255036\RI CADD\21a_SOIL SOURCE AREAS 0-5 BTEX.dwg, 5/20/2011 1:46:05 PM



EXPLANATION

( ) Sample Depth Unknown

ND – Non Detect

RED CONCENTRATION VALUES ARE RI SOIL SAMPLES (2002–2010)

GREEN CONCENTRATION VALUES ARE HISTORIC SOIL SAMPLES (1992–2000)

CONCENTRATIONS ARE IN MICROGRAMS PER KILOGRAM (µg/kg)

10 — SOIL CVOC CONCENTRATION CONTOURS (DASHED WHERE INFERRED) CONTOUR INTERVAL–LOGARITHMIC

SAW-2 — DEEP SPRINGFIELD PLATEAU AQUIFER WELL

MW-5 — MONITORING WELL

TMW-4 — TEMPORARY MONITORING WELL

B5 — SOIL BORING

IW-6 — PILOT TEST INJECTION WELL

E47B — EXTRACTION BEDROCK WELL

TF11 — TANK FARM SOIL SAMPLE

E53 — MODIFIED HVE WELL

GP-30 — DIRECT PUSH BORING

J — ESTIMATED VALUE

< — LESS THAN

RAILROAD TRACKS

FENCE LINE

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Soil Source Areas
Total CVOC Concentrations 0-5' BGS
(Historic and RI Soil Samples 1992-2010)

Springfield, Missouri

Project Number: OK001255.0036
Drawing Date: 10 November 2010
Figure: 21b

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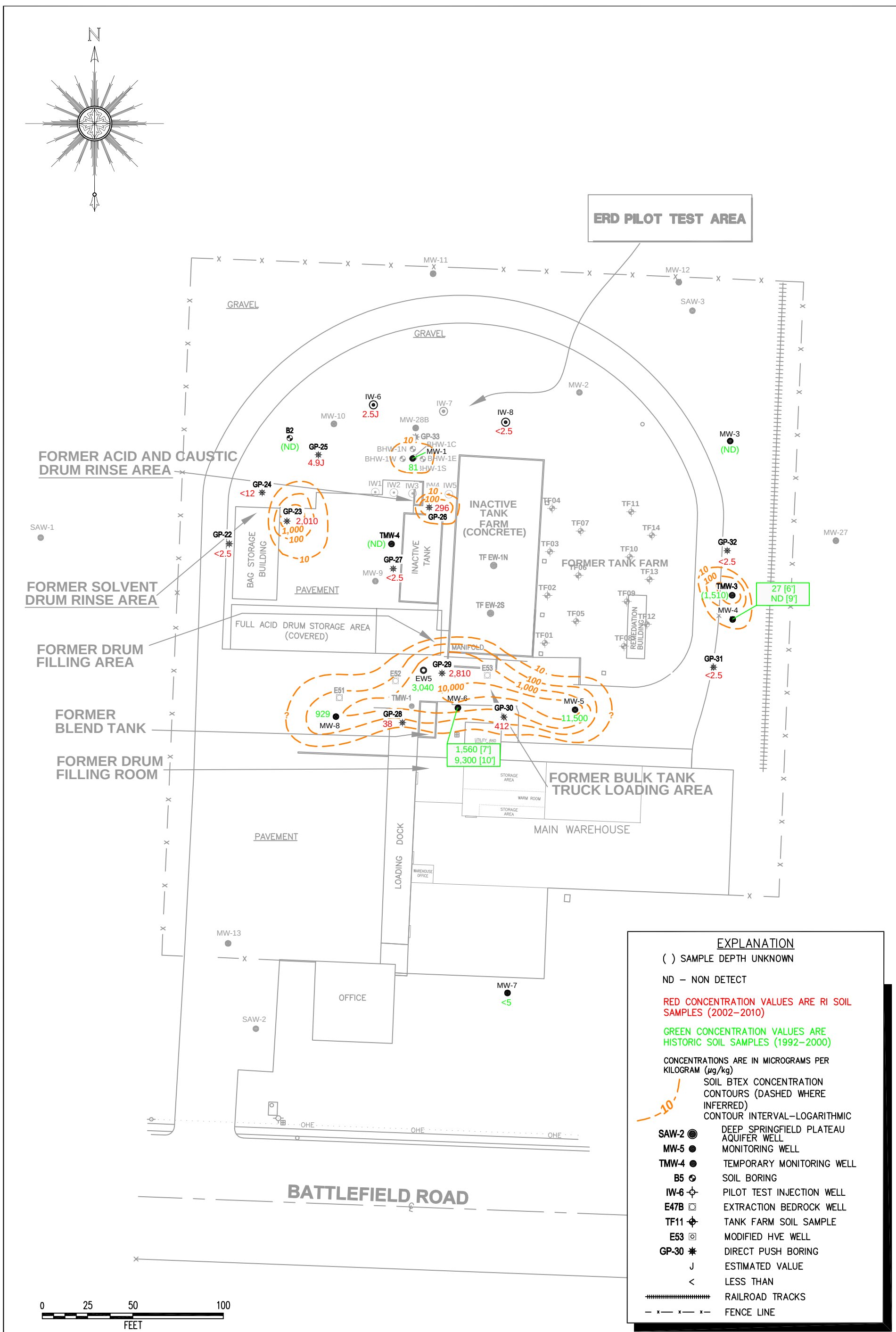

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2235 W. Battlefield Rd.

Soil Source Areas
Total BTEX Concentrations 6-10' BGS
(Historic and RI Soil Samples 1992-2010)

