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3 April 2017

Mr. Daniel R. Gravatt
US EPA Region 7 AWMD/WRAP/RCAP
11201 Renner Boulevard
Lenexa, KS 66219

ERM

RE: Revised Remedy Implementation Plan submittal
Former Waterloo Industries facility, 300 Ansborough Avenue, Waterloo, Iowa 50701
IAD005277959

Dear Mr. Gravatt:

Per your request, please find attached an electronic copy of the Remedy Implementation Plan (RIP) for the former Waterloo Industries facility located at 300 Ansborough Avenue, Waterloo, Iowa. The attached RIP, Material Management Plan (MMP), and Quality Assurance Project Plan (QAPP) have been revised to address comments provided in EPA correspondences dated March 7, 2017, and March 2017. The attached CD includes a PDF copy of the complete RIP, text, figures, tables, and appendix. Per our correspondence, Appendices E and F in the attached PDF copy have been mark with pages noting "Pending EPA Review and Approval."

If you have any questions or comments, or if I can provide any additional information, please feel free to contact me at (515) 223-8225.

Sincerely,
Environmental Resources Management, Inc.

Mark E. Seaman, P.E.
Senior Project Manager

Christopher B. Weggemann
Partner

cc: Dennis W. McKinney
Sarah Sullivan
Larry Corkery

RCRA 04/03/2017

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Remedy Implementation Plan

Former Waterloo Industries Facility
300 Ansborough Avenue
Waterloo, Iowa

8 February 2017
(Revised 3 April 2017)

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ERM

Waterloo Industries

Remedy Implementation Plan Former Waterloo Industries Facility

300 Ansborough Avenue
Waterloo, Iowa
IAD005277959

8 February 2017
(Revised 3 April 2017)

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Appendix B *Health and Safety Plan*
Appendix C *Material Management Plan*
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Appendix E *Environmental Covenant Agreement*
Appendix F *Financial Cost Estimate*

1.0 INTRODUCTION AND PURPOSE

1.1 INTRODUCTION

On behalf of Fortune Brands Home & Security, Inc. (FBHS), Environmental Resources Management Inc. (ERM) has compiled this Remedy Implementation Plan (RIP) as requested by the United States Environmental Protection Agency (EPA) Region 7 in a correspondence dated 22 July 2016. The former Waterloo Industries (Waterloo) facility is located at 300 Ansborough Avenue in Waterloo, Black Hawk County, Iowa (the "Site" or "Facility"). The location of the Site is shown on **Figures 1-1 and 1-2.**

The work scope outlined in this RIP has been developed based on EPA guidance regarding performance monitoring associated with monitored natural attenuation (MNA) remedies (*Performance Monitoring of MNA Remedies for VOCs in Groundwater*, EPA 600/R-04/027 April 2004). This guidance was used in conjunction with OSWER Directive 9200.4-17P *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites* (EPA, 1999) and guidance presented in *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (EPA, 1998) and *An Approach for Evaluating the Progress of Natural Attenuation in Groundwater* (EPA, 2011). In addition, the work is in accordance with the Final Decision and Response to Comments (FD/RTC) dated 17 June 2016 and the Remedy Selection Process (RSP) Meeting Report (Update 1), dated 6 November 2015.

1.2 PURPOSE

The scope and purpose of this RIP has been developed based on the data and findings presented in the RCRA Facility Investigation (RFI) Report (21 July 2015 update), the 17 June 2016 FD/RTC, as well as the corrective action implementation request letter issued by EPA on 22 July 2016 and subsequent discussions with EPA. The purpose of the RIP is to identify data needs, evaluation methods, monitoring network layout, reporting requirements, remedial system maintenance and monitoring requirements, and methods for routine evaluation of institutional controls that are associated with implementing the corrective action at the Waterloo Site.

1.3 REPORT ORGANIZATION

This work plan is organized as follows:

- Section 1 – Performance Monitoring Plan Introduction and Purpose
- Section 2 – Background and Site Description
- Section 3 - Conceptual Site Model
- Section 4 - Objectives and Decisions Points
- Section 5 - Monitoring Network and Schedule
- Section 6 - Sampling and Analysis Plan
- Section 7 - Dual Phase Extraction System Design Plan
- Section 8 - Dual Phase Extraction System Operations Plan
- Section 9 – Monitoring of Institutional Controls
- Section 10 – Evaluation of Remedy Effectiveness
- Section 11 – Plan for Verifying Attainment of Remedial Objectives

2.0 BACKGROUND

2.1 PROJECT TEAM ROLES AND RESPONSIBILITIES

2.1.1 General Project Management

Mr. Dennis McKinney, Fortune Brands Home & Security (which formerly owned Waterloo Industries, Inc.), will be the Waterloo project manager and will have the overall responsibility for the sampling and reporting efforts. ERM will report to Mr. McKinney and will be responsible for the execution of the work to implement the corrective action, and for issuing all project deliverables. EPA Region 7 will review all documents and provide regulatory management of the project. The operational responsibilities involving the execution and direct management of the technical and administrative aspects of this project are summarized below.

General Project Oversight:

ERM

Project Manager – Mr. Mark Seaman, P.E.

ERM's Project Manager will establish and manage budgets and schedules; select and oversee subcontractors and project staff, review all submittals prepared by ERM for the project, and be responsible for the preparation and quality of all deliverables.

Quality Assurance:

ERM

Quality Assurance Officer – Dr. Maureen C. Leahy, Ph.D.

The Quality Assurance Officer (QAO) is responsible for auditing the implementation of the QA program in conformance with the demands of specific investigations, applicable policies and EPA Region 7's requirements.

Laboratory

QAO Test America – Dr. Thomas J. Tjaden

QAP Pace Analytical Services – Ms. Charlotte Washlaski

The laboratory's QAOs will be responsible for auditing the implementation of their own QA program and for meeting the requirements of the Quality Assurance Project Plan (QAPP).

Regulatory Management of the Project:

EPA Region 7

Project Manager – Mr. Daniel Gravatt, P.G.

The EPA Region 7 Project Manager has the overall responsibility for reviewing and approving all work performed at the Site.

2.1.2 Field Activities

ERM will perform or supervise all data collection activities. ERM's Project Manager will be responsible for the overall execution of the remedy implementation and will ensure that all field activities are executed in accordance with the requirements outlined in this site-specific QAPP and the project-specific HASP. Specific individuals involved in the field activities include:

Facility and Property Owner

Property Owner Contact – Mr. Larry Corkery of JRL Holding Company, LLC, or his designee.

ERM

Field Operations Manager – Mr. Darron deBoer, or designated qualified alternate. ERM's Field Operations Manager will be responsible for the field activities and supervise the day-to-day activities.

Subcontractors

The following subcontractors to ERM may be employed to provide professional services in completion of the field activities.

Test America, Cedar Falls, IA	Groundwater Chemical and Geochemical Laboratory Analyses
Pace Analytical Services, Pittsburg, PA	Groundwater Biochemical Laboratory Analyses
VJ Engineering, Waterloo, Iowa	Surveying

All subcontractors will provide appropriate project management support as needed to complete the designated project work scopes.

2.1.3 *QA Organization*

ERM is responsible for the overall quality of all project deliverables. ERM's QAO will provide overall QA of the project's field activities. Specific functions and duties include:

- Review and approve the QA plans and procedures;
- Provide QA technical assistance to project staff;
- Review the field data acquired during the field activities to ensure they were collected in accordance with the QAPP;
- Review the field notebooks to determine whether proper custody procedures were followed during the field work and decide if any location should be re-sampled;
- Review all laboratory analytical data to ensure they were generated in accordance with the approved QAPP;
- Perform or oversee the required data validation; and
- Ensure that QAPP procedures regarding project documentation and evidence file are followed.

ERM's QAO may delegate some or all of these duties to another qualified ERM staff member or an outside qualified consultant. An ERM staff member will be considered qualified for a specific task if that person has the appropriate training, education, and experience to perform the task. ERM's QAO will oversee the work completed by other ERM staff members or subcontractors and will have the overall responsibility for ensuring that any delegated task is performed in accordance with the QAPP.

The laboratory's QAO will be responsible for enforcing and documenting the QA/QC procedures performed during the analytical work.

2.2 *BACKGROUND AND SITE DESCRIPTION*

The former Waterloo manufacturing facility property consists of approximately 10.3 acres located at the southwest corner of the intersection of Ansborough Avenue and Highway 218 in Waterloo, Iowa, as presented on **Figures 1-1 and 1-2**. The Property has one main building comprised of several additions, and several small storage buildings as represented on **Figure 2-1.** The ground surface around the buildings is covered by parking areas, driveways, railroad right of ways, landscaped areas, and city streets.

Waterloo and prior owners of Waterloo conducted manufacturing operations at the facility from approximately 1946 to 1997. During the years of operation from 1946 to 1997, the Property was owned by Sulentic Family Trust and leased to Waterloo and prior owners of Waterloo.

The ownership history of the property both historic and present is summarized as follows:

- 1941 - 1999: Sulentic Family Trust;
- 1999 – 2008: Fishels Warehousing, LLC;
- 2008 - Current: JRL Holding Company, LLC.

2.3 *CURRENT LAND USE*

The facility is currently owned by JRL Holding Company, LLC, with two tenants leasing space within the facility. The building currently contains a recycling operation which utilizes warehouse, water treatment, and material processing equipment on site, as well as limited self-storage space, and a gym. The current operations and tenant storage areas, as understood through discussions with Mr. Larry Corkery of JRL Holding Company, LLC, are depicted on **Figure 2-2.** The locations of the solid waste management units (SWMUs) and areas of concern (AOCs) identified in the RFI and related documents are depicted on **Figure 2-3.** The current tenants and use of the facilities are summarized as follows:

- The majority of the main building is currently occupied by Green Line Polymers (Subsidiary of Advanced Drainage Systems, Inc. (ADS)), engaged in processing of recyclable plastics on site. On **Figure 2-2** areas not otherwise designated as occupied by another tenant should be assumed to be occupied by Green Line Polymers.;

- Bare Bones Gym- Small walk-in gym facility located in a refurbished area of the former Waterloo office space; and

- Climate Controlled Self Storage- Business record and file storage business located in the basement area of the northeast corner of the former Waterloo facility.

Based on visual observations and an Environmental Data Resources, Inc. City Directory Abstract dated October 11, 2010, land use on adjacent and surrounding properties includes the following as depicted on **Figure 1-2**:

- East: Interchange of Ansborough Avenue and Hwy 218;

- West: Rainbow Drive, then Annis Petroleum Products (wholesaler), former Waterloo storage building, Whittaker Foods (food processing and distribution), and residences;

- South: Buzz's Bar, Buffalo Weaver, Inc. (weaving company), and residences; and

- North: Hwy 218, then the National Cattle Congress fairgrounds.

All business properties along Ansborough Ave and Rainbow Drive are zoned for light industrial use by the City of Waterloo. Surrounding residential properties (south and east) are zoned for one or two family homes.

2.4 REGULATORY STATUS

Waterloo voluntarily conducted investigation and sampling activities in connection with the shutdown of the Waterloo manufacturing operation in November 1997, and to develop information in the context of an ongoing RCRA Facility Assessment (RFA) initiated by EPA in March 1995. Waterloo actively participated in the RFA process with three information submittals dated May 30, 1995; September 3, 1996; and April 10, 1997 in

response to a March 27, 1995 Request for Information Regarding Solid Waste Management Units. In addition, Waterloo participated in an April 18, 1996 Visual Site Inspection (VSI) of the Waterloo facility conducted by EPA's contractor Science Applications International Corporation (SAIC) and reviewed and commented, in part, on SAIC's draft Task 3 Report within Waterloo's September 3, 1996 submittal.

Based on current information, the following summary lists the Investigation Reports related to the Waterloo site that was compiled prior to the RFI:

- *SAIC Draft Task 3 Report to EPA* (SAIC, 1995). Identified 28 SWMUs and 9 AOCs at the Site;
- *Sampling Report and Request for No Further Action*, Waterloo Industries Former Manufacturing Facility (Weston, 1998). Site activities included the collection of 11 soil samples from 11 sampling locations;
- *Limited Site Investigation Report (*Terracon, May 20, 2008). Collection of five soil and five groundwater samples outside the building, focused around the west end of the facility;
- *Data Summary Report* (SES, January 5, 2009). Collection of 23 soil samples and 2 groundwater samples from 17 targeted sample locations on the property; and
- EPA Letter regarding Former Site of Waterloo Industries sampling Results (EPA, July 19, 2010). The summary letter included soil and groundwater analytical data contained in the SES January 5, 2009 Summary Report, and the sub-slab soil vapor sample analytical data from sampling conducted on April 29, 2009.

A RFI Work Plan and subsequent addendums were compiled for the Site and submitted to EPA in 2011 and 2012 with final approval by EPA on 23 August 2013. The purpose of the RFI was to determine the nature and extent of releases of hazardous wastes and/or hazardous constituents from regulated units, hazardous waste management units (HWMUs), SWMUs, AOCs and other source areas at the former site (as defined by the RCRA Facility Assessment [RFA]). The RFI Report (updated 21 July 2015) summarizing the RFI activities and findings was submitted to the EPA and approved on 30 July 2015.

Maps depicting Site investigation activities and locations are provided as **Figures 2-4** through **2-7** (soil, groundwater, soil vapor, and indoor air

locations, respectively). The results of the investigation activities are discussed in **Section 3.0**.

On 27 August 2015, a RSP Meeting was conducted between EPA, Fortune Brands Home Security, and ERM to develop concurrence between EPA and Waterloo on the conclusions of the RFI and to identify a remedy selection path forward for the former facility. The RSP Meeting discussions and recommendations are summarized in the RSP Meeting Report (Revision 1) dated 6 November 2015. On 17 June 2016, following a public comment period and public meeting, EPA issued the FD/RTC, detailing the selected final remedy for the Site.

3.0 CONCEPTUAL SITE MODEL

The sections that follow provide descriptions and summaries of the Site conditions as presented in the RFI Report (update 1, dated 21 July 2015) and the RSP Meeting Report (revision 1, dated 6 November 2015).

3.1 SURFACE FEATURES

An overview of the Site and surrounding area is shown on **Figure 1-2**. The overview shows roads adjacent to the Site, and natural and man-made features within 2,000 feet of the Property. Site features are shown in more detail on **Figures 2-2** and **2-3**. Structures currently onsite include the main facility building, a few small out buildings previously used for water treatment or storage, several concrete pads associated with former above ground storage tanks (ASTs), and one concrete retaining wall for containment of a former fuel oil AST. Open areas are covered with gravel, asphalt, concrete or grass. Onsite and nearby utility lines and conduits include natural gas, fiber optic, water, sewer, and overhead electric. An abandoned railroad spur enters the southwest corner of the Site and extends approximately 180 feet inside the Site boundary.

3.2 TOPOGRAPHY

Topography of the property slopes sharply toward the north and east. The unpaved areas on the north and east sides of the property are approximately 18 feet lower than the ground surface on the south side of the property and main floor of the facility. In addition, highway 218 which runs along the northeast property boundary is significantly elevated, further defining this bowled area created in the north and east side of the Site.

3.3 VEGETATION

According to the Iowa Department of Natural Resources, the urban area of Waterloo, Black Hawk County, is surrounded by land primarily used for agricultural purposes, specifically row crops. Land surface in the area is nearly level to gently rolling with long slopes, low relief, and open views (Natural Resources Conservation Service [NRCS]). Native vegetation is mixed tall and short grass prairie, but it is not currently present at the property.

As shown on **Figure 2-2**, the 10.3-acre Site has the following types of surficial covers (all measures are approximate):

- Buildings: 3.64 acres;
- Asphalt/concrete parking lots: 2.58 acres;
- Gravel-covered surfaces: 2.22 acres; and
- Landscaping plants and grass: 1.85 acres.

3.4 HYDROLOGY

Surface water features near the Site are depicted on **Figure 3-1**. The Cedar River, located 1/3 mile north-northeast of the property, is a regional drainage feature in northern and eastern Iowa. The Cedar River is a wide, meandering stream that flows toward the southeast through Black Hawk County, with a flood plain more than one mile wide in some areas. Based on Federal Emergency Management Agency (FEMA) GIS data, the northern (lowest elevation) part of Site is located within the 500 year flood plain for the Cedar River as depicted on **Figure 3-2**. Black Hawk Creek, a tributary of the Cedar River, follows a southwest to northeast course south of the Site and joins the Cedar River slightly more than one mile east-southeast of the Site.

No mapped wetlands are located at the site, according to the U.S. Fish and Wildlife Service National Wetlands Inventory on-line Mapper (http://www.fws.gov/wetlands/Data/Mapper.html). The mapped wetlands closest to the site are a Palustrine Emergent Temporary Flooded (PEMA) wetland located approximately 0.3 miles north, a Palustrine Forested Broad-Leaved Deciduous Temporary Flooded (PFO1A) wetland located approximately 0.4 miles north-northwest, and a Palustrine Emergent Semi permanently Flooded (PEMF) wetland located approximately 0.4 miles northwest.

Storm water at the Site is directed toward several storm sewer inlets that lead to either the storm sewer beneath Rainbow Drive or to an exposed storm water conveyance structure (i.e., a concrete trough) that begins on the east side of the Site (visible on **Figure 1-2)** and parallels the northern Site boundary and Highway 218. The conveyance structure leads to a retention basin approximately 0.4 miles northwest of the Site.

The Site is located in the Middle Cedar watershed – Hydrologic Unit Code (HUC) 07080205 - which covers most of Blackhawk County as well as

parts of eight surrounding counties. The Middle Cedar watershed encompasses the Cedar River and all tributaries between the confluences with Beaver Creek in northwestern Blackhawk County and Prairie Creek in southern Linn County.

3.5 GEOLOGY AND HYDROGEOLOGY

The property and surrounding area are situated on Quaternary unconsolidated deposits composed of glacial till and alluvium. The Quaternary deposits non-uniformly overlay sedimentary rocks including (in descending order): the Devonian Cedar Valley Group (limestone and dolomite) and Wapsipinicon Group (limestone, shale, and dolomite); Silurian dolomite; and the Ordovician Maquoketa Shale. Regionally, the thicknesses of the Devonian and Silurian units average approximately 120 feet and 60 feet, respectively (McKay, et al., 2009).

The Site is located on soil classified by the United States Department of Agriculture (USDA)/Soil Survey Geographic (SSURGO) Database as Bassett-Urban land complex, a loam, and Finchford-Urban land complex, described as loamy sand and sand. The area surrounding the site location contains soil types Kenyon-Urban land complex (loam), Clyde-Floyd Urban land complex (silty clay loam/ sandy loam), Saude-Urban Land complex (loam/ loamy sand), and Orthents-Urban land complex (fill material). A soil survey map is presented as **Figure 3-3**.

Site geology is discussed in the following sections and illustrated on four cross-sections presented as **Figures 3-5** through **3-8.** The cross-section trace map is presented as **Figure 3-4**.

3.5.1 Unconsolidated Deposits

3.5.1.1 Unit Descriptions

Fill Material

Fill material emplaced during construction of the facility building and additions, comprised primarily of sand with slag and debris (i.e. wood, concrete and metal fragments), is present under the northern two-thirds of the building at thicknesses up to approximately 20 feet (at SB-26). Fill was also placed in low-lying areas to level the lawn, parking, and driveway areas on the north side of the Site. The fill and native sands have very

similar characteristics, and no consistent, obvious base of the fill was identified.

Perched Zone Clay

A dense clay unit is present above bedrock beneath the southern half of the Site. The clay unit, where present in soil borings, ranges in thickness from 1.5 feet to 27 feet, and is encountered at depths ranging from 5 to 27 feet below ground surface (BGS). Soil boring observations indicate that the clay "pinches out" near the northern building wall. This clay defines the base of the perched groundwater zone discussed below. The clay is non-plastic, very hard and dense, contains fine gravel, and is typically gray or pale brown in color. In borings SB-3, 14, and 17, the clay was yellowish brown, similar in color to the overlying sand. Other than color, however, the clay encountered in these borings exhibited all typical characteristics observed elsewhere. The clay, where present, extends to the bedrock contact in all borings. For the purposes of this report, the clay unit is referred to as the "perched zone clay." A contour map of the perched zone clay surface elevation is presented on **Figure 3-9**, illustrating that the clay surface slopes toward the east/northeast, consistent with measured perched groundwater flow direction. Detailed descriptions of unconsolidated materials encountered during Site investigation activities are provided in the RFI Report.

3.5.2 Bedrock

Bedrock at the Site was encountered in several borings at depths ranging from 9 feet on the north side of the property (several wells) to 37 feet on the south side of the property (MW-2D). It should be noted that the surface topography of the site drops significantly from the south to the north as indicated in **Figure 1-1**, while the bedrock surface remains relatively flat. The bedrock encountered in the borings was predominantly highly to completely weathered for several feet below the unconsolidated/ bedrock contact. The completely weathered material consisted of grayish orange, low plasticity clay. More competent, slightly weathered bedrock was generally encountered within several feet of the contact; however, highly to completely weathered rock was observed to total depth in borings SB-12, SB-13, and SB-2D. A contour map illustrating the elevation of the bedrock surface at the Site is presented in **Figure 3-10**. In general, the bedrock surface elevation decreases toward the east and west from a ridge extending along an axis extending from approximately MW-15 through SB-14A/MW-14 and SB-17/MW-17. A

minor east-west trending trough is evident between SB-14A/MW-14 and SB-15A/MW-15.

3.5.3 *Hydrogeology*

The limestone and dolomite of the Devonian and Silurian units are hydraulically connected and considered one aquifer package. The Devonian-Silurian aquifer is the primary source of water for portions of eastern and north-central Iowa and contributes base flow to the Cedar River. Regional groundwater flow in the Devonian-Silurian aquifer is toward the southeast (Prior et al., 2003).

The top-most groundwater found at the Site occurs in the unconsolidated sand and silt deposits in a perched zone, created by a dense clay unit (the "perched zone clay") that is present above bedrock beneath the southern half of the Site. Groundwater is not encountered in the unconsolidated deposits northeast of the building where the clay is not present. Boring logs generated by Terracon for the 2008 investigation show that clay extends from the ground surface to at least 20 feet BGS along the northwest side of the building (see **Figure 2-4**). In contrast to the northeast side of the building, Terracon collected groundwater samples from temporary wells, indicating that perched groundwater is present in this part of the Site.

Depth to perched groundwater ranges from approximately 1.61 feet BGS on the south side of the Site (MW-1) to 23.15 feet BGS under the main building (MW-14). The flow direction of the perched water is controlled by the topography of the perched zone clay, which slopes sharply toward the northeast (falling over 22 feet in approximately 140 feet of distance down gradient). Perched groundwater reaches the weathered bedrock where the clay "pinches out," likely near the north wall of the building, and flows through fractures at the top of bedrock downward to the regional water table in the Devonian limestone/ dolomite. There are several feet of fractured bedrock at the contact between the unconsolidated soil and the bedrock. The water table is encountered in bedrock at depths ranging from 14 feet on the north side of the Site (MW-5) to 37 feet BGS on the south site of the Site (MW-1D and 2D).

Recharge occurs locally via surface water infiltration on unpaved surfaces on the north and northeast side of the Site. Regionally, the Devonian limestone/ dolomite aquifer is recharged by infiltration, specifically in outcrop areas.

Permeability testing was conducted both in a laboratory on relatively undisturbed soil samples collected during boring activities, and in-situ in several monitoring wells. Laboratory sample SB-2 (22-24) and the lower portion of sample SB-4(20-22) were comprised of perched zone clay; and samples SB-6 (7-8.5) and the upper portion of sample SB-4 (20-22) were comprised of poorly graded sand. The perched zone clay samples had very similar results (4.30 $x10^{-8}$ and 5.80 $x10^{-8}$ cm/s, respectively) with an average hydraulic conductivity of 5.05 $x10^{-8}$ cm/s. The poorly graded sand samples exhibited calculated hydraulic conductivity values ranging from 2.59 $x10^{-2}$ to 4.92 $x10^{-2}$ cm/s, with an average of 3.76 $x10^{-2}$ cm/s. The hydraulic conductivity values calculated for clay and sand are typical for their respective material type (Fetter, 2001).

Slug tests were performed in bedrock zone wells MW-3, 5, 6, 23, 24, and 25; and in perched zone wells MW-4, 8, 9, and 10. Test data was analyzed using the Bouwer-Rice slug test solution, which assumes that the aquifer has an infinite areal extent. Because the perched zone is known to be absent in part of the Site, the analyses of slug tests conducted in perched zone wells violate the assumption of infinite aquifer extent. Therefore, hydraulic conductivity values reported for perched zone wells are considered estimates.

The hydraulic conductivity calculated for perched zone wells ranged from 6.0 x 10^{-7} cm/s in MW-8 to 5.3 $x10^{-5}$ cm/s in MW-10, respectively, with an average of 1.4 $x10^{-5}$ cm/s, typical hydraulic conductivity ranges for clay and silt. The hydraulic conductivity calculated for bedrock zone wells ranged from 5.3 x 10^{-5} cm/s in MW-25 to 2.8 $x10^{-3}$ cm/s in MW-5, with an average of 7.2 $x10^{-4}$ cm/s.

The horizontal hydraulic gradient measured in the bedrock zone is 0.007. Using the assumed effective porosity of 0.15 (average porosity reported in Charbeneau, 2000), the groundwater velocity ranges from 2.47$x10^{-6}$ cm/s to 1.30$x10^{-4}$ cm/sec (7.01$x10^{-3}$ feet/day to 0.368 feet/day) with an average groundwater velocity of 3.36 x 10^{-5} cm/s (0.095 feet/day).

The horizontal hydraulic gradient measured in the perched zone is 0.084. Borings SB-2 and SB-4 (and subsequent monitoring wells) were advanced in areas of the Site where perched groundwater is present. The perched aquifer is comprised of two distinct lithologies, one dominated by clay with the second dominated by sand. Using the average porosity measured in the clay-dominated interval geotechnical samples of 0.31, the groundwater velocities range from 1.17$x10^{-8}$ cm/s to 1.57$x10^{-8}$ cm/s (3.32$x10^{-5}$ feet/day to 4.45$x10^{-5}$ feet/day) with an average of 1.37 x 10^{-8} cm/s (3.88$x10^{-5}$ feet/day)

in intervals dominated by clay. Using the porosity (0.34) and hydraulic conductivity (2.59 $x10^{-2}$ cm/s) measured in the sand-dominated geotechnical sample SB-4(20-22), the groundwater velocity was calculated to be 6.40 $x10^{-3}$ cm/s or 13.0 feet/day in intervals dominated by sand. Based on these values, the clay-dominated intervals are the limiting factor in groundwater movement in the perched aquifer.

3.6 ANALYTICAL SUMMARY

This section describes the nature and extent of contamination at the Site based on historical data and data collected during the RFI. This section is focused on impacts associated with the RFI investigation areas, consisting of AOC 5 and the former wastewater treatment area.

AOC 5

Based on the RFA (SAIC, 1995), AOC 5 was defined as a solvent AST reportedly located on the south wall of the main building at the location shown on **Figure 2-3**. Waterloo reported a one-time release of approximately 5 to 10 gallons of solvent from the tank to the storm sewer.

Monitoring well MW-8 and sub-slab soil vapor location WSVS-1 are the nearest sampling locations to AOC 5. However, the highest concentrations of VOCs in soil vapor and groundwater were measured at locations WSVS-2R and MW-9, respectively, which are located approximately 60 feet southeast of AOC 5. These data indicate that the source of contamination in the AOC 5 investigation area is associated with historical incidental release(s) in the area of monitoring location MW-9 and is unrelated to the former solvent AST (AOC 5).

Based on soil sampling (DP-1 through DP-8, and SB-28 through 30) within AOC 5 and around MW-9, the area of impact in soils is very limited and has been well defined (**Figure 3-11**), as described in detail in **Section 3.6.1**. Similarly, groundwater samples in the AOC 5 area collected in conjunction with the direct push and soil boring data collection activities delineated the limited area of impact in the perched zone aquifer beneath the building footprint centering on monitoring well MW-9.

Former Wastewater Treatment Area

The former wastewater treatment area consists of the following potential sources, whose locations are depicted in **Figure 2-3**:

- SWMU 13: A 20,000 gallon evaporator tank that was used to evaporate liquid from the wastewater treatment/parts washer sludge.
- SWMU 15: Three wastewater pretreatment underground storage tanks (USTs). Inputs included metal surface preparation wastewater and waterfall paint booth wastewater.
- SWMU 18: The wastewater pretreatment system consisting of one large compartment that received wastewater from the parts washers and strip tank rinse process.
- AOC 7: Releases of 6,000 to 7,000 gallons of partially treated wastewater that reportedly overflowed the 19,000 gallon settling tank (a SWMU 15 UST) and was discharged to the parking lot. It is unknown on either occasion if any wastewater was recovered for treatment.
- AOC 10: A concrete enclosure constructed as a dike for a fuel oil tank that contained standing water during the 1996 Site inspection.

The source of VOC groundwater contamination in this area may be related to leaks from one or more former tanks and/or the AOC 7 release; however, a specific source was not identified. As described in **Section 3.6.1,** soil impacts were limited to near surface locations, vertically delineated to concentrations below the RSL within each boring, with the surface impacts significantly above the expected depth to groundwater. As a result, the soil analytical data from samples collected near the former wastewater treatment area indicate that residual near surface soil contamination (three PAHs (SB-7) and PCE (SB-12) exceeded the RSLs) is not contributing to groundwater contamination in this area. The source of near-surface PAH impacts in soil are discussed in **Section 3.6.1.3**.

3.6.1 Unsaturated Soil Zone

3.6.1.1 VOCs

The investigation results indicate that the Site soil is not significantly impacted by VOCs. None of the soil samples collected during the RFI had compounds above the industrial soil RSLs. However, PCE was found in four AOC 5 borings (SB-9 and 15, DP-2 and 3) at concentrations of up to 1.51 mg/kg, which were above the groundwater protection SSL of 0.046 mg/kg. The concentration of 1.51 mg/kg was detected in a duplicate of SB-9(3-5); the original sample had only 0.179 mg/kg of PCE, indicating a very limited area at the higher concentration. Historical soil analytical results confirm the RFI findings near the presumed AOC 5 source area.

Samples S18 (2-4 feet BGS) and S19 (10-12 feet BGS), collected near RFI boring SB-8, contained several compounds above groundwater protection RSLs, including PCE, cis-1,2-DCE, and vinyl chloride. However, all concentrations were below current industrial soil RSLs.

As presented in **Figure 3-11**, limited un-saturated soil impacts in the area of SB-9 were horizontally delineated based on soil analytical data to concentrations below the groundwater protection SSLs. It should be noted that PID data was collected as part of the field data collection from un-saturated and saturated soils. The PID data can be used as a screening tool, however, PID data collected from wet or saturated soils can be misleading due to false positive measurements associate with water vapor. An example is the elevated PID readings (9.8 ppm) in DP-8 and SB-29 (19.1 ppm), with corresponding analytical data reported as below detection limits for all analytes on both soil samples.

However, based on the groundwater concentrations and related soil vapor concentrations exhibited at MW-9 and WSVE-2R, adsorbed residual source material is likely present in the saturated soil in this limited area. Although these concentrations are elevated, comparison of both the soil and soil vapor concentrations with site-specific soil and vapor saturation concentrations indicates that non-aqueous-phase liquid is not likely to be present.

The unsaturated soil concentrations for PCE were compared to the site-specific soil saturation concentration (C_{sat}), which is the soil concentration at which PCE is at saturation in the dissolved, vapor and sorbed phases in soil and above which non-aqueous-phase liquid may be present. The site-specific soil saturation concentration (C_{sat}) for PCE in unsaturated zone soil was calculated using the measured soil characteristics of sample SB-6 (7-8.5 ft)

The site-specific C_{sat} is 178 mg/kg. This value is similar to the default C_{sat} of 166 mg/kg in the current EPA Risk Screening Level table. The highest soil concentration that has been detected in soil in AOC 5 has been 1.51 mg/kg in the sample from SB-9 (3-5 ft). This maximum concentration is more than 100-fold below the calculated C_{sat} and indicates that PCE is not present as non-aqueous-phase liquid in these soils.

Similarly, the sub-slab soil gas concentrations of PCE at WSVS-2R, which ranged from 1,400,000 to 2,500,000 $\mu g/m^3$, are 60 to 100-fold lower than the vapor saturation concentration of 151,000,000 $\mu g/m^3$ for PCE at C_{sat}.

The PCE concentration in groundwater at MW-9 is equal to about 7.5% of solubility. While this concentration indicates the potential presence of PCE as non-aqueous-phase liquid, the soil concentrations and soil vapor concentrations are well below saturation concentrations and low groundwater concentrations have been detected at all surrounding well locations.

The soil samples collected from wastewater treatment area boring SB-15 contained naphthalene at a concentration of 0.606 mg/kg, which is above the groundwater protection RSL, and PCE concentration of 0.0543 mg/kg in SB-12(0.5-2 feet BGS) above the groundwater protection SSL of 0.046 mg/kg. Nearby historical samples B-5 (0-2 feet BGS) and S4 (0.5-2 feet BGS) contained PCE at a concentration just above the groundwater protection SSL. Other than naphthalene and PCE, only two additional VOCs were detected at concentrations just above detection limits. These results support that residual soil contamination is present only in isolated areas and likely does not represent a continuing source of groundwater contamination in the AOC 5 or former wastewater treatment investigation areas.

Table 3-1 summarizes the analytical results for VOCs in soil samples collected during RFI activities.

3.6.1.2 *Inorganics*

The USGS National Geochemical Survey database, available at http://tin.er.usgs.gov/geochem/doc/averages/countydata.htm, has an average background soil concentration for arsenic in Black Hawk County, where the City of Waterloo is located, of 6.994 mg/kg with a standard deviation of 1.243 mg/kg. The maximum arsenic concentration reported in the Site soil samples was 8.2 mg/kg and only one out of 40 samples analyzed had arsenic above the average background soil concentration. Therefore, ERM concludes that the arsenic detected in the Site soil samples is related to background conditions in the area and, thus, requires no further evaluation as a Site COC, as indicated in the RFI Work Plan as approved by EPA.

3.6.1.3 *SVOCs*

The only SVOCs detected in the Site soils above the RSLs are the following PAHs: benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene. Only benzo(a)pyrene was detected at concentrations exceeding its industrial soil RSL (**Table 3-2)**. The two samples where either two or three

of these PAHs were detected (SB-7 and SB-22) were collected from the 0.5 to 2 foot BGS interval, which consists primarily of fill material. The extent of benzo(a)pyrene concentrations in near surface soil exceeding the RSL is depicted on **Figure 3-12**. The extent of benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene impact is defined horizontally, except for the area south and east of boring SB-22. The vertical extent of the PAH impact is defined by non-detect results from deeper soil samples in SB-5, SB-6, and SB-7.

RFI soil boring SB-22, where a near surface sample had benzo(a)pyrene above the RSL, is located near the top of a slope that extends from the north building wall down to the driveway (depicted with gray color on **Figure 3-12**). The ground elevation of SB-22 (861.8 feet) is 3.5 feet higher than the driveway (858.3 feet), indicating that overflow or leaks from the former wastewater treatment tanks could not flow toward SB-22. This fact, combined with the limited depth of impact, indicates that the PAHs are present in the fill material itself and are not the result of release(s) at the Site.

RFI soil boring observations indicate that fill material is present across the entire driveway/ parking area between the building and the northern Site boundary. The concentrations of PAHs in this part of the Site are likely variable and based on the composition of the fill material in a given area. The fill material is comprised primarily of sand with slag and debris (i.e. wood, concrete and metal fragments), which would be expected to contain elevated PAH concentrations consistent with the material encountered in this area. Therefore, no further delineation of the PAHs is necessary.

3.6.2 Soil Vapor

The limited residual soil contamination discussed in **Section 3.6.1** indicates that the source of VOCs in soil vapor is impacted groundwater in the perched zone, as well as adsorbed impacts in saturated soil localized near monitoring well MW-9. Sub-slab soil vapor primarily contains PCE and TCE; but 1,1-DCE and vinyl chloride were also detected at elevated concentrations in WSVS-1. As shown on **Figure 3-13**, the extent of PCE in soil vapor exceeding the RSL has not been fully defined. However, concentrations of PCE and other VOCs detected in indoor air sample indicate that, although VOCs may be present in soil vapor at concentrations above the Calculated Soil Gas Vapor Intrusion Cleanup Levels, PCE; TCE; 1,1-DCE; and vinyl chloride concentrations appear to attenuate across the slab to concentrations below the Target Industrial Indoor Air Concentrations in all areas with the exception of WIAS-11, the

supervisors office near monitoring well MW-4. The occupied office areas on the southeast side of the building and the basement under that office area were not found to be affected by VOCs based on historic sampling conducted in 2011.

Based on the extent of the indoor air impacts, discussed in **Section 3.6.3**, VOC impacts to soil vapor likely extend from the AOC 5 source area southeast to the climate-controlled self-storage facility (lower level segment of building) and east to the unoccupied storage space adjacent to the offices.

Soil vapor analytical results collected as part of the RFI activities are summarized on **Table 3-3.**

3.6.3 Indoor Air

A total of nine indoor air samples were collected during the 2013/2014 RI activities from within the current warehousing, supervisor's office, and in the basement level storage space. Only one sample location (WIAS-11) had TCE concentrations (6.5 ug/m^3 in August 17, 2014, and 9.8 ug/m^3 in September 28, 2014) above the Target Industrial Indoor Air screening levels (**Table 3-3** and **Figure 3-14**) of 3 ug/m^3.

The laboratory analytical data reported for IAS-11 was the first exceedance of the Target Industrial Indoor Air Concentrations associated with the RFI activities conducted to date. Based on review of the August 16 and 17, 2014 sampling data, an additional sampling event was conducted on September 27 and 28, 2014 (included in **Table 3-3**). The results of the September samples were similar to those obtained for the August samples (9.8 ug/m^3 and 6.5 ug/m^3 respectively), concentrations exceeded the TCE screening level of 3 ug/m^3.

None of the other indoor air sample locations contained PCE, TCE, 1,1-DCE or vinyl chloride, the compounds detected in sub-slab soil vapor samples at concentrations above their Target Industrial Indoor Air Concentrations. Although not detected in sub-slab soil vapor samples, concentrations of one or more of the following compounds exceeded Target Industrial Indoor Air Concentration(s) in each indoor air sample: benzene, carbon tetrachloride, chloroform, 1,4-dichlorobenzene, 1,2-DCA and ethylbenzene.

Based on review of the August and September 2014 indoor air analytical data, and with consideration of the PCE and TCE concentrations in the

perched zone groundwater within the AOC 5 area extending beneath the supervisors office (WIAS-11), shallow ground could be a potential source to the indoor air concentrations reported.

3.6.4 Groundwater

Groundwater contour maps for the most recent sampling event (May 2014) are provided as **Figure 3-15** (perched zone) and **Figure 3-16** (bedrock zone). Historical Site groundwater elevations are summarized in **Table 3-4.** Groundwater analytical results RFI are summarized in **Table 3-5** (VOCs) and **Table 3-6** (PAHs). The magnitude and extent of PCE impacts to groundwater in the perched zone (AOC 5 only) are presented as **Figure 3-17** for the most recent sampling event (December 2013). The bedrock zone is presented as **Figure 3-18** for the December 2013 event and as **Figure 3-19** for the most recent sampling event (April 2014). Groundwater concentration trend plots have been compiled for select perched zone monitoring wells (**Figures 3-20 through 3-24**) and bedrock zone monitoring wells (**Figures 3-25 through 3-30**). However, based on the limited number of data collection events conducted to date there is not sufficient data to discuss or evaluate trends.

Although the same primary group of compounds was detected in both the AOC 5 and former wastewater treatment investigation areas, the distribution of concentrations across the Site and groundwater flow data indicate that the groundwater VOC impacts are associated with two separate source areas. The conceptual site model cross-sections include groundwater RSL exceedances detected in monitoring well samples and are presented as **Figures 3-5** through **3-8**. The cross-section traces are depicted on **Figure 3-4**.

3.6.4.1 AOC 5

Based on data collected during the RFI, PCE represents the most significant impact to groundwater at the AOC 5 investigation area. As shown on **Figure 3-17**, groundwater analytical data indicates that the PCE impacts in the perched zone originate near MW-9. Impacted groundwater flows toward the northeast in the perched zone, following the slope of the clay surface illustrated on **Figure 3-6**. At the terminus of the perched zone clay unit, PCE migrates with groundwater vertically through the bedrock to the regional water table approximately five to seven feet below the unconsolidated/ bedrock contact. Regional groundwater flows toward the southeast. Groundwater elevation data indicate that groundwater flow in the bedrock zone underneath the Site is toward the south or southwest,

the difference likely attributed to local variations in the bedrock geology and elevation. The conceptual flow path for contaminants from the AOC 5 source area (near MW-9) to the down gradient Site boundary (near MW-17) is illustrated on cross-section C-C′ (**Figure 3-6**). Cross-section C-C′ is oriented parallel to the direction of groundwater flow in the perched zone.

The perched zone PCE impacts are delineated by (see **Figure 3-17**):

- Minor concentrations at MW-2 to the southwest;
- Stratigraphy to the north (i.e. absence of perched zone groundwater in boring SB-3);
- Monitoring wells MW-8 and declining concentrations at MW-28 to the northwest;
- Monitoring wells MW-10 and 14 to the east; and
- The perched zone clay terminus to the northeast.

With the data collection completed in 2014, the perched zone impacts have been fully defined with current data.

A similar evaluation of the bedrock zone PCE impacts indicate delineation by (see **Figures 3-18** and **3-19**):

- Minor concentrations at monitoring wells MW-15 and 16 to the east; and
- Concentrations below the detection limits to the west (MW-2D), east (MW-25), and south (MW-23 and 24) (as presented on **Figures 3-18** and **3-19**).

As depicted on **Figures 3-18** and **3-19**, the bedrock zone PCE impacts associated with AOC 5 have been fully defined with current data.

The limited residual soil contamination discussed in **Section 3.6.1** indicates that the source of VOCs in perched zone groundwater and associated soil vapor is likely attributable to adsorbed impacts in saturated soil localized near monitoring well MW-9.

3.6.4.2 Former Wastewater Treatment Area

Consistent with the AOC 5 results, PCE represented the most significant impacts to groundwater in the former wastewater treatment area. **Figure 3-18** illustrates the magnitude and extent of the PCE impacts in this area, which has groundwater only within the bedrock. Cross-section B-B′

(**Figure 3-5**) bisects the PCE impacts and is oriented generally parallel to the direction of groundwater flow. Groundwater analytical data and groundwater elevation data indicate that the affected area originates near MW-5 and flows with bedrock groundwater toward the south-southwest.

The former wastewater treatment area PCE impacts within the bedrock zone are delineated by (see **Figure 3-18**):

- Minor concentrations above the EPA Maximum Contaminant Level (MCL) at monitoring wells MW-12 and 13 to the north (up gradient) (September and December 2013). Further delineation up gradient was not possible because of the presence of Highway 218 immediately north of the Site and parallel to the northern property boundary of the Site; Concentrations below the detection limit to the west (MW-26) and southwest (MW-27) (April 10, 2014);
- Concentrations below the MCL at MW-6 to the east in December 2013, but greater than the MCL in September 2013; and
- Concentrations below the detection limit to the south (MW-3) reported in all sampling events (2012 and 2013).

As depicted on **Figures 3-18 and 3-19**, the former wastewater treatment area PCE impacts have been fully defined with current data.

3.7 POTENTIAL EXPOSURE PATHWAYS

The only risk exposure pathways considered to be of potential concern result from the limited soil, groundwater, and soil vapor VOC impacts associated with the AOC 5 area summarized as follows:

- Soil ingestion and dermal contact for construction workers performing excavation activities at the Site or for industrial workers if the impacted soil is excavated and placed on the ground without cover,
- Dermal contact for construction workers during excavations that reach the perched groundwater in the area of MW-1 and MW-2, and:
- Inhalation of VOCs in indoor air.

The exposure pathways of ingestion of soil and dermal contact with groundwater can be effectively addressed by establishing institutional controls in the form of voluntary land-use restrictions to secure continued

use of the site for industrial and commercial purposes and to exclude groundwater use.

The only risk exposure pathways considered to be of potential concern result from the limited PAH surface soil impacts associated with the former Waste Water Treatment area north of the main building are as follows:

- Soil ingestion and dermal contact for construction workers performing excavation activities at the Site or for industrial workers if the impacted soil is excavated and placed on the ground without cover.

3.8 PAST AND PRESENT REMEDIAL ACTIONS AND INSTITUTIONAL CONTROLS

No remedial actions have taken place at the Site as of the date of this RIP.

A City of Waterloo ordinance is currently in place to prohibit the construction of water wells for use as potable water supply within the city limits, which includes the Waterloo Site and down gradient properties. No additional institutional controls are currently in place for the Site.

4.0 SELECTED REMEDY, OBJECTIVES, AND DECISION POINTS

4.1 EPA SELECTED REMEDY

As presented in FD/RTC, EPA selected the following corrective measures as a final remedy to address the impacts at the Waterloo Site.

Unsaturated Soil:

- Operate a dual-phase vacuum extraction system to remediate the absorbed residual source of VOCs by extracting vapors from the shallow soil beneath the building slab at AOC 5

Vapor Intrusion:

- Operate the dual-phase vacuum extraction (DPVE) system to maintain a negative pressure beneath the building slab to prevent vapor intrusion (including start-up testing of exhaust vapors and ambient air); and

- Install a separate sub-slab depressurization system (SSDS) specifically to provide soil vapor mitigation in the limited area around the supervisor's office (center of warehouse space, east of MW-9). The SSDS system would be utilized until such time that groundwater concentrations have been reduced in the area beneath the supervisor's office, eliminating the need for the SSDS.

Groundwater:

- Operate a dual-phase extraction system to remove contaminated groundwater in the highest concentration portion of the impacted area beneath the building slab in AOC 5. The system will be placed with targeted extraction points in a grid surrounding monitoring well MW-9; and

- Implement a groundwater remedy performance monitoring program including routine groundwater sampling (for VOCs and geochemical parameters) to evaluate the effectiveness of the dual-phase vacuum extraction system and whether natural attenuation is occurring.

Institutional Controls:

Implement institutional controls through environmental covenants in accordance with the Uniform Environmental Covenants Act (Iowa Code Chapter 455I), to include the following:

- Restrict land use to non-residential purposes;
- Prohibit the use of groundwater;
- Provide notice to EPA for construction projects involving excavation or de-watering in the vicinity of AOC 5;
- Provide notice to EPA for construction projects involving disturbance of surface soil contaminated with PAHs above RSLs north of the main facility building (former wastewater treatment area); and
- Maintain the concrete slab of the building to serve as an engineered cap preventing exposure to contaminated soil beneath the slab.

4.2 *REMEDIAL ACTION OBJECTIVES*

The current and expected future land use for the former Waterloo Industries facility is as a commercial-industrial property. The groundwater on-site and down gradient from the facility is classified as a current and potential source for drinking water, in accordance with EPA's Guidelines for Groundwater Classification under the EPA Groundwater Protection Strategy (December 1986). As a result, the promulgated MCLs have been established as the remedial action objectives (RAOs) for groundwater to return the groundwater to maximum beneficial use for current and future users.

The groundwater data collected during the RFI was used to identify target analytes that exceeded the remedial goals. **Table 4-1** that follows provides the analyte specific remedial goals for groundwater on site.

Table 4-1- RAOs for Groundwater

	Units	Regional Screening Level
Parameter		**Tap Water [1]**
Volatile Organic Compounds		**or MCL as noted**
Benzene	mg/l	0.005 (MCL)
Carbon Tetrachloride	mg/l	0.005 (MCL)
1,2-Dibromo-3-chloropropane	mg/l	0.0002 (MCL)
Dichloroethane, 1,1-	mg/l	0.0027
Dichloroethylene, 1,2-cis-	mg/l	0.07 (MCL)
Hexachlorobutadiene	mg/l	0.00014
Naphthalene	mg/l	0.00017
Tetrachloroethane, 1,1,1,2-	mg/l	0.00057
Tetrachloroethane, 1,1,2,2-	mg/l	0.000076
Tetrachloroethylene (PCE)	mg/l	0.005 (MCL)
Trichloroethylene (TCE)	mg/l	0.005 (MCL)
Trichloropropane, 1,2,3-	mg/l	0.00000075
Trimethylbenzene, 1,3,5-	mg/l	0.12
Trimethylbenzene, 1,2,4-	mg/l	0.015
Vinyl chloride	mg/l	0.002 (MCL)

Notes:

(1) Maximum Contaminant Level (MCLs) used for goal; in the event none are available, Regional Screening Levels (RSLs) for tap water (HQ-1.0 and TR 1E-06 as of June 2015) are provided.

For the protection of potential exposure to impacted soil identified in the RFI in the area of monitoring well MW-9 and to prevent leaching from soil to groundwater in that area, the remedial goal for soil has been established using the groundwater protection RSLs. The soil data collected during the RFI was used to identify target analytes that exceeded the remedial goals. **Table 4-2** provides the analyte specific RAOs for unsaturated soil on site.

Table 4-2 – RAOs for Unsaturated Soil

Parameter	Units	CAS #	Regional Screening Level[1,2]	
Volatile Organic Compounds			**Industrial Soil**	**Groundwater Protection**
Naphthalene	mg/kg	91-20-3	17	0.0108
Tetrachloroethylene (PCE)	mg/kg	127-18-4	100	0.046

Notes:

1 EPA Regional Screening Levels (RSLs) for Industrial Soil (June 2015).
2 EPA RSLs for Protection of Groundwater (June 2015), times a DAF of 20. The value for PCE is based on the MCL.

The remedial action objectives were identified in the RSP Meeting Report approved by EPA and was based on an evaluation of current site conditions as well as future expected Site conditions and the use of an institutional control.

4.3 *MONITORING OBJECTIVES*

Based on the RAOs established for the Site, the proposed performance monitoring objectives include the following major elements as outlined in the FD/RTC letter:

- Verify that the dual phase extraction system is effectively reducing contaminant mass and contaminant concentrations in Site soil and groundwater; Verify that the SSDS is adequately mitigating soil vapor intrusion in the area around the supervisors office;
- Verify that natural attenuation is occurring, reducing contaminant mass and contaminant concentrations in groundwater on- and off-site;
- Verify that additional engineering controls (concrete warehouse floor) are operating as intended;
- Demonstrate the efficacy of institutional controls that were put in place to protect the potential receptors; and
- Verify attainment of remediation objectives.

The sections that follow describe the Performance Criteria and Decision Points that would be used to demonstrate that the performance objectives have been attained.

4.4 *PERFORMANCE CRITERIA*

Based on the RAOs and proposed performance monitoring objectives, specific performance criteria have been identified that would support reporting and monitoring of the selected remedy. The performance criteria would include the following;

1. The ability of the monitoring network to assess contaminant concentrations of COCs up gradient of the source area, at the source area, at the down gradient boundary, at the perched to bedrock zones transition area, and at side gradient monitoring points to verify the remedy is effectively reducing the contaminant concentrations and mass in Site groundwater;

2. The ability of the monitoring network to assess the occurrence of all COCs at concentrations nearing the RAOs at the source area down gradient monitoring locations within the Site:

3. The ability of the monitoring network to assess geochemical and biochemical parameters up gradient, down gradient, and cross gradient of the source area to confirm that natural attenuation is occurring;

4. The ability to assess contaminant concentrations of COCs in the source area unsaturated soil to verify that the remedy is effectively reducing contaminant concentrations and mass;

5. The ability to verify that the SSDS is effectively preventing soil vapors from intruding into the facility indoor air; and

6. Available means to readily verify that Institutional Controls are in place to protect potential receptors.

4.5 *DECISION POINTS*

Based on the RAOs, proposed performance monitoring objectives, and performance criteria described above, specific decision points have been defined to support each of the performance criteria. The following provides a summary of the performance criteria and associated decision point.

1) The ability of the monitoring network to assess contaminant concentrations of COCs up gradient of the source areas, at the source areas, at the down gradient boundary, at the perched to bedrock zones mixing area (where the perched zone groundwater intersects the bedrock groundwater), and at side gradient monitoring points to verify the remedy is effectively reducing the contaminant concentrations and mass in Site groundwater:

    - Detection of up gradient contaminant concentrations for all RAO analytes at concentrations at or below the RAOs from monitoring locations MW-1 (perched), MW-2 (perched) and MW-26 (bedrock);

    - Detection of source area contaminant concentrations for all RAO analytes at concentrations at or below the RAOs from monitoring location MW-9 (perched);

    - Detection of down gradient contaminant concentrations for all RAO analytes at concentrations at or below the RAOs from monitoring locations MW-23 (bedrock) and MW-24 (bedrock);

    - Detection of the perched to bedrock zone mixing area contaminant concentrations for all RAO analytes at concentrations at or below the RAOs from monitoring locations MW-15 (bedrock) and MW-16 (bedrock); and

    - Detection of side gradient contaminant concentrations for all RAO analytes at concentrations at or below the RAOs from monitoring locations MW-1D (bedrock), MW-2D (bedrock), MW-3 (bedrock), MW-8 (perched), MW-10 (perched), MW-14 (perched), MW-25 (bedrock), MW-27 (bedrock), and MW-28 (perched).

2) The ability of the monitoring network to assess the occurrence of all COCs at concentrations nearing RAOs at the source area down gradient monitoring locations within the Site:

    - Detection of down gradient contaminant concentrations for all RAO analytes at concentrations at or below the RAOs from monitoring locations MW-4 (perched), MW-11 (perched), and MW-17 (bedrock).

3) The ability of the monitoring network to assess geochemical and biochemical parameters up gradient, down gradient, and cross gradient of the source area to confirm that natural attenuation is occurring.

    - Collection of up gradient geochemical and biochemical parameters from monitoring location MW-1 (perched), MW-2 (perched) and MW-26 (bedrock);

    - Collection of source area geochemical and biochemical parameters from monitoring location MW-9 (perched); and

    - Collection of down gradient geochemical and biochemical parameters from monitoring locations MW-4 (perched), MW-11 (perched), and MW-17 (bedrock).

4) The ability to assess contaminant concentrations of COCs in the source area unsaturated soil to verify that the remedy is effectively reducing contaminant concentrations and mass:

    - Detection of Site soil COCs at or below the RAOs from unsaturated soil samples collected from AOC 5.

5) The ability to verify that the SSDS is effectively preventing soil vapors from intruding into the facility indoor air:

    - Detection of Site indoor air COCs at or below the Target Industrial Indoor Air Concentration RSLs for indoor air samples collected in the supervisor's office area.

6) Verify that Institutional Controls are in place to protect potential receptors. **Section 9.0** of this RIP provided details related to monitoring of the Institutional Controls associated with the selected site Remedy.

5.0 MONITORING NETWORK AND SCHEDULE

Based on the RAOs, proposed performance monitoring objectives, performance criteria, and specific decision points described in **Section 4.0**, a monitoring schedule and proposed monitoring network has been designed to provide specific monitoring requirements identified for the Site and the selected remedy. This section describes the proposed sample locations, analytical methods, frequency, and rationale proposed to monitor the Site remedy.

The RIP is designed to:

- Collect hydrologic data both on and off-Site from the monitoring network;
- Collect groundwater chemical, geochemical, and biochemical data to document Site conditions, the effectiveness of the remedial systems, as well as the occurrence of natural attenuation on and off-site;
- Collect indoor air chemical data to assess the effectiveness of the SSDS on preventing soil vapors from impacting indoor air quality; and
- Collect data on regular basis to verify that Institutional Controls are in-place to protect potential receptors.

The sections that follow describe in detail the proposed sampling approach and rationale for data collection activities on site.

5.1 GROUNDWATER MONITORING NETWORK

The proposed monitoring network is composed of existing monitoring wells (construction details provided in **Table 5-1**) located both on and off-Site within the perched and bedrock zones.

As presented in **Section 4.0** of this RIP, the monitoring network has been designed to collect hydrologic and chemical data both on and off-Site with monitoring locations up gradient, within the source area, down gradient, and side gradient of the source area. The data will be used to verify the remedy is effectively reducing the contaminant concentrations and mass; verify that the remedy is effectively controlling contaminant migration; and verify that natural attenuation occurring.

In addition, the monitoring network has been designed to collect geochemical and biochemical data using monitoring locations up

gradient, within the source area, and down gradient of the source area along the groundwater flow lines from the Site. Isoconcentration Maps presented as **Figures 3-17** through **3-19** provide details on the boundary of contaminants on and off-site. The data will be used to confirm and document that natural attenuation is occurring.
The performance monitoring events will include groundwater elevation measurements and sample collection from select existing monitoring wells shown on **Figure 2-5**. Groundwater elevation measurements will be collected according to the procedures described in **Section 6.1.1** of this RIP, and groundwater samples will be collected according to the procedures described in **Section 6.1.2.**

In addition to the monitoring locations identified as decisions points in **Section 4.5** of the RIP, groundwater samples will be collected on an annual basis from monitoring locations associated with the former waste water treatment area north of the facility buildings near the property boundary. As described in detail in Section 3.2.1 of the Remedy Selection Process Meeting Report (November 6, 2015), "while no remedial actions were targeted for this area, it should be noted that future remedy implementation will include collection of groundwater samples to continue monitoring of the groundwater in this area as well as the AOC 5 area. " Monitoring wells MW-5 (bedrock), MW-6 (bedrock), MW-12 (bedrock), and MW-13 (bedrock) have been included in the monitoring network to document the contaminant concentrations in these monitoring points.

Table 5-2 provides a summary of the proposed data collection activities, locations, media, laboratory analysis, and rational for each sample location. **Table 5-3** presents media-specific sampling and analysis requirements. **Table 5-4** presents laboratory analysis details for specific methods to be used during the remedy implementation.

5.2 SOIL VAPOR INDOOR AIR AND OUTDOOR AIR

Sub slab soil vapor will be monitored at two locations. These locations will correspond with the suspected source area in AOC 5 (sampling location WSVS-2R) and adjacent to the facility supervisor's office (WSVS-8). The soil vapor sampling data will be used to confirm that the remedial system and the SSDS is effectively reducing the vapors generated from impacted soil and groundwater as well as effectively removing soil vapors from beneath the facility concrete slab foundation.

Indoor air monitoring will be performed at one location, located within the facility supervisor's office. This location will correspond with the RFI sampling location WIAS-11. This indoor air sampling data will be used to confirm that the SSDS is effectively removing subs lab soil vapors that otherwise may have negatively impacted the indoor air. For the ambient (outdoor) air sample, a location upwind of the facility (historically central south side of the building) will be sampled.

Table 5-2 provides a summary of the proposed data collection activities, locations, media, laboratory analysis, and rational for each sample location. **Table 5-3** presents media-specific sampling and analysis requirements. **Table 5-4** presents laboratory analysis details for specific methods to be used during the remedy implementation.

5.3 DPVE SYSTEM EFFLUENT

In addition to the sub-slab, indoor air, and outdoor air (ambient) sampling, effluent air samples will be collected from the discharge of the DPVE system. Details on the proposed sampling are provided in **Section 8.1** of this RIP.

5.4 MONITORING SCHEDULE

Groundwater sampling and monitoring of the Site monitoring well network has occurred at irregular intervals since 2011 as part of Site investigation activities. The Site Conceptual Model provided as **Section 3.0** presents the groundwater data collected during those monitoring events and as **Tables 3-5** and **3-6.**

The groundwater monitoring frequency proposed as part of the RIP is semi-annual groundwater sampling (calendar quarters 2 and 4) for Site COCs and on an annual basis for geochemical and biochemical parameters. The semi-annual events have been proposed for quarter 2 (sampling to occur in April) and Quarter 4 (sampling to occur in October). This schedule eliminates the first quarter and late fourth quarter which have historically been the most likely to have poor weather that would inhibit sampling and monitoring events.

Indoor air, outdoor air, and soil vapor monitoring will be performed on a semi-annual basis in conjunction with the groundwater sampling events.

Details on the proposed DPVE system effluent sampling are provided in **Section 8.1** of this RIP.

5.5 MONITORING NETWORK MODIFICATION

As described in **Section 10.3**, the results of the proposed groundwater sampling and monitoring will be reported to EPA on an annual basis. Based on the recommendations provided in those reports, modification of the monitoring network may be proposed to EPA in the future. The basis for those recommendations are outlined in a Decision Tree Diagram provided as **Figure 5-1**.

6.0 *SAMPLING AND ANALYSIS PLAN*

This section describes the media analyzed, sampling procedures, investigation-derived waste handling procedures, and decontamination procedures, serving as the Sampling and Analysis Plan (SAP) for the remedy implementation. The SAP has been prepared in accordance with EPA Guidance on Choosing a Sampling Design for Environmental Data Collection (EPA, December 2002). The purpose of this sampling and analysis plan is to develop and maintain good quality control in field operations and to create uniformity between field personnel involved in data collection activities.

6.1 *GROUNDWATER MONITORING AND SAMPLING PROCEDURES*

The following subsections detail procedures for groundwater and aquifer data collection, including groundwater elevation measurements, and groundwater sampling. The groundwater sampling approach and analysis requirements are summarized in **Table 5-2**.

6.1.1 *Groundwater Elevation Measurements*

Prior to collecting groundwater samples, the depth to water will be measured in each monitoring well according to the following procedure:.

1. Visually examine the exterior of the monitoring well for signs of damage or tampering and record in the field logbook. Also examine the water level indicator and, if necessary, decontaminate the instrument before starting the measurement process.

2. Measure the static water level in the well by lowering the probe gently into the well until the liquid/air interface is detected, indicated by a steady tone on the water level indicator. Mark an arrow on the exterior of each casing with permanent marker to indicate the location for measuring water level, providing a consistent monitoring location. Move the probe up and down until an exact depth of interface is determined. Measurements should be taken from the location of the arrow mark on the top and side of the casing. Record the groundwater elevation to the nearest 0.01 foot increment in the field log book.

3. In addition to the static water level, measure the well total depth during each site monitoring event. The measured total well depth is to be compared to the total depth when the well was installed. In the event that fines are noted during sampling or an accumulated

thickness equal to or greater than 6 inches is encountered, the well should be re-developed to remove the accumulated fines.

4. Decontaminate the water level indicator in between individual wells using an Alconox™ and de-ionized water solution to prevent cross-contamination. A complete round of water level measurements will be completed on the same day.

Given the VOC concentrations detected in groundwater samples collected previously, Dense Non-Aqueous Phase Liquid (DNAPL) is not expected at the Site. If DNAPL is encountered in a monitoring well, the SAP will be revised to include a procedure for measuring the elevation and thickness of the liquid.

6.1.2 Groundwater Sample Collection

Groundwater sampling will be performed using EPA low-flow well purging/sample collection techniques. The low-flow groundwater purging/sampling technique employs the use of a flow-through cell equipped with probes and a meter for measuring groundwater quality parameters including pH, temperature, conductivity, dissolved oxygen, and oxidation/reduction potential. Examples of this equipment include the YSI 556 and In-Situ TROLL 9500. Turbidity will be measured with a separate meter, such as the Hach 2100P or LaMotte 2020e. Water collected for turbidity readings will be obtained from a valve assembly before the water enters the flow-through cell. Specific manufacturer's calibration and operation instructions will be followed. Purging will be performed using a submersible pump with controlled variable flow rates. Examples of this type could include a portable pneumatic bladder pump (e.g. Geotech® stainless steel bladder pump) or 12 volt impeller pump (e.g. Proactive® Monsoon).

The following procedure will be used for groundwater sampling from monitoring wells:

1. Lower pump, safety cable, tubing, and electrical lines very slowly into the well to a depth corresponding to the center of the saturated screen section of the well. The pump intake must be kept at least two feet above the bottom of the well to prevent mobilization of any sediment. Lowering the pump quickly, or even at a moderate rate, will result in disturbing sediment in the well. This step is one of the most important steps in low flow sampling.

2. Start pumping the well at 100 to 500 milliliters per minute. Ideally, the pump rate should cause little or no water level drawdown in the well (less than 0.3 foot and the water level should stabilize).
   - Measure and record the depth to water and pumping rate every 3 to 5 minutes (or as appropriate) during pumping. If purging continues for more than 30 minutes, readings will be recorded at approximately 10-minute intervals. However, once stabilization is indicated, a minimum of 3 consecutive readings at 3 to 5 minute intervals will be recorded prior to sample collection.
   - Care should be taken not to cause pump suction to be broken or entrainment of air in the sample. Do not allow the groundwater level to go below the pump intake.
   - Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to minimize drawdown and/or to ensure stabilization of indicator parameters.
3. During purging, measure and record the field indicator parameters using the in-line meter [turbidity, temperature, specific conductance, pH, Oxidation Reduction Potential (ORP), and dissolved oxygen (DO)] every 3 to 5 minutes (or as appropriate). If purging continues for more than 30 minutes, readings will be recorded at approximately 10-minute intervals. However, once stabilization is indicated, a minimum of 3 consecutive readings at 3 to 5 minute intervals will be recorded prior to sample collection.
   - The well is considered stabilized and ready for sample collection once the field indicator parameter values remain within the following limits for 3 consecutive readings:
     - ± 0.1 for pH;
     - ± 5% for conductivity;
     - ± 2 degrees C
     - ± 10% for dissolved oxygen
     - ± 10% for ORP
     - < 10 NTUs or ±10% for turbidity
   - If the recovery rates are too slow and drawdown in the well is measured at one foot or more, the well will be purged to dryness. Once the water level in the well has recovered to 90% of the static level measured prior to purging, a sample will be collected using a

bailer with double check valve and bottom emptying device. Sample collection using bailers, if necessary, will be conducted in accordance with US EPA sampling guidance (*Field Sampling Guidance Document #1220 – Groundwater Well Sampling* [EPA, 2004]).

4. Before sampling, either disconnect the in-line cell or use a bypass assembly to collect groundwater samples before the in-line cell. All sample containers should be filled by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

5. Collect samples in the following order: VOC, dissolved gases, volatile fatty acids, and other parameters.

6. Label the samples using waterproof labels, or apply clear tape over the paper labels. Place all samples in a cooler as described in the QAPP with bagged ice and maintain at 4°C for delivery to the laboratory. Do not use ice for packing material; melting will cause bottle contact and possible breakage.

7. Secure the well.

6.2 SOIL SAMPLING PROCEDURES

At the completion of the remedial activities on site (once groundwater RAOs are achieved) soil sampling will be performed within AOC 5 to confirm on site Soil RAOs have been achieved (**Table 4-2**). Based on review of the existing soil sampling data (**Table 3-1**) with comparison to site specific soil RAOs, proposed soil sample locations are indicated on **Figure 6-1** and summarized in **Tables 5-2** and **5-3**. The confirmation soil sampling is proposed after the groundwater RAOs have been achieved. Proposed confirmation sampling will be performed using direct-push drilling methods as described in the sections that follow.

Direct-push boring and soil sample collection will be performed according to the following procedures:

1. Prior to any drilling activities the location of the existing DPVE and or SSDS system piping within the soil sampling area will be traced and marked on site to ensure the subsurface piping is not struck or damaged during the drilling activities. All marked utility lines will be provided a minimum of ten feet of separation from any proposed ground disturbance.

2. Continuously collect soil in macro-core or equivalent type acetate sleeves.

3. Retain a portion of the soil contained in each sleeve (every 2 feet) for field screening of VOCs using a PID with a 10.6 eV lamp and the headspace technique. Record the field screening results for each soil sample in the field notebook.

4. Place soil from the selected depth interval (targeted to duplicate the depth of sampling indicated in **Table 5-2**, replicating historic soil RAO exceedances as indicated in **Table 3-1**) in the appropriate laboratory-supplied sample containers. In addition, based on PID field screening described above, in the event an unsaturated soil interval other than the replicate location exhibits PID concentrations above background, that sample interval will also be submitted for laboratory analysis. Each container will be properly filled, sealed, and labeled with the sample name, site name, analysis requested, name of sampler, and the time and date of sample collection. Each sample container will be placed on ice in a cooler immediately following sample collection.

5. Place soil cuttings not selected for sampling in DOT-approved 55-gallon ring-top drums. Label the drums according to the borehole/ monitoring well number.

6. Following sample collection, each boring location is to be grouted to Iowa Department of Natural Resources (IDNR) requirements (Iowa Administrative Code 567- 39 – *Requirements for Properly Plugging Abandoned Wells)*, and the concrete floor patched with concrete to match the thickness of the material removed.

7. Record a standard "Geologic Log" for each boring that includes all of the geological information gathered in the field including the following:

   - The structure of the material sampled, including layering stratification features, and the dominant soil types;
   - Physical indications of contamination, including odor and staining;

   - The structure of the material sampled, including layering stratification features, and the dominant soil types;
   - Physical indications of contamination, including odor and staining;

- The color of the material, using Munsell Soil Color Charts;
- The moisture content of material;
- Textural quality of the material including grain size, degree of sorting or grading, angularity, and mineralogy;
- Identification of any rock fragments, organic material or other components; and
- The consistency of the material.

2. All of the soil information collected will be recorded as a designation under the USCS along with additional observations for each distinctive soil type within each sample. All soil samples will be collected and stored in glass jars or re-sealable plastic bags. Decontaminate all equipment between borings/ samples according to the procedures in **Section 6.6**.

6.3 SOIL VAPOR AIR AND DPVE SYSTEM EFFLUENT SAMPLING PROCEDURES

6.3.1 Sub-slab Soil Gas Monitoring Point Installation

Sub-slab soil gas sampling approach and analytical method requirements for each sample location are summarized in **Table 5-2**. The installation of additional sub-slab soil gas monitoring points is not currently proposed. However, if soil gas / indoor air monitoring data indicate that additional monitoring points are needed, the monitoring points will be installed in accordance with the procedure outlined in EPA (2006), as follows:

- Prior to drilling holes in the slab, local utility companies will be contacted to identify and mark utilities coming into the building from the outside (e.g., gas, water, sewer, refrigerant, and electrical lines) and consult with a plant maintenance staff to identify the location of utilities inside the building.

- Use a rotary hammer drill to create a one- inch "outer" hole that partially penetrates the slab.

- Following drilling the "outer" hole, use a rotary hammer drill to create a 5/16th-inch diameter "inner" hole (e.g., 5/16 inch) through the remainder of the slab and approximately three inches into sub-slab material. **Figure 6-2** illustrates the appearance of "inner and "outer" holes. Drilling into sub-slab material will create an open cavity which

will prevent obstruction of probes during sampling by small pieces of gravel. ERM will use a vacuum to clean the rock dust from the hole.

- Construct sub-slab vapor probes from ¼-inch OD diameter stainless steel tubing and stainless steel compression to thread fittings (¼ inch OD x 1/8 inch NPT Swagelok female threat connections) as illustrated in **Figure 6-2**. ERM will use stainless steel materials to ensure that construction materials are not a source of VOCs. The steel tubing will be trimmed to a length that is shorter than the thickness of the slab so it does not become plugged with sub-slab material.

- As illustrated in **Figure 6-2**, the top of the probes will be completed flush with the slab and have recessed stainless steel plugs so as not to interfere with day-to-day use of buildings. ERM will mix a quick-drying Portland cement which expands upon drying (to ensure a tight seal) with water to form a slurry and inject or push into the annular space between the probe and outside of the "outer" hole. The cement will be allowed to cure for at least 24 hours prior to sampling.

6.3.2 Indoor Air/Sub-slab Vapor Sample Collection Procedures

The procedures that follow outline the steps to follow when collecting the concurrent indoor air/sub-slab vapor sample.

Prior to all sampling activities, the following general procedures will be followed:

- Sampling personnel will avoid activities immediately before and during the sampling that may contaminate the sample (e.g., using markers, fueling vehicles, etc.).

- Weather information (temperature, barometric pressure, relative humidity, wind speed, and wind direction) and indoor temperature and humidity will be recorded at the beginning of the sampling event. Record substantial changes to these conditions that may have occurred over the past 24 to 48 hours and that do occur during the course of sampling. The information may be measured with onsite equipment or obtained from a reliable source of local measurements (e.g., a local airport).

- The Indoor Air/Sub Slab and Ambient Air Sample will be analyzed using USEPA Method TO-15 SIM by Test America. The initial vacuum reading for each of the evacuated Summa® stainless steel sample canisters will be recorded prior to setup on site, using the

vacuum gauges provided by the analytical laboratory as part of the sampling train. The pre-sampling vacuum in the canisters should be between -30 and -25 in of Hg. If a canister is not within this initial range, it will be rejected and a new canister will be used.

Indoor air and ambient (outdoor) air samples will be set up as follows:

- For the indoor air sample, the sampling location will be identified on a floor plan that also identifies locations of HVAC equipment, chemical storage areas, garages, doorways, stairways, sumps, drains, utility perforations, north direction, and separate footing sections. For the ambient air sample, a location upwind of the facility will be sampled.

- An evacuated 6 L Summa® stainless steel canister will be used to collect each sample. The canisters will be provided by the laboratory, along with flow controllers equipped with an in-line particulate filter and vacuum gauge. Each flow controller will be pre-calibrated by the laboratory for the desired flow rate or duration of sample collection (in this case, 24 hours). The sampling flow rate will always be less than 0.2 liter per minute (lpm).

- The canister intake placed at breathing height (e.g., 3 to 5 feet above ground).

- The protective brass plug will be removed from each canister and the pre-calibrated flow controller will be attached.

- The identification numbers for the canisters and flow controllers will be recorded, along with the initial canister pressures on the vacuum gauge (check equipment-specific instructions for taking this measurement). Canisters with a significantly different pressure than originally recorded by the testing laboratory should not be used for sampling. These numbers and values will be recorded on the chain-of-custody form for each sample.

- The valve on the vacuum canister will be completely opened. The time each valve was opened (beginning of sampling) will be recorded.

- A photograph will be taken of each canister and the area surrounding the canisters. Additionally, for the ambient air sample, the sample technician will document on a field form an outdoor plot sketch that indicates the building being sampled, streets, sampling location, location of potential outdoor air sources, north direction and paved areas. The technician will also record pertinent observations, such as

odors, readings from field instruments, and significant activities in the vicinity that result in air emissions.

- Sample collection will be stopped after the scheduled duration of sample collection (24 hours), but the pressure will be checked regularly to assure that the canister still has a minimum amount of vacuum remaining. Typically, the minimum vacuum is between 2 and 5 inches of mercury, but not zero. If there is no vacuum remaining the sample will be rejected and will be collected again in a new canister.

- The final vacuum pressure will be recorded and the canister valve closed. The date and time that sample collection was stopped will be recorded.

- The flow controller will be removed from each canister and replaced with the protective brass plugs.

- Labels/tags (sample name, time/date of sampling, etc.) will be attached to the canisters as directed by the laboratory.

- The canisters and other laboratory-supplied equipment will be placed into the packaging provided by the laboratory.

- The chain of custody form will be completed, making sure to include the identification numbers for each canister and flow controller, and the initial and final canister pressures on the vacuum gauge.

- The sample canisters will be delivered to the laboratory within one business day of sample collection and via overnight delivery when shipping. If pressure reading of canister is "zero" when logged in by the laboratory, the sample will not be analyzed and will be recollected.

Sub-slab soil gas samples will be collected as follows:

- Sample tubing will be purged using a gas-tight syringe (-60cc). Three tubing volumes will be purged prior to sample collection at a rate of approximately 0.1 liter per minute (lpm).

- An evacuated 1-Liter Summa® canister will be used to collect the sub-slab vapor sample. The canister will be provided by the laboratory, along with a flow controller equipped with an in-line particulate filer and a vacuum gauge. The flow controller will be pre-calibrated by the laboratory for the desired flow rate (0.1 lpm) for the duration of 8

minutes for sample collection. The protective brass plug will be removed from the canister and the pre-calibrated flow controller will be connected.

- The identification numbers for the canister and flow controller will be recorded, along with the initial canister pressure on the vacuum gauge (check equipment-specific instructions for taking this measurement). A canister with a significantly different pressure than originally recorded by the testing laboratory will not be used for sampling.
- The tubing from the sub-slab vapor monitoring point will be connected to the flow controller using Swagelok fittings.
- The canister valve will be completely opened and the time (beginning of sampling) and the canister pressure on the vacuum gauge will be recorded.
- A photograph will be taken of the canister and the area surrounding the canister.
- Sample collection will be stopped after the scheduled duration of sample collected (approximately 8 minutes at a flow setting of 1 lpm), but when the canister still has a minimum of 5 inches of mercury vacuum remaining.
- The final vacuum pressure will be recorded after the canister valve has been closed.
- The flow controller will be removed from the canister and the protective brass plug replaced.
- The sample technician will attach labels/tags (sample name, time/date of sampling, etc.) to the canister as directed by the laboratory.
- The canister and other laboratory supplied equipment will be placed in the packaging provided by the laboratory.
- The chain of custody form will be completed, making sure to include the identification numbers for each canister and flow controller, and the initial and final canister pressures on the vacuum gauge.
- The samples will be shipped to the laboratory within one business day of sample collection and via overnight delivery (when shipping).

6.3.3 *DPVE System Sample Collection Procedures*

The procedures that follow outline the steps to follow when collecting the DPVE system effluent samples.

Prior to all sampling activities, the following general procedures will be followed:

- Sampling personnel will avoid activities immediately before and during the sampling that may contaminate the sample (e.g., using markers, fueling vehicles, etc.).
- Weather information (temperature, barometric pressure, relative humidity, wind speed, and wind direction) and indoor temperature and humidity will be recorded at the beginning of the sampling event. Record substantial changes to these conditions that may have occurred over the past 24 to 48 hours and that do occur during the course of sampling. The information may be measured with onsite equipment or obtained from a reliable source of local measurements (e.g., a local airport).
- The DPVE system effluent samples will be analyzed using USEPA Method TO-15 SIM by Test America. The initial vacuum reading for each of the evacuated Summa® stainless steel sample canisters will be recorded prior to setup on site, using the vacuum gauges provided by the analytical laboratory as part of the sampling train. The pre-sampling vacuum in the canisters should be between -30 and -25 in of Hg. If a canister is not within this initial range, it will be rejected and a new canister will be used.

DPVE system effluent samples will be collected as follows:

- An evacuated 1-Liter Summa® canister will be used to collect the sub-slab vapor sample. The canister will be provided by the laboratory, along with a flow controller equipped with an in-line particulate filer and a vacuum gauge. The flow controller will be pre-calibrated by the laboratory for the desired flow rate (0.1 lpm) for the duration of 8 minutes for sample collection. The protective brass plug will be removed from the canister and the pre-calibrated flow controller will be connected.
- The identification numbers for the canister and flow controller will be recorded, along with the initial canister pressure on the vacuum gauge (check equipment-specific instructions for taking this measurement).

A canister with a significantly different pressure than originally recorded by the testing laboratory will not be used for sampling.

- The tubing from the DPVE system sample port will be connected to the flow controller using Swagelok fittings.
- The canister valve will be completely opened and the time (beginning of sampling) and the canister pressure on the vacuum gauge will be recorded.
- Sample collection will be stopped after the scheduled duration of sample collected (approximately 8 minutes at a flow setting of 1 lpm), but when the canister still has a minimum of 5 inches of mercury vacuum remaining.
- The final vacuum pressure will be recorded after the canister valve has been closed.
- The flow controller will be removed from the canister and the protective brass plug replaced.
- The sample technician will attach labels/tags (sample name, time/date of sampling, etc.) to the canister as directed by the laboratory.
- The canister and other laboratory supplied equipment will be placed in the packaging provided by the laboratory.
- The chain of custody form will be completed, making sure to include the identification numbers for each canister and flow controller, and the initial and final canister pressures on the vacuum gauge.

The samples will be shipped to the laboratory within one business day of sample collection and via overnight delivery (when shipping). During the system start up (as described in detail in Section 8.1.1) samples will be submitted for 24 hour expedited laboratory analysis. During the routine monitoring described in Section 8.1.2, samples will be submitted for standard (10 day typical) laboratory analysis.