Springfield, Missouri

Project Number	OK001255.0036
Drawing Date	10 November 2010
Figure	21c

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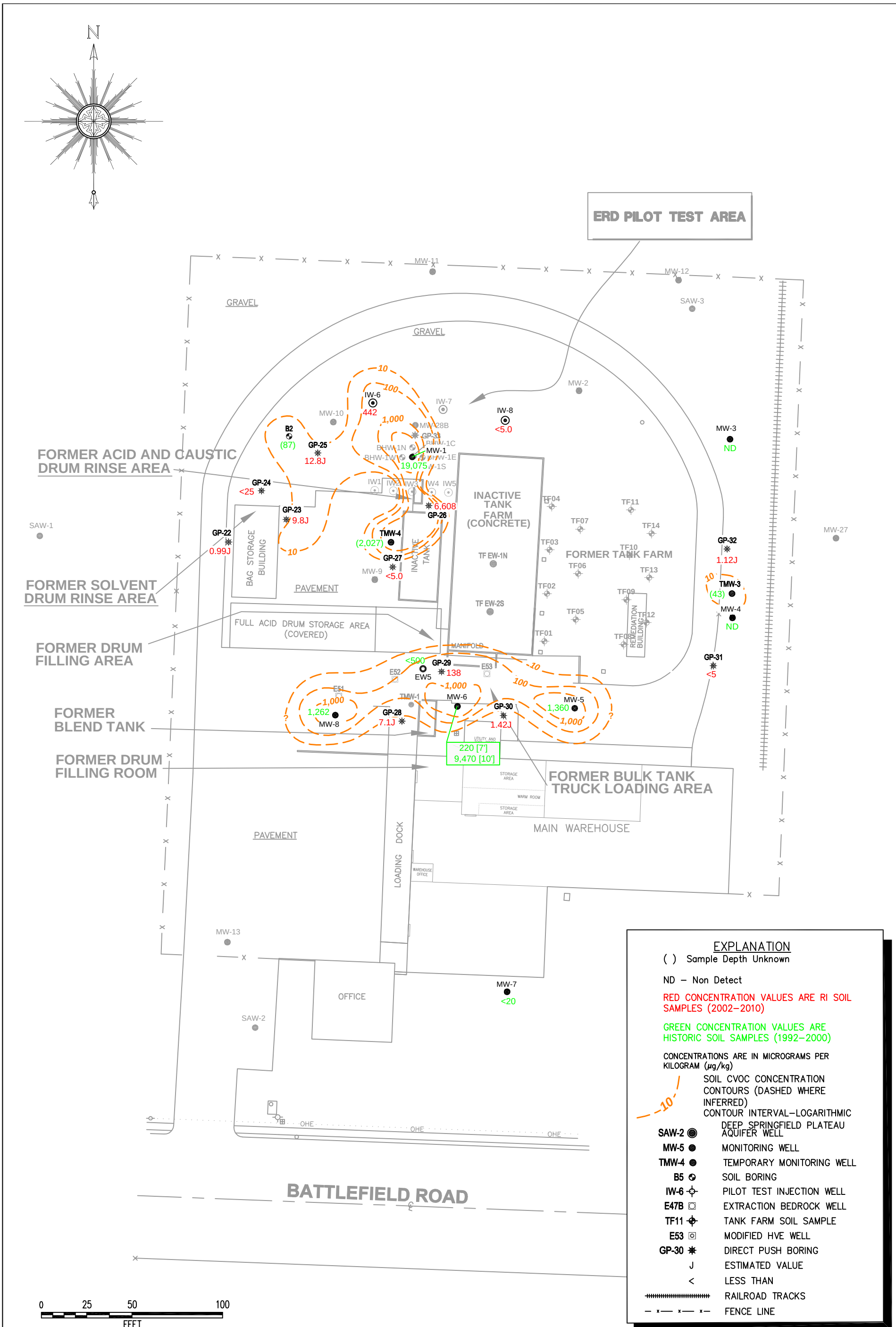

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Soil Source Areas
Total CVOC Concentrations 6-10' BGS
(Historic and RI Soil Samples 1992-2010)

Springfield, Missouri

Project Number	OK001255.0036
Drawing Date	10 November 2010
Figure	21d

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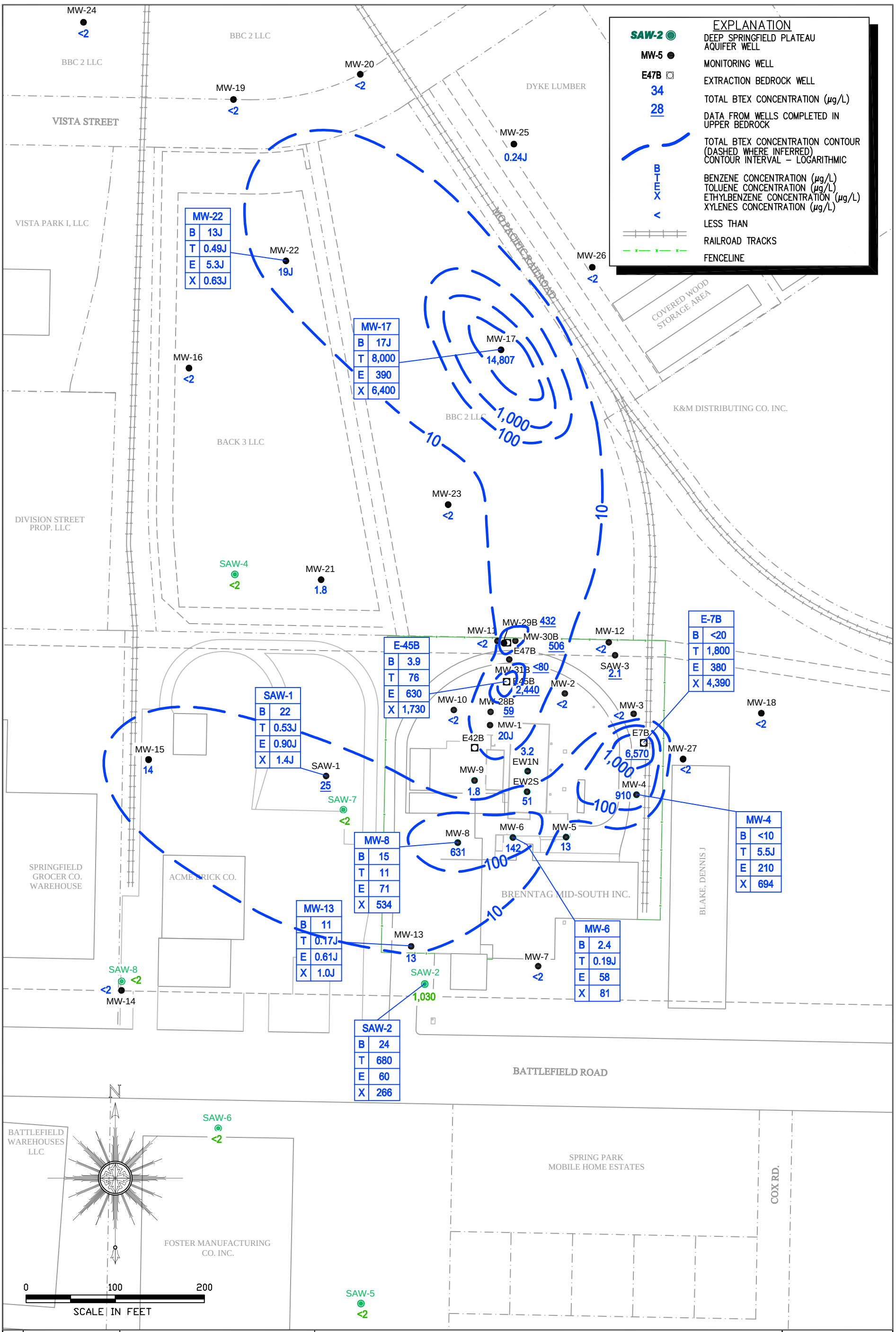

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Total BTEX Concentrations in Groundwater
August 3-5, 2010

Springfield, Missouri

Project Number	OK001255.0036
Drawing Date	9-7-10
Figure	22

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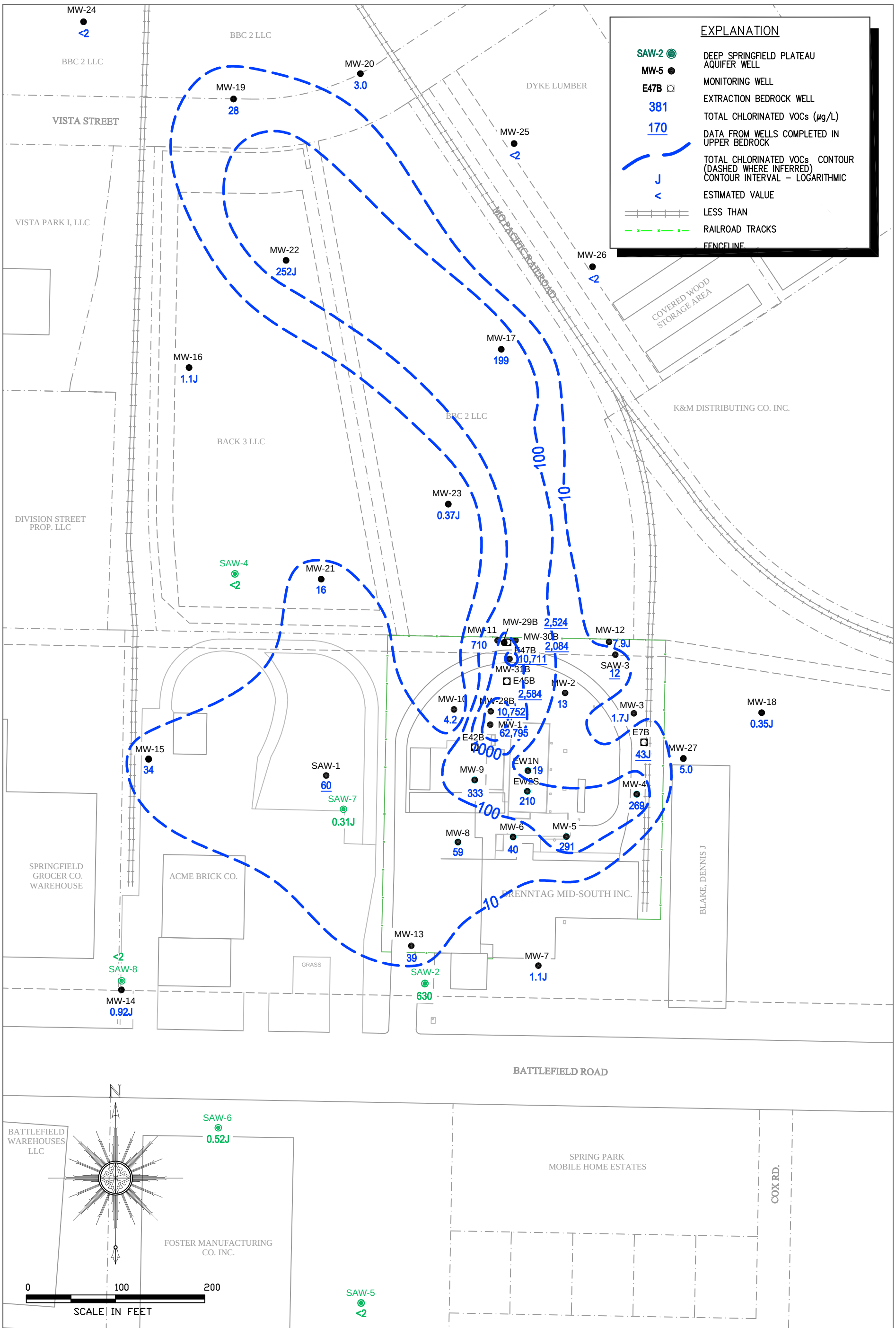

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Total Chlorinated VOC Concentrations in Groundwater August 3-5, 2010

Springfield, Missouri

Project Number	OK001255.0036
Drawing Date	9-7-10
Figure	23

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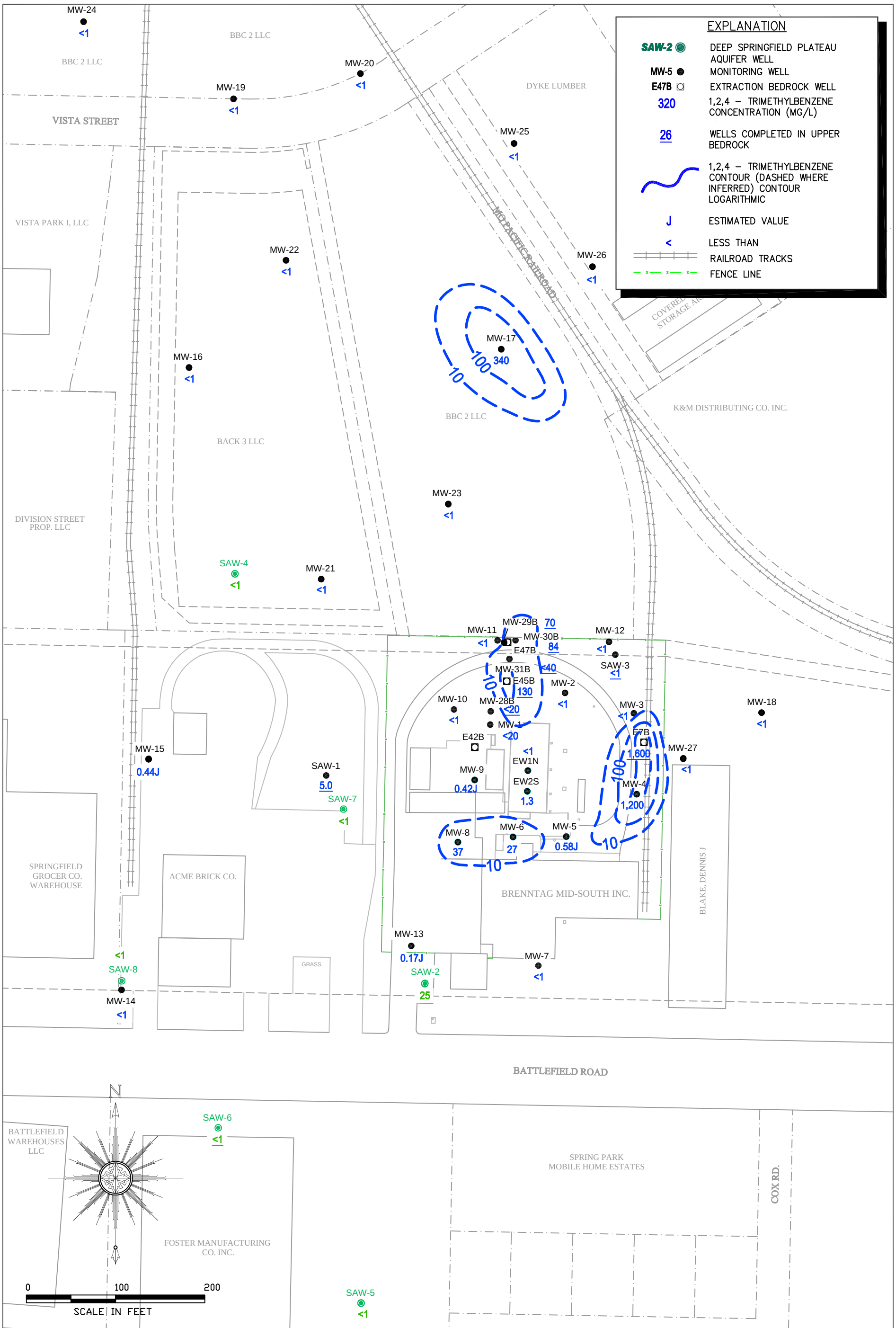