6.4 *QA/QC SAMPLING SUMMARY, PROCEDURES, AND FREQUENCY*

The following quality control (QC) samples will be collected as a basis for evaluating sampling and analytical procedures, in accordance with Section 2.5.1 of the QAPP.

- Equipment Rinsate Blanks – Equipment rinsate blanks will only be collected from non-dedicated sampling equipment that is to be re-used during the project (e.g., pumps, hand augers). As appropriate, equipment rinsate blanks will be collected at a rate of 1 per 20 samples.
- Field Blanks – Field blanks will consist of distilled water or deionized water poured from one set of containers to the sampling containers at the sampling site. Field blanks will be collected at a frequency of 1 per 20 samples, and analyzed for the same parameters as the environmental media samples.
- Trip Blanks – Trip blanks will be provided by the laboratory for analysis of VOCs. One trip blank will accompany each sample cooler that contains samples for VOC analyses. The trip blanks will not be opened in the field.
- Duplicates – Blind duplicates will be included for soil, soil vapor/air, and groundwater at a rate of 1 per 10 samples. The duplicates will be analyzed for the same parameters as the samples. The sample locations where the duplicates were collected will not be identified to the laboratory.
- Matrix Spike and Matrix Spike Duplicates (MS/MSD) – MS and MSD samples will be generated for the soil and water at a rate of 1 per 20 samples. The samples will be identified as MS and MSD samples so that the laboratory can perform the necessary spike evaluation procedures. The sample locations will target areas that field screening indicates as possibly moderately impacted.

6.4.1 *QA/QC Groundwater Sampling Equipment Calibration and Measurement Procedures*

This procedure defines the requirements for obtaining groundwater pH, temperature, and conductivity measurements associated with groundwater sampling from temporary or permanent monitoring wells using a hand held instrument.

The purpose of this procedure is to develop and maintain good quality control in field operations and to create uniformity between field

personnel involved in groundwater sample collection. Equipment includes pH, temperature, conductivity, ORP, and DO meter, flow through cell (optional), disposable nitrile sampling gloves, field data forms and/or log book, and decontamination equipment.

Calibration Procedures:

1. Calibrate instrument according to manufacturers' specifications, at a minimum daily. If the manufacturers' specifications were not included with the rented instrument, follow the calibration procedures listed below.

2. pH Calibration. The pH meter will be calibrated with standard buffer solutions prior to a field trip. In the field, the meter will be calibrated daily with two buffers before use. Thereafter, the meter will be checked against the two buffer solutions to confirm calibration. Calibration procedures and frequency will be recorded in a field logbook along with the lot numbers of the buffers. The general procedures for pH meter calibration is as follows:
    a. Temperature of sample and buffer should be the same.
    b. Connect pH electrode into pH meter and turn on pH meter.
    c. Set temperature setting based on the temperature of buffer; place electrode in first buffer solution.
    d. After reading has stabilized, adjust "CALIB" knob to display correct value.
    e. Repeat procedure for second buffer solution.
    f. Place pH electrode in the sample and record the pH as displayed.
    g. Remove pH electrode from sample and rinse off with distilled water.
    h. The pH meter must be recalibrated every time it is turned off and turned back on, or if it starts giving erratic results.
    i. The calibrations performed, standards used, and sample pH values are to be recorded in the field notebook. Appropriate new batteries will be purchased and kept with the meters to facilitate immediate replacement in the field as necessary.

3. Temperature Calibration. Temperature measurements are carried out utilizing a thermometer. Inspect the thermometer before use to

ensure there is no mercury separation. Rented thermometers are calibrated by the rental company, but the thermometer should be rechecked in the field before and after use to see if the readings are logical and the mercury is still intact. If ERM owns the thermometer, check it biannually for calibration by immersing it in a bath of known temperature until equilibrium is reached. Discard the thermometer if it has more than 10 percent error. The reference thermometer used for the bath calibration should be National Bureau of Standards (NBS) traceable.

4. Conductivity Meter Calibration. The conductivity cells of the specific conductivity meter will be cleaned and checked against known conductivity standards before each field trip. In the field, the instrument will be checked daily with NBS-traceable standards. The calibration procedure is described below.

    a. Place the probe in the conductivity calibration standard solution.

    b. Set the temperature knob for the temperature of the standard solution.

    c. Turn to the appropriate scale and set the instrument for the value of the calibration standard.

    d. Rinse off the electrode with distilled water.

    e. Measure the conductivity for distilled water to be used for field blank, making sure the temperature is set correctly for the temperature of the solution to be tested.

    f. If the conductivity of blank (distilled water) is high, it must be discarded and a new blank sample procured.

5. Turbidity Meter Calibration. The turbidity meter will be cleaned and checked against Formazin standards before each field trip. In the field, the instrument will be checked daily with a blank and a standard. The calibration procedure is described below.

    a. Rinse the tube with the blank.

    b. Fill the tube with the blank.

    c. Clean the tube with a lint-free cloth or towel

    d. Place the tube in the meter, set the instrument to calibrate, and scan the blank.

    e. Repeat steps (a) through (c) with the calibration standard.

f. Place the tube in the meter, scan the standard and scroll through the menu options to calibrate.

g. Select the concentration standard used for calibrating the instrument.

h. Repeat steps (f) through (g) three times with the same standard.

i. If the readings of the standard are not consistent, repeat steps (a) through (g.)

Measurement Procedures

1. Rinse probes thoroughly before the analysis of any sample. If a flow-through cell is utilized, the probes only require rinsing as part of decontamination prior to initiating sampling of the next well.

2. Immediately after a sample is collected, place a portion of the sample in a small decontaminated container. Insert the probes into the container, and take the readings once the instrument stabilizes (indicated by constant temperature reading with less than +/- 1 degree Celsius fluctuation). For flow-through cell readings, record the data on a consistent interval every three to five minutes.

3. Perform a reproducibility test, consisting of repeating the conductivity measurement in the same sample at least once a day. Temperature and pH are not evaluated for reproducibility because they may vary with time of exposure to the ambient air.

4. Record readings to two significant figures for pH and conductivity, and three significant figures for temperature in the field book and/or the field sampling forms.

5. Following the sampling, decontaminate the probes using an Alconox™ and de-ionized water solution. Turn off the power if no additional wells are to be sampled.

6.5 *FIELD DOCUMENTATION AND SAMPLE CUSTODY AND SHIPPING PROCEDURES*

6.5.1 *Field Documentation*

All field activities will be documented in dedicated, bound field notebooks, as described in Section 2.3.2.1 of the QAPP.

6.5.2 *Sample Custody*

Chain-of-custody forms will be used to document sample collection, analytical requirements, and sample custody. Specific procedures are presented in Section 2.3.2.2 of the QAPP (provided as **Appendix A**).

6.5.3 *Sample Shipment*

Samples will be properly packaged for shipment in shipping containers provided by the laboratory. Samples will be dispatched to the appropriate laboratory for analysis with a single signed custody record enclosed in one of the shipping containers. The original record and one copy will accompany the shipment, and a second copy will be retained by the sampler. If sent via courier, shipping containers will be secured with strapping tape and custody seals for shipment to the laboratory. Samples will be shipped on the same day they are collected via overnight mail to the laboratory for analysis.

6.6 *INVESTIGATION-DERIVED WASTE*

Investigation-derived waste (IDW) generated during the remedy implementation will include groundwater purged from monitoring wells, soil removed during remedial system construction, disposable personal protective equipment, and disposable sampling equipment. All personal protective equipment and disposable sampling equipment will be handled in accordance with Waterloo's waste handling protocols. All soil will be containerized in Department of Transportation approved 55-gallon drums or other appropriate bulk containers for characterization and disposal. The IDW drums will be secured at the end of the day by placing the lid, securing the ring back on the drums, and tightening the drum bolts.

Drums will be placed in a secured area on the facility, and will be labeled as to content, potential hazards, accumulation start date, and responsible party contact information. Once accumulated, Waterloo and/or ERM will

arrange disposal of the wastes in accordance with applicable state and federal laws and regulations.

IDW associated with the DPVE system operation is discussed in more detail in **Section 7.10** of this RIP.

6.7 DECONTAMINATION PROCEDURES

In order to minimize the potential for cross-contamination, all sampling equipment will be properly decontaminated prior to and after each use. All heavy equipment will be decontaminated in a designated clean area. Sampling equipment and probes will be decontaminated in an area covered by plastic near the sampling location. All wash water used in the decontamination process will be collected and treated through the dual phase extraction system to be constructed and operated on site. All disposable sampling equipment will be properly disposed of in dry containers.

Extraneous contamination and cross-contamination will be controlled by wrapping the sampling equipment with aluminum foil or plastic sheeting when not in use, and changing and disposing of the sampler's gloves between samples. Decontamination of sampling equipment will be kept to a minimum in the field, and wherever possible, dedicated sampling equipment will be used. Personnel directly involved in equipment decontamination will wear appropriate protective equipment, as detailed in the site Health and Safety Plan (HASP) (**Appendix B**).

6.7.1 Aqueous Sampling Equipment

In the event that field decontamination of reusable sampling equipment is necessary, decontamination procedures will be as follows:

- Alconox detergent and water (tap or distilled water) scrub to remove visual contamination;
- Generous water rinse; and
- Distilled and deionized (ASTM Type II) water rinse;

Submersible purging pumps that are placed in the monitoring wells will be decontaminated with an Alconox detergent rinse and by pumping approximately 2 gallons of potable or distilled water through the pump. Since dedicated new lengths of polyethylene tubing will be used for

sampling each well, the tubing will not be decontaminated. Unless otherwise specified, the submersible pumps will be decontaminated prior to purging the first well and between each subsequent well as follows:

- Potable water rinse;
- Alconox detergent and potable water scrub;
- Distilled/deionized water rinse; and
- Wrap in plastic, or place in a poly bag for storage.

6.7.2 Meters and Probes

All meters and probes that are used in the field (other than those used solely for air monitoring purposes, for example, oxygen meters, vacuum meters, explosimeters, etc.) will be decontaminated between use as follows:

- Alconox solution;
- tap water; and
- deionized water (triple rinse).

7.0 DUAL PHASE VAPOR EXTRACTION (DPVE) SYSTEM DESIGN PLAN

7.1 DESIGN BASIS

As presented in the FD/RTC (see Section 4.1 of this plan), the final remedy selected by the EPA consists of the following key components:

1. Construct and operate a DPVE system in the area of AOC-5 to…
    a. Treat residual vadose zone soil;
    b. Establish a negative pressure under the building slab to prevent vapor intrusion; and
    c. Treat impacted groundwater and saturated soil, which is considered the key source of migrating vapors.
2. Construct and operate an SSDS to mitigate vapor intrusion in the area of the supervisor's office.
3. Combine active remediation with a performance monitoring program to track the effectiveness of the remedial strategy.

The design criteria for the system are summarized as follows:

- Implement the components listed above to address target unsaturated and saturated soil impacts, groundwater contamination, and vapor intrusion in AOC-5;
- Operate the two systems while obtaining performance data to assess continued operation; and
- Comply with all applicable Federal, State, and local regulations and appropriate permit requirements.

DPVE was selected as the preferred remedial technology based on its ability to remediate chlorinated compounds within vadose zone soils and surficial impacted groundwater. This technology is especially applicable at the site where the bulk of the contamination is positioned within a relatively narrow layer of soil sandwiched between two silt/clay layers with lower permeability. This area corresponds with the perched groundwater zone. DPVE presents an approach to effectively remediate

the target area via management of recovered water and vapors. By extracting the impacted groundwater, the area becomes dewatered, exposing additional soils for remediating via vapor extraction. A degree of hydraulic management is also achieved, thereby limiting the migration of the groundwater impacts horizontally and vertically.

DPVE consists of applying a vacuum to a network of extraction wells through a drop-tube (aka, stinger tube) typically set at the groundwater interface. The drop-tube and applied vacuum are then adjusted to optimize the removal or drawdown of impacted groundwater. The relatively shallow groundwater positioned in the perched groundwater zone will be targeted at the site. The quantity of groundwater recovered through the process can range based on the hydraulic conductivity of adjacent soils, depth of the drop-tube, the vacuum applied, air flow, storm events, and recovery well construction details. DPVE differs from other groundwater extraction strategies (e.g. pump and treat) because it aims to recover relatively small amounts of groundwater, as needed to achieve influence within the treatment zone. For this site, groundwater inflow is estimated to be less than 1 gallon per minute (gpm), with 0.1-0.25 gpm being typical.

Vapor and groundwater containing dissolved chlorinated compounds are extracted in the same process stream using the suction lift created by a single aboveground vacuum pump. Extracted liquids (i.e., groundwater) are separated from the extracted vapors using an Air Water Separator (AWS). The separated liquids are then conveyed to a groundwater storage system. Alternatively, groundwater can be treated (when necessary) and then discharged. The separated vapors are treated (when necessary) and then discharged to the atmosphere.

7.2 SYSTEM EXPANSION DETAILED DESIGN

The following section presents a tentatively-planned design for full-scale implementation of DPVE at the site. The design is based upon ERM's understanding of the conceptual site model, the remedial action objectives, and professional experience at other sites. Details are subject to change based on the encountered site conditions, pilot testing, etc. Figures related to the remedial design are as follows:

Figure 7-1 – DPVE System Layout Map
Figure 7-2 – DPVE System Piping Map
Figure 7-3 – Conceptual DPVE System Cross Section C-C'

Figure 7-4 – Conceptual DPVE System Cross Section D-D'
Figure 7-5 – Process and Instrumentation Diagram
Figure 7-6 – Well Construction Diagram & Wellhead Detail
Figure 7-7 – DPVE Trenching Detail

In summary, the proposed groundwater and soil remediation system consists of a high vacuum, dual-phase extraction system utilizing a liquid-ring, rotary lobe positive displacement blower. The system will contain up to eight (8) recovery wells positioned within the facility around AOC-5. See **Figure 7-1** for a system layout map. The well network will be divided into two zones, each consisting of 4 wells with common header pipes and corresponding manifold assemblies. Each zone header will manifold within the system compound, to be positioned immediately outside the southern facility wall. A piping layout map is included as **Figure 7-2**. Conceptual cross-sectional views are presented as **Figures 7-3 and 7-4**. These paths are subject to change based on the findings of utility locating and input from facility personnel regarding impacts on operations. The system is sized to operate all eight wells at once; however, individual zones or subsets therein can be operated independently if deemed effective.

Each recovery well is expected to have an estimated radius of influence (ROI) of 25 feet. This value is deemed a conservative estimate based on site knowledge and experience at similar sites. An airflow rate of approximately 30-40 scfm per well is expected at an operating vacuum of between 20 to 25 inches of mercury (in Hg). With a system comprised of 8 DPVE wells, the system is designed to handle at least 320 scfm at 25 in Hg. The system is expected to encounter minimal groundwater inflow. Initially, the recovery wells will extract a greater quantity of water as the perched water zone is dewatered. The flowrate will decrease while maintaining a dewatered zone. The DPVE system equipment will be constructed to manage a continuous groundwater flowrate between 0.1 and 0.25 gpm with a short-term capacity up to 1.0 gpm during initial dewatering. In the event that the groundwater inflow rate exceeds the system's capacity, each recovery well's drop tube can be adjusted to reduce total groundwater inflow to an acceptable level. For additional system flexibility, the vacuum can be turned off to individual wells to manipulate system influence and groundwater inflow.

The proposed DPVE system consists of the following components as laid out on **Figure 7-5**:

- 8 DPVE wells;
- Vacuum measurement and flow control devices;

- Liquid ring vacuum pump with optional variable frequency drive;
- AWS;
- Liquid particulate bag filters;
- Vapor-phase carbon absorption vessels for treating extracted vapors; and
- Process transfer pumps.

The radius of influence will be assessed during pilot testing or at full-scale startup, whichever is chosen as the preferred approach. ERM will evaluate the need for system adjustments and/or modifications at that time. Such adjustments could include the addition of more wells or changes to the piping configuration.

The DPVE system will consist of 8 wells positioned in a staggered grid array. Assuming a 25-foot ROI, the array will provide full coverage of the treatment area with limited overlapping. Each of the 8 DPVE wells will be constructed of 4-inch Schedule 80 PVC. The well screens will be made of .020-slot Schedule 80 PVC. The total depth of the 8 wells will vary from approximately 12 to 26 feet bgs. Well screen lengths and intervals will be determined based on field screening of soil samples during well installation. The base of each well will be positioned approximately 1 foot into the silty clay layer underlying the perched groundwater zone. The depth to the clay layer is approximately 11 feet on the southwestern side of the treatment zone and increases towards the northeast. The screens will be sized to bridge the sand layer between the underlying clay layer and the overlying clay lens, if present. In the absence of an overlying clay lens, the screen length will be determined based on historical groundwater elevation data, with the goal of providing approximately 3 feet of screened interval above the historical average water table elevation. Locating the screens in such a manner will target fluid and vapor extraction within the primary contaminant zone and will reduce the risk of short-circuiting (e.g. primarily extracting air above the overlying clay lenses). Refer to **Figures 7-6** of DPVE well construction details.

7.3 DPVE WELLS

The DPVE wells will be installed using a truck- or track-mounted hallow-stem auger drill rig. A washed silica sand filter pack will be used to fill the annular space between the borehole wall and the DPVE well screen. The sand pack will be placed from the vertical extent of the well to 1-2 feet

above the top of the screen. A remaining length of the well will be sealed with bentonite and then grouted to grade.

Each well will be surge developed. This method utilizes a surge block during development pumping that achieves improved connection with the formation and improves groundwater flow into the filter pack. Surging involves raising and lowering a surge block or surge plunger inside the well. The resulting surging motion will force water into the formation and loosens sediment to be pulled from the formation into the well, thus increasing the transmissivity of the surrounding formation. A minimum of three well volumes will be purged or until the water appears to be free of suspended solids. Investigation-derived waste (IDW) including soil cuttings and development water will be containerized or stockpiled as discussed in Section 7.10. After installation, each well will be surveyed by an approved professional.

7.4 DPVE WELLHEADS AND DROP-TUBES

The proposed area of remediation is located within an active facility with frequent worker traffic. Therefore, all wellheads and transfer piping will be positioned below grade. Each DPVE well will be housed in an H-20 traffic-rated, flush-mounted, well vault. The well vaults will be bolted or locked shut for security. Refer to **Figure 7-6** for wellhead construction details. Each well will be equipped with a 4-inch compression type or equivalent well seal. A 1-inch flush threaded drop-tube (aka stinger tube) is inserted into the well through the well seal to target groundwater within the perched zone and soil vapors. The extraction wellhead and drop-tube design consist of the following:

- Drop Tube - constructed of varying lengths of 1-inch diameter, flush threaded, schedule 80 PVC well casing sections with a 45-degree angle cut at the bottom to enhance a slurping action that results in improved vapor recovery while reducing groundwater recovery. Due to tight conditions within the flush-mounted well vaults, the drop-tubes will contain at least two 1-foot segments of PVC casing to allow minor adjustments to the drop-tube height while still enabling the well vault to be safely closed. Additional sections of drop tube (1-foot, 2-foot, etc.) will be stored onsite in anticipation of future adjustments;

- Well Seal - includes the ability to seal the well, adjust and secure the drop-tube depth, and a valved port for

monitoring the depth to groundwater. The port will also allow a technician to control vacuum in the well while maintaining the extraction velocity required for groundwater recovery, if necessary.

- Gauges / Controls - the top of each drop-tube will be attached to a section of piping equipped with a vacuum gauge or port for monitoring induced vacuum in the well, a ball or raising-stem gate valve to shut off/isolate the well, and a Camlock™ fitting to connect the drop-tube to a section of 1-inch flexible vacuum hose to allow minor vertical adjustments between the drop tubes and the extraction headers.

7.5 TRANSFER PIPING & MANIFOLDS

Due to worker traffic in the remediation area, all transfer piping will be positioned below ground. Trenches will be cut to each well, following common paths, where possible. The respective transfer piping will then be positioned within each trench and backfilled. Any cut concrete or asphalt will be backfilled to match the surrounding conditions.

The two DPVE transfer headers will consist of 4-inch Schedule 80 PVC or SDR11 HDPE. Each individual DPVE well branch will be 2-inch PVC or HDPE. Upon entering the system equipment building, each of the two zone headers will manifold into a single return. To monitor and control flow to each zone, each header will contain the following:

- Four-inch ball or gate valve,
- Electronic solenoid valve,
- Sample collection port,
- Vacuum gauge,
- Flow indicator, and
- Sight glass (clear section of Schedule 80 PVC or equal to observe liquid flow within the piping).

The main system header will contain a series of sample ports, flow meters, and vacuum gauges for complete system control and monitoring. See **Figure 7-5** for additional details.

Schedule 80 PVC was selected for the rigid piping based on the following reasons:

- Cost effectiveness;
- Durability with the expected levels of COCs;
- Availability of materials; and
- Ease of installation, repair, and modification.

SDR-11 HDPE piping was selected as an alternative to PVC piping for the following reasons:

- Ease of installation (flexibility);
- Superior durability;
- Ability to handle long-term exposure to chlorinated compounds;

7.6 DPVE SYSTEM COMPONENTS

The DPVE system equipment will be constructed and housed within a prefabricated, insulated building (approx. 8 ft. X 16 ft.). The building will contain one roof-mounted temperature-controlled ventilation fan (e.g. 14", 1600 cfm with ½ HP motor) with at least one corresponding intake louver (e.g. 24"X 24") positioned to maximize air flow throughout the building and across the blower motor. The system building will contain ceiling-mounted lighting and a heater for winter protection. Dual 36-inch doors will provide access and additional ventilation when performing operations and maintenance (O&M) activities. The package will include the following major components, which are subject to change based on input from equipment vendors:

- Primary system header pipe (6-inch) connected to two zone headers (4-inch) with separate control assemblies, as discussed in Section 7.5;
- Oil-sealed, liquid-ring vacuum pump capable of extracting soil vapors at a rate in excess 320 scfm at 25 in Hg. The actual vacuum pump will be selected based on input from vendors and the results of possible pilot testing;
- AWS (capable of handing the design airflow and a potential groundwater inflow of 1 gpm) to separate liquids from the extracted soil vapors;

- Liquids transfer pump (progressive cavity pump to overcome vacuum from the air/liquid separator and reduce LNAPL emulsification) and auto-drain to convey separated liquids from the air/liquid separator to the onsite water storage tank;
- Float switch assembly (low/low, low, high, high/high) in the AWS sight-glass to control other system components based on accumulated liquid levels;
- Locking control panel for enhanced security and safety equipped with an external emergency stop (E-stop) button on the exterior of each control panel so that personnel working on site can readily shut the system down in case of an emergency. The control panel, breaker panels, and motor starters will be positioned within a separate partition of the equipment building, isolated from the DPVE equipment. This partition will include a separate, locking entrance;
- Air/air heat exchanger to reduce the level of moisture in the vapor stream, cool the air temperature to an acceptable range for the PVC downstream transfer piping, and to increase the effectiveness of the vapor treatment;
- Inline particular filter with differential vacuum indicator to remove debris from the vapor stream of the AWS;
- Vacuum break/anti-siphon on the highest elevation of the produced water discharge conveyance pipe to prevent siphoning of the produced water in the collection tank in the event there is a line break; and
- Vacuum, flow, and temperature measurement devices and sample collection ports.

The vacuum pump may be fitted with a variable frequency drive (VFD) to allow adjustment to the flow conditions. A VFD can reduce operating power requirements and provide a wider range of operational parameters. The pump assembly will include an ambient air-dilution valve and a moisture separator. The ambient air intake will be equipped with an inlet air filter/silencer and flow meter. An in-line air particulate filter will be installed between the separator and the vacuum pump. The air/moisture separator will include a float assembly to operate a transfer pump capable of overcoming the design vacuum of 25 in Hg.

The vacuum pump and/or components listed above are subject to change based on availability, recommendations from the selected equipment

vendor, or new information to improve performance and reduce potential O&M costs.

7.7 *SYSTEM CONTROLS & PROTECTION*

A single control panel will be located within an isolated partition of the equipment building. The control panel will not be explosion proof due to its remote location relative to the extraction system equipment. A licensed electrician will install electrical components of the system. The guidelines of the National Electric Code and the local municipal code will be followed during installation activities.

The DPVE system will be equipped with several safety control switches, which will allow the system to respond to alarm conditions. Each safety control will be installed in such a way to control the previous component in the treatment system. This will give the system the opportunity to stabilize before being shut down. If stabilization does not occur, then the system components will shut down in a reverse operation order until the vacuum pump is shut down. Possible system conditions and treatment component responses are summarized below.

- When liquid in the AWS tank reaches a specified high level, a high level control switch will trigger the water transfer pump to turn on. When the liquid level reaches a specified low level, a low level switch will turn off the transfer pump. In the event the transfer pump does not drain and the liquid level continues to rise, a high-high level control switch will shut down the DPVE vacuum pump to reduce the potential that the pump would be flooded with liquid;

- In the event of excessive vacuum or temperature within the vacuum pump, interlock switches located within the pump will shut down the system;

- Control switches inside the vacuum pump will monitor seal fluid levels and shut down the pump in the case of extreme levels;

- Should the liquid level within the water storage tank exceed a set high level, the AWS knockout tank transfer pump will be shut down; and

- If high pressures occur within the particulate filter, the vacuum pump will be shut down.

The system will include a programmable logic controller (PLC) with a graphical display for quick reference (e.g. GE Quickpanel View Operator Interface with 12" color display). The PLC will control the motor starters for the vacuum pump, exhaust fan, and moisture separator tank transfer pump. The DPVE system will contain basic telemetry capabilities located within the control panel along with a cellular modem for remote system monitoring. The system will be capable of email and SMS (text messaging) communications, and will monitor the following inputs:

- Power ON/OFF status;
- Vacuum pump ON/OFF status;
- DPVE flowrate and vacuum;
- System and equipment building temperatures;
- DPVE zone header solenoid valve positions;
- VFD control adjustments (e.g. vacuum or flow set-points);
- Equipment building fan and heater ON/OFF status;
- System operation alarm conditions;
- AWS high-level alarms;
- Water storage tank high-level alarms and tank level position (e.g. % capacity full); and
- Total liquid flowrate.

7.8 AIR EMISSIONS

Vapors recovered by the liquid-ring vacuum pump will be separated from the liquids through the AWS tank, which is capable of withstanding the system's designed vacuum. Residual moisture is removed by the air-to-air heat exchanger. Liquids generated by the heat exchanger will be returned to the AWS via an automated condensate drain. The separated vapors are then transferred to a vapor-phase carbon treatment unit, positioned immediately outside of the equipment building. The carbon treatment

unit consists of two carbon tanks placed in series (primary followed by a secondary), each containing 500 pounds of vapor-phase activated carbon. The vessel will have a 4-in pipe inlet and outlet and a flow capacity in excess of the system design flow. Following treatment, the vapors are discharged to the atmosphere through a 4-inch vent stack attached to the exterior of the southern facility wall. The vent stack will terminate approximately 10-feet above the building roofline.

7.9 GROUNDWATER MANAGEMENT

The site is located in a commercial/industrial area with no apparent water discharge options (e.g. NPDES permitted discharge). Based on the low anticipated groundwater inflow rate (0.1-0.25 gpm following dewatering), a bulk storage tank will be used. The AWS will periodically transfer liquids to the bulk storage tank. An ultrasonic level sensor will transmit the approximate depth of liquid in the tank. When necessary, the tank contents will be transferred to a tanker truck by a qualified waste hauler and transported for offsite management. Representative samples of the recovered water will be analyzed for site-specific COCs prior to disposal.

Due to uncertainty of the sustained groundwater inflow rate, a frack tank or mobile storage solution may be used temporarily during startup. Once the flowrate is known, an appropriately-sized, long-term solution will be implemented.

7.10 INVESTIGATION DERIVED WASTES

A volume of soil, water, and construction debris will be generated through trenching activities and the installation of the DPVE wells. Due to the likelihood of encountering COC impacted soils, all generated soils will be containerized in 55-gallon steel drums or stockpiled and disposed of properly following characterization. Composite samples will be collected at a frequency of at least one sample per 10 drums and analyzed for toxicity characteristic leaching procedure (TCLP) VOCs by a certified laboratory. Impacted soils will be transported off-site by a licensed hauler for disposal at an appropriate, licensed facility. All liquids generated through the development of the DPVE wells will also be containerized in 55-gallon steel drums and disposed of properly.

Paved surfaces within the facility will be promptly repaired and sealed. Surfaces outside the facility will be repaired to match the surrounding conditions.

Spent carbon will be removed from the site, as needed, by a qualified vendor and either reactivated or disposed of in an appropriate fashion. The need for new carbon will be determined through regularly occurring pre- and post-carbon air sampling.

In conjunction with the remedial design, a Materials Management Plan (MMP) has been compiled for the project and is provided as **Appendix C**.

IDW will also be generated through site sampling activities, as discussed in detail in **Section 6.6** of this RIP.

8.0 *DUAL PHASE EXTRACTION SYSTEM STARTUP AND OPERATIONS AND MAINTENANCE*

Upon completion of the remediation system installation, a start-up and de-bugging event will be performed to fine-tune the operation of the DPVE system to achieve the required vacuum and air/liquid flow rates. This will include the following activities:

- Evaluating system recovery (water, vapor) relative to design parameters;
- Testing for vacuum, pressure leaks or constrictions that may affect system performance;
- Evaluating the vapor-phase carbon treatment system to verify proper capacity and operation relative to the design parameters;
- Emissions (following carbon treatment) will be measured to confirm compliance with any applicable air emissions limits;
- Testing system fail-safes and the telemetry system by simulating alarm conditions;
- Testing multiple vacuum pump VFD settings to determine approximate corresponding vapor recovery rates and wellhead vacuums; and
- Adjusting the well drop-tubes to achieve a desired groundwater inflow, while maintaining focused vapor recovery in the perched water zone;

Following initial start-up, the system will be observed for a minimum of eight hours before beginning unattended operation. Vapor effluent conditions will be evaluated through field measurements and laboratory samples to determine the most effective system operation based on mass recovery.

An operations and maintenance (O&M) manual will be prepared for the DPVE system. At a minimum, the manual will include the following:

- Manufacturers specifications for system equipment;
- Required maintenance schedule for system components;
- System equipment troubleshooting guidelines;
- System layout sketch/construction as-built and electrical straight line drawings.

Following the initial system start-up event, O&M visits are expected to occur weekly for the first month and then bi-weekly for the remainder of the first quarter. At that point, O&M visits will transition to monthly unless previous experiences dictate more frequent observation. During site visits, groundwater and air flow rates will be monitored at the recovery manifold. Vacuums at each wellhead will be recorded and compared to those observed during system startup. Effluent totals (vapor, water) will be estimated (e.g., instantaneous for vapor, totalized for liquids).

Routine maintenance activities will include the following:

- Inspection of vacuum pump filter pressures and replacement when necessary;
- Inspect oil levels and observe for signs of leaks;
- Inspection and cleaning of the AWS;
- Inspection of the bulk water storage tank;
- Adjustments to the vacuum pump output to effect the extraction flow rates to optimize vapor mass removal;
- Adjustments to the DPVE wellheads to balance or focus influence in specific areas.
- Testing of the system failsafe controls and alarms by manipulating system conditions; and
- Groundwater gauging of select on-site RWs or MWs.

8.1 DPVE SYSTEM PERFORMANCE MONITORING

8.1.1 Startup

Within the first 8 hours of system startup, assuming such time is adequate to achieve functional conditions within the effluent treatment system, a pair of effluent air samples will be collected. The pair will consist of one exhaust sample collected before the carbon vessel and the other after the carbon vessel. The air samples will be submitted for laboratory analysis of VOCs using USEPA Method TO-15. At the same time, system flowrate will be recorded to calculate the estimated mass removal rate. The mass removal of the system will be tracked through regularly-occurring sampling events. Exhaust samples (one pair per event) will be collected for laboratory analysis for VOCs. Samples will be collected on the following frequency (times following system startup):

- Eight hours
- One day
- One week
- One month

Thereafter, effluent air samples will be collected no less than monthly for the first six months and semi-annually thereafter until such time that historical data is adequate to predict future mass recovery maximums. Throughout the first year of operation, the projected total mass of VOC emissions will be calculated.

As described in Section 6.3.3, the samples will be shipped to the laboratory within one business day of sample collection and via overnight delivery (when shipping). During the system start up (as described above) samples will be submitted for 24 hour expedited laboratory analysis. During the routine monitoring described in Section 8.1.2 (as described in the section that follows), samples will be submitted for standard (10 day typical) laboratory analysis.

8.1.2 DPVE System Performance Monitoring

DPVE system performance monitoring will be performed on a routine basis to track and document system operation and any changes to operating parameters. System performance will be tracked using field measurement forms and reported to EPA in the report described in **Section 11.0** of this plan.

The monitoring forms will include the following (forms are provided as **Appendix D**);

- ***Appendix D – Example Form A*** : O&M System monitoring form (final form to be provided following system construction); and

- ***Appendix D – Example Form B***: Semi-Annually detailed system monitoring forms (final form to be provided following system construction).

Based on the data collected during semi-annual monitoring events, the DPVE system operating parameters will be reviewed and adjusted as needed to optimize system operation. The DPVE system monitoring data will be used to calculate VOC mass removal rates using the PID data

collected during the monitoring events. Continued system operation or shut down recommendation will be provided to EPA using the logic presented as a decision tree diagram provided as **Figure 8-1**.

9.0 SUB-SLAB DEPRESSURIZATION SYSTEM

9.1 VAPOR MITIGATION APPROACH

VOCs underlying the facility slab have demonstrated the potential to migrate to indoor air within isolated areas of the facility. As such, a system has been designed to establish vacuum conditions in portions of the facility, as needed, to mitigate the transmission of vapors. Based on the review and evaluation of the available site data gathered to date, the installation of a full-scale, active mitigation system is not warranted. Rather, a small-scale SSDS will be implemented to influence the supervisor's office for targeted mitigation. Sub-slab depressurization was identified as the most applicable form of mitigation based on an analysis of site data and pilot testing.

An SSDS is designed to function by continuously creating a lower pressure directly beneath a building floor relative to the pressure within a building using an electric powered fan or blower, which draws air from beneath the slab. The resulting sub-slab negative pressure below the foundation inhibits soil gases from migrating into the building, thus reducing volatile chemical entry into the building work space. Volatile chemicals caught in this negative pressure field are collected and piped to an ambient air discharge point exterior of the facility.

The SSDS fan has both an intake (suction) and an exhaust. Suction piping connects from the intake side of the fan/blower to sumps installed within the fill material beneath the floor slab. On the exhaust side of the fan/blower, vent piping is connected from the fan to the final vent location exterior of the building above the roof line. The exhaust piping terminates with a vent cap or other device that prevents intrusion of rainwater. Multiple fans and/or suction points may be used to create the necessary suction beneath the floor slab. Based on current data, a single extraction point system is planned for the supervisor's office. This approach can be expanded or replicated for other areas should the need arise.

It is important to note that an SSDS system is not intended to remediate the soil or groundwater beneath the facility. Its design objective is to prevent soil gases from infiltrating the building. However, by venting soil gases impacted by VOCs, the SSDS system facilitates the mass removal of contaminants from subsurface media. Soil and groundwater remediation will be primarily handled by the proposed DPVE system.

9.2 *DESIGN GOALS & SUMMARY*

The goal of the SSDS is to create a sub-slab negative pressure field throughout the desired footprint of implementation, beneath the supervisor office. The Interstate Technology Regulatory Council (ITRC) Petroleum Vapor Intrusion guidance document, dated October 2014, states that a sub-slab pressure differential of 0.004 inches of water column (in H_2O) is adequate in portions of the United States, including New York and New Jersey. The SSDS will target this industry standard, with a minimum pressure differential throughout the year of 0.004 in H_2O. Achievement of the pressure differential will be tracked and verified through regularly-occurring O&M events (see Section 9.9). A general schematic of an SSD system is provided in **Figure 9-1 (Detail 1).**

SSDS will be implemented with coverage enveloping the supervisor's office, which is approximately 12.5′ x 19.5′ in size (244 sq. ft.) and constructed as a stand-alone structure within the larger facility building. The foundation of the building is slab on grade, with an approximate thickness of 6 inches. Subsurface materials consist of fine-grained sand with silt. The design criteria, such as applied vacuum and ROI, are based on the findings of pilot testing as presented in the 2012 *Vapor Intrusion Mitigation Design Plan*. The pilot testing concluded that an ROI of up to 80 feet could be achieved when inducing a vacuum of at least 5.6 in H_2O. The ROI demonstrated a steep decline beyond 45 feet. Therefore, for the purposes of this design, an ROI of 45 feet will be assumed as a conservative estimate.

The vapor mitigation system consists of the following elements, which are discussed in further detail below:

- One sub-slab suction point measuring 1 foot by 1 foot by 1 foot deep (approx.);
- Extraction point consisting of 4-inch ID Schedule 40 PVC and transfer piping consisting of 3-inch ID Schedule 40 PVC;
- Extraction point control assembly (valve, gauges, etc.);
- Blower fan, roof penetration, and exhaust vent stack;
- Vacuum monitoring points (e.g. VAPOR PIN®); and,
- Floor sealant.

9.3 *SSDS EXTRACTION POINT AND PIPING*

The single proposed suction point will be located immediately outside the southern wall of the supervisor's office in proximity to a facility support column. Considering an achievable ROI of 45 feet, as determined during the pilot test, the extraction point can be positioned anywhere surrounding the office and still achieve complete influence. The final location will be determined in the field following utility locating and based on input from the supervisor.

Details of the extraction point are presented on **Figure 9-1 (Detail 3)**. The point will be placed 1 to 2 feet out from the office wall, outside the footprint of the support column. A 6-inch hole will be cored through the concrete. A trowel, shop vacuum, or other hand tools will be used to dig out an area approximately 1-foot by 1-foot by 1-foot in size (1 cubic foot). The base of this void space will be backfilled with approximately 3 inches of pea gravel; the remaining area will not be backfilled. A 4-inch section of vent pipe will be installed within the void with the bottom of the pipe extending approximately 2 to 4 inches below the base of the concrete slab. Foam backer rod will be placed between the pipe and the concrete sidewalls, and the remaining cored opening will be backfilled with hydraulic cement or self-leveling urethane sealant.

Vertical 3-inch piping will connect to the extraction point and travel along the support column to the ceiling using pipe hangers or unistrut. The following components will be positioned along the support column at a height to allow easy access by system technicians:

- Sample port;
- Vacuum gauge (0-10" H_20);
- Flow control valve (gate or butterfly valve);
- Flow measurement device (e.g. pitot tube with pressure differential meter connections and magnahelic gauge);
- Battery powered indicator light to notify of power failure to the blower; and
- Vacuum switch (to confirm blower operation) with alarm feature connected to DPVE system telemetry system.

The vertical pipe will also contain a y-fitting with a moisture drain valve in case rainwater enters the vent line.

Figure 9-1 (Detail 4) details a conceptual pipe run from the suction point to the roof penetration. A single, 3.5-inch penetration will be made in the roof through which the vent pipe will exit the facility. The penetration will be protected using a fire collar, fire-rated caulking, or fire-rated boot to prevent rain from entering the facility.

9.4 BLOWER FAN, ROOF PENETRATION, AND EXHAUST STACK

Piping from the suction point will extend vertically through the roof to the location of the roof-mounted blower. A typical specification for the roof penetration and blower installation is included in **Figure 9-1 (Detail 1).** The final location of the roof penetration and blower will be determined based on roof access, roof support features (roof trusses or support columns) and building features. All roof penetrations (suction piping, power supply conduit) will be completed and sealed by an approved contractor.

Suction will be provided by a single blower, such as an Obar GBR76 SOE. The final blower selection will be made after receiving input from equipment vendors. The determination will be based on continuous operation, the ability to achieve 5.6 in H_2O suction at the extraction point, and other blower specifications (i.e., size, flowrate, power supply). A dedicated breaker will be used for the blower. Wiring and conduits will be installed by a licensed contractor, and all components will be suitable for outdoor use.

The exhaust vent stack that exits the blower will meet the following standards to prevent entry of exhausted vapors into the building. The exhaust vent stack must terminate:

1) At least 8 feet above the roof apex; and
2) At least 25 feet laterally from HVAC or other air intakes.

The location of the blower, piping, and/or roof penetration may need to be adjusted to meet the above restrictions. The exhaust pipe will vent vertically upwards and will include a rodent screen cap (e.g. ½" galvanized wire mesh).

9.5 *VACUUM MONITORING POINTS*

Permanent sub-slab vacuum monitoring points will be installed in the concrete slab within the supervisor's office. Up to 4 monitoring points will be installed to observe the influence of the SSDS throughout the office space. At the least, a vacuum point will be installed in the northeastern and northwestern corners of the office, representing the greatest lateral distances from the extraction point. The final locations will be determined based on utility locating and possible obstructions within the office (e.g. filing cabinets). Typical construction specifications are shown in **Figure 9-1 (Detail 5).**

Proposed monitoring points utilize a Vapor Pin® that is fitted with a silicone sleeve to create a seal between the pin and the concrete. Monitoring points will be drilled into the concrete slab using a hammer drill and will be countersunk such that the monitoring port is below the floor surface. A Vapor Pin® stainless steel secure cover will be threaded onto each monitoring point to provide a protective metal plate over each point.

9.6 *CRACK SEALING*

To increase the effectiveness of the SSDS and to help prevent short circuiting, significant cracks or joints observed within and immediately surrounding the supervisor's office will be sealed while installing the system. Cracks and joints should be cleared of small debris with a shop vacuum or channel cut to clean and widen the space for proper, more permanent sealing. Sealing will consist of urethane caulk or similar and backer rod followed by self-leveling urethane or similar. Alternatively, a 2-part epoxy coating may be used. Openings around nearby pipe penetrations and columns, if accessible, will also be cleaned and sealed Locations of sealed cracks and joints may be recorded for future monitoring and maintenance activities.

9.7 *EMISSIONS*

Due to the intended use and designed low flow rate of the SSDS, it is not anticipated that air emission controls will be needed. As previously mentioned, the SSDS is not intended to serve as a form of remediation for impacted soil and/or groundwater. Rather, it is intended to mitigate vapor intrusion.

9.8 *INVESTIGATION DERIVED WASTE*

A small volume of soil and construction debris will be generated through installing the suction point. Due to the potential of encountering COC impacted soils, all generated soils will be containerized in 55-gallon steel drums or stockpiled and disposed of properly following characterization. Composite samples will be collected at a frequency of at least one sample per 10 drums and analyzed for toxicity characteristic leaching procedure (TCLP) VOCs by a certified laboratory. Impacted soils will be transported off-site by a licensed hauler for disposal at an appropriate, licensed facility.

9.9 *OPERATIONS & MAINTENANCE*

System operation and maintenance will be completed on the SSDS with a common frequency as the DPVE system. A system O&M plan will be created to include the following:

- Final system equipment specifications and owner manuals;
- Construction as-built and photographic log of major system components;
- Procedures for system start-up and shutdown;
- System initial and minimum expected operating parameters;
- O&M parameter checklists; and,
- Initial schedule for conducting O&M.

After installing the SSDS, an initial start-up and de-bugging event will be performed to achieve the required vacuum and airflow. This will include the following activities:

- Evaluating system air flowrate relative to design parameters;
- Measuring vacuum within the suction point piping and slab differential pressures via the Vapor Pin® monitoring points;
- Inspecting for leaks or constrictions that may affect system performance; and
- Testing the system failure indicator light.

Following initial start-up, the system will be observed for a minimum of eight hours before beginning unattended operation.

Following the initial system start-up event, O&M visits are expected to occur weekly for the first month and then monthly for the remainder of the first year. Routine maintenance activities will include the following:

- Inspection of vacuum blower for signs of wear or damage;
- Inspection of valves and gauges for signs of damage;
- Inspection of system piping, penetration seals, and slab conditions within the area of influence;
- Measuring vacuum within the suction point piping and slab differential pressures via the Vapor Pin® monitoring points and
- Draining of any condensate within the suction line

10.0 MONITORING OF INSTITUTIONAL CONTROLS

As presented in the FD/RTC, institutional controls are to be established as follows;

- Restrict land use to non-residential purposes;
- Prohibit the use of groundwater;
- Provide notice to EPA for construction projects involving excavation or de-watering in the vicinity of AOC 5;
- Provide notice to EPA for construction projects involving disturbance of surface soil contaminated with PAHs above RSLs north of the main facility building (former wastewater treatment area); and
- Maintain the concrete slab of the building to serve as an engineered cap preventing exposure to contaminated soil beneath the slab.

Institutional controls in the form of an environmental covenant agreement (ECA) will be developed by EPA and Waterloo to support the remedy for the Waterloo Site (on-site area only). A draft of this agreement is provided as **Appendix E**.

Maintenance of the concrete slab associated with AOC 5 area (as indicated on Exhibit 3 within the draft ECA provided in **Appendix E**) will include covering of any areas of paving temporarily removed as part of the remedial construction or facility replacement with plastic sheeting to prevent exposure to contaminated soils beneath the slab. Following completion of construction activities, the slab will be replaced with concrete paving of similar thickness and construction as that removed, as rapidly as reasonably possible.

In addition, the concrete flooring within AOC 5 area (indicted on Exhibit 3 within **Appendix E)** will be inspected upon the DPVE system start up for evidence of potential short circuiting. Such evidence may include the following:

- Obvious suction through surficial cracks or seams (based on visual identifiers, air noise, etc.),

- Air leakage around building columns and footers,
- Air leakage within the DPVE extraction point vaults,
- Evident noise around the SSDS extraction point piping, or
- Formation of new cracks.

If short circuiting is observed and deemed to have potentially significant impact on system operations, these cracks will be sealed with an appropriate caulking, paint, or epoxy product. The cracks may first be mechanically widened, scoured, or altered in another way to promote proper adhesion of the selected sealant.

Following startup, the concrete slab in the AOC 5 area (as indicated on Exhibit 3 within **Appendix E**) will be inspected no less than annually. Any observed cracks or leaks will be evaluated and repaired, as warranted.

11.0 EVALUATION OF REMEDY EFFECTIVENESS (DATA EVALUATION AND REPORTING)

The performance monitoring data that are collected pursuant to this RIP will be used to evaluate the effectiveness of the selected remedy. In accordance with the performance criteria listed in **Section 4.3**, the evaluation will focus on verifying the remedy is effectively reducing contaminant concentrations and mass, and controlling contaminant migration.

This section of the plan describes the techniques that will be used to evaluate the groundwater data at the Site and to determine compliance with the established RAOs.

11.1 DATA REDUCTION

ERM will summarize all analytical and QA/QC data in tabular form. Data review, verification, and validation will be performed as described in Section 4.0 of the QAPP (provided as **Appendix A**). Formal data validation will not be performed unless any of the laboratory results are suspect. Laboratory results will be considered suspect if the results fall outside of the laboratory QA criteria and are not able to be reconciled by the laboratory or if the results deviate greater than 25% from expected historical ranges. If necessary, data validation will follow the appropriate EPA protocols. The laboratory will provide electronic deliverables in the appropriate format for direct uploading to ERM data summary tables.

The analytical data will be summarized and compared to the RAOs described in **Section 4.3** of this RIP.

11.2 DATA EVALUATION

The data evaluation process will generally follow the three lines of evidence approach for evaluating natural attenuation described in the OSWER Directive 9200.4-17, 1997:

1. Contaminant concentration trend analysis to demonstrate contaminant reduction in concentration and mass;

2. Detection of daughter products to demonstrate that biological or abiotic degradation processes are active at the Site; and

3. Hydrological and geochemical data to provide indirect evidence of the natural attenuation processes that are active.

These evaluation steps are discussed in detail in the following sections.

11.2.1 Contaminant Trend Analysis

Statistical tests for trend will be performed on contaminant concentrations from the perched and bedrock zone wells to show continued concentration and mass reduction. The data trend analysis will be supported by guidance documents including *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (EPA 530/R-09-007, March 2009), and *An Approach for Evaluation the Progression of Natural Attenuation in Groundwater* (EPA 600/R-11/204 December 2011). These guidance documents provide several methods for trend analyses including linear regression and the Mann-Kendall Statistical Test for Trend. The Mann-Kendall Statistical Test for Trend will be used to evaluate the contaminant trends at the Site because the Mann-Kendall test is based on the relative ranking of the data and calculates a test statistic, which is then compared to the normal distribution and can provide a more reliable trend analysis for groundwater data.

11.2.1.1 Mann Kendall Statistical Test for Trend

Mann-Kendall is a non-parametric test that can be used to assess a series of numbers exhibiting an increasing or decreasing trend or no trend to a specified level of significance. The test requires a minimum of four values and compares all the values to each other in pairs sequentially and assigns a value of 1, 0, or -1. A score of 1 is given if the second value is greater than the first; 0 if the values are equal; and -1 if the second value is less than the first value. The sum of the scores yields the Mann-Kendall Statistic S. For a set of values with an increasing trend, calculated S will be positive, since the first value in a pair will on average be higher than the second number. Conversely, a decreasing trend will yield a negative S. The larger the absolute value of S the more significant the trend. A value near zero indicates a set with no apparent trend.

Care must be taken to avoid trending the analytical method quantitation limits if the data set includes events where analytes were not detected above laboratory quantitation limits. To avoid this issue, these non-detect values are generally assigned a common value in the Mann-Kendall Test that is less than the lowest quantitation limit. Any pairing of non-detect values is given an S Statistic of 0. While this treatment of non-detect values

is imperfect as it is impossible to establish an accurate trend for an analyte that is not detected above laboratory quantitation limits, this is the solution presented in EPA guidance (Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance, March 2009, EPA 530/R-09-007).

11.2.1.2 Trend Analysis on Site Data

The data from the perched and bedrock zone wells will first be inspected to determine which of the contaminants remain above RAOs at specific wells. Trend tests will be performed on contaminants that have been detected above the RAOs for two of the previous four sampling events. Evaluation of contaminants at wells for which concentrations are at or below the RAOs will be evaluated for verification of attainment of the RAOs, as discussed in **Section 12.0** of this RIP.

Because precipitation and recharge are seasonally variable, groundwater elevation, gradient and flow direction change seasonally and potentially affect trends in chemical concentrations. The data set may be filtered to minimize the effect of seasonal changes by only focusing on samples collected in the season when the maximum concentrations of VOCs have been observed.

For each constituent above the RAO at each well, the trend will be reported as increasing, decreasing, stable, or that no trend could be calculated. Concentrations of cDCE and VC, which are produced during natural attenuation, may also transiently present increasing trends.

11.2.2 Detection of Daughter Products

The major mass reduction processes for the natural attenuation of chlorinated ethenes are biological degradation through reductive dechlorination under anaerobic conditions with the production of less chlorinated daughter products.

11.2.2.1 Production of Daughter Products from Reductive Dechlorination

Reductive dechlorination is carried out by a number of naturally occurring anaerobic bacteria including Dehalococcoides (EPA, 2006). The process involves the sequential removal of chlorine atoms and produces lesser chlorinated daughter products and ultimately innocuous non-chlorinated end products and inorganic chloride. For PCE and TCE, the sequence of this process is as follows:

$$PCE \rightarrow TCE \rightarrow cDCE \rightarrow VC \rightarrow \text{ethene, ethane, chloride}$$

1,1-DCE, which is a daughter product of the abiotic dehydrohalogenation of 1,1,1-TCA, also naturally attenuates through reductive dechlorination:

$$\text{1,1-DCE} \rightarrow VC \rightarrow \text{ethene, ethane, chloride}$$

The presence of cDCE, VC and ethene in groundwater is a direct indication that PCE and TCE are being dechlorinated reductively.

11.2.2.2 Evaluation of Daughter Product Production

CVOC daughter product production will be evaluated by comparing the mole fractions of parent and daughter products over time at each well and spatially across the Site.

The portions of parent and daughter products will be calculated using molar concentrations. According to stoichiometry, one mole of PCE will be converted to one mole of ethene through reductive dechlorination. Concentration units of mass will be converted to molar units using the molecular weight of each compound. To facilitate evaluation, this information will be displayed graphically.

11.2.3 Hydrologic Data and Geochemical Parameters

The fate and transport of contaminants in groundwater during natural attenuation is controlled by both groundwater flow characteristics and geochemical conditions within the aquifer.

11.2.3.1 Hydrologic Data

Groundwater gradients and flow direction are subject to variations over time due to changes in groundwater pumping, recharge and elevation of the Cedar River relative to groundwater elevation (e.g. flood events). These variations are not expected to change exposure pathways or the effectiveness of the remedy, but will be monitored and evaluated on an annual basis.

Groundwater elevation data will be collected from the on and off-Site monitoring network of wells as described in **Section 6.1**. The groundwater elevation data will be reported in table format and on a groundwater potentiometric surface map (e.g. **Figures 3-15** and **3-16**) to verify the interpreted direction of groundwater flow and gradient.

11.2.3.2 *Geochemical Parameters*

Geochemical parameter data provides evidence that conditions within the aquifer are conducive to natural attenuation processes. Select parameters will be qualitatively evaluated to confirm that conditions exist to support natural attenuation.

Redox Parameters - DO concentrations and ORP (or redox potential) measurements provide information regarding the potential of the groundwater environment to support biological and chemical oxidation and reduction reactions. DO acts as an electron acceptor for aerobic microbial processes and is depleted in the presence of aerobically degradable carbon compounds or reduced minerals. When DO concentrations are low, the redox potential favors reducing reactions and other terminal electron acceptors such as nitrate, sulfate and ferric iron are utilized by anaerobic bacteria. Under reducing conditions, many chlorinated VOCs are also used as electron acceptors by dehalogenating microorganisms.

pH - The pH within an aquifer can influence both biological and abiotic attenuation processes.

Anaerobic Electron Acceptors and Products – Nitrate, nitrite and sulfate can be used by microorganisms as electron acceptors under anaerobic conditions. At elevated concentrations, these constituents can have negative impacts on the natural attenuation of chlorinated VOCs through reductive dechlorination, but can also support the biodegradation of ethylbenzene and the lesser chlorinated ethenes. Similarly, the metals iron and manganese can serve as electron acceptors for these compounds and are reduced to their more soluble species ferrous iron and reduced manganese, which can be detected in groundwater.

Methane - Methane is the product of anaerobic methanogenesis and occurs only under strong reducing conditions. It is produced from the anaerobic degradation of organics including ethylbenzene and natural occurring organics. Its presence confirms that conditions conducive to reductive dechlorination are present within the aquifer. Methane is also the primary substrate for methanotrophic bacteria and can support aerobic cometabolic degradation of chlorinated VOCs.

Total Organic Carbon (TOC) - TOC includes naturally occurring organic matter and provides carbon substrates that can support reductive dechlorination.

These geochemical data will be presented in tabular form and evaluated qualitatively as indicators of conditions with the aquifer.

11.3 REPORTING

As described in **Section 5.4** of this RIP groundwater sampling and monitoring will be performed on a semi-annual basis (calendar quarters Q2 (April) and Q4 (October) proposed), with reporting on a quarterly basis for the first year of DPVE system operation, then annual there after unless otherwise directed by EPA. The quarterly and annual reports will describe in detail the data collected, findings based on the analytical data, data trends, changes in conditions if applicable, and recommendations (if needed) based on the data collected.

In addition to the groundwater monitoring, the DPVE system progress will be tracked through progress reports on a quarterly throughout the first complete year of system operation, then annually thereafter to correspond with the groundwater monitoring. Progress reports will summarize the results of DPVE system monitoring and operation and will include the analytical results collected during effluent air sampling events. Each progress report will include at a minimum the following:

- DPVE effluent monitoring data;
- Evaluation of the carbon treatment system performance;
- DPVE system operational data (airflow, total fluid inflow, system uptime, etc.);
- DPVE mass-removal calculations;
- Time-series concentration graphs;
- Evaluation of system efficiency; and
- Recommendations for system modifications to improve system efficiency (if applicable).

Similar to the DPVE system, the sub-slab depressurization system progress will be tracked throughout the first complete year of system operation. Following the first year of system operation, the frequency of progress reporting may be revised. Progress will be documented in the corresponding DPVE progress reports, submitted quarterly. Progress reports will summarize the results of the SSDS O&M and will include, at a minimum, the following:

- SSDS system operational data (airflow, vacuum, system uptime, etc.);
- A discussion of observed system influence based on differential pressure readings; and
- Recommendations for system modifications to improve system efficiency (if applicable).

The quarterly or annual report (containing groundwater analytical data collected in Q2 and Q4) will be submitted to EPA within 30 days of receipt of the final quality assured laboratory report for groundwater sampling conducted in calendar quarter Q2 or Q4. For annual reporting, the report will be submitted following the Q4 data receipt. In addition, FBHS will submit to EPA a copy of the quality assured laboratory report (data only) for groundwater sampling conducted in calendar quarter Q2 within 30 days of receipt of final reports meeting QA/QC requirements.

12.0 FINANCIAL ASSURANCE

12.1 COST ESTIMATE

A detailed estimate of the cost to complete all activities identified in this RIP, including costs associated with the future decommissioning of the groundwater monitoring well network used to perform the RIP Work in accordance with State of Iowa requirements (the "Cost Estimate) is provided in **Appendix F**. FBHS will adjust the Cost Estimate on an annual basis to account for completion of activities within that year of operation as well as inflation until the RIP work is complete. For the Financial Assurances Instrument, FBHS will use a surety bond guaranteeing payment at the direction of EPA into a standby Trust Fund. The surety company issuing the bond shall, at minimum, be among those listed as acceptable sureties on Federal Bonds as set forth in Circular 570 of U.S. Department of Treasury. The Trust Fund will be administered by a trustee who has the authority to act as a trustee under Federal or State law and whose trust operations are regulated and examined by a Federal or State agency, and that is acceptable in all respects to EPA. Within thirty (30) days after EPA's approval of both the initial Cost Estimate and the draft Financial Assurances Instrument, whichever is later, FBHS shall execute or otherwise finalize all instruments or other documents required to make the Financial Assurances Instrument legally binding. The Financial Assurance Instrument shall be automatically renewed at the time of its expiration and such renewals shall continue until the RIP work is complete.

13.0 PLAN FOR VERIFYING ATTAINMENT OF RAOS

The groundwater monitoring outlined in this RIP will be used as the basis for attainment of the RAO for groundwater. As presented in **Section 11.3** of this RIP, annual reports will be provided to EPA to present data trends and sampling summaries. Continued system operation or shut down recommendation will be provided to EPA using the logic presented as a decision tree diagram provided as **Figure 8-1**.

At the completion of the remedial activities on site (once groundwater RAOs are achieved) soil sampling will be performed within AOC 5 to confirm On-Site Soil RAOs have been achieved. Based on review of the existing soil sampling data (**Table 3-1**) with comparison to site specific soil RAOs, proposed soil sample locations are indicated on **Figure 6-1** and summarized in **Tables 5-2** and **5-3**. Confirmation sampling will be performed using direct-push drilling methods as described in **Section 6.2** of this plan.

Once FBHS believes the RAOs have been achieved, they will prepare a letter report to EPA presenting the supporting data and lines of evidence (final summary report) to EPA for either confirmation of attainment of the RAOs or request for additional remedial actions.

13.1 REGULATORY CLOSURE

Upon approval by EPA of the final summary report, FBHS may release, cancel or discontinue any financial assurance provided under this RIP.

13.2 NOTICES

All notices regarding the RIP shall be in writing and directed to the persons and addresses set forth in this Section and shall be deemed duly given: (a) when personally delivered to other party; (b) one (1) day after delivery by email transmission to the other party; or (c) two (2) days after being mailed to the other party by regular and certified main, return receipt requested:

For EPA: Mr. Daniel Gravatt, P.G.
EPA Region 7
11201 Renner Boulevard
Lenexa, KS 66219

(913) 551-7324
Gravatt.dan@epa.gov

For Waterloo: Mr. Dennis McKinney
Fortune Brands Home & Security
520 Lake Cook Road
Deerfield, Illinois 60015
(847) 484-4589
Dennis.McKinney@fbhs.com

Tables

TABLE 3-1
SUMMARY OF SOIL ANALYTICAL RESULTS - VOLATILE ORGANIC COMPOUNDS
RCRA FACILITY INVESTIGATION
FORMER WATERLOO INDUSTRIES FACILITY, WATERLOO, IOWA

Investigation Target							AOC 5	AOC 5	AOC 5	AOC 5	AOC 5	AOC 5	AOC 5	AOC 5	AOC 5	AOC 5	AOC 5	Former WWT Area	Former WWT Area	Former WWT Area	Former WWT Area	Former WWT Area	Former WWT Area	Former WWT Area
Sample ID							SB-1 (0.5-2)	SB-1 (2-4)	SB-2 (2-4)	SB-2 (4-6)	SB-3 (3-5)	SB-3 (17.5-19.5)	SB-3 (22-24)	SB-4 (2-4)	SB-4 (5-7)	SB-4 (18-20)	SB-4 Dup (18-20)	SB-5 (4-6)	SB-5 (7-9)	SB-6 (0.5-2)	SB-6 Dup (0.5-2)	SB-6 (5-7)	SB-7 (0.5-2)	SB-7 (6-8)
Sample Location							SB-1	SB-1	SB-2	SB-2	SB-3	SB-3	SB-3	SB-4	SB-4	SB-4	SB-4	SB-5	SB-5	SB-6	SB-6	SB-6	SB-7	SB-7
Sample Depth (feet BGS)							0.5-2	2-4	2-4	4-6	3-5	17.5-19.5	22-24	2-4	5-7	18-20	18-20	4-6	7-9	0.5-2	0.5-2	5-7	0.5-2	6-8
Date Collected							7/28/2011	7/28/2011	7/27/2011	7/27/2011	7/26/2011	7/26/2011	7/26/2011	7/28/2011	7/28/2011	7/28/2011	7/28/2011	7/26/2011	7/26/2011	7/27/2011	7/27/2011	7/27/2011	7/27/2011	7/27/2011
Parameter	**Units**	**CAS #**	**Regional Screening Level [1,2]**																					
Volatile Organic Compounds			**Industrial Soil**	**Industrial Soil**	**Groundwater Protection**	**Groundwater Protection**																		
1,1-Dichloropropene	mg/kg	563-58-6	NE	NE	NE	NE	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
1,2,3-Trichlorobenzene	mg/kg	87-61-6	490	660	0.3	0.42	<0.0654	<0.075	<0.0684	<0.0726	<0.0563	<0.0557	<0.0581	<0.0551	<0.0593	<0.0534	<0.0644	<0.0604	<0.0528	<0.0585	<0.0718	<0.0396	<0.0596	<0.0542
2,2-Dichloropropane	mg/kg	594-20-7	NE	NE	NE	NE	<0.0523	<0.06	<0.0547	<0.0581	<0.045	<0.0446	<0.0465	<0.044	<0.0475	<0.0427	<0.0515	<0.0483	<0.0423	<0.0468	<0.0575	<0.0317	<0.0477	<0.0434
Acetone	mg/kg	67-64-1	630,000	670,000	48	58	<0.131	<0.15	<0.137	<0.145	<0.113	<0.111	<0.116	<0.11	<0.119	<0.107	<0.129	<0.121	<0.106	<0.117	<0.144	<0.0792	<0.119	<0.108
Acrylonitrile	mg/kg	107-13-1	1.2	1.1	0.000196	0.00022	<0.131	<0.15	<0.137	<0.145	<0.113	<0.111	<0.116	<0.11	<0.119	<0.107	<0.129	<0.121	<0.106	<0.117	<0.144	<0.0792	<0.119	<0.108
Benzene	mg/kg	71-43-2	5.4	5.1	0.052	0.052	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Bromobenzene	mg/kg	108-86-1	1,800	1,800	0.72	0.84	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Bromochloromethane	mg/kg	74-97-5	680	630	0.42	0.42	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Bromodichloromethane	mg/kg	75-27-4	1.4	1.3	0.44	0.44	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Bromoform	mg/kg	75-25-2	220	290	0.42	0.42	<0.0262	<0.03	<0.0274	<0.029	<0.0225	<0.0223	<0.0233	<0.022	<0.0237	<0.0213	<0.0258	<0.0242	<0.0211	<0.0234	<0.0287	<0.0158	<0.0239	<0.0217
Bromomethane	mg/kg	74-83-9	32	30	0.036	0.038	<0.0523	<0.06	<0.0547	<0.0581	<0.045	<0.0446	<0.0465	<0.044	<0.0475	<0.0427	<0.0515	<0.0483	<0.0423	<0.0468	<0.0575	<0.0317	<0.0477	<0.0434
Butylbenzene, n-	mg/kg	104-51-8	51,000	58,000	50	64	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Carbon disulfide	mg/kg	75-15-0	3,700	3,500	4.2	4.8	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Carbon Tetrachloride	mg/kg	56-23-5	3	2.9	0.038	0.038	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Chlorobenzene	mg/kg	108-90-7	1,400	1,300	1.36	1.36	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Chloroethane	mg/kg	75-00-3	61,000	57,000	118	118	<0.0523	<0.06	<0.0547	<0.0581	<0.045	<0.0446	<0.0465	<0.044	<0.0475	<0.0427	<0.0515	<0.0483	<0.0423	<0.0468	<0.0575	<0.0317	<0.0477	<0.0434
Chloroform	mg/kg	67-66-3	1.5	1.4	0.44	0.44	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Chloromethane	mg/kg	74-87-3	500	460	0.98	0.98	<0.0523	<0.06	<0.0547	<0.0581	<0.045	<0.0446	<0.0465	<0.044	<0.0475	<0.0427	<0.0515	<0.0483	<0.0423	<0.0468	<0.0575	<0.0317	<0.0477	<0.0434
Chlorotoluene, o-	mg/kg	95-49-8	20,000	23,000	3.4	4.6	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Chlorotoluene, p-	mg/kg	106-43-4	20,000	23,000	3.6	4.8	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Cumene (Isopropylbenzene)	mg/kg	98-82-8	11,000	9,900	12.8	14.8	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Dibromo-3-chloropropane, 1,2- (DBCP)	mg/kg	96-12-8	0.069	0.064	0.00172	0.00172	<0.131	<0.15	<0.137	<0.145	<0.113	<0.111	<0.116	<0.11	<0.119	<0.107	<0.129	<0.121	<0.106	<0.117	<0.144	<0.0792	<0.119	<0.108
Dibromochloromethane	mg/kg	124-48-1	3.3	3.2	0.42	0.42	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Dibromoethane, 1,2-	mg/kg	106-93-4	0.17	0.16	0.00028	0.00028	<0.131	<0.15	<0.137	<0.145	<0.113	<0.111	<0.116	<0.11	<0.119	<0.107	<0.129	<0.121	<0.106	<0.117	<0.144	<0.0792	<0.119	<0.108
Dibromomethane (Methylene Bromide)	mg/kg	74-95-3	110	98	0.038	0.04	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Dichlorobenzene, 1,2-	mg/kg	95-50-1	9,800	9,300	11.6	11.6	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Dichlorobenzene, 1,3-	mg/kg	541-73-1	NE	NE	NE	NE	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Dichlorobenzene, 1,4-	mg/kg	106-46-7	12	11	1.44	1.44	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Dichlorodifluoromethane	mg/kg	75-71-8	400	370	6.0	6.0	<0.0392	<0.045	<0.041	<0.0436	<0.0338	<0.0334	<0.0349	<0.033	<0.0356	<0.032	<0.0386	<0.0363	<0.0317	<0.0351	<0.0431	<0.0238	<0.0358	<0.0325
Dichloroethane, 1,1-	mg/kg	75-34-3	17	16	0.0136	0.0156	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Dichloroethane, 1,2-	mg/kg	107-06-2	2.2	2	0.028	0.028	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Dichloroethylene, 1,1-	mg/kg	75-35-4	1,100	1,000	0.05	0.05	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Dichloroethylene, 1,2-cis-	mg/kg	156-59-2	2,000	2,300	0.42	0.42	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Dichloroethylene, 1,2-trans-	mg/kg	156-60-5	690	23,000	0.58	0.58	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Dichloropropane, 1,2-	mg/kg	78-87-5	4.7	4.4	0.034	0.034	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Dichloropropane, 1,3-	mg/kg	142-28-9	20000	23000	1.98	26	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dichloropropene, 1,3-	mg/kg	542-75-6	8.3	8.2	0.003	0.0034	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Ethylbenzene	mg/kg	100-41-4	27	25	15.6	15.6	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Hexachlorobutadiene	mg/kg	87-68-3	22	30	0.01	0.0114	<0.0654	<0.075	<0.0684	<0.0726	<0.0563	<0.0557	<0.0581	<0.0551	<0.0593	<0.0534	<0.0644	<0.0604	<0.0528	<0.0585	<0.0718	<0.0396	<0.0596	<0.0542
Hexane, N-	mg/kg	110-54-3	2,600	2,500	36	46	<0.0654	<0.075	<0.0684	<0.0726	<0.0563	<0.0557	<0.0581	<0.0551	<0.0593	<0.0534	<0.0644	<0.0604	<0.0528	<0.0585	<0.0718	<0.0396	<0.0596	<0.0542
Methyl Ethyl Ketone	mg/kg	78-93-3	200,000	190,000	20	24	<0.131	<0.15	<0.137	<0.145	<0.113	<0.111	<0.116	<0.11	<0.119	<0.107	<0.129	<0.121	<0.106	<0.117	<0.144	<0.0792	<0.119	<0.108
Methyl tert-Butyl Ether (MTBE)	mg/kg	1634-04-4	220	210	0.056	0.064	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Methylene Chloride (Dichloromethane)	mg/kg	75-09-2	960 [4]	1000	0.026	0.026	<0.131	<0.15	<0.137	<0.145	<0.113	<0.111	<0.116	<0.11	<0.119	<0.107	<0.129	<0.121	<0.106	<0.117	<0.144	<0.0792	<0.119	<0.108
Naphthalene	mg/kg	91-20-3	18	17	0.0094	0.0108	<0.0654	<0.075	<0.0684	<0.0726	<0.0563	<0.0557	<0.0581	<0.0551	<0.0593	<0.0534	<0.0644	<0.0604	<0.0528	<0.0585	<0.0718	<0.0396	<0.0596	<0.0542
n-Propylbenzene	mg/kg	103-65-1	21,000	22,000	19.8	24	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
p-Isopropyltoluene	mg/kg	99-87-6	NE	NE	NE	NE	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
sec-Butylbenzene	mg/kg	135-98-8	100,000 [4]	120,000	92 [4]	118	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Styrene	mg/kg	100-42-5	36,000	35,000	2.2	2.2	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
tert-Butylbenzene	mg/kg	98-06-6	100000 [4]	120,000	22 [4]	32	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Tetrachloroethane, 1,1,1,2-	mg/kg	630-20-6	9.3	8.8	0.0038	0.0044	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Tetrachloroethane, 1,1,2,2-	mg/kg	79-34-5	2.8	2.7	0.00052	0.0006	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Tetrachloroethylene	mg/kg	127-18-4	96.3[3]	100	0.046	0.046	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Toluene	mg/kg	108-88-3	45,000	47,000	13.8	13.8	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Trichlorobenzene, 1,2,4-	mg/kg	120-82-1	99	110	4	4	<0.0654	<0.075	<0.0684	<0.0726	<0.0563	<0.0557	<0.0581	<0.0551	<0.0593	<0.0534	<0.0644	<0.0604	<0.0528	<0.0585	<0.0718	<0.0396	<0.0596	<0.0542
Trichloroethane, 1,1,1-	mg/kg	71-55-6	38,000	36,000	1.4	1.4	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Trichloroethane, 1,1,2-	mg/kg	79-00-5	5.3	5	0.032	0.032	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Trichloroethylene	mg/kg	79-01-6	6.4	6	0.036	0.036	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Trichlorofluoromethane	mg/kg	75-69-4	3,400	3,100	13.8	14.6	<0.0523	<0.06	<0.0547	<0.0581	<0.045	<0.0446	<0.0465	<0.044	<0.0475	<0.0427	<0.0515	<0.0483	<0.0423	<0.0468	<0.0575	<0.0317	<0.0477	<0.0434
Trichloropropane, 1,2,3-	mg/kg	96-18-4	0.095	0.11	0.0000056	0.0000064	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Trimethylbenzene, 1,2,4-	mg/kg	95-63-6	260	240	0.42	0.42	<0.0523	<0.06	<0.0547	<0.0581	<0.045	<0.0446	<0.0465	<0.044	<0.0475	<0.0427	<0.0515	<0.0483	<0.0423	<0.0468	<0.0575	<0.0317	<0.0477	<0.0434
Trimethylbenzene, 1,3,5-	mg/kg	108-67-8	10,000	12,000	2.4	3.4	<0.0131	<0.015	<0.0137	<0.0145	<0.0113	<0.0111	<0.0116	<0.011	<0.0119	<0.0107	<0.0129	<0.0121	<0.0106	<0.0117	<0.0144	<0.00792	<0.0119	<0.0108
Vinyl chloride	mg/kg	75-01-4	1.7	1.7	0.0138	0.0138	<0.0392	<0.045	<0.041	<0.0436	<0.0338	<0.0334	<0.0349	<0.033	<0.0356	<0.032	<0.0386	<0.0363	<0.0317	<0.0351	<0.0431	<0.0238	<0.0358	<0.0325
Xylene, Mixture	mg/kg	1330-20-7	2,700	2,500	196	196	<0.0392	<0.045	<0.041	<0.0436	<0.0338	<0.0334	<0.0349	<0.033	<0.0356	<0.032	<0.0386	<0.0363	<0.0317	<0.0351	<0.0431	<0.0238	<0.0358	<0.0325

Notes:
Bold values were detected above laboratory detection limits
Highlighted (gray) values exceed the Groundwater Protection RSL
DAF = Dilution attenuation factor
NE = Not Established
WWT = Wastewater Treatment
[1] EPA Regional Screening Levels (RSLs) for Industrial Soil (January 2015).
[2] EPA RSLs for Protection of Groundwater (January 2015), times a DAF of 20.