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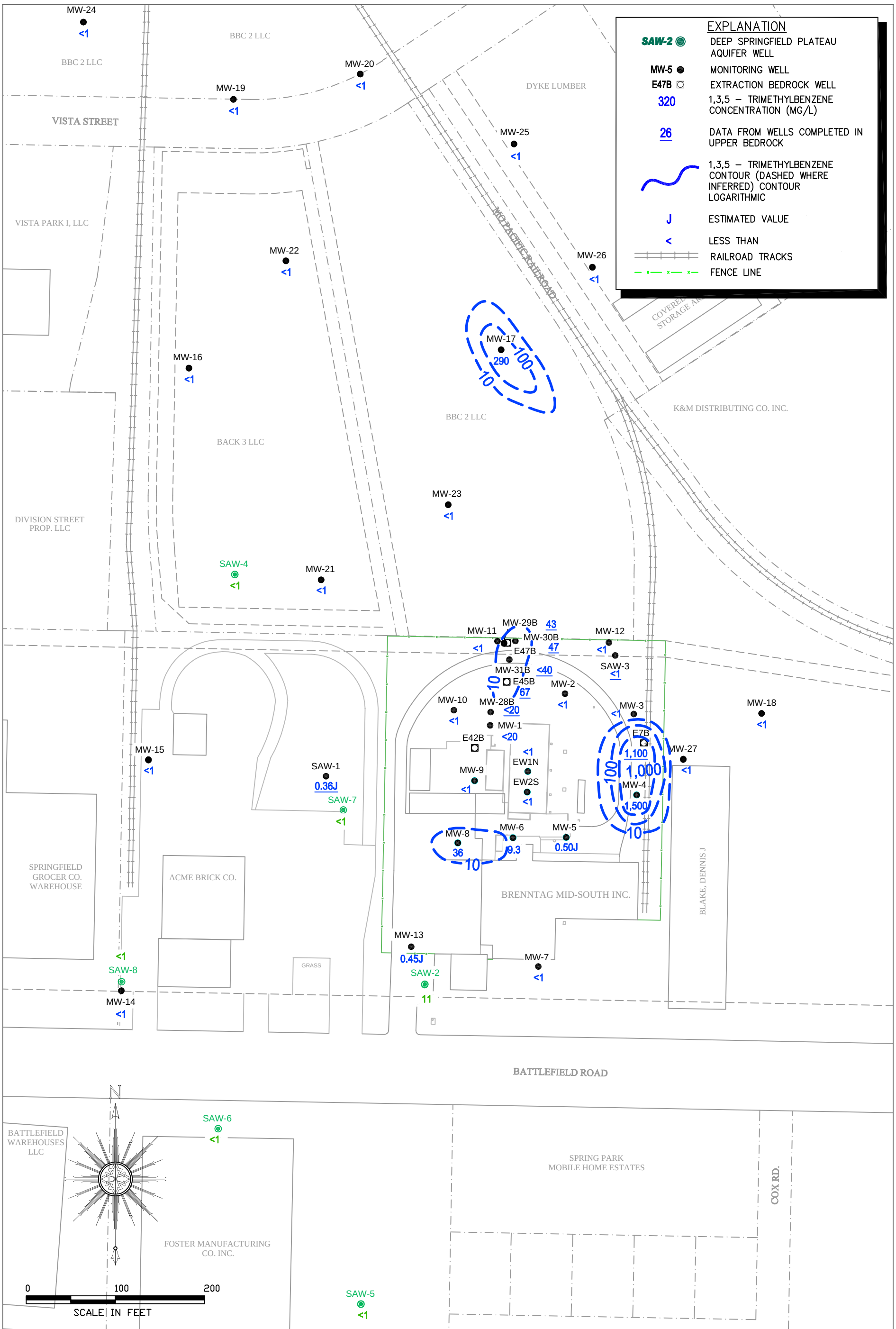

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1,3,5- Trimethylbenzene Concentrations in Groundwater August 3-5, 2010

Springfield, Missouri

Project Number	OK001255.0036
Drawing Date	9-7-10
Figure	25

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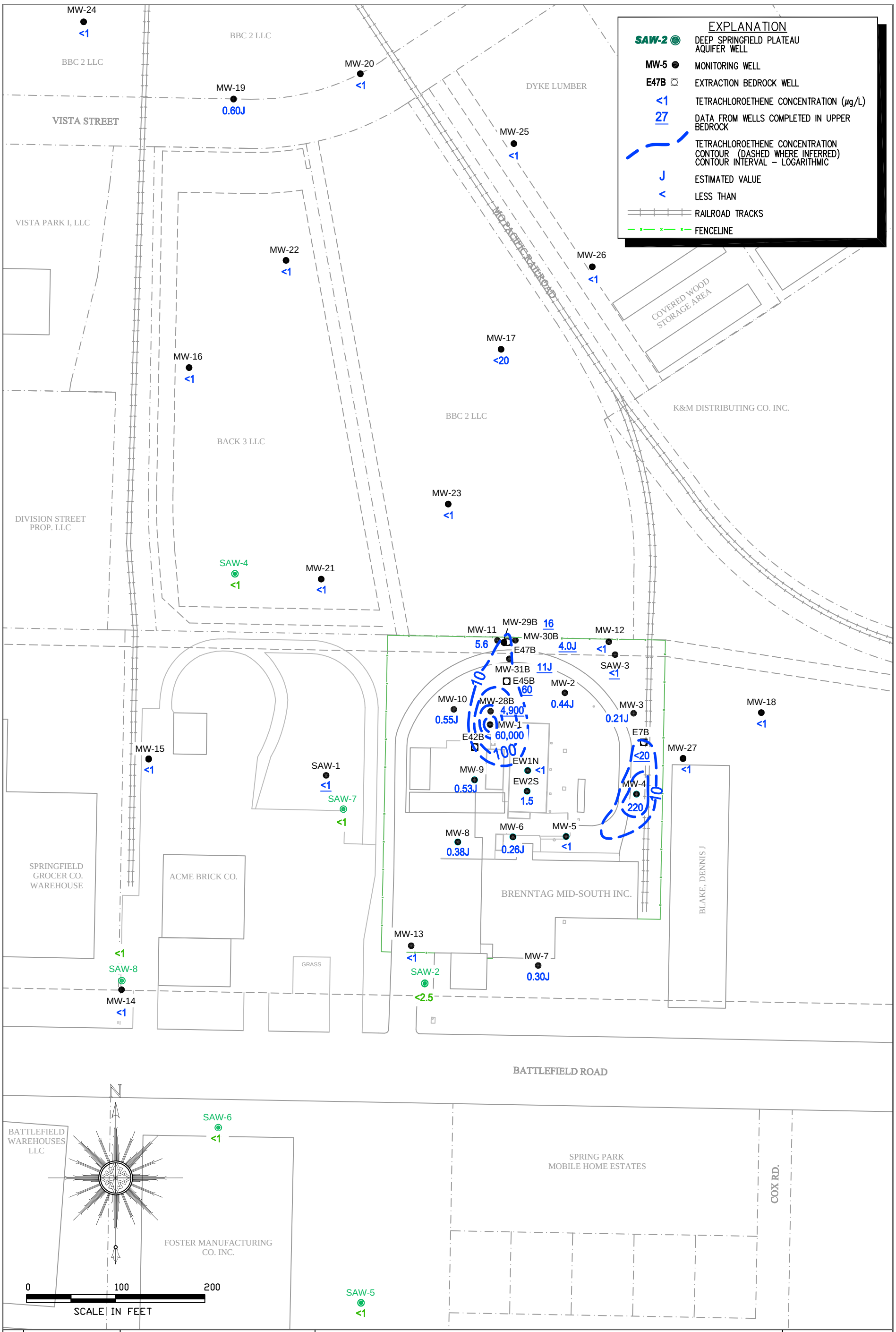