TABLE 3-1
SUMMARY OF SOIL ANALYTICAL RESULTS - VOLATILE ORGANIC COMPOUNDS
RCRA FACILITY INVESTIGATION
FORMER WATERLOO INDUSTRIES FACILITY, WATERLOO, IOWA

Investigation Target						AOC 5	AOC 5	AOC 5	AOC 5	AOC 5	AOC 5	AOC 5	AOC 5	Former WWT Area	Former WWT Area	Former WWT Area	Former WWT Area	AOC 5	AOC 5	AOC 5	AOC 5	AOC 5	AOC 5
Sample ID						SB-8 (3-5)	WSB9 (3-5)	SB Dup 2	WSB9 (5-7)	WSB10 (3-5)	WSB10 (10-12)	WSB11 (8-10)	WSB11 (24-25)	WSB12 (0.5-2)	WSB12 (5-7)	WSB13 (0.5-2)	WSB13 (5-7)	WSB14A (1-3)	WSB15A (0.5-2)	WSB15A (3-5)	WSB16A (1-3)	WSB16A (7-9)	WSB17A (0.5-2)
Sample Location						SB-8	SB-9	SB-9	SB-9	SB-10	SB-10	SB-11	SB-11	SB-12	SB-12	SB-13	SB-13	SB-14	SB-15	SB-15	SB-16	SB-16	SB-17
Sample Depth (feet BGS)						3-5	3-5	3-5	5-7	3-5	10-12	8-10	24-25	0.5-2	5-7	0.5-2	5-7	(1-3)	(0.5-2)	(3-5)	(1-3)	(7-9)	(0.5-2)
Date Collected						7/28/2011	10/19/2011	10/19/2011	10/19/2011	10/19/2011	10/19/2011	10/19/2011	10/19/2011	10/18/2011	10/18/2011	10/18/2011	10/18/2011	1/11/2012	1/11/2012	1/11/2012	1/11/2012	1/11/2012	1/10/2012
Parameter	**Units**	**CAS #**	**Regional Screening Level [1,2]**																				
Volatile Organic Compounds			**Industrial Soil**	**Industrial Soil**	**Groundwater Protection**																		
1,1-Dichloropropene	mg/kg	563-58-6	NE	NE	NE	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
1,2,3-Trichlorobenzene	mg/kg	87-61-6	490	660	0.3	<0.0687	<0.0397	<0.0534	<0.0572	<0.0482	<0.042	<0.0558	<0.0537	<0.0863	<0.0456	<0.0396	<0.0348	<0.0464	<0.0405	<0.0523	<0.0495	<0.0315	<0.0625
2,2-Dichloropropane	mg/kg	594-20-7	NE	NE	NE	<0.055	<0.0318	<0.0427	<0.0457	<0.0385	<0.0336	<0.0446	<0.043	<0.069	<0.0365	<0.0317	<0.0278	<0.0371	<0.0324	<0.0418	<0.0396	<0.0252	<0.05
Acetone	mg/kg	67-64-1	630,000	670,000	48	<0.137	<0.0794	<0.107	<0.114	<0.0964	<0.084	<0.112	<0.107	<0.173	<0.0912	<0.0793	<0.0696	<0.0927	<0.0811	<0.105	**0.112**	<0.063	<0.125
Acrylonitrile	mg/kg	107-13-1	1.2	1.1	0.000196	<0.137	<0.0794	<0.107	<0.114	<0.0964	<0.084	<0.112	<0.107	<0.173	<0.0912	<0.0793	<0.0696	<0.0927	<0.0811	<0.105	<0.0991	<0.063	<0.125
Benzene	mg/kg	71-43-2	5.4	5.1	0.052	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Bromobenzene	mg/kg	108-86-1	1,800	1,800	0.72	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Bromochloromethane	mg/kg	74-97-5	680	630	0.42	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Bromodichloromethane	mg/kg	75-27-4	1.4	1.3	0.44	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Bromoform	mg/kg	75-25-2	220	290	0.42	<0.0275	<0.0159	<0.0214	<0.0229	<0.0193	<0.0168	<0.0223	<0.0215	<0.0345	<0.0182	<0.0159	<0.0139	<0.017	<0.0218	<0.0167	<0.0173	<0.0206	<0.0255
Bromomethane	mg/kg	74-83-9	32	30	0.036	<0.055	<0.0318	<0.0427	<0.0457	<0.0385	<0.0336	<0.0446	<0.043	<0.069	<0.0365	<0.0317	<0.0278	<0.0371	<0.0324	<0.0418	<0.0396	<0.0252	<0.05
Butylbenzene, n-	mg/kg	104-51-8	51,000	58,000	50	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Carbon disulfide	mg/kg	75-15-0	3,700	3,500	4.2	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Carbon Tetrachloride	mg/kg	56-23-5	3	2.9	0.038	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Chlorobenzene	mg/kg	108-90-7	1,400	1,300	1.36	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Chloroethane	mg/kg	75-00-3	61,000	57,000	118	<0.055	<0.0318	<0.0427	<0.0457	<0.0385	<0.0336	<0.0446	<0.043	<0.069	<0.0365	<0.0317	<0.0278	<0.0371	<0.0324	<0.0418	<0.0396	<0.0252	<0.05
Chloroform	mg/kg	67-66-3	1.5	1.4	0.44	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Chloromethane	mg/kg	74-87-3	500	460	0.98	<0.055	<0.0318	<0.0427	<0.0457	<0.0385	<0.0336	<0.0446	<0.043	<0.069	<0.0365	<0.0317	<0.0278	<0.0371	<0.0324	<0.0418	<0.0396	<0.0252	<0.05
Chlorotoluene, o-	mg/kg	95-49-8	20,000	23,000	3.4	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Chlorotoluene, p-	mg/kg	106-43-4	20,000	23,000	3.6	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Cumene (Isopropylbenzene)	mg/kg	98-82-8	11,000	9,900	12.8	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Dibromo-3-chloropropane, 1,2- (DBCP)	mg/kg	96-12-8	0.069	0.064	0.00172	<0.137	<0.0794	<0.107	<0.114	<0.0964	<0.084	<0.112	<0.107	<0.173	<0.0912	<0.0793	<0.0696	<0.0927	<0.0811	<0.105	<0.0991	<0.063	<0.125
Dibromochloromethane	mg/kg	124-48-1	3.3	3.2	0.42	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Dibromoethane, 1,2-	mg/kg	106-93-4	0.17	0.16	0.00028	<0.137	<0.0794	<0.107	<0.114	<0.0964	<0.084	<0.112	<0.107	<0.173	<0.0912	<0.0793	<0.0696	<0.0927	<0.0811	<0.105	<0.0991	<0.063	<0.125
Dibromomethane (Methylene Bromide)	mg/kg	74-95-3	110	98	0.038	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Dichlorobenzene, 1,2-	mg/kg	95-50-1	9,800	9,300	11.6	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Dichlorobenzene, 1,3-	mg/kg	541-73-1	NE	NE	NE	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Dichlorobenzene, 1,4-	mg/kg	106-46-7	12	11	1.44	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Dichlorodifluoromethane	mg/kg	75-71-8	400	370	6.0	<0.0412	<0.0238	<0.0321	<0.0343	<0.0289	<0.0252	<0.0335	<0.0322	<0.0518	<0.0274	<0.0238	<0.0209	<0.0278	<0.0243	<0.0314	<0.0297	<0.0189	<0.0375
Dichloroethane, 1,1-	mg/kg	75-34-3	17	16	0.0136	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Dichloroethane, 1,2-	mg/kg	107-06-2	2.2	2	0.028	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Dichloroethylene, 1,1-	mg/kg	75-35-4	1,100	1,000	0.05	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Dichloroethylene, 1,2-cis-	mg/kg	156-59-2	2,000	2,300	0.42	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Dichloroethylene, 1,2-trans-	mg/kg	156-60-5	690	23,000	0.58	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Dichloropropane, 1,2-	mg/kg	78-87-5	4.7	4.4	0.034	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Dichloropropane, 1,3-	mg/kg	142-28-9	20000	23000	1.98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dichloropropene, 1,3-	mg/kg	542-75-6	8.3	8.2	0.003	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Ethylbenzene	mg/kg	100-41-4	27	25	15.6	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Hexachlorobutadiene	mg/kg	87-68-3	22	30	0.01	<0.0687	<0.0397	<0.0534	<0.0572	<0.0482	<0.042	<0.0558	<0.0537	<0.0863	<0.0456	<0.0396	<0.0348	<0.0464	<0.0405	<0.0523	<0.0495	<0.0315	<0.0625
Hexane, N-	mg/kg	110-54-3	2,600	2,500	36	<0.0687	<0.0397	<0.0534	<0.0572	<0.0482	<0.042	<0.0558	<0.0537	<0.0863	<0.0456	<0.0396	<0.0348	<0.0464	<0.0405	<0.0523	<0.0495	<0.0315	<0.0625
Methyl Ethyl Ketone	mg/kg	78-93-3	200,000	190,000	20	<0.137	<0.0794	<0.107	<0.114	<0.0964	<0.084	<0.112	<0.107	<0.173	<0.0912	<0.0793	<0.0696	<0.0927	<0.0811	<0.105	<0.0991	<0.063	<0.125
Methyl tert-Butyl Ether (MTBE)	mg/kg	1634-04-4	220	210	0.056	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Methylene Chloride (Dichloromethane)	mg/kg	75-09-2	960 [4]	1000	0.026	<0.137	<0.0794	<0.107	<0.114	<0.0964	<0.084	<0.112	<0.107	<0.173	<0.0912	<0.0793	<0.0696	<0.0927	<0.0811	<0.105	<0.0991	<0.063	<0.125
Naphthalene	mg/kg	91-20-3	18	17	0.0094	<0.0687	<0.0397	<0.0534	<0.0572	<0.0482	<0.042	<0.0558	<0.0537	<0.0863	<0.0456	<0.0396	<0.0348	<0.0464	**0.0606**	<0.0523	<0.0495	<0.0315	<0.0625
n-Propylbenzene	mg/kg	103-65-1	21,000	22,000	19.8	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
p-Isopropyltoluene	mg/kg	99-87-6	NE	NE	NE	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
sec-Butylbenzene	mg/kg	135-98-8	100,000 [4]	120,000	92 [4]	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Styrene	mg/kg	100-42-5	36,000	35,000	2.2	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
tert-Butylbenzene	mg/kg	98-06-6	100000 [4]	120,000	22 [4]	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Tetrachloroethane, 1,1,1,2-	mg/kg	630-20-6	9.3	8.8	0.0038	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Tetrachloroethane, 1,1,2,2-	mg/kg	79-34-5	2.8	2.7	0.00052	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Tetrachloroethylene	mg/kg	127-18-4	96.3[3]	100	0.046	<0.0137	**0.179**	**1.51**	**0.118**	<0.00964	<0.0084	<0.0112	<0.0107	**0.0543**	<0.00912	**0.0102**	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Toluene	mg/kg	108-88-3	45,000	47,000	13.8	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Trichlorobenzene, 1,2,4-	mg/kg	120-82-1	99	110	4	<0.0687	<0.0397	<0.0534	<0.0572	<0.0482	<0.042	<0.0558	<0.0537	<0.0863	<0.0456	<0.0396	<0.0348	<0.0464	<0.0405	<0.0523	<0.0495	<0.0315	<0.0625
Trichloroethane, 1,1,1-	mg/kg	71-55-6	38,000	36,000	1.4	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Trichloroethane, 1,1,2-	mg/kg	79-00-5	5.3	5	0.032	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Trichloroethylene	mg/kg	79-01-6	6.4	6	0.036	<0.0137	<0.00794	**0.0194**	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Trichlorofluoromethane	mg/kg	75-69-4	3,400	3,100	13.8	<0.055	<0.0318	<0.0427	<0.0457	<0.0385	<0.0336	<0.0446	<0.043	<0.069	<0.0365	<0.0317	<0.0278	<0.0371	<0.0324	<0.0418	<0.0396	<0.0252	<0.05
Trichloropropane, 1,2,3-	mg/kg	96-18-4	0.095	0.11	0.0000056	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Trimethylbenzene, 1,2,4-	mg/kg	95-63-6	260	240	0.42	<0.055	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Trimethylbenzene, 1,3,5-	mg/kg	108-67-8	10,000	12,000	2.4	<0.0137	<0.00794	<0.0107	<0.0114	<0.00964	<0.0084	<0.0112	<0.0107	<0.0173	<0.00912	<0.00793	<0.00696	<0.00927	<0.00811	<0.0105	<0.00991	<0.0063	<0.0125
Vinyl chloride	mg/kg	75-01-4	1.7	1.7	0.0138	<0.0412	<0.0238	<0.0321	<0.0343	<0.0289	<0.0252	<0.0335	<0.0322	<0.0518	<0.0274	<0.0238	<0.0209	<0.0278	<0.0243	<0.0314	<0.0297	<0.0189	<0.0375
Xylene, Mixture	mg/kg	1330-20-7	2,700	2,500	196	<0.0412	<0.0238	<0.0321	<0.0343	<0.0289	<0.0252	<0.0335	<0.0322	<0.0518	<0.0274	<0.0238	<0.0209	<0.0278	<0.0243	<0.0314	<0.0297	<0.0189	<0.0375

Notes:
Bold values were detected above laboratory detection limits
Highlighted (gray) values exceed the Groundwater Protection RSL
DAF = Dilution attenuation factor
NE = Not Established
WWT = Wastewater Treatment
[1] EPA Regional Screening Levels (RSLs) for Industrial Soil (January 2015).
[2] EPA RSLs for Protection of Groundwater (January 2015), times a DAF of 20.

TABLE 3-1
SUMMARY OF SOIL ANALYTICAL RESULTS - VOLATILE ORGANIC COMPOUNDS
RCRA FACILITY INVESTIGATION
FORMER WATERLOO INDUSTRIES FACILITY, WATERLOO, IOWA

Investigation Target						AOC 5	AOC 5	AOC 5	AOC 5	Former WWT Area	Former WWT Area	AOC 5	AOC 5	AOC 5	AOC 5	AOC 5	AOC 5	AOC 5	AOC 5	AOC 5	AOC 5	AOC 5	AOC 5	AOC 5
Sample ID						WSB17A (8-10)	WSB23 (30-31)	WSB24 (7-8)	WSB25 (16-17)	WSB26 (12-13)	WSB27 (8-9)	WSB28 (3-5)	WSB29 (3-5)	WSB30 (3-5)	SB-DUP-01	WDP01	WDP02	WDP03	WDP03 DUP	WDP04	WDP05	WDP06	WDP07	WDP08
Sample Location						SB-17	SB-23	SB-24	SB-25	SB-26	SB-27	SB-28	SB-30	SB-30	SB-30	DP-01	DP-02	DP-03	DP-03	DP-04	DP-05	DP-06	DP-07	DP-09
Sample Depth (feet BGS)						(8-10)	(30-31)	(7-8)	(16-17)	(12-13)	(8-9)	(3-5)	(3-5)	(3-5)	(3-5)	(3-5)	(3-5)	(3-5)	(3-5)	(3-5)	(3-5)	(3-5)	(3-5)	(3-5)
Date Collected						1/10/2012	3/25/2014	3/25/2014	3/24/2014	3/27/2014	3/26/2014	3/26/2014	3/26/2014	3/26/2014	3/26/2014	9/24/2013	9/24/2013	9/25/2013	9/25/2013	9/24/2013	9/25/2013	9/24/2013	9/24/2013	9/24/2013
Parameter	**Units**	**CAS #**	**Regional Screening Level [1,2]**																					
Volatile Organic Compounds			**Industrial Soil**	**Industrial Soil**	**Groundwater Protection**																			
1,1-Dichloropropene	mg/kg	563-58-6	NE	NE	NE	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
1,2,3-Trichlorobenzene	mg/kg	87-61-6	490	660	0.3	<0.0361	<0.0684	<0.0749	<0.0760	<0.0621	<0.0614	<0.0620	<0.0642	<0.0657	<0.0613	<0.0725	<0.0664	<0.0605	<0.0614	<0.0598	<0.0589	<0.0615	<0.0648	<0.0629
2,2-Dichloropropane	mg/kg	594-20-7	NE	NE	NE	<0.0289	<0.0547	<0.0599	<0.0608	<0.0497	<0.0491	<0.0496	<0.0513	<0.0526	<0.0491	<0.0580	<0.0531	<0.0484	<0.0491	<0.0478	<0.0471	<0.0492	<0.0519	<0.0503
Acetone	mg/kg	67-64-1	630,000	670,000	48	<0.0723	<0.137	<0.150	<0.152	<0.124	<0.123	<0.124	<0.128	<0.131	<0.123	<0.145	<0.133	<0.121	<0.123	<0.120	<0.118	<0.123	<0.130	<0.126
Acrylonitrile	mg/kg	107-13-1	1.2	1.1	0.000196	<0.0723	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	mg/kg	71-43-2	5.4	5.1	0.052	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Bromobenzene	mg/kg	108-86-1	1,800	1,800	0.72	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Bromochloromethane	mg/kg	74-97-5	680	630	0.42	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Bromodichloromethane	mg/kg	75-27-4	1.4	1.3	0.44	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Bromoform	mg/kg	75-25-2	220	290	0.42	<0.0237	<0.0274	<0.0299	<0.0304	<0.0248	<0.0245	<0.0248	<0.0257	<0.0263	<0.0245	<0.0290	<0.0266	<0.0242	<0.0246	<0.0239	<0.0236	<0.0246	<0.0259	<0.0252
Bromomethane	mg/kg	74-83-9	32	30	0.036	<0.0289	<0.0547	<0.0599	<0.0608	<0.0497	<0.0491	<0.0496	<0.0513	<0.0526	<0.0491	<0.0580	<0.0531	<0.0484	<0.0491	<0.0478	<0.0471	<0.0492	<0.0519	<0.0503
Butylbenzene, n-	mg/kg	104-51-8	51,000	58,000	50	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Carbon disulfide	mg/kg	75-15-0	3,700	3,500	4.2	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Carbon Tetrachloride	mg/kg	56-23-5	3	2.9	0.038	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Chlorobenzene	mg/kg	108-90-7	1,400	1,300	1.36	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Chloroethane	mg/kg	75-00-3	61,000	57,000	118	<0.0289	<0.0547	<0.0599	<0.0608	<0.0497	<0.0491	<0.0496	<0.0513	<0.0526	<0.0491	<0.0580	<0.0531	<0.0484	<0.0491	<0.0478	<0.0471	<0.0492	<0.0519	<0.0503
Chloroform	mg/kg	67-66-3	1.5	1.4	0.44	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Chloromethane	mg/kg	74-87-3	500	460	0.98	<0.0289	<0.0547	<0.0599	<0.0608	<0.0497	<0.0491	<0.0496	<0.0513	<0.0526	<0.0491	<0.0580	<0.0531	<0.0484	<0.0491	<0.0478	<0.0471	<0.0492	<0.0519	<0.0503
Chlorotoluene, o-	mg/kg	95-49-8	20,000	23,000	3.4	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Chlorotoluene, p-	mg/kg	106-43-4	20,000	23,000	3.6	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Cumene (Isopropylbenzene)	mg/kg	98-82-8	11,000	9,900	12.8	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Dibromo-3-chloropropane, 1,2- (DBCP)	mg/kg	96-12-8	0.069	0.064	0.00172	<0.0723	<0.137	<0.150	<0.152	<0.124	<0.123	<0.124	<0.128	<0.131	<0.123	<0.145	<0.133	<0.121	<0.123	<0.120	<0.118	<0.123	<0.130	<0.126
Dibromochloromethane	mg/kg	124-48-1	3.3	3.2	0.42	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Dibromoethane, 1,2-	mg/kg	106-93-4	0.17	0.16	0.00028	<0.0723	<0.137	<0.150	<0.152	<0.124	<0.123	<0.124	<0.128	<0.131	<0.123	<0.145	<0.133	<0.121	<0.123	<0.120	<0.118	<0.123	<0.130	<0.126
Dibromomethane (Methylene Bromide)	mg/kg	74-95-3	110	98	0.038	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Dichlorobenzene, 1,2-	mg/kg	95-50-1	9,800	9,300	11.6	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Dichlorobenzene, 1,3-	mg/kg	541-73-1	NE	NE	NE	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Dichlorobenzene, 1,4-	mg/kg	106-46-7	12	11	1.44	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Dichlorodifluoromethane	mg/kg	75-71-8	400	370	6.0	<0.0217	<0.0410	<0.0449	<0.0456	<0.0372	<0.0368	<0.0372	<0.0385	<0.0394	<0.0368	<0.0435	<0.0398	<0.0363	<0.0368	<0.0359	<0.0353	<0.0369	<0.0389	<0.0377
Dichloroethane, 1,1-	mg/kg	75-34-3	17	16	0.0136	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Dichloroethane, 1,2-	mg/kg	107-06-2	2.2	2	0.028	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Dichloroethylene, 1,1-	mg/kg	75-35-4	1,100	1,000	0.05	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Dichloroethylene, 1,2-cis-	mg/kg	156-59-2	2,000	2,300	0.42	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Dichloroethylene, 1,2-trans-	mg/kg	156-60-5	690	23,000	0.58	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Dichloropropane, 1,2-	mg/kg	78-87-5	4.7	4.4	0.034	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Dichloropropane, 1,3-	mg/kg	142-28-9	20000	23000	1.98	NA	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Dichloropropene, 1,3-	mg/kg	542-75-6	8.3	8.2	0.003	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	mg/kg	100-41-4	27	25	15.6	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Hexachlorobutadiene	mg/kg	87-68-3	22	30	0.01	<0.0361	<0.0684	<0.0749	<0.0760	<0.0621	<0.0614	<0.0620	<0.0642	<0.0657	<0.0613	<0.0725	<0.0664	<0.0605	<0.0614	<0.0598	<0.0589	<0.0615	<0.0648	<0.0629
Hexane, N-	mg/kg	110-54-3	2,600	2,500	36	<0.0361	<0.0684	<0.0749	<0.0760	<0.0621	<0.0614	<0.0620	<0.0642	<0.0657	<0.0613	<0.0725	<0.0664	<0.0605	<0.0614	<0.0598	<0.0589	<0.0615	<0.0648	<0.0629
Methyl Ethyl Ketone	mg/kg	78-93-3	200,000	190,000	20	<0.0723	<0.137	<0.150	<0.152	<0.124	<0.123	<0.124	<0.128	<0.131	<0.123	<0.145	<0.133	<0.121	<0.123	<0.120	<0.118	<0.123	<0.130	<0.126
Methyl tert-Butyl Ether (MTBE)	mg/kg	1634-04-4	220	210	0.056	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Methylene Chloride (Dichloromethane)	mg/kg	75-09-2	960 [4]	1000	0.026	<0.0723	<0.137	<0.150	<0.152	<0.124	<0.123	<0.124	<0.128	<0.131	<0.123	<0.145	<0.133	<0.121	<0.123	<0.120	<0.118	<0.123	<0.130	<0.126
Naphthalene	mg/kg	91-20-3	18	17	0.0094	<0.0361	<0.0684	<0.0749	<0.0760	<0.0621	<0.0614	<0.0620	<0.0642	<0.0657	<0.0613	<0.0725	<0.0643	<0.0605	<0.0614	<0.0598	<0.0589	<0.0615	<0.0648	<0.0629
n-Propylbenzene	mg/kg	103-65-1	21,000	22,000	19.8	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
p-Isopropyltoluene	mg/kg	99-87-6	NE	NE	NE	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
sec-Butylbenzene	mg/kg	135-98-8	100,000 [4]	120,000	92 [4]	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Styrene	mg/kg	100-42-5	36,000	35,000	2.2	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
tert-Butylbenzene	mg/kg	98-06-6	100000 [4]	120,000	22 [4]	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Tetrachloroethane, 1,1,1,2-	mg/kg	630-20-6	9.3	8.8	0.0038	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Tetrachloroethane, 1,1,2,2-	mg/kg	79-34-5	2.8	2.7	0.00052	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Tetrachloroethylene	mg/kg	127-18-4	96.3[3]	100	0.046	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	**0.0305**	<0.0128	<0.0131	<0.0123	**0.0171**	**0.0527**	**0.0794**	**0.0866**	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Toluene	mg/kg	108-88-3	45,000	47,000	13.8	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Trichlorobenzene, 1,2,4-	mg/kg	120-82-1	99	110	4	<0.0361	<0.0684	<0.0749	<0.0760	<0.0621	<0.0614	<0.0620	<0.0642	<0.0657	<0.0613	<0.0725	<0.0664	<0.0605	<0.0614	<0.0598	<0.0589	<0.0615	<0.0648	<0.0629
Trichloroethane, 1,1,1-	mg/kg	71-55-6	38,000	36,000	1.4	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Trichloroethane, 1,1,2-	mg/kg	79-00-5	5.3	5	0.032	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Trichloroethylene	mg/kg	79-01-6	6.4	6	0.036	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Trichlorofluoromethane	mg/kg	75-69-4	3,400	3,100	13.8	<0.0289	<0.0547	<0.0599	<0.0608	<0.0497	<0.0491	<0.0496	<0.0513	<0.0526	<0.0491	<0.0580	<0.0531	<0.0484	<0.0491	<0.0478	<0.0471	<0.0492	<0.0519	<0.0503
Trichloropropane, 1,2,3-	mg/kg	96-18-4	0.095	0.11	0.0000056	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Trimethylbenzene, 1,2,4-	mg/kg	95-63-6	260	240	0.42	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Trimethylbenzene, 1,3,5-	mg/kg	108-67-8	10,000	12,000	2.4	<0.00723	<0.0137	<0.0150	<0.0152	<0.0124	<0.0123	<0.0124	<0.0128	<0.0131	<0.0123	<0.0145	<0.0133	<0.0121	<0.0123	<0.0120	<0.0118	<0.0123	<0.0130	<0.0126
Vinyl chloride	mg/kg	75-01-4	1.7	1.7	0.0138	<0.0217	<0.0410	<0.0449	<0.0456	<0.0372	<0.0368	<0.0372	<0.0385	<0.0394	<0.0368	<0.0435	<0.0398	<0.0363	<0.0368	<0.0359	<0.0353	<0.0369	<0.0389	<0.0377
Xylene, Mixture	mg/kg	1330-20-7	2,700	2,500	196	<0.0217	<0.0410	<0.0449	<0.0456	<0.0372	<0.0368	<0.0372	<0.0385	<0.0394	<0.0368	<0.0435	<0.0398	<0.0363	<0.0368	<0.0359	<0.0353	<0.0369	<0.0389	<0.0377

Notes:
Bold values were detected above laboratory detection limits
Highlighted (gray) values exceed the Groundwater Protection RSL
DAF = Dilution attenuation factor
NE = Not Established
WWT = Wastewater Treatment
[1] EPA Regional Screening Levels (RSLs) for Industrial Soil (January 2015).
[2] EPA RSLs for Protection of Groundwater (January 2015), times a DAF of 20.

TABLE 3-2
SUMMARY OF SOIL ANALYTICAL RESULTS - SEMI-VOLATILE ORGANIC COMPOUNDS
RCRA FACILITY INVESTIGATION
FORMER WATERLOO INDUSTRIES FACILITY, WATERLOO, IOWA

Investigation Target								Former WWT Area	Former WWT Area	Former WWT Area	Former WWT Area	Former WWT Area	Former WWT Area	Former WWT Area	Former WWT Area	Former WWT Area	Former WWT Area	Former WWT Area	Former WWT Area	Former WWT Area	Former WWT Area
Sample ID								**SB-5(4-6)**	**SB-5 (7-9)**	**SB-6 (0.5-2)**	**SB-6 Dup (0.5-2)**	**SB-6 (5-7)**	**SB-7 (0.5-2)**	**SB-7 (6-8)**	**SB-18 (0.5-2)**	**SB-19 (0.5-2)**	**SB-20 (0.5-2)**	**SB-21 (0.5-2)**	**SBDup3**	**SB-22 (0.5-2)**	**SBDup4**
Sample Location								**SB-5**	**SB-5**	**SB-6**	**SB-6**	**SB-6**	**SB-7**	**SB-7**	**SB-18**	**SB-19**	**SB-20**	**SB-21**	**SB-21**	**SB-22**	**SB-22**
Sample Depth (feet BGS)								**4-6**	**7-9**	**0.5-2**	**0.5-2**	**5-7**	**0.5-2**	**6-8**	**0.5-2**	**0.5-2**	**0.5-2**	**0.5-2**	**0.5-2**	**0.5-2**	**0.5-2**
Date Collected								**07/26/11**	**07/26/11**	**07/27/11**	**07/27/11**	**07/27/11**	**07/27/11**	**07/27/11**	**02/14/12**	**01/09/12**	**02/14/12**	**02/14/12**	**02/14/12**	**02/14/12**	**02/14/12**
Parameter	**Units**	**CAS #**	**Regional Screening Level [1,3]**																		
Semivolatile Organics by GC/MS			**Industrial Soil**	**Industrial Soil**	**Groundwater Protection**	**Daf 1**	**Groundwater Protection**														
2-Nitroaniline	mg/kg	88-74-4	600	8,000	0.124		1.6	<0.0144	<0.0146	<0.218	<0.271	<0.221	<0.228	<0.0150	--	--	--	--	--	--	--
2-Nitrophenol	mg/kg	88-75-5	NE	NE	NE		NE	<0.0237	<0.0240	<0.359	<0.445	<0.363	<0.375	<0.0246	--	--	--	--	--	--	--
3-Nitroaniline	mg/kg	99-09-2	NE	NE	NE		NE	<0.0123	<0.0125	<0.187	<0.232	<0.189	<0.195	<0.0128	--	--	--	--	--	--	--
4,6-Dinitro-2-methylphenol	mg/kg	534-52-1	4.9	66	0.004		0.052	<0.00823	<0.00834	<0.125	<0.155	<0.126	<0.130	<0.00857	--	--	--	--	--	--	--
4-Bromophenyl phenyl ether	mg/kg	101-55-3	NE	NE	NE		NE	<0.0175	<0.0177	<0.265	<0.329	<0.268	<0.277	<0.0182	--	--	--	--	--	--	--
4-Chloro-3-methylphenol	mg/kg	59-50-7	6,200	82,000	2.6		34	<0.0103	<0.0104	<0.156	<0.194	<0.158	<0.163	<0.0107	--	--	--	--	--	--	--
4-Chlorophenyl phenyl ether	mg/kg	7005-72-3	NE	NE	NE		NE	<0.0123	<0.0125	<0.187	<0.232	<0.189	<0.195	<0.0128	--	--	--	--	--	--	--
Acenaphthene	mg/kg	83-32-9	3,300	45,000	8.2		110	<0.00720	<0.00730	<0.109	<0.136	<0.110	**0.179 J**	<0.00750	<0.198	<0.0123	<0.773	<0.198	<0.200	<0.826	<0.544
Acenaphthylene	mg/kg	208-96-8	NE	NE	NE		NE	<0.00823	<0.00834	<0.125	<0.155	<0.126	<0.130	<0.00857	<0.198	<0.0123	<0.773	<0.198	<0.200	<0.826	<0.544
Anthracene	mg/kg	120-12-7	17,000	230,000	84		1160	<0.0103	<0.0104	<0.156	<0.194	<0.158	**0.760 J**	<0.0107	<0.198	<0.0123	<0.773	<0.198	<0.200	<0.826	<0.544
Benzidine	mg/kg	92-87-5	0.0075		0.0000048			<0.00823	<0.00834	<0.125	<0.155	<0.126	<0.130	<0.00857	--	--	--	--	--	--	--
Benzo[a]anthracene	mg/kg	56-55-3	2.1		0.2			<0.0113	<0.0115	<0.171	<0.213	<0.173	**2.03 J**	<0.0118	<0.198	**0.0227**	<0.773	<0.198	<0.200	**1.46**	<0.544
Benzo[a]pyrene	mg/kg	50-32-8	0.21		4.8			<0.0144	<0.0146	<0.218	<0.271	<0.221	**2.00 J**	<0.0150	**0.0328 J**	**0.0283**	<0.0672	**0.0319 J**	**0.0346 J**	**1.26**	<0.0473
Benzo[b]fluoranthene	mg/kg	205-99-2	2.1		0.7			<0.0154	<0.0156	<0.234	<0.291	<0.237	**1.48 J**	<0.0161	<0.198	**0.0374**	<0.773	<0.198	<0.200	**1.59**	<0.544
Benzo (g,h,i) perylene	mg/kg	191-24-2	NE		NE			<0.0165	<0.0167	<0.249	<0.310	<0.252	**1.25 J**	<0.0171	<0.198	**0.0227**	<0.773	<0.198	<0.200	**0.861**	<0.544
Benzo[k]fluoranthene	mg/kg	207-08-9	21		7			<0.0123	<0.0125	<0.187	<0.232	<0.189	**1.72 J**	<0.0128	<0.198	<0.0123	<0.773	<0.198	<0.200	<0.826	<0.544
Benzoic acid	mg/kg	65-85-0	250,000		28			<0.452	<0.459	<6.86	<8.52	<6.94	<7.17	<0.471	--	--	--	--	--	--	--
Benzyl alcohol	mg/kg	100-51-6	6,200		0.74			<0.00925	<0.00938	<0.140	<0.174	<0.142	<0.147	<0.00964	--	--	--	--	--	--	--
Bis(2-chloroethoxy)methane	mg/kg	111-91-1	180		0.022			<0.0103	<0.0104	<0.156	<0.194	<0.158	<0.163	<0.0107	--	--	--	--	--	--	--
Bis(2-chloroethyl)ether	mg/kg	111-44-4	1		0.000062			<0.00720	<0.00730	<0.109	<0.136	<0.110	<0.114	<0.00750	--	--	--	--	--	--	--
Bis(2-chloroisopropyl) ether	mg/kg	108-60-1	22		0.0022			<0.00720	<0.00730	<0.109	<0.136	<0.110	<0.114	<0.00750	--	--	--	--	--	--	--
bis(2-Ethylhexyl)phthalate	mg/kg	117-81-7	120		28			<0.0216	<0.0219	<0.327	<0.407	<0.331	<0.342	<0.0225	--	--	--	--	--	--	--
Butyl Benzyl Phthlate	mg/kg	85-68-7	910		4			<0.0206	<0.0208	<0.312	<0.387	<0.315	<0.326	<0.0214	--	--	--	--	--	--	--
Carbazole	mg/kg	86-74-8	NE		NE			<0.0134	<0.0136	<0.203	<0.252	<0.205	**0.266 J**	<0.0139	--	--	--	--	--	--	--
Chloroaniline, p-	mg/kg	106-47-8	8.6		0.0026			<0.00720	<0.00730	<0.109	<0.136	<0.110	<0.114	<0.00750	--	--	--	--	--	--	--
Chloronaphthalene, Beta-	mg/kg	91-58-7	8,200		5.8			<0.0113	<0.0115	<0.171	<0.213	<0.173	<0.179	<0.0118	--	--	--	--	--	--	--
Chlorophenol, 2-	mg/kg	95-57-8	510		0.114			<0.0103	<0.0104	<0.156	<0.194	<0.158	<0.163	<0.0107	--	--	--	--	--	--	--
Chrysene	mg/kg	218-01-9	210		22			<0.0123	<0.0125	<0.187	<0.232	<0.189	**2.09 J**	<0.0128	<0.198	**0.0233**	<0.773	<0.198	<0.200	**1.36**	<0.544
Cresol(s)	mg/kg	1319-77-3	6,200		2.4			<0.257	<0.261	<3.90	<4.84	<3.94	<4.07	<0.268	--	--	--	--	--	--	--
Dibenzo[a,h]anthracene	mg/kg	53-70-3	0.21		0.22			<0.0195	<0.0198	<0.296	<0.368	<0.300	<0.309	<0.0203	<0.0145	<0.0123	<0.0564	<0.0145	<0.0146	**0.198**	<0.0397
Dibenzofuran	mg/kg	132-64-9	100		0.22			<0.0103	<0.0104	<0.156	<0.194	<0.158	<0.163	<0.0107	--	--	--	--	--	--	--
Dibutyl Phthalate	mg/kg	84-74-2	6,200		3.4			<0.0206	<0.0208	<0.312	<0.387	<0.315	<0.326	<0.0214	--	--	--	--	--	--	--
Dichlorobenzene, 1,2-	mg/kg	95-50-1	980		11.6			<0.00925	<0.00938	<0.140	<0.174	<0.142	<0.147	<0.00964	--	--	--	--	--	--	--
Dichlorobenzene, 1,3-	mg/kg	541-73-1	NE		NE			<0.00823	<0.00834	<0.125	<0.155	<0.126	<0.130	<0.00857	--	--	--	--	--	--	--
Dichlorobenzene, 1,4-	mg/kg	106-46-7	12		1.44			<0.00823	<0.00834	<0.125	<0.155	<0.126	<0.130	<0.00857	--	--	--	--	--	--	--
Dichlorobenzidine, 3,3-	mg/kg	91-94-1	3.8		0.0142			<0.0103	<0.0104	<0.156	<0.194	<0.158	<0.163	<0.0107	--	--	--	--	--	--	--
Dichlorophenol, 2,4-	mg/kg	120-83-2	180		0.082			<0.00925	<0.00938	<0.140	<0.174	<0.142	<0.147	<0.00964	--	--	--	--	--	--	--
Diethyl Phthalate	mg/kg	84-66-2	49,000		9.4			**0.0185 J**	**0.017 J**	<0.187	<0.232	<0.189	<0.195	**0.0157**	--	--	--	--	--	--	--
Dimethyl phthalate	mg/kg	131-11-3	NE		NE			<0.0144	<0.0146	<0.218	<0.271	<0.221	<0.228	<0.0150	--	--	--	--	--	--	--
Dimethylphenol, 2,4-	mg/kg	105-67-9	1,200		0.64			<0.0154	<0.0156	<0.234	<0.291	<0.237	<0.244	<0.0161	--	--	--	--	--	--	--

TABLE 3-2
SUMMARY OF SOIL ANALYTICAL RESULTS - SEMI-VOLATILE ORGANIC COMPOUNDS
RCRA FACILITY INVESTIGATION
FORMER WATERLOO INDUSTRIES FACILITY, WATERLOO, IOWA

Investigation Target								Former WWT Area	Former WWT Area	Former WWT Area	Former WWT Area	Former WWT Area	Former WWT Area	Former WWT Area	Former WWT Area	Former WWT Area	Former WWT Area	Former WWT Area	Former WWT Area	Former WWT Area	Former WWT Area
Sample ID								**SB-5(4-6)**	**SB-5 (7-9)**	**SB-6 (0.5-2)**	**SB-6 Dup (0.5-2)**	**SB-6 (5-7)**	**SB-7 (0.5-2)**	**SB-7 (6-8)**	**SB-18 (0.5-2)**	**SB-19 (0.5-2)**	**SB-20 (0.5-2)**	**SB-21 (0.5-2)**	**SBDup3**	**SB-22 (0.5-2)**	**SBDup4**
Sample Location								**SB-5**	**SB-5**	**SB-6**	**SB-6**	**SB-6**	**SB-7**	**SB-7**	**SB-18**	**SB-19**	**SB-20**	**SB-21**	**SB-21**	**SB-22**	**SB-22**
Sample Depth (feet BGS)								**4-6**	**7-9**	**0.5-2**	**0.5-2**	**5-7**	**0.5-2**	**6-8**	**0.5-2**	**0.5-2**	**0.5-2**	**0.5-2**	**0.5-2**	**0.5-2**	**0.5-2**
Date Collected								**07/26/11**	**07/26/11**	**07/27/11**	**07/27/11**	**07/27/11**	**07/27/11**	**07/27/11**	**02/14/12**	**01/09/12**	**02/14/12**	**02/14/12**	**02/14/12**	**02/14/12**	**02/14/12**
Parameter	**Units**	**CAS #**	**Regional Screening Level [1,3]**																		
Semivolatile Organics by GC/MS			**Industrial Soil**	**Industrial Soil**	**Groundwater Protection**	**Daf 1**	**Groundwater Protection**														
Dinitrophenol, 2,4-	mg/kg	51-28-5	120		0.068			<0.0730	<0.0740	<1.11	<1.38	<1.12	<1.16	<0.0760	--	--	--	--	--	--	--
Dinitrotoluene, 2,4-	mg/kg	121-14-2	5.5		0.0056			<0.0185	<0.0188	<0.281	<0.349	<0.284	<0.293	<0.0193	--	--	--	--	--	--	--
Dinitrotoluene, 2,6	mg/kg	606-20-2	1.2		0.00116			<0.0144	<0.0146	<0.218	<0.271	<0.221	<0.228	<0.0150	--	--	--	--	--	--	--
Di-n-octyl phthalate	mg/kg	117-84-0	620		88			<0.0380	<0.0386	<0.577	<0.717	<0.584	<0.603	<0.0396	--	--	--	--	--	--	--
Fluoranthene	mg/kg	206-44-0	2,200		140			<0.0103	<0.0104	<0.156	<0.194	**0.163 J**	**4.51 J**	<0.0107	<0.198	**0.0365**	<0.773	<0.198	<0.200	**3.63**	<0.544
Fluorene	mg/kg	86-73-7	2,200		8			<0.00925	<0.00938	<0.140	<0.174	<0.142	**0.212 J**	<0.00964	<0.198	<0.0123	<0.773	<0.198	<0.200	<0.826	<0.544
Hexachlorobenzene	mg/kg	118-74-1	1.1		0.26			<0.0144	<0.0146	<0.218	<0.271	<0.221	<0.228	<0.0150	--	--	--	--	--	--	--
Hexachlorobutadiene	mg/kg	87-68-3	22		0.01			<0.0103	<0.0104	<0.156	<0.194	<0.158	<0.163	<0.0107	--	--	--	--	--	--	--
Hexachlorocyclopentadiene	mg/kg	77-47-4	370		3.2			<0.0123	<0.0125	<0.187	<0.232	<0.189	<0.195	<0.0128	--	--	--	--	--	--	--
Hexachloroethane	mg/kg	67-72-1	43		0.0062			<0.0103	<0.0104	<0.156	<0.194	<0.158	<0.163	<0.0107	--	--	--	--	--	--	--
Indeno[1,2,3-cd]pyrene	mg/kg	193-39-5	2.1		4			<0.0154	<0.0156	<0.234	<0.291	<0.237	**1.10 J**	<0.0161	<0.198	**0.0173**	<0.773	<0.198	<0.200	<0.826	<0.544
Isophorone	mg/kg	78-59-1	1,800		0.44			<0.00925	<0.00938	<0.140	<0.174	<0.142	<0.147	<0.00964	--	--	--	--	--	--	--
Methylnaphthalene, 2	mg/kg	91-57-6	220		0.28			<0.00823	<0.00834	<0.125	<0.155	<0.126	<0.130	<0.00857	<0.198	<0.0123	<0.773	<0.198	<0.200	<0.826	<0.544
Methylphenol, 2	mg/kg	95-48-7	3,100		1.16			<0.264	<0.268	<4.01	<4.98	<4.05	<4.19	<0.275	--	--	--	--	--	--	--
Methylphenol, 4	mg/kg	106-44-5	6,200		2.2			<0.00823	<0.00834	<0.125	<0.155	<0.126	<0.130	<0.00857	--	--	--	--	--	--	--
Naphthalene	mg/kg	91-20-3	18		0.0094			<0.266	<0.270	<4.04	<5.02	<4.08	<4.22	<0.277	<0.198	<0.0123	<0.773	<0.198	<0.200	<0.826	<0.544
Nitrobenzene	mg/kg	98-95-3	24		0.00158			<0.0113	<0.0115	<0.171	<0.213	<0.173	<0.179	<0.0118	--	--	--	--	--	--	--
Nitrophenol, p-	mg/kg	100-02-7	NE		NE			<0.0165	<0.0167	<0.249	<0.310	<0.252	<0.261	<0.0171	--	--	--	--	--	--	--
Nitroanaline, 4-	mg/kg	100-01-6	86		0.028			<0.0103	<0.0104	<0.156	<0.194	<0.158	<0.163	<0.0107	--	--	--	--	--	--	--
Nitrosodiphenylamine, N-	mg/kg	86-30-6	350		1.14			<0.0134	**0.0173 J**	<0.203	<0.252	<0.205	<0.212	<0.0139	--	--	--	--	--	--	--
N-Nitrosodimethylamine	mg/kg	62-75-9	0.034		0.000002			<0.00823	<0.00834	<0.125	<0.155	<0.126	<0.130	<0.00857	--	--	--	--	--	--	--
N-Nitrosodi-n-propylamine	mg/kg	621-64-7	0.25		0.00014			<0.0699	<0.0709	<1.06	<1.32	<1.07	<1.11	<0.0728	--	--	--	--	--	--	--
Pentachlorophenol	mg/kg	87-86-5	2.7		0.2			<0.247	<0.250	<3.74	<4.65	<3.79	<3.91	<0.257	--	--	--	--	--	--	--
Phenanthrene	mg/kg	85-01-8	NE		NE			<0.0123	<0.0125	<0.187	<0.232	<0.189	**3.00 J**	<0.0128	<0.198	**0.0175**	<0.773	<0.198	<0.200	**2.92**	<0.544
Phenol	mg/kg	108-95-2	18,000		5.2			<0.247	<0.250	<3.74	<4.65	<3.79	<3.91	<0.257	--	--	--	--	--	--	--
Pyrene	mg/kg	129-00-0	1,700		19			<0.0134	<0.0136	<0.203	<0.252	<0.205	**4.17 J**	<0.0139	<0.198	**0.0331**	<0.773	<0.198	<0.200	**2.59**	<0.544
Pyridine	mg/kg	110-86-1	100		0.0106			<0.00925	<0.00938	<0.140	<0.174	<0.142	<0.147	<0.00964	--	--	--	--	--	--	--
Trichlorobenzene, 1,2,4-	mg/kg	120-82-1	27		4			<0.00720	<0.00730	<0.109	<0.136	<0.110	<0.114	<0.00750	--	--	--	--	--	--	--
Trichlorophenol, 2,4,5-	mg/kg	95-95-4	6,200		6.6			<0.0165	<0.0167	<0.249	<0.310	<0.252	<0.261	<0.0171	--	--	--	--	--	--	--
Trichlorophenol, 2,4,6-	mg/kg	88-06-2	62		0.068			<0.0206	<0.0208	<0.312	<0.387	<0.315	<0.326	<0.0214	--	--	--	--	--	--	--

Notes:
Bold values were detected above laboratory detection limits
Highlighted (gray) values exceed the Groundwater Protection RSL
Highlighted (green) values exceed the Industrial Soil RSL but do not exceed the Groundwater Protection RSL
-- = Analysis not requested
DAF = Dilution attenuation factor
J = Estimated concentration between the Reporting Limit (RL) and Method Detection Limit (MDL)
NE = Not Established
WWT = Wastewater Treatment
[1] EPA Regional Screening Levels for Industrial Soil (May 2013).
[2] EPA Regional Screening Levels for Protection of Groundwater (May 2013), times a DAF of 20.

TABLE 3-3
SUMMARY OF SOIL VAPOR, INDOOR AIR, AND AMBIENT AIR ANALYTICAL RESULTS
FORMER WATERLOO INDUSTRIES FACILITY
WATERLOO, IOWA

Compound	*Future On-Site Industrial Worker*				*Sub Slab Soil Vapor Samples*																							
	Target Industrial Indoor Air Concentration [1]		*Calculated Soil Gas Vapor Intrusion Cleanup Level* [3]		*Laboratory ID/Sample Location*																							
	C_{ia}		$CL_{ia,gw,iw,on}$		*WSVS-1*	*WSVS-DUP1*	*WSVS-2R*	*WSVS-2R*	*WSVS-DUP1*	*WSVS-2R*	*WSVS-3*	*WSVS-3*	*WSVS-3*	*WSVS-DUP1*	*WSVS-4*	*WSVS-4*	*WSVS-4*	*WSVS-5*	*WSVS-6*	*WSVS-6*	*WSVS-7*	*WSVS-DUP1*	*WSVS-7*	*WSVS-7*	*WSVS-8*	*WSVS-8*	*WSVS-8*	*WSVS-EB1*
	(ug/m³)		*(ug/m³)*		*SVP-9*	*SVP-18*	*SVP-18*	*SVP-18*	*WSVS-2R*	*SVP-18*	*SVP-8*	*SVP-8*	*SVP-8*	*WSVS-3*	*SVP-1*	*SVP-1*	*SVP-1*	*MW-10*				*WSVS-7*			*MW-11*	*MW-11*	*MW-11*	
					10/21/11	*10/21/11*	*10/21/11*	*10/20/13*	*10/20/13*	*8/17/14*	*11/18/11*	*10/19/13*	*8/17/14*	*8/17/14*	*11/18/11*	*10/20/13*	*8/17/14*	*11/18/11*	*11/18/11*	*10/19/13*	*11/20/11*	*11/20/11*	*10/19/13*	*8/17/14*	*11/20/11*	*10/20/13*	*8/17/14*	*10/20/13*
Benzene	1.60E+00	c*	1.60E+01	c*	<9800	<2500	<2500	<4000	<3200	<4500	<6.4	<2.6	<31	<16	<130	<250	<470	<35	<6.5	<2.6	**2.7**	<2.6	<2.6	<2.6	<110	<12	<130	<2.6
Benzyl chloride	2.50E-01	c*	2.50E+00	c*	<32000	<8200	<8200	<13000	<10000	<15000	<21	<8.3	<100	<51	<420	<820	<1500	<110	<21	<8.3	<8.4	<8.3	<8.3	<8.3	<370	<39	<410	<8.3
Bromomethane	2.20E+01	nc	2.20E+02	nc	<12000	<3100	<3100	<4900	<3900	<5500	<7.8	<3.1	<36	<19	<160	<310	<570	<43	<7.9	<3.1	<3.2	<3.1	<3.1	<3.1	<140	<15	<150	<3.1
Carbon tetrachloride	2.00E+00	c	2.00E+01	c	<19000	<5000	<5000	<7900	<6300	<8900	<13	<5.0	<61	<31	<250	<500	<930	<69	**17**	**6.5**	<5.1	<5.1	<5.0	<5.0	<220	<24	<250	<5.0
Chlorobenzene	2.20E+02	nc	2.20E+03	nc	<14000	<3700	<3600	<5800	<4600	<6500	<9.2	<3.7	<45	<23	<190	<360	<680	<51	<9.4	<3.7	<3.8	<3.7	<3.7	<3.7	<160	<17	<180	<3.7
Chloroethane	4.40E+04	nc	4.40E+05	nc	<8100	<2100	<2100	<3300	<2600	<3800	<5.3	<2.1	<26	<13	<110	<210	<390	<29	<5.4	<2.1	<2.2	<2.1	<2.1	<2.1	<94	<9.9	<100	<2.1
Chloroform	5.30E-01	c	5.30E+00	c	<15000	<3900	<3800	<6100	<4900	<6900	<9.8	<3.9	<47	<24	<200	<390	<720	<54	<10	<3.9	<4.0	<3.9	<3.9	<3.9	<170	<18	<190	<3.9
Chloromethane	3.90E+02	nc	3.90E+03	nc	<16000	<4100	<4100	<6500	<5100	<7300	<10	<4.1	<50	<26	<210	<410	<760	<57	<11	<4.1	<4.2	<4.1	<4.1	<4.1	<180	<19	<200	<4.1
1,2-Dibromoethane (EDB)	2.00E-02	c	2.00E-01	c	<23000	<6100	<6100	<9700	<7600	<11000	<15	<6.1	<75	<38	<310	<610	<1100	<85	<16	<6.1	<6.3	<6.2	<6.1	<6.1	<270	<29	<300	<6.1
1,2-Dichlorobenzene	8.80E+02	nc	8.80E+03	nc	<18000	<4800	<4700	<7600	<6000	<8500	12	<4.8	<58	<30	<240	<470	<890	<66	<12	<4.8	<4.9	<4.8	<4.8	<4.8	<210	<23	<240	<4.8
1,3-Dichlorobenzene	NA		NA		<18000	<4800	<4700	<7600	<6000	<8500	<12	<4.8	<58	<30	<240	<470	<890	<66	<12	<4.8	<4.9	<4.8	<4.8	<4.8	<210	<23	<240	<4.8
1,4-Dichlorobenzene	1.10E+00	c	1.10E+01	c	<18000	<4800	<4700	<7600	<6000	<8500	<12	<4.8	<58	<30	<240	<470	<890	<66	<12	<4.8	<4.9	<4.8	<4.8	<4.8	<210	<23	<240	<4.8
Dichlorodifluoromethane	4.40E+02	nc	4.40E+03	nc	<15000	<3900	<3900	<6200	<4900	<7000	**320**	**16**	<48	<24	<200	<390	<730	<54	<10	**4.1**	**4.0**	**8.2**	**6.8**	**14**	<180	<19	<190	<4.0
1,1-Dichloroethane	7.70E+00	c	7.70E+01	c	<12000	<3200	<3200	<5100	<4000	<5800	<8.1	<3.2	<39	<20	<160	<320	<600	<45	<8.3	<3.2	<3.3	<3.3	<3.2	<3.2	<140	<15	<160	<3.2
1,2-Dichloroethane	4.70E-01	c*	4.70E+00	c*	<12000	<3200	<3200	<5100	<4000	<5800	<8.1	<3.2	<39	<20	<160	<320	<600	<45	<8.3	<3.2	<3.3	<3.3	<3.2	<3.2	<140	<15	<160	<3.2
1,1-Dichloroethene	8.80E+02	nc	8.80E+03	nc	**1,800,000**	<3200	<3100	<5000	<3900	<5600	<8.0	<3.2	<38	<20	<160	<310	<580	<44	<8.1	<3.2	<3.2	<3.2	<3.2	<3.2	<140	<15	<160	<3.2
cis-1,2-Dichloroethene	NA		NA		<12000	<3200	<3100	<5000	<3900	<5600	<8.0	<3.2	<38	<20	<160	<310	<580	<44	<8.1	<3.2	<3.2	<3.2	<3.2	<3.2	<140	<15	<160	<3.2
1,2-Dichloropropane	1.20E+00	c*	1.20E+01	c*	<14000	<3700	<3600	<5800	<4600	<6600	<9.3	<3.7	<45	<23	<190	<360	<680	<51	<9.5	<3.7	<3.8	<3.7	<3.7	<3.7	<160	<17	<180	<3.7
cis-1,3-Dichloropropene	NA		NA		<14000	<3600	<3600	<5700	<4500	<6500	<9.1	<3.6	<44	<22	<180	<360	<670	<50	<9.3	<3.6	<3.7	<3.6	<3.6	<3.6	<160	<17	<180	<3.6
trans-1,3-Dichloropropene	NA		NA		<14000	<3600	<3600	<5700	<4500	<6500	<9.1	<3.6	<44	<22	<180	<360	<670	<50	<9.3	<3.6	<3.7	<3.6	<3.6	<3.6	<160	<17	<180	<3.6
1,2-Dichloro-1,1,2,2-tetrafluorothane	NA		NA		<21000	<5600	<5500	<8800	<7000	<9900	<14	<5.6	<68	<35	<280	<550	<1000	<77	<14	<5.6	<5.7	<5.6	<5.6	<5.6	<250	<26	<270	<5.6
Ethylbenzene	4.90E+00	c	4.90E+01	c	<13000	<3500	<3400	<5500	<4300	<6200	**22**	<3.5	<42	<21	<180	<340	<640	<48	**28**	<3.5	**8.4**	**4.1**	<3.5	<3.5	<150	<16	<170	<3.5
Hexachlorobutadiene	5.60E-01	c	5.60E+00	c	<160000	<42000	<42000	<67000	<53000	<76000	<110	<43	<520	<260	<2200	<4200	<7900	<590	<110	<43	<43	<43	<43	<43	<1900	<200	<2100	<43
Methylene chloride	1.20E+03	c	1.20E+04	c	<27000	**7,200**	<6800	<11000	<8600	<12000	<17	**10**	<84	<43	<350	<690	<1300	<96	<18	**31**	**7.3**	<7.0	**95**	<6.9	<310	<33	<340	<6.9
Styrene	4.40E+03	nc	4.40E+04	nc	<13000	<3400	<3400	<5300	<4200	<6100	<8.6	<3.4	<41	<21	<170	<340	<630	<47	<8.7	<3.4	<3.5	<3.4	<3.4	<3.4	<150	<16	<170	<3.4
1,1,2,2-Tetrachloroethane	2.10E-01	c	2.10E+00	c	<21000	<5500	<5400	<8600	<6800	<9800	<14	<5.5	<67	<34	<280	<540	<1000	<76	<14	<5.5	<5.6	<5.5	<5.5	<5.5	<240	<26	<270	<5.5
Tetrachloroethene	4.70E+01	c	4.70E+02	c	**530,000**	**1,700,000 D**	**1,400,000 D**	**2,200,000 E**	**2,500,000 E**	**2,100,000 E**	**1,700**	**1,600 E**	**2,700**	**3,200**	**29,000**	**150,000 E**	**130,000**	**21,000 D**	**650**	**1,100 E**	**110**	**120**	**150**	**270**	**24,000**	**12,000 E**	**13,000**	<5.4
Toluene	2.20E+04	nc	2.20E+05	nc	**14,000**	<3000	<3000	<7100	<5600	<8000	**40**	<4.5	<55	<26	<150	<450	<830	<41	**77**	**9.2**	**22**	**12**	**11**	<4.5	<130	<21	<220	<4.5
1,2,4-Trichlorobenzene	8.80E+00	nc	8.80E+01	nc	<110000	<30000	<29000	<47000	<37000	<53000	<75	<30	<360	<180	<1500	<2900	<5500	<410	<76	<30	<30	<30	<30	<30	<1300	<140	<1500	<30
1,1,1-Trichloroethane	2.20E+04	nc	2.20E+05	nc	<17000	<4300	<4300	<6900	<5400	<7800	**27**	**63**	**150**	**170**	<220	<430	<800	**180**	**25**	**27**	**47**	**48**	**44**	**82**	<190	<21	<210	<4.4
1,1,2-Trichloroethane	7.70E-01	c*	7.70E+00	c*	<17000	<4300	<4300	<6900	<5400	<7800	<11	<4.4	<53	<27	<220	<430	<800	<60	<11	<4.4	<4.4	<4.4	<4.4	<4.4	<190	<21	<210	<4.4
Trichloroethene	3.00E+00	c*	3.00E+01	c*	**180,000**	**9,400**	**8,000**	**12,000**	**13,000**	**14,000**	<5.4	**2.3**	<26	<13	**280**	**1,200**	**1,200**	<30	<5.5	**8.0**	<2.2	<2.2	<2.1	<2.1	<96	**19**	<110	<2.1
Trichlorofluoromethane	3.10E+03	nc	3.10E+04	nc	<17000	<4500	<4400	<7100	<5600	<8000	**11**	<4.5	<55	<28	<230	<440	<830	<62	<11	**6.7**	<4.6	<4.5	**12**	<4.5	<200	<21	<220	<4.5
1,1,2-Trichloro-1,2,2-trifluoroethane	1.30E+05	nc	1.30E+06	nc	<23000	<6100	<6000	<9600	<7600	<11000	<15	<6.1	<74	<38	<310	<600	<1100	<84	<16	<6.1	<6.2	<6.2	<6.1	<6.1	<270	<29	<300	<6.1
1,2,4-Trimethylbenzene	3.10E+01	nc	3.10E+02	nc	<15000	<3900	<3900	<6200	<4900	<7000	<9.9	<3.9	<48	<24	<200	<390	<720	<54	<10	<3.9	**610**	**180**	**27**	**49**	<180	<18	<190	<3.9
1,3,5-Trimethylbenzene	NA		NA		<15000	<3900	<3900	<6200	<4900	<7000	<9.9	<3.9	<48	<24	<200	<390	<720	<54	<10	<3.9	**61**	**18**	<3.9	**5.8**	<180	<18	<190	<3.9
Vinyl chloride	2.80E+00	c	2.80E+01	c	**260,000**	<2000	<2000	<3200	<2500	<3600	<5.1	<2.0	<25	<13	<100	<200	<380	<28	<5.2	<2.0	<2.1	<2.1	<2.0	<2.0	<91	<9.6	<100	<2.0
m-Xylene & p-Xylene	4.40E+02	nc	4.40E+03	nc	<13000	<3500	<3400	<5500	<4300	<6200	**110**	<3.5	<42	<21	<180	<340	<640	**83**	**130**	<3.5	**28**	**12**	<3.5	<3.5	<150	<16	<170	<3.5
o-Xylene	4.40E+02	nc	4.40E+03	nc	<13000	<3500	<3400	<5500	<4300	<6200	**27**	<3.5	<42	<21	<180	<340	<640	<48	**31**	<3.5	**13**	**5.5**	<3.5	<3.5	<150	<16	<170	<3.5

Key:

blank cell = Data are not available
c = Carcinogen, target risk = 1×10^{-6}
c* = Noncarcinogenic value is less than 100 times the carcinogenic value
CAS # = Chemical Abstracts Service number
D = Result was obtained from the analysis of a dilution
E = Result exceeded calibration range
nc = Noncarcinogen, target hazard index = 1
NA= No toxicity factors available
USEPA, 2002 = U. S. Environmental Protection Agency, OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance), EPA 530-D-02-004, November 2002

[1] From the Regional Screening Level tables, dated November 2013, downloaded from http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm
[2] Obtained from USEPA, 2002, pages 28 and 44.
[3] Calculated as the Target Industrial Indoor Air Concentration divided by the Soil Gas-to-Indoor Air Attenuation Factor, per Section 6 of Appendix F of USEPA, 2002.

TABLE 3-3
SUMMARY OF SOIL VAPOR, INDOOR AIR, AND AMBIENT AIR ANALYTICAL RESULTS
FORMER WATERLOO INDUSTRIES FACILITY
WATERLOO, IOWA

Compound	Future On-Site Industrial Worker: Target Industrial Indoor Air Concentration [1]		Future On-Site Industrial Worker: Calculated Soil Gas Vapor Intrusion Cleanup Level [3]		Indoor Air Samples: Laboratory ID/Sample Location																							
	C_{ia} (ug/m^3)		$CL_{ia,gw,iw,on}$ (ug/m^3)		WIAS-1	WIAS-2	WIAS-DUP 1	WIAS-2	WIAS-2	WIAS-3	WIAS-DUP 1	WIAS-4	WIAS-5	WIAS-6	WIAS-7	WIAS-8	WIAS-9	WIAS-10	WIAS-10	WIAS-11	WIAS-DUP 2	WIAS-11	WIAS-DUP1	WIAS-11	WIAS-DUP1	WIAS-11	WIAS-DUP1
					SVP-9	SVP-18	WIAS-2	SVP-18	SVP-18		WIAS-3										WIAS-11		WIAS-11		WIAS-11		WIAS-11
					10/22/11	10/22/11	10/22/11	10/20/13	8/17/14	11/20/11	11/20/11	11/20/11	11/20/11	11/20/11	11/20/11	11/20/11	11/20/11	11/20/11	10/20/13	8/17/14	11/20/11	11/20/11	10/20/13	10/20/13	8/17/14	8/17/14	9/28/14	9/28/14
Benzene	1.60E+00	c*	1.60E+01	c*	2.2	2.1	2.2	1.2	1.0	1.1	0.98	0.96	1.0	1.1	0.88	<0.26	2.4	2.4	0.78	1.5	2.6	2.7	1.1	1.2	1.3	1.1	1.8	1.9
Benzyl chloride	2.50E-01	c*	2.50E+00	c*	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83
Bromomethane	2.20E+01	nc	2.20E+02	nc	<0.31	<0.31	<0.31	<0.31	0.35	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31
Carbon tetrachloride	2.00E+00	c	2.00E+01	c	64	67	72	67	23	4.6	4.5	4.4	3.7	4.3	5.2	2.8	40	38	17	8.4	130 D	96 D	59	62	12	13	11	12
Chlorobenzene	2.20E+02	nc	2.20E+03	nc	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37
Chloroethane	4.40E+04	nc	4.40E+05	nc	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	0.22	<0.21
Chloroform	5.30E-01	c	5.30E+00	c	16	19	18	9.2	8.3	1.50	1.4	1.4	1.4	1.3	1.7	1.6	12.0	11.0	2.7	3.5	30.0	29	8.1	8.4	5.8	5.2	5.0	4.1
Chloromethane	3.90E+02	nc	3.90E+03	nc	1.2	1.1	1.1	1.6	4.1	1.1	1.0	0.88	0.9	0.84	0.87	0.9	1.1	1.0	1.1	2.5	1.4	1.3	1.3	1.4	3.6	3.3	5.3	4.2
1,2-Dibromoethane (EDB)	2.00E-02	c	2.00E-01	c	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61
1,2-Dichlorobenzene	8.80E+02	nc	8.80E+03	nc	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48
1,3-Dichlorobenzene	NA		NA		<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48
1,4-Dichlorobenzene	1.10E+00	c	1.10E+01	c	1.6	1.5	1.9	<0.48	0.50	3.1	2.5	3.0	3.1	1.0	3.7	<0.48	7.6	7.3	<0.48	1.2	1.1	0.88	0.50	<0.48	1.6	1.5	1.4	1.4
Dichlorodifluoromethane	4.40E+02	nc	4.40E+03	nc	2.2	2.1	2.2	1.6	2.7	2.4	2.5	1.8	2.2	2.0	2.0	1.9	2.2	2.0	1.6	2.3	2.0	2.0	1.4	1.5	2.2	2.1	2.0	2.1
1,1-Dichloroethane	7.70E+00	c	7.70E+01	c	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32
1,2-Dichloroethane	4.70E-01	c*	4.70E+00	c*	0.57	0.67	0.69	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	0.34	0.33	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32
1,1-Dichloroethene	8.80E+02	nc	8.80E+03	nc	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32
cis-1,2-Dichloroethene	NA		NA		<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32
1,2-Dichloropropane	1.20E+00	c*	1.20E+01	c*	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37
cis-1,3-Dichloropropene	NA		NA		<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36
trans-1,3-Dichloropropene	NA		NA		<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36
1,2-Dichloro-1,1,2,2-tetrafluorothane	NA		NA		<0.56	<0.56	<0.56	<0.56	<0.56	<0.56	<0.56	<0.56	<0.56	<0.56	<0.56	<0.56	<0.56	<0.56	<0.56	<0.56	<0.56	<0.56	<0.56	<0.56	<0.56	<0.56	<0.56	<0.56
Ethylbenzene	4.90E+00	c	4.90E+01	c	16	16	18	7.4	2.7	1.2	1.1	1.2	1.2	0.58	1.4	<0.35	6.7	6.7	2.8	6.2	13	11	6.3	6.6	4.4	4.3	6.0	6.4
Hexachlorobutadiene	5.60E-01	c	5.60E+00	c	<4.3	<4.3	<4.3	<4.3	<4.3	<4.3	<4.3	<4.3	<4.3	<4.3	<4.3	<4.3	<4.3	<4.3	<4.3	<4.3	<4.3	<4.3	<4.3	<4.3	<4.3	<4.3	<4.3	<4.3
Methylene chloride	1.20E+03	c	1.20E+04	c	3.9	3.6	5.3	2.3	3.6	2.2	4.0	2.3	1.8	2.0	4.5	2.7	4.9	5.8	1.4	5.2	10	11	15	14	24	22	43	43
Styrene	4.40E+03	nc	4.40E+04	nc	5.4	6.1	6.9	2.2	4.1	0.55	0.51	0.59	0.61	<0.34	0.65	<0.34	3.1	3	0.92	3.1	9.9	8.4	2.1	2.1	8.1	7.8	14	16
1,1,2,2-Tetrachloroethane	2.10E-01	c	2.10E+00	c	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55
Tetrachloroethene	4.70E+01	c	4.70E+02	c	5.1	4.6	5.3	3.8	2.0	0.75	0.7	0.83	0.73	0.69	0.9	<0.54	4.7	4.6	3.3	1.5	13	12	5.0	5.2	2.2	2.2	1.9	2.1
Toluene	2.20E+04	nc	2.20E+05	nc	50	53	59	12	7.2	7.6	7.5	7.5	7.7	4.5	7.7	<0.30	21	21	5.5	10	49	44	13	14	14	14	16	16
1,2,4-Trichlorobenzene	8.80E+00	nc	8.80E+01	nc	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,1,1-Trichloroethane	2.20E+04	nc	2.20E+05	nc	<0.44	0.50	0.48	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44
1,1,2-Trichloroethane	7.70E-01	c*	7.70E+00	c*	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44
Trichloroethene	3.00E+00	c*	3.00E+01	c*	0.41	0.43	0.43	0.86	<0.21	<0.21	<0.21	<0.21	<0.21	0.24	<0.21	<0.21	0.7	0.68	0.25	0.26	1.6	1.7	0.76	0.82	6.5	6.1	9.4	9.8
Trichlorofluoromethane	3.10E+03	nc	3.10E+04	nc	5.3	6.9	6.7	3.8	2.7	1.6	1.5	1.4	1.4	1.4	1.6	1.6	2.6	2.4	1.8	1.5	4	3.9	3.4	3.3	2.0	1.6	1.7	1.3
1,1,2-Trichloro-1,2,2-trifluoroethane	1.30E+05	nc	1.30E+06	nc	<0.61	<0.61	<0.61	0.65	0.65	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	0.61	0.62	0.65	<0.61	<0.61	<0.61
1,2,4-Trimethylbenzene	3.10E+01	nc	3.10E+02	nc	21	23	26	7.6	8.6	1.5	1.2	1.5	1.6	0.59	1.9	<0.39	9.9	9.4	3.6	8.3	36	31	7.4	7.3	17	17	14	15
1,3,5-Trimethylbenzene	NA		NA		6.1	6.6	7.6	2.2	2.5	0.4	<0.39	0.53	0.41	<0.39	0.53	<0.39	3.2	3.0	1.0	2.6	10	9.3	2.1	2.1	5.2	5.0	4.4	4.7
Vinyl chloride	2.80E+00	c	2.80E+01	c	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
m-Xylene & p-Xylene	4.40E+02	nc	4.40E+03	nc	53	52	59	29	9.4	3.6	3.4	3.7	3.6	1.6	4.3	<0.35	20	20	9.8	21	33	28	24	25	15	14	20	22
o-Xylene	4.40E+02	nc	4.40E+03	nc	19	19	21	11	4.2	1.5	1.4	1.5	1.5	0.69	1.8	<0.35	8.9	9.3	3.5	7.5	14	12	8.9	9.2	6.5	6.2	14	16

Key:

blank cell = Data are not available
c = Carcinogen, target risk = 1 x 10^{-6}
c* = Noncarcinogenic value is less than 100 times the carcinogenic value
CAS # = Chemical Abstracts Service number
D = Result was obtained from the analysis of a dilution
E = Result exceeded calibration range
nc = Noncarcinogen, target hazard index = 1
NA= No toxicity factors available
USEPA, 2002 = U. S. Environmental Protection Agency, OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance), EPA 530-D-02-004, November 2002

[1] From the Regional Screening Level tables, dated June 2011, downloaded from http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm
[2] Obtained from USEPA, 2002, pages 28 and 44.
[3] Calculated as the Target Industrial Indoor Air Concentration divided by the Soil Gas-to-Indoor Air Attenuation Factor, per Section 6 of Appendix F of USEPA, 2002.
[4] This value was calculated by using the equations and parameters specified in the June 2011 Regional Screening Tables web page and the September 28, 2011 toxicity factors published by USEPA.

TABLE 3-3
SUMMARY OF SOIL VAPOR, INDOOR AIR, AND AMBIENT AIR ANALYTICAL RESULTS
FORMER WATERLOO INDUSTRIES FACILITY
WATERLOO, IOWA

Compound	*Future On-Site Industrial Worker*				*Indoor Air Samples*					*Outdoor Air Samples*							
	Target Industrial Indoor Air Concentration [1]		*Calculated Soil Gas Vapor Intrusion Cleanup Level* [3]		*Laboratory ID/Sample Location*					*Laboratory ID/Sample Location*							
	C_{ia}		$CL_{ia,gw,iw,on}$		*WIAS-12*	*WIAS-13*	*WIAS-13*	*WIAS-13*	*WIAS-EB1*	*WOAS-1*	*WOAS-DUP1*	*WOAS-1*	*WOAS-DUP1*	*WOAS-1*	*WOAS-DUP2*	*WOAS-2*	*WOAS-DUP1*
	(ug/m³)		*(ug/m³)*							*SVP-13*	*SVP-13*	*SVP-13*	*WOAS-1*	*SVP-13*	*WOAS-1*	*SVP-13*	*SVP-13*
					11/20/11	*11/20/11*	*10/20/13*	*8/17/14*	*10/20/13*	*10/22/11*	*10/22/11*	*10/20/13*	*10/20/13*	*8/17/14*	*8/17/14*	*11/20/11*	*11/20/11*
Benzene	1.60E+00	c*	1.60E+01	c*	**1.5**	**1.5**	**11**	**19**	<0.26	**0.75**	**0.72**	**0.56**	**0.56**	**0.55**	**0.70**	**0.47**	**0.41**
Benzyl chloride	2.50E-01	c*	2.50E+00	c*	<0.83	<0.83	<1.7	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83
Bromomethane	2.20E+01	nc	2.20E+02	nc	<0.31	<0.31	<0.62	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31
Carbon tetrachloride	2.00E+00	c	2.00E+01	c	**1.8**	**1.7**	<1.0	**1.9**	<0.50	**0.71**	**0.64**	**0.58**	**0.58**	**0.59**	**0.70**	**0.73**	**0.56**
Chlorobenzene	2.20E+02	nc	2.20E+03	nc	<0.37	<0.37	<0.74	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37
Chloroethane	4.40E+04	nc	4.40E+05	nc	<0.21	<0.21	<0.42	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21
Chloroform	5.30E-01	c	5.30E+00	c	**0.7**	**0.65**	<0.78	**1.3**	<0.41	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39
Chloromethane	3.90E+02	nc	3.90E+03	nc	**1.0**	**1.0**	**1.4**	**1.1**	<0.41	**0.78**	**0.80**	**1.1**	**1.2**	**1.1**	**0.81**	**0.84**	**0.80**
1,2-Dibromoethane (EDB)	2.00E-02	c	2.00E-01	c	<0.61	<0.61	<1.2	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61
1,2-Dichlorobenzene	8.80E+02	nc	8.80E+03	nc	<0.48	<0.48	<0.96	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48
1,3-Dichlorobenzene	NA		NA		<0.48	<0.48	<0.96	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48
1,4-Dichlorobenzene	1.10E+00	c	1.10E+01	c	<0.48	**0.55**	**1.2**	**14**	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	**1.2**	<0.48	<0.48
Dichlorodifluoromethane	4.40E+02	nc	4.40E+03	nc	**2.2**	**2.2**	**2.9**	**2.4**	**1.2**	**1.8**	**1.8**	**1.4**	**1.2**	**2.1**	**2.4**	**2.0**	**2.0**
1,1-Dichloroethane	7.70E+00	c	7.70E+01	c	<0.32	<0.32	<0.65	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32
1,2-Dichloroethane	4.70E-01	c*	4.70E+00	c*	**0.8**	**0.73**	**1.8**	**2.8**	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32
1,1-Dichloroethene	8.80E+02	nc	8.80E+03	nc	<0.32	<0.32	<0.63	<0.32	**0.33**	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32
cis-1,2-Dichloroethene	NA		NA		<0.32	<0.32	<0.63	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32
1,2-Dichloropropane	1.20E+00	c*	1.20E+01	c*	<0.37	<0.37	<0.74	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37
cis-1,3-Dichloropropene	NA		NA		<0.36	<0.36	<0.73	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36
trans-1,3-Dichloropropene	NA		NA		<0.36	<0.36	<0.73	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36
1,2-Dichloro-1,1,2,2-tetrafluorothane	NA		NA		<0.56	<0.56	<1.1	<0.56	<0.56	<0.56	<0.56	<0.56	<0.56	<0.56	<0.56	<0.56	<0.56
Ethylbenzene	4.90E+00	c	4.90E+01	c	**3.2**	**3.5**	**13**	**29**	<0.35	**0.59**	**0.40**	**0.38**	<0.35	**0.37**	**0.69**	<0.35	<0.35
Hexachlorobutadiene	5.60E-01	c	5.60E+00	c	<4.3	<4.3	<8.5	<4.3	<4.3	<4.3	<4.3	<4.3	<4.3	<4.3	<4.3	<4.3	<4.3
Methylene chloride	1.20E+03	c	1.20E+04	c	**4.6**	**6**	**2.4**	**2.0**	**3.8**	**1.4**	**5.4**	**5.7**	**1.8**	**0.76**	**18**	**1.9**	**1.8**
Styrene	4.40E+03	nc	4.40E+04	nc	**0.96**	**1.0**	**0.78**	**2.5**	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34
1,1,2,2-Tetrachloroethane	2.10E-01	c	2.10E+00	c	<0.55	<0.55	<1.1	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55
Tetrachloroethene	4.70E+01	c	4.70E+02	c	**5.3**	**5.2**	**8.2**	**3.5**	<0.54	<0.54	<0.54	<0.54	<0.54	<0.54	<0.54	<0.54	<0.54
Toluene	2.20E+04	nc	2.20E+05	nc	**9.8**	**11**	**62**	**93 E**	<0.45	**2.7**	**2.9**	**1.5**	**1.2**	**1.6**	**6.1**	**1.0**	**0.68**
1,2,4-Trichlorobenzene	8.80E+00	nc	8.80E+01	nc	<3.0	<3.0	<5.9	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,1,1-Trichloroethane	2.20E+04	nc	2.20E+05	nc	**0.47**	**0.54**	<0.87	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44
1,1,2-Trichloroethane	7.70E-01	c*	7.70E+00	c*	<0.44	<0.44	<0.87	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44
Trichloroethene	3.00E+00	c*	3.00E+01	c*	<0.21	<0.21	<0.43	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21
Trichlorofluoromethane	3.10E+03	nc	3.10E+04	nc	**1.5**	**1.4**	**1.6**	**1.8**	<0.45	**1.1**	**1.1**	**1.5**	**1.3**	**1.2**	**2.3**	**1.1**	**1.1**
1,1,2-Trichloro-1,2,2-trifluoroethane	1.30E+05	nc	1.30E+06	nc	**0.78**	**0.62**	<1.2	**0.65**	**3.1**	<0.61	<0.61	**0.64**	**0.66**	<0.61	<0.61	<0.61	<0.61
1,2,4-Trimethylbenzene	3.10E+01	nc	3.10E+02	nc	**2.3**	**2.8**	**13**	**33**	<0.39	**0.73**	<0.39	<0.39	<0.39	<0.39	**0.42**	<0.39	<0.39
1,3,5-Trimethylbenzene	NA		NA		**0.75**	**0.67**	**2.9**	**8.3**	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39
Vinyl chloride	2.80E+00	c	2.80E+01	c	<0.20	<0.20	<0.41	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
m-Xylene & p-Xylene	4.40E+02	nc	4.40E+03	nc	**9.6**	**10**	**44**	**91**	<0.35	**2.0**	**1.1**	**1.3**	**1.0**	**1.5**	**2.6**	**0.54**	**0.54**
o-Xylene	4.40E+02	nc	4.40E+03	nc	**3.1**	**3.5**	**15**	**33**	<0.35	**0.72**	**0.38**	**0.44**	**0.37**	**0.60**	**0.89**	<0.35	<0.35

Key:

blank cell = Data are not available
c = Carcinogen, target risk = 1×10^{-6}
c* = Noncarcinogenic value is less than 100 times the carcinogenic value
CAS # = Chemical Abstracts Service number
D = Result was obtained from the analysis of a dilution
E = Result exceeded calibration range
nc = Noncarcinogen, target hazard index = 1
NA= No toxicity factors available
USEPA, 2002 = U. S. Environmental Protection Agency, OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance), EPA 530-D-02-004, November 2002

[1] From the Regional Screening Level tables, dated June 2011, downloaded from http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm
[2] Obtained from USEPA, 2002, pages 28 and 44.
[3] Calculated as the Target Industrial Indoor Air Concentration divided by the Soil Gas-to-Indoor Air Attenuation Factor, per Section 6 of Appendix F of USEPA, 2002.
[4] This value was calculated by using the equations and parameters specified in the June 2011 Regional Screening Tables web page and the September 28, 2011 toxicity factors published by USEPA.

TABLE 3-4
GROUNDWATER ELEVATION DATA SUMMARY
FORMER WATERLOO INDUSTRIES FACILITY
WATERLOO, IOWA

Well	*Monitored Zone*	*TOC Elevation (feet AMSL)*	*Date*	*Depth to Water (feet BTOC)*	*Groundwater Elevation (feet AMSL)*
MW-1	Perched	873.89	8/10/2011	8.81	865.08
MW-1	Perched	873.89	11/9/2011	3.13	870.76
MW-1	Perched	873.89	12/6/2011	2.90	870.99
MW-1	Perched	873.89	1/19/2012	2.99	870.90
MW-1	Perched	873.89	9/24/2013	2.80	871.09
MW-1	Perched	873.89	12/9/2013	2.94	870.95
MW-1	Perched	873.89	4/7/2014	1.36	872.53
MW-1	Perched	873.89	5/29/2014	1.61	872.28
MW-1D	Bedrock	874.05	1/19/2012	36.26	837.79
MW-1D	Bedrock	874.05	9/24/2013	35.76	838.29
MW-1D	Bedrock	874.05	12/9/2013	37.94	836.11
MW-1D	Bedrock	874.05	4/7/2014	34.32	839.73
MW-1D	Bedrock	874.05	5/29/2014	34.91	839.14
MW-2	Perched	874.35	8/10/2011	5.85	868.50
MW-2	Perched	874.35	11/9/2011	6.57	867.78
MW-2	Perched	874.35	12/6/2011	6.19	868.16
MW-2	Perched	874.35	1/19/2012	6.89	867.46
MW-2	Perched	874.35	9/24/2013	6.48	867.87
MW-2	Perched	874.35	12/9/2013	8.30	866.05
MW-2	Perched	874.35	4/7/2014	6.09	868.26
MW-2	Perched	874.35	5/29/2014	6.04	868.31
MW-2D	Bedrock	874.57	11/9/2011	36.74	837.83
MW-2D	Bedrock	874.57	12/6/2011	37.09	837.48
MW-2D	Bedrock	874.57	1/19/2012	36.78	837.79
MW-2D	Bedrock	874.57	9/24/2013	36.13	838.44
MW-2D	Bedrock	874.57	12/9/2013	37.32	837.25
MW-2D	Bedrock	874.57	4/7/2014	34.71	839.86
MW-2D	Bedrock	874.57	5/29/2014	34.95	839.62
MW-3	Bedrock	873.89	1/19/2012	36.10	837.79
MW-3	Bedrock	873.89	9/24/2013	35.28	838.61
MW-3	Bedrock	873.89	12/9/2013	36.27	837.62
MW-3	Bedrock	873.89	4/7/2014	33.73	840.16
MW-3	Bedrock	873.89	5/29/2014	34.03	839.86
MW-4	Perched	873.89	8/10/2011	19.85	854.04
MW-4	Perched	873.89	11/9/2011	18.44	855.45
MW-4	Perched	873.89	12/6/2011	18.59	855.30
MW-4	Perched	873.89	1/19/2012	18.50	855.39
MW-4	Perched	873.89	9/24/2013	18.27	855.62
MW-4	Perched	873.89	12/9/2013	19.17	854.72
MW-4	Perched	873.89	4/7/2014	22.58	851.31
MW-4	Perched	873.89	5/29/2014	22.91	850.98

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WATERLOO, IOWA

Well	*Monitored Zone*	*TOC Elevation (feet AMSL)*	*Date*	*Depth to Water (feet BTOC)*	*Groundwater Elevation (feet AMSL)*
MW-5	Bedrock	855.98	8/10/2011	15.87	840.11
MW-5	Bedrock	855.98	11/9/2011	16.17	839.81
MW-5	Bedrock	855.98	12/6/2011	15.67	840.31
MW-5	Bedrock	855.98	1/19/2012	16.13	839.85
MW-5	Bedrock	855.98	9/24/2013	16.48	839.50
MW-5	Bedrock	855.98	12/9/2013	17.51	838.47
MW-5	Bedrock	855.98	4/7/2014	14.33	841.65
MW-5	Bedrock	855.98	5/29/2014	14.31	841.67
MW-6	Bedrock	856.46	8/10/2011	15.81	840.65
MW-6	Bedrock	856.46	11/9/2011	16.34	840.12
MW-6	Bedrock	856.46	12/6/2011	15.94	840.52
MW-6	Bedrock	856.46	1/19/2012	16.39	840.07
MW-6	Bedrock	856.46	9/24/2013	16.43	840.03
MW-6	Bedrock	856.46	12/9/2013	17.34	839.12
MW-6	Bedrock	856.46	4/7/2014	13.25	843.21
MW-6	Bedrock	856.46	5/29/2014	13.87	842.59
MW-8	Perched	874.04	8/10/2011	10.56	863.48
MW-8	Perched	874.04	11/9/2011	7.11	866.93
MW-8	Perched	874.04	12/6/2011	7.00	867.04
MW-8	Perched	874.04	1/19/2012	6.76	867.28
MW-8	Perched	874.04	9/24/2013	6.94	867.10
MW-8	Perched	874.04	12/9/2013	7.35	866.69
MW-8	Perched	874.04	4/7/2014	6.43	867.61
MW-8	Perched	874.04	5/29/2014	6.44	867.60
MW-9	Perched	874.11	11/9/2011	10.57	863.54
MW-9	Perched	874.11	12/6/2011	10.28	863.83
MW-9	Perched	874.11	1/19/2012	10.72	863.39
MW-9	Perched	874.11	9/24/2013	10.64	863.47
MW-9	Perched	874.11	12/9/2013	10.64	863.47
MW-9	Perched	874.11	4/7/2014	9.79	864.32
MW-9	Perched	874.11	5/29/2014	could not locate	
MW-10	Perched	874.14	11/9/2011	13.08	861.06
MW-10	Perched	874.14	12/6/2011	12.79	861.35
MW-10	Perched	874.14	1/19/2012	13.29	860.85
MW-10	Perched	874.14	9/24/2013	12.88	861.26
MW-10	Perched	874.14	12/9/2013	13.65	860.49
MW-10	Perched	874.14	4/7/2014	12.58	861.56
MW-10	Perched	874.14	5/29/2014	11.85	862.29
MW-11	Perched	873.88	11/9/2011	19.59	854.29
MW-11	Perched	873.88	12/6/2011	19.33	854.55
MW-11	Perched	873.88	1/19/2012	19.08	854.80
MW-11	Perched	873.88	9/24/2013	18.77	855.11
MW-11	Perched	873.88	12/9/2013	18.99	854.89
MW-11	Perched	873.88	4/7/2014	18.74	855.14
MW-11	Perched	873.88	5/29/2014	18.42	855.46

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Well	*Monitored Zone*	*TOC Elevation (feet AMSL)*	*Date*	*Depth to Water (feet BTOC)*	*Groundwater Elevation (feet AMSL)*
MW-12	Bedrock	855.86	11/9/2011	15.80	840.06
MW-12	Bedrock	855.86	12/6/2011	15.33	840.53
MW-12	Bedrock	855.86	1/19/2012	NA	NA
MW-12	Bedrock	855.86	9/24/2013	16.29	839.57
MW-12	Bedrock	855.86	12/9/2013	17.34	838.52
MW-12	Bedrock	855.86	4/7/2014	14.30	841.56
MW-12	Bedrock	855.86	5/29/2014	14.13	841.73
MW-13	Bedrock	855.85	11/9/2011	16.07	839.78
MW-13	Bedrock	855.85	12/6/2011	15.57	840.28
MW-13	Bedrock	855.85	1/19/2012	NA	NA
MW-13	Bedrock	855.85	9/24/2013	16.40	839.45
MW-13	Bedrock	855.85	12/9/2013	17.42	838.43
MW-13	Bedrock	855.85	4/7/2014	14.33	841.52
MW-13	Bedrock	855.85	5/29/2014	14.23	841.62
MW-14	Perched	874.10	1/19/2012	Dry	Dry
MW-14	Perched	874.10	2/14/2012	23.15	850.95
MW-14	Perched	874.10	9/24/2013	21.28	852.82
MW-14	Perched	874.10	12/9/2013	21.45	852.65
MW-14	Perched	874.10	4/7/2014	21.38	852.72
MW-14	Perched	874.10	5/29/2014	21.12	852.98
MW-15	Bedrock	857.91	1/16/2012	NA	NA
MW-15	Bedrock	857.91	1/19/2012	NA	NA
MW-15	Bedrock	857.91	9/24/2013	15.94	841.97
MW-15	Bedrock	857.91	12/9/2013	17.05	840.86
MW-15	Bedrock	857.91	4/7/2014	14.28	843.63
MW-15	Bedrock	857.91	5/29/2014	14.02	843.89
MW-16	Bedrock	857.32	1/19/2012	17.92	839.40
MW-16	Bedrock	857.32	9/24/2013	17.29	840.03
MW-16	Bedrock	857.32	12/9/2013	18.29	839.03
MW-16	Bedrock	857.32	4/7/2014	16.38	840.94
MW-16	Bedrock	857.32	5/29/2014	16.45	840.87
MW-17	Bedrock	873.63	1/19/2012	36.04	837.59
MW-17	Bedrock	873.63	9/24/2013	35.44	838.19
MW-17	Bedrock	873.63	12/9/2013	36.65	836.98
MW-17	Bedrock	873.63	4/7/2014	34.1	839.53
MW-17	Bedrock	873.63	5/29/2014	34.33	839.30
MW-23	Bedrock	870.10	4/7/2014	30.65	839.45
MW-23	Bedrock	870.10	5/29/2014	30.89	839.21
MW-24	Bedrock	869.77	4/7/2014	30.40	839.37
MW-24	Bedrock	869.77	5/29/2014	30.49	839.28
MW-25	Bedrock	873.36	4/7/2014	32.78	840.58
MW-25	Bedrock	873.36	5/29/2014	33.50	839.86

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WATERLOO, IOWA

Well	*Monitored Zone*	*TOC Elevation (feet AMSL)*	*Date*	*Depth to Water (feet BTOC)*	*Groundwater Elevation (feet AMSL)*
MW-26	Bedrock	868.55	4/7/2014	25.29	843.26
MW-26	Bedrock	868.55	5/29/2014	24.07	844.48
MW-27	Bedrock	874.03	4/7/2014	33.48	840.55
MW-27	Bedrock	874.03	5/29/2014	33.61	840.42
MW-28	Perched	873.91	4/7/2014	9.81	864.10
MW-28	Perched	873.91	5/29/2014	9.42	864.49

Notes:
AMSL = above mean sea level
BGS = below ground surface
BTOC = below top of casing
NA = not applicable

TABLE 3-5
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - VOLATILE ORGANIC COMPOUNDS
RCRA FACILITY INVESTIGATION
FORMER WATERLOO INDUSTRIES FACILITY, WATERLOO, IOWA

Investigation Target			AOC 5			Former WWT Area			AOC 5				Former WWT Area			Former WWT Area		
Sample ID			MW-1	WGW-1	WGW1	WGW-1D		WGW1D	MW-2	MW-2 Duplicate	WGW-2	WGW2	WGW2D			WGW-3		WGW3
Sample Location			MW-1			MW-1D			MW-2				MW-2D			MW-3		
Date Collected			8/10/2011	9/27/2013	12/12/2013	1/18/2012	9/25/2013	12/12/2013	8/10/2011	8/10/2011	9/27/2013	12/12/2013	11/10/2011	9/24/2013	12/12/2013	1/19/2012	9/26/2013	12/12/2013
	Units	Regional Screening Level																
Parameter		Tap Water [1]																
Volatile Organic Compounds		or MCL as noted																
1,1-Dichloropropene	mg/l	NE	<0.00015	<0.00100	<0.00100	<0.00015	<0.00100	<0.00100	<0.00015	<0.00015	<0.00100	<0.00100	**0.00021 J**	<0.00100	<0.00100	<0.00015	<0.00100	<0.00100
1,2,3-Trichlorobenzene	mg/l	0.0052 [2]	<0.00016	<0.00500	<0.00500	<0.00016	<0.00500	<0.00500	<0.00016	<0.00016	<0.00500	<0.00500	<0.00282	<0.00500	<0.00500	<0.00029	<0.00500	<0.00500
2,2-Dichloropropane	mg/l	NE	<0.00018	<0.00400	<0.00400	<0.00018	<0.00400	<0.00400	<0.00018	<0.00018	<0.00400	<0.00400	<0.00018	<0.00400	<0.00400	<0.00018	<0.00400	<0.00400
Acetone	mg/l	12 [2]	**0.0182**	<0.0100	<0.0100	<0.00179	<0.0100	<0.0100	**0.00754 J**	**0.0103**	<0.0100	<0.0100	<0.0023	<0.0100	<0.0100	<0.00225	<0.0100	<0.0100
Acrylonitrile	mg/l	0.000045 [2]	<0.00053	NA	NA	<0.00053	NA	NA	<0.00053	<0.00053	NA	NA	<0.00053	NA	NA	<0.00053	NA	NA
Benzene	mg/l	0.005 (MCL)	<0.00011	<0.000500	<0.000500	<0.00011	<0.000500	<0.000500	<0.00011	<0.00011	**0.000798**	**0.000739**	<0.00011	<0.000500	<0.000500	**0.00015 J**	<0.000500	<0.000500
Bromochloromethane	mg/l	0.083	<0.00012	<0.00500	<0.00500	<0.00012	<0.00500	<0.00500	<0.00012	<0.00012	<0.00500	<0.00500	**0.00013 J**	<0.00500	<0.00500	<0.00012	<0.00500	<0.00500
Bromodichloromethane	mg/l	0.08 (MCL)	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100
Bromoform	mg/l	0.08 (MCL)	<0.00014	<0.00500	<0.00500	<0.00014	<0.00500	<0.00500	<0.00014	<0.00014	<0.00500	<0.00500	<0.00014	<0.00500	<0.00500	<0.00014	<0.00500	<0.00500
Bromomethane	mg/l	0.007 [2]	<0.00022	<0.00400	<0.00400	<0.00022	<0.00400	<0.00400	<0.00022	<0.00022	<0.00400	<0.00400	<0.00037	<0.00400	<0.00400	<0.00058	<0.00400	<0.00400
Butylbenzene, n-	mg/l	0.78 [2]	<0.00037	<0.00100	<0.00100	<0.00037	<0.00100	<0.00100	<0.00037	<0.00037	<0.00100	<0.00100	<0.00043	<0.00100	<0.00100	<0.00037	<0.00100	<0.00100
Carbon disulfide	mg/l	0.72 [2]	**0.00015 J**	<0.00100	<0.00100	<0.00015	<0.00100	<0.00100	<0.00015	<0.00015	<0.00100	<0.00100	<0.00024	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100
Carbon Tetrachloride	mg/l	0.005 (MCL)	<0.00024	<0.00200	<0.00200	<0.00024	<0.00200	<0.00200	<0.00024	<0.00024	<0.00200	<0.00200	<0.00024	<0.00200	<0.00200	<0.00024	<0.00200	<0.00200
Chlorobenzene	mg/l	0.1 (MCL)	<0.00019	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100	<0.00019	<0.00019	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100
Chloroethane	mg/l	21	<0.00015	<0.00400	<0.00400	<0.00015	<0.00400	<0.00400	<0.00015	<0.00015	<0.00400	<0.00400	<0.00015	<0.00400	<0.00400	<0.00015	<0.00400	<0.00400
Chloroform	mg/l	0.08 (MCL)	<0.00028	<0.00100	<0.00100	<0.00028	<0.00100	<0.00100	<0.00028	<0.00028	<0.00100	<0.00100	<0.00028	<0.00100	<0.00100	<0.00028	<0.00100	<0.00100
Chloromethane	mg/l	0.19	<0.00031	<0.00300	<0.00300	<0.00031	<0.00300	<0.00300	<0.00031	<0.00031	<0.00300	<0.00300	<0.00031	<0.00300	<0.00300	<0.00031	<0.00300	<0.00300
Chlorotoluene, 2-	mg/l	0.18	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.00012	<0.00100	<0.00100	<0.00013	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100
Chlorotoluene, 4-	mg/l	0.19 [2]	<0.00013	<0.00100	<0.00100	<0.00013	<0.00100	<0.00100	<0.00013	<0.00013	<0.00100	<0.00100	<0.00015	<0.00100	<0.00100	<0.00013	<0.00100	<0.00100
Cumene (Isopropylbenzene)	mg/l	0.39 [2]	<0.00019	<0.00100	<0.00100	**0.00035 J**	**0.00153**	**0.00111**	<0.00019	<0.00019	<0.00100	<0.00100	<0.000190	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100
Dibromo-3-chloropropane, 1,2- (DBCP)	mg/l	0.0002 (MCL)	<0.00012	<0.0100	<0.0100	<0.00012	<0.0100	<0.0100	<0.00012	<0.00012	<0.0100	<0.0100	**0.00213 J**	<0.0100	<0.0100	<0.00012	<0.0100	<0.0100
Dibromochloromethane	mg/l	0.08 (MCL)	<0.0002	<0.00500	<0.00500	<0.0002	<0.00500	<0.00500	<0.0002	<0.0002	<0.00500	<0.00500	<0.0002	<0.00500	<0.00500	<0.0002	<0.00500	<0.00500
Dibromoethane, 1,2-	mg/l	0.00005 (MCL) [2]	<0.00013	<0.0100	<0.0100	<0.00013	<0.0100	<0.0100	<0.00013	<0.00013	<0.0100	<0.0100	<0.00013	<0.0100	<0.0100	<0.00013	<0.0100	<0.0100
Dibromomethane (Methylene Bromide)	mg/l	0.0079 [2]	<0.00018	<0.00100	<0.00100	<0.00018	<0.00100	<0.00100	<0.00018	<0.00018	<0.00100	<0.00100	<0.00018	<0.00100	<0.00100	<0.00018	<0.00100	<0.00100
Dichlorobenzene, 1,2-	mg/l	0.6 (MCL)	<0.00014	<0.00100	<0.00100	<0.00014	<0.00100	<0.00100	<0.00014	<0.00014	<0.00100	<0.00100	<0.00032	<0.00100	<0.00100	<0.00014	<0.00100	<0.00100
Dichlorobenzene, 1,3-	mg/l	NE	<0.00017	<0.00100	<0.00100	<0.00017	<0.00100	<0.00100	<0.00017	<0.00017	<0.00100	<0.00100	**0.00028 J**	<0.00100	<0.00100	<0.00017	<0.00100	<0.00100
Dichlorobenzene, 1,4-	mg/l	0.075 (MCL)	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.0002	<0.0002	<0.00100	<0.00100	<0.00040	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100
Dichlorodifluoromethane	mg/l	0.19 [2]	<0.0002	<0.00300	<0.00300	<0.0002	<0.00300	<0.00300	<0.0002	<0.0002	<0.00300	<0.00300	<0.0002	<0.00300	<0.00300	<0.0002	<0.00300	<0.00300
Dichloroethane, 1,1-	mg/l	0.0024	<0.00021	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	**0.0007 J**	**0.00076 J**	**0.00337**	**0.0035**	<0.00021	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100
Dichloroethane, 1,2-	mg/l	0.005 (MCL)	<0.00018	<0.00100	<0.00100	<0.00018	<0.00100	<0.00100	<0.00018	<0.00018	**0.00248**	**0.00231**	<0.00018	<0.00100	<0.00100	<0.00018	<0.00100	<0.00100
Dichloroethylene, 1,1-	mg/l	0.007 (MCL)	<0.00015	<0.00200	<0.00200	<0.00015	<0.00200	<0.00200	<0.00015	<0.00015	**0.00319**	**0.00346**	<0.00015	<0.00200	<0.00200	<0.00015	<0.00200	<0.00200

TABLE 3-5
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - VOLATILE ORGANIC COMPOUNDS
RCRA FACILITY INVESTIGATION
FORMER WATERLOO INDUSTRIES FACILITY, WATERLOO, IOWA

Investigation Target			AOC 5			Former WWT Area			AOC 5				Former WWT Area			Former WWT Area		
Sample ID			MW-1	WGW-1	WGW1	WGW-1D		WGW1D	MW-2	MW-2 Duplicate	WGW-2	WGW2	WGW2D			WGW-3		WGW3
Sample Location			MW-1			MW-1D			MW-2				MW-2D			MW-3		
Date Collected			8/10/2011	9/27/2013	12/12/2013	1/18/2012	9/25/2013	12/12/2013	8/10/2011	8/10/2011	9/27/2013	12/12/2013	11/10/2011	9/24/2013	12/12/2013	1/19/2012	9/26/2013	12/12/2013
	Units	Regional Screening Level																
Parameter		Tap Water [1]																
Volatile Organic Compounds		or MCL as noted																
Dichloroethylene, 1,2-cis-	mg/l	0.07 (MCL)	<0.00013	<0.00100	<0.00100	<0.00044	<0.00100	<0.00100	**0.0004 J**	**0.00034 J**	**0.00961**	**0.0112**	**0.00081 J**	<0.00100	<0.00100	**0.00298**	**0.00177**	**0.00263**
Dichloroethylene, 1,2-trans-	mg/l	0.1 (MCL)	<0.00021	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	<0.00021	<0.00021	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	**0.00023 J**	<0.00100	<0.00100
Dichloropropane, 1,2-	mg/l	0.005 (MCL)	<0.00087	<0.00100	<0.00100	<0.00087	<0.00100	<0.00100	<0.00087	<0.00087	**0.00167**	**0.00185**	<0.00087	<0.00100	<0.00100	<0.00087	<0.00100	<0.00100
Dichloropropane, 1,3-	mg/l	0.29	<0.00016	<0.00100	<0.00100	<0.00016	<0.00100	<0.00100	<0.00016	<0.00016	<0.00100	<0.00100	<0.00016	<0.00100	<0.00100	<0.00016	<0.00100	<0.00100
Dichloropropene, 1,3-cis	mg/l	NE	<0.00015	<0.00500	<0.00500	<0.00015	<0.00500	<0.00500	<0.00015	<0.00015	<0.00500	<0.00500	<0.00015	<0.00500	<0.00500	<0.00015	<0.00500	<0.00500
Dichloropropene, 1,3-trans	mg/l	NE	<0.00022	<0.00500	<0.00500	<0.00022	<0.00500	<0.00500	<0.00022	<0.00022	<0.00500	<0.00500	<0.00022	<0.00500	<0.00500	<0.00022	<0.00500	<0.00500
Ethylbenzene	mg/l	0.7 (MCL)	<0.00021	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	<0.00021	<0.00021	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100
Hexachlorobutadiene	mg/l	0.00026 [2]	<0.0002	<0.00500	<0.00500	<0.0002	<0.00500	<0.00500	<0.0002	<0.0002	<0.00500	<0.00500	<0.00111	<0.00500	<0.00500	<0.00065	<0.00500	<0.00500
Hexane, N-	mg/l	0.25 [2]	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.0002	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100
Methyl Ethyl Ketone	mg/l	4.9 [2]	<0.00047	<0.0100	<0.0100	<0.00047	<0.0100	<0.0100	<0.00047	<0.00047	<0.0100	<0.0100	<0.00134	<0.0100	<0.0100	<0.00047	<0.0100	<0.0100
Methyl tert-Butyl Ether (MTBE)	mg/l	0.012	<0.00016	<0.00100	<0.00100	<0.00016	<0.00100	<0.00100	<0.00016	<0.00016	<0.00100	<0.00100	<0.00016	<0.00100	<0.00100	<0.00016	<0.00100	<0.00100
Methylene Chloride (Dichloromethane)	mg/l	0.005 (MCL)	**0.00021 J**	<0.00500	<0.00500	<0.00026	<0.00500	<0.00500	<0.00017	**0.00019 J**	<0.00500	<0.00500	<0.00019	<0.00500	<0.00500	<0.00054	<0.00500	<0.00500
Naphthalene	mg/l	0.00014	<0.00037	<0.00500	<0.00500	<0.0014	<0.00500	**0.00503**	<0.00037	<0.00037	<0.00500	<0.00500	<0.00359	<0.00500	<0.00500	<0.00299	<0.00500	<0.00500
p-Isopropyltoluene	mg/l	NE	<0.00014	<0.00100	<0.00100	<0.00014	<0.00100	<0.00100	<0.00014	<0.00014	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	<0.00014	<0.00100	<0.00100
n-Propylbenzene	mg/l	0.53 [2]	<0.0001	<0.00100	<0.00100	**0.0004 J**	**0.00169**	**0.00158**	<0.0001	<0.0001	<0.00100	<0.00100	<0.00014	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100
sec-Butylbenzene	mg/l	1.6 [2]	<0.0002	<0.00100	<0.00100	<0.00021	**0.00104**	**0.00108**	<0.0002	<0.0002	<0.00100	<0.00100	<0.00030	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100
Styrene	mg/l	0.1 (MCL)	<0.0001	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100	<0.0001	<0.0001	<0.00100	<0.00100	**0.0001 J**	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100
tert-Butylbenzene	mg/l	0.51 [2]	<0.00012	<0.00100	<0.00100	**0.00012 J**	<0.00100	<0.00100	<0.00012	<0.00012	<0.00100	<0.00100	<0.00026	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100
Tetrachloroethane, 1,1,1,2-	mg/l	0.0005	<0.00021	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	<0.00021	<0.00021	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100
Tetrachloroethane, 1,1,2,2-	mg/l	0.000066	<0.0001	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100	<0.0001	<0.0001	<0.00100	<0.00100	**0.00038 J**	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100
Tetrachloroethylene	mg/l	0.005 (MCL)	<0.00018	<0.00100	**0.00723**	<0.00018	<0.00100	<0.00100	**0.00023 J**	<0.00018	<0.00100	**0.00234**	<0.00018	<0.00100	<0.00100	**0.00025 J**	**0.00101**	<0.00100
Toluene	mg/l	1.0 (MCL)	<0.00015	<0.00100	<0.00100	<0.00015	<0.00100	<0.00100	<0.00015	<0.00015	<0.00100	<0.00100	<0.00015	<0.00100	<0.00100	<0.00015	<0.00100	<0.00100
Trichlorobenzene, 1,2,4-	mg/l	0.07 (MCL)	<0.00016	<0.00500	<0.00500	<0.00016	<0.00500	<0.00500	<0.00016	<0.00016	<0.00500	<0.00500	<0.0014	<0.00500	<0.00500	<0.00016	<0.00500	<0.00500
Trichloroethane, 1,1,1-	mg/l	0.2 (MCL)	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100
Trichloroethane, 1,1,2-	mg/l	0.005 (MCL)	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.00012	<0.00100	<0.00100	**0.00012 J**	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100
Trichloroethylene	mg/l	0.005 (MCL)	<0.00019	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100	<0.00019	<0.00019	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100	**0.00036 J**	<0.00100	<0.00100
Trichlorofluoromethane	mg/l	1.1 [2]	<0.00017	<0.00400	<0.00400	<0.00017	<0.00400	<0.00400	<0.00017	<0.00017	<0.00400	<0.00400	<0.00017	<0.00400	<0.00400	<0.00017	<0.00400	<0.00400
Trichloropropane, 1,2,3-	mg/l	0.00000065 [2]	<0.00019	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100	<0.00019	<0.00019	<0.00100	<0.00100	**0.00022 J**	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100
Trimethylbenzene, 1,2,4-	mg/l	0.015	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.0002	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100
Trimethylbenzene, 1,3,5-	mg/l	0.087 [2]	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.0002	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100
Vinyl chloride	mg/l	0.002 (MCL)	<0.0001	<0.00100	<0.00100	**0.00072 J**	<0.00100	<0.00100	<0.0001	<0.0001	**0.00146**	<0.00100	**0.00119**	**0.00103**	<0.00100	**0.00253**	<0.00100	**0.00102**
Xylene, Total	mg/l	10 (MCL)	<0.00013	<0.00300	<0.00300	<0.00013	<0.00300	<0.00300	<0.00013	<0.00013	<0.00300	<0.00300	<0.00018	<0.00300	<0.00300	<0.00013	<0.00300	<0.00300

Notes:
Bold values were detected above laboratory detection limits
Highlighted values exceed the applicable regional screening level
(1) MCLs used for purposes of screening, in event none are available. Regional Screening Levels (RSLs) for tap water (as of November 2011) are provided.
(2) Updated based on November 2013 RSLs (reviewed 12/27/2013). Data prior to November 2013 will be compared to previous RSLs.
B = Analyte was detected in the associated method blank
J = Analyte detected at a level less than the Reporting Limit (RL) and greater than or equal to the Method Detection Limit (MDL); concentrations within this range are estimated
MCL = Maximum Contaminant Level
NE = Not Established
WWT = Wastewater Treatment
NA = Not Analyzed

TABLE 3-5
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - VOLATILE ORGANIC COMPOUNDS
RCRA FACILITY INVESTIGATION
FORMER WATERLOO INDUSTRIES FACILITY, WATERLOO, IOWA

Investigation Target			AOC 5				Former WWT Area			Former WWT Area			AOC 5			
Sample ID			MW-4	WGW-4	WGW4	WGWDup7	MW-5	WGW-5	WGW5	MW-6	WGW-6	WGW6	MW-8	WGW-8	WGW-Dup 6	WGW8
Sample Location			MW-4				MW-5			MW-6			MW-8			
Date Collected			8/10/2011	9/27/2013	12/10/2013	12/10/2013	8/3/2011	9/24/2013	12/11/2013	8/3/2011	9/24/2013	12/10/2013	8/10/2011	9/27/2013	9/27/2013	12/13/2013
	Units	Regional Screening Level														
Parameter		Tap Water [1]														
Volatile Organic Compounds		or MCL as noted														
1,1-Dichloropropene	mg/l	NE	<0.00015	<0.00100	<0.00100	<0.00100	<0.00015	<0.00100	<0.00100	<0.00015	<0.00100	<0.00100	<0.00015	<0.0100	<0.0100	<0.00100
1,2,3-Trichlorobenzene	mg/l	0.0052 [2]	<0.00016	<0.00500	<0.00500	<0.00500	**0.00044 J**	<0.00500	<0.00500	<0.00016	<0.00500	<0.00500	<0.00016	<0.0500	<0.0500	<0.00500
2,2-Dichloropropane	mg/l	NE	<0.00018	<0.00400	<0.00400	<0.00400	<0.00018	<0.00400	<0.00400	<0.00018	<0.00400	<0.00400	<0.00018	<0.0400	<0.0400	<0.00400
Acetone	mg/l	12 [2]	**0.00957 J**	<0.0100	<0.0100	<0.0100	**0.0021 J**	<0.0100	<0.0100	**0.00302 J**	<0.0100	<0.0100	**0.0214**	<0.100	<0.100	**0.0183**
Acrylonitrile	mg/l	0.000045 [2]	<0.00053	NA	NA	NA	<0.00053	NA	NA	<0.00053	NA	NA	<0.00053	NA	NA	NA
Benzene	mg/l	0.005 (MCL)	<0.00011	<0.000500	<0.000500	<0.000500	<0.00011	<0.000500	<0.000500	<0.00011	<0.000500	<0.000500	**0.0003 J**	**0.00693**	<0.00500	**0.00307**
Bromochloromethane	mg/l	0.083	<0.00012	<0.00500	<0.00500	<0.00500	<0.00021	<0.00500	<0.00500	<0.00021	<0.00500	<0.00500	<0.00012	<0.0500	<0.0500	<0.00500
Bromodichloromethane	mg/l	0.08 (MCL)	<0.00012	<0.00100	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.0100	<0.0100	<0.00100
Bromoform	mg/l	0.08 (MCL)	<0.00014	<0.00500	<0.00500	<0.00500	<0.00014	<0.00500	<0.00500	<0.00014	<0.00500	<0.00500	<0.00014	<0.0500	<0.0500	<0.00500
Bromomethane	mg/l	0.007 [2]	**0.00025 J**	<0.00400	<0.00400	<0.00400	<0.00022	<0.00400	<0.00400	<0.00022	<0.00400	<0.00400	<0.00022	<0.0400	<0.0400	<0.00400
Butylbenzene, n-	mg/l	0.78 [2]	<0.00037	<0.00100	<0.00100	<0.00100	<0.00037	<0.00100	<0.00100	<0.00037	<0.00100	<0.00100	**0.00707**	**0.0666**	**0.0523**	**0.0712**
Carbon disulfide	mg/l	0.72 [2]	**0.0002 J**	<0.00100	<0.00100	<0.00100	**0.00023 J**	<0.00100	<0.00100	<0.00015	<0.00100	<0.00100	<0.00015	<0.0100	<0.0100	<0.00100
Carbon Tetrachloride	mg/l	0.005 (MCL)	<0.00024	<0.00200	<0.00200	<0.00200	<0.00024	<0.00200	<0.00200	<0.00024	<0.00200	<0.00200	<0.00024	<0.0200	**0.0747**	<0.00200
Chlorobenzene	mg/l	0.1 (MCL)	<0.00019	<0.00100	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100	<0.00019	<0.0100	<0.0100	<0.00100
Chloroethane	mg/l	21	<0.00015	<0.00400	<0.00400	<0.00400	<0.00015	<0.00400	<0.00400	<0.00015	<0.00400	<0.00400	<0.00015	<0.0400	<0.0400	<0.00400
Chloroform	mg/l	0.08 (MCL)	<0.00028	<0.00100	<0.00100	<0.00100	<0.00028	<0.00100	<0.00100	<0.00028	<0.00100	<0.00100	**0.0003 J**	<0.0100	<0.0100	<0.00100
Chloromethane	mg/l	0.19	<0.00031	<0.00300	<0.00300	<0.00300	<0.00031	<0.00300	<0.00300	<0.00031	<0.00300	<0.00300	<0.00031	<0.0300	<0.0300	<0.00300
Chlorotoluene, 2-	mg/l	0.18	<0.00012	<0.00100	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.0100	<0.0100	**0.00775**
Chlorotoluene, 4-	mg/l	0.19 [2]	<0.00013	<0.00100	<0.00100	<0.00100	<0.00013	<0.00100	<0.00100	<0.00013	<0.00100	<0.00100	<0.00013	<0.0100	<0.0100	**0.00655**
Cumene (Isopropylbenzene)	mg/l	0.39 [2]	<0.00019	<0.00100	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100	<0.00019	<0.0100	<0.0100	**0.00147**
Dibromo-3-chloropropane, 1,2- (DBCP)	mg/l	0.0002 (MCL)	<0.00012	<0.0100	<0.0100	<0.0100	<0.00012	<0.0100	<0.0100	<0.00012	<0.0100	<0.0100	<0.00012	<0.100	<0.100	<0.0100
Dibromochloromethane	mg/l	0.08 (MCL)	<0.0002	<0.00500	<0.00500	<0.00500	<0.0002	<0.00500	<0.00500	<0.0002	<0.00500	<0.00500	<0.0002	<0.0500	<0.0500	<0.00500
Dibromoethane, 1,2-	mg/l	0.00005 (MCL) [2]	<0.00013	<0.0100	<0.0100	<0.0100	<0.00013	<0.0100	<0.0100	<0.00013	<0.0100	<0.0100	<0.00013	<0.100	<0.100	<0.0100
Dibromomethane (Methylene Bromide)	mg/l	0.0079 [2]	<0.00018	<0.00100	<0.00100	<0.00100	<0.00018	<0.00100	<0.00100	<0.00018	<0.00100	<0.00100	<0.00018	<0.0100	<0.0100	<0.00100
Dichlorobenzene, 1,2-	mg/l	0.6 (MCL)	<0.00014	<0.00100	<0.00100	<0.00100	<0.00014	<0.00100	<0.00100	<0.00014	<0.00100	<0.00100	<0.00014	<0.0100	<0.0100	<0.00100
Dichlorobenzene, 1,3-	mg/l	NE	<0.00017	<0.00100	<0.00100	<0.00100	<0.00017	<0.00100	<0.00100	<0.00017	<0.00100	<0.00100	<0.00017	<0.0100	<0.0100	<0.00100
Dichlorobenzene, 1,4-	mg/l	0.075 (MCL)	<0.0002	<0.00100	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.0002	<0.0100	<0.0100	<0.00100
Dichlorodifluoromethane	mg/l	0.19 [2]	<0.0002	<0.00300	<0.00300	<0.00300	<0.0002	<0.00300	<0.00300	<0.0002	<0.00300	<0.00300	<0.0002	<0.0300	<0.0300	<0.00300
Dichloroethane, 1,1-	mg/l	0.0024	**0.00021 J**	<0.00100	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	<0.00021	<0.0100	<0.0100	<0.00100
Dichloroethane, 1,2-	mg/l	0.005 (MCL)	<0.00018	<0.00100	<0.00100	<0.00100	<0.00018	<0.00100	<0.00100	<0.00018	<0.00100	<0.00100	<0.00018	<0.0100	<0.0100	<0.00100
Dichloroethylene, 1,1-	mg/l	0.007 (MCL)	<0.00015	<0.00200	<0.00200	<0.00200	**0.0002 J**	<0.00200	<0.00200	<0.00015	<0.00200	<0.00200	<0.00015	<0.0200	<0.0200	<0.00200

TABLE 3-5
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - VOLATILE ORGANIC COMPOUNDS
RCRA FACILITY INVESTIGATION
FORMER WATERLOO INDUSTRIES FACILITY, WATERLOO, IOWA

Investigation Target			AOC 5				Former WWT Area			Former WWT Area			AOC 5			
Sample ID			MW-4	WGW-4	WGW4	WGWDup7	MW-5	WGW-5	WGW5	MW-6	WGW-6	WGW6	MW-8	WGW-8	WGW-Dup 6	WGW8
Sample Location			MW-4				MW-5			MW-6			MW-8			
Date Collected			8/10/2011	9/27/2013	12/10/2013	12/10/2013	8/3/2011	9/24/2013	12/11/2013	8/3/2011	9/24/2013	12/10/2013	8/10/2011	9/27/2013	9/27/2013	12/13/2013
	Units	Regional Screening Level														
Parameter		Tap Water [1]														
Volatile Organic Compounds		or MCL as noted														
Dichloroethylene, 1,2-cis-	mg/l	0.07 (MCL)	**0.00894**	**0.00394**	**0.00436**	**0.00442**	**0.0392**	**0.0482**	**0.067**	**0.00686**	**0.00611**	**0.00593**	**0.012**	<0.0100	<0.0100	**0.0158**
Dichloroethylene, 1,2-trans-	mg/l	0.1 (MCL)	**0.00028 J**	<0.00100	<0.00100	<0.00100	**0.00055 J**	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	<0.00021	<0.0100	<0.0100	<0.00100
Dichloropropane, 1,2-	mg/l	0.005 (MCL)	<0.00087	<0.00100	<0.00100	<0.00100	<0.00087	<0.00100	<0.00100	<0.00087	<0.00100	<0.00100	<0.00087	<0.0100	<0.0100	<0.00100
Dichloropropane, 1,3-	mg/l	0.29	<0.00016	<0.00100	<0.00100	<0.00100	<0.00016	<0.00100	<0.00100	<0.00016	<0.00100	<0.00100	<0.00016	<0.0100	<0.0100	<0.00100
Dichloropropene, 1,3-cis	mg/l	NE	<0.00015	<0.00500	<0.00500	<0.00500	<0.00015	<0.00500	<0.00500	<0.00015	<0.00500	<0.00500	<0.00015	<0.0500	<0.0500	<0.00500
Dichloropropene, 1,3-trans	mg/l	NE	<0.00022	<0.00500	<0.00500	<0.00500	<0.00022	<0.00500	<0.00500	<0.00022	<0.00500	<0.00500	<0.00022	<0.0500	<0.0500	<0.00500
Ethylbenzene	mg/l	0.7 (MCL)	<0.00021	<0.00100	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	<0.00021	**0.0106**	<0.0100	**0.00255**
Hexachlorobutadiene	mg/l	0.00026 [2]	<0.0002	<0.00500	<0.00500	<0.00500	**0.00106 J**	<0.00500	<0.00500	<0.0002	<0.00500	<0.00500	<0.0002	<0.0500	<0.0500	<0.00500
Hexane, N-	mg/l	0.25 [2]	<0.0002	<0.00100	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.0002	<0.0100	<0.0100	<0.00100
Methyl Ethyl Ketone	mg/l	4.9 [2]	<0.00047	<0.0100	<0.0100	<0.0100	<0.00047	<0.0100	<0.0100	<0.00047	<0.0100	<0.0100	**0.0164**	<0.100	<0.100	<0.0100
Methyl tert-Butyl Ether (MTBE)	mg/l	0.012	<0.00016	<0.00100	<0.00100	<0.00100	<0.00016	<0.00100	<0.00100	<0.00016	<0.00100	<0.00100	<0.00016	<0.0100	<0.0100	<0.00100
Methylene Chloride (Dichloromethane)	mg/l	0.005 (MCL)	<0.00017	<0.00500	<0.00500	<0.00500	**0.00028 J**	<0.00500	<0.00500	**0.00023 J**	<0.00500	<0.00500	**0.00023 J**	<0.0500	<0.0500	<0.00500
Naphthalene	mg/l	0.00014	<0.00037	<0.00500	<0.00500	<0.00500	<0.00037	<0.00500	<0.00500	<0.00037	<0.00500	<0.00500	**0.012**	**0.196**	**0.165**	**0.267**
p-Isopropyltoluene	mg/l	NE	<0.00014	<0.00100	<0.00100	<0.00100	<0.00014	<0.00100	<0.00100	<0.00014	<0.00100	<0.00100	**0.00062 J**	<0.0100	<0.0100	**0.00382**
n-Propylbenzene	mg/l	0.53 [2]	<0.0001	<0.00100	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100	**0.00076 J**	**0.0191**	**0.0153**	**0.0195**
sec-Butylbenzene	mg/l	1.6 [2]	<0.0002	<0.00100	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	**0.00052 J**	**0.264**	<0.0100	**0.00493**
Styrene	mg/l	0.1 (MCL)	<0.0001	<0.00100	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100	<0.0001	<0.0100	<0.0100	<0.00100
tert-Butylbenzene	mg/l	0.51 [2]	<0.00012	<0.00100	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.0100	<0.0100	<0.00100
Tetrachloroethane, 1,1,1,2-	mg/l	0.0005	<0.00021	<0.00100	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	<0.00021	<0.0100	<0.0100	<0.00100
Tetrachloroethane, 1,1,2,2-	mg/l	0.000066	<0.0001	<0.00100	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100	<0.0001	<0.0100	<0.0100	<0.00100
Tetrachloroethylene	mg/l	0.005 (MCL)	**0.410**	**0.173**	**0.228**	**0.224**	**0.165**	**0.0308**	**0.0833**	**0.00547**	**0.00684**	**0.00455**	**0.00242**	<0.0100	<0.0100	<0.00100
Toluene	mg/l	1.0 (MCL)	<0.00015	<0.00100	<0.00100	<0.00100	<0.00015	<0.00100	<0.00100	<0.00015	<0.00100	<0.00100	**0.00057 J**	**0.0567**	**0.023**	**0.00703**
Trichlorobenzene, 1,2,4-	mg/l	0.07 (MCL)	<0.00016	<0.00500	<0.00500	<0.00500	**0.00027 J**	<0.00500	<0.00500	<0.00016	<0.00500	<0.00500	<0.00016	<0.0500	<0.0500	<0.00500
Trichloroethane, 1,1,1-	mg/l	0.2 (MCL)	<0.00012	<0.00100	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.0100	<0.0100	<0.00100
Trichloroethane, 1,1,2-	mg/l	0.005 (MCL)	<0.00012	<0.00100	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.0100	<0.0100	<0.00100
Trichloroethylene	mg/l	0.005 (MCL)	**0.0401**	**0.0175**	**0.0190**	**0.0194**	**0.0292**	**0.0518**	**0.0495**	**0.0026**	**0.00265**	**0.00197**	**0.00362**	<0.0100	<0.0100	<0.00100
Trichlorofluoromethane	mg/l	1.1 [2]	<0.00017	<0.00400	<0.00400	<0.00400	<0.00017	<0.00400	<0.00400	<0.00017	<0.00400	<0.00400	<0.00017	<0.0400	<0.0400	<0.00400
Trichloropropane, 1,2,3-	mg/l	0.00000065 [2]	<0.00019	<0.00100	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100	<0.00019	<0.0100	<0.0100	<0.00100
Trimethylbenzene, 1,2,4-	mg/l	0.015	<0.0002	<0.00100	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	**0.0459**	**0.304**	**0.239**	**0.338**
Trimethylbenzene, 1,3,5-	mg/l	0.087 [2]	<0.0002	<0.00100	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	**0.00909**	**0.0526**	**0.0435**	**0.0572**
Vinyl chloride	mg/l	0.002 (MCL)	<0.0001	<0.00100	<0.00100	<0.00100	**0.00268**	<0.00100	**0.00474**	**0.0013**	**0.00108**	<0.00100	**0.00426**	<0.0100	<0.0100	**0.00874**
Xylene, Total	mg/l	10 (MCL)	**0.00018 J**	<0.00300	<0.00300	<0.00300	**0.00013 J**	<0.00300	<0.00300	<0.00013	<0.00300	<0.00300	**0.00124 J**	**0.046**	<0.0300	**0.0113**

Notes:
Bold values were detected above laboratory detection limits
Highlighted values exceed the applicable regional screening level
(1) MCLs used for purposes of screening, in event none are available. Regional Screening Levels (RSLs) for tap water (as of November 2011) are provided.
(2) Updated based on November 2013 RSLs (reviewed 12/27/2013). Data prior to November 2013 will be compared to previous RSLs.
B = Analyte was detected in the associated method blank
J = Analyte detected at a level less than the Reporting Limit (RL) and greater than or equal to the Method Detection Limit (MDL); concentrations within this range are estimated
MCL = Maximum Contaminant Level
NE = Not Established
WWT = Wastewater Treatment
NA = Not Analyzed

TABLE 3-5
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - VOLATILE ORGANIC COMPOUNDS
RCRA FACILITY INVESTIGATION
FORMER WATERLOO INDUSTRIES FACILITY, WATERLOO, IOWA

Investigation Target			AOC 5				AOC 5			AOC 5				Former WWT Area		
Sample ID			WGW9	GWDup2	WGW9		WGW10			WGW11			WGWDup8	WGW12		
Sample Location			MW-9				MW-10			MW-11				MW-12		
Date Collected			11/11/2011	11/11/2011	9/27/2013	12/12/2013	11/11/2011	9/25/2013	12/12/2013	11/11/2011	9/26/2013	12/12/2013	12/12/2013	11/10/2011	9/24/2013	12/11/2013
	Units	Regional Screening Level														
Parameter		Tap Water [1]														
Volatile Organic Compounds		or MCL as noted														
1,1-Dichloropropene	mg/l	NE	<0.00015	<0.00015	<0.00100	<0.00100	<0.00015	<0.00100	<0.00100	<0.00015	<0.00100	<0.00100	<0.00100	<0.00015	<0.00100	<0.00100
1,2,3-Trichlorobenzene	mg/l	0.0052 [2]	<0.00019	M0.00017	<0.00500	<0.00500	<0.00016	<0.00500	<0.00500	<0.00016	<0.00500	<0.00500	<0.00500	<0.00033	<0.00500	<0.00500
2,2-Dichloropropane	mg/l	NE	**0.00049 J**	**0.00092 J**	<0.00400	<0.00400	<0.00018	<0.00400	<0.00400	<0.00018	<0.00400	<0.00400	<0.00400	<0.00018	<0.00400	<0.00400
Acetone	mg/l	12 [2]	<0.00397	**0.0042 J**	<0.0100	<0.0100	<0.00179	<0.0100	<0.0100	<0.00552	<0.0100	<0.0100	<0.0100	<0.00253	<0.0100	<0.0100
Acrylonitrile	mg/l	0.000045 [2]	<0.00053	<0.00053	NA	NA	<0.00053	NA	NA	<0.00053	NA	NA	NA	<0.00053	NA	NA
Benzene	mg/l	0.005 (MCL)	**0.00052**	**0.00042 J**	<0.000500	<0.000500	<0.00011	<0.000500	<0.000500	<0.00011	<0.000500	<0.000500	<0.000500	<0.00011	<0.000500	<0.000500
Bromochloromethane	mg/l	0.083	<0.00012	<0.00012	<0.00500	<0.00500	<0.00012	<0.00500	<0.00500	<0.00012	<0.00500	<0.00500	<0.00500	<0.00012	<0.00500	<0.00500
Bromodichloromethane	mg/l	0.08 (MCL)	<0.00012	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100
Bromoform	mg/l	0.08 (MCL)	<0.00014	<0.00014	<0.00500	<0.00500	<0.00014	<0.00500	<0.00500	<0.00014	<0.00500	<0.00500	<0.00500	<0.00014	<0.00500	<0.00500
Bromomethane	mg/l	0.007 [2]	<0.00022	<0.00022	<0.00400	<0.00400	<0.00024	<0.00400	<0.00400	<0.00028	<0.00400	<0.00400	<0.00400	<0.00036	<0.00400	<0.00400
Butylbenzene, n-	mg/l	0.78 [2]	<0.00037	<0.00037	<0.00100	<0.00100	<0.00037	<0.00100	<0.00100	<0.00037	<0.00100	<0.00100	<0.00100	<0.00037	<0.00100	<0.00100
Carbon disulfide	mg/l	0.72 [2]	<0.00015	<0.00018	<0.00100	<0.00100	<0.00015	<0.00100	<0.00100	<0.00015	<0.00100	**0.00201**	**0.00220**	<0.00015	<0.00100	<0.00100
Carbon Tetrachloride	mg/l	0.005 (MCL)	<0.00024	<0.00024	<0.00200	<0.00200	<0.00024	<0.00200	<0.00200	<0.00024	<0.00200	<0.00200	<0.00200	<0.00024	<0.00200	<0.00200
Chlorobenzene	mg/l	0.1 (MCL)	**0.00027 J**	**0.00037 J**	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100
Chloroethane	mg/l	21	<0.00015	<0.00016	<0.00400	<0.00400	<0.00015	<0.00400	<0.00400	<0.00024	<0.00400	<0.00400	<0.00400	<0.00015	<0.00400	<0.00400
Chloroform	mg/l	0.08 (MCL)	<0.00028	<0.00028	<0.00100	<0.00100	<0.00028	<0.00100	<0.00100	<0.00028	<0.00100	<0.00100	<0.00100	**0.0017**	<0.00100	<0.00100
Chloromethane	mg/l	0.19	<0.00031	<0.00031	<0.00300	<0.00300	<0.00031	<0.00300	<0.00300	<0.00031	<0.00300	<0.00300	<0.00300	<0.00031	<0.00300	<0.00300
Chlorotoluene, 2-	mg/l	0.18	<0.00012	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100
Chlorotoluene, 4-	mg/l	0.19 [2]	<0.00013	<0.00013	<0.00100	<0.00100	<0.00013	<0.00100	<0.00100	<0.00013	<0.00100	<0.00100	<0.00100	<0.00013	<0.00100	<0.00100
Cumene (Isopropylbenzene)	mg/l	0.39 [2]	<0.000190	<0.000190	<0.00100	<0.00100	<0.000190	<0.00100	<0.00100	<0.000190	<0.00100	<0.00100	<0.00100	<0.000190	<0.00100	<0.00100
Dibromo-3-chloropropane, 1,2- (DBCP)	mg/l	0.0002 (MCL)	<0.00012	<0.00012	<0.0100	<0.0100	<0.00012	<0.0100	<0.0100	<0.00012	<0.0100	<0.0100	<0.0100	<0.00012	<0.0100	<0.0100
Dibromochloromethane	mg/l	0.08 (MCL)	<0.0002	<0.0002	<0.00500	<0.00500	<0.0002	<0.00500	<0.00500	<0.0002	<0.00500	<0.00500	<0.00500	<0.0002	<0.00500	<0.00500
Dibromoethane, 1,2-	mg/l	0.00005 (MCL) [2]	<0.00013	<0.00013	<0.0100	<0.0100	<0.00013	<0.0100	<0.0100	<0.00013	<0.0100	<0.0100	<0.0100	<0.00013	<0.0100	<0.0100
Dibromomethane (Methylene Bromide)	mg/l	0.0079 [2]	<0.00018	<0.00018	<0.00100	<0.00100	<0.00018	<0.00100	<0.00100	<0.00018	<0.00100	<0.00100	<0.00100	<0.00018	<0.00100	<0.00100
Dichlorobenzene, 1,2-	mg/l	0.6 (MCL)	<0.00014	<0.00014	<0.00100	<0.00100	<0.00014	<0.00100	<0.00100	<0.00014	<0.00100	<0.00100	<0.00100	<0.00014	<0.00100	<0.00100
Dichlorobenzene, 1,3-	mg/l	NE	<0.00017	<0.00017	<0.00100	<0.00100	<0.00017	<0.00100	<0.00100	<0.00017	<0.00100	<0.00100	<0.00100	<0.00017	<0.00100	<0.00100
Dichlorobenzene, 1,4-	mg/l	0.075 (MCL)	<0.0002	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100
Dichlorodifluoromethane	mg/l	0.19 [2]	<0.0002	<0.0002	<0.00300	<0.00300	<0.0002	<0.00300	<0.00300	<0.0002	<0.00300	<0.00300	<0.00300	<0.0002	<0.00300	<0.00300
Dichloroethane, 1,1-	mg/l	0.0024	**0.00026 J**	**0.00026 J**	<0.00100	<0.00100	**0.0101**	**0.00713**	**0.00888**	<0.00021	<0.00100	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100
Dichloroethane, 1,2-	mg/l	0.005 (MCL)	**0.00029 J**	**0.00023 J**	<0.00100	<0.00100	<0.00018	<0.00100	<0.00100	<0.00018	<0.00100	<0.00100	<0.00100	<0.00018	<0.00100	<0.00100
Dichloroethylene, 1,1-	mg/l	0.007 (MCL)	**0.00176 J**	**0.00154 J**	<0.00200	**0.00249**	**0.00514**	**0.00412**	**0.00366**	<0.00015	<0.00200	<0.00200	<0.00200	<0.00015	<0.00200	<0.00200

TABLE 3-5
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - VOLATILE ORGANIC COMPOUNDS
RCRA FACILITY INVESTIGATION
FORMER WATERLOO INDUSTRIES FACILITY, WATERLOO, IOWA

Investigation Target			AOC 5				AOC 5			AOC 5				Former WWT Area		
Sample ID			WGW9	GWDup2	WGW9		WGW10			WGW11			WGWDup8	WGW12		
Sample Location			MW-9				MW-10			MW-11				MW-12		
Date Collected			11/11/2011	11/11/2011	9/27/2013	12/12/2013	11/11/2011	9/25/2013	12/12/2013	11/11/2011	9/26/2013	12/12/2013	12/12/2013	11/10/2011	9/24/2013	12/11/2013
	Units	Regional Screening Level														
Parameter		Tap Water [1]														
Volatile Organic Compounds		or MCL as noted														
Dichloroethylene, 1,2-cis-	mg/l	0.07 (MCL)	**0.0478**	**0.0476**	**0.0948**	**0.157**	**0.00019 J**	<0.00100	<0.00100	<0.00013	<0.00100	<0.00100	<0.00100	<0.00013	**0.00175**	<0.00100
Dichloroethylene, 1,2-trans-	mg/l	0.1 (MCL)	**0.00054 J**	**0.00063 J**	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100
Dichloropropane, 1,2-	mg/l	0.005 (MCL)	<0.00087	<0.00087	<0.00100	<0.00100	<0.00087	<0.00100	<0.00100	<0.00087	<0.00100	<0.00100	<0.00100	<0.00087	<0.00100	<0.00100
Dichloropropane, 1,3-	mg/l	0.29	<0.00016	<0.00016	<0.00100	<0.00100	<0.00016	<0.00100	<0.00100	<0.00016	<0.00100	<0.00100	<0.00100	<0.00016	<0.00100	<0.00100
Dichloropropene, 1,3-cis	mg/l	NE	<0.00015	<0.00015	<0.00500	<0.00500	<0.00015	<0.00500	<0.00500	<0.00015	<0.00500	<0.00500	<0.00500	<0.00015	<0.00500	<0.00500
Dichloropropene, 1,3-trans	mg/l	NE	<0.00022	<0.00022	<0.00500	<0.00500	<0.00022	<0.00500	<0.00500	<0.00022	<0.00500	<0.00500	<0.00500	<0.00022	<0.00500	<0.00500
Ethylbenzene	mg/l	0.7 (MCL)	<0.00021	<0.00021	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100
Hexachlorobutadiene	mg/l	0.00026 [2]	<0.00024	<0.0002	<0.00500	<0.00500	<0.0002	<0.00500	<0.00500	<0.0002	<0.00500	<0.00500	<0.00500	<0.0002	<0.00500	<0.00500
Hexane, N-	mg/l	0.25 [2]	<0.0002	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100
Methyl Ethyl Ketone	mg/l	4.9 [2]	<0.00127	**0.00186 J**	<0.0100	<0.0100	<0.00047	<0.0100	<0.0100	<0.00095	<0.0100	<0.0100	<0.0100	<0.00227	<0.0100	<0.0100
Methyl tert-Butyl Ether (MTBE)	mg/l	0.012	<0.00016	<0.00016	<0.00100	<0.00100	<0.00016	<0.00100	<0.00100	<0.00016	<0.00100	<0.00100	<0.00100	<0.00016	<0.00100	<0.00100
Methylene Chloride (Dichloromethane)	mg/l	0.005 (MCL)	<0.00017	<0.00017	<0.00500	<0.00500	<0.00021	<0.00500	<0.00500	<0.00017	<0.00500	<0.00500	<0.00500	<0.00025	<0.00500	<0.00500
Naphthalene	mg/l	0.00014	<0.00037	<0.00037	<0.00500	<0.00500	<0.00037	<0.00500	<0.00500	<0.00037	<0.00500	<0.00500	<0.00500	<0.00037	<0.00500	<0.00500
p-Isopropyltoluene	mg/l	NE	<0.00014	<0.00014	<0.00100	<0.00100	<0.00014	<0.00100	<0.00100	<0.00014	<0.00100	<0.00100	<0.00100	<0.00014	<0.00100	<0.00100
n-Propylbenzene	mg/l	0.53 [2]	<0.0001	<0.0001	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100
sec-Butylbenzene	mg/l	1.6 [2]	<0.0002	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100
Styrene	mg/l	0.1 (MCL)	<0.0001	<0.0001	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100
tert-Butylbenzene	mg/l	0.51 [2]	<0.00012	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100
Tetrachloroethane, 1,1,1,2-	mg/l	0.0005	**0.00184**	**0.00212**	<0.00100	**0.00302**	<0.00021	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100
Tetrachloroethane, 1,1,2,2-	mg/l	0.000066	<0.0001	<0.0001	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100
Tetrachloroethylene	mg/l	0.005 (MCL)	**6.65**	**6.65**	**3.88**	**13.4**	**0.00221**	**0.00138**	**0.00693**	**0.156**	**0.195**	**0.201**	**0.206**	**0.00181**	**0.00773**	**0.00816**
Toluene	mg/l	1.0 (MCL)	**0.00047 J**	**0.00057 J**	<0.00100	<0.00100	<0.00015	<0.00100	<0.00100	**0.00057 J**	<0.00100	<0.00100	<0.00100	<0.00015	<0.00100	<0.00100
Trichlorobenzene, 1,2,4-	mg/l	0.07 (MCL)	<0.00016	<0.00016	<0.00500	<0.00500	<0.00016	<0.00500	<0.00500	<0.00016	<0.00500	<0.00500	<0.00500	<0.00029	<0.00500	<0.00500
Trichloroethane, 1,1,1-	mg/l	0.2 (MCL)	<0.00012	<0.00012	<0.00100	<0.00100	**0.00767**	**0.00483**	0.00625	<0.00012	<0.00100	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100
Trichloroethane, 1,1,2-	mg/l	0.005 (MCL)	<0.00012	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100
Trichloroethylene	mg/l	0.005 (MCL)	**0.174**	**0.173**	**0.191**	**0.444**	**0.00075 J**	<0.00100	<0.00100	**0.00333**	**0.00474**	**0.00457**	**0.00448**	**0.00023 J**	**0.00182**	<0.00100
Trichlorofluoromethane	mg/l	1.1 [2]	<0.00017	<0.00017	<0.00400	<0.00400	<0.00017	<0.00400	<0.00400	<0.00017	<0.00400	<0.00400	<0.00400	<0.00017	<0.00400	<0.00400
Trichloropropane, 1,2,3-	mg/l	0.00000065 [2]	<0.00019	<0.00019	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100
Trimethylbenzene, 1,2,4-	mg/l	0.015	<0.0002	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100
Trimethylbenzene, 1,3,5-	mg/l	0.087 [2]	<0.0002	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100
Vinyl chloride	mg/l	0.002 (MCL)	**0.00109**	**0.001**	**0.00127**	**0.00213**	<0.0001	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100
Xylene, Total	mg/l	10 (MCL)	<0.00031	<0.0004	<0.00300	<0.00300	<0.00013	<0.00300	<0.00300	<0.00098	<0.00300	<0.00300	<0.00300	<0.00013	<0.00300	<0.00300

Notes:
Bold values were detected above laboratory detection limits
Highlighted values exceed the applicable regional screening level
(1) MCLs used for purposes of screening, in event none are available. Regional Screening Levels (RSLs) for tap water (as of November 2011) are provided.
(2) Updated based on November 2013 RSLs (reviewed 12/27/2013). Data prior to November 2013 will be compared to previous RSLs.
B = Analyte was detected in the associated method blank
J = Analyte detected at a level less than the Reporting Limit (RL) and greater than or equal to the Method Detection Limit (MDL); concentrations within this range are estimated
MCL = Maximum Contaminant Level
NE = Not Established
WWT = Wastewater Treatment
NA = Not Analyzed

TABLE 3-5
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - VOLATILE ORGANIC COMPOUNDS
RCRA FACILITY INVESTIGATION
FORMER WATERLOO INDUSTRIES FACILITY, WATERLOO, IOWA

Investigation Target			Former WWT Area			AOC 5			AOC 5				AOC 5			AOC 5			
Sample ID			WGW13			WGW-14		WGW14	WGW-15		WGW-Dup5	WGW15	WGW-16		WGW16	WGW-17	WGW-Dup4	WGW-17	WGW17
Sample Location			MW-13			MW-14			MW-15				MW-16			MW-17			
Date Collected			11/10/2011	9/24/2013	12/11/2013	2/14/2012	9/27/2013	12/12/2013	1/20/2012	9/24/2013	9/24/2013	12/13/2013	1/19/2012	9/24/2013	12/12/2013	1/18/2012	1/18/2012	9/25/2013	12/11/2013
	Units	Regional Screening Level																	
Parameter		Tap Water [1]																	
Volatile Organic Compounds		or MCL as noted																	
1,1-Dichloropropene	mg/l	NE	<0.00015	<0.00100	<0.00100	<0.00015	<0.00100	<0.00100	<0.00015	<0.00100	<0.00100	<0.00100	<0.00015	<0.00100	<0.00100	<0.00015	<0.00015	<0.00100	<0.00100
1,2,3-Trichlorobenzene	mg/l	0.0052 [2]	<0.00090	<0.00500	<0.00500	<0.00016	<0.00500	<0.00500	<0.00016	<0.00500	<0.00500	<0.00500	<0.00071	<0.00500	<0.00500	<0.00016	<0.00016	<0.00500	<0.00500
2,2-Dichloropropane	mg/l	NE	<0.00018	<0.00400	<0.00400	<0.00018	<0.00400	<0.00400	<0.00018	<0.00400	<0.00400	<0.00400	<0.00018	<0.00400	<0.00400	<0.00018	<0.00018	<0.00400	<0.00400
Acetone	mg/l	12 [2]	<0.00231	<0.0100	<0.0100	**0.0115**	<0.0100	<0.0100	<0.0106	<0.0100	<0.0100	<0.0100	<0.00607	<0.0100	<0.0100	<0.00179	<0.00179	<0.0100	<0.0100
Acrylonitrile	mg/l	0.000045 [2]	<0.00053	NA	NA	NA	NA	NA	<0.00053	NA	NA	NA	<0.00053	NA	NA	<0.00053	<0.00053	NA	NA
Benzene	mg/l	0.005 (MCL)	<0.00011	<0.000500	<0.000500	<0.00011	<0.000500	<0.000500	**0.00046 J**	<0.000500	<0.000500	<0.000500	**0.00022 J**	<0.000500	<0.000500	<0.00011	<0.00011	<0.000500	<0.000500
Bromochloromethane	mg/l	0.083	<0.00012	<0.00500	<0.00500	<0.00021	<0.00500	<0.00500	<0.00012	<0.00500	<0.00500	<0.00500	<0.00012	<0.00500	<0.00500	<0.00012	<0.00012	<0.00500	<0.00500
Bromodichloromethane	mg/l	0.08 (MCL)	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.00012	<0.00100	<0.00100
Bromoform	mg/l	0.08 (MCL)	<0.00014	<0.00500	<0.00500	<0.00014	<0.00500	<0.00500	<0.00014	<0.00500	<0.00500	<0.00500	<0.00014	<0.00500	<0.00500	<0.00014	<0.00014	<0.00500	<0.00500
Bromomethane	mg/l	0.007 [2]	<0.00054	<0.00400	<0.00400	<0.0003	<0.00400	<0.00400	<0.00035	<0.00400	<0.00400	<0.00400	<0.00051	<0.00400	<0.00400	<0.00029	<0.00042	<0.00400	<0.00400
Butylbenzene, n-	mg/l	0.78 [2]	<0.00037	<0.00100	<0.00100	<0.00037	<0.00100	<0.00100	<0.00037	<0.00100	<0.00100	<0.00100	<0.00037	<0.00100	<0.00100	<0.00037	<0.00037	<0.00100	<0.00100
Carbon disulfide	mg/l	0.72 [2]	<0.00015	<0.00100	<0.00100	<0.0004	<0.00100	<0.00100	<0.00046	<0.00100	<0.00100	<0.00100	<0.00043	<0.00100	<0.00100	<0.00015	<0.00015	<0.00100	<0.00100
Carbon Tetrachloride	mg/l	0.005 (MCL)	<0.00024	<0.00200	<0.00200	<0.00024	<0.00200	<0.00200	<0.00024	<0.00200	<0.00200	<0.00200	<0.00024	<0.00200	<0.00200	<0.00024	<0.00024	<0.00200	<0.00200
Chlorobenzene	mg/l	0.1 (MCL)	<0.00019	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100	<0.00019	<0.00019	<0.00100	<0.00100
Chloroethane	mg/l	21	<0.00019	<0.00400	<0.00400	<0.00023	<0.00400	<0.00400	<0.00015	<0.00400	<0.00400	<0.00400	<0.00015	<0.00400	<0.00400	<0.00015	<0.00015	<0.00400	<0.00400
Chloroform	mg/l	0.08 (MCL)	**0.00097 J**	<0.00100	<0.00100	<0.00028	<0.00100	<0.00100	**0.00039 J**	<0.00100	<0.00100	<0.00100	<0.00028	<0.00100	<0.00100	<0.00028	<0.00028	<0.00100	<0.00100
Chloromethane	mg/l	0.19	<0.00031	<0.00300	<0.00300	<0.00031	<0.00300	<0.00300	<0.00031	<0.00300	<0.00300	<0.00300	<0.00031	<0.00300	<0.00300	<0.00031	<0.00031	<0.00300	<0.00300
Chlorotoluene, 2-	mg/l	0.18	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.00012	<0.00100	<0.00100
Chlorotoluene, 4-	mg/l	0.19 [2]	<0.00013	<0.00100	<0.00100	<0.00013	<0.00100	<0.00100	<0.00013	<0.00100	<0.00100	<0.00100	<0.00013	<0.00100	<0.00100	<0.00013	<0.00013	<0.00100	<0.00100
Cumene (Isopropylbenzene)	mg/l	0.39 [2]	<0.000190	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100	<0.00019	<0.00019	<0.00100	<0.00100
Dibromo-3-chloropropane, 1,2- (DBCP)	mg/l	0.0002 (MCL)	<0.00012	<0.0100	<0.0100	<0.00012	<0.0100	<0.0100	<0.00012	<0.0100	<0.0100	<0.0100	<0.00012	<0.0100	<0.0100	<0.00012	<0.00012	<0.0100	<0.0100
Dibromochloromethane	mg/l	0.08 (MCL)	<0.0002	<0.00500	<0.00500	<0.0002	<0.00500	<0.00500	<0.0002	<0.00500	<0.00500	<0.00500	<0.0002	<0.00500	<0.00500	<0.0002	<0.0002	<0.00500	<0.00500
Dibromoethane, 1,2-	mg/l	0.00005 (MCL) [2]	<0.00013	<0.0100	<0.0100	<0.00013	<0.0100	<0.0100	<0.00013	<0.0100	<0.0100	<0.0100	<0.00013	<0.0100	<0.0100	<0.00013	<0.00013	<0.0100	<0.0100
Dibromomethane (Methylene Bromide)	mg/l	0.0079 [2]	<0.00018	<0.00100	<0.00100	<0.00018	<0.00100	<0.00100	<0.00018	<0.00100	<0.00100	<0.00100	<0.00018	<0.00100	<0.00100	<0.00018	<0.00018	<0.00100	<0.00100
Dichlorobenzene, 1,2-	mg/l	0.6 (MCL)	<0.00014	<0.00100	<0.00100	<0.00014	<0.00100	<0.00100	<0.00014	<0.00100	<0.00100	<0.00100	<0.00014	<0.00100	<0.00100	<0.00014	<0.00014	<0.00100	<0.00100
Dichlorobenzene, 1,3-	mg/l	NE	<0.00017	<0.00100	<0.00100	<0.00017	<0.00100	<0.00100	<0.00017	<0.00100	<0.00100	<0.00100	<0.00017	<0.00100	<0.00100	<0.00017	<0.00017	<0.00100	<0.00100
Dichlorobenzene, 1,4-	mg/l	0.075 (MCL)	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.0002	<0.0002	<0.00100	<0.00100
Dichlorodifluoromethane	mg/l	0.19 [2]	<0.0002	<0.00300	<0.00300	<0.0002	<0.00300	<0.00300	<0.0002	<0.00300	<0.00300	<0.00300	<0.0002	<0.00300	<0.00300	<0.0002	<0.0002	<0.00300	<0.00300
Dichloroethane, 1,1-	mg/l	0.0024	<0.00021	<0.00100	<0.00100	**0.00053 J**	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	**0.00078 J**	**0.0008 J**	**0.00119**	**0.00102**
Dichloroethane, 1,2-	mg/l	0.005 (MCL)	<0.00018	<0.00100	<0.00100	<0.00018	<0.00100	<0.00100	<0.00018	<0.00100	<0.00100	<0.00100	<0.00018	<0.00100	<0.00100	<0.00018	<0.00018	<0.00100	<0.00100
Dichloroethylene, 1,1-	mg/l	0.007 (MCL)	<0.00015	<0.00200	<0.00200	**0.00016 J**	<0.00200	<0.00200	<0.00015	<0.00200	<0.00200	<0.00200	<0.00015	<0.00200	<0.00200	<0.00015	<0.00015	<0.00200	<0.00200

TABLE 3-5
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - VOLATILE ORGANIC COMPOUNDS
RCRA FACILITY INVESTIGATION
FORMER WATERLOO INDUSTRIES FACILITY, WATERLOO, IOWA

Investigation Target			Former WWT Area			AOC 5			AOC 5				AOC 5			AOC 5			
Sample ID			WGW13			WGW-14		WGW14	WGW-15		WGW-Dup5	WGW15	WGW-16		WGW16	WGW-17	WGW-Dup4	WGW-17	WGW17
Sample Location			MW-13			MW-14			MW-15				MW-16			MW-17			
Date Collected			11/10/2011	9/24/2013	12/11/2013	2/14/2012	9/27/2013	12/12/2013	1/20/2012	9/24/2013	9/24/2013	12/13/2013	1/19/2012	9/24/2013	12/12/2013	1/18/2012	1/18/2012	9/25/2013	12/11/2013
	Units	Regional Screening Level																	
Parameter		Tap Water [1]																	
Volatile Organic Compounds		or MCL as noted																	
Dichloroethylene, 1,2-cis-	mg/l	0.07 (MCL)	**0.00029 J**	**0.00174**	**0.00206**	<0.00013	<0.00100	<0.00100	**0.00139**	<0.00100	<0.00100	<0.00100	**0.0218**	**0.015**	**0.0216**	**0.00103**	**0.00103**	**0.00178**	**0.00297**
Dichloroethylene, 1,2-trans-	mg/l	0.1 (MCL)	<0.00021	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	<0.00100	**0.00035 J**	<0.00100	<0.00100	<0.00021	<0.00021	<0.00100	<0.00100
Dichloropropane, 1,2-	mg/l	0.005 (MCL)	<0.00087	<0.00100	<0.00100	<0.00087	<0.00100	<0.00100	<0.00087	<0.00100	<0.00100	<0.00100	<0.00087	<0.00100	<0.00100	<0.00087	<0.00087	<0.00100	<0.00100
Dichloropropane, 1,3-	mg/l	0.29	<0.00016	<0.00100	<0.00100	<0.00016	<0.00100	<0.00100	<0.00016	<0.00100	<0.00100	<0.00100	<0.00016	<0.00100	<0.00100	<0.00016	<0.00016	<0.00100	<0.00100
Dichloropropene, 1,3-cis	mg/l	NE	<0.00015	<0.00500	<0.00500	<0.00016	<0.00500	<0.00500	<0.00015	<0.00500	<0.00500	<0.00500	<0.00015	<0.00500	<0.00500	<0.00015	<0.00015	<0.00500	<0.00500
Dichloropropene, 1,3-trans	mg/l	NE	<0.00022	<0.00500	<0.00500	<0.00022	<0.00500	<0.00500	<0.00022	<0.00500	<0.00500	<0.00500	<0.00022	<0.00500	<0.00500	<0.00022	<0.00022	<0.00500	<0.00500
Ethylbenzene	mg/l	0.7 (MCL)	<0.00021	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	**0.00037 J**	<0.00100	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	<0.00021	<0.00021	<0.00100	<0.00100
Hexachlorobutadiene	mg/l	0.00026 [2]	<0.00054	<0.00500	<0.00500	<0.0002	<0.00500	<0.00500	<0.00022	<0.00500	<0.00500	<0.00500	<0.00096	<0.00500	<0.00500	<0.0002	<0.0002	<0.00500	<0.00500
Hexane, N-	mg/l	0.25 [2]	<0.0002	<0.00100	<0.00100	**0.00091 J**	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.0002	<0.0002	<0.00100	<0.00100
Methyl Ethyl Ketone	mg/l	4.9 [2]	<0.00174	<0.0100	<0.0100	**0.00158 J**	<0.0100	<0.0100	<0.00361	<0.0100	<0.0100	<0.0100	<0.00229	<0.0100	<0.0100	<0.00047	<0.00047	<0.0100	<0.0100
Methyl tert-Butyl Ether (MTBE)	mg/l	0.012	<0.00016	<0.00100	<0.00100	<0.00016	<0.00100	<0.00100	<0.00016	<0.00100	<0.00100	<0.00100	<0.00016	<0.00100	<0.00100	<0.00016	<0.00016	<0.00100	<0.00100
Methylene Chloride (Dichloromethane)	mg/l	0.005 (MCL)	<0.00022	<0.00500	<0.00500	**0.00063 J**	<0.00500	<0.00500	<0.00038	<0.00500	<0.00500	<0.00500	<0.00031	<0.00500	<0.00500	<0.00017	<0.00017	<0.00500	<0.00500
Naphthalene	mg/l	0.00014	<0.00087	<0.00500	<0.00500	<0.00037	<0.00500	<0.00500	<0.00098	<0.00500	<0.00500	<0.00500	<0.00155	<0.00500	<0.00500	<0.00037	<0.00037	<0.00500	<0.00500
p-Isopropyltoluene	mg/l	NE	<0.00014	<0.00100	<0.00100	<0.00014	<0.00100	<0.00100	<0.00015	<0.00100	<0.00100	<0.00100	<0.00014	<0.00100	<0.00100	<0.00014	<0.00014	<0.00100	<0.00100
n-Propylbenzene	mg/l	0.53 [2]	<0.0001	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100	**0.00012 J**	<0.00100	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100	<0.0001	<0.0001	<0.00100	<0.00100
sec-Butylbenzene	mg/l	1.6 [2]	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.0002	<0.0002	<0.00100	<0.00100
Styrene	mg/l	0.1 (MCL)	<0.0001	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100	**0.00011 J**	<0.00100	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100	<0.0001	<0.0001	<0.00100	<0.00100
tert-Butylbenzene	mg/l	0.51 [2]	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.00012	<0.00100	<0.00100
Tetrachloroethane, 1,1,1,2-	mg/l	0.0005	<0.00021	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	<0.00100	<0.00021	<0.00100	<0.00100	<0.00021	<0.00021	<0.00100	<0.00100
Tetrachloroethane, 1,1,2,2-	mg/l	0.000066	<0.0001	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100	<0.0001	<0.0001	<0.00100	<0.00100
Tetrachloroethylene	mg/l	0.005 (MCL)	**0.00383**	**0.0108**	**0.00915**	**0.00535**	**0.00315**	**0.00347**	<0.00018	**0.00101**	<0.00100	<0.00100	**0.00557**	<0.00100	**0.00352**	**0.0644**	**0.0652**	**0.0439**	**0.0592**
Toluene	mg/l	1.0 (MCL)	<0.00015	<0.00100	<0.00100	**0.00016 J**	<0.00100	<0.00100	**0.00083 J**	<0.00100	<0.00100	<0.00100	**0.0004 J**	<0.00100	<0.00100	<0.00015	<0.00015	<0.00100	<0.00100
Trichlorobenzene, 1,2,4-	mg/l	0.07 (MCL)	<0.00043	<0.00500	<0.00500	<0.00016	<0.00500	<0.00500	<0.00016	<0.00500	<0.00500	<0.00500	**0.00034 J**	<0.00500	<0.00500	<0.00016	<0.00016	<0.00500	<0.00500
Trichloroethane, 1,1,1-	mg/l	0.2 (MCL)	<0.00012	<0.00100	<0.00100	**0.0004 J**	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	**0.00063 J**	**0.00065 J**	<0.00100	<0.00100
Trichloroethane, 1,1,2-	mg/l	0.005 (MCL)	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00100	<0.00012	<0.00100	<0.00100	<0.00012	<0.00012	<0.00100	<0.00100
Trichloroethylene	mg/l	0.005 (MCL)	**0.00058 J**	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100	**0.00031 J**	<0.00100	<0.00100	<0.00100	**0.0136**	**0.00405**	**0.0068**	**0.00632**	**0.0062**	**0.00578**	**0.00733**
Trichlorofluoromethane	mg/l	1.1 [2]	<0.00017	<0.00400	<0.00400	<0.00017	<0.00400	<0.00400	<0.00017	<0.00400	<0.00400	<0.00400	<0.00017	<0.00400	<0.00400	<0.00017	<0.00017	<0.00400	<0.00400
Trichloropropane, 1,2,3-	mg/l	0.00000065 [2]	<0.00019	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100	<0.00100	<0.00019	<0.00100	<0.00100	<0.00019	<0.00019	<0.00100	<0.00100
Trimethylbenzene, 1,2,4-	mg/l	0.015	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	**0.00053 J**	<0.00100	<0.00100	<0.00100	<0.00032	<0.00100	<0.00100	<0.0002	<0.0002	<0.00100	<0.00100
Trimethylbenzene, 1,3,5-	mg/l	0.087 [2]	<0.0002	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	**0.00022 J**	<0.00100	<0.00100	<0.00100	<0.0002	<0.00100	<0.00100	<0.0002	<0.0002	<0.00100	<0.00100
Vinyl chloride	mg/l	0.002 (MCL)	<0.0001	<0.00100	<0.00100	<0.0001	<0.00100	<0.00100	**0.00038 J**	<0.00100	<0.00100	<0.00100	**0.00043 J**	<0.00100	**0.00111**	<0.0001	<0.0001	<0.00100	<0.00100
Xylene, Total	mg/l	10 (MCL)	<0.00013	<0.00300	<0.00300	**0.00017 J**	<0.00300	<0.00300	**0.00097 J**	<0.00300	<0.00300	<0.00300	**0.00046 J**	<0.00300	<0.00300	<0.00013	<0.00013	<0.00300	<0.00300

Notes:
Bold values were detected above laboratory detection limits
Highlighted values exceed the applicable regional screening level
(1) MCLs used for purposes of screening, in event none are available. Regional Screening Levels (RSLs) for tap water (as of November 2011) are provided.
(2) Updated based on November 2013 RSLs (reviewed 12/27/2013). Data prior to November 2013 will be compared to previous RSLs.
B = Analyte was detected in the associated method blank
J = Analyte detected at a level less than the Reporting Limit (RL) and greater than or equal to the Method Detection Limit (MDL); concentrations within this range are estimated
MCL = Maximum Contaminant Level
NE = Not Established
WWT = Wastewater Treatment
NA = Not Analyzed

TABLE 3-5
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - VOLATILE ORGANIC COMPOUNDS
RCRA FACILITY INVESTIGATION
FORMER WATERLOO INDUSTRIES FACILITY, WATERLOO, IOWA

Investigation Target			AOC 5	AOC 5	AOC 5	Former WWT Area	Former WWT Area	AOC 5		AOC 5	AOC 5	AOC 5	AOC 5
Sample ID			**WGW23**	**WGW24**	**WGW25**	**WGW26**	**WGW27**	**WGW28**	**WGWDup9**	**WDPW02**	**WDPW04**	**WDPW05**	**WDPW08**
Sample Location			**MW-23**	**MW-24**	**MW-25**	**MW-26**	**MW-27**	**MW-28**		**DP-02**	**DP-04**	**DP-05**	**DP-08**
Date Collected			**4/8/2014**	**4/8/2014**	**4/10/2014**	**4/10/2014**	**4/8/2014**	**4/8/2014**	**4/8/2014**	**9/24/2013**	**9/25/2013**	**9/25/2013**	**9/25/2013**
	Units	**Regional Screening Level**											
Parameter		**Tap Water [1]**											
Volatile Organic Compounds		**or MCL as noted**											
1,1-Dichloropropene	mg/l	NE	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
1,2,3-Trichlorobenzene	mg/l	0.0052 [2]	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500
2,2-Dichloropropane	mg/l	NE	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400
Acetone	mg/l	12 [2]	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	**0.0126**
Acrylonitrile	mg/l	0.000045 [2]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	mg/l	0.005 (MCL)	<0.000500	<0.000500	<0.000500	<0.000500	<0.000500	<0.000500	<0.000500	**0.00851**	**0.00147**	<0.000500	**0.000536**
Bromochloromethane	mg/l	0.083	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500
Bromodichloromethane	mg/l	0.08 (MCL)	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Bromoform	mg/l	0.08 (MCL)	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500
Bromomethane	mg/l	0.007 [2]	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400
Butylbenzene, n-	mg/l	0.78 [2]	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	**0.0314**	<0.00100	<0.00100	<0.00100
Carbon disulfide	mg/l	0.72 [2]	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Carbon Tetrachloride	mg/l	0.005 (MCL)	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200
Chlorobenzene	mg/l	0.1 (MCL)	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Chloroethane	mg/l	21	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400
Chloroform	mg/l	0.08 (MCL)	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Chloromethane	mg/l	0.19	<0.00300	<0.00300	<0.00300	<0.00300	<0.00300	<0.00300	<0.00300	<0.00300	<0.00300	<0.00300	<0.00300
Chlorotoluene, 2-	mg/l	0.18	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Chlorotoluene, 4-	mg/l	0.19 [2]	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Cumene (Isopropylbenzene)	mg/l	0.39 [2]	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	**0.00238**	<0.00100	<0.00100	<0.00100
Dibromo-3-chloropropane, 1,2- (DBCP)	mg/l	0.0002 (MCL)	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100
Dibromochloromethane	mg/l	0.08 (MCL)	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500
Dibromoethane, 1,2-	mg/l	0.00005 (MCL) [2]	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100
Dibromomethane (Methylene Bromide)	mg/l	0.0079 [2]	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Dichlorobenzene, 1,2-	mg/l	0.6 (MCL)	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Dichlorobenzene, 1,3-	mg/l	NE	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Dichlorobenzene, 1,4-	mg/l	0.075 (MCL)	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Dichlorodifluoromethane	mg/l	0.19 [2]	<0.00300	<0.00300	<0.00300	<0.00300	<0.00300	<0.00300	<0.00300	<0.00300	<0.00300	<0.00300	<0.00300
Dichloroethane, 1,1-	mg/l	0.0024	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	**0.00121**	<0.00100	<0.00100	<0.00100	**0.00158**
Dichloroethane, 1,2-	mg/l	0.005 (MCL)	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Dichloroethylene, 1,1-	mg/l	0.007 (MCL)	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	**0.00224**	<0.00200	<0.00200

TABLE 3-5
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - VOLATILE ORGANIC COMPOUNDS
RCRA FACILITY INVESTIGATION
FORMER WATERLOO INDUSTRIES FACILITY, WATERLOO, IOWA