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Project Number: OK001255.0036
Drawing Date: 9-7-10
Figure: 26

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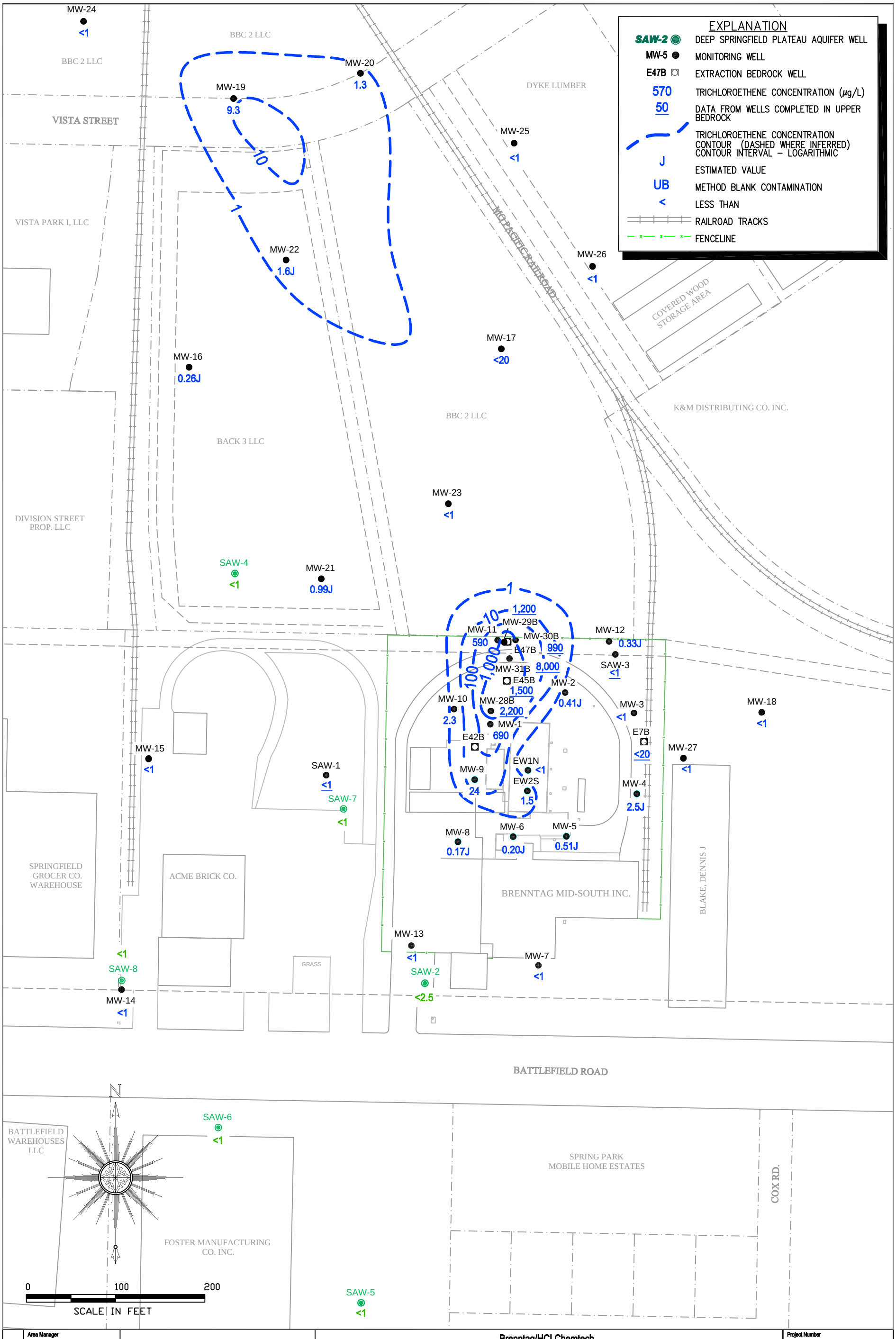

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Trichloroethene Concentrations in Groundwater
August 3-5, 2010