Investigation Target			AOC 5	AOC 5	AOC 5	Former WWT Area	Former WWT Area	AOC 5		AOC 5	AOC 5	AOC 5	AOC 5
Sample ID			WGW23	WGW24	WGW25	WGW26	WGW27	WGW28	WGWDup9	WDPW02	WDPW04	WDPW05	WDPW08
Sample Location			MW-23	MW-24	MW-25	MW-26	MW-27	MW-28		DP-02	DP-04	DP-05	DP-08
Date Collected			4/8/2014	4/8/2014	4/10/2014	4/10/2014	4/8/2014	4/8/2014	4/8/2014	9/24/2013	9/25/2013	9/25/2013	9/25/2013
	Units	Regional Screening Level											
Parameter		Tap Water [1]											
Volatile Organic Compounds		or MCL as noted											
Dichloroethylene, 1,2-cis-	mg/l	0.07 (MCL)	<0.00100	<0.00100	<0.00100	<0.00100	**0.00419**	<0.00100	<0.00100	**0.0354**	**0.11**	<0.00100	**0.0175**
Dichloroethylene, 1,2-trans-	mg/l	0.1 (MCL)	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	**0.00126**	**0.00167**	<0.00100	**0.00147**
Dichloropropane, 1,2-	mg/l	0.005 (MCL)	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Dichloropropane, 1,3-	mg/l	0.29	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Dichloropropene, 1,3-cis	mg/l	NE	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500
Dichloropropene, 1,3-trans	mg/l	NE	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500
Ethylbenzene	mg/l	0.7 (MCL)	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	**0.0023**	<0.00100	<0.00100	<0.00100
Hexachlorobutadiene	mg/l	0.00026 [2]	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500
Hexane, N-	mg/l	0.25 [2]	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Methyl Ethyl Ketone	mg/l	4.9 [2]	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100
Methyl tert-Butyl Ether (MTBE)	mg/l	0.012	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Methylene Chloride (Dichloromethane)	mg/l	0.005 (MCL)	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500
Naphthalene	mg/l	0.00014	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	**0.177**	<0.00500	<0.00500	<0.00500
p-Isopropyltoluene	mg/l	NE	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
n-Propylbenzene	mg/l	0.53 [2]	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	**0.0152**	<0.00100	<0.00100	<0.00100
sec-Butylbenzene	mg/l	1.6 [2]	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	**0.00834**	<0.00100	<0.00100	<0.00100
Styrene	mg/l	0.1 (MCL)	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
tert-Butylbenzene	mg/l	0.51 [2]	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Tetrachloroethane, 1,1,1,2-	mg/l	0.0005	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Tetrachloroethane, 1,1,2,2-	mg/l	0.000066	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Tetrachloroethylene	mg/l	0.005 (MCL)	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	**0.0404**	**0.0388**	**0.092**	**8.35**	**0.0889**	**0.00479**
Toluene	mg/l	1.0 (MCL)	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Trichlorobenzene, 1,2,4-	mg/l	0.07 (MCL)	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500
Trichloroethane, 1,1,1-	mg/l	0.2 (MCL)	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Trichloroethane, 1,1,2-	mg/l	0.005 (MCL)	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Trichloroethylene	mg/l	0.005 (MCL)	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	**0.00172**	**0.00153**	**0.0064**	**0.64**	**0.00181**	**0.0021**
Trichlorofluoromethane	mg/l	1.1 [2]	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400
Trichloropropane, 1,2,3-	mg/l	0.00000065 [2]	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Trimethylbenzene, 1,2,4-	mg/l	0.015	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	**0.00117**	<0.00100	<0.00100	<0.00100
Trimethylbenzene, 1,3,5-	mg/l	0.087 [2]	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Vinyl chloride	mg/l	0.002 (MCL)	<0.00100	<0.00100	<0.00100	<0.00100	**0.00177**	<0.00100	<0.00100	**0.0324**	**0.00425**	<0.00100	**0.00131**
Xylene, Total	mg/l	10 (MCL)	<0.00300	<0.00300	<0.00300	<0.00300	<0.00300	<0.00300	<0.00300	<0.00300	<0.00300	<0.00300	<0.00300

Notes:
Bold values were detected above laboratory detection limits
Highlighted values exceed the applicable regional screening level
(1) MCLs used for purposes of screening, in event none are available. Regional Screening Levels (RSLs) for tap water (as of November 2011) are provided.
(2) Updated based on November 2013 RSLs (reviewed 12/27/2013). Data prior to November 2013 will be compared to previous RSLs.
B = Analyte was detected in the associated method blank
J = Analyte detected at a level less than the Reporting Limit (RL) and greater than or equal to the Method Detection Limit (MDL); concentrations within this range are estimated
MCL = Maximum Contaminant Level
NE = Not Established
WWT = Wastewater Treatment
NA = Not Analyzed

TABLE 3-5
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - VOLATILE ORGANIC COMPOUNDS
RCRA FACILITY INVESTIGATION
FORMER WATERLOO INDUSTRIES FACILITY, WATERLOO, IOWA

Investigation Target			NA	NA	NA	NA	NA	NA	NA	NA	NA
Sample ID			Equipment Blank	WGWEB2	WGW-EB3	WGW-EB4	WGW-EB5	WGWEB6	WGWEB7	Field Blank	WGWFB2
Sample Location			Equipment Blank	Equipment Blank	Equipment Blank	Equipment Blank	Equipment Blank	Equipment Blank	Equipment Blank	Field Blank	Field Blank
Date Collected			8/10/2011	11/11/2011	1/18/2012	1/19/2012	9/25/2013	12/12/2013	4/10/2014	8/10/2011	11/11/2011
	Units	Regional Screening Level									
Parameter		Tap Water [1]									
Volatile Organic Compounds		or MCL as noted									
1,1-Dichloropropene	mg/l	NE	<0.00015	<0.00015	<0.00015	<0.00015	<0.00100	<0.00100	<0.00100	<0.00015	<0.00015
1,2,3-Trichlorobenzene	mg/l	0.0052 [2]	<0.00016	<0.00016	<0.00016	**0.00017 JB**	<0.00500	<0.00500	<0.00500	<0.00016	<0.00016
2,2-Dichloropropane	mg/l	NE	<0.00018	<0.00018	<0.00018	<0.00018	<0.00400	<0.00400	<0.00400	<0.00018	<0.00018
Acetone	mg/l	12 [2]	**0.00703 J**	**0.00386 J**	<0.00179	**0.00183 J**	<0.0100	<0.0100	<0.0100	**0.00694 J**	**0.0025 J**
Acrylonitrile	mg/l	0.000045 [2]	<0.00053	<0.00053	<0.00053	<0.00053	NA	NA	NA	<0.00053	<0.00053
Benzene	mg/l	0.005 (MCL)	<0.00011	<0.00011	<0.00011	<0.00011	<0.000500	<0.000500	<0.000500	<0.00011	<0.00011
Bromochloromethane	mg/l	0.083	<0.00012	<0.00012	<0.00012	<0.00012	<0.00500	<0.00500	<0.00500	<0.00012	<0.00012
Bromodichloromethane	mg/l	0.08 (MCL)	<0.00012	<0.00012	<0.00012	<0.00012	<0.00100	<0.00100	<0.00100	<0.00012	<0.00012
Bromoform	mg/l	0.08 (MCL)	<0.00014	<0.00014	<0.00014	<0.00014	<0.00500	<0.00500	<0.00500	<0.00014	<0.00014
Bromomethane	mg/l	0.007 [2]	<0.00022	<0.00022	<0.00022	**0.00032 J**	<0.00400	<0.00400	<0.00400	<0.00022	**0.00028 JB**
Butylbenzene, n-	mg/l	0.78 [2]	<0.00037	<0.00037	<0.00037	<0.00037	<0.00100	<0.00100	<0.00100	<0.00037	<0.00037
Carbon disulfide	mg/l	0.72 [2]	<0.00015	<0.00015	<0.00015	<0.00015	<0.00100	<0.00100	<0.00100	<0.00015	<0.00015
Carbon Tetrachloride	mg/l	0.005 (MCL)	<0.00024	<0.00024	<0.00024	<0.00024	<0.00200	<0.00200	<0.00200	<0.00024	<0.00024
Chlorobenzene	mg/l	0.1 (MCL)	<0.00019	<0.00019	<0.00019	<0.00019	<0.00100	<0.00100	<0.00100	<0.00019	<0.00019
Chloroethane	mg/l	21	<0.00015	<0.00015	<0.00015	<0.00015	<0.00400	<0.00400	<0.00400	<0.00015	<0.00015
Chloroform	mg/l	0.08 (MCL)	<0.00028	<0.00028	<0.00028	<0.00028	<0.00100	<0.00100	<0.00100	<0.00028	<0.00028
Chloromethane	mg/l	0.19	<0.00031	<0.00031	<0.00031	<0.00031	<0.00300	<0.00300	<0.00300	<0.00031	<0.00031
Chlorotoluene, 2-	mg/l	0.18	<0.00012	<0.00012	<0.00012	<0.00012	<0.00100	<0.00100	<0.00100	<0.00012	<0.00012
Chlorotoluene, 4-	mg/l	0.19 [2]	<0.00013	<0.00013	<0.00013	<0.00013	<0.00100	<0.00100	<0.00100	<0.00013	<0.00013
Cumene (Isopropylbenzene)	mg/l	0.39 [2]	<0.00019	<0.00019	<0.00019	<0.00019	<0.00100	<0.00100	<0.00100	<0.00019	<0.00019
Dibromo-3-chloropropane, 1,2- (DBCP)	mg/l	0.0002 (MCL)	<0.00012	<0.00012	<0.00012	<0.00012	<0.0100	<0.0100	<0.0100	<0.00012	<0.00012
Dibromochloromethane	mg/l	0.08 (MCL)	<0.0002	<0.0002	<0.0002	<0.0002	<0.00500	<0.00500	<0.00500	<0.0002	<0.0002
Dibromoethane, 1,2-	mg/l	0.00005 (MCL) [2]	<0.00013	<0.00013	<0.00013	<0.00013	<0.0100	<0.0100	<0.0100	<0.00013	<0.00013
Dibromomethane (Methylene Bromide)	mg/l	0.0079 [2]	<0.00018	<0.00018	<0.00018	<0.00018	<0.00100	<0.00100	<0.00100	<0.00018	<0.00018
Dichlorobenzene, 1,2-	mg/l	0.6 (MCL)	<0.00014	<0.00014	<0.00014	<0.00014	<0.00100	<0.00100	<0.00100	<0.00014	<0.00014
Dichlorobenzene, 1,3-	mg/l	NE	<0.00017	<0.00017	<0.00017	<0.00017	<0.00100	<0.00100	<0.00100	<0.00017	<0.00017
Dichlorobenzene, 1,4-	mg/l	0.075 (MCL)	<0.0002	<0.0002	<0.0002	<0.0002	<0.00100	<0.00100	<0.00100	<0.0002	<0.0002
Dichlorodifluoromethane	mg/l	0.19 [2]	<0.0002	<0.0002	<0.0002	<0.0002	<0.00300	<0.00300	<0.00300	<0.0002	<0.0002
Dichloroethane, 1,1-	mg/l	0.0024	<0.00021	<0.00021	<0.00021	<0.00021	<0.00100	<0.00100	<0.00100	<0.00021	<0.00021
Dichloroethane, 1,2-	mg/l	0.005 (MCL)	<0.00018	<0.00018	<0.00018	<0.00018	<0.00100	<0.00100	<0.00100	<0.00018	<0.00018
Dichloroethylene, 1,1-	mg/l	0.007 (MCL)	<0.00015	<0.00015	<0.00015	<0.00015	<0.00200	<0.00200	<0.00200	<0.00015	<0.00015

TABLE 3-5
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - VOLATILE ORGANIC COMPOUNDS
RCRA FACILITY INVESTIGATION
FORMER WATERLOO INDUSTRIES FACILITY, WATERLOO, IOWA

Investigation Target			NA	NA	NA	NA	NA	NA	NA	NA	NA
Sample ID			Equipment Blank	WGWEB2	WGW-EB3	WGW-EB4	WGW-EB5	WGWEB6	WGWEB7	Field Blank	WGWFB2
Sample Location			Equipment Blank	Equipment Blank	Equipment Blank	Equipment Blank	Equipment Blank	Equipment Blank	Equipment Blank	Field Blank	Field Blank
Date Collected			8/10/2011	11/11/2011	1/18/2012	1/19/2012	9/25/2013	12/12/2013	4/10/2014	8/10/2011	11/11/2011
	Units	Regional Screening Level									
Parameter		Tap Water [1]									
Volatile Organic Compounds		or MCL as noted									
Dichloroethylene, 1,2-cis-	mg/l	0.07 (MCL)	<0.00013	<0.00013	<0.00013	<0.00013	<0.00100	<0.00100	<0.00100	<0.00013	<0.00013
Dichloroethylene, 1,2-trans-	mg/l	0.1 (MCL)	<0.00021	<0.00021	<0.00021	<0.00021	<0.00100	<0.00100	<0.00100	<0.00021	<0.00021
Dichloropropane, 1,2-	mg/l	0.005 (MCL)	<0.00087	<0.00087	<0.00087	<0.00087	<0.00100	<0.00100	<0.00100	<0.00087	<0.00087
Dichloropropane, 1,3-	mg/l	0.29	<0.00016	<0.00016	<0.00016	<0.00016	<0.00100	<0.00100	<0.00100	<0.00016	<0.00016
Dichloropropene, 1,3-cis	mg/l	NE	<0.00015	<0.00015	<0.00015	<0.00015	<0.00500	<0.00500	<0.00500	<0.00015	<0.00015
Dichloropropene, 1,3-trans	mg/l	NE	<0.00022	<0.00022	<0.00022	<0.00022	<0.00500	<0.00500	<0.00500	<0.00022	<0.00022
Ethylbenzene	mg/l	0.7 (MCL)	<0.00021	<0.00021	<0.00021	<0.00021	<0.00100	<0.00100	<0.00100	<0.00021	<0.00021
Hexachlorobutadiene	mg/l	0.00026 [2]	<0.0002	<0.0002	<0.0002	**0.00052 JB**	<0.00500	<0.00500	<0.00500	<0.0002	<0.0002
Hexane, N-	mg/l	0.25 [2]	<0.0002	<0.0002	<0.0002	<0.0002	<0.00100	<0.00100	<0.00100	<0.0002	<0.0002
Methyl Ethyl Ketone	mg/l	4.9 [2]	**0.00067 J**	**0.00202 J**	**0.00048 J**	**0.00061 J**	<0.0100	<0.0100	<0.0100	**0.00077 J**	**0.00065 J**
Methyl tert-Butyl Ether (MTBE)	mg/l	0.012	<0.00016	<0.00016	<0.00016	<0.00016	<0.00100	<0.00100	<0.00100	<0.00016	<0.00016
Methylene Chloride (Dichloromethane)	mg/l	0.005 (MCL)	<0.00017	**0.00017 J**	<0.00017	**0.00027 J**	<0.00500	<0.00500	<0.00500	<0.00017	<0.00017
Naphthalene	mg/l	0.00014	<0.00037	<0.00037	<0.00037	**0.00043 JB**	<0.00500	<0.00500	<0.00500	<0.00037	<0.00037
p-Isopropyltoluene	mg/l	NE	<0.00014	<0.00014	<0.00014	<0.00014	<0.00100	<0.00100	<0.00100	<0.00014	<0.00014
n-Propylbenzene	mg/l	0.53 [2]	<0.0001	<0.0001	<0.0001	<0.0001	<0.00100	<0.00100	<0.00100	<0.0001	<0.0001
sec-Butylbenzene	mg/l	1.6 [2]	<0.0002	<0.0002	<0.0002	<0.0002	<0.00100	<0.00100	<0.00100	<0.0002	<0.0002
Styrene	mg/l	0.1 (MCL)	<0.0001	<0.0001	<0.0001	<0.0001	<0.00100	<0.00100	<0.00100	<0.0001	<0.0001
tert-Butylbenzene	mg/l	0.51 [2]	<0.00012	<0.00012	<0.00012	<0.00012	<0.00100	<0.00100	<0.00100	<0.00012	<0.00012
Tetrachloroethane, 1,1,1,2-	mg/l	0.0005	<0.00021	<0.00021	<0.00021	<0.00021	<0.00100	<0.00100	<0.00100	<0.00021	<0.00021
Tetrachloroethane, 1,1,2,2-	mg/l	0.000066	<0.0001	<0.0001	<0.0001	<0.0001	<0.00100	<0.00100	<0.00100	<0.0001	<0.0001
Tetrachloroethylene	mg/l	0.005 (MCL)	<0.00018	**0.00027 JB**	<0.00018	<0.00018	<0.00100	<0.00100	<0.00100	<0.00018	**0.00021 JB**
Toluene	mg/l	1.0 (MCL)	**0.0014**	<0.00015	<0.00015	<0.00015	<0.00100	<0.00100	<0.00100	**0.00158**	<0.00015
Trichlorobenzene, 1,2,4-	mg/l	0.07 (MCL)	<0.00016	<0.00016	<0.00016	<0.00016	<0.00500	<0.00500	<0.00500	<0.00016	<0.00016
Trichloroethane, 1,1,1-	mg/l	0.2 (MCL)	<0.00012	<0.00012	<0.00012	<0.00012	<0.00100	<0.00100	<0.00100	<0.00012	<0.00012
Trichloroethane, 1,1,2-	mg/l	0.005 (MCL)	<0.00012	<0.00012	<0.00012	<0.00012	<0.00100	<0.00100	<0.00100	<0.00012	<0.00012
Trichloroethylene	mg/l	0.005 (MCL)	<0.00019	<0.00019	<0.00019	<0.00019	<0.00100	<0.00100	<0.00100	<0.00019	<0.00019
Trichlorofluoromethane	mg/l	1.1 [2]	<0.00017	<0.00017	<0.00017	<0.00017	<0.00400	<0.00400	<0.00400	<0.00017	<0.00017
Trichloropropane, 1,2,3-	mg/l	0.00000065 [2]	<0.00019	<0.00019	<0.00019	<0.00019	<0.00100	<0.00100	<0.00100	<0.00019	<0.00019
Trimethylbenzene, 1,2,4-	mg/l	0.015	<0.0002	<0.0002	<0.0002	<0.0002	<0.00100	<0.00100	<0.00100	<0.0002	<0.0002
Trimethylbenzene, 1,3,5-	mg/l	0.087 [2]	<0.0002	<0.0002	<0.0002	<0.0002	<0.00100	<0.00100	<0.00100	<0.0002	<0.0002
Vinyl chloride	mg/l	0.002 (MCL)	<0.0001	<0.0001	<0.0001	<0.0001	<0.00100	<0.00100	<0.00100	<0.0001	<0.0001
Xylene, Total	mg/l	10 (MCL)	**0.00019 J**	<0.00013	<0.00013	<0.00013	<0.00300	<0.00300	<0.00300	**0.00014 J**	<0.00013

Notes:
Bold values were detected above laboratory detection limits
Highlighted values exceed the applicable regional screening level
(1) MCLs used for purposes of screening, in event none are available. Regional Screening Levels (RSLs) for tap water (as of November 2011) are provided.
(2) Updated based on November 2013 RSLs (reviewed 12/27/2013). Data prior to November 2013 will be compared to previous RSLs.
B = Analyte was detected in the associated method blank
J = Analyte detected at a level less than the Reporting Limit (RL) and greater than or equal to the Method Detection Limit (MDL); concentrations within this range are estimated
MCL = Maximum Contaminant Level
NE = Not Established
WWT = Wastewater Treatment
NA = Not Analyzed

TABLE 3-5
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - VOLATILE ORGANIC COMPOUNDS
RCRA FACILITY INVESTIGATION
FORMER WATERLOO INDUSTRIES FACILITY, WATERLOO, IOWA

Investigation Target			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sample ID			WGW-FB3	WGW-FB4	WGW-FB5	WGWFB6	WGWFB7	WGWFB8	Trip Blank	Trip Blank	TB02	TB03	WGW-Trip Blan	WGWTrip Blank	WGWTrip Blank
Sample Location			Field Blank	Field Blank	Field Blank	Field Blank	Field Blank	Field Blank	Trip Blank	Trip Blank	Trip Blank	Trip Blank	Trip Blank	Trip Blank	Trip Blank
Date Collected			1/18/2012	9/25/2013	9/27/2013	12/10/2013	12/12/2013	4/8/2014	8/3/2011	8/10/2011	11/11/2011	1/18/2012	9/27/2013	12/13/2013	4/10/2014
	Units	Regional Screening Level													
Parameter		Tap Water [1]													
Volatile Organic Compounds		or MCL as noted													
1,1-Dichloropropene	mg/l	NE	<0.00015	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00015	<0.00015	<0.00015	<0.00015	<0.00100	<0.00100	<0.00100
1,2,3-Trichlorobenzene	mg/l	0.0052 [2]	<0.00016	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00016	<0.00016	<0.00016	<0.00016	<0.00500	<0.00500	<0.00500
2,2-Dichloropropane	mg/l	NE	<0.00018	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00018	<0.00018	<0.00018	<0.00018	<0.00400	<0.00400	<0.00400
Acetone	mg/l	12 [2]	<0.00179	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.00179	**0.00295 J**	**0.00187 J**	<0.00179	<0.0100	<0.0100	<0.0100
Acrylonitrile	mg/l	0.000045 [2]	<0.00053	NA	NA	NA	NA	NA	<0.00053	<0.00053	<0.00053	<0.00053	NA	NA	
Benzene	mg/l	0.005 (MCL)	<0.00011	<0.000500	<0.000500	<0.000500	<0.000500	<0.000500	<0.00011	<0.00011	<0.00011	<0.00011	<0.000500	<0.000500	<0.000500
Bromochloromethane	mg/l	0.083	<0.00012	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00021	<0.00012	<0.00012	<0.00012	<0.00500	<0.00500	<0.00500
Bromodichloromethane	mg/l	0.08 (MCL)	<0.00012	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00012	<0.00012	<0.00012	<0.00012	<0.00100	<0.00100	<0.00100
Bromoform	mg/l	0.08 (MCL)	<0.00014	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00014	<0.00014	<0.00014	<0.00014	<0.00500	<0.00500	<0.00500
Bromomethane	mg/l	0.007 [2]	**0.00028 J**	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00022	<0.00022	<0.00022	**0.00024 J**	<0.00400	<0.00400	<0.00400
Butylbenzene, n-	mg/l	0.78 [2]	<0.00037	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00037	<0.00037	<0.00037	<0.00037	<0.00100	<0.00100	<0.00100
Carbon disulfide	mg/l	0.72 [2]	<0.00015	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	**0.00017 J**	<0.00015	<0.00015	<0.00015	<0.00100	<0.00100	<0.00100
Carbon Tetrachloride	mg/l	0.005 (MCL)	<0.00024	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00024	<0.00024	<0.00024	<0.00024	<0.00200	<0.00200	<0.00200
Chlorobenzene	mg/l	0.1 (MCL)	<0.00019	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00019	<0.00019	<0.00019	<0.00019	<0.00100	<0.00100	<0.00100
Chloroethane	mg/l	21	<0.00015	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00015	<0.00015	<0.00015	<0.00015	<0.00400	<0.00400	<0.00400
Chloroform	mg/l	0.08 (MCL)	<0.00028	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00028	<0.00028	<0.00028	<0.00028	<0.00100	<0.00100	<0.00100
Chloromethane	mg/l	0.19	<0.00031	<0.00300	<0.00300	<0.00300	<0.00300	<0.00300	<0.00031	<0.00031	<0.00031	**0.00041 J**	<0.00300	<0.00300	<0.00300
Chlorotoluene, 2-	mg/l	0.18	<0.00012	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00012	<0.00012	<0.00012	<0.00012	<0.00100	<0.00100	<0.00100
Chlorotoluene, 4-	mg/l	0.19 [2]	<0.00013	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00013	<0.00013	<0.00013	<0.00013	<0.00100	<0.00100	<0.00100
Cumene (Isopropylbenzene)	mg/l	0.39 [2]	<0.00019	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00019	<0.00019	<0.00019	<0.00019	<0.00100	<0.00100	<0.00100
Dibromo-3-chloropropane, 1,2- (DBCP)	mg/l	0.0002 (MCL)	<0.00012	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.00012	<0.00012	<0.00012	<0.00012	<0.0100	<0.0100	<0.0100
Dibromochloromethane	mg/l	0.08 (MCL)	<0.0002	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.0002	<0.0002	<0.0002	<0.0002	<0.00500	<0.00500	<0.00500
Dibromoethane, 1,2-	mg/l	0.00005 (MCL) [2]	<0.00013	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.00013	<0.00013	<0.00013	<0.00013	<0.0100	<0.0100	<0.0100
Dibromomethane (Methylene Bromide)	mg/l	0.0079 [2]	<0.00018	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00018	<0.00018	<0.00018	<0.00018	<0.00100	<0.00100	<0.00100
Dichlorobenzene, 1,2-	mg/l	0.6 (MCL)	<0.00014	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00014	<0.00014	<0.00014	<0.00014	<0.00100	<0.00100	<0.00100
Dichlorobenzene, 1,3-	mg/l	NE	<0.00017	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00017	<0.00017	<0.00017	<0.00017	<0.00100	<0.00100	<0.00100
Dichlorobenzene, 1,4-	mg/l	0.075 (MCL)	<0.0002	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.0002	<0.0002	<0.0002	<0.0002	<0.00100	<0.00100	<0.00100
Dichlorodifluoromethane	mg/l	0.19 [2]	<0.0002	<0.00300	<0.00300	<0.00300	<0.00300	<0.00300	<0.0002	<0.0002	<0.0002	<0.0002	<0.00300	<0.00300	<0.00300
Dichloroethane, 1,1-	mg/l	0.0024	<0.00021	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00021	<0.00021	<0.00021	<0.00021	<0.00100	<0.00100	<0.00100
Dichloroethane, 1,2-	mg/l	0.005 (MCL)	<0.00018	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00018	<0.00018	<0.00018	<0.00018	<0.00100	<0.00100	<0.00100
Dichloroethylene, 1,1-	mg/l	0.007 (MCL)	<0.00015	<0.00200	<0.00200	<0.00200	<0.00200	<0.00200	<0.00015	<0.00015	<0.00015	<0.00015	<0.00200	<0.00200	<0.00200

TABLE 3-5
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - VOLATILE ORGANIC COMPOUNDS
RCRA FACILITY INVESTIGATION
FORMER WATERLOO INDUSTRIES FACILITY, WATERLOO, IOWA

Investigation Target			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sample ID			WGW-FB3	WGW-FB4	WGW-FB5	WGWFB6	WGWFB7	WGWFB8	Trip Blank	Trip Blank	TB02	TB03	WGW-Trip Blan	WGWTrip Blank	WGWTrip Blank
Sample Location			Field Blank	Field Blank	Field Blank	Field Blank	Field Blank	Field Blank	Trip Blank	Trip Blank	Trip Blank	Trip Blank	Trip Blank	Trip Blank	Trip Blank
Date Collected			1/18/2012	9/25/2013	9/27/2013	12/10/2013	12/12/2013	4/8/2014	8/3/2011	8/10/2011	11/11/2011	1/18/2012	9/27/2013	12/13/2013	4/10/2014
	Units	Regional Screening Level													
Parameter		Tap Water [1]													
Volatile Organic Compounds		or MCL as noted													
Dichloroethylene, 1,2-cis-	mg/l	0.07 (MCL)	<0.00013	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00013	**0.00015 J**	<0.00013	<0.00013	<0.00100	<0.00100	<0.00100
Dichloroethylene, 1,2-trans-	mg/l	0.1 (MCL)	<0.00021	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00021	<0.00021	<0.00021	<0.00021	<0.00100	<0.00100	<0.00100
Dichloropropane, 1,2-	mg/l	0.005 (MCL)	<0.00087	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00087	<0.00087	<0.00087	<0.00087	<0.00100	<0.00100	<0.00100
Dichloropropane, 1,3-	mg/l	0.29	<0.00016	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00016	<0.00016	<0.00016	<0.00016	<0.00100	<0.00100	<0.00100
Dichloropropene, 1,3-cis	mg/l	NE	<0.00015	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00015	<0.00015	<0.00015	<0.00015	<0.00500	<0.00500	<0.00500
Dichloropropene, 1,3-trans	mg/l	NE	<0.00022	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00022	<0.00022	<0.00022	<0.00022	<0.00500	<0.00500	<0.00500
Ethylbenzene	mg/l	0.7 (MCL)	<0.00021	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00021	<0.00021	<0.00021	<0.00021	<0.00100	<0.00100	<0.00100
Hexachlorobutadiene	mg/l	0.00026 [2]	<0.0002	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.0002	<0.0002	<0.0002	<0.0002	<0.00500	<0.00500	<0.00500
Hexane, N-	mg/l	0.25 [2]	<0.0002	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.0002	<0.0002	<0.0002	<0.0002	<0.00100	<0.00100	<0.00100
Methyl Ethyl Ketone	mg/l	4.9 [2]	<0.00047	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.00047	<0.00047	**0.00169 J**	<0.00047	<0.0100	<0.0100	<0.0100
Methyl tert-Butyl Ether (MTBE)	mg/l	0.012	<0.00016	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00016	<0.00016	<0.00016	<0.00016	<0.00100	<0.00100	<0.00100
Methylene Chloride (Dichloromethane)	mg/l	0.005 (MCL)	**0.00029 J**	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	**0.00026 J**	<0.00017	**0.00038 J**	**0.00049 J**	<0.00500	<0.00500	<0.00500
Naphthalene	mg/l	0.00014	<0.00037	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00037	<0.00037	<0.00037	<0.00037	<0.00500	<0.00500	<0.00500
p-Isopropyltoluene	mg/l	NE	<0.00014	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00014	<0.00014	<0.00014	<0.00014	<0.00100	<0.00100	<0.00100
n-Propylbenzene	mg/l	0.53 [2]	<0.0001	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.0001	<0.0001	<0.0001	<0.0001	<0.00100	<0.00100	<0.00100
sec-Butylbenzene	mg/l	1.6 [2]	<0.0002	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.0002	<0.0002	<0.0002	<0.0002	<0.00100	<0.00100	<0.00100
Styrene	mg/l	0.1 (MCL)	<0.0001	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.0001	<0.0001	<0.0001	<0.0001	<0.00100	<0.00100	<0.00100
tert-Butylbenzene	mg/l	0.51 [2]	<0.00012	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00012	<0.00012	<0.00012	<0.00012	<0.00100	<0.00100	<0.00100
Tetrachloroethane, 1,1,1,2-	mg/l	0.0005	<0.00021	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00021	<0.00021	<0.00021	<0.00021	<0.00100	<0.00100	<0.00100
Tetrachloroethane, 1,1,2,2-	mg/l	0.000066	<0.0001	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.0001	<0.0001	<0.0001	<0.0001	<0.00100	<0.00100	<0.00100
Tetrachloroethylene	mg/l	0.005 (MCL)	<0.00018	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00018	<0.00018	**0.00026 JB**	<0.00018	<0.00100	<0.00100	<0.00100
Toluene	mg/l	1.0 (MCL)	<0.00015	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00015	<0.00015	<0.00015	<0.00015	<0.00100	<0.00100	<0.00100
Trichlorobenzene, 1,2,4-	mg/l	0.07 (MCL)	<0.00016	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00016	<0.00016	<0.00016	<0.00016	<0.00500	<0.00500	<0.00500
Trichloroethane, 1,1,1-	mg/l	0.2 (MCL)	<0.00012	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00012	<0.00012	<0.00012	<0.00012	<0.00100	<0.00100	<0.00100
Trichloroethane, 1,1,2-	mg/l	0.005 (MCL)	<0.00012	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00012	<0.00012	<0.00012	<0.00012	<0.00100	<0.00100	<0.00100
Trichloroethylene	mg/l	0.005 (MCL)	<0.00019	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00019	<0.00019	<0.00019	<0.00019	<0.00100	<0.00100	<0.00100
Trichlorofluoromethane	mg/l	1.1 [2]	<0.00017	<0.00400	<0.00400	<0.00400	<0.00400	<0.00400	<0.00017	<0.00017	<0.00017	<0.00017	<0.00400	<0.00400	<0.00400
Trichloropropane, 1,2,3-	mg/l	0.00000065 [2]	<0.00019	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00019	<0.00019	<0.00019	<0.00019	<0.00100	<0.00100	<0.00100
Trimethylbenzene, 1,2,4-	mg/l	0.015	<0.0002	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.0002	<0.0002	<0.0002	<0.0002	<0.00100	<0.00100	<0.00100
Trimethylbenzene, 1,3,5-	mg/l	0.087 [2]	<0.0002	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.0002	<0.0002	<0.0002	<0.0002	<0.00100	<0.00100	<0.00100
Vinyl chloride	mg/l	0.002 (MCL)	<0.0001	**0.00103**	<0.00100	<0.00100	<0.00100	<0.00100	<0.0001	<0.0001	<0.0001	<0.0001	<0.00100	<0.00100	<0.00100
Xylene, Total	mg/l	10 (MCL)	<0.00013	<0.00300	<0.00300	<0.00300	<0.00300	<0.00300	<0.00013	**0.00015 J**	<0.00013	<0.00013	<0.00300	<0.00300	<0.00300

Notes:
Bold values were detected above laboratory detection limits
Highlighted values exceed the applicable regional screening level
(1) MCLs used for purposes of screening, in event none are available. Regional Screening Levels (RSLs) for tap water (as of November 2011) are provided.
(2) Updated based on November 2013 RSLs (reviewed 12/27/2013). Data prior to November 2013 will be compared to previous RSLs.
B = Analyte was detected in the associated method blank
J = Analyte detected at a level less than the Reporting Limit (RL) and greater than or equal to the Method Detection Limit (MDL); concentrations within this range are estimated
MCL = Maximum Contaminant Level
NE = Not Established
WWT = Wastewater Treatment
NA = Not Analyzed

TABLE 3-6
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
POLYNUCLEAR AROMATIC HYDROCARBONS
RCRA FACILITY INVESTIGATION
FORMER WATERLOO INDUSTRIES FACILITY, WATERLOO, IOWA

Investigation Target			**Former WWT Area**	**Former WWT Area**	**Former WWT Area**
Sample ID			**MW-5**	**MW-6**	**MW-6 Duplicate**
Sample Location			**MW-5**	**MW-6**	**MW-6**
Date Collected			**8/3/2011**	**8/3/2011**	**8/3/2011**
	Units	**Regional Screening Level**			
Parameter		**Tap Water [1]**			
Semivolatile Organics by GC/MS		**or MCL as noted**			
Acenaphthene	mg/l	0.4	<0.0001	<0.000111	<0.0001
Acenaphthylene	mg/l	NE	<0.0001	<0.000111	<0.0001
Anthracene	mg/l	1.3	<0.0001	<0.000111	<0.0001
Benzo (g,h,i) perylene	mg/l	NE	<0.0001	<0.000111	<0.0001
Benzo[a]anthracene	mg/l	0.000029	<0.0001	<0.000111	<0.0001
Benzo[a]pyrene	mg/l	0.0000029	<0.0001	<0.000111	<0.0001
Benzo[b]fluoranthene	mg/l	0.000029	<0.0001	<0.000111	<0.0001
Benzo[k]fluoranthene	mg/l	0.00029	<0.0001	<0.000111	<0.0001
Chrysene	mg/l	0.0029	<0.0001	<0.000111	<0.0001
Dibenz[a,h]anthracene	mg/l	0.0000029	<0.0001	<0.000111	<0.0001
Fluoranthene	mg/l	0.63	<0.0001	<0.000111	<0.0001
Fluorene	mg/l	0.22	<0.0001	<0.000111	<0.0001
Indeno[1,2,3-cd]pyrene	mg/l	0.000029	<0.0001	<0.000111	<0.0001
Methylnaphthalene, 2	mg/l	0.027	<0.0001	<0.000111	<0.0001
Naphthalene	mg/l	0.00014	<0.0001	<0.000111	<0.0001
Phenanthrene	mg/l	NE	<0.0001	<0.000111	<0.0001
Pyrene	mg/l	0.087	<0.0001	<0.000111	<0.0001

Notes:
Bold values were detected above laboratory detection limits
Highlighted values exceed the applicable regional screening level
(1) MCLs used for purposes of screening, in event none are available Regional Screening Levels (RSLs) for tap water (as of November 2011) are provided.
MCL = Maximum Contaminant Level
NE = Not Established
WWT = Wastewater Treatment

TABLE 5-1
MONITORING WELL CONSTRUCTION DETAILS
FORMER WATERLOO INDUSTRIES FACILITY
WATERLOO, IOWA

Well ID	*Construction Date*	*Monitored Zone*	*Northing*	*Easting*	*Screened Interval BGS (feet)*	*Total Depth (ft BGS)*	*Elevation (feet AMSL)*		
							Ground	*TOC*	*Screened Interval*
MW-1	7/28/2011	Perched	3650166.54	5223577.40	4.33 - 14.33	14.33	874.41	873.89	870.08 - 860.08
MW-1D	1/12/2012	Bedrock	3650169.94	5223573.49	35.15 - 45.15	45.15	874.44	874.05	839.29 - 829.29
MW-2	7/27/2011	Perched	3650109.56	5223676.16	8.20 - 18.20	18.20	874.81	874.35	866.61 - 856.61
MW-2D	10/20/2011	Bedrock	3650106.13	5223680.40	35.08 - 45.08	45.08	874.84	874.57	839.76 - 829.76
MW-3	1/13/2012	Bedrock	3650282.16	5223680.90	34.21 - 44.21	44.21	874.35	873.89	840.14 - 830.14
MW-4	7/28/2011	Perched	3650220.13	5223756.28	14.50 - 24.50	24.50	874.32	873.89	859.82 - 849.82
MW-5	7/27/2011	Bedrock	3650500.63	5223719.55	12.85 - 22.85	22.85	856.58	855.98	843.73 - 833.73
MW-6	7/27/2011	Bedrock	3650440.03	5223778.28	12.31 - 22.31	22.31	856.91	856.46	844.60 - 834.60
MW-8	7/28/2011	Perched	3650169.06	5223659.95	4.80 - 14.80	14.80	874.55	874.04	869.75 - 859.75
MW-9	10/19/2011	Perched	3650135.22	5223700.39	5.85 - 15.85	15.85	874.49	874.11	868.64 - 858.64
MW-10	10/19/2011	Perched	3650090.84	5223790.65	13.25 - 23.25	23.25	874.52	874.14	861.27 - 851.27
MW-11	10/19/2011	Perched	3650174.12	5223813.57	18.80 - 28.80	28.80	874.27	873.88	855.47 - 845.47
MW-12	10/18/2011	Bedrock	3650584.30	5223680.63	15.00 - 25.00	25.00	856.30	855.86	841.30 - 831.30
MW-13	10/18/2011	Bedrock	3650532.82	5223750.09	15.05 - 25.05	25.05	856.31	855.85	841.26 - 831.26
MW-14	1/11/2012	Perched	3650122.36	5223901.67	14.79 - 24.79	24.79	874.39	874.10	859.60 - 849.60
MW-15	1/11/2012	Bedrock	3650322.51	5223838.63	14.07 - 24.07	24.07	858.28	857.91	844.21 - 834.21
MW-16	1/12/2012	Bedrock	3650237.02	5223925.60	14.58 - 24.58	24.58	857.70	857.32	843.12 - 833.12
MW-17	1/13/2012	Bedrock	3649982.42	5223848.39	35.07 - 45.07	45.07	874.01	873.63	838.94 - 828.94
MW-23	3/25/2014	Bedrock	3649716.86	5223671.94	35.00 - 45.00	50.00	870.10	870.32	835.10 - 825.10
MW-24	3/25/2014	Bedrock	3649715.86	5223742.44	35.00 - 45.00	45.00	869.90	869.77	834.90 - 824.90
MW-25	3/24/2014	Bedrock	3649868.40	5224014.51	35.00 - 45.00	45.00	873.76	876.36	838.76 - 828.76
MW-26	3/27/2014	Bedrock	3650502.70	5223569.79	35.00 - 45.00	45.00	868.90	868.55	833.90 - 823.90
MW-27	3/27/2014	Bedrock	3650329.72	5223599.76	35.00 - 45.00	45.00	874.39	879.03	839.39 - 829.39
MW-28	3/26/2014	Perched	3650193.16	5223681.65	5.00 - 15.00	20.00	874.42	873.91	869.42 - 859.42

Notes:
Coordinates are based grid north, Iowa State Plane, North Zone, NAD 83
AMSL = above mean sea level
BGS = below ground surface
BTOC = below top of casing
NA = not applicable
TOC = Top of casing

TABLE 5-2
DATA COLLECTION RATIONALE AND OBJECTIVES
FORMER WATERLOO INDUSTRIES FACILITY
WATERLOO, IOWA

Sample Location	Groundwater Zone	Location Description	Frequency	Analysis	Sample Quantity	Objective
Groundwater						
MW-1 and 2	Perched	Upgradient of the suspect source area	Semi-Annual	VOCs (EPA Method 8260B)	24	Collection of chemical data for all RAO analytes at concentrations at or below the RAOs.The data will be used to document the remedy is effectively reducing the contaminant concentrations and mass, as well as contaminant migration.
MW-26	Bedrock					
MW-9	Perched	Source area				
MW-4 and 11	Perched	Downgradient of source area				
MW-17	Bedrock					
MW-5, 6, 12, and 13	Bedrock	Former wastewater treatment area				
MW-23 and 24	Bedrock	Downgradient of Site				
MW-15 and 16	Bedrock	Perched zone to bedrock zone mixing area				
MW-8, 10, 14, and 28	Perched	Side gradient of the suspect source area				
MW-1D, 2D, 3, 25, and 27	Bedrock					
MW-1 and 2	Perched	Upgradient of the suspect source area	Annual	Pace Analytical Microseeps Method AM20GAX, pH (SM4500CI-E), TOC (SM 5310C), nitrate and nitrite (SM4500), ferrous iron (SM 3500Fe-B), total iron and manganese (SW846 Method 6010 or 6010C), and chloride and sulfate (EPA Method 9056A)	7	Collection of geochemical and biochemical data. The data will be used to document site conditions as well as the occurrence of natural attenuation on and off-site.
MW-26	Bedrock					
MW-9	Perched	Source area				
MW-4, and 11	Perched	Downgradient of suspect source area				
MW-17	Bedrock					
Soil Vapor / Air						
WSVS-2R	NA	Sub-slab soil vapor in suspect source area	Semi-Annual (See RIP Section 8.1 for DPVE startup sampling frequency)	VOCs (EPA Method TO-15 SIM)	6	Collection of sub-slab soil vapor data. The data will be used to confirm that the SSDS is effective in reducing sub-slab soil vapors.
WSVS-8	NA	Sub-slab soil vapor in vicinity of supervisors office				
WIAS-11	NA	Indoor air sample at supervisors office				Collection of indoor air sample. The data will be used to document site conditions and confirm that the SSDS is effective in preventing soil vapors from impacting indoor air.
Ambient	NA	Ambient (outdoor) air sample, collected upwind of facility				Collection of ambient air sample. Data will be used for comparison to indoor air data to document potential off-site influence to on-site data collection.
DPVE Effluent	NA	Remediation system effluent pair (one sample collected before carbon vessel, one after carbon vessel).				Collection of remedial system effluent air sample. Data will be used to evaluate DPVE system performance and to ensure that the system effluent does not exceed any applicable effluent limits.

TABLE 5-2
DATA COLLECTION RATIONALE AND OBJECTIVES
FORMER WATERLOO INDUSTRIES FACILITY
WATERLOO, IOWA

Sample Location	Groundwater Zone	Location Description	Frequency	Analysis	Sample Quantity	Objective
Unsaturated Soil						
DP-2 (3'-5'), DP-3 (3'-5'), and SB-9 (3'-5'),(5'-7').	NA	Suspected source area unsaturated soil	Soil sample collection upon remedial action completion	VOCs (EPA Method 8260B)	4	Collection of soil samples from locations and depths where VOCs were detected above the Site-specific remedial action objectives during previous investigations. The data will be used to confirm that the soil meets the site RAOs.

Key:
EPA = Environmental Protection Agency
VOC = Volatile Organic Compound

TABLE 5-3
SAMPLING AND ANALYSIS SUMMARY
FORMER WATERLOO INDUSTRIES FACILITY
WATERLOO, IOWA

Media	Sample Quantity	Frequency	QA/QC Sample Quantity [1]	QA/QC Requirements	Analysis	Container(s) [2]	Preservation	Holding Time [3]	RIP Section
Groundwater	24	Semi-Annual	4	One duplicate per 10 samples; One MS/MSD per 20 samples; One field blank per 20 samples; One equipment rinsate blank per 20 samples; One trip blank per cooler.	VOCs (EPA Method 8260B)	Three 40-mL glass vials	HCl and cool to <6°C	14 days	6.4
Groundwater	7	Annual	1	One duplicate per 10 samples	pH (SM4500CI-E)	One 100-ml glass or poly	cool to <6°C	Immediate	6.4
Groundwater	7	Annual	1	One duplicate per 10 samples	TOC (SM 5310C)	One 60-ml glass or poly	HCl and cool to <6°C	28 days	6.4
Groundwater	7	Annual	1	One duplicate per 10 samples	Nitrate, Nitrite (SM4500)	One 500-ml poly	cool to <6°C	48 hours	6.4
Groundwater	7	Annual	1	One duplicate per 10 samples	Iron (ferrous) (SM 3500Fe-B)	One 500-ml poly	cool to <6°C	not regulated	6.4
Groundwater	7	Annual	1	One duplicate per 10 samples	Iron (Total) and Manganese (SW 846 Method 6010C or 6010)	One 500-ml poly	HNO_3 and cool to <6°C	6 months	6.4
Groundwater	7	Annual	1	One duplicate per 10 samples	Sulfate, Chloride (EPA Method 9056A)	One 100-ml glass or poly	cool to <6°C	28 days	6.4
Groundwater	7	Annual	1	One duplicate per 10 samples	Methane, Ethane, Ethene, Acetylene, Carbon Dioxide, Oxygen, Nitrogen, Hydrogen (Pace Analytical Microseeps AM20GAX)	Two 40-mL glass vials	TSP and cool to <6°C	14 days	6.4
Soil Vapor / Indoor and Ambient Air	4	Semi-Annual (See RIP Section 8.1 for DPVE startup sampling frequency)	1	One duplicate per 10 samples	VOCs (EPA Method TO-15 SIM)	1- lliter Summa Canister for soil vapor, 6-liter Summa canister for indoor air and ambient air	NA	30 days	6.4
DPVE System Effluent	2	See RIP Section 8.1 for DPVE startup sampling frequency	1	One duplicate per 10 samples	VOCs (EPA Method TO-15 SIM)	1-liter Summa canister	NA	30 days	6.4
Soil	4	Soil sample collection upon remedial action completion	1	One duplicate per 10 samples; One MS/MSD per 20 samples; One field blank per 20 samples; One equipment rinsate blank per 20 samples; One trip blank per cooler.	VOCs (EPA Method 8260B)	Laboratory supplied 5035 kit	Methanol and cool to <6°C	14 days	6.4

Key:

EPA = Environmental Protection Agency
MS/MSD = Matrix Spike/ Matrix Spike Duplicate
QA/QC = Quality assurance/quality control
VOC = Volatile organic compound

[1] QA/QC sample quantities include all samples listed under QA/QC requirements less equipment blank and trip blank.
[2] Triple the groundwater volume will be collected for samples designated for MS/MSD analysis.
[3] Holding times are from the day of sample collection.

TABLE 5-4
ANALYTICAL METHOD DETAILS
FORMER WATERLOO INDUSTRIES FACILITY
WATERLOO, IOWA
(Page 1 of 2)

Analyte	MDL	MRL	Units	Surr. %R	DUP RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike %R	Blank Spike RPD	CAS #
Method 8260B Volatile Organic Compounds in Water - Nonpotable										
Benzene	0.11	0.50	µg/L	-	15	53-128	15	74-127	15	71-43-2
Carbon Tetrachloride	0.24	2.00	µg/L	-	32	40-131	32	71-131	20	56-23-5
1,2-Dibromo-3-chloropropane	0.50	5.00	µg/L	-	29	28-143	29	45-131	20	96-12-8
1,1-Dichloroethane	0.21	1.00	µg/L	-	17	56-135	17	71-135	15	75-34-3
cis-1,2-Dichloroethene	0.13	1.00	µg/L	-	16	57-130	16	72-130	15	156-59-2
Hexachlorobutadiene	0.20	5.00	µg/L	-	29	16-134	29	62-134	25	87-68-3
Naphthalene	0.37	5.00	µg/L	-	34	33-134	34	50-129	20	91-20-3
1,1,1,2-Tetrachloroethane	0.21	1.00	µg/L	-	16	56-117	16	72-117	15	630-20-6
1,1,2,2-Tetrachloroethane	0.10	1.00	µg/L	-	18	48-133	18	62-123	15	79-34-5
Tetrachloroethene	0.18	1.00	µg/L	-	20	33-138	20	68-138	20	127-18-4
Trichloroethene	0.19	1.00	µg/L	-	15	49-132	15	73-132	15	79-01-6
1,2,3-Trichloropropane	0.19	1.00	µg/L	-	21	47-135	21	66-124	20	96-18-4
1,2,4-Trimethylbenzene	0.20	1.00	µg/L	-	20	41-126	20	66-126	20	95-63-6
1,3,5-Trimethylbenzene	0.20	1.00	µg/L	-	35	41-128	35	69-128	35	108-67-8
Vinyl chloride	0.10	1.00	µg/L	-	20	67-139	20	67-139	20	75-01-4
Toluene-d8			Surrogate	77-117	-	77-117	-	77-117	-	2037-26-5
Dibromofluoromethane			Surrogate	79-119	-	79-119	-	79-119	-	1868-53-7
4-Bromofluorobenzene			Surrogate	82-122	-	82-122	-	82-122	-	460-00-4
GeoChemical Parameters in Water										
TOC	0.396	1.000	mg/L	-	20	75-125	20	90-110	-	7440-44-0
Iron, Total	0.066	0.100	mg/L	-	20	75-125	20	80-120	-	7439-89-6
Iron, Ferrous	0.066	0.100	mg/L	-	20	75-125	20	80-120	-	15438-31-0
Manganese	0.010	0.010	mg/L	-	20	75-125	20	80-120	-	7439-96-5
Sulfate	0.350	1.000	mg/L	-	15	80-120	15	90-110	-	14808-79-8
Chloride	0.317	1.000	mg/L	-	15	80-120	15	90-110	-	16887-00-6
Nitrite	0.054	0.100	mg/L	-	20	75-125	10	90-110	-	14797-65-0
Nitrate	0.0571	0.100	mg/L	-	20	75-125	20	90-110	-	14797-55-8
BioChemical Parameters in Water (Pace Analytical Microseeps Method AM20GAX)										
Acetylene	0.038	0.500	µg/L	-	20	70-130	-	-	-	74-86-2
Carbon Dioxide	0.27	5.000	mg/l	-	20	70-130	-	-	-	124-38-9
Ethane	0.004	0.100	µg/L	-	20	70-130	-	-	-	74-84-0
Ethene	0.005	0.100	µg/L	-	20	70-130	-	-	-	74-85-1
Hydrogen	0.088	0.600	nM	-	20	70-130	-	-	-	1333-74-0
Methane	0.037	0.500	µg/L	-	20	70-130	-	-	-	74-82-8
Nitrogen	0.203	2.000	mg/l	-	20	70-130	-	-	-	7727-37-9
Oxygen	0.097	0.500	mg/l	-	20	70-130	-	-	-	7782-44-7
Method TO-15 Volatile Organic Compounds in Soil Vapor / Air										
1,1,1-Trichloroethane	0.012	0.08	ppb (v/v)	-	25	-	-	70-130	25	71-55-6
1,1,2,2-Tetrachloroethane	0.024	0.08	ppb (v/v)	-	25	-	-	70-130	25	79-34-5
1,1,2-Trichloro-1,2,2-trifluoroethane	0.012	0.08	ppb (v/v)	-	25	-	-	70-130	25	76-13-1
1,1,2-Trichloroethane	0.021	0.08	ppb (v/v)	-	25	-	-	70-130	25	79-00-5
1,1-Dichloroethane	0.01	0.08	ppb (v/v)	-	25	-	-	70-130	25	75-34-3
1,1-Dichloroethene	0.014	0.08	ppb (v/v)	-	25	-	-	70-130	25	75-35-4
1,2,4-Trichlorobenzene	0.039	0.4	ppb (v/v)	-	25	-	-	60-140	25	120-82-1
1,2,4-Trimethylbenzene	0.025	0.08	ppb (v/v)	-	25	-	-	70-130	25	95-63-6
1,2-Dibromoethane (EDB)	0.018	0.08	ppb (v/v)	-	25	-	-	70-130	25	106-93-4
1,2-Dichloro-1,1,2,2-tetrafluoroethane	0.013	0.08	ppb (v/v)	-	25	-	-	60-140	25	76-14-2
1,2-Dichlorobenzene	0.028	0.08	ppb (v/v)	-	25	-	-	70-130	25	95-50-1
1,2-Dichloroethane	0.019	0.08	ppb (v/v)	-	25	-	-	70-130	25	107-06-2
1,2-Dichloropropane	0.021	0.08	ppb (v/v)	-	25	-	-	70-130	25	78-87-5
1,3,5-Trimethylbenzene	0.026	0.08	ppb (v/v)	-	25	-	-	70-130	25	108-67-8
1,3-Dichlorobenzene	0.026	0.08	ppb (v/v)	-	25	-	-	70-130	25	541-73-1
1,4-Dichlorobenzene	0.026	0.08	ppb (v/v)	-	25	-	-	70-130	25	106-46-7
1,4-Dioxane	0.032	0.2	ppb (v/v)	-	25	-	-	60-140	25	123-91-1
2-Butanone (MEK)	0.08	0.4	ppb (v/v)	-	25	-	-	60-140	25	78-93-3
4-Methyl-2-pentanone (MIBK)	0.018	0.2	ppb (v/v)	-	25	-	-	60-140	25	108-10-1
Acetone	0.54	2	ppb (v/v)	-	25	-	-	60-140	25	67-64-1
Benzene	0.023	0.08	ppb (v/v)	-	25	-	-	70-130	25	71-43-2
Benzyl chloride	0.031	0.16	ppb (v/v)	-	25	-	-	70-130	25	100-44-7
Bromodichloromethane	0.018	0.08	ppb (v/v)	-	25	-	-	70-130	25	75-27-4
Bromoform	0.019	0.1	ppb (v/v)	-	25	-	-	60-140	25	75-25-2
Bromomethane	0.013	0.08	ppb (v/v)	-	25	-	-	70-130	25	74-83-9
Carbon disulfide	0.012	0.2	ppb (v/v)	-	25	-	-	70-130	25	75-15-0
Carbon tetrachloride	0.015	0.08	ppb (v/v)	-	25	-	-	70-130	25	56-23-5
Chlorobenzene	0.02	0.08	ppb (v/v)	-	25	-	-	70-130	25	108-90-7
Chloroethane	0.014	0.08	ppb (v/v)	-	25	-	-	70-130	25	75-00-3
Chloroform	0.015	0.08	ppb (v/v)	-	25	-	-	70-130	25	67-66-3
Chloromethane	0.064	0.2	ppb (v/v)	-	25	-	-	60-140	25	74-87-3
cis-1,2-Dichloroethene	0.024	0.08	ppb (v/v)	-	25	-	-	70-130	25	156-59-2
cis-1,3-Dichloropropene	0.029	0.08	ppb (v/v)	-	25	-	-	70-130	25	10061-01-5
Cyclohexane	0.016	0.2	ppb (v/v)	-	25	-	-	70-130	25	110-82-7
Dibromochloromethane	0.017	0.08	ppb (v/v)	-	25	-	-	70-130	25	124-48-1
Dichlorodifluoromethane	0.027	0.08	ppb (v/v)	-	25	-	-	60-140	25	75-71-8
Ethylbenzene	0.027	0.08	ppb (v/v)	-	25	-	-	70-130	25	100-41-4
Hexachlorobutadiene	0.049	0.4	ppb (v/v)	-	25	-	-	60-140	25	87-68-3
Hexane	0.013	0.2	ppb (v/v)	-	25	-	-	70-130	25	110-54-3
Isopropyl alcohol	0.094	0.8	ppb (v/v)	-	25	-	-	60-140	25	67-63-0
Isopropylbenzene	0.024	0.16	ppb (v/v)	-	25	-	-	70-130	25	98-82-8
Methyl tert-butyl ether	0.068	0.4	ppb (v/v)	-	25	-	-	60-140	25	163-40-44
Methylene Chloride	0.13	0.2	ppb (v/v)	-	25	-	-	70-130	25	75-09-2
m-Xylene & p-Xylene	0.053	0.08	ppb (v/v)	-	25	-	-	70-130	25	179601-23-1
Naphthalene	0.04	0.2	ppb (v/v)	-	25	-	-	60-140	25	91-20-3
o-Xylene	0.024	0.08	ppb (v/v)	-	25	-	-	70-130	25	95-47-6

TABLE 5-4
ANALYTICAL METHOD DETAILS
FORMER WATERLOO INDUSTRIES FACILITY
WATERLOO, IOWA
(Page 2 of 2)

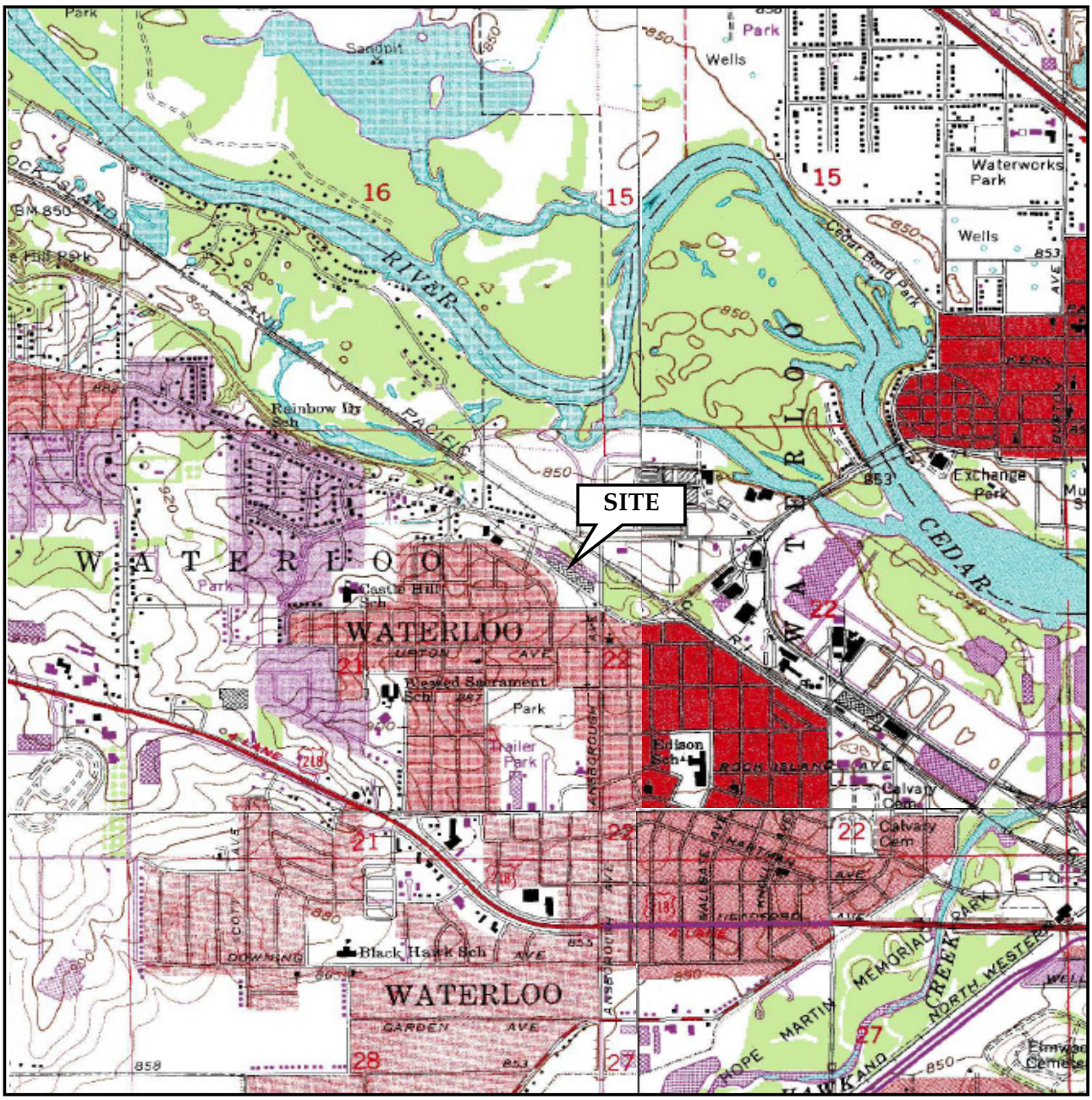
				Surr.	DUP	Matrix Spike		Blank Spike		
Analyte	**MDL**	**MRL**	**Units**	**%R**	**RPD**	**%R**	**RPD**	**%R**	**RPD**	**CAS #**
Styrene	0.023	0.08	ppb (v/v)	-	25	-	-	70-130	25	100-42-5
Tetrachloroethene	0.016	0.08	ppb (v/v)	-	25	-	-	70-130	25	127-18-4
Tetrahydrofuran	0.025	0.4	ppb (v/v)	-	25	-	-	60-140	25	109-99-9
Toluene	0.12	0.12	ppb (v/v)	-	25	-	-	70-130	25	108-88-3
trans-1,2-Dichloroethene	0.02	0.08	ppb (v/v)	-	25	-	-	70-130	25	156-60-5
trans-1,3-Dichloropropene	0.019	0.08	ppb (v/v)	-	25	-	-	70-130	25	10061-02-6
Trichloroethene	0.014	0.04	ppb (v/v)	-	25	-	-	70-130	25	79-01-6
Trichlorofluoromethane	0.0098	0.08	ppb (v/v)	-	25	-	-	60-140	25	75-69-4
Vinyl acetate	0.054	0.4	ppb (v/v)	-	25	-	-	60-140	25	108-05-4
Vinyl bromide	0.014	0.08	ppb (v/v)	-	25	-	-	60-140	25	593-60-2
Vinyl chloride	0.029	0.08	ppb (v/v)	-	25	-	-	70-130	25	75-01-4
4-Bromofluorobenzene			Surrogate	60-140	-	-	-	60-140	-	460-00-4
Method 8260B Volatile Organic Compounds in Soil										
Naphthalene	0.14	25.0	ug/kg dry wt	-	40	10-147	40	58-145	30	91-20-3
Tetrachloroethene	0.20	5.00	ug/kg dry wt	-	35	33-140	35	55-140	35	127-18-4
Dibromofluoromethane			Surrogate	73-113	-	73-113	-	73-113	-	1868-53-7
Toluene-d8			Surrogate	80-120	-	80-120	-	80-120	-	2037-26-5
4-Bromofluorobenzene			Surrogate	80-120	-	80-120	-	80-120	-	460-00-4

Key:

MDL = Method detection limit
MRL = Method reporting limit
mg/L = Milligrams per liter
ng/L = Nanograms per liter
µg/L = Micrograms per liter
% R = Percent recovery
DUP = Duplicate
RPD = Relative percent difference

Figures

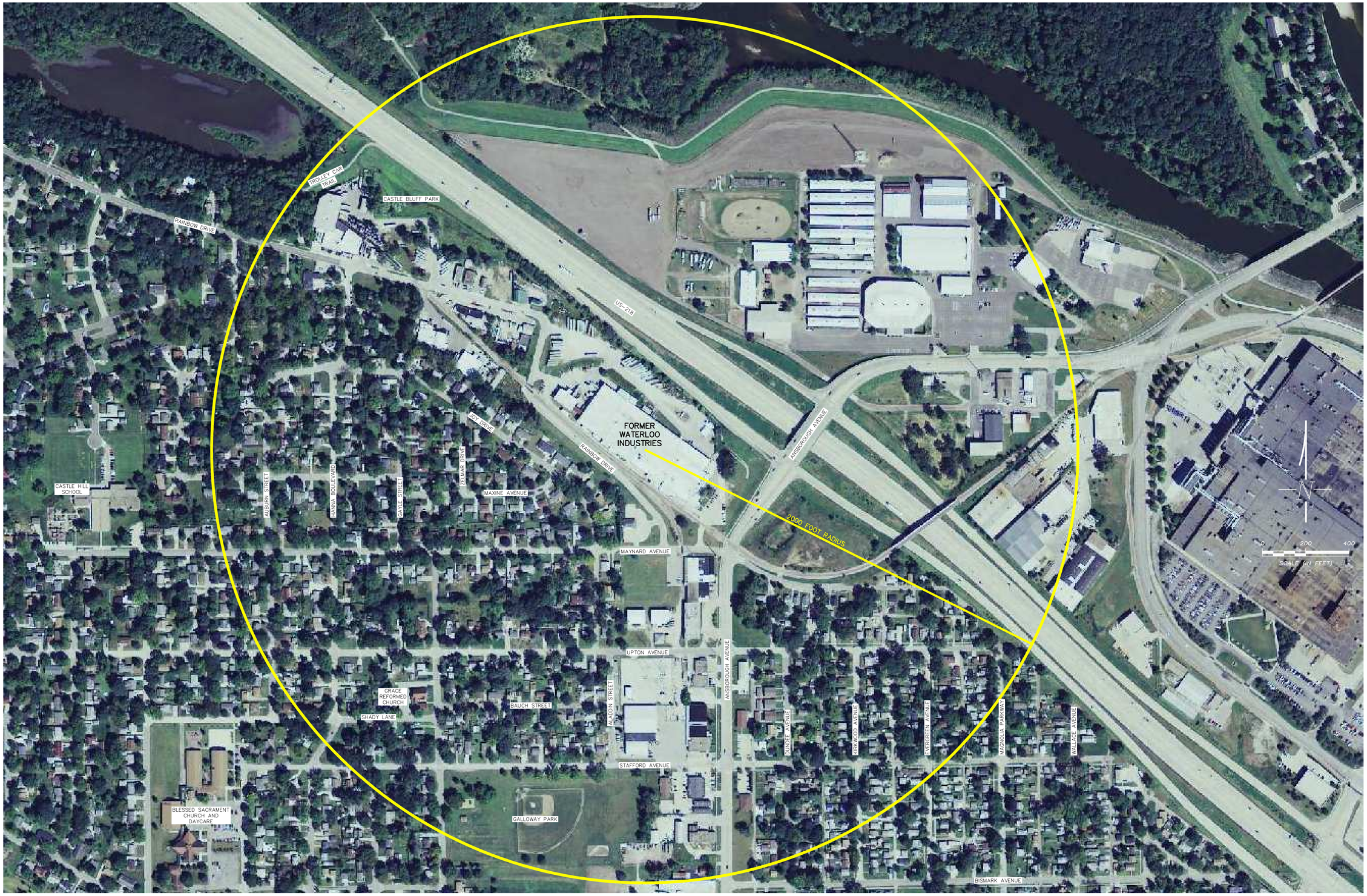
Source: Cedar Falls, Iowa (1980) United States Geological Survey 7.5 Minute Quadrangle



QUADRANGLE LOCATION

FIGURE 1-1
SITE LOCATION MAP
FORMER WATERLOO INDUSTRIES FACILITY
300 ANSBOROUGH AVE
WATERLOO, IOWA

ERM



Rev.	Date	Description	By	Chk

DRAWN BY RMK | CADD Review FGB | CHECKED BY BK-MIL

Environmental Resources Management

ERM®

FORMER WATERLOO INDUSTRIES FACILITY

300 ANSBOROUGH AVENUE
WATERLOO, IOWA

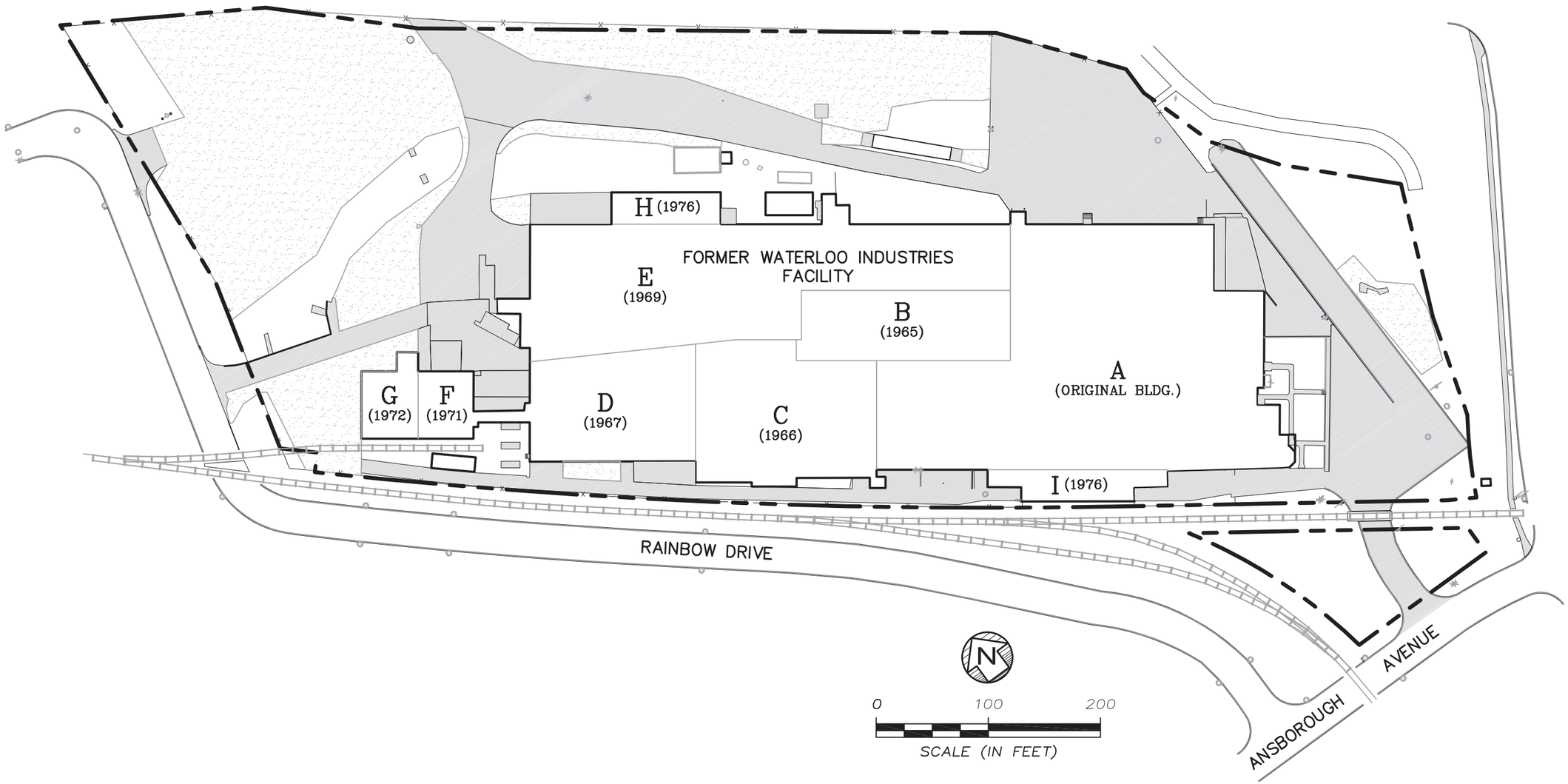
SITE AND SURROUNDING AREA OVERVIEW

SCALE	PROJECT NUMBER	SHEET	REV.
AS NOTED	0140077	FIGURE 1-2	
DATE 02/24/2012			

R:\Cadd\Cin\Q-T\Stinson Morrison Hecker LLC\0140077\0140077-03.dwg, FIG 2-1, 2/24/2012 2:43:55 PM, RMK - HOLLAND

REVISIONS TO BE MADE ON THE CADD FILE ONLY

HISTORICAL BUILDING LAYOUT MAP



LEGEND

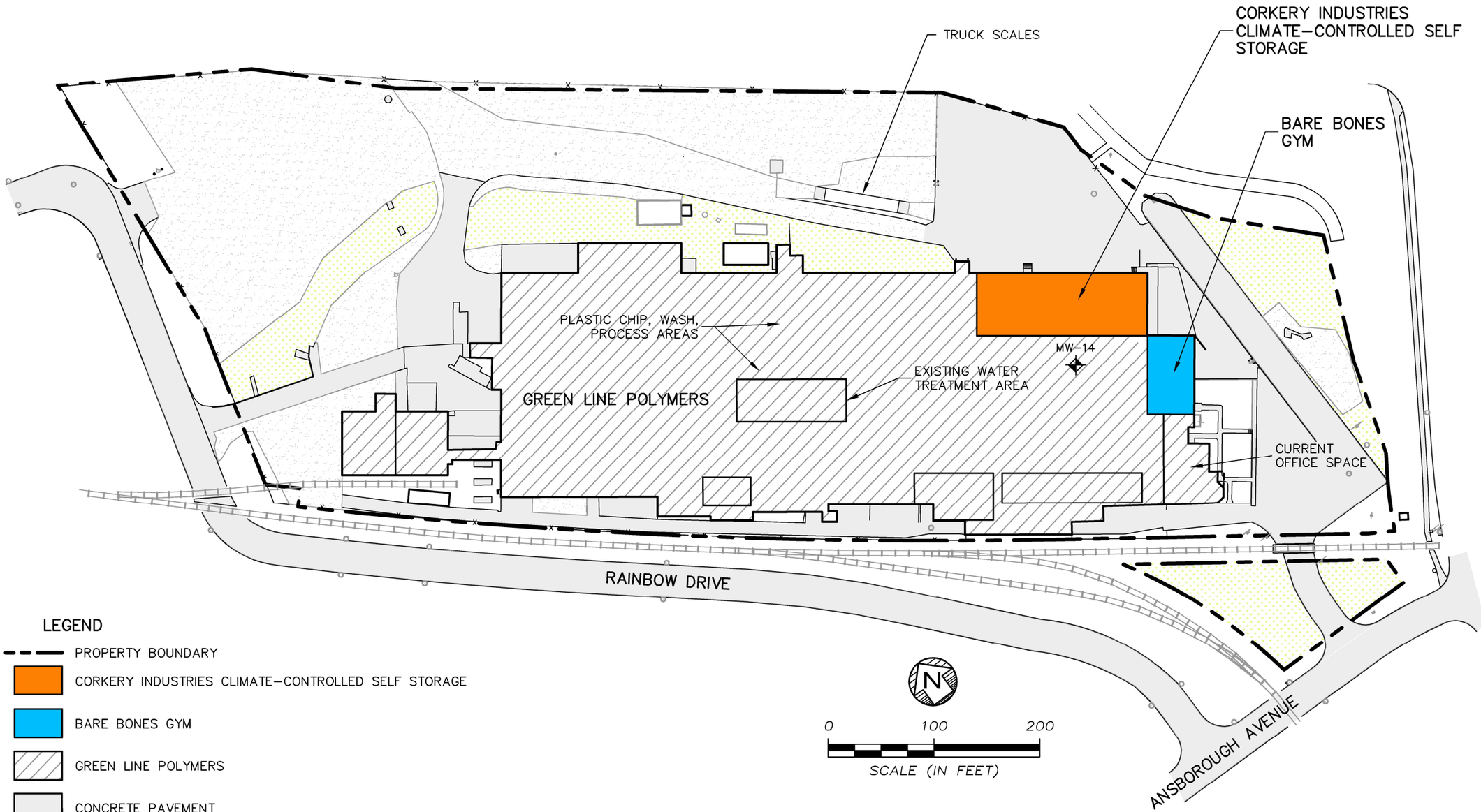
PROPERTY BOUNDARY

D (1967) BUILDING ADDITION (YEAR OF CONSTRUCTION)

Drawn By GML	ERM®	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE WATERLOO, IOWA	CHK'D BK
CADD Review RMK			0140077
Date Drawn/Rev'd 11/9/11–11/29/11		Environmental Resources Management	FIGURE 2–1

R:\Cadd\ClntE-H\Former Waterloo Industries\0140077\0140077-01.dwg, SITE LAYOUT BLDG ADDITION, 3/8/2012 12:03:48 PM, GML

SITE LAYOUT–CURRENT TENANTS AND OPERATIONS



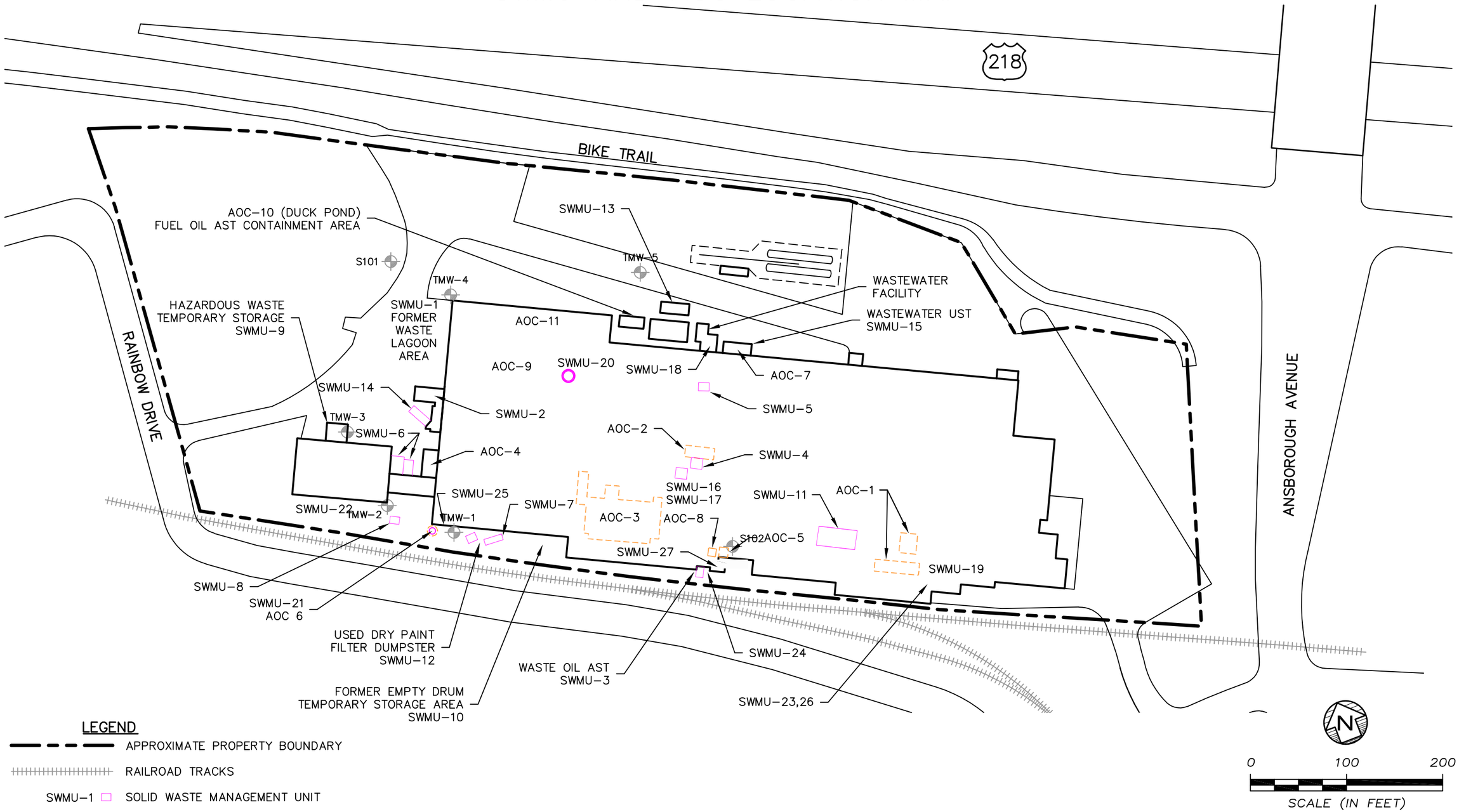
LEGEND

- PROPERTY BOUNDARY
- CORKERY INDUSTRIES CLIMATE–CONTROLLED SELF STORAGE
- BARE BONES GYM
- GREEN LINE POLYMERS
- CONCRETE PAVEMENT
- GRASS
- GRAVEL

Drawn By GML	ERM®	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE WATERLOO, IOWA	CHK'D BK
CADD Review RMK			0339767
Date Drawn/Rev'd 11/9/11–8/28/16		Environmental Resources Management	FIGURE 2–2

R:\Cadd\ClntE-H\Fortune Brands Inc\0339767\0339767-03.dwg, SITE LAYOUT MAP, 8/29/2016 10:23:11 AM, GML

SWMU AND AOC LOCATION MAP



LEGEND

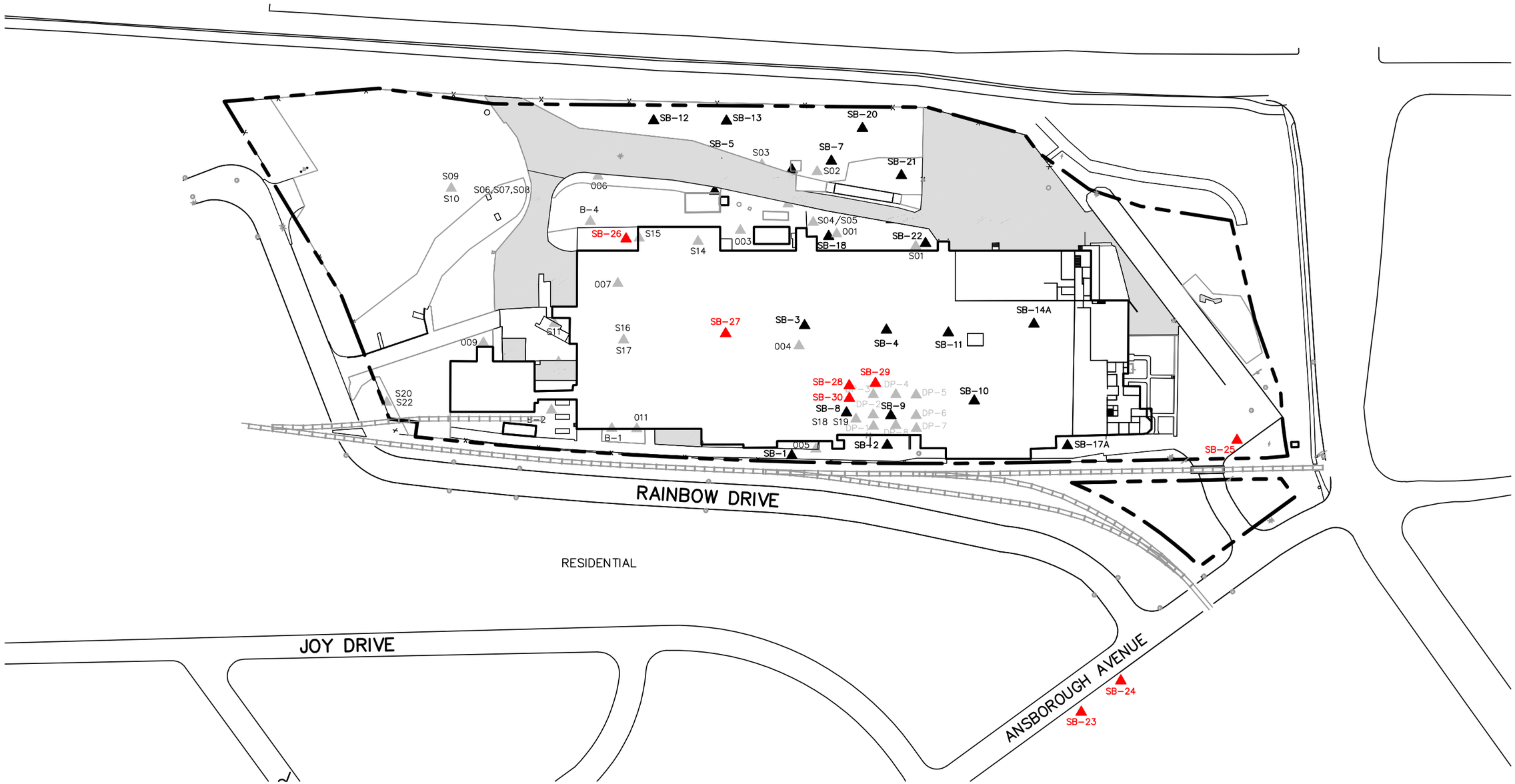
- APPROXIMATE PROPERTY BOUNDARY
- RAILROAD TRACKS
- SWMU-1 SOLID WASTE MANAGEMENT UNIT
- AOC-1 AREA OF CONCERN

REFERENCE: BASE MAP AS PRESENTED IN "SAMPLING REPORT AND REQUEST FOR NO FURTHER ACTION," COMPILED BY ROY F. WESTON, INC., 1998.