Springfield, Missouri

Project Number	OK001255.0036
Drawing Date	9-7-10
Figure	27

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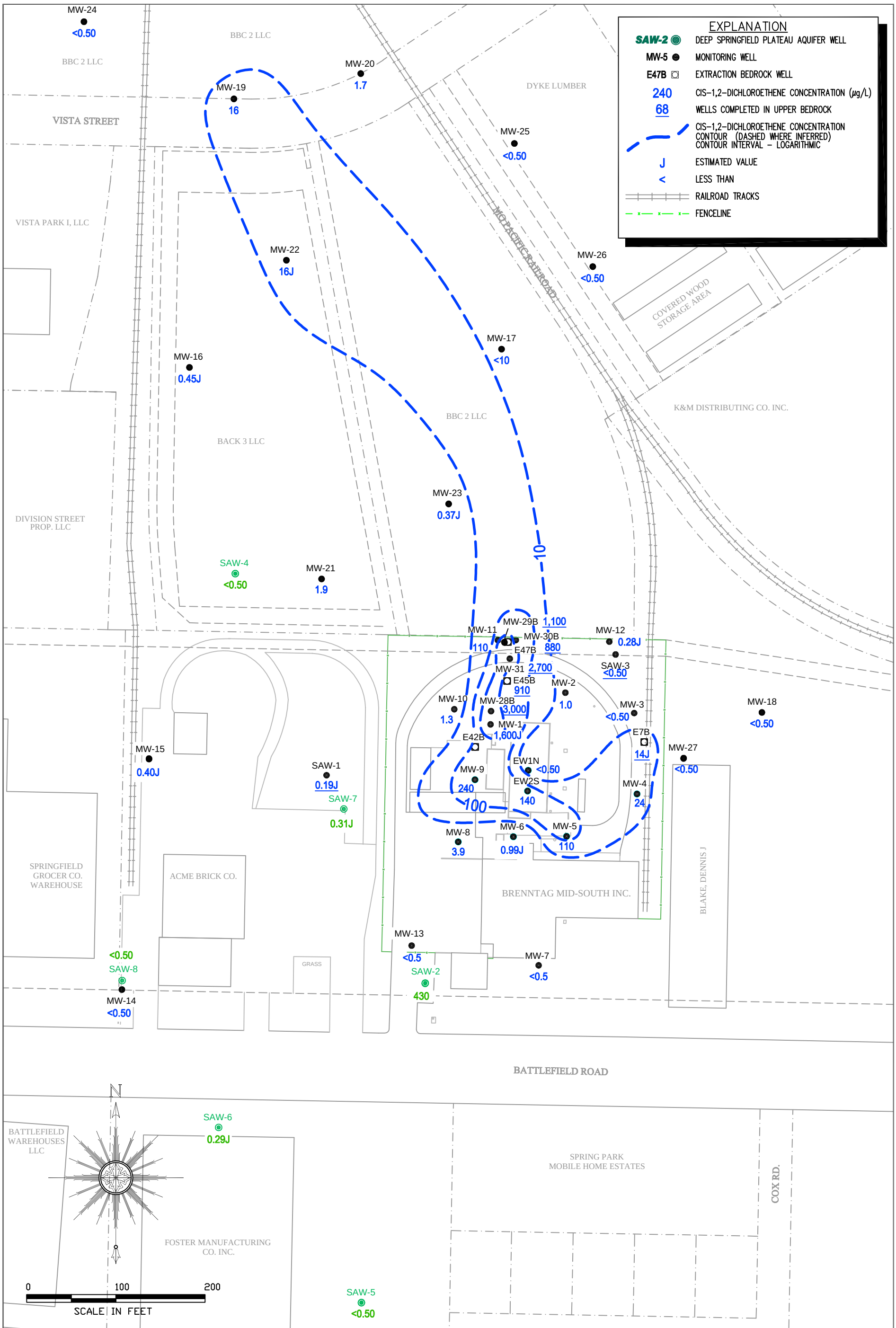

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cis-1, 2-Dichloroethene Concentrations in Groundwater August 3-5, 2010

Springfield, Missouri

Project Number	OK001255.0036
Drawing Date	6-14-10
Figure	28

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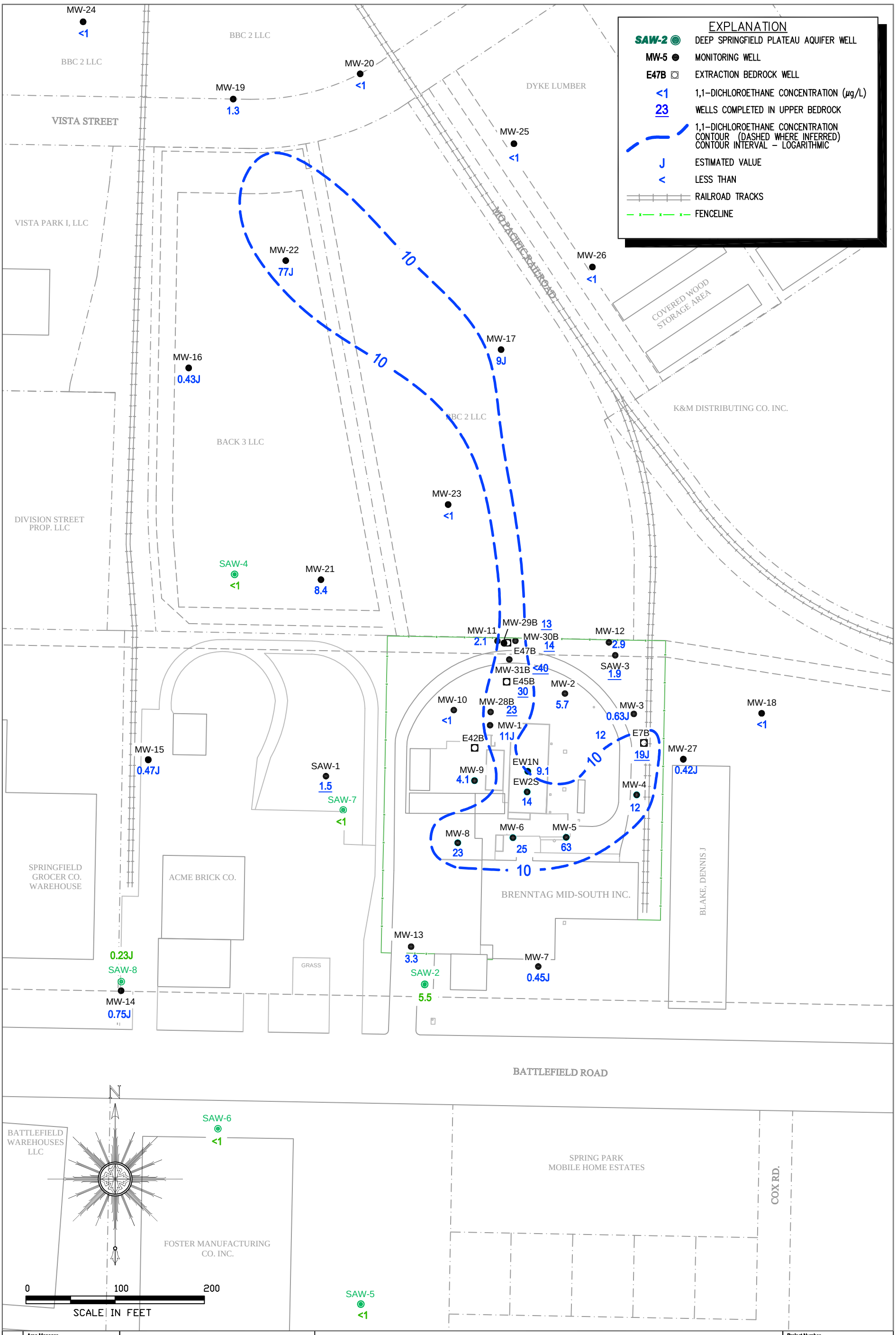

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1, 1-Dichloroethane Concentrations in Groundwater August 3-5, 2010