Drawn By GML	ERM	FORMER WATERLOO INDUSTRIES FACILITY 300 ANSBOROUGH AVENUE WATERLOO, IOWA	CHK'D BK
CADD Review RMK			0124706
Date Drawn/Rev'd 1/27/11–3/8/12		Environmental Resources Management	FIGURE 2–3

R:\Cadd\ClntQ-T\SMH-Waterloo Industries\0124706\BASE MAP.dwg, SWMU AND AOC LOC MAP, 3/8/2012 10:39:26 AM, GML

SOIL SAMPLE LOCATION MAP



LEGEND

- SOIL BORING
- SOIL BORING (MARCH 2014)
- SOIL SAMPLE LOCATION
  - 001 through 011 (Weston 1998)
  - B-1 through 5 (Terracon 2008)
  - S01 through 22 (SES 2008)
  - DP-1 through DP-8 (ERM 2013)
- PROPERTY BOUNDARY

N

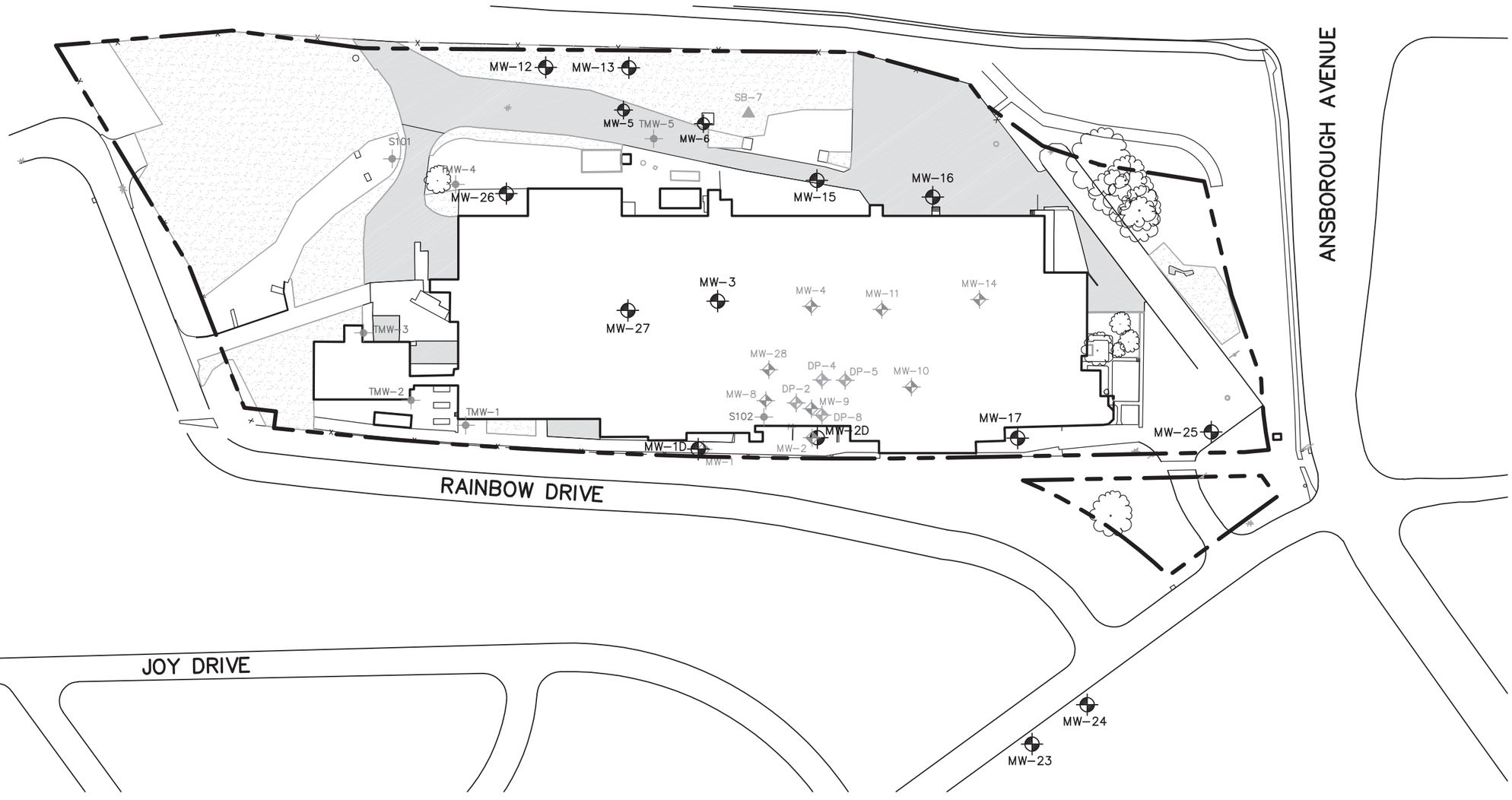
0 120 240

SCALE (IN FEET)

Drawn By RMK-GML	ERM®	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE WATERLOO, IOWA	CHK'D MF
CADD Review RMK			0140077
Date Drawn/Rev'd 11/30/11-5/13/14		Environmental Resources Management	FIGURE 2-4

R:\Cadd\CintE-H\Former Waterloo Industries\0140077\0140077-01.dwg-SOIL SAMPLE MAP FIG 1 - ANSI B (17.00 x 11.00 Inches) - 2/26/2015 - robert.keen

GROUNDWATER MONITORING WELL LOCATION MAP



LEGEND

- PERCHED ZONE MONITORING WELL
- BEDROCK ZONE MONITORING WELL
- GROUNDWATER SAMPLE LOCATION
  TMW-1 through 5 (Terracon 2008)
  S101 and 102 (SES 2008)
- SOIL BORING
- APPROXIMATE PROPERTY BOUNDARY

N

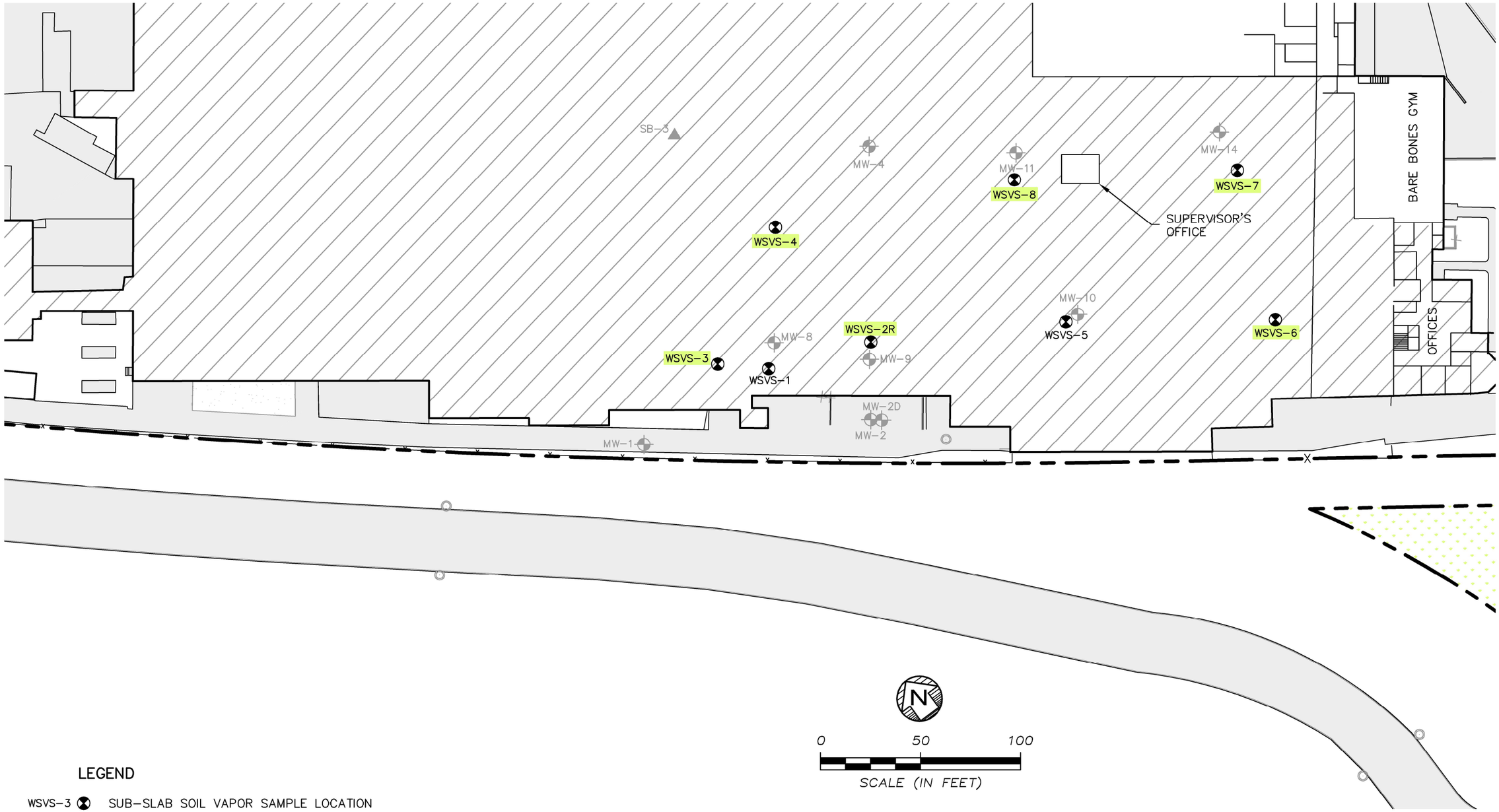
0 120 240

SCALE (IN FEET)

Drawn By GML	ERM®	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE WATERLOO, IOWA	CHK'D MF
CADD Review RMK			0140077
Date Drawn/Rev'd 3/5/12 – 2/26/15		Environmental Resources Management	FIGURE 2-5

R:\Cadd\ClntE-H\Former Waterloo Industries\0140077\0140077-14.dwg-GW MW LOCATION MAP – 2/26/2015 – robert.keen

SUB–SLAB SOIL VAPOR SAMPLE LOCATIONS



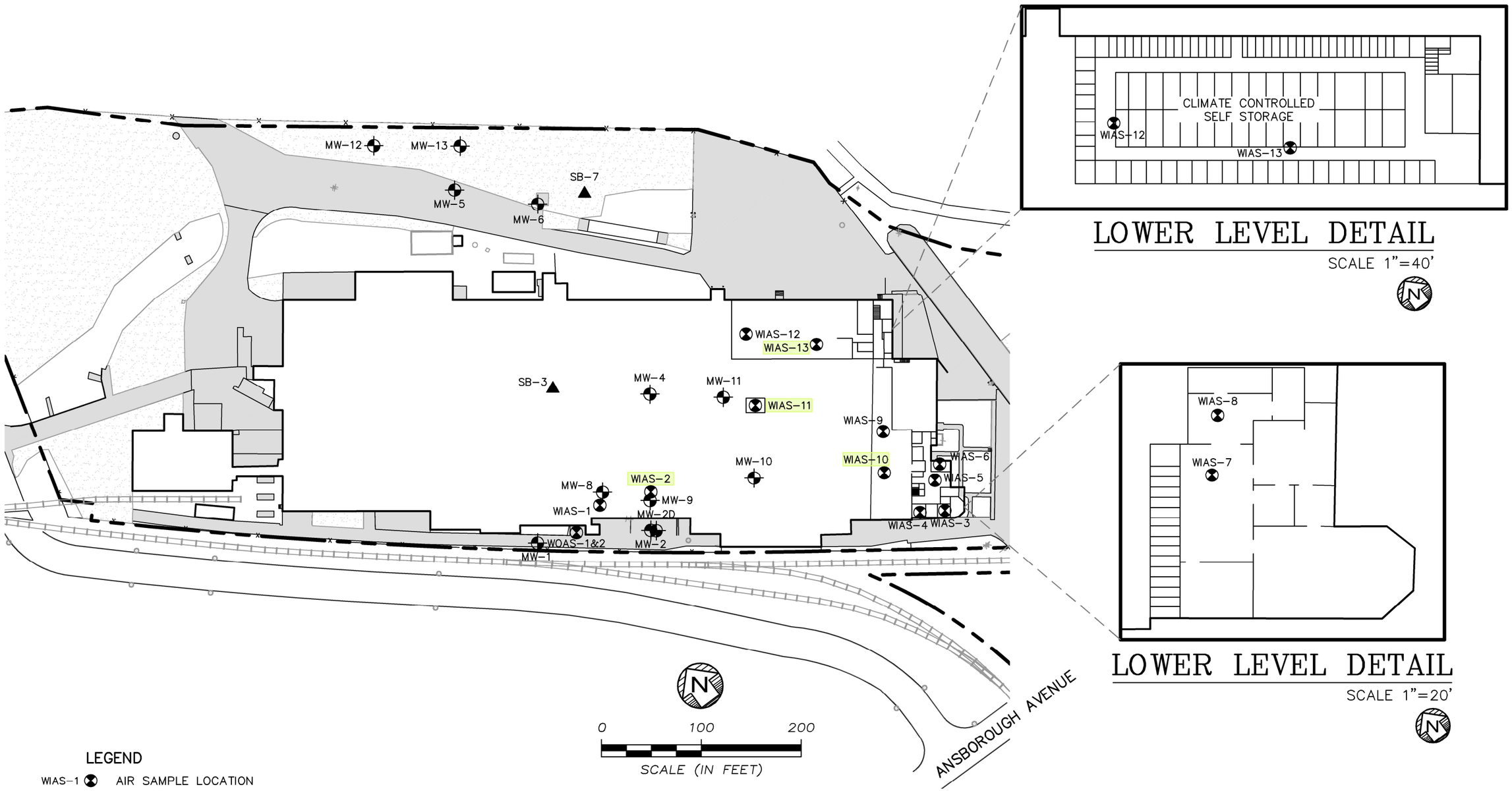
LEGEND

WSVS–3	SUB–SLAB SOIL VAPOR SAMPLE LOCATION
	MONITORING WELL LOCATION
	SOIL SAMPLE LOCATION
	PROPERTY BOUNDARY
WSVS–3	SAMPLE LOCATION (2013/2014)

Drawn By GML	ERM®	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE WATERLOO, IOWA	CHK'D BK
CADD Review RMK			0339767
Date Drawn/Rev'd 12/12/11–8/29/16		Environmental Resources Management	FIGURE 2–6

R:\Cadd\CIntE-H\Fortune Brands Inc\0339767\0339767-03.dwg, SUB SLAB SOIL VAPOR SAMPLE, 8/29/2016 10:36:35 AM, GML

INDOOR AIR SAMPLE LOCATIONS



LEGEND

- WIAS-1 AIR SAMPLE LOCATION
- MONITORING WELL LOCATION
- SOIL BORING
- PROPERTY BOUNDARY
- WSVS-2 SAMPLE LOCATION (2013/2014)

Drawn By GML	ERM®	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE WATERLOO, IOWA	CHK'D BK-MIL
CADD Review RMK			0140077
Date Drawn/Rev'd 2/28/12-3/3/15		Environmental Resources Management	FIGURE 2-7

R:\Cadd\ClntE-H\Former Waterloo Industries\0140077\0140077-06.dwg, INDOOR AIR SAMPLE 2, 3/3/2015 12:25:28 PM, GML

2000 Foot Site Buffer

River/Stream/ Drain Flow Course

NWI Wetlands

River/Lake/Pond

Emergent

Forested

Scrub Shrub

N

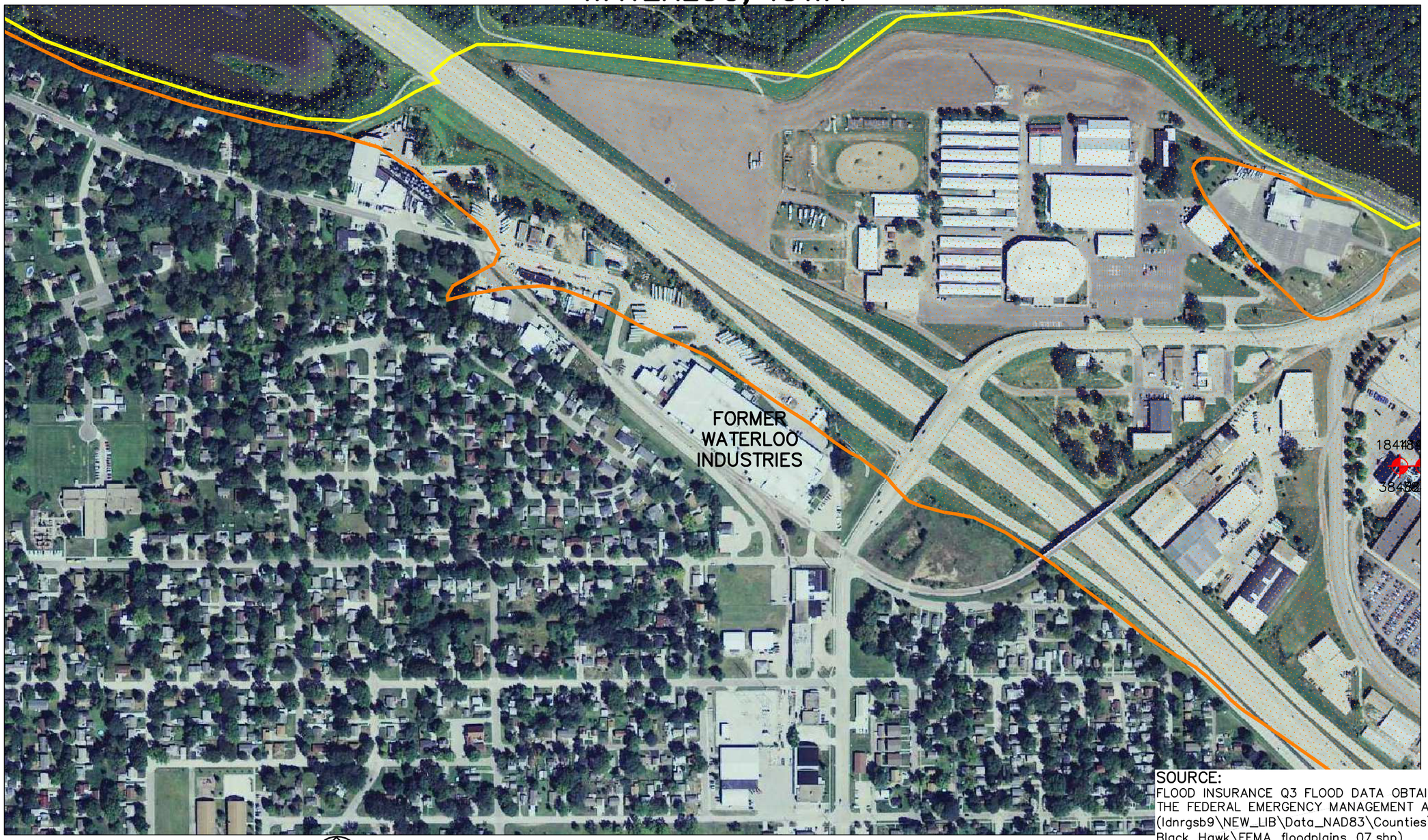
0 250 500 1,000 Feet

ERM

Figure 3.1
Surface Waters and Wetlands
Former Waterloo Industries Site
300 Ansborough Avenue
Waterloo, Iowa

February 2015

FLOODPLAIN SUMMARY MAP
WATERLOO, IOWA



SOURCE:
FLOOD INSURANCE Q3 FLOOD DATA OBTAINED FROM THE FEDERAL EMERGENCY MANAGEMENT AGENCY (ldnrgsb9\NEW_LIB\Data_NAD83\Counties\Black_Hawk\FEMA_floodplains_07.shp)

100 YEAR FLOOD PLAIN BOUNDARY (APPROXIMATE)

500 YEAR FLOOD PLAIN BOUNDARY (APPROXIMATE)

N

0 400 800

SCALE (IN FEET)

Drawn By GML	ERM®	FORMER WATERLOO INDUSTRIES FACILITY 300 ANSBOROUGH AVENUE WATERLOO, IOWA	CHK'D MS
CADD Review RMK			0136257
Date Drawn/Rev'd 01/26/12		Environmental Resources Management	FIGURE 3-2

R:\Cadd\Clnt\Q-T\Stinson Morrison Hecker LLC\0140077\0140077-03.dwg, FLOOD PLAIN MAP, 9/28/2015 11:18:56 AM, GML

Site Buffer

USDA/SSURGO Soil Type

- 1585 - Spillville-Coland (Loam)
- 4391B - Clyde-Floyd-Urban land complex (Silty Clay Loam/ Sandy Loam)
- 4083B/C - Kenyon-Urban land complex (Loam)
- 4171D - Bassett-Urban land complex (Loam)
- 4159 - Finchford-Urban land complex (Loamy Sand/ Sand)
- 4177 - Saude-Urban land complex (Loam/ Laomy Sand)
- 4946 - Orthents-urban land complex (Fill)
- W - Water

N

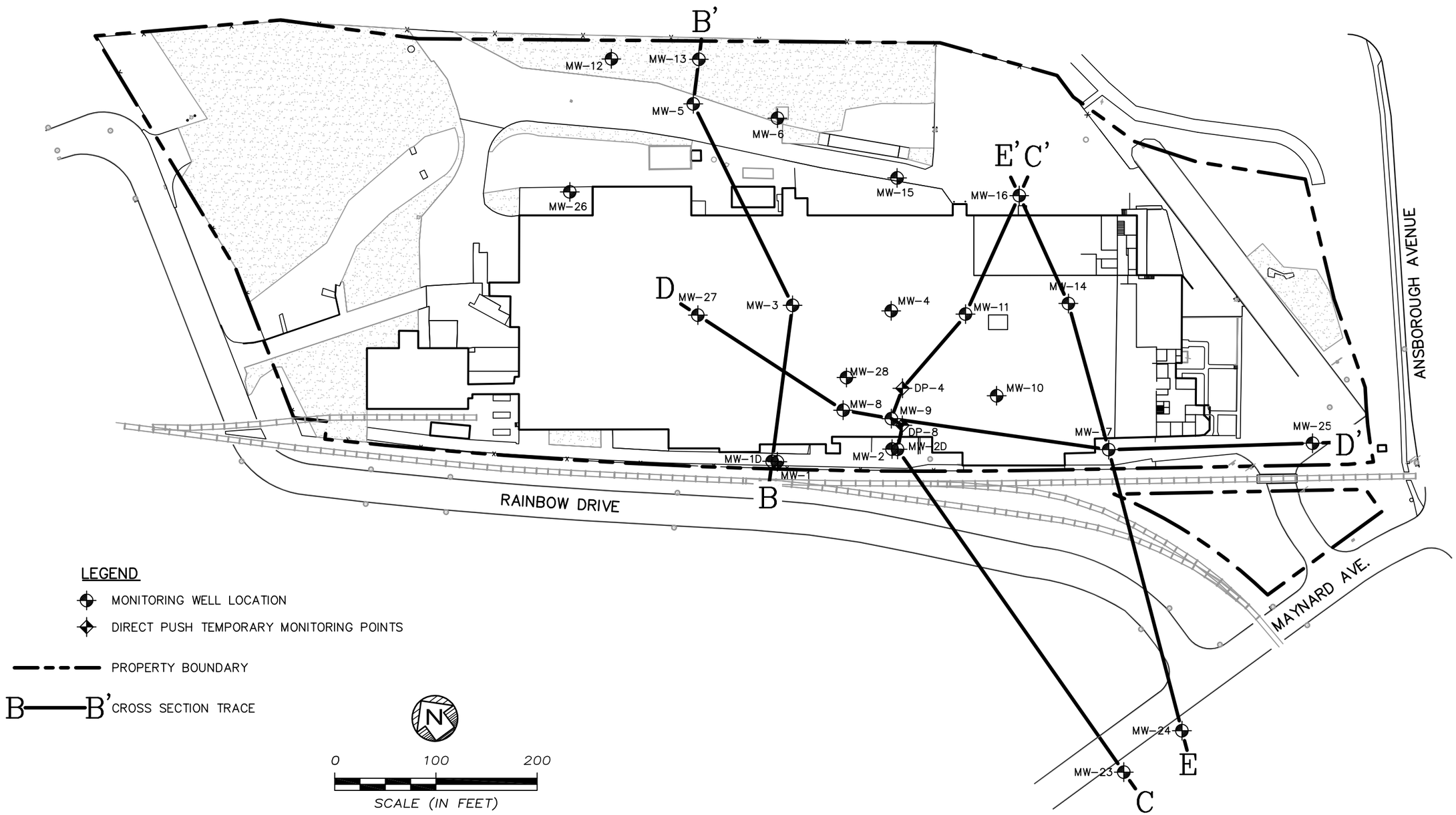
0 250 500 1,000 Feet

ERM

Figure 3-3
Soil Survey Map
Former Waterloo Industries Site
300 Ansborough Avenue
Waterloo, Iowa

February 2015

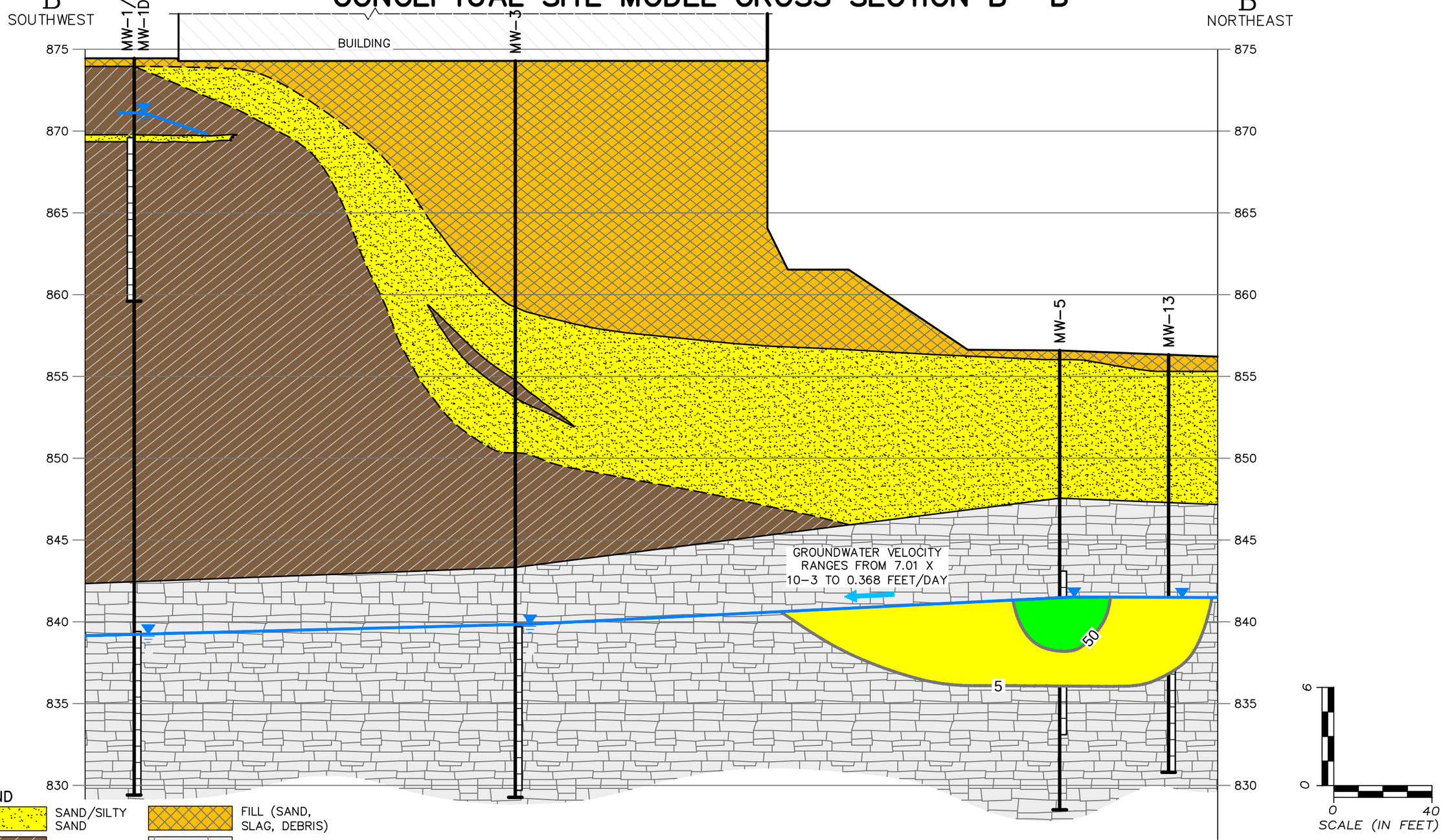
CONCEPTUAL SITE MODEL CROSS SECTION TRACE MAP



Drawn By GML	ERM®	**FORMER WATERLOO INDUSTRIES** 300 ANSBOROUGH AVENUE WATERLOO, IOWA	CHK'D MS
CADD Review RMK			0140077
Date Drawn/Rev'd 2/3/12–6/15/15		Environmental Resources Management	FIGURE 3-4

R:\Cadd\CIntE-H\Former Waterloo Industries\0287853\0287853-10.dwg, CONCEPTUAL SITE MODEL, 9/28/2015 1:17:28 PM, GML

CONCEPTUAL SITE MODEL CROSS SECTION B –B'



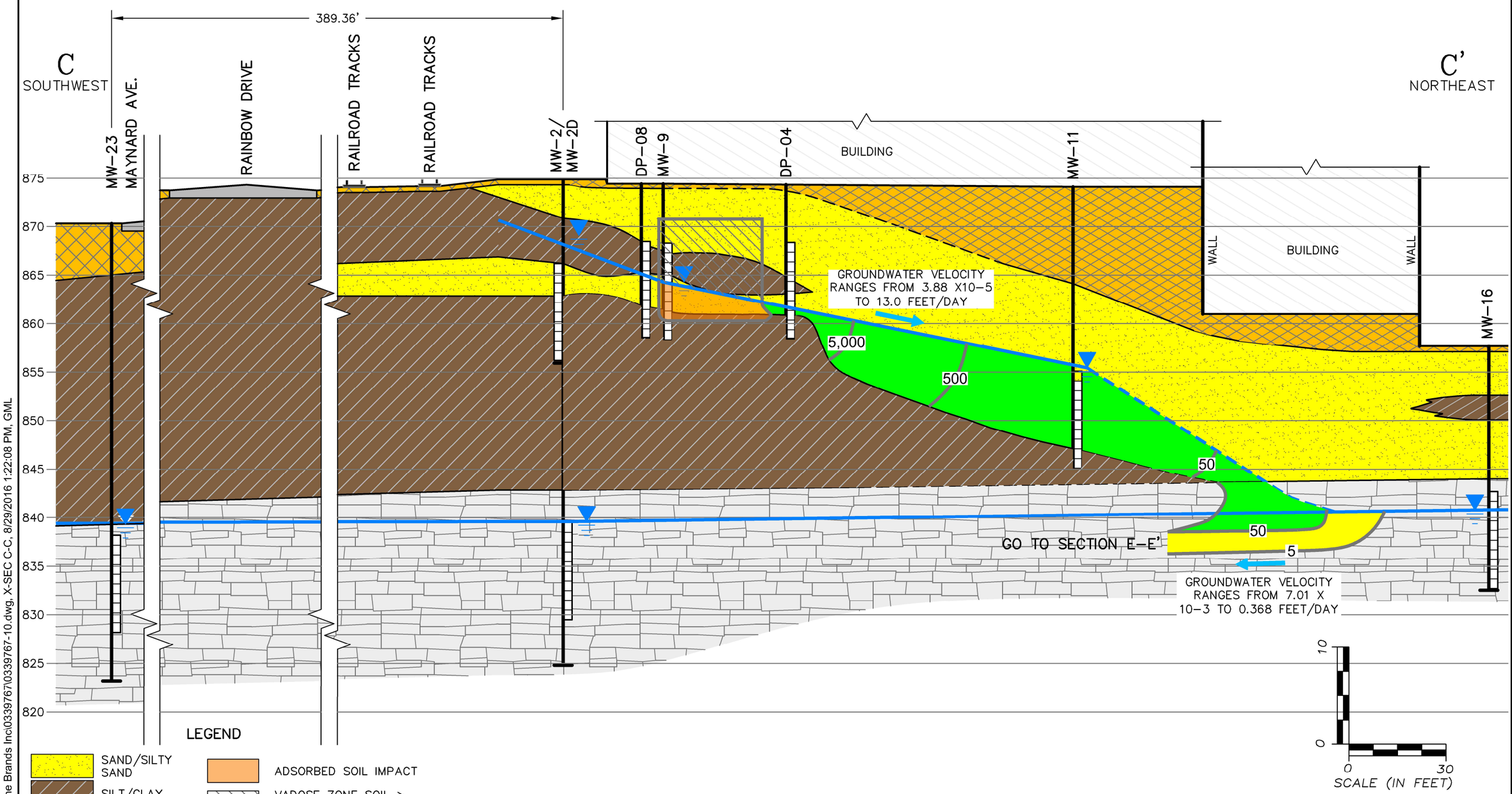
LEGEND

- SAND/SILTY SAND
- SILT/CLAY
- FILL (SAND, SLAG, DEBRIS)
- BEDROCK
- WATER ELEVATION
- APPARENT GROUNDWATER FLOW DIRECTION
- 5 — GROUNDWATER PCE CONCENTRATIONS µg/L
- SCREENED INTERVAL

Drawn By GML	ERM®	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE WATERLOO, IOWA	CHK'D BK
CADD Review RMK			0339767
Date Drawn/Rev'd 2/13/12–8/29/16		Environmental Resources Management	FIGURE 3–5

R:\Cadd\CIntE-H\Fortune Brands Inc\0339767\0339767-10.dwg, X-SEC B-B, 8/29/2016 10:43:17 AM, GML

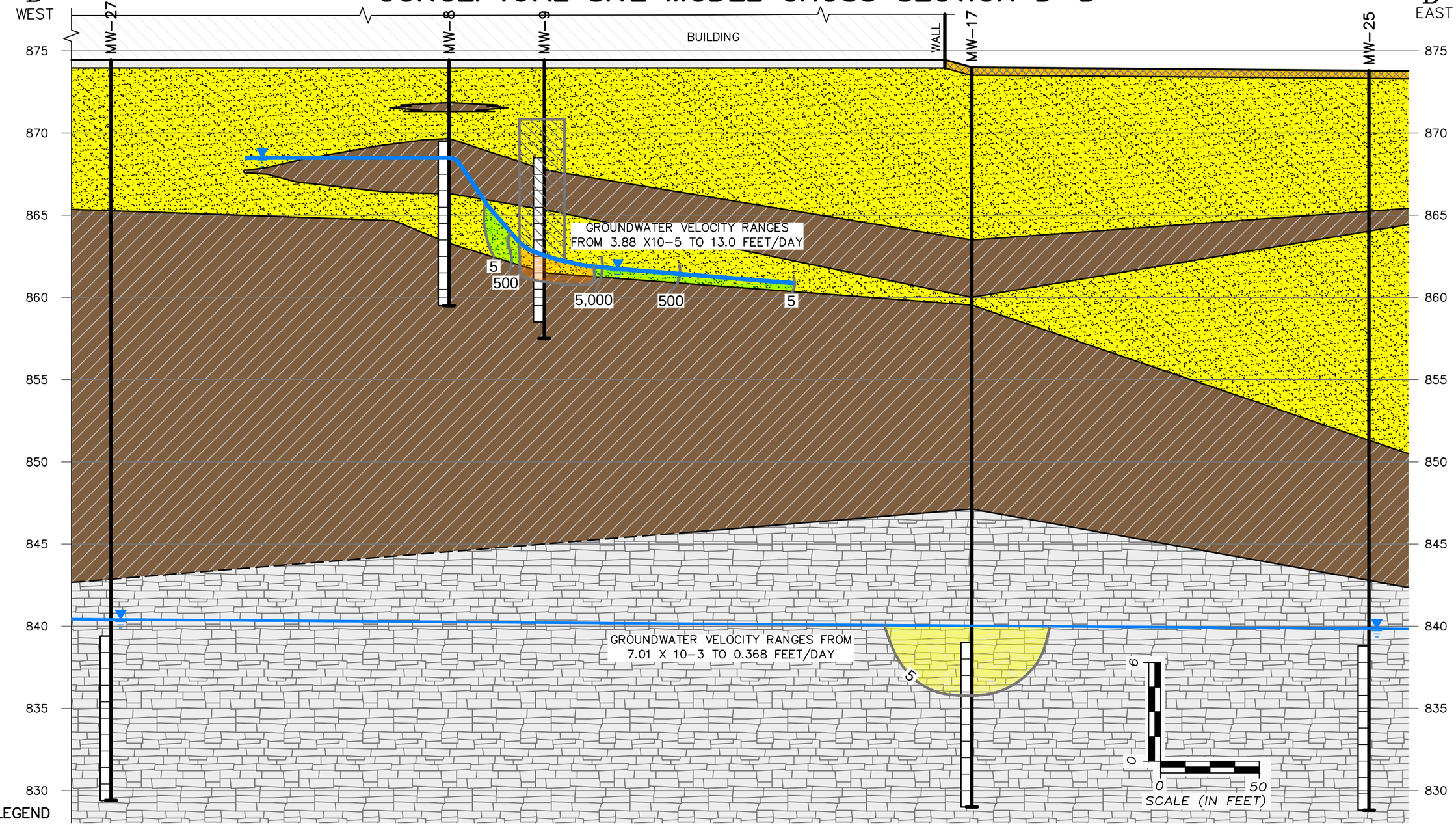
CONCEPTUAL SITE MODEL CROSS SECTION C–C'



Drawn By GML	ERM®	**FORMER WATERLOO INDUSTRIES** 300 ANSBOROUGH AVENUE WATERLOO, IOWA	CHK'D BK
CADD Review RMK			0339767
Date Drawn/Rev'd 2/13/12–8/29/16		Environmental Resources Management	FIGURE 3–6

R:\Cadd\CIntE-H\Fortune Brands Inc\0339767\0339767-10.dwg, X-SEC C-C, 8/29/2016 1:22:08 PM, GML

CONCEPTUAL SITE MODEL CROSS SECTION D–D'



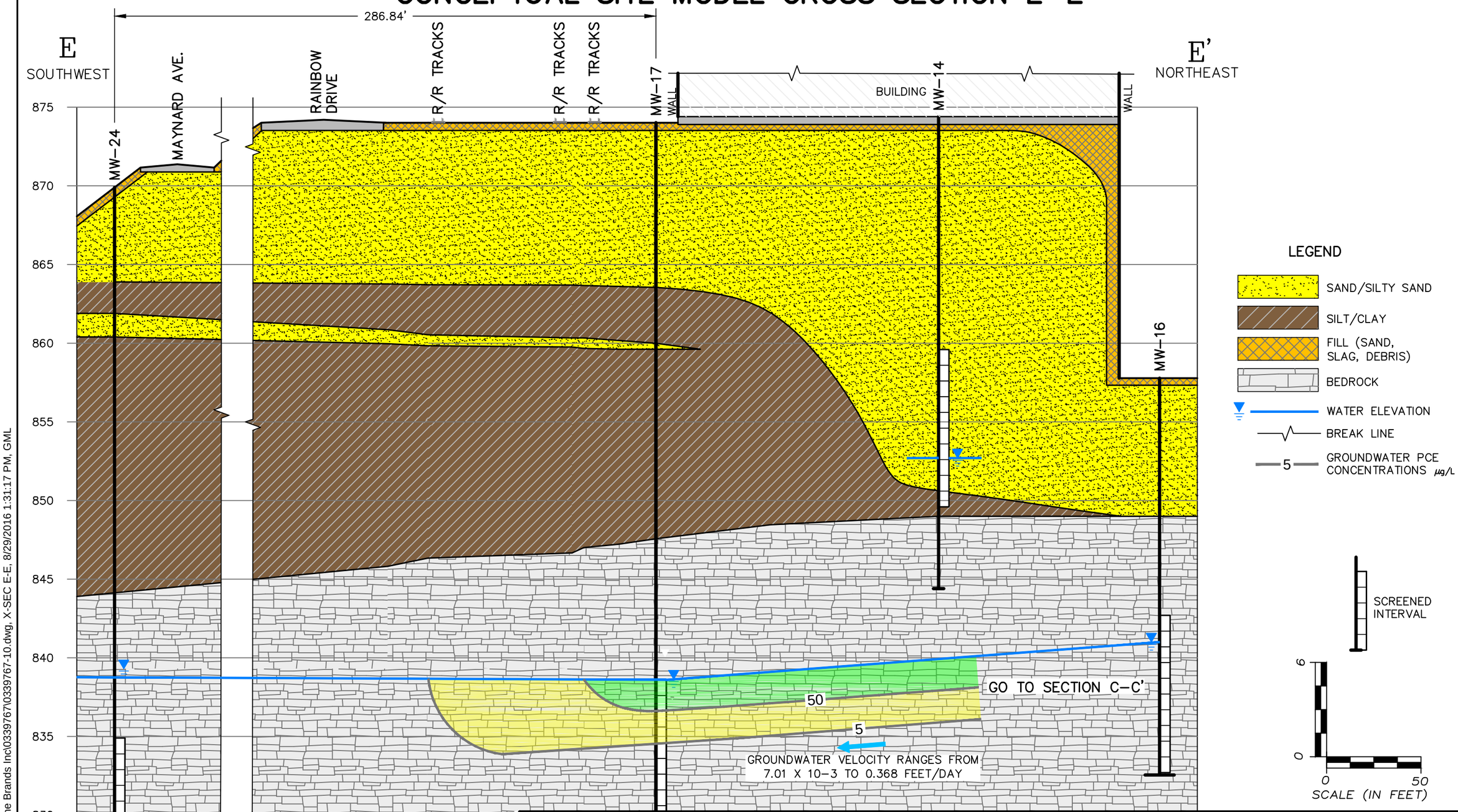
LEGEND

- SAND/SILTY SAND
- SILT/CLAY
- FILL (SAND, SLAG, DEBRIS)
- BEDROCK
- ADSORBED SOIL IMPACT
- VADOSE ZONE SOIL > PCE SSL
- 5 — GROUNDWATER PCE CONCENTRATIONS µg/L
- WATER ELEVATION
- SCREENED INTERVAL

Drawn By GML	ERM®	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE WATERLOO, IOWA	CHK'D MS
CADD Review RMK			0140077
Date Drawn/Rev'd 2/10/12–9/9/16		Environmental Resources Management	FIGURE 3–7

R:\Cadd\CIntE-H\Fortune Brands Inc\0339767\0339767-10.dwg, X-SEC D-D, 9/9/2016 9:58:59 AM, GML

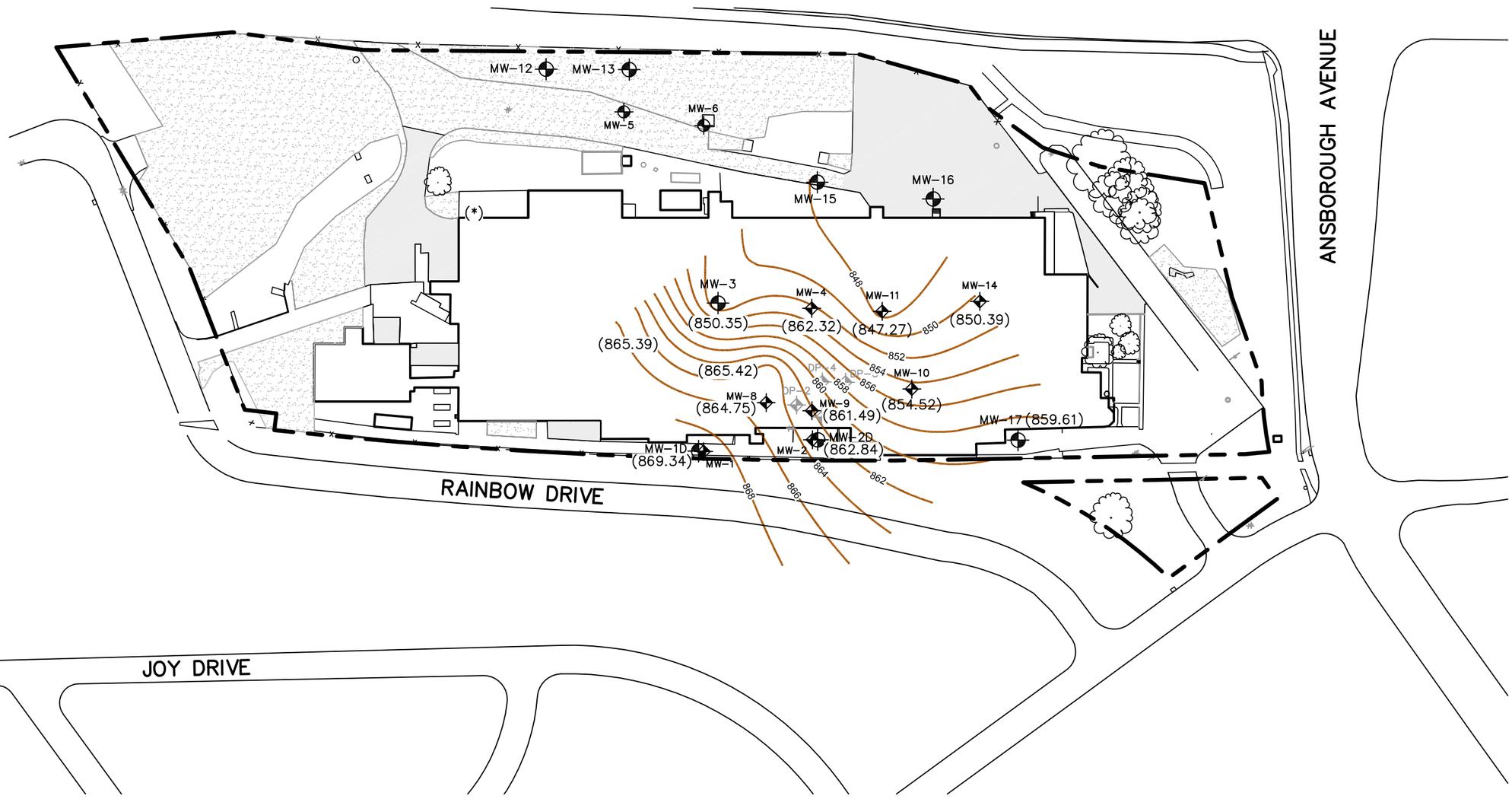
CONCEPTUAL SITE MODEL CROSS SECTION E–E'



Drawn By GML	ERM®	**FORMER WATERLOO INDUSTRIES** 300 ANSBOROUGH AVENUE WATERLOO, IOWA	CHK'D MS
CADD Review RMK			0339767
Date Drawn/Rev'd 2/10/12–8/29/16		Environmental Resources Management	FIGURE 3–8

R:\Cadd\CIntE-H\Fortune Brands Inc\0339767\0339767-10.dwg, X-SEC E-E, 8/29/2016 1:31:17 PM, GML

PERCHED ZONE CLAY SURFACE ELEVATION CONTOUR MAP



LEGEND

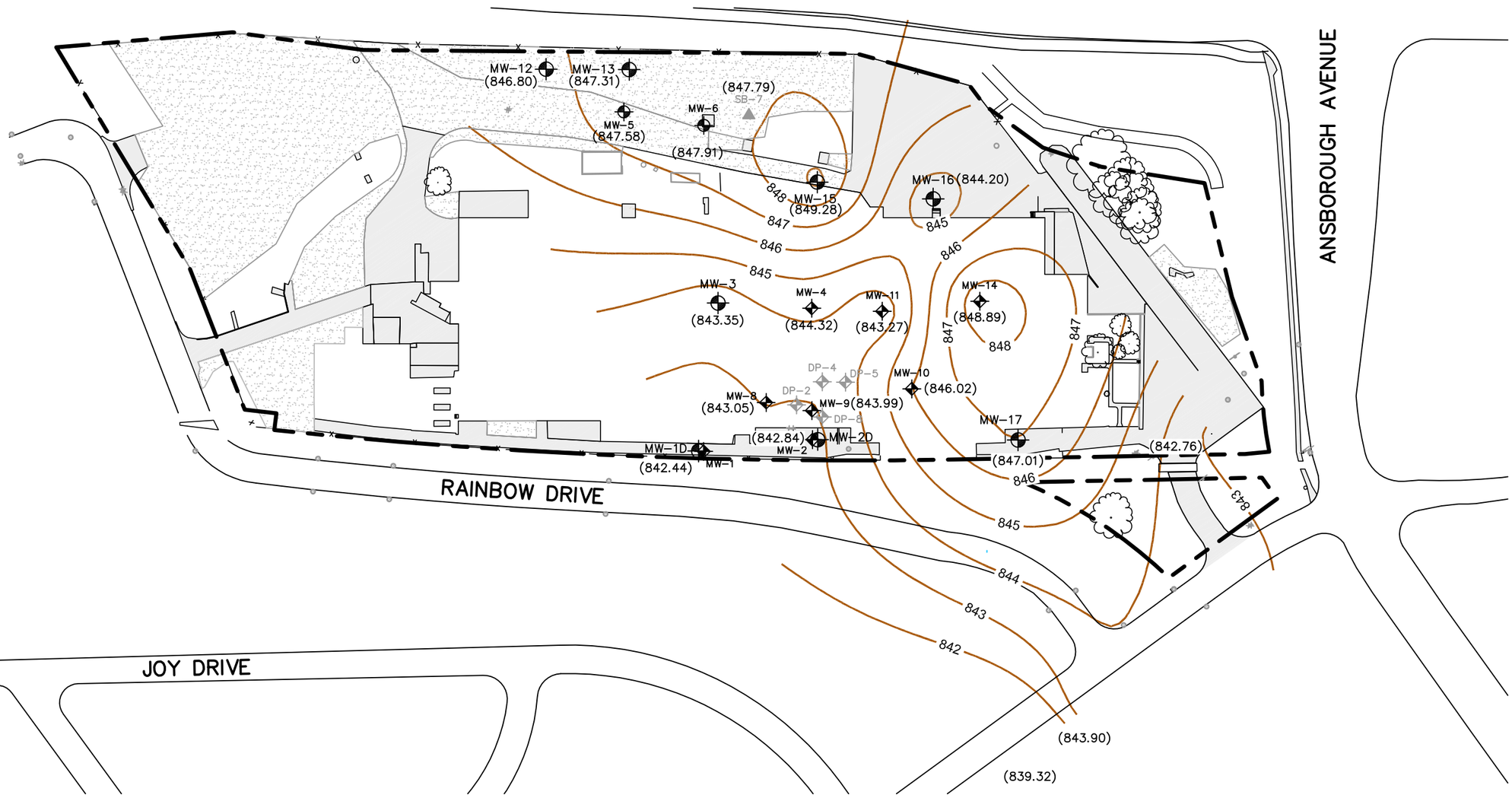
- PERCHED ZONE MONITORING WELL
- BEDROCK ZONE MONITORING WELL
- 858 — PERCHED ZONE CLAY SURFACE CONTOUR
- (840.0) PERCHED ZONE CLAY SURFACE ELEVATION
- APPROXIMATE PROPERTY BOUNDARY

* NOTE:
MW-26 WAS NOT USED IN CALCULATIONS. NO CLAY WAS ENCOUNTERED WILE DRILLING.

Drawn By GML	ERM®	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE WATERLOO, IOWA	CHK'D MF
CADD Review RMK			0140077
Date Drawn/Rev'd 3/5/12 – 2/26/15		Environmental Resources Management	FIGURE 3-9

R:\Cadd\ClntE-H\Former Waterloo Industries\0140077\0140077-14.dwg, PERCHED ZONE CLAY CONTOUR, 9/28/2015 1:12:25 PM, GML

BEDROCK SURFACE ELEVATION CONTOUR MAP



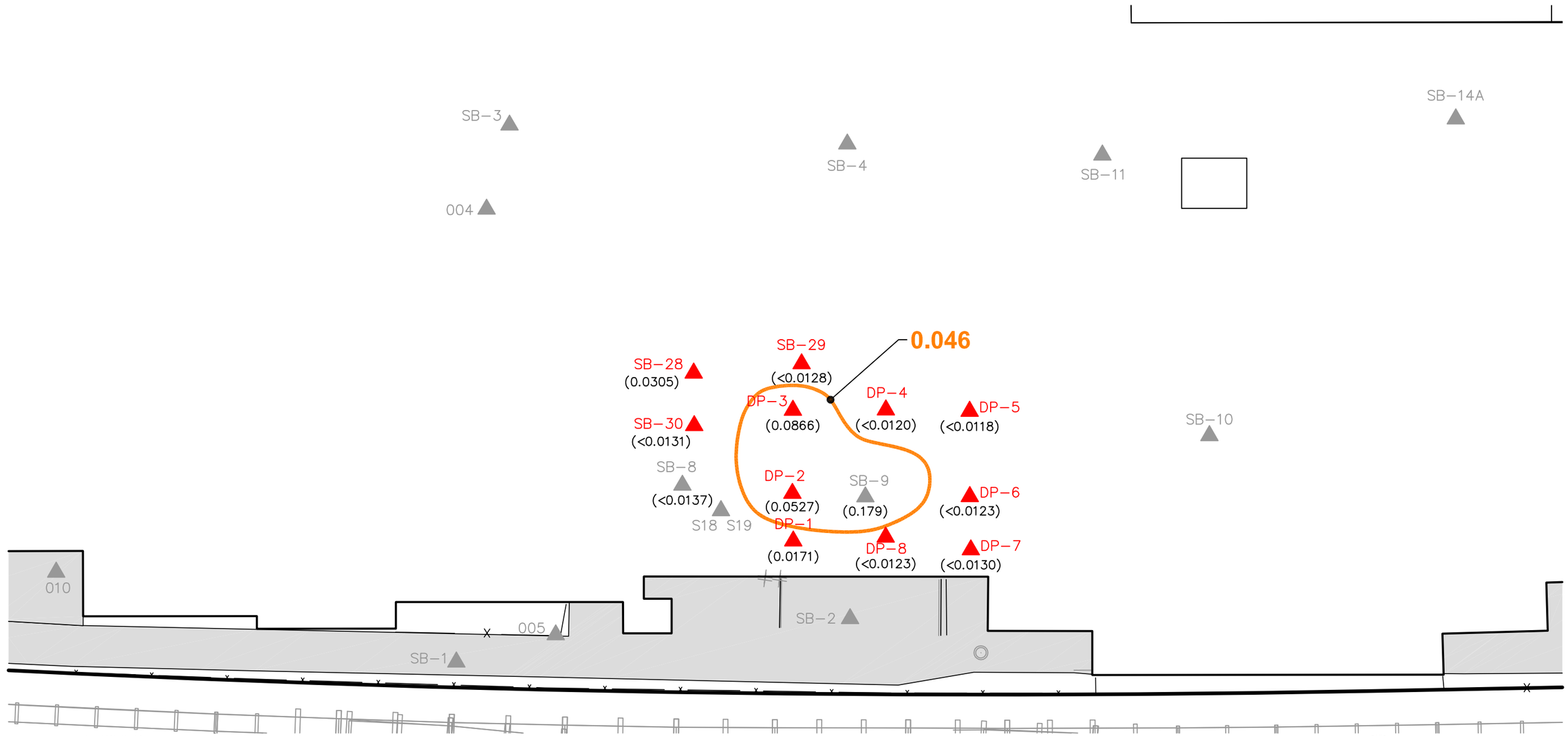
LEGEND

- PERCHED ZONE MONITORING WELL
- BEDROCK ZONE MONITORING WELL
- 858 BEDROCK SURFACE CONTOUR
- (840.0) BEDROCK SURFACE ELEVATION
- APPROXIMATE PROPERTY BOUNDARY

Drawn By FAK-GML	ERM®	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE WATERLOO, IOWA	CHK'D MF
CADD Review RMK			0140077
Date Drawn/Rev'd 4/30/1 -3/3/15		Environmental Resources Management	FIGURE 3-10

R:\Cadd\ClntE-H\Former Waterloo Industries\0140077\0140077-14.dwg, GWC PERCHED ZONE CLAY, 9/28/2015 1:14:00 PM, GML

AOC 5 AREA–PCE SOIL CONCENTRATION SUMMARY MAP
SEPTEMBER 2013 AND MARCH 2014



LEGEND

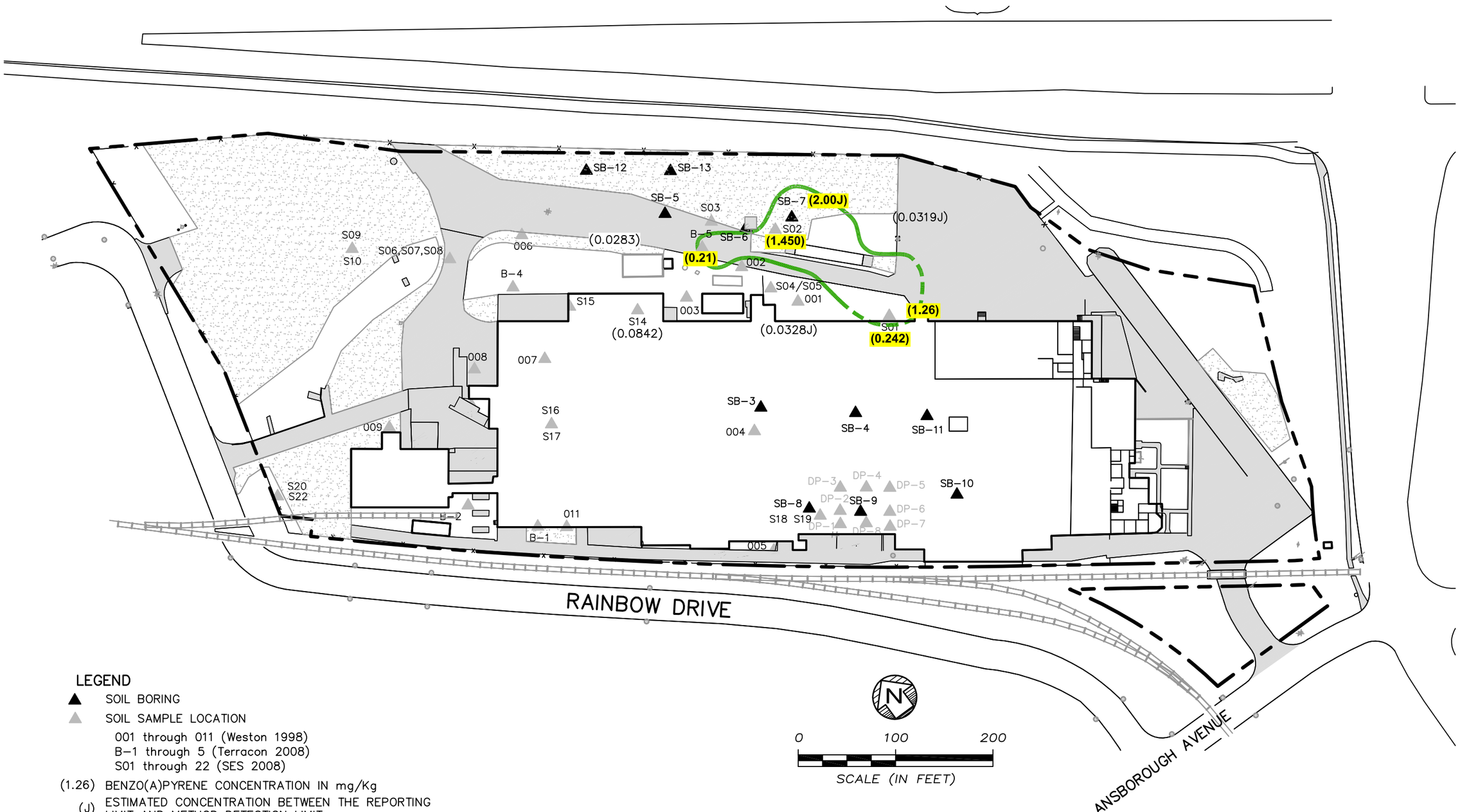
- ▲ DIRECT PUSH SAMPLES DP–1 THROUGH DP–8 (ERM 2013 AND 2014)
- ▲ SOIL SAMPLE LOCATION
  - 001 THROUGH 011 (Weston 1998)
  - B–1 THROUGH 5 (Terracon 2008)
  - S01 THROUGH 22 (SES 2008)
  - SB–1 THROUGH 13 (ERM 2011)
  - SB–14 THROUGH 17 (ERM 2012)
- PROPERTY BOUNDARY
- (0.0527) PCE CONCENTRATION IN mg/kg
- EXTENT OF PCE RSL EXCEEDANCE

NOTE:
PCE CONCENTRATION REPORTED IN mg/kg (EPA RSL FOR GROUNDWATER PROTECTION = 0.046 mg/kg)

Drawn By RMK–GML	ERM®	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE WATERLOO, IOWA	CHK'D MF
CADD Review FGB			0140077
Date Drawn/Rev'd 11/30/11–3/20/15		Environmental Resources Management	FIGURE 3-11

R:\Cadd\ClntE-H\Former Waterloo Industries\0140077\0140077-17.dwg, AOC 5 AREA PCE FIG 4-1, 6/29/2015 7:57:59 AM, GML

BENZO(A)PYRENE DETECTIONS IN NEAR SURFACE SOIL (0.5–2 FEET)



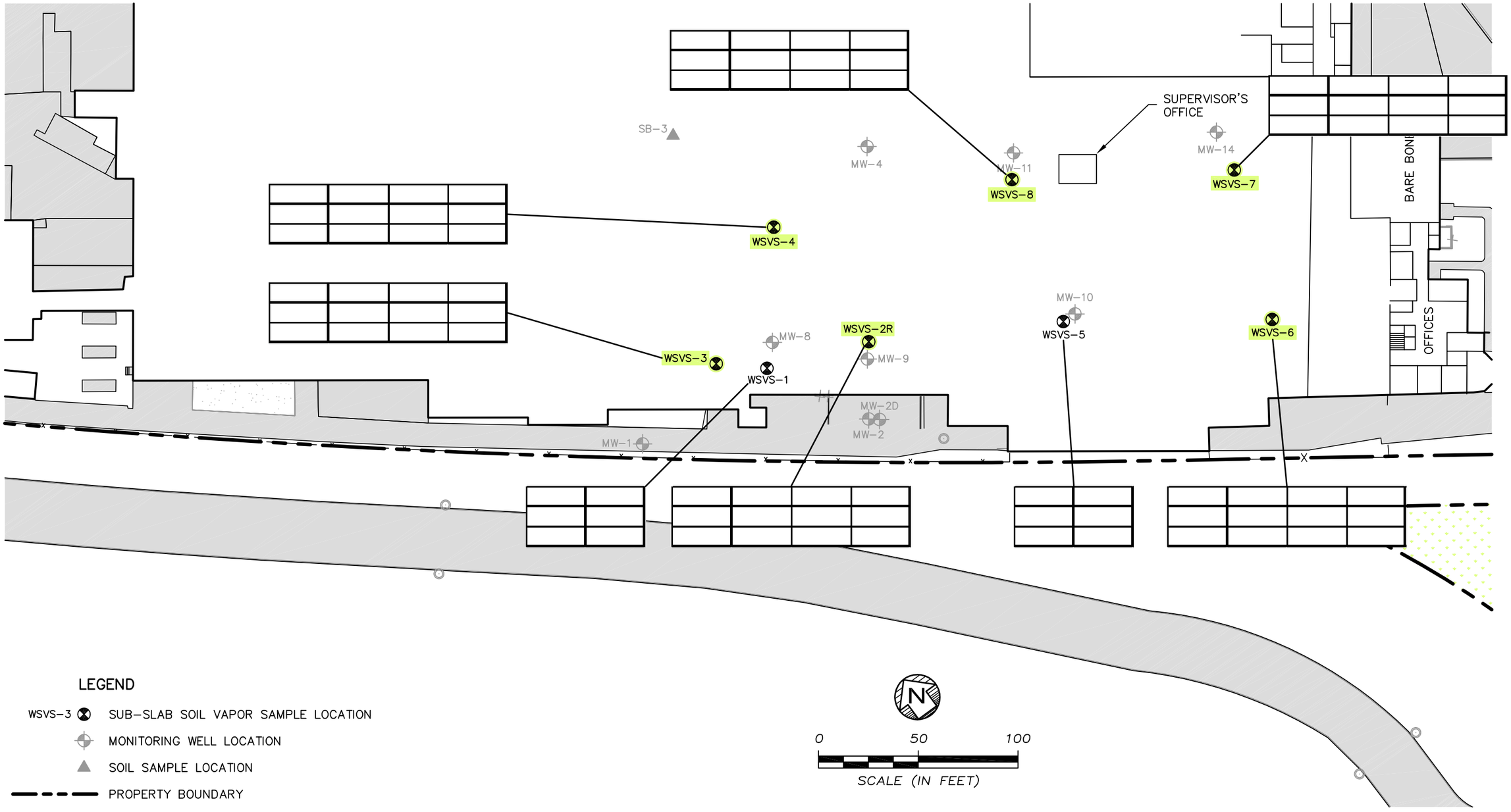
LEGEND

- ▲ SOIL BORING
- ▲ SOIL SAMPLE LOCATION
  - 001 through 011 (Weston 1998)
  - B–1 through 5 (Terracon 2008)
  - S01 through 22 (SES 2008)
- (1.26) BENZO(A)PYRENE CONCENTRATION IN mg/Kg
- (J) ESTIMATED CONCENTRATION BETWEEN THE REPORTING LIMIT AND METHOD DETECTION LIMIT.
- **(BOLD)** VALUE INDICATES CONCENTRATION EXCEEDS THE REGIONAL SCREENING LEVEL 0.21 mg/Kg
- EXTENT OF BENZO(A)PYRENE RSL EXCEEDANCE
- PROPERTY BOUNDARY

Drawn By RMK–GML	ERM®	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE WATERLOO, IOWA	CHK'D BK–Mil
CADD Review RMK			0140077
Date Drawn/Rev'd 11/30/11–3/3/15		Environmental Resources Management	FIGURE 3-12

R:\Cadd\CintE-H\Former Waterloo Industries\0140077\0140077-01.dwg, BENZO IN SOIL, 3/19/2015 9:58:12 AM, GML

SUB–SLAB SOIL VAPOR SAMPLE LOCATIONS WITH PCE AND TCE (ug/m3) CONCENTRATIONS



LEGEND

WSVS–3 SUB–SLAB SOIL VAPOR SAMPLE LOCATION

MONITORING WELL LOCATION

SOIL SAMPLE LOCATION

PROPERTY BOUNDARY

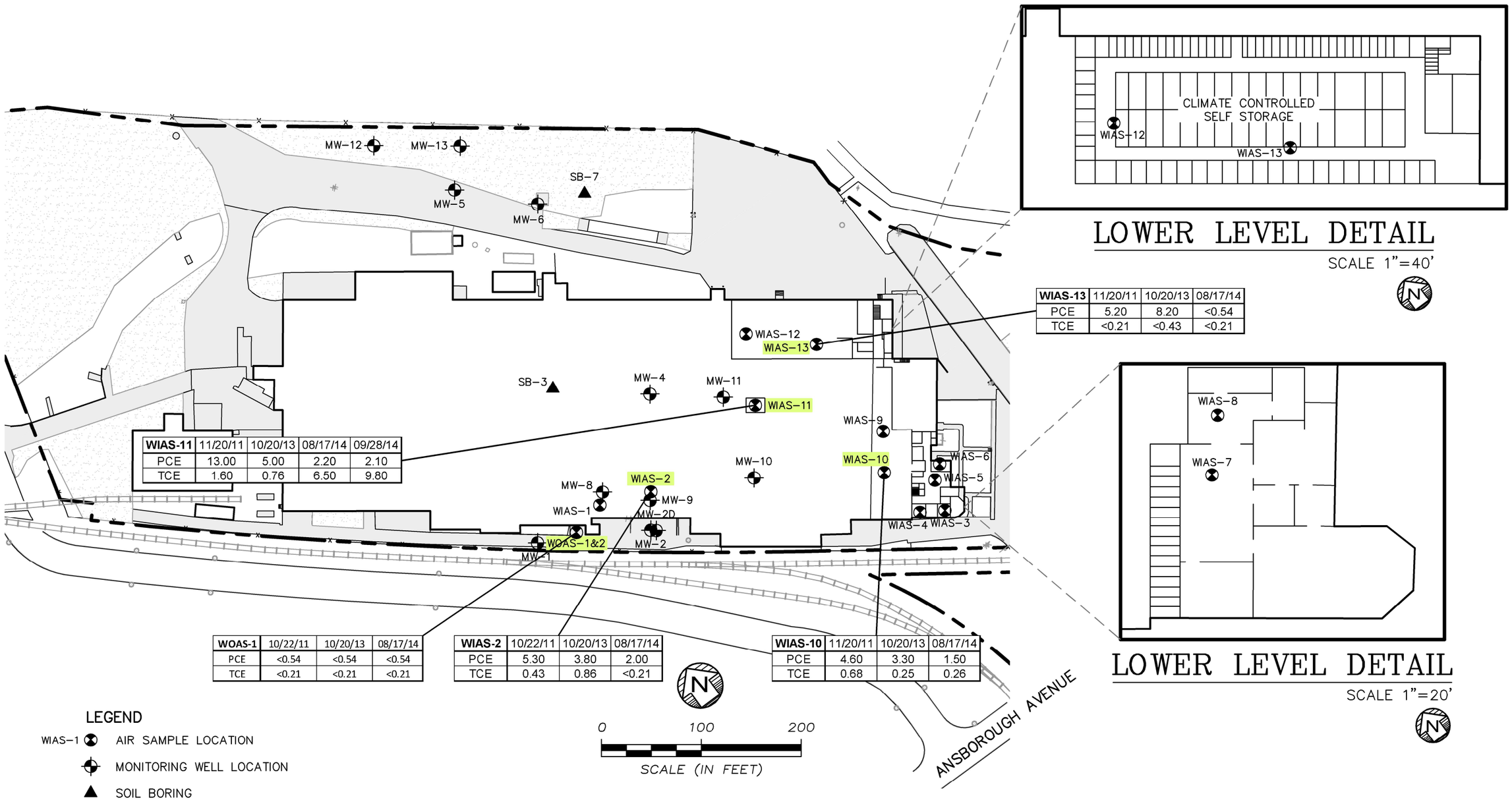
SAMPLE LOCATION (2013/2014)

NOTE:
CALCULATED SOIL GAS VAPOR INTRUSION (VI) CLEANUP LEVEL (EPA JUNE 2015) FOR PCE = 1,600 ug/m^3; TCE = 100 ug/m^3.