Springfield, Missouri

Project Number	OK001255.0036
Drawing Date	9-7-10
Figure	29

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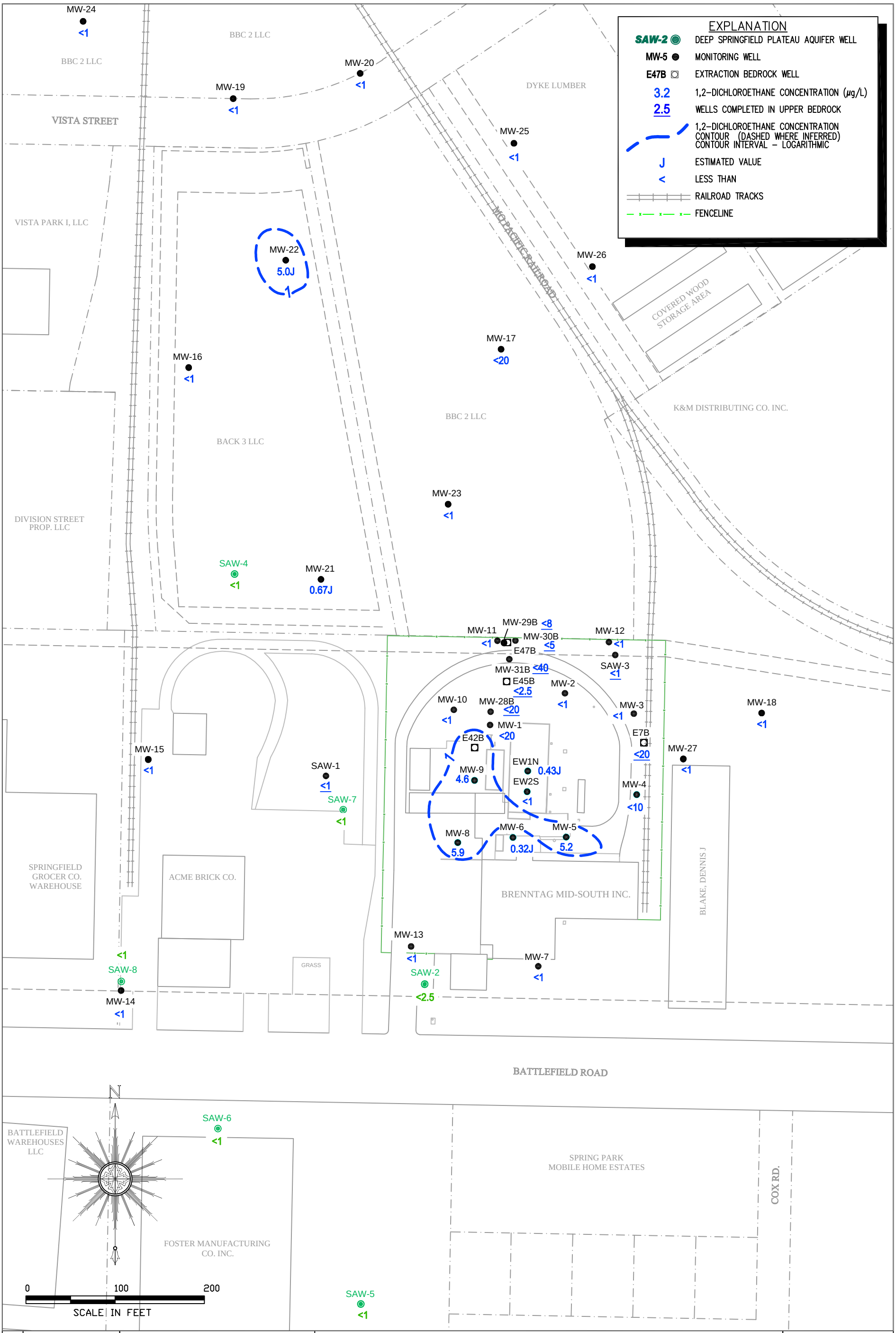

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1, 2-Dichloroethane Concentrations in Groundwater August 3-5, 2010

Springfield, Missouri

Project Number	OK001255.0036
Drawing Date	9-7-10
Figure	30

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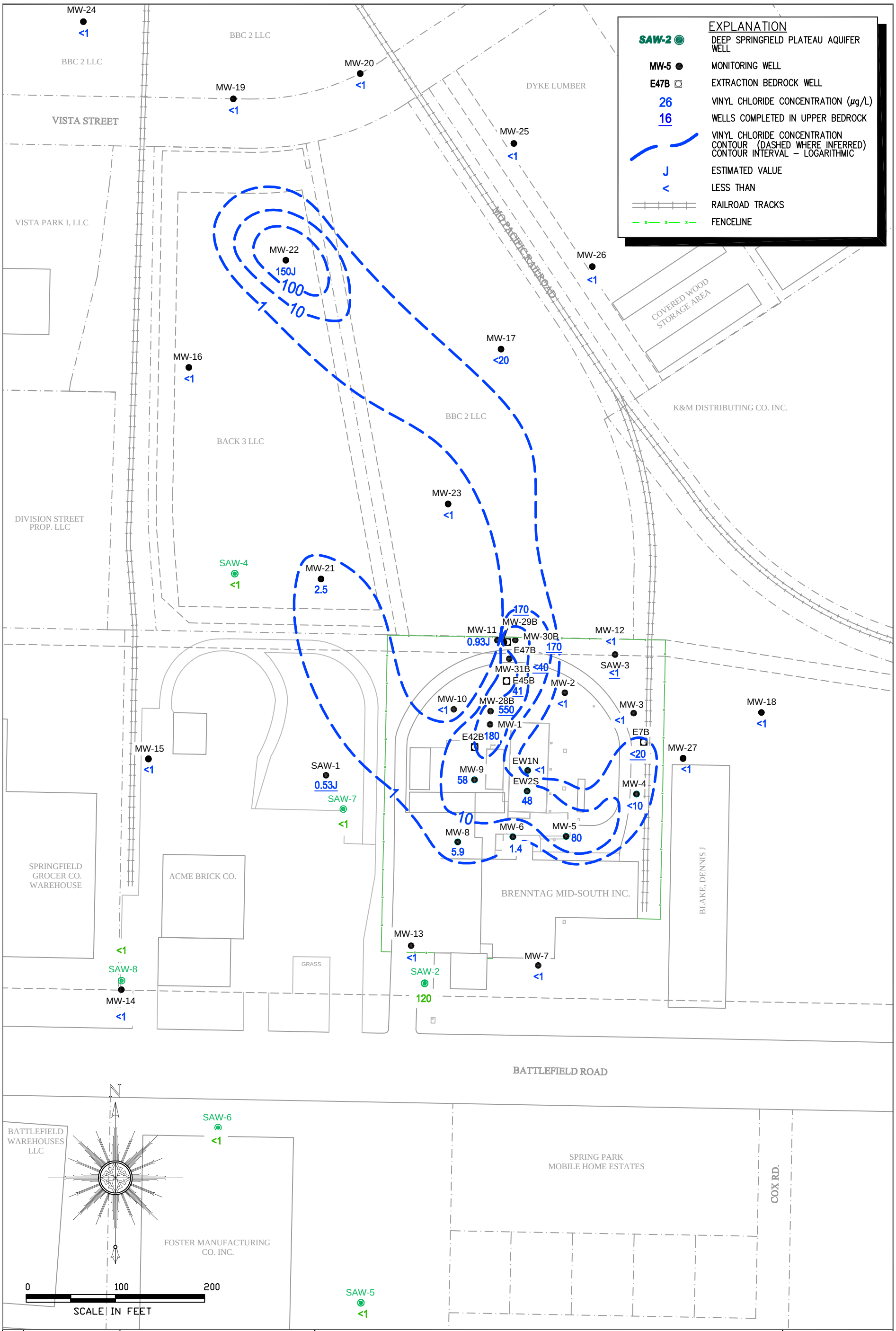

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Vinyl Chloride Concentrations in Groundwater
August 3-5, 2010

Springfield, Missouri

Project Number	OK001255.0036
Drawing Date	9-7-10
Figure	31

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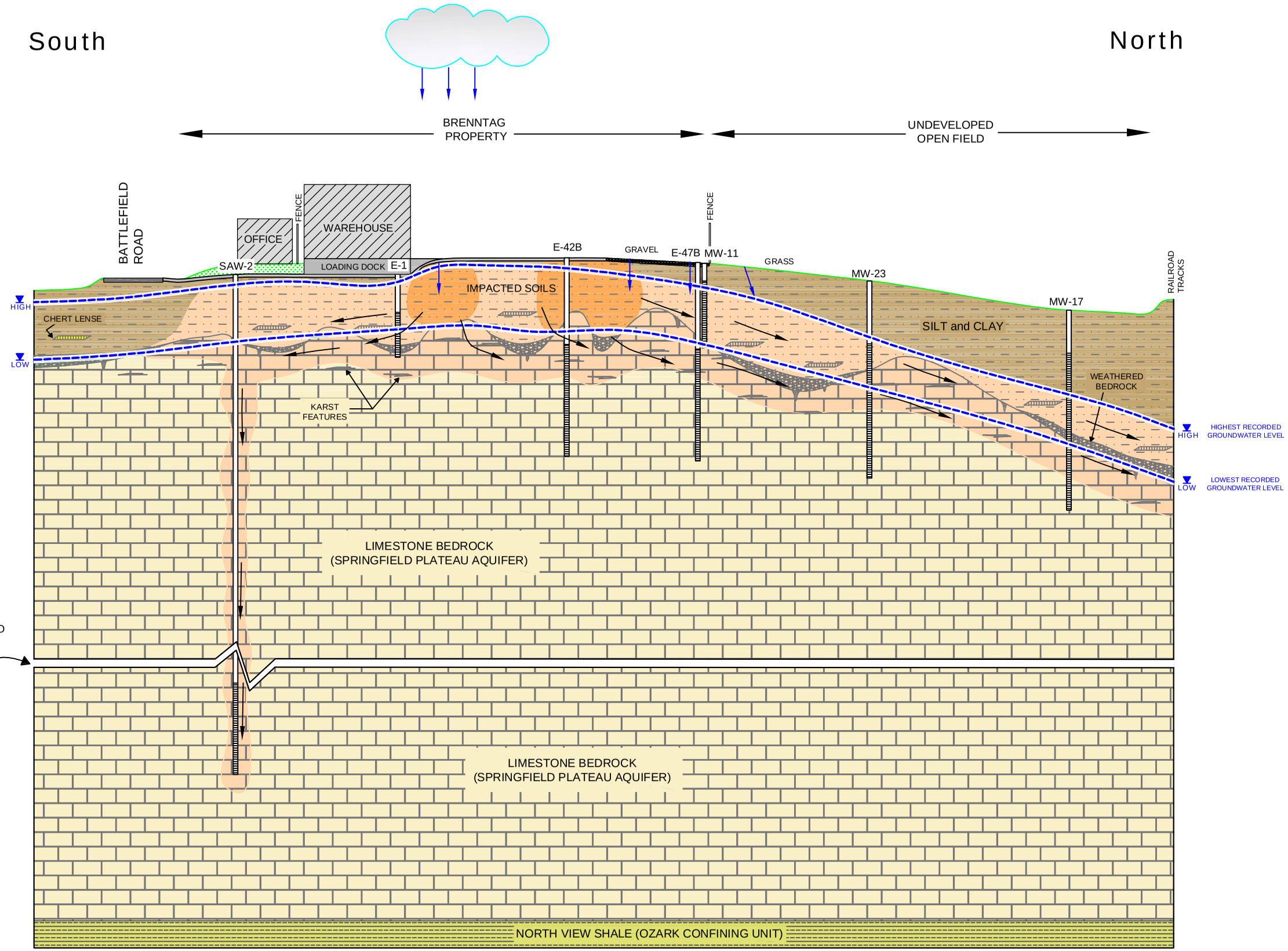

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Conceptual Site Model

Springfield, Missouri

Project Number	OK001255.0036
Drawing Date	9 July 2007
Figure	32

G:\Aproject\BRENNTAG\OK12550036\RI CADD\32_CONCEPT SITE MODEL 2009.dwg, 5/20/2011 1:55:10 PM

Appendix A
Geological Logs (on CD)

Direct Push Borings

- GP-22 through GP-33

Shallow Springfield Plateau Aquifer Monitoring Wells

- MW-1 through MW-31B, SAW-1 and SAW-3

Deep Springfield Plateau Aquifer Monitoring Wells

- SAW-2, SAW-4 through SAW-8

High Vacuum Extraction Wells

- EW5, E51, E52 and E53

ERD Injection Wells

- IW-1, IW-3, IW-5, IW-6, IW-7 and IW-8

Geotechnical Soil Boring

- GSB-1

Appendix B

Summary of Fluid-Level Measurements (on CD)

Appendix C
Well Construction Logs (on CD)

Former Dayco Products, Inc. - Water Supply Well (Carlisle Power Transmission Products)

Shallow Springfield Plateau Aquifer Monitoring Wells

- MW-7 through MW-31B

Deep Springfield Plateau Aquifer Monitoring Wells

- SAW-2, SAW-4 through SAW-8

High Vacuum Extraction Wells

- EW4, EW-5, EW-7, EW8, EW9,E51 E52, and E53
- E7B, E42B, E45B, and E47B

ERD Injection Wells

- IW-1 through IW-8

MDNR Well Certification Records

- MW-1 through MW-6
- MW14 through MW-31B
- SAW-2, SAW-4 through SAW-8
- E7B, E42B, E47B, E51, E52, and E53
- IW-1 through IW-8
- HVE Wells

Appendix D

Historical Summary of Volatile Organic Compounds Detected in Groundwater (on CD)

- MWs 1-31B
- EW-1N, EW-2S (New Tank Farm)
- SAW 1-8
- E7B, E42B, E45, E47B
- E48, E51, E52, E53
- IW-1, IW-3, IW-5
- Equipment Blank
- Field Blank
- Trip Blank
- Footnotes

Appendix E

Geotechnical Testing Data (on CD)

Appendix F

Laboratory Data Validation Reports

(On CD)

Appendix G

Laboratory Reports (On CD)

for Soil Samples

ARCADIS - RI 2010 - 2002

CJE - Historic 1999 - 1992

Appendix H

Well Development Form - SAW-2 (on CD)

Appendix I

Laboratory Reports (On CD

for

Groundwater Samples

ARCADIS 2010 - 2003

CJE 2001 - 1992

Appendix J

Laboratory Reports for Soil Vapor
and Sub-slab Vapor Samples
(On CD)

Appendix K

Human Health Risk Assessment

(Hard Copy Bound Separatly and copied on CD)