Drawn By GML	ERM®	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE Waterloo, Iowa	CHK'D MS
CADD Review RMK			0140077
Date Drawn/Rev'd 2/28/12–6/17/15		Environmental Resources Management	FIGURE 3-13

R:\Cadd\ClntE-H\Former Waterloo Industries\0140077\0140077-03.dwg, SUB SLAB VAPOR PCE-TCE CONCEN, 6/29/2015 8:02:47 AM, GML

INDOOR AND AMBIENT AIR SAMPLE DATA SUMMARY WITH PCE AND TCE CONCENTRATIONS (ug/m^3)



WIAS-11	11/20/11	10/20/13	08/17/14	09/28/14
PCE	13.00	5.00	2.20	2.10
TCE	1.60	0.76	6.50	9.80

WIAS-13	11/20/11	10/20/13	08/17/14
PCE	5.20	8.20	<0.54
TCE	<0.21	<0.43	<0.21

WOAS-1	10/22/11	10/20/13	08/17/14
PCE	<0.54	<0.54	<0.54
TCE	<0.21	<0.21	<0.21

WIAS-2	10/22/11	10/20/13	08/17/14
PCE	5.30	3.80	2.00
TCE	0.43	0.86	<0.21

WIAS-10	11/20/11	10/20/13	08/17/14
PCE	4.60	3.30	1.50
TCE	0.68	0.25	0.26

LEGEND

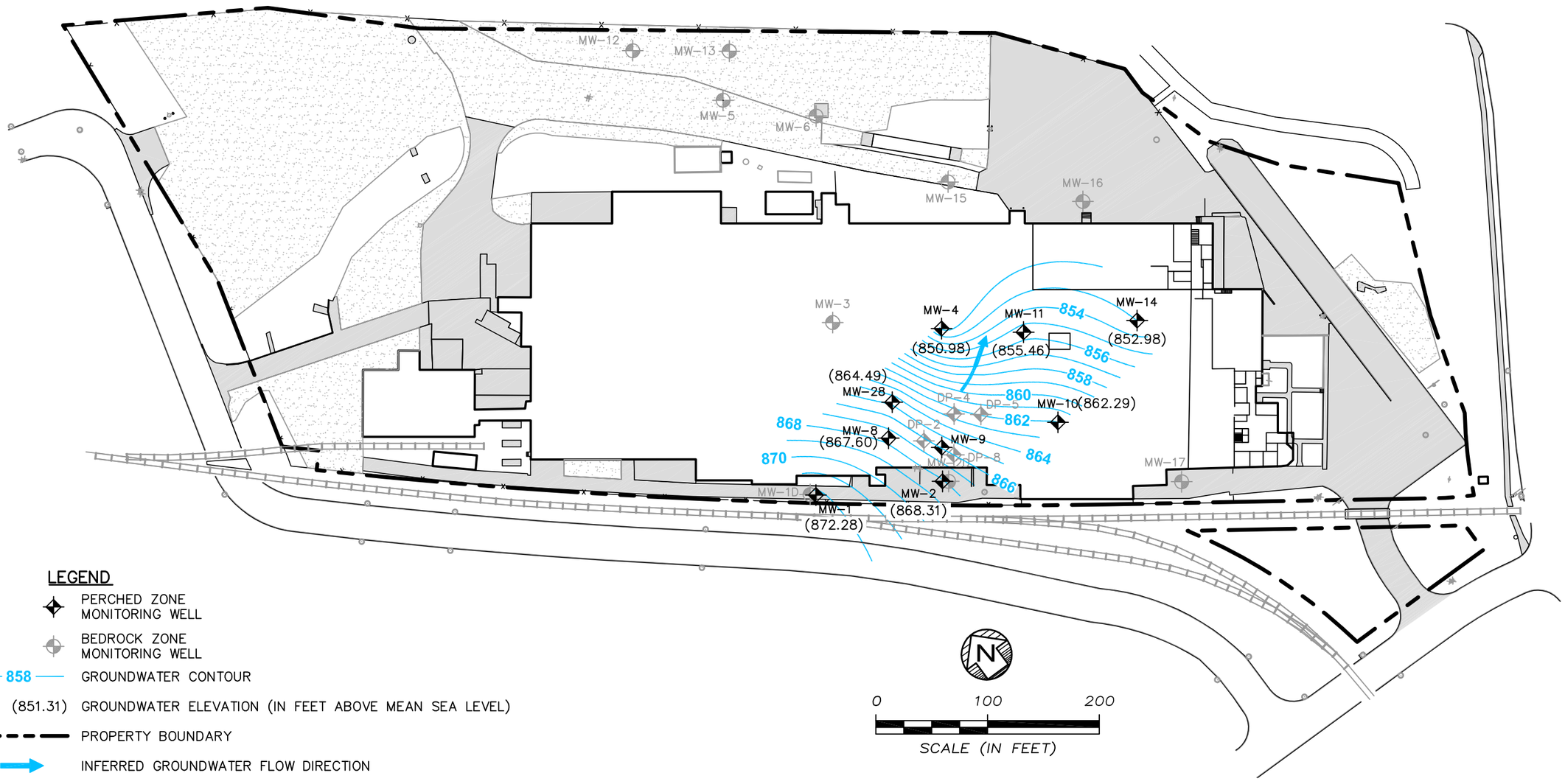
- WIAS-1 — AIR SAMPLE LOCATION
- MONITORING WELL LOCATION
- SOIL BORING
- PROPERTY BOUNDARY
- WSVS-2 — SAMPLE LOCATION (2011/2013)

NOTE:
EPA TARGET INDUSTRIAL INDOOR AIR CONCENTRATIONS FOR PCE: 47 ug/m^3 AND TCE: 3.0 ug/m^3

Drawn By GML	ERM®	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE WATERLOO, IOWA	CHK'D MS
CADD Review RMK			0339767
Date Drawn/Rev'd 2/28/12–8/29/16		Environmental Resources Management	FIGURE 3–14

R:\Cadd\ClntE-H\Fortune Brands Inc\0339767\0339767-06.dwg, INDOOR AIR PCE-TCE, 8/29/2016 1:35:30 PM, GML

PERCHED ZONE GROUNDWATER CONTOUR MAP
(MAY 29, 2014)



LEGEND

- PERCHED ZONE MONITORING WELL
- BEDROCK ZONE MONITORING WELL
- 858 — GROUNDWATER CONTOUR
- (851.31) GROUNDWATER ELEVATION (IN FEET ABOVE MEAN SEA LEVEL)
- PROPERTY BOUNDARY
- INFERRED GROUNDWATER FLOW DIRECTION

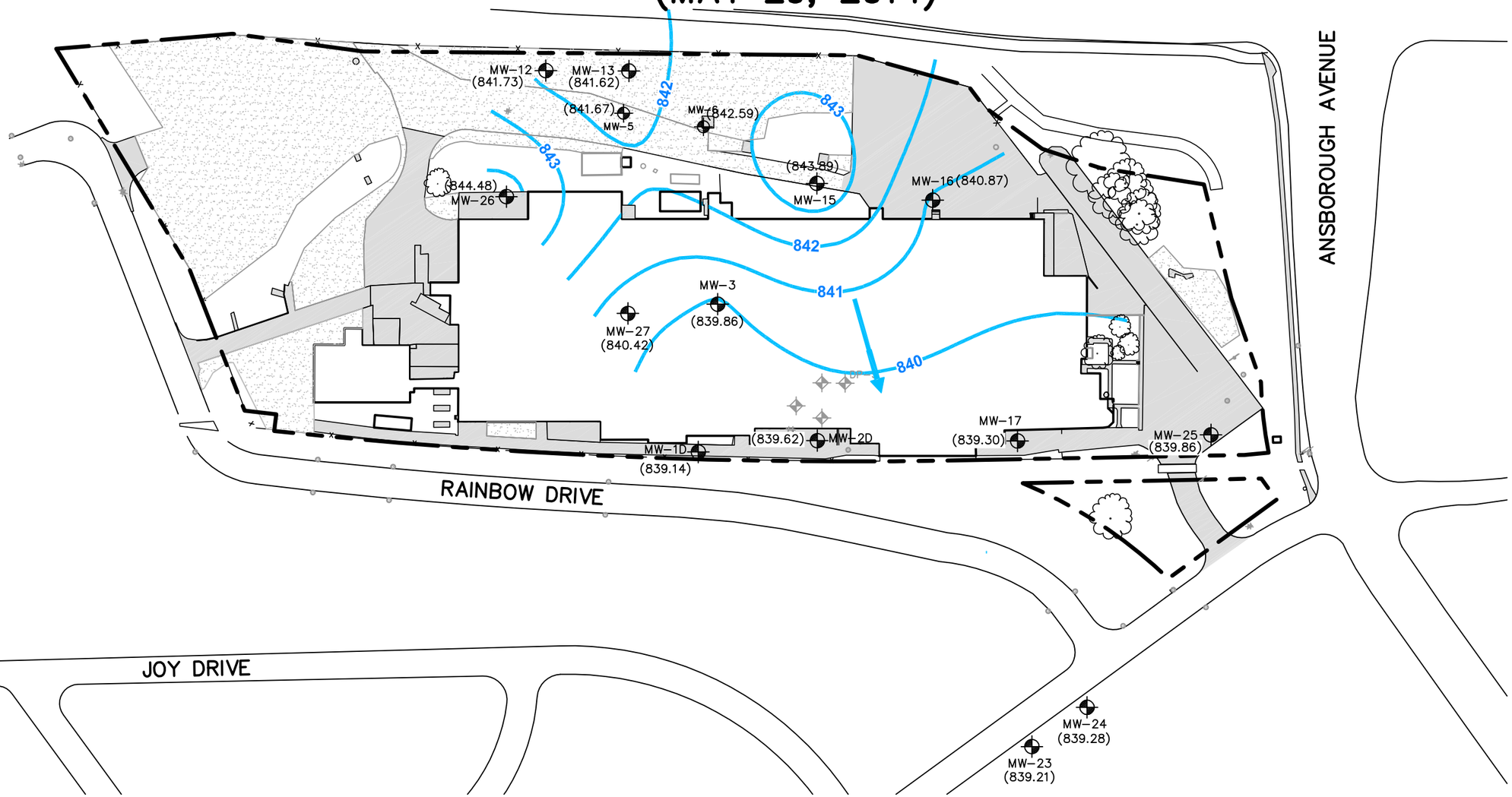
NOTE:
MW-9 WAS UNABLE TO BE LOCATED DUE TO THE STORAGE OF GAYLORD BOXES IN THE AREA OF THE WELL BY THE CURRENT TENANT.

SOURCE:
DRAWING ADAPTED FROM VJ ENGINEERING DRAWING, TITLED, EXISTING SITE SURVEY, DWG. NO. 118068, DATED 8/23/11

Drawn By GML	ERM®	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE Waterloo, Iowa	CHK'D MF
CADD Review RMK			0140077
Date Drawn/Rev'd 2/6/12–3/3/15		Environmental Resources Management	FIGURE 3.15

R:\Cadd\CIntE-H\Former Waterloo Industries\0140077\0140077-08.dwg, GWC PERCHED ZONE MAY 2014, 6/12/2015 1:20:29 PM, GML

BEDROCK ZONE GROUNDWATER CONTOUR MAP
(MAY 29, 2014)



LEGEND

- BEDROCK ZONE MONITORING WELL
- 840 — GROUNDWATER CONTOUR
- (840.55) — GROUNDWATER ELEVATION (FEET ABOVE MSL)
- PROPERTY BOUNDARY
- INFERRED GROUNDWATER FLOW DIRECTION

N

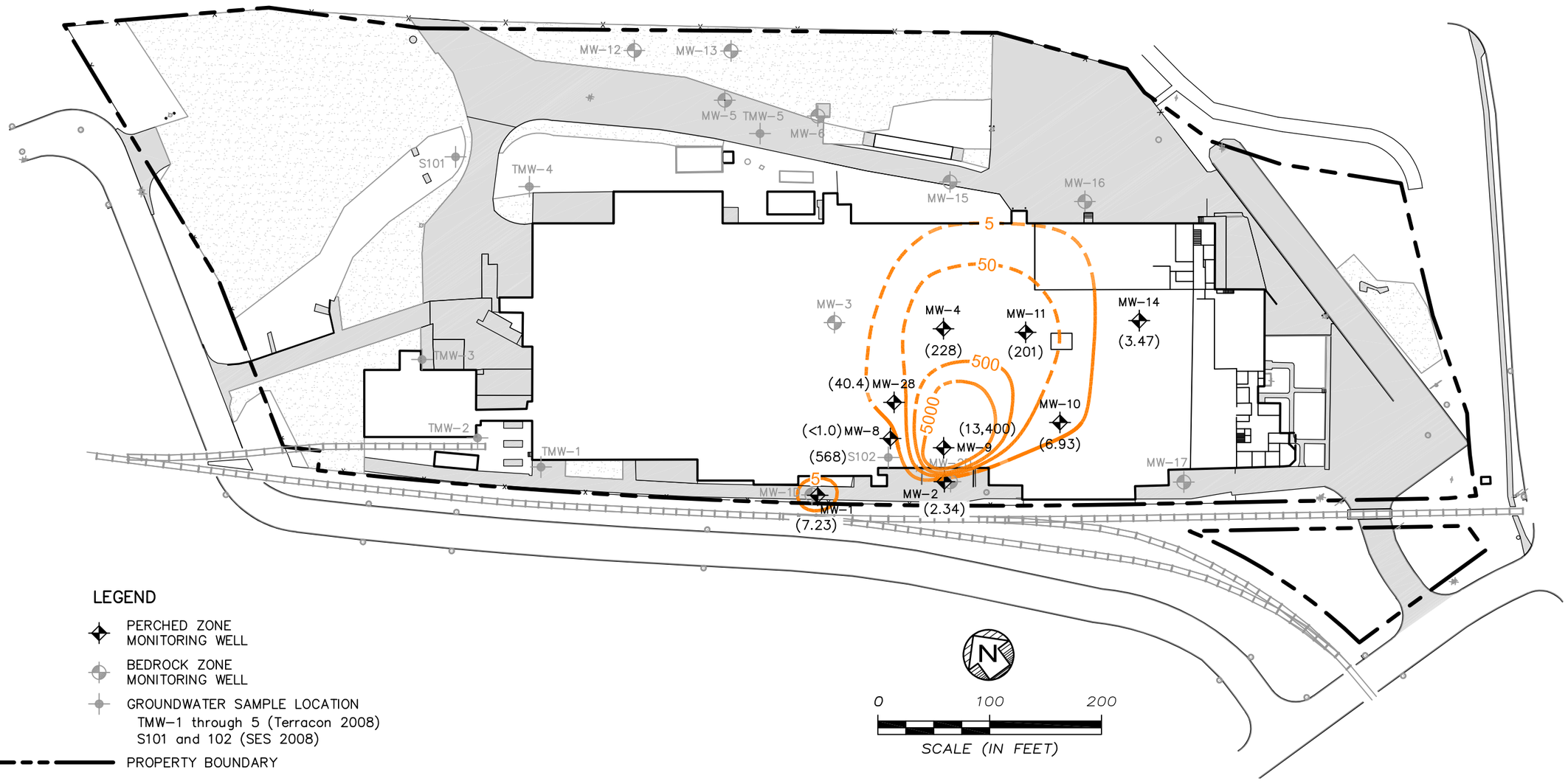
0 120 240

SCALE (IN FEET)

Drawn By FAK–GML	ERM®	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE WATERLOO, IOWA	CHK'D MF
CADD Review RMK			0140077
Date Drawn/Rev'd 4/30/14 –2/26/15		Environmental Resources Management	FIGURE 3-16

R:\Cadd\CIntE-H\Former Waterloo Industries\0140077\0140077-14.dwg, GWC BEDROCK MAY 14, 6/12/2015 3:05:50 PM, GML

TETRACHLOROETHENE CONCENTRATIONS IN PERCHED ZONE GROUNDWATER (DECEMBER 2013)



LEGEND

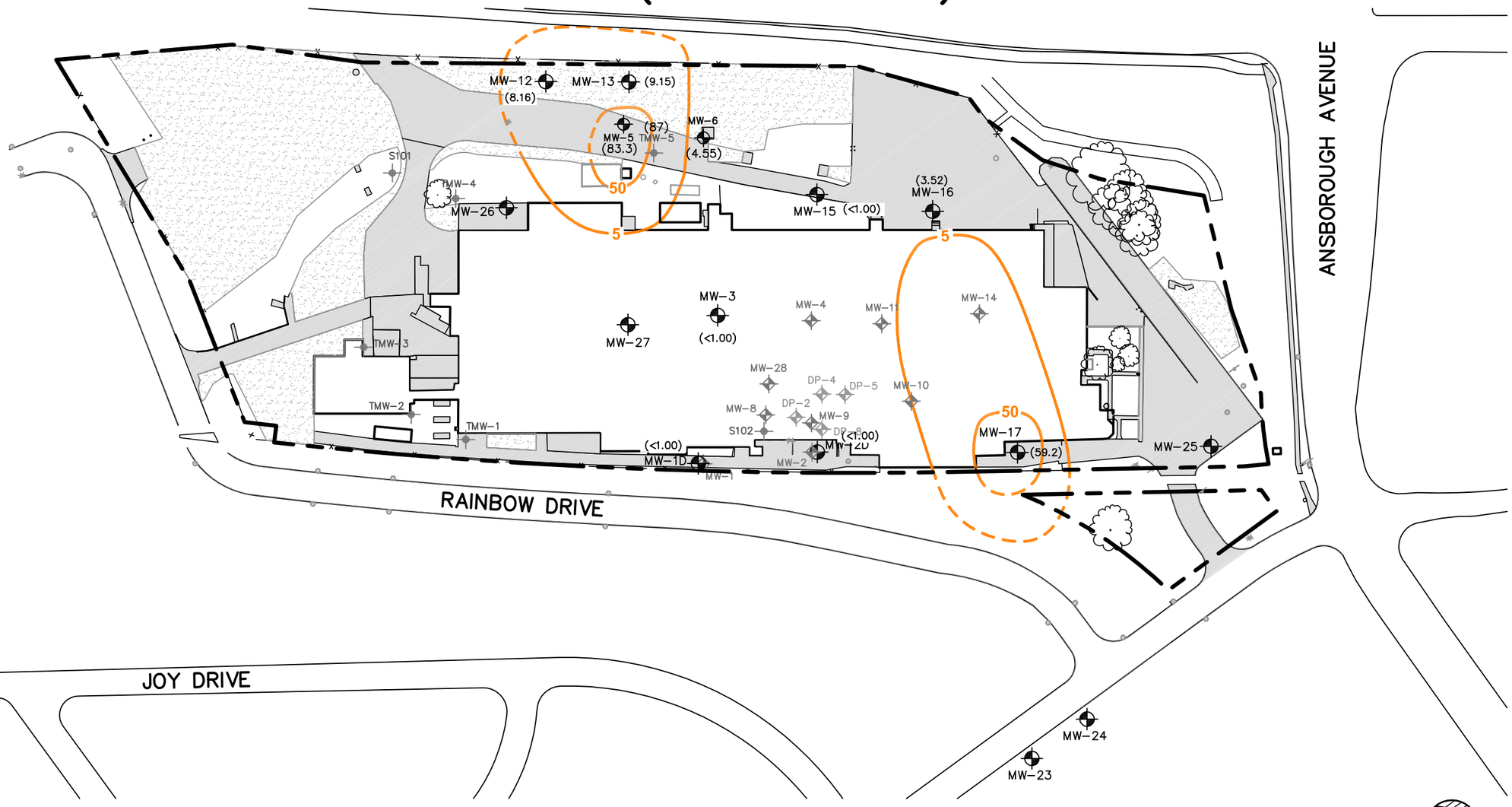
- PERCHED ZONE MONITORING WELL
- BEDROCK ZONE MONITORING WELL
- GROUNDWATER SAMPLE LOCATION
  TMW-1 through 5 (Terracon 2008)
  S101 and 102 (SES 2008)
- PROPERTY BOUNDARY
- GROUNDWATER PCE CONCENTRATION CONTOUR INTERVAL
- (410) PCE CONCENTRATION IN ug/l

NOTE:
MAXIMUM CONTAMINANT LEVEL (MCL) FOR PCE = 5 ug/l

Drawn By GML	ERM®	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE WATERLOO, IOWA	CHK'D MF
CADD Review RMK			0140077
Date Drawn/Rev'd 12/12/11 – 2/26/15		Environmental Resources Management	FIGURE 3-17

R:\Cadd\ClntE-H\Former Waterloo Industries\0140077\0140077-04.dwg-TCE IN GW-DEC2013 – 2/26/2015 – robert.keen

TETRACHLOROETHENE CONCENTRATIONS IN BEDROCK ZONE GROUNDWATER (DECEMBER 2013)



LEGEND

- PERCHED ZONE MONITORING WELL
- BEDROCK ZONE MONITORING WELL
- GROUNDWATER SAMPLE LOCATION
  TMW-1 through 5 (Terracon 2008)
  S101 and 102 (SES 2008)
- PROPERTY BOUNDARY
- BEDROCK ZONE GROUNDWATER PCE CONCENTRATION CONTOUR INTERVAL (DECEMBER 2013)
- (59.2) PCE CONCENTRATION IN ug/l

NOTE:
MAXIMUM CONTAMINANT LEVEL (MCL) FOR PCE = 5 ug/l

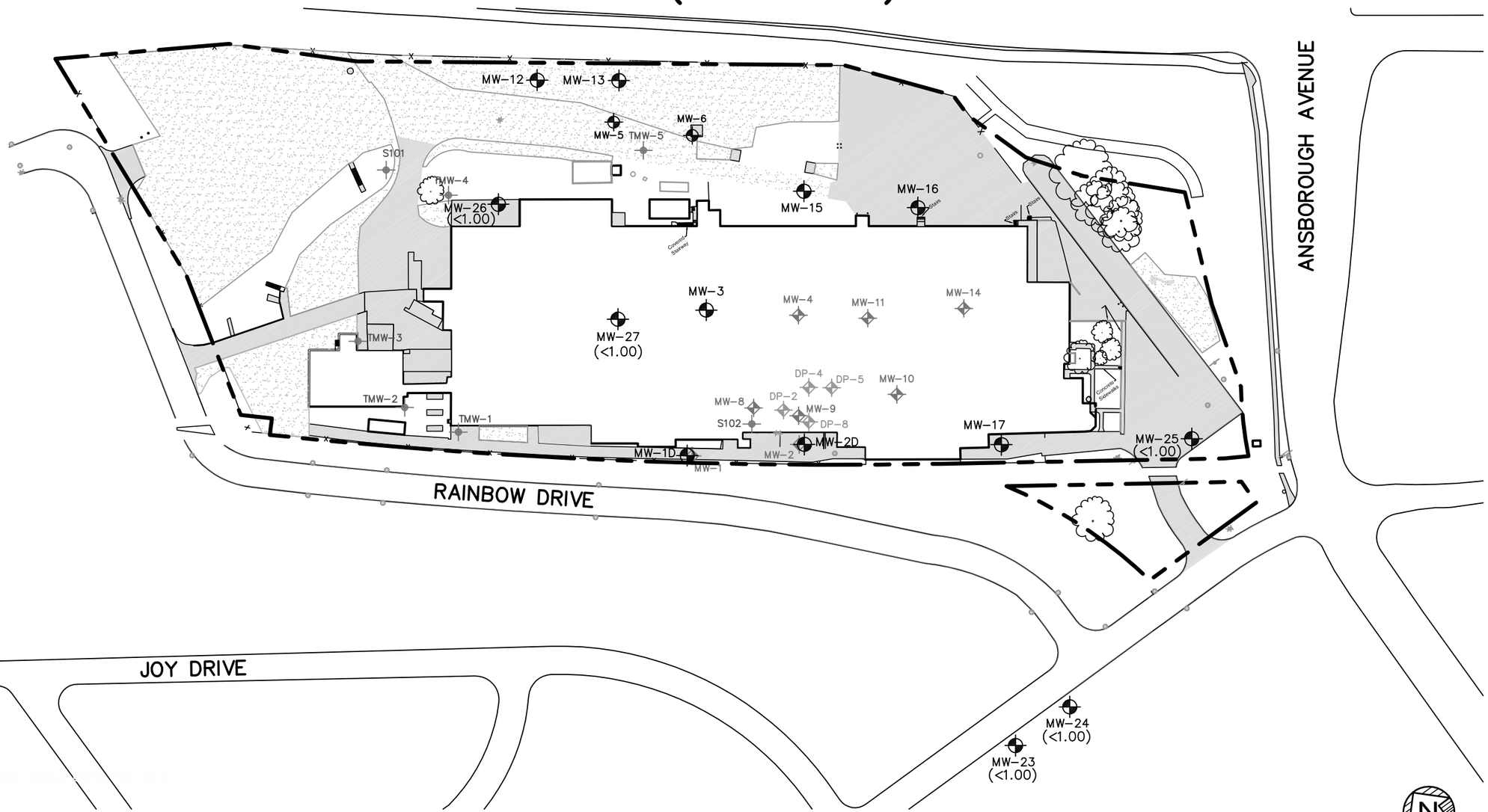
N

0 120 240
SCALE (IN FEET)

Drawn By GML	ERM®	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE WATERLOO, IOWA	CHK'D MF
CADD Review RMK			0140077
Date Drawn/Rev'd 3/5/12–3/3/15		Environmental Resources Management	FIGURE 3-18

R:\Cadd\CIntE-H\Former Waterloo Industries\0140077\0140077-14.dwg, PCE-BEDROCK DEC 13, 3/20/2015 8:06:02 AM, GML

TETRACHLOROETHENE CONCENTRATIONS IN BEDROCK ZONE GROUNDWATER (APRIL 2014)



LEGEND

- PERCHED ZONE MONITORING WELL
- BEDROCK ZONE MONITORING WELL
- GROUNDWATER SAMPLE LOCATION
  TMW-1 through 5 (Terracon 2008)
  S101 and 102 (SES 2008)
- PROPERTY BOUNDARY
- PCE CONCENTRATION CONTOUR (APRIL 2014)
- (<1.00) PCE CONCENTRATION IN ug/l

NOTE:
MAXIMUM CONTAMINANT LEVEL (MCL) FOR PCE = 5 ug/l

Drawn By GML	ERM®	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE WATERLOO, IOWA	CHK'D MF
CADD Review RMK			0140077
Date Drawn/Rev'd 3/5/12–3/3/15		Environmental Resources Management	FIGURE 3-19

R:\Cadd\CIntE-H\Former Waterloo Industries\0140077\0140077-14.dwg, PCE-BEDROCK APRIL 2014, 6/22/2015 7:27:29 AM, GML

FIGURE 3-20
PCE AND TCE TREND PLOTS
PERCHED ZONE MONITORING WELL 4
FORMER WATERLOO INDUSTRIES FACILITY
WATERLOO, IOWA

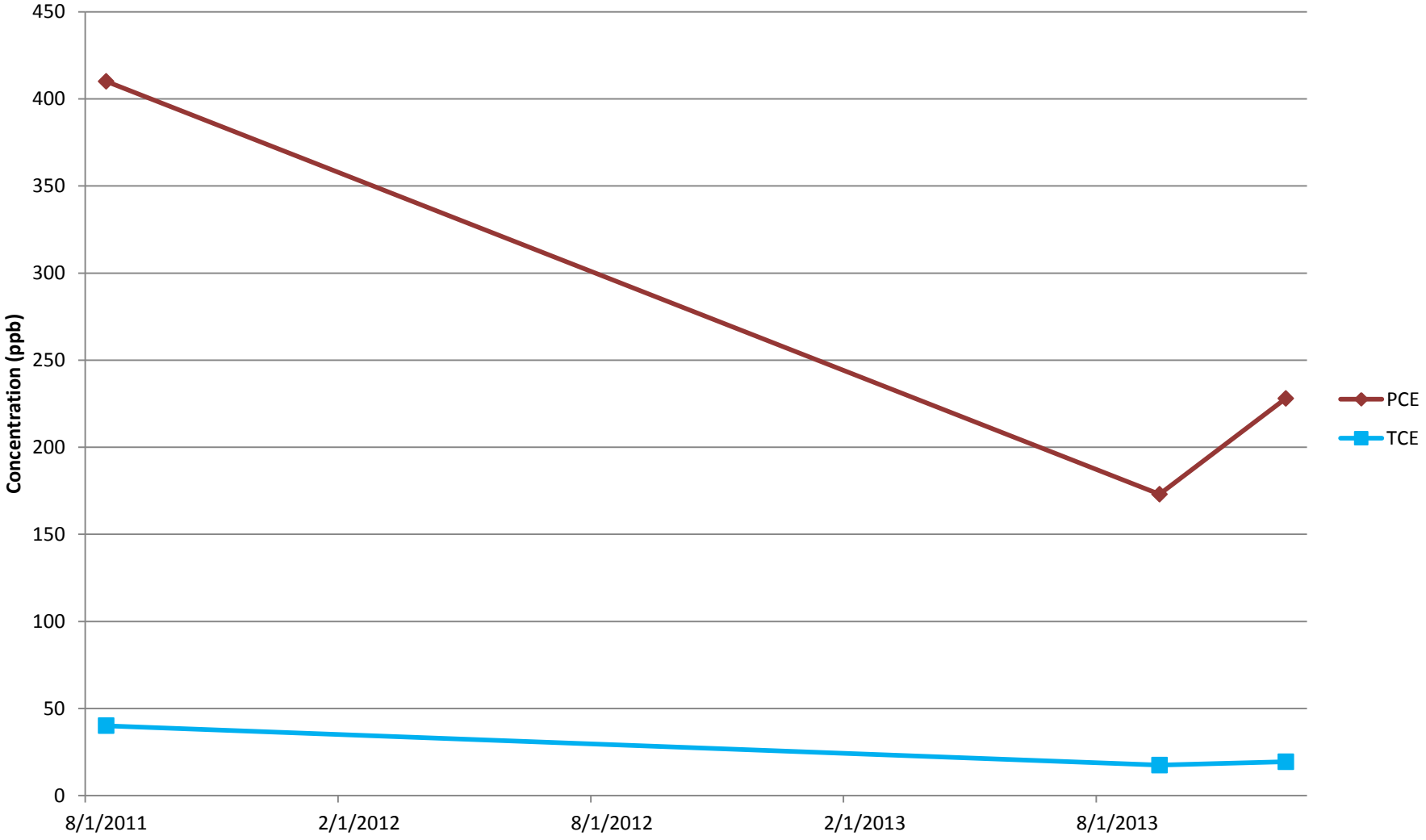


FIGURE 3-21
PCE AND TCE TREND PLOTS
PERCHED ZONE MONITORING WELL 8
FORMER WATERLOO INDUSTRIES FACILITY
WATERLOO, IOWA

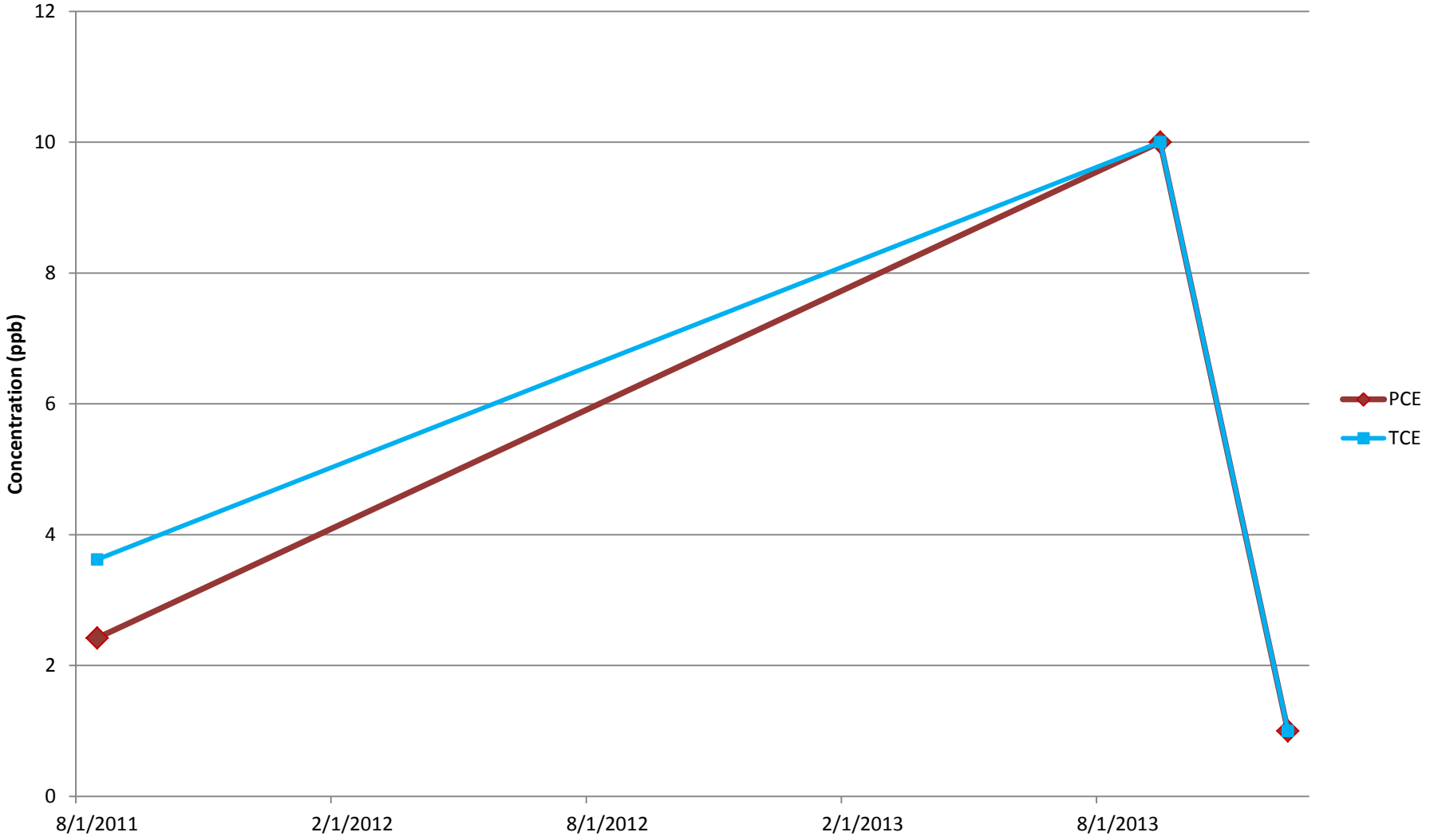


FIGURE 3-22
PCE AND TCE TREND PLOTS
PERCHED ZONE MONITORING WELL 9
FORMER WATERLOO INDUSTRIES FACILITY
WATERLOO, IOWA

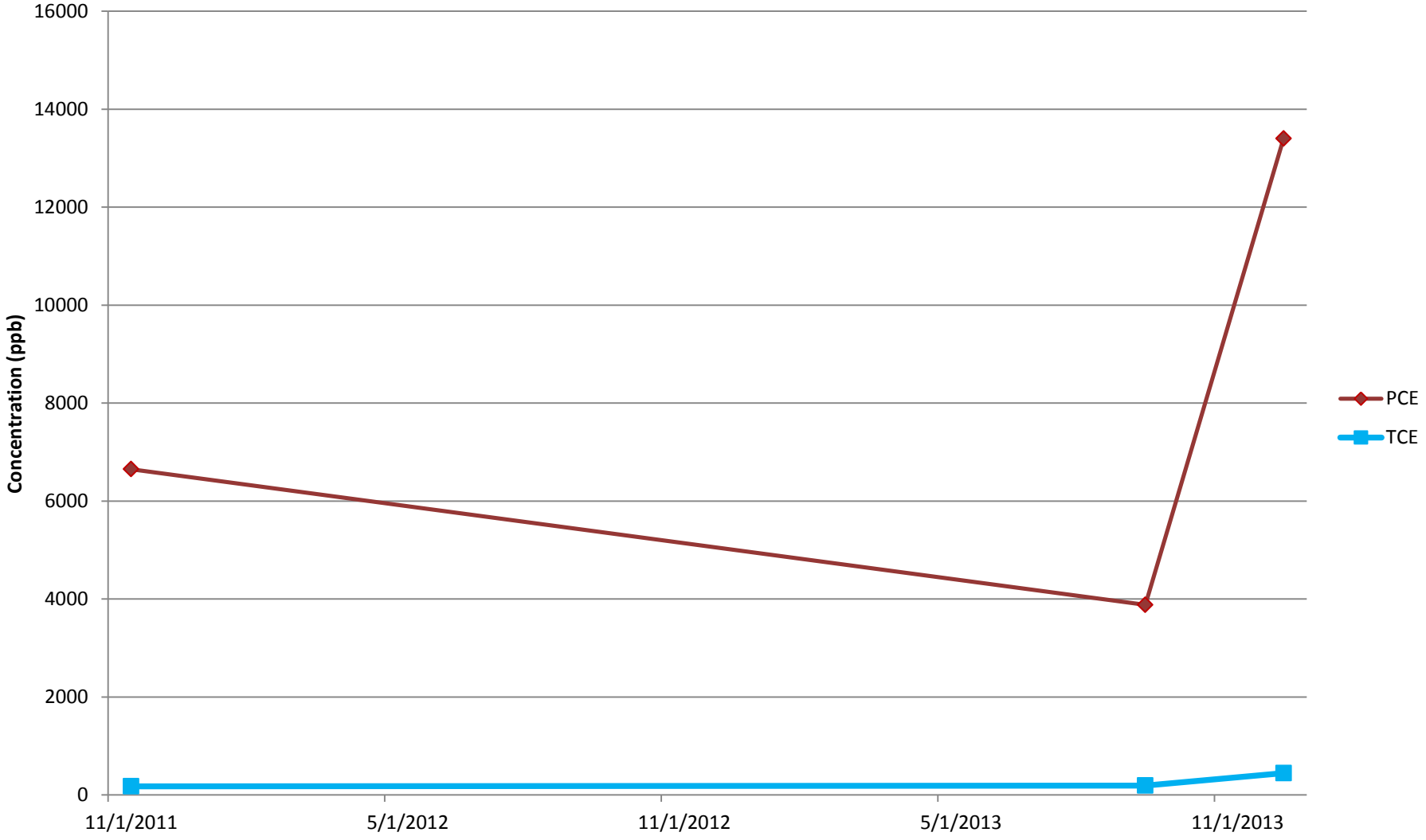


FIGURE 3-23
PCE AND TCE TREND PLOTS
PERCHED ZONE MONITORING WELL 11
FORMER WATERLOO INDUSTRIES FACILITY
WATERLOO, IOWA

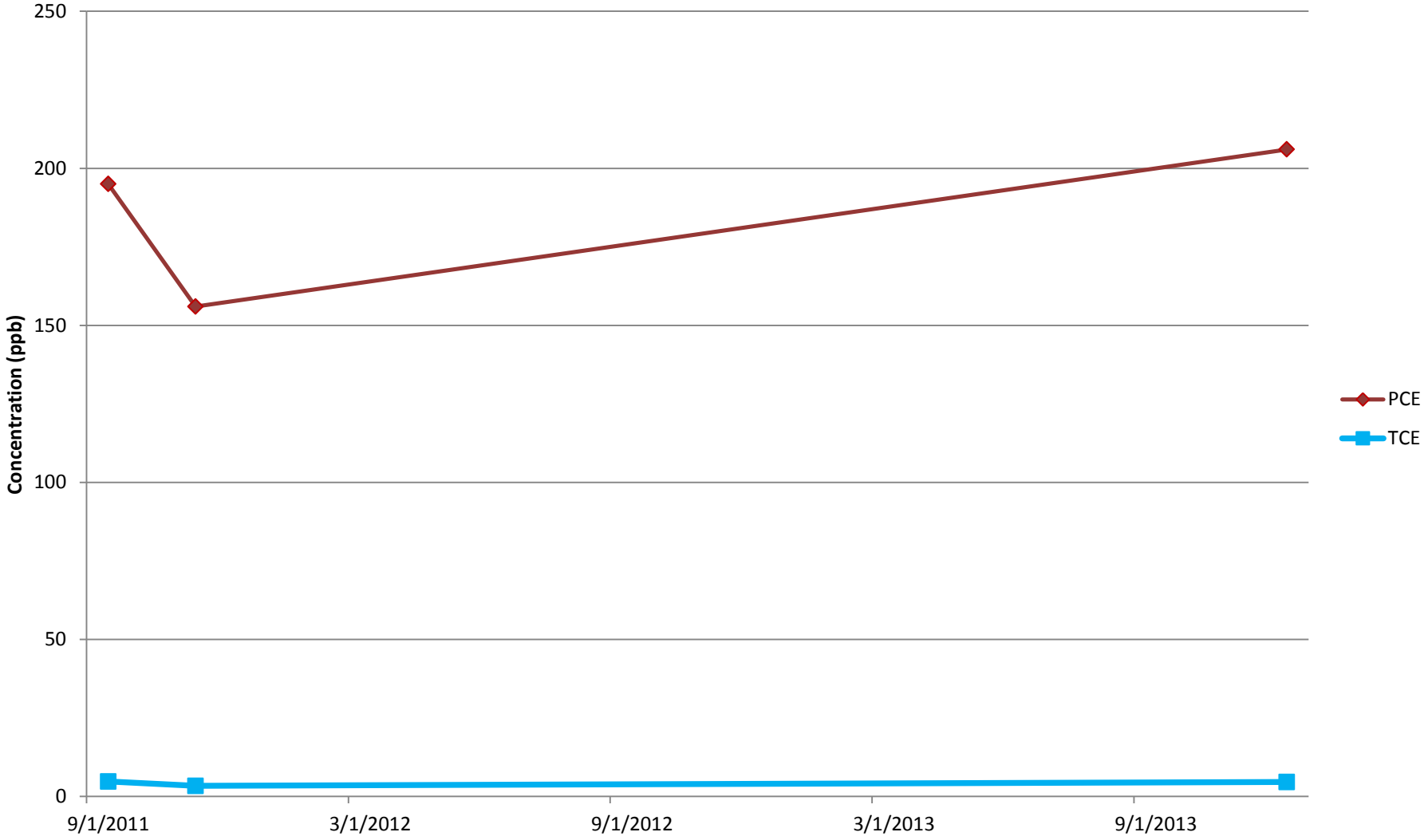


FIGURE 3-24
PCE AND TCE TREND PLOTS
PERCHED ZONE MONITORING WELL 14
FORMER WATERLOO INDUSTRIES FACILITY
WATERLOO, IOWA

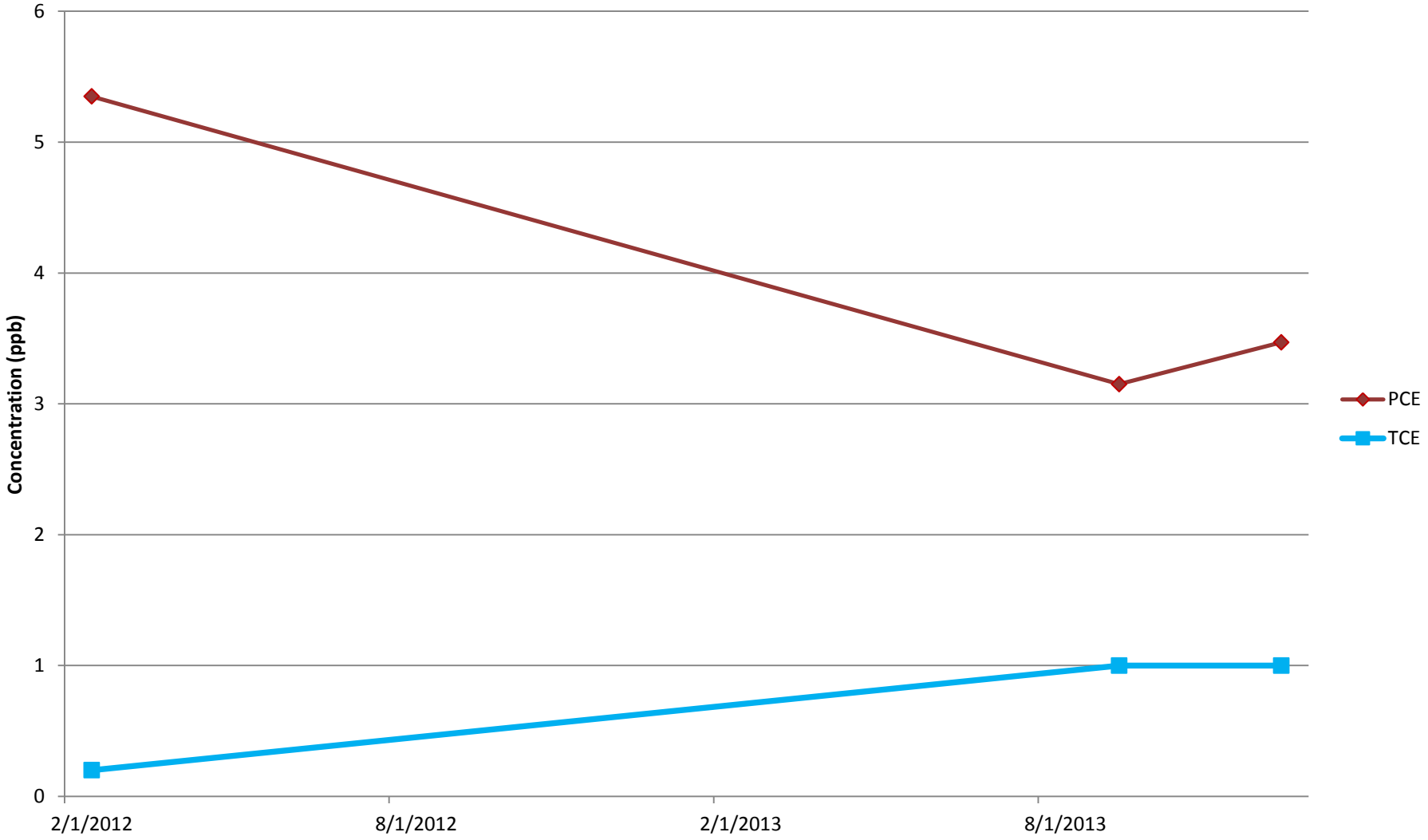


FIGURE 3-25
PCE AND TCE TREND PLOTS
BEDROCK ZONE MONITORING WELL 5
FORMER WATERLOO INDUSTRIES FACILITY
WATERLOO, IOWA

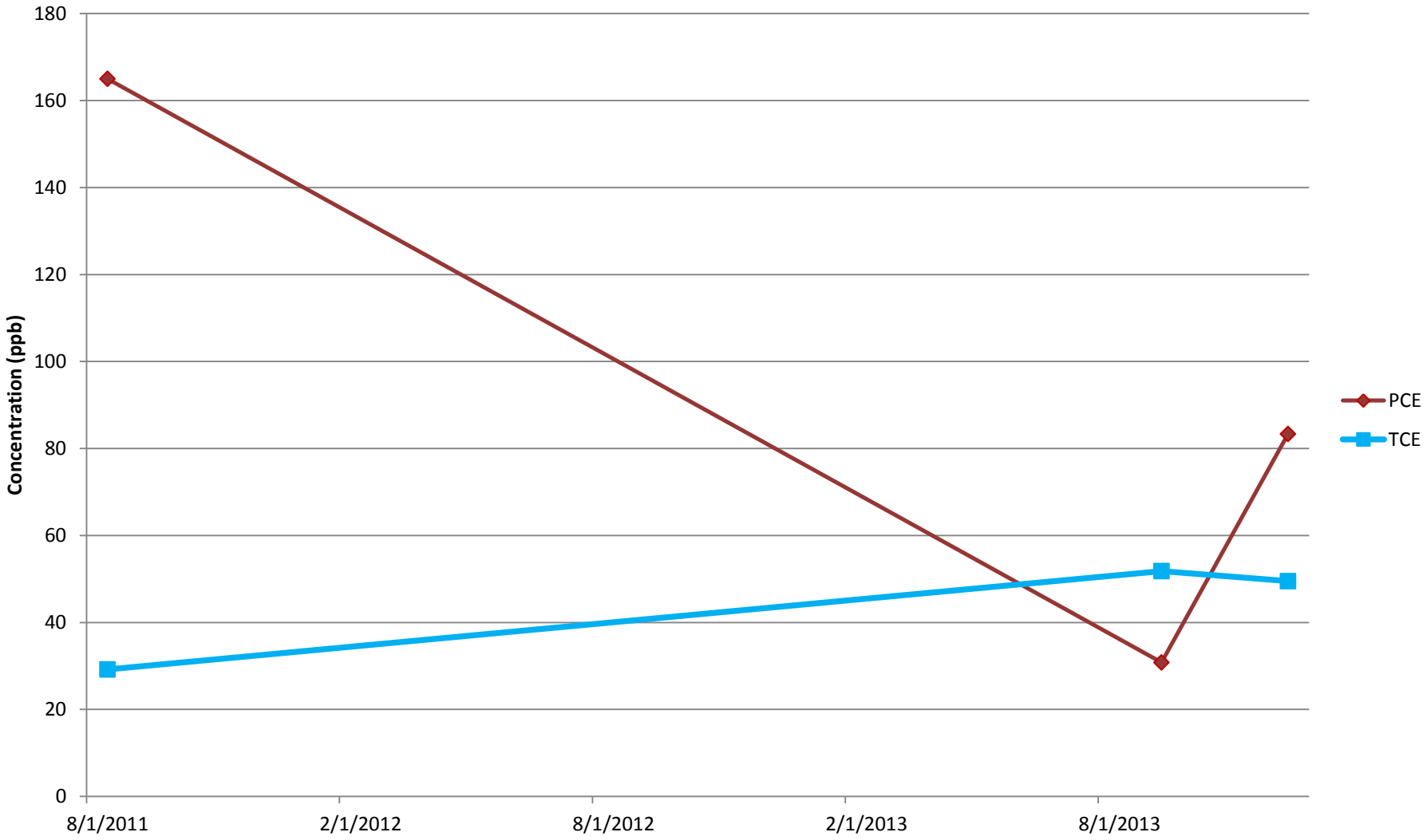


FIGURE 3-26
PCE AND TCE TREND PLOTS
BEDROCK ZONE MONITORING WELL 12
FORMER WATERLOO INDUSTRIES FACILITY
WATERLOO, IOWA

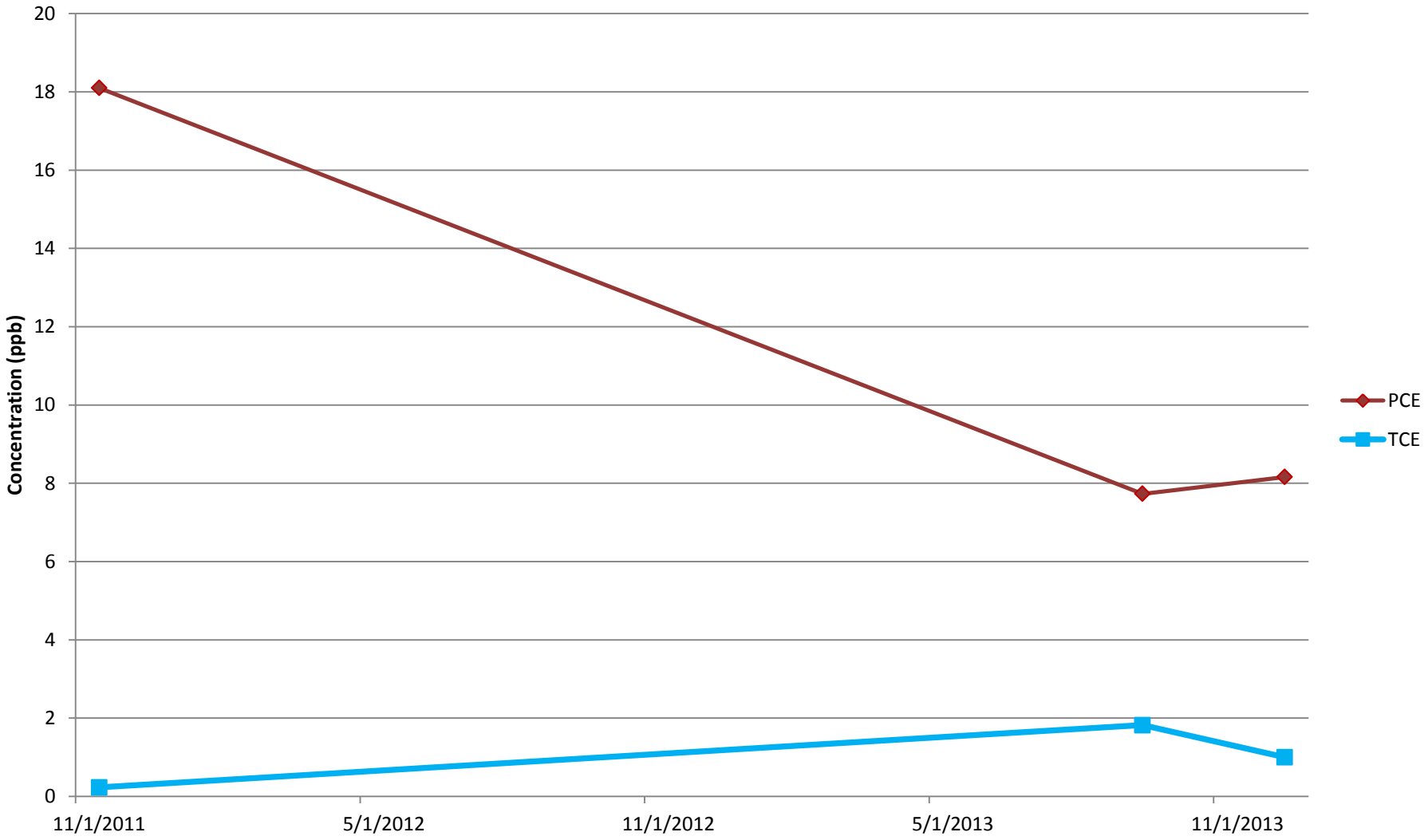


FIGURE 3-27
PCE AND TCE TREND PLOTS
BEDROCK ZONE MONITORING WELL 13
FORMER WATERLOO INDUSTRIES FACILITY
WATERLOO, IOWA

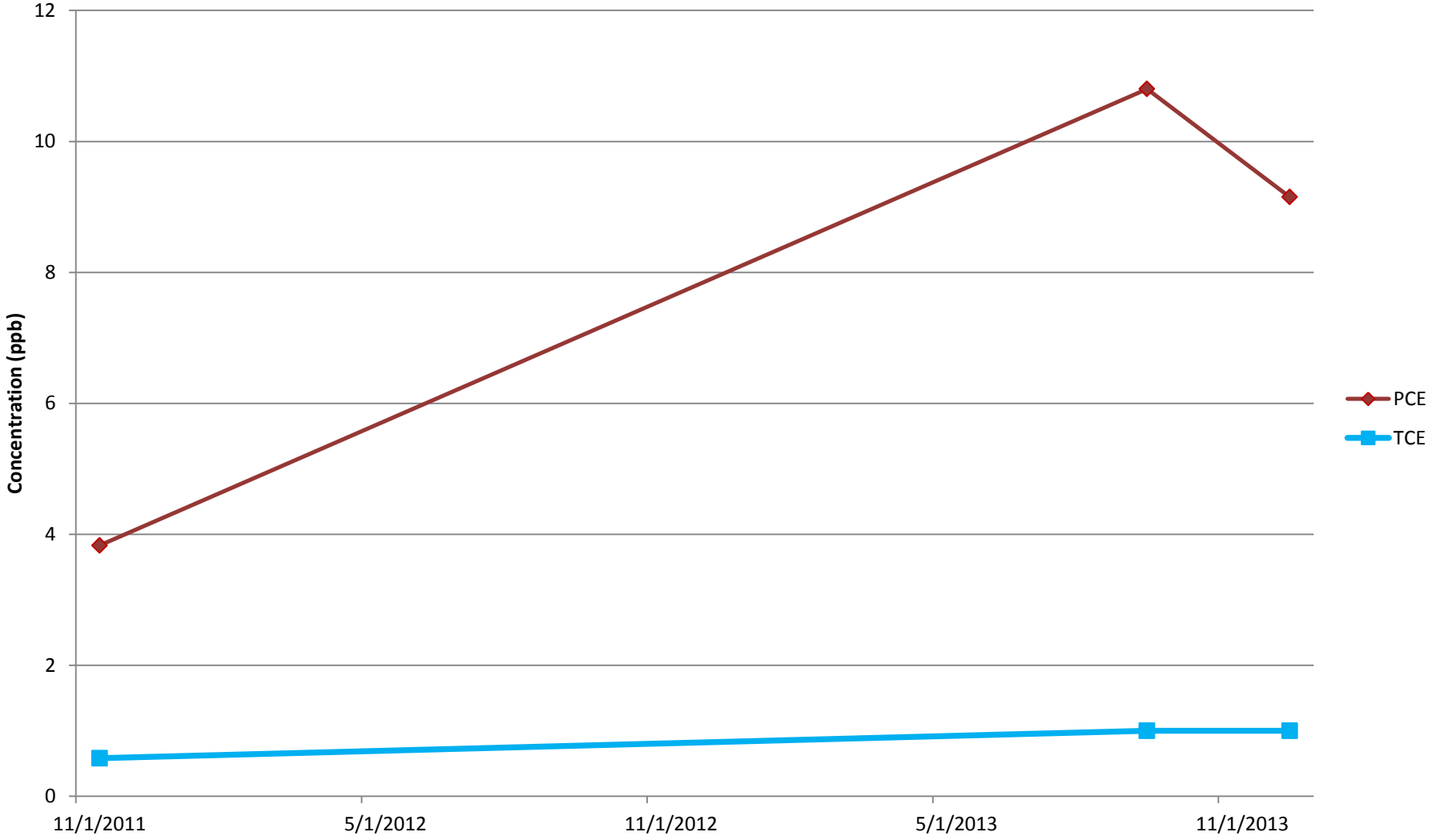


FIGURE 3-28
PCE AND TCE TREND PLOTS
BEDROCK ZONE MONITORING WELL 15
FORMER WATERLOO INDUSTRIES FACILITY
WATERLOO, IOWA

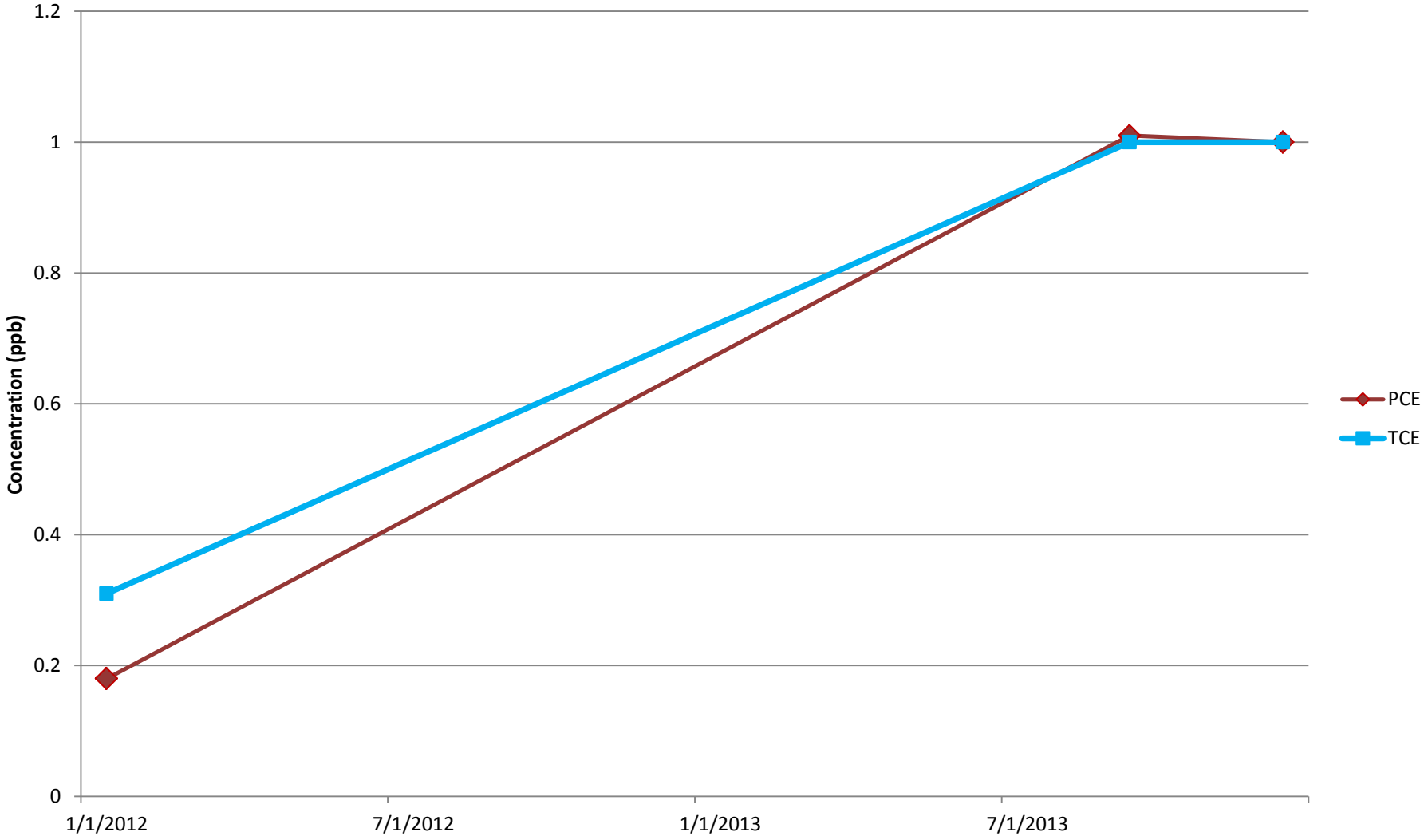


FIGURE 3-29
PCE AND TCE TREND PLOTS
BEDROCK ZONE MONITORING WELL 16
FORMER WATERLOO INDUSTRIES FACILITY
WATERLOO, IOWA

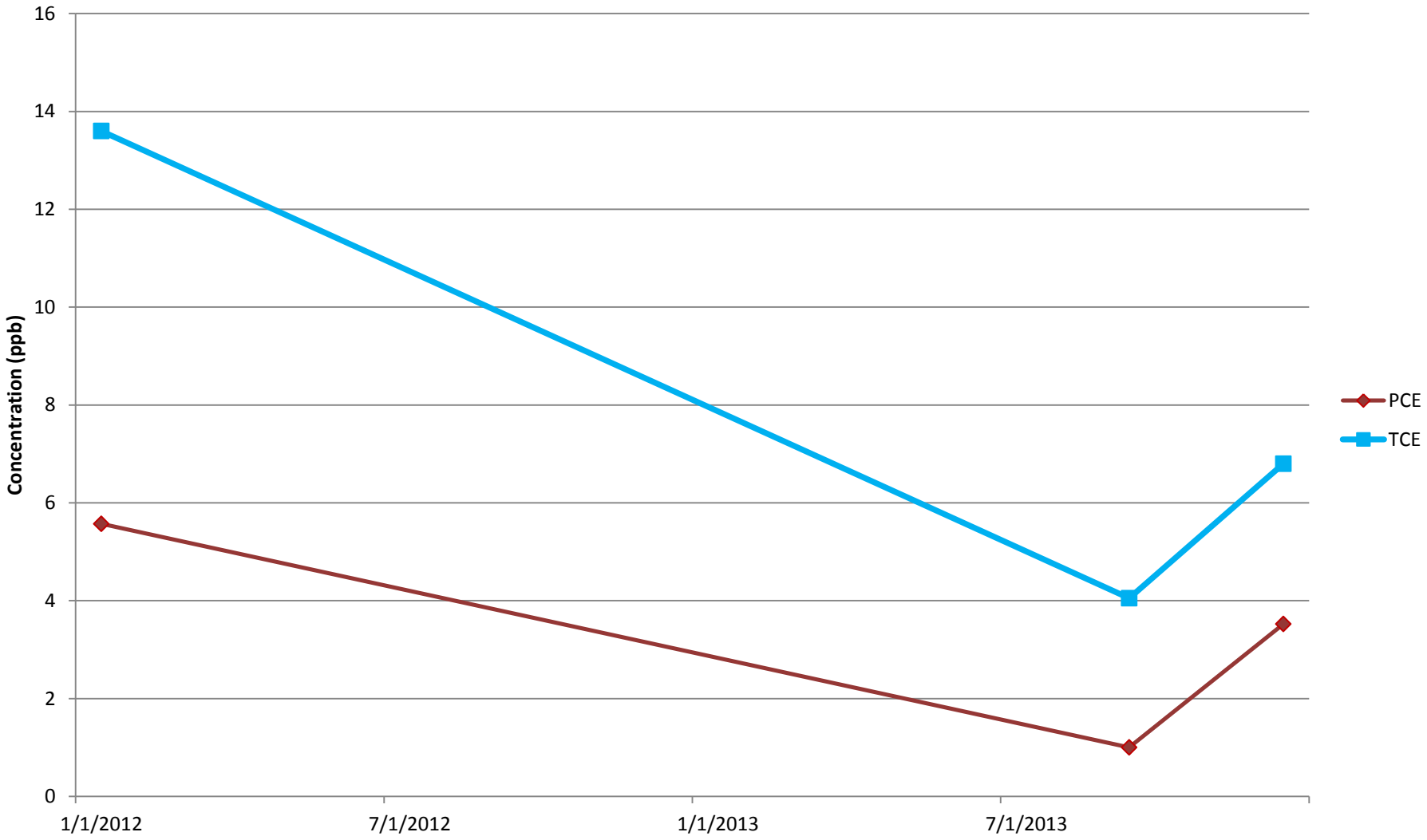


FIGURE 3-30
PCE AND TCE TREND PLOTS
BEDROCK ZONE MONITORING WELL 17
FORMER WATERLOO INDUSTRIES FACILITY
WATERLOO, IOWA

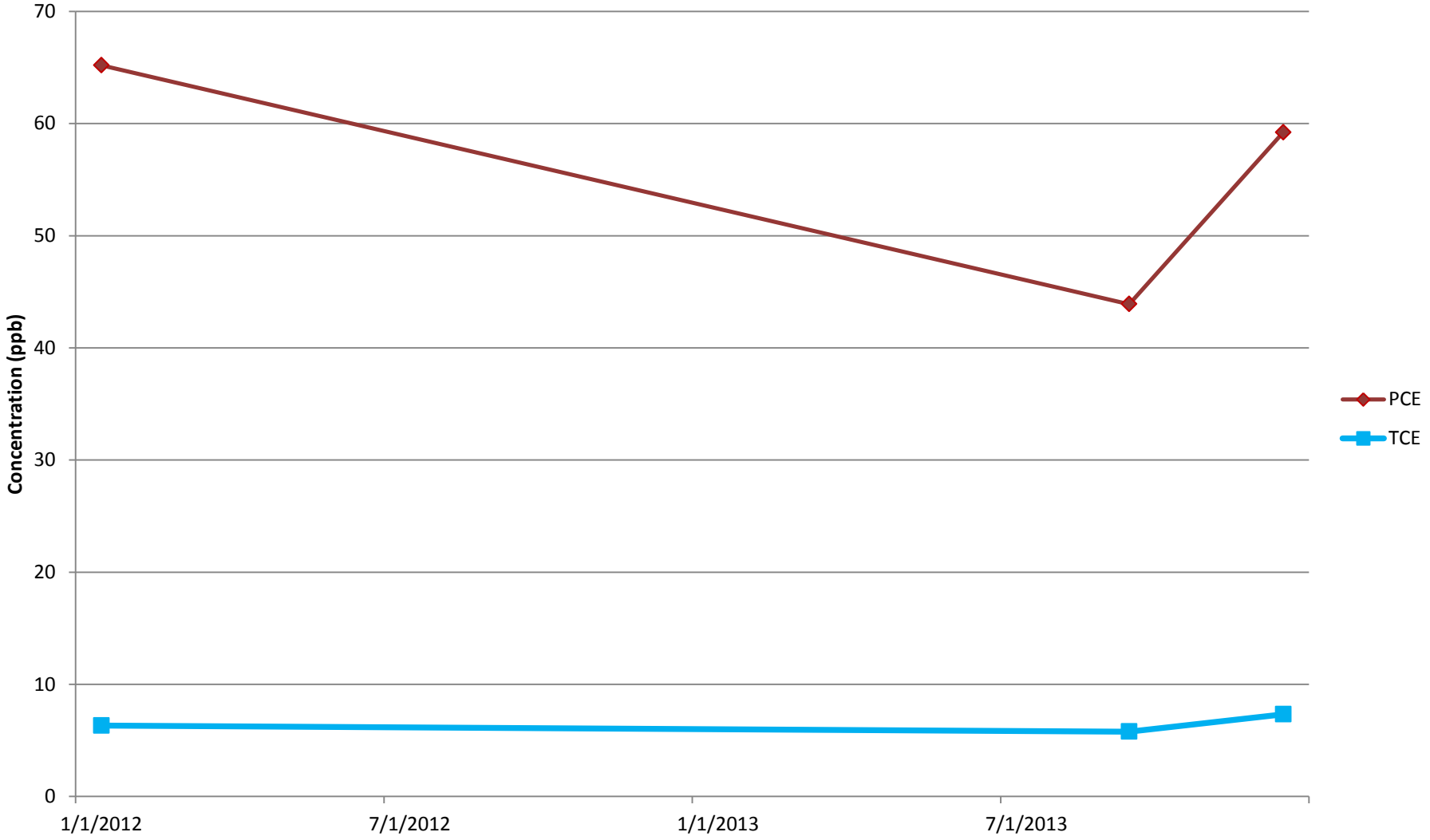
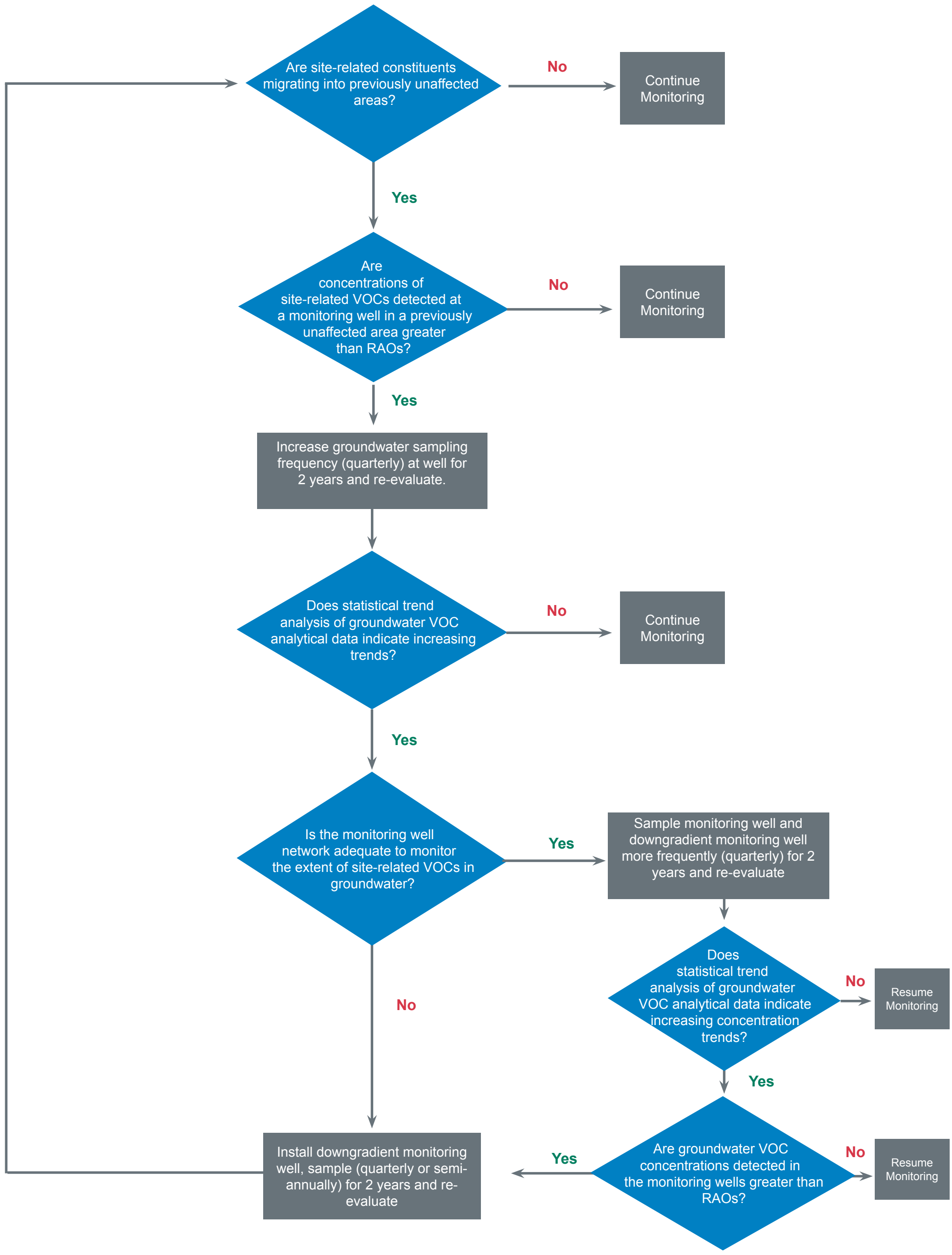
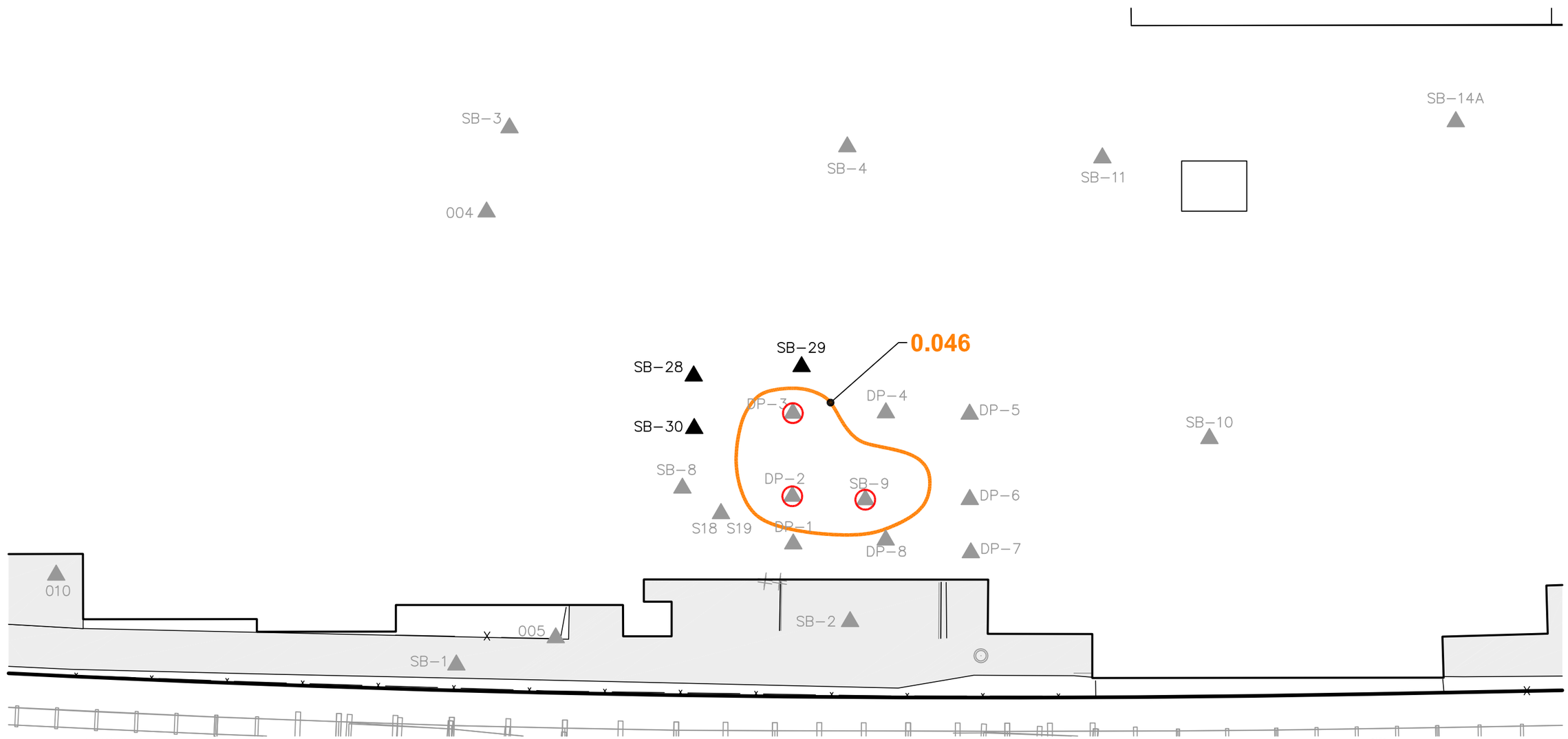


FIGURE 5-1: DECISION TREE DIAGRAM - MONITORING NETWORK MODIFICATIONS



PROPOSED SOIL CONFIRMATION SAMPLING LAYOUT MAP



LEGEND

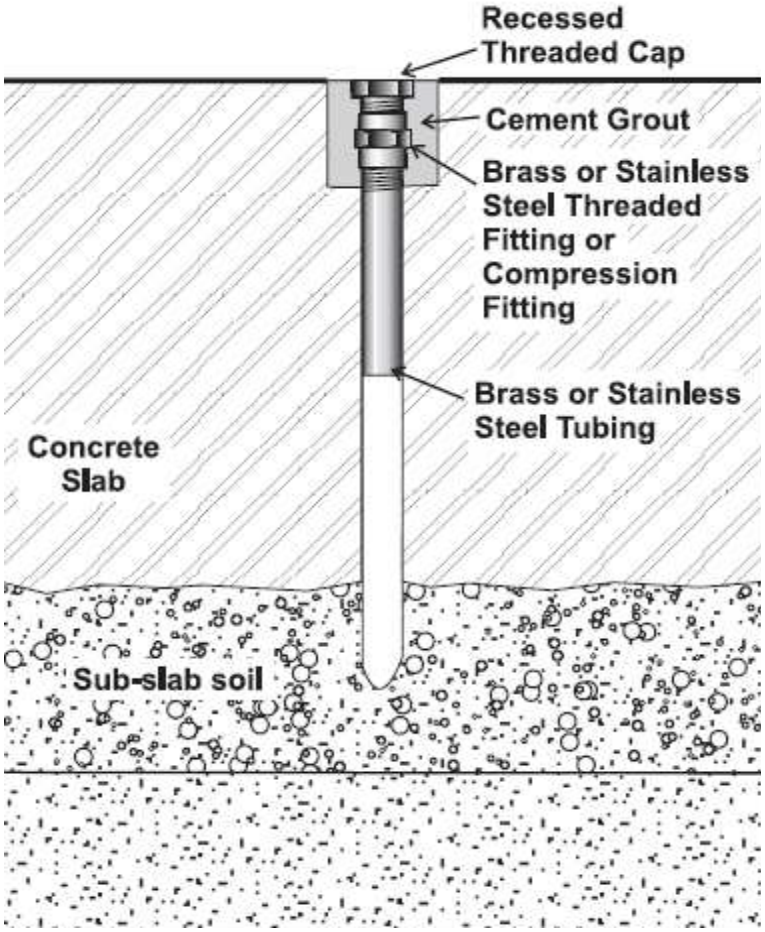
- ▲ DIRECT PUSH SAMPLES DP-1 THROUGH DP-8 (ERM 2013 AND 2014)
- ▲ SOIL SAMPLE LOCATION
  - 001 THROUGH 011 (Weston 1998)
  - B-1 THROUGH 5 (Terracon 2008)
  - S01 THROUGH 22 (SES 2008)
  - SB-1 THROUGH 13 (ERM 2011)
  - SB-14 THROUGH 17 (ERM 2012)
- ○ PROPOSED CONFIRMATION SAMPLING LOCATION
- PROPERTY BOUNDARY
- EXTENT OF PCE RSL EXCEEDANCE

NOTE:
PCE CONCENTRATION REPORTED IN mg/kg (EPA RSL FOR GROUNDWATER PROTECTION = 0.046 mg/kg)

Drawn By RMK-GML	ERM®	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE WATERLOO, IOWA	CHK'D MF
CADD Review FGB			0339767
Date Drawn/Rev'd 11/30/11-8/29/16		Environmental Resources Management	FIGURE 6-1

R:\Cadd\ClntE-H\Fortune Brands Inc\0339767\0339767-17.dwg, PROP SOIL SAMPLE, 8/29/2016 1:52:52 PM, GML

SUB–SLAB SOIL VAPOR PROBE DIAGRAM



SOURCE

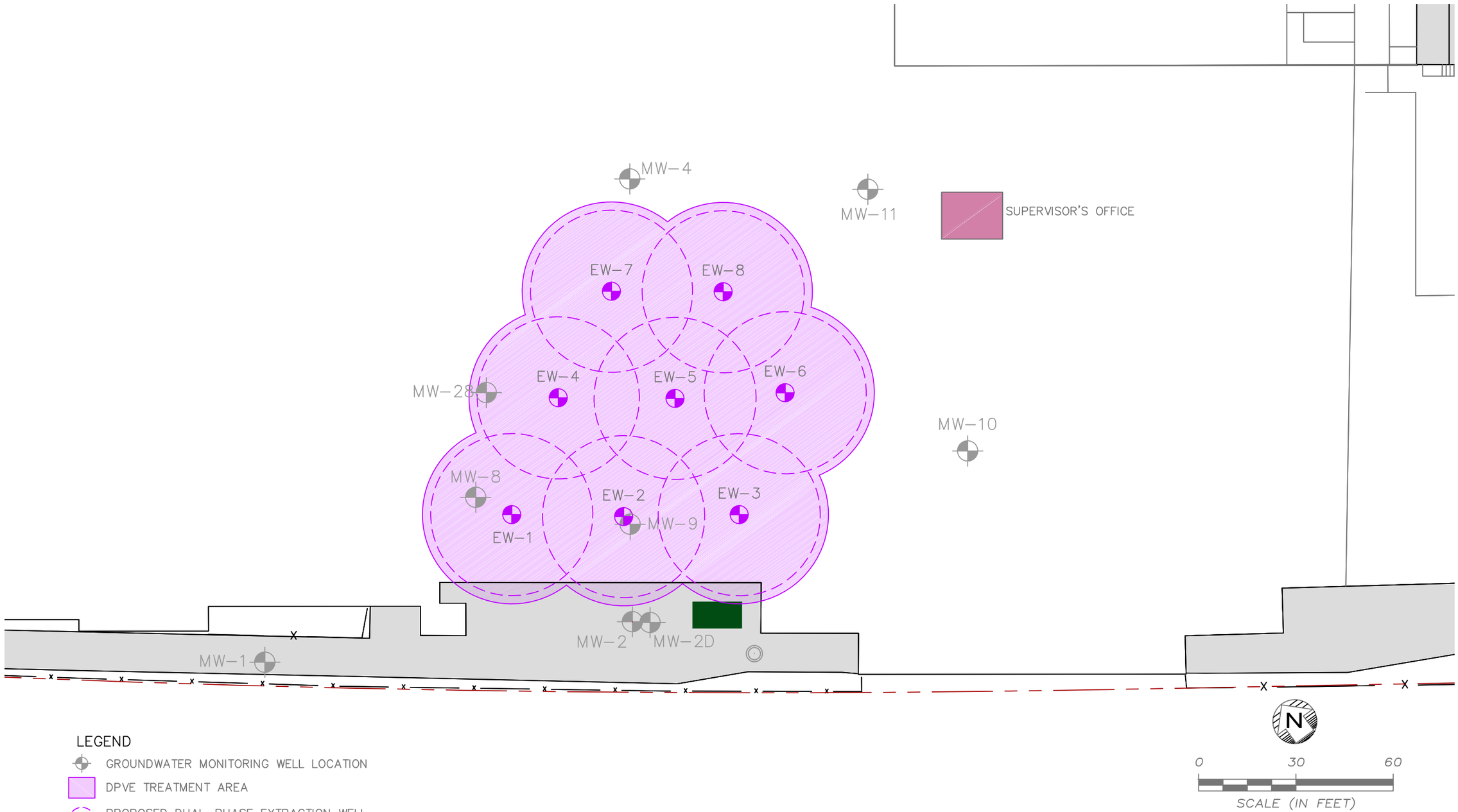
US EPA, 2006. ASSESSMENT OF VAPOR INTRUSION IN HOMES NEAR THE RAYMARK SUPERFUND SITE USING BASEMENT AND SUB–SLAB AIR SAMPLES.

REVISIONS TO BE MADE ON THE CADD FILE ONLY

FAK 3/3/15	**FORMER WATERLOO INDUSTRIES FACILITY** 300 ANSBOROGUH AVENUE WATERLOO, IOWA	CADD Review RMK CHK'D BK 0124706
ERM®	Environmental Resources Management	FIGURE 6 – 2

R:\Cadd\CIntQ-T\Stinson Morrison Hecker LLC\0124706\0124706-01.dwg, VAPOR PROBE, 3/3/2015 12:19:45 PM, GML

DPVE SYSTEM LAYOUT MAP

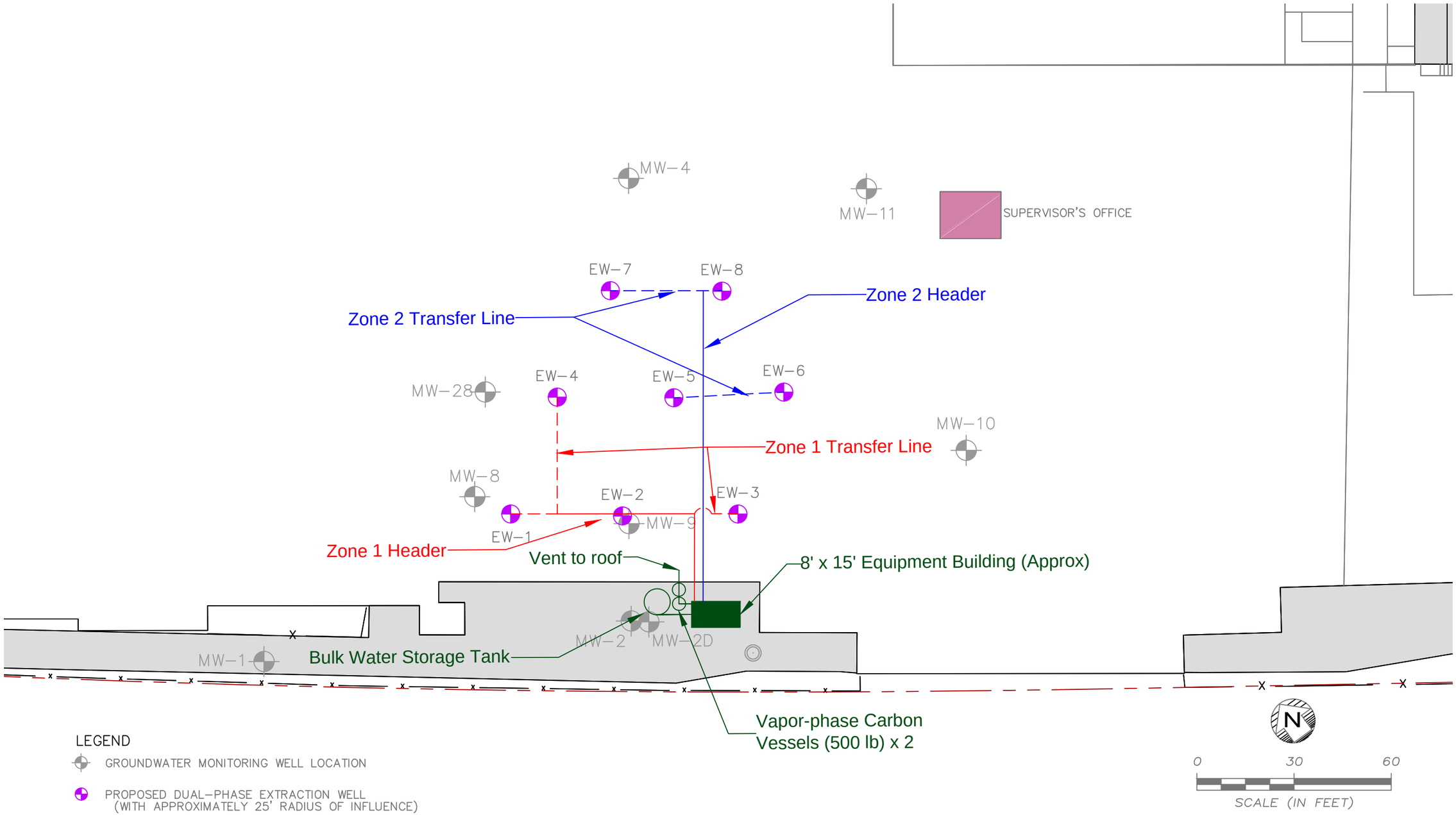


LEGEND

- GROUNDWATER MONITORING WELL LOCATION
- DPVE TREATMENT AREA
- PROPOSED DUAL-PHASE EXTRACTION WELL (WITH APPROXIMATELY 25' RADIUS OF INFLUENCE)
- PROPOSED DPVE TREATMENT BUILDING
- PROPOSED SUB-SLAB DEPRESSURIZATION TREATMENT AREA

Drawn By RMK-GML-ABF	ERM®	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE Waterloo, Iowa	CHK'D BK-Mil
CADD Review JF			0339767
Date Drawn/Rev'd 10/27/2016		Environmental Resources Management	FIGURE 7-1

DPVE SYSTEM PIPING MAP

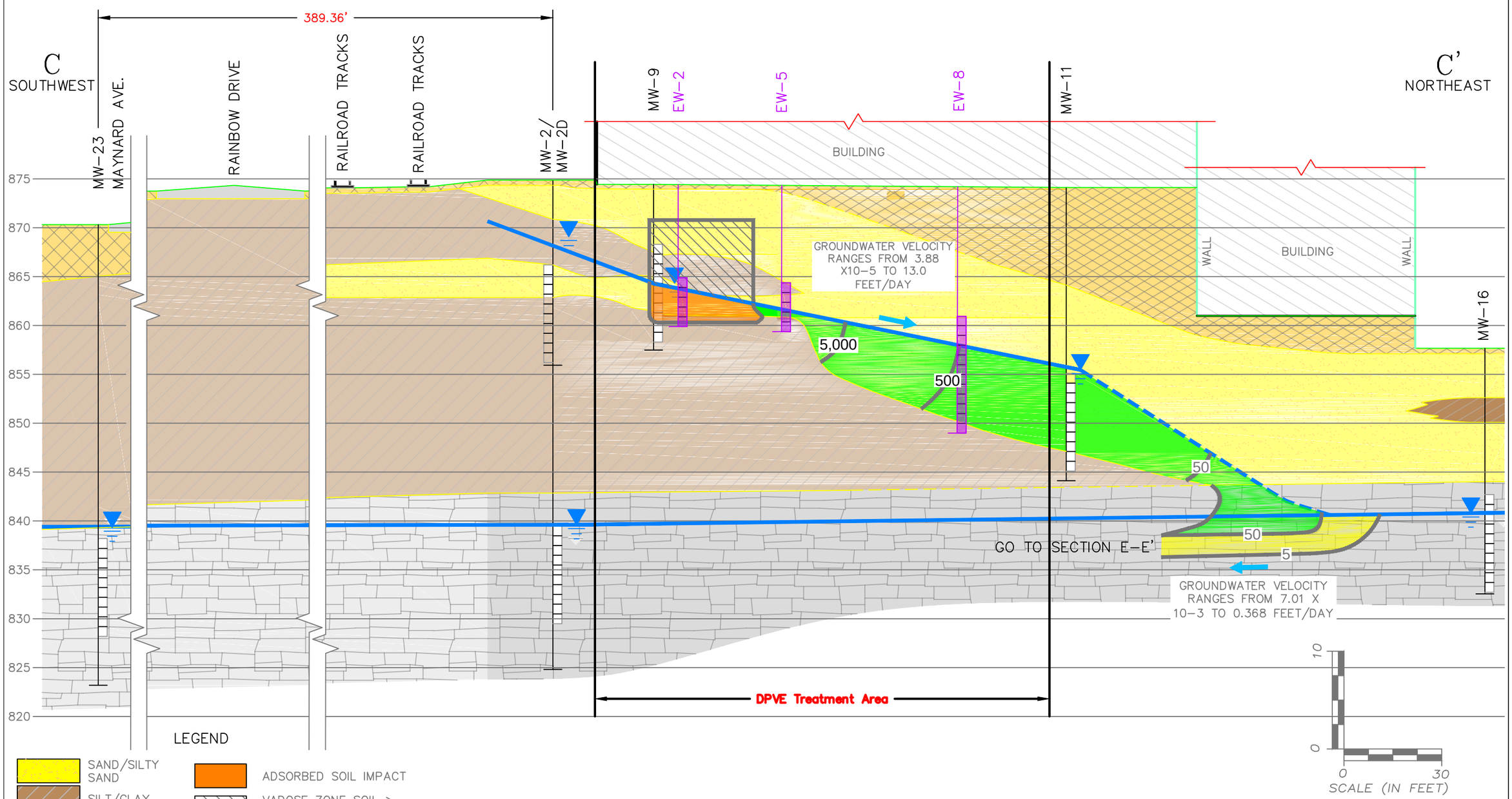


LEGEND

- GROUNDWATER MONITORING WELL LOCATION
- PROPOSED DUAL-PHASE EXTRACTION WELL (WITH APPROXIMATELY 25' RADIUS OF INFLUENCE)
- PROPOSED TREATMENT BUILDING
- ZONE 1 HEADER (4")
- ZONE 2 HEADER (4")
- ZONE 1 TRANSFER LINE (2")
- ZONE 2 TRANSFER LINE (2")
- PROPOSED SUB-SLAB DEPRESSURIZATION TREATMENT AREA

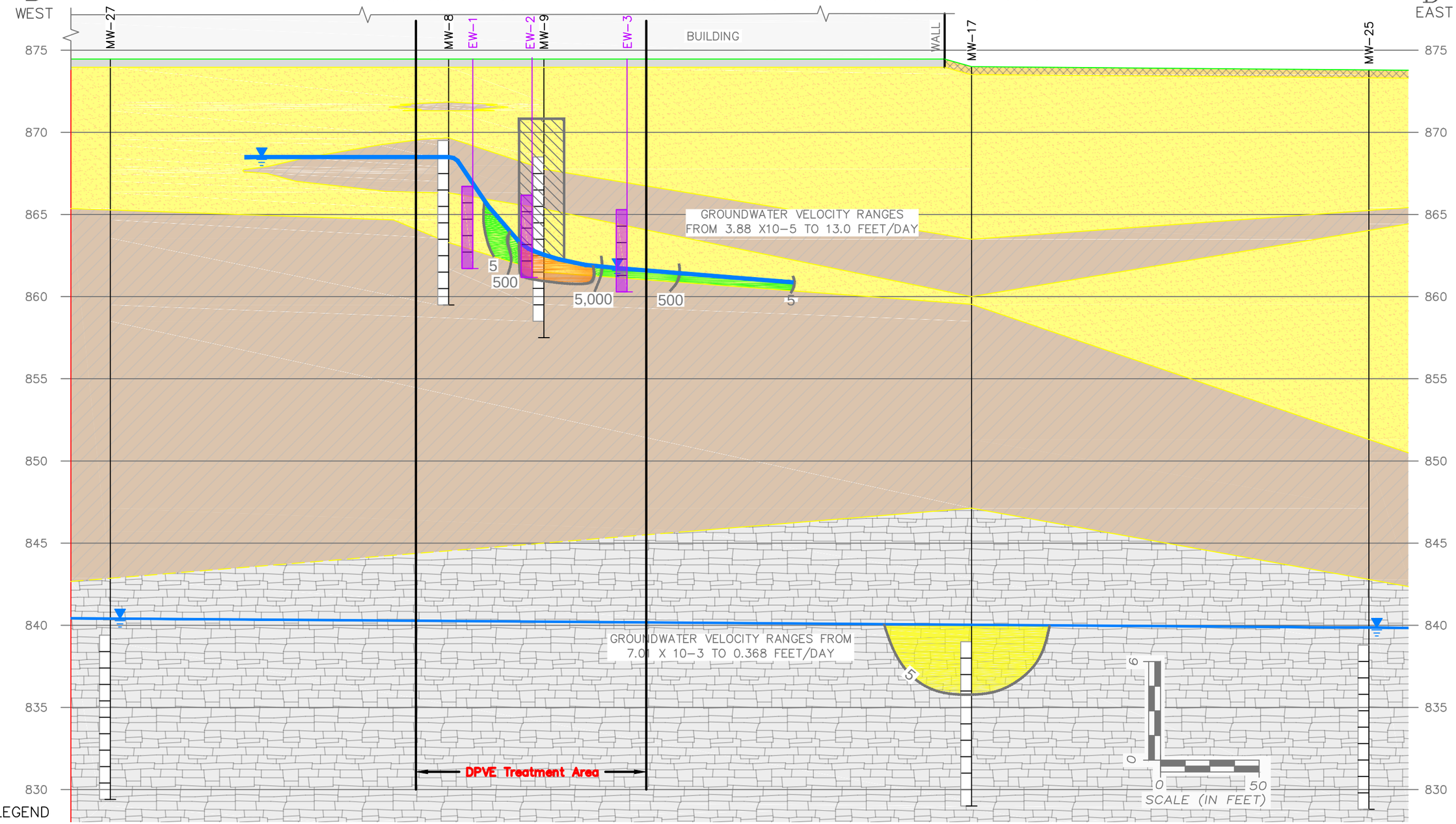
Drawn By RMK-GML-ABF	ERM	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE Waterloo, Iowa	CHK'D BK-Mil
CADD Review JF			0339767
Date Drawn/Rev'd 10/27/2016		Environmental Resources Management	FIGURE 7-2

CONCEPTUAL DPVE SYSTEM CROSS SECTION C-C'



Drawn By GML-ABF	ERM®	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE WATERLOO, IOWA	CHK'D BK
CADD Review JF			0339767
Date Drawn/Rev'd 10/27/2016		Environmental Resources Management	FIGURE 7-3

CONCEPTUAL DPVE SYSTEM CROSS SECTION D-D'

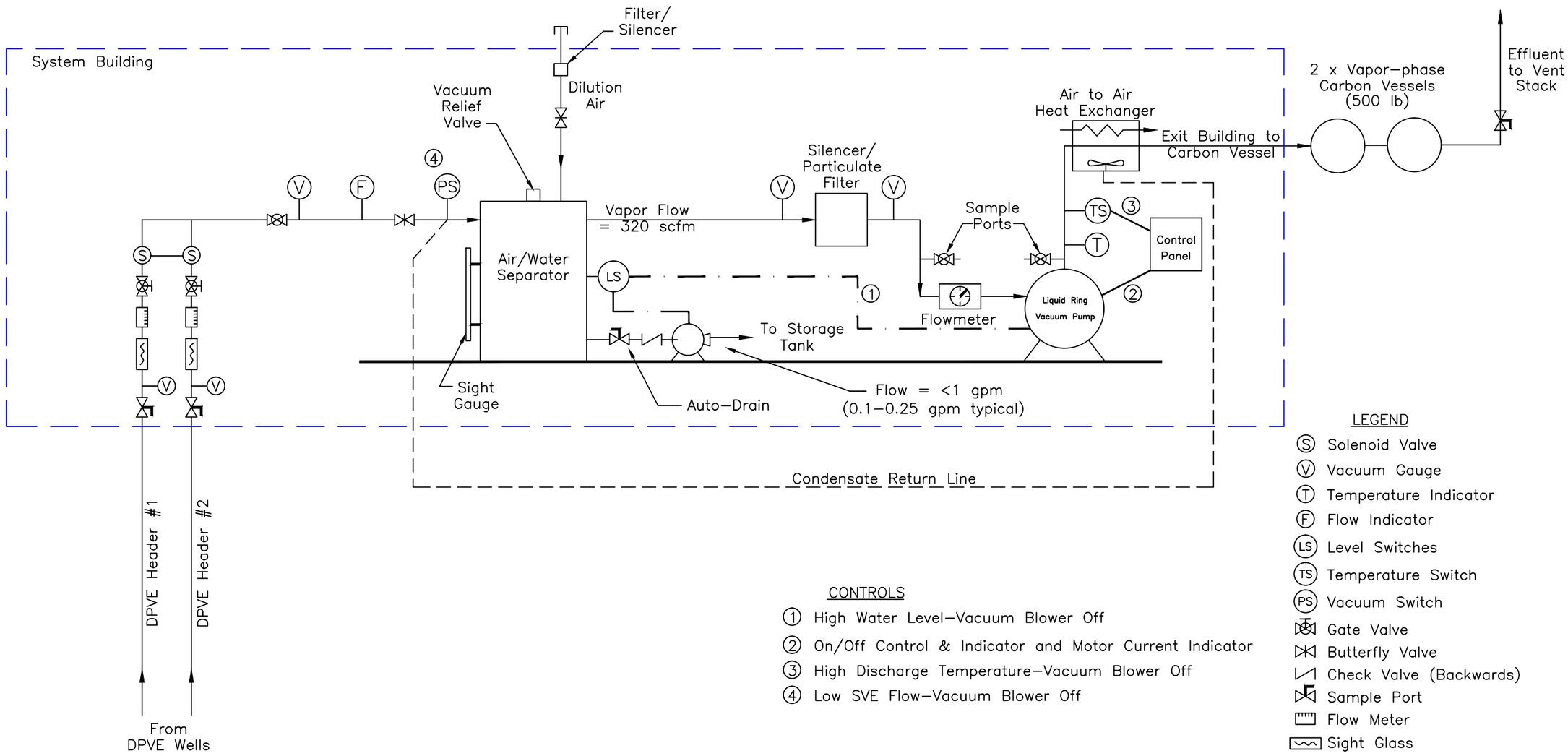


LEGEND

- SAND/SILTY SAND
- SILT/CLAY
- FILL (SAND, SLAG, DEBRIS)
- BEDROCK
- ADSORBED SOIL IMPACT
- VADOSE ZONE SOIL > PCE SSL
- 5 — GROUNDWATER PCE CONCENTRATIONS µg/L
- WATER ELEVATION
- SCREENED INTERVAL

Drawn By GML-ABF	ERM®	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE WATERLOO, IOWA	CHK'D MS
CADD Review JF			0339767
Date Drawn/Rev'd 10/27/2016		Environmental Resources Management	FIGURE 7-4

PROCESS AND INSTRUMENTATION DIAGRAM



CONTROLS

1. High Water Level–Vacuum Blower Off
2. On/Off Control & Indicator and Motor Current Indicator
3. High Discharge Temperature–Vacuum Blower Off
4. Low SVE Flow–Vacuum Blower Off

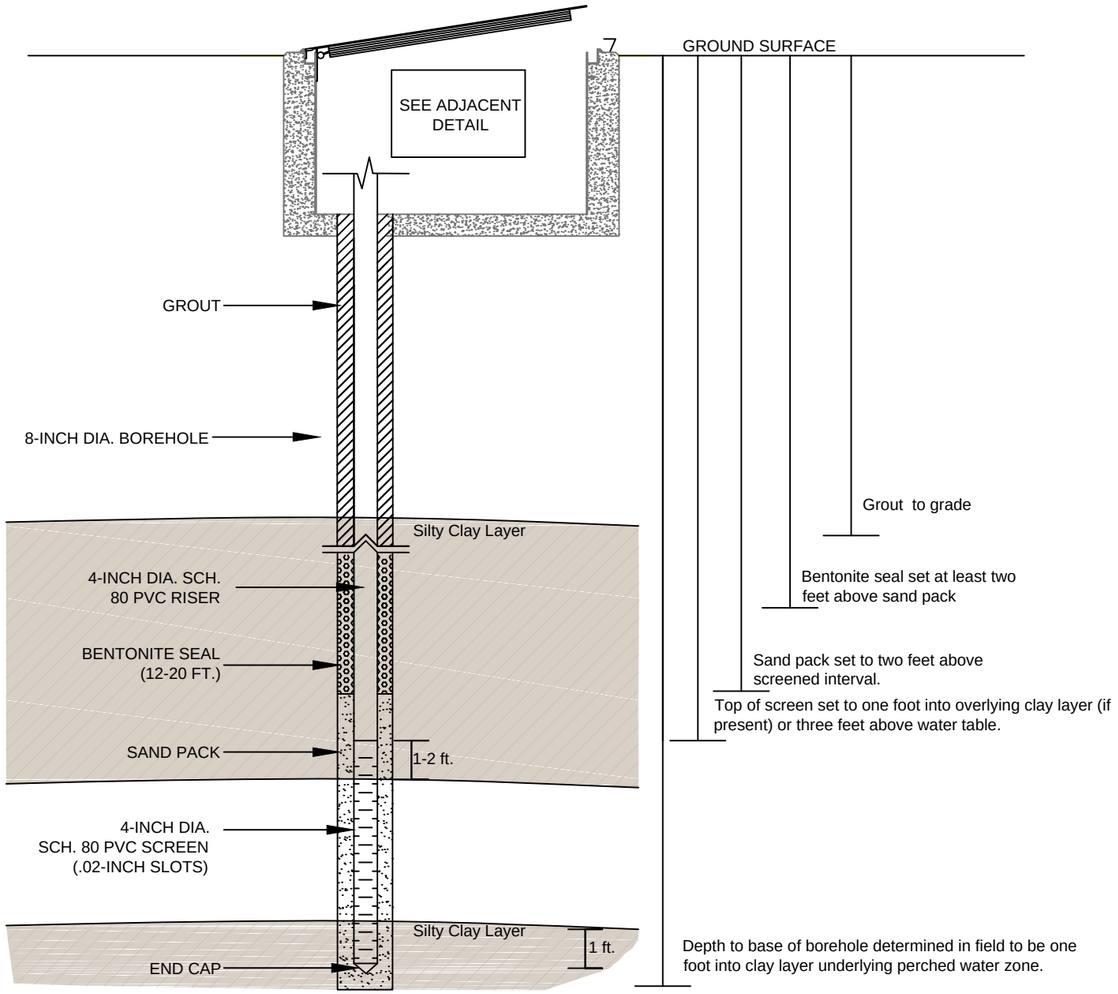
LEGEND

- S Solenoid Valve
- V Vacuum Gauge
- T Temperature Indicator
- F Flow Indicator
- LS Level Switches
- TS Temperature Switch
- PS Vacuum Switch
- Gate Valve
- Butterfly Valve
- Check Valve (Backwards)
- Sample Port
- Flow Meter
- Sight Glass

NOTE:
VOC = Volatile Organic Compounds
DPVE Header #1 contains DPVE wells EW–1 through EW–4
DPVE Header #2 contains DPVE wells EW–5 through EW–8

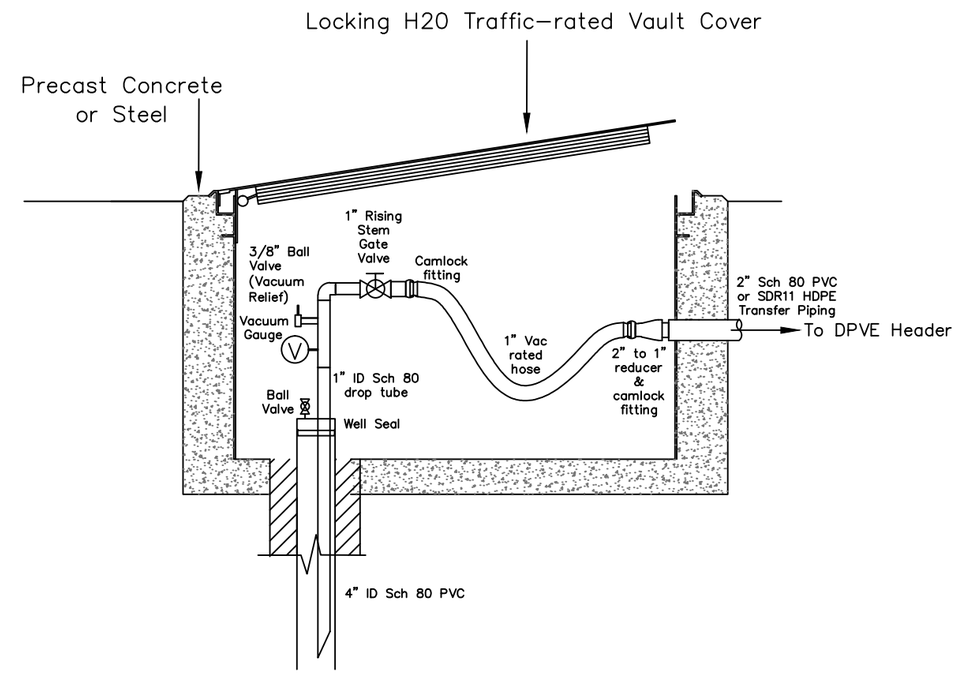
Drawn By RMK-GML-ABF	ERM®	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE Waterloo, Iowa	CHK'D BK-Mil
CADD Review JF			0339767
Date Drawn/Rev'd 10/27/2016		Environmental Resources Management	FIGURE 7-5

WELL CONSTRUCTION DIAGRAM & WELLHEAD DETAIL



DPVE WELL CONSTRUCTION DETAIL

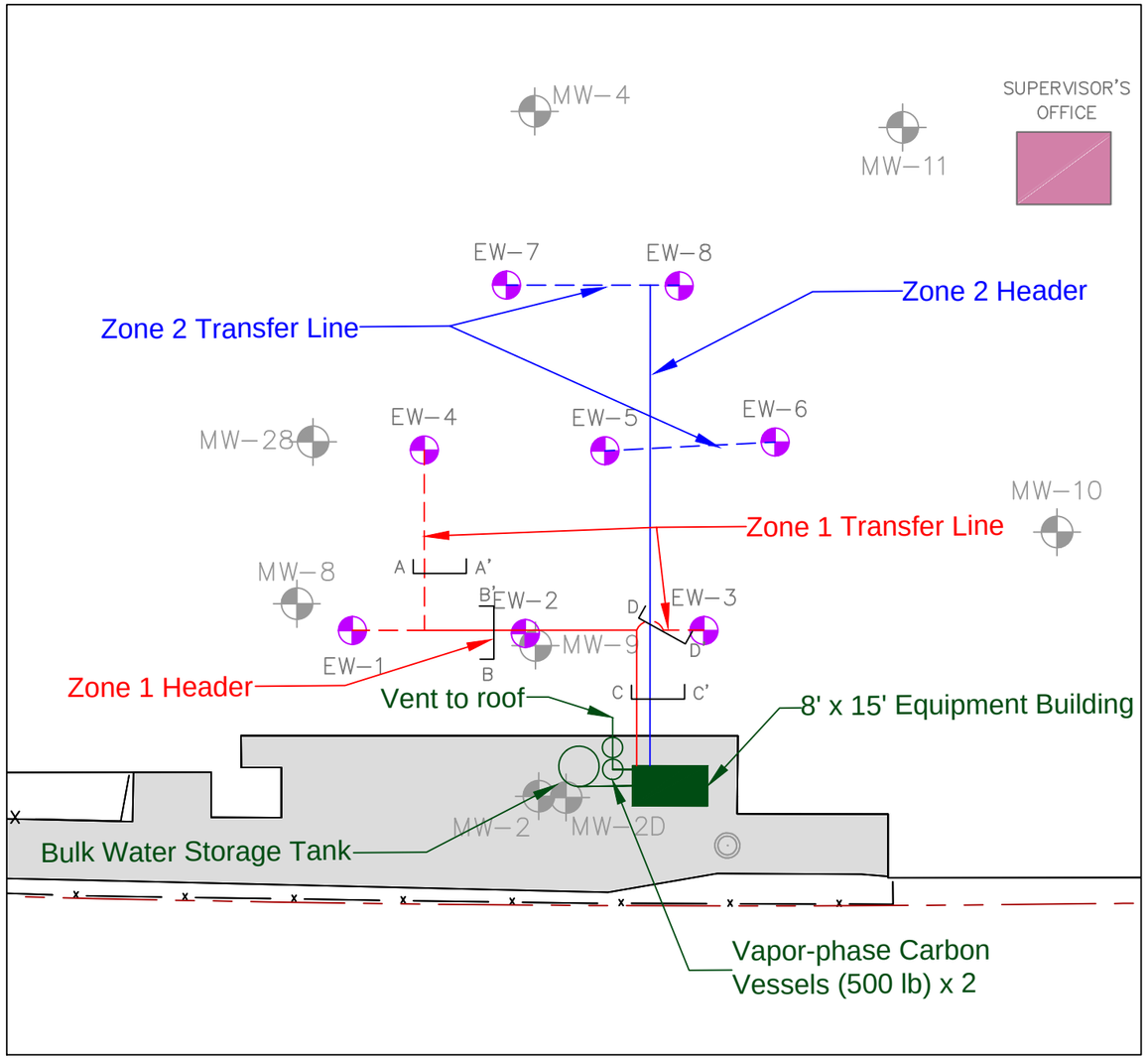
Note: Actual depths will be determined during installation based on conditions encountered. The information provided above presents the rationale for installation.

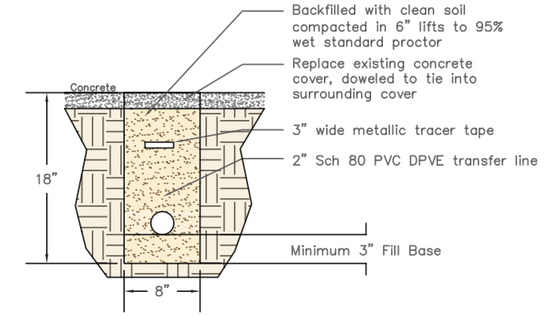


DPVE WELLHEAD DETAIL

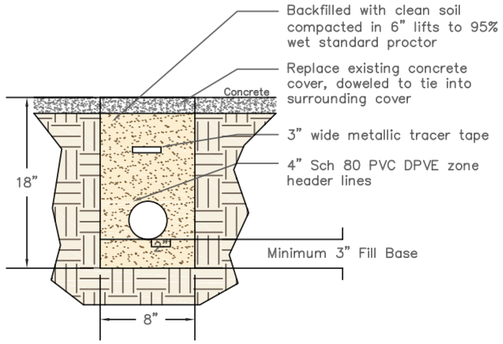
Drawn By RMK-GML-ABF	ERM®	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE Waterloo, Iowa	CHK'D BK-Mil
CADD Review JF			0339767
Date Drawn/Rev'd 10/27/2016		Environmental Resources Management	FIGURE 7-6

DPVE TRENCHING DETAILS

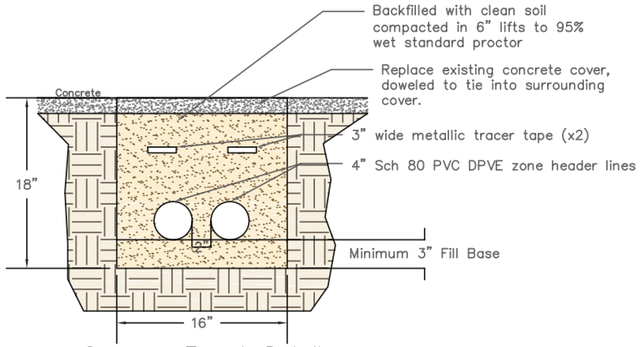




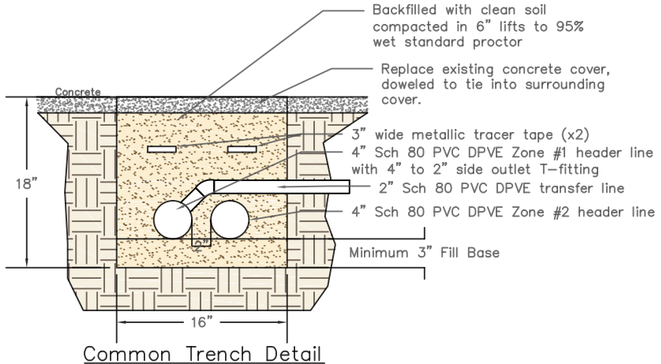
Individual Transfer Line Trench Detail (2" Piping)
(A–A')



DPVE Header Trench Detail
(B–B')



Common Trench Detail
(C–C')



Common Trench Detail
(D–D')

LEGEND

- GROUNDWATER MONITORING WELL LOCATION
- PROPOSED DUAL–PHASE EXTRACTION WELL (WITH APPROXIMATELY 25' RADIUS OF INFLUENCE)
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- ZONE 1 HEADER (4")
- ZONE 2 HEADER (4")
- ZONE 1 TRANSFER LINE (2")
- ZONE 2 TRANSFER LINE (2")
- PROPOSED SUB–SLAB DEPRESSURIZATION TREATMENT AREA

N

0 30 60

SCALE (IN FEET)

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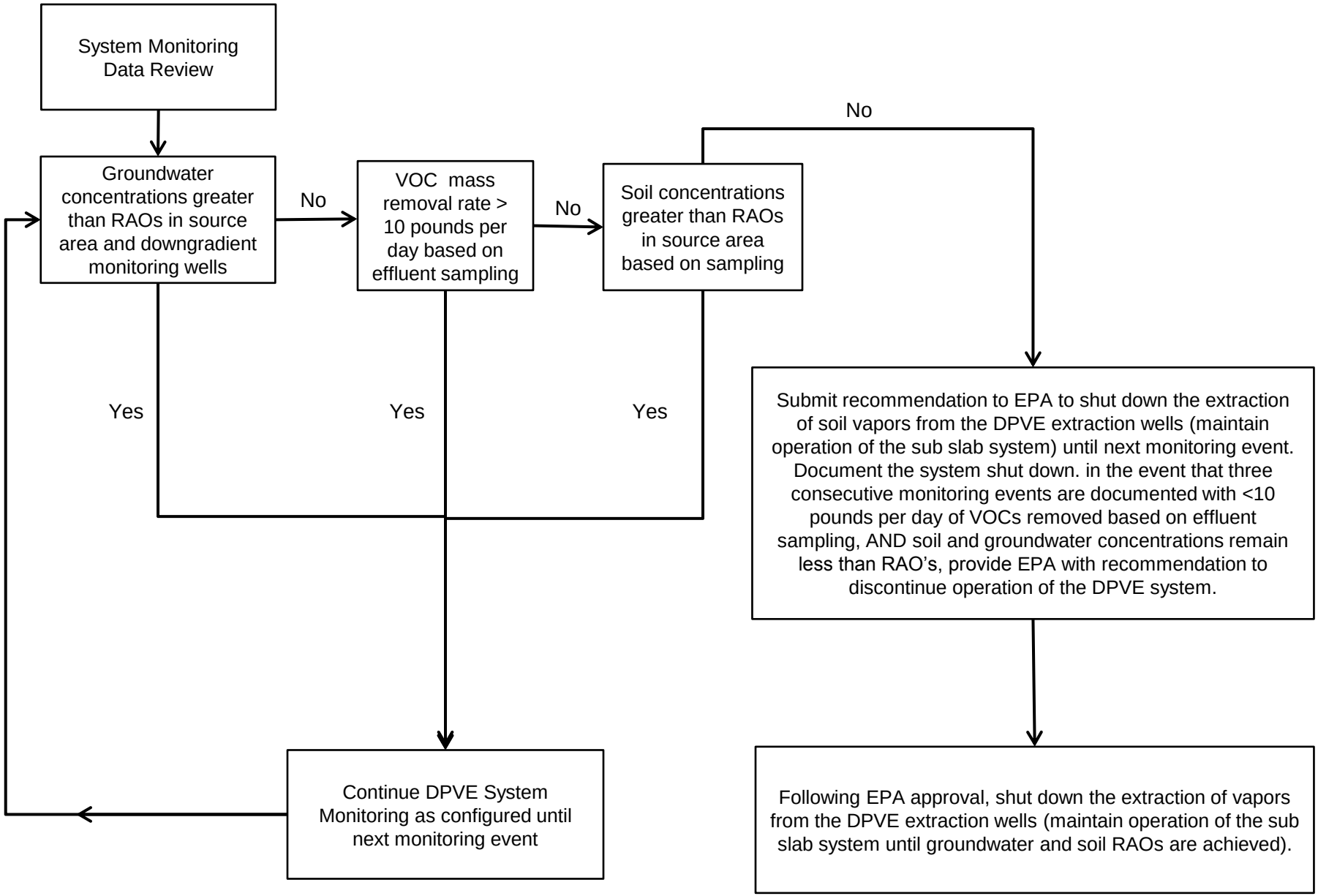
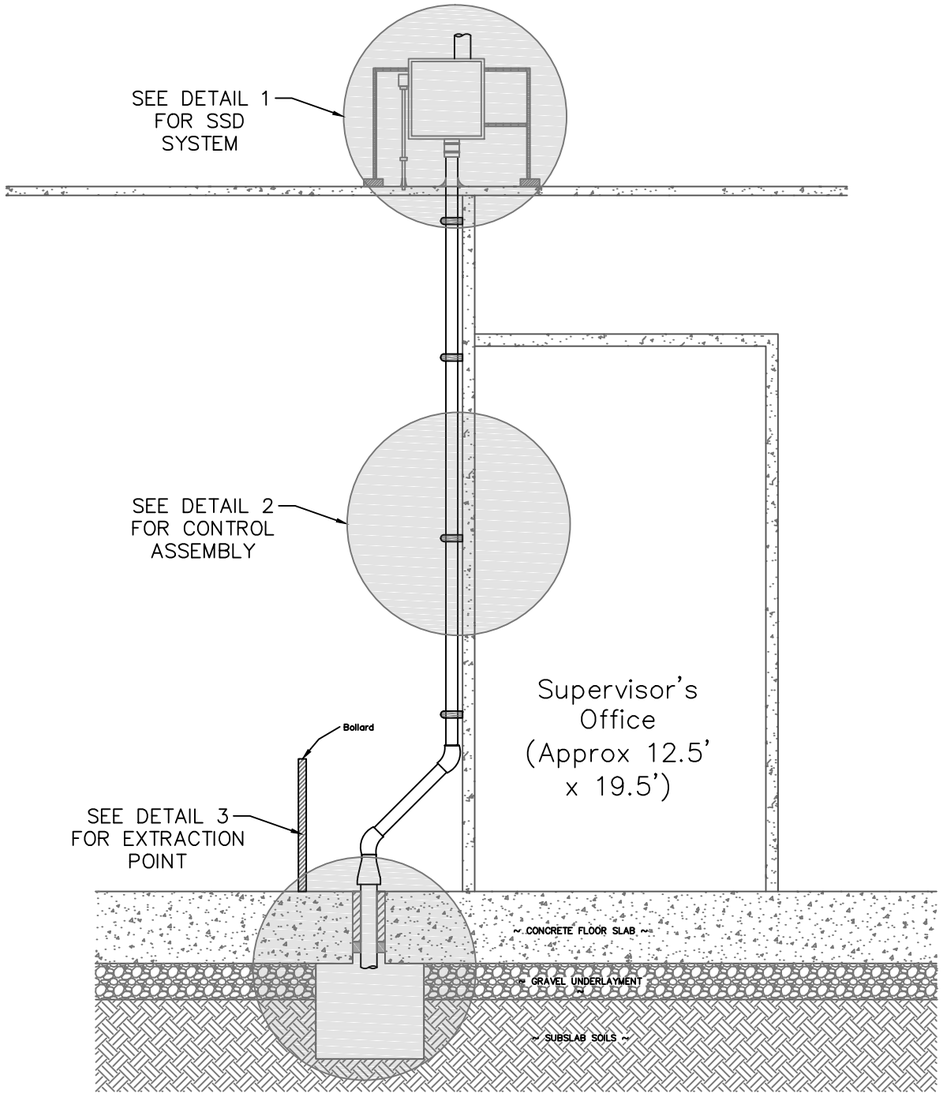
CADD Review JF			0339767
Date Drawn/Rev'd 10/27/2016		Environmental Resources Management	FIGURE 7-7

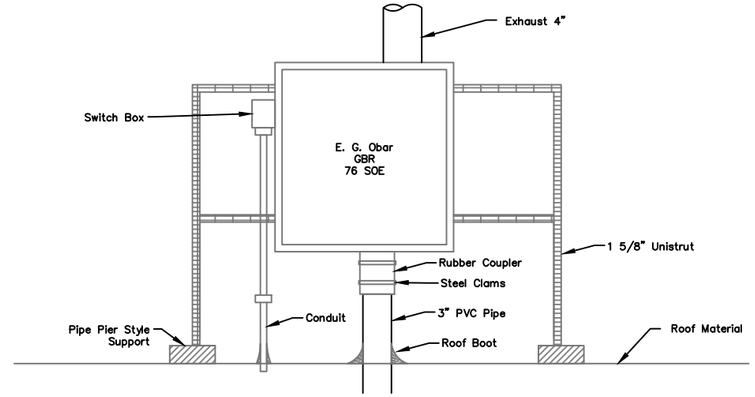
Figure 8-1 - Decision Tree Diagram DPVE System Operation and Shut Down



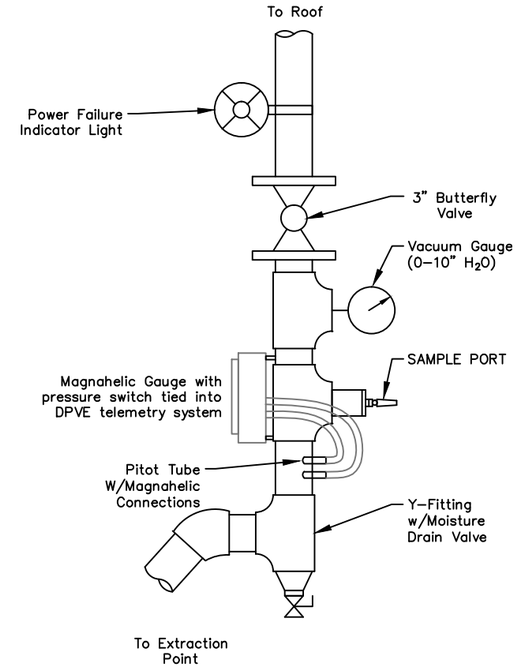
SUB-SLAB DEPRESSURIZATION SYSTEM DETAILS



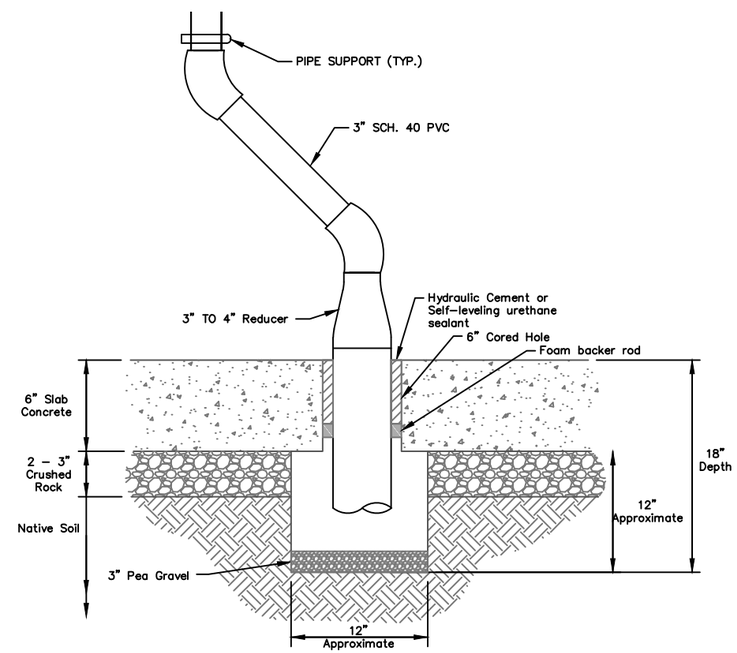
Detail #4
Piping Schematic



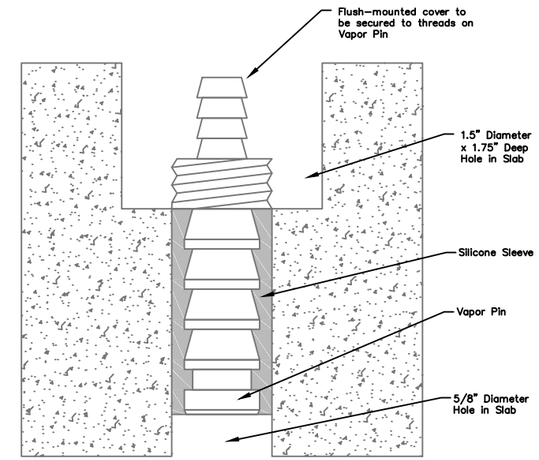
Detail #1
SSD System Layout



Detail #2
Control Assembly



Detail #3
Extraction Point



Detail #5
Vacuum Monitoring Point

NOTE: Where practical, 45–degree fittings will be used to minimize friction losses.

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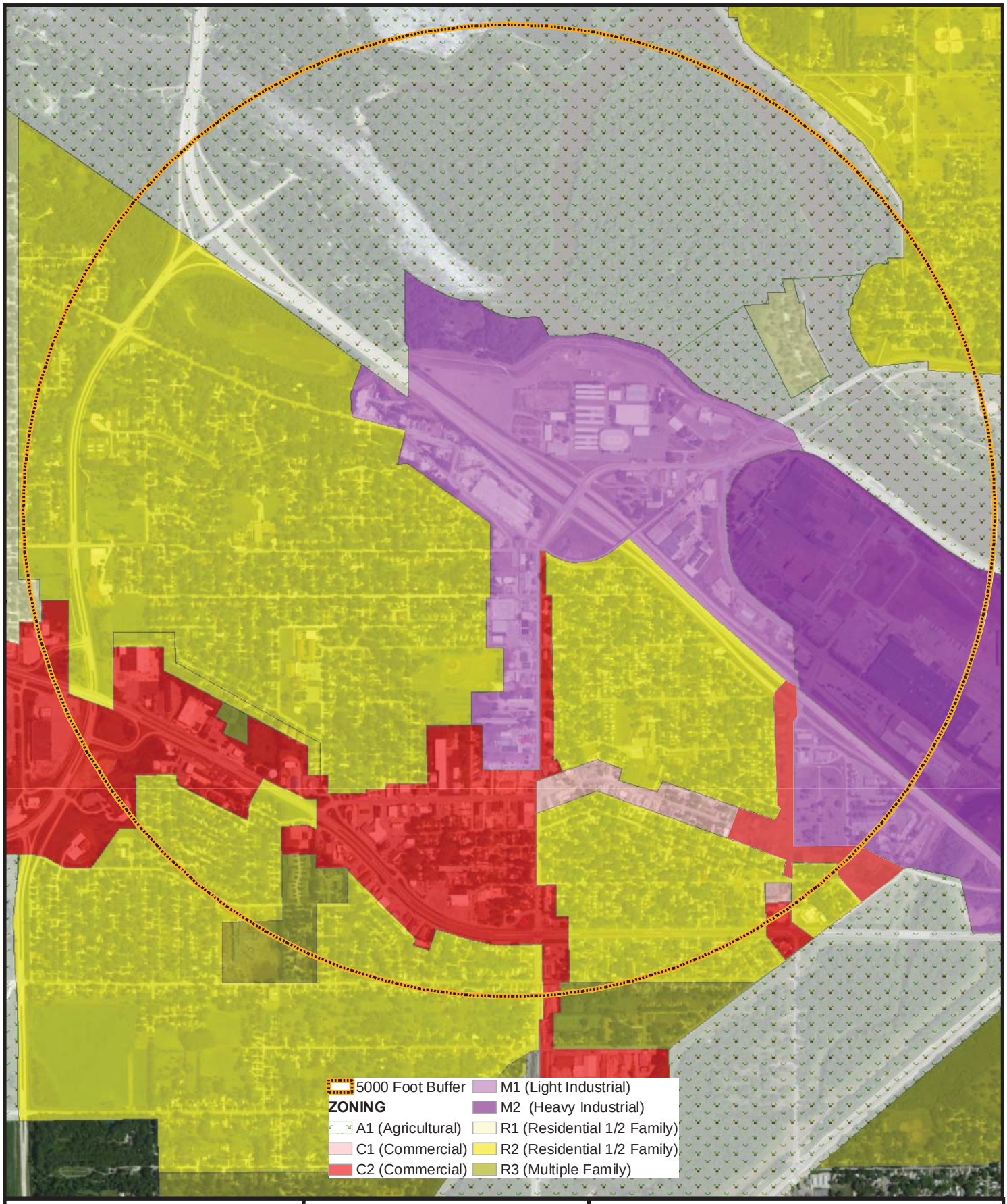
Date Drawn/Rev'd 10/27/2016		Environmental Resources Management	FIGURE 9-1



N

0 500 1,000 2,000 Feet

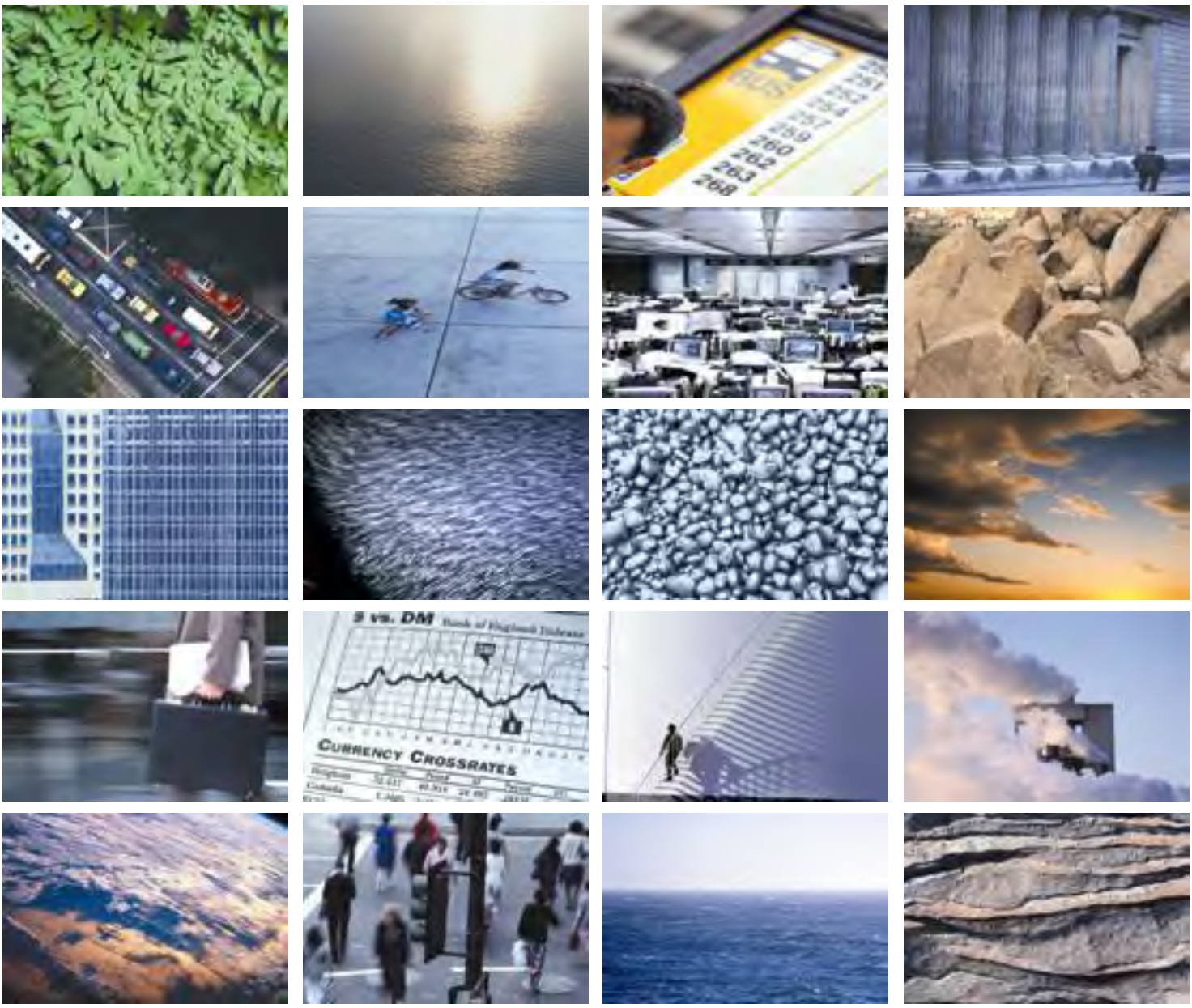
ERM

Figure 10-1
City of Waterloo Zoning Map
Former Waterloo Industries Site
300 Ansborough Avenue
Waterloo, Iowa

February 2012

Appendix A

Quality Assurance Project Plan



Quality Assurance Project Plan

Former Waterloo Industries Facility
300 Ansborough Avenue
Waterloo, Iowa

29 November 2016
Revised 30 January 2017

Delivering sustainable solutions in a more competitive world

ERM

Former Waterloo Industries Facility

Quality Assurance Project Plan

300 Ansborough Avenue
Waterloo, Iowa

29 November 2016
Revised 30 January 2017
ERM Project No. 0339767

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D Chain-of-Custody Forms

E Sampling Equipment Maintenance and Calibration Log

F Corrective Action Form

G Internal Document Distribution Log

LIST OF ACRONYMS

AOC	Area of concern
cDCE	cis-1,2-Dichloroethene
COC	Chain of custody
DQIs	Data quality indicators
DQOs	Data quality objectives
EPA Region 7	United States Environmental Protection Agency Region 7
ERM	Environmental Resources Management, Inc.
H&S	Health and safety
Waterloo	Former Waterloo Industries
LCS	Laboratory control sample
LCSD	LCS duplicate
MS	Matrix spike
MSD	MS duplicate
PCE	Tetrachloroethene
PID	Photoionization detector
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QAO	QA Officer
QC	Quality Control
%R	Percent recovery
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RIP	Remedial Implementation Plan
RPD	Relative percent difference
RSLs	Regional Screening Levels
SVOC	Semivolatile organic compounds
TCE	Trichloroethene
USEPA	United States Environmental Protection Agency
VC	Vinyl chloride
VOC	Volatile organic compound

1.0 PROJECT MANAGEMENT

1.1 PROBLEM DEFINITION/BACKGROUND

Environmental Resources Management, Inc. (ERM) has developed this Quality Assurance Project Plan (QAPP) to cover the sampling activities to be conducted at the Former Waterloo Industries (Waterloo) facility located at 300 Ansborough Avenue in Waterloo, IA (the "Site"), shown in **Figure 1**. This QAPP was prepared as a component of the Remedial Implementation Plan (RIP) requested by the United States Environmental Protection Agency (USEPA) Region 7. The work scope outlined in this RIP has been developed based on USEPA guidance regarding performance monitoring associated with monitored natural attenuation (MNA) remedies (*Performance Monitoring of MNA Remedies for VOCs in Groundwater*, EPA 600/R-04/027 April 2004). This guidance was used in conjunction with OSWER Directive 98200.4-17P *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites* (USEPA 1999) and guidance presented in *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (USEPA, 1998) and *An Approach for Evaluating the Progress of Natural Attenuation in Groundwater* (USEPA, 2011). In addition, the work is in accordance with the Final Decision and Response to Comments (FD/RTC) dated 17 June 2016 and the Remedy Selection Process (RSP) Meeting Report (Update 1), dated 6 November 2015.

The USEPA, under the Resource Conservation and Recovery Act (RCRA), requires that any party generating data implement minimum quality assurance procedures to assure that the precision, accuracy, completeness, and representativeness of the data collected are known and documented. To ensure this responsibility is met uniformly, each party must prepare a written QAPP for the activities to be performed.

This QAPP presents the policies, organization, objectives, quality assurance (QA), and quality control (QC) activities designed to achieve the specific data quality objectives (DQOs) associated with the groundwater sampling. This plan has been prepared in accordance with the requirements outlined in: (1) the USEPA *Guidance on Systematic Planning Using the Data Quality Objectives Process (February 2006, QA/G-4*), (2) the USEPA *Requirements for Quality Assurance Project Plans (March 2001, QA/R-5),* and (3) the USEPA *Guidance for Quality Assurance Project Plans* (December 2002, QA/G-5).

1.2 PROJECT/TASK DESCRIPTION

1.2.1 Site Background

The former Waterloo manufacturing facility property consists of approximately 10.3 acres located at the southwest corner of the intersection of Ansborough Avenue and Highway 218 in Waterloo, Iowa **(Figure 1).** The Property has one main building comprised of several additions, and several small storage buildings as represented on **Figure 2.** The ground surface around the buildings is covered by parking areas, driveways, railroad right of ways, landscaped areas, and city streets. The properties and features surrounding the facility are shown on **Figure 3.**

Waterloo and prior owners of Waterloo conducted manufacturing operations at the facility from approximately 1946 to 1997. During the years of operation from 1946 to 1997, the Property was owned by Sulentic Family Trust and leased to Waterloo and prior owners of Waterloo.

The ownership history of the property both historic and present is summarized as follows:

- 1941 - 1999: Sulentic Family Trust;
- 1999 – 2008: Fishels Warehousing, LLC;
- 2008 - Current: JRL Holding Company, LLC.

The facility is currently owned by JRL Holding Company, LLC, with two tenants leasing space within the facility. The building currently contains a recycling operation which utilizes warehouse, water treatment, and material processing equipment on site, as well as limited self-storage space, and a gym. The current operations and tenant storage areas, as understood through discussions with Mr. Larry Corkery of JRL Holding Company, LLC, are depicted on **Figure 2.** The locations of the solid waste management units (SWMUs) and areas of concern (AOCs) identified in the RFI and related documents are also depicted on **Figure 2.** The current tenants and use of the facilities are summarized as follows:

- The majority of the main building is currently occupied by Green Line Polymers (Subsidiary of Advanced Drainage Systems, Inc. (ADS)), engaged in processing of recyclable plastics on site. On **Figure 2-2** areas not otherwise designated as occupied by another tenant should be assumed to be occupied by Green Line Polymers.;

- Bare Bones Gym- Small walk in gym facility located in a refurbished area of the former Waterloo office space; and

- Climate Controlled Self Storage- Business record and file storage business located in the basement area of the northeast corner of the former Waterloo facility.

1.2.2 Project Objective and Scope

Waterloo voluntarily conducted investigation and sampling activities in connection with the shutdown of the Waterloo manufacturing operation in November 1997, and to develop information in the context of an ongoing RCRA Facility Assessment (RFA) initiated by EPA in March 1995. Waterloo actively participated in the RFA process with three information submittals dated May 30, 1995; September 3, 1996; and April 10, 1997 in response to a March 27, 1995 Request for Information Regarding Solid Waste Management Units. In addition, Waterloo participated in an April 18, 1996 Visual Site Inspection (VSI) of the Waterloo facility conducted by EPA's contractor Science Applications International Corporation (SAIC) and reviewed and commented, in part, on SAIC's draft Task 3 Report within Waterloo's September 3, 1996 submittal.

Based on current information, the following summary lists the Investigation Reports related to the Waterloo site that were conducted prior to the RFI:

- *SAIC Draft Task 3 Report to EPA* (SAIC, 1995). Identified 28 SWMUs and 9 AOCs at the Site.
- *Sampling Report and Request for No Further Action*, Waterloo Industries Former Manufacturing Facility (Weston, 1998). Site activities included the collection of 11 soil samples from 11 sampling locations;
- *Limited Site Investigation Report (*Terracon, May 20, 2008). Collection of five soil and five groundwater samples outside the building, focused around the west end of the facility;
- *Data Summary Report* (SES, January 5, 2009). Collection of 23 soil samples and 2 groundwater samples from 17 targeted sample locations on the property; and
- EPA Letter regarding Former Site of Waterloo Industries sampling Results (EPA, July 19, 2010). The summary letter included soil and groundwater analytical data contained in the SES January 5, 2009

Summary Report, and the sub-slab soil vapor sample analytical data from sampling conducted on April 29, 2009.

A RFI Work Plan and subsequent addendums were compiled for the Site and submitted to EPA in 2011 and 2012 with final approval by EPA on 23 August 2013. The purpose of the RFI was to determine the nature and extent of releases of hazardous wastes and/or hazardous constituents from regulated units, hazardous waste management units (HWMUs), SWMUs, AOCs and other source areas at the former site (as defined by the RCRA Facility Assessment [RFA]). The RFI Report (updated 21 July 2015) summarizing the RFI activities and findings was submitted to the EPA and approved on 30 July 2015.

Maps depicting Site investigation activities and locations are provided as **Figures 2-4** through **2-7** (soil, groundwater, soil vapor, and indoor air locations, respectively) in the RIP. The results of the investigation activities are discussed in Section 3.0 of the RIP.

On 27 August 2015, a RSP Meeting was conducted between EPA, Fortune Brands Home Security, and ERM to develop concurrence between EPA and Waterloo on the conclusions of the RFI and to identify a remedy selection path forward for the former facility. The RSP Meeting discussions and recommendations are summarized in the RSP Meeting Report (Revision 1) dated 6 November 2015. On 17 June 2016, EPA issued the FD/RTC, detailing the selected final remedy for the Site.

The purpose of the RIP and related QAPP is to identify data needs, evaluation methods, monitoring network layout, reporting requirements, and methods for routine evaluation of institutional controls that are associated with implementing the selected remedy at the Waterloo site.

1.2.3 Groundwater Sample Network Design and Rationale

The proposed monitoring network is composed of existing monitoring wells (construction details provided in Table 5-1 of the RIP) located both on and off-Site within the perched and bedrock zones.

As presented in Section 4.0 of the RIP, the monitoring network has been designed to collect hydrologic and chemical data both on and off-Site with monitoring locations up gradient, within the source area, down gradient, and side gradient of the source area. The data will be used to verify the remedy is effectively reducing the contaminant concentrations and mass;

verify that the remedy is effectively controlling contaminant migration; and verify that natural attenuation occurring.

In addition, the monitoring network has been designed to collect geochemical and biochemical data using monitoring locations up gradient, within the source area, and down gradient of the source area along the groundwater flow lines from the Site. Isoconcentration Maps (presented as **Figures 3-17** through **3-19** of the RIP) provide details on the boundary of contaminants on and off-site. The data will be used to confirm and document that natural attenuation is occurring.

The performance monitoring events will include groundwater elevation measurements and sample collection from existing monitoring wells. Groundwater elevation measurements will be collected according to the procedures described in Section 6.1.1 of the RIP, and groundwater samples will be collected according to the procedures described in Section 6.1.2 of the RIP.

1.2.4 Soil Vapor and Indoor Air Sampling Design and Rationale

Subslab soil vapor will be monitored at two locations. These locations will correspond with the suspected source area in AOC 5 (sampling location WSVS-2R) and adjacent to the facility supervisor's office (WSVS-8). The soil vapor sampling data will be used to confirm that the remedial system and the SSDS is effectively reducing the vapors generated from impacted soil and groundwater as well as effectively removing soil vapors from beneath the facility concrete slab foundation.

Indoor air monitoring will be performed at one location, located within the facility supervisor's office. This location will correspond with the RFI sampling location WIAS-11. This indoor air sampling data will be used to confirm that the SSDS is effectively removing subslab soil vapors that otherwise may have negatively impacted the indoor air.

Air samples will be collected from the remedial system effluent to confirm that the volatiles in the system effluent to assess system performance and to ensure that effluent does not exceed applicable permit/screening levels. Effluent samples will be collected at two locations; before the system carbon canisters and after the carbon canisters.

Additionally, ambient (outdoor) air samples will be collected at a location upwind of the facility.

Air and vapor samples will be collected according to the procedures described in Sections 6.3.2 and 6.3.3 of the RIP.

1.2.5 Parameters to Be Tested and Frequency

The groundwater samples will be analyzed for VOCs, geochemical parameters, and biochemical parameters. Soil and air/vapor samples will be sampled for VOCs. The specific compounds to be analyzed are presented in **Table 1**.

The groundwater monitoring frequency proposed as part of the RIP is semi-annual groundwater sampling (calendar quarters 2 and 4) for Site COCs and on an annual basis for geochemical and biochemical parameters. The semi-annual events have been proposed for quarter 2 (sampling to occur in April) and Quarter 4 (sampling to occur in October). This schedule eliminates the first quarter and late fourth quarter which have historically been the most likely to have poor weather that would inhibit sampling and monitoring events.

Indoor air, soil vapor, and remedial system effluent air monitoring will be performed on a semi-annual basis in conjunction with the groundwater sampling events.

Soil sampling will be completed upon attainment of the Site groundwater RAOs.

1.2.6 Intended Data Usage

The data uses for the analyses conducted during the field data collection activities include the following:

- Collect hydrologic data both on and off-site from the monitoring network to determine the potentiometric groundwater surface;
- Groundwater qualitative descriptions and field measurements for low-flow (micropurge) sampling to check the stability of the groundwater prior to sampling;
- Collect groundwater chemical data to document the remedy is effectively reducing the contaminant concentrations and mass, as well as contaminant migration;
- Collect groundwater geochemical, and biochemical data to document site conditions as well as the occurrence of natural attenuation on and off-site;

- Collect sub-slab soil vapor data to confirm that the SSDS is effective in reducing sub-slab soil vapors;
- Collect indoor air chemical data to document site conditions and to confirm that the SSDS is effective in preventing soil vapors from impacting indoor air;
- Collect ambient air chemical data for comparison to indoor air data to document potential off-site influence to on-site data collection;
- Collect remedial system effluent air chemical data to be used to evaluate DPVE system performance and to ensure that the system effluent does not exceed any applicable effluent limits; and
- Collect soil chemical data at the completion of the remedial activities on site (once groundwater RAOs are achieved) soil sampling will be performed within AOC 5 to confirm on-site Soil RAO have been achieved. (**Figure 6-1** of the RIP).

1.3 QUALITY OBJECTIVES AND CRITERIA

1.3.1 Data Quality Objectives

To achieve the project objectives, DQOs have been established to ensure that the data collected are sufficient and of adequate quality for their intended uses. The DQOs for the area data collections are based on the USEPA *Guidance on Systematic Planning Using the Data Quality Objectives Process (February 2006*). The DQO evaluation is summarized in **Table 2**.

1.3.2 Criteria for Measurement Data

The overall QA objectives are to develop and implement procedures for field sampling, chain of custody, laboratory analysis, field measurement, and reporting that will provide data that are scientifically valid, meet the DQOs summarized in **Table 2**, are to a degree of quality consistent with their intended use, and are defensible in a court of law. This section defines the goals for the QC effort and the data quality indicators (DQIs) for the sampling, including accuracy, precision, sensitivity, completeness, representativeness, and comparability of field and laboratory analyses.

1.3.2.1 Definitions

The following definitions were extracted from the IDEM VRP Resource Guide, and supplemented by information from USEPA's document, *Data*

Quality Objectives for Remedial Response Activities, March 1987, EPA/540/G-87-003.

- Accuracy is the closeness of agreement between an observed value and an accepted reference value. The difference between the observed value and the reference value includes components of both systematic error (bias) and random error. Laboratories assess the overall accuracy of their instruments and analysis methods (independent of sample or matrix effects) through the measurement of "standards," which are materials of accepted reference values.
- Accuracy will vary from analysis to analysis because of individual sample and matrix effects. In an individual analysis, accuracy can be measured and expressed in terms of the recovery of surrogate compounds (organic analyses) or recovery of spiked compounds (inorganic analyses). These give an indication of expected recoveries for analytes that tend to behave chemically like the spiked or surrogate compounds.
- Precision is the agreement among a set of replicate measurements without consideration of the "true" or accurate value, i.e., variability between measurements of the same material for the same analyte. Precision is measured in a variety of ways, including statistically, such as calculating variance or standard deviation.
- Completeness is defined as the percentage of measurements made that are judged to be valid measurements.
- Representativeness expresses the degree to which the data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, process condition, or an environmental condition. Representativeness is a qualitative parameter, which is dependent upon the proper design of the sampling program and the laboratory QC protocol.
- Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. This goal is achieved through using standard techniques to collect and analyze representative samples and reporting analytical results in appropriate units.

1.3.2.2 *Accuracy, Precision, and Sensitivity of Analyses*

The QA objectives of field analyses with respect to accuracy, precision, and sensitivity are to obtain acceptable data based on specified

performance criteria. Information about each parameter is presented below:

- pH: The accuracy of field measurements will be ensured by performing pre-measurement calibration using at least two standard buffer solutions. (The pH meter will be calibrated using two standard buffer solutions, and then the pH of both solutions will be measured.) The pH measurement must be within ± 0.10 pH units of the actual buffer solution values, or the meter will require recalibration. Precision will be assessed through duplicate measurements. (The electrode will be withdrawn from the sample, rinsed with distilled water, and re-immersed between each duplicate.) The duplicate measurement must be within ± 0.10 pH units of the initial measurement, or the meter will require recalibration. The instrument used will be capable of providing measurements to 0.01 pH units.
- Specific Conductance: The accuracy of field measurements will be ensured by performing pre-measurement calibration using solutions of known specific conductance. The measured specific conductance of the standard solution must be within 5% of the actual specific conductance of the solution. The sensitivity of the specific conductivity meter is 0.001 mS/cm in the 0 to 200 mS/cm range.
- Temperature: Sample temperature will be measured with the temperature probe on the pH meter. The sensitivity and accuracy of the meter will be 0.3°C and ± 0.6°C, respectively, or better. The precision and accuracy of the field temperature probe will not be verified because of the difficulty of evaluating these parameters in the field. The instrument selected for the field data collection will include automatic calibration of the temperature sensor.
- Turbidity: The accuracy of field measurements of turbidity will be evaluated by daily pre-measurement calibration. The instrument will have a sensitivity of 0.01 Nephelometric turbidity units (NTUs) on the lowest range, an accuracy of ±2% of reading plus stray light (0.02 NTUs) from 0-1000 NTU, and a precision of ±1% of reading or 0.01 NTU, whichever is greater. Precision will be assessed by duplicate readings of the calibration standard after calibration is completed.
- Dissolved Oxygen (DO): The accuracy will be assessed through daily pre-measurement calibration. The instrument will have a sensitivity of 0.01 mg/L, an accuracy of ± 0.2 mg/L, and a precision

of ± 0.1 mg/L. Precision will be assessed by duplicate readings of the calibration standard after calibration is completed.

- Oxidation-Reduction Potential (ORP): The accuracy will be evaluated through daily pre-measurement calibration. The instrument's sensitivity, accuracy, and precision will be 0.1 mV, ± 20 mV, and ± 5 mV, respectively. Precision will be determined by duplicate readings of the calibration standard after calibration is completed.

The laboratory will meet their own accuracy, sensitivity, and precision limits for the respective USEPA analytical methods. The limits to be met are indicated in **Table 1**. If any changes are required, a revised table will be attached to the semi-annual report; accuracy or precision limits will only be changed if they are more stringent than the ones listed in **Table 1**.

The acceptance criteria for relative percent difference (see **Section 4.3.2.1**) of laboratory analytical data for field duplicates will be 25% for groundwater samples.

1.3.2.3 Data Completeness, Representativeness, and Comparability

Field activities are expected to generate at least 90% of the planned samples. Representativeness will be ensured by proper selection of the sampling locations and use of standard data collection, measurement, and QA/QC procedures. Comparability will be ensured by performing the field measurements in a consistent manner during all data collections at the Site.

It is expected that the laboratories will provide data meeting the QC acceptance criteria for 95% or better of the compounds analyzed. The completeness of an analysis will be documented by the laboratory with data such as blanks, duplicates, and matrix spikes to allow the data user to assess the quality of the results.

The sampling and analysis program is designed to provide data representative of site conditions. Data representativeness will be achieved by performing all field sampling and laboratory testing and analysis in a standardized manner that adheres to the procedures specified in this QAPP.

Data comparability will be ensured by conducting all of the monitoring, sampling, and analysis in a similar manner in all of the data collection

areas addressed by this QAPP and the RIP. Specifically, data comparability will be ensured by:

- Reporting results in appropriate units,
- Using the same or similar sampling procedures in all data collection areas,
- Using the same or equivalent analytical procedures in all data collection areas, and
- Following the same or equivalent QA/QC requirements in all data collection areas.

1.4 PROJECT/TASK ORGANIZATION AND SCHEDULE

1.4.1 Project Organization

This section presents the operational responsibilities involving the execution and direct management of the technical and administrative aspects of this project.

1.4.1.1 General Project Management

Mr. Dennis McKinney, Fortune Brands Home and Security (corporate successor to Waterloo Industries), will be the Waterloo project manager and will have the overall responsibility for the sampling and reporting efforts. ERM will report to Mr. McKinney and will be responsible for the execution of the work to implement the corrective action, and for issuing all project deliverables. EPA Region 7 will review all documents and provide regulatory management of the project. The operational responsibilities involving the execution and direct management of the technical and administrative aspects of this project are summarized below.

General Project Oversight:

Client

Mr. Dennis McKinney, Fortune Brands Home and Security.

Mr. McKinney will oversee the activities performed at the Site and will be responsible for approval of the strategies and activities required to complete the project.

Overall Management of the Remedy Implementation Activities:

ERM

Partner-in-Charge – Mr. Christopher Weggemann
Project Manager – Mr. Mark Seaman, P.E.

ERM's Partner-in-Charge has the overall responsibility for ensuring that the project meets all of Waterloo's and EPA Region 7's requirements.

ERM's Project Manager will establish and manage budgets and schedules; select and oversee subcontractors and project staff, review all submittals prepared by ERM for the project, and be responsible for the preparation and quality of all deliverables.

Quality Assurance:

ERM

Quality Assurance Officer – Dr. Maureen C. Leahy, Ph.D.

The Quality Assurance Officer (QAO) is responsible for auditing the implementation of the QA program in conformance with the demands of specific investigations, ERM's policies, Waterloo's policies, and EPA Region 7's requirements.

Laboratory

QAO Test America – Dr. Thomas J. Tjaden

QAP Microseeps – Ms. Charlotte Washlaski

The laboratory's QAOs will be responsible for auditing the implementation of their own QA program and for meeting the requirements of this QAPP.

Regulatory Management of the Project:

EPA Region 7

Project Manager – Mr. Daniel Gravatt, P.G.

The EPA Region 7 Project Manager has the overall responsibility for reviewing and approving all work performed at the Site.

1.4.1.2 *Field Activities*

Waterloo will have the overall responsibility for all phases of the remedy implementation. ERM will perform or supervise all data collection activities. ERM's Project Manager will be responsible for the overall execution of the remedy implementation and will ensure that all field activities are executed in accordance with the requirements outlined in this site-specific QAPP and the project-specific HASP. Specific individuals involved in the field activities include:

Facility and Property Owner

Property Owner Contact – Mr. Larry Corkery of JRL Holding Company, LLC, or his designee.

ERM

Field Operations Manager – Mr. Darron deBoer, or designated qualified alternate. ERM's Field Operations Manager will be responsible for the field activities and supervise the day-to-day activities.

Subcontractors

The following subcontractors to ERM may be employed to provide professional services in completion of the field activities.

Test America, Cedar Falls, IA (and affiliated locations)	Groundwater (chemical and geochemical), soil, soil vapor, and air sample laboratory analyses
Pace Analytical Services, Pittsburg, PA	Groundwater biochemical laboratory analyses
VJ Engineering, Waterloo, Iowa	Surveying

All subcontractors will provide appropriate project management support as needed to complete the designated project work scopes

1.4.1.3 QA Organization

The ERM Project Manager and Partner-in-Charge are responsible for the overall quality of all project deliverables. ERM's QAO will provide overall QA of the project's field activities. Specific functions and duties include:

- Review and approve the QA plans and procedures;
- Provide QA technical assistance to project staff;
- Review the field data acquired during the field activities to ensure they were collected in accordance with this QAPP;
- Review the field notebooks to determine whether proper custody procedures were followed during the field work and decide if any location should be re-sampled;
- Review all laboratory analytical data to ensure they were generated in accordance with the approved QAPP;
- Perform or oversee the required data validation; and
- Ensure that QAPP procedures regarding project documentation and evidence file are followed.

ERM's QAO may delegate some or all of these duties to another qualified ERM staff member or an outside qualified consultant. An ERM staff member will be considered qualified for a specific task if that person has the appropriate training, education, or experience to perform the task. ERM's QAO will oversee the work completed by other ERM staff members or subcontractors and will have the overall responsibility for ensuring that any delegated task is performed in accordance with the QAPP.

The laboratory's QAO will be responsible for enforcing and documenting the QA/QC procedures performed during the analytical work.

1.4.2 Project Schedule

The project will proceed on the schedule established in **Section 5.0** of the RIP.

1.5 DOCUMENTATION AND RECORDS

For the field measurements, the documentation provided to the ERM QAO or designee(s) for QA review will include the Sampling Field Data Forms, chain-of-custody (COC) records, and copies of the field notebooks (see **Section 2.3** for the contents of these documents).

The laboratory documentation system will comply with the requirements of the USEPA analytical protocols, as appropriate, and with the laboratory's Quality Systems Manuals included in **Appendices A and B** (for groundwater chemical, geochemical, and biochemical samples) if more stringent than USEPA's requirements. The laboratory will provide Level II data packages for all samples. The contents of the Level II data packages and the hierarchy of bookmarks in the electronic version of the data package are presented in **Table 3**.

Section 11.3 of the RIP presents a brief description of the contents of the report(s) to be produced. A list of the documents to be kept in the final evidence file is presented in **Section 2.3.4**.

1.5.1 Document Distribution

The ERM Project Manager will be responsible for maintaining and distributing the most recently approved RIP and QAPP to the people in the distribution list and to the Field Managers and other field personnel prior to mobilization to the Site to perform the tasks assigned to them. An Internal Document Distribution Log will be maintained to ensure that all personnel who will perform activities subject to the QAPP receive the updates. A copy of the form to be used is included in **Appendix G** and includes the name of the document, date of approval of the changes, name of the person who received the document, and date of receipt of the document by that staff member.

1.5.2 Procedure for Changing the QAPP

Changes to the QAPP will be initiated by the Field Leaders or other field personnel, and will be submitted to the ERM Project Manager, who will approve or disapprove the changes in consultation with the ERM QAM and the ERM Partner-in-Charge. Upon obtaining this approval, the ERM Project Manager will submit to the EPA Region 7 Project Manager for review. Upon receipt of approval of the changes, the ERM Project Manager will distribute the final copy of the page(s) containing the changes to the people in the distribution list. The copies to the Field

Leaders and other field personnel will have attached a brief memorandum explaining the changes

1.6 SPECIAL TRAINING REQUIREMENTS/CERTIFICATION

Samples will be collected by experienced geologists or field samplers. All subcontractors will be experienced in the work they will be performing and certified as applicable.

1.7 DISTRIBUTION LIST

Copies of the data collection reports produced during this project will be submitted to the following individuals:

- Mr. Daniel Gravatt, EPA Region 7; and
- Mr. Dennis McKinney, Fortune Brands Home and Security.

2.0 DATA GENERATION AND ACQUISITION

2.1 SAMPLING PROCESS DESIGN

The rationale for the selection of the sampling locations is described in **Sections 4.0** and **5.0** of the RIP.

2.2 SAMPLING METHODS REQUIREMENTS

Section 6.0 of the RIP contains the field sampling equipment and procedures. A summary table of the investigative and QA/QC samples to be collected, sample containers, preservation techniques, and holding times is presented in **Table 4** of this QAPP.

2.3 SAMPLE HANDLING AND CUSTODY

Sample custody procedures will be consistent with Section 3 of the EPA Region IV guidance entitled *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual* (2001).

A sample will be considered under a person's custody if it is (1) in a person's physical possession, (2) in view of the person after he or she has taken possession, (3) secured by that person so that no one can tamper with the sample, or (4) secured by that person in an area that is restricted to authorized personnel.

2.3.1 Sample Designation, Handling, and Shipping

2.3.1.1 Sample Designation

The sample designation system to be followed during the RIP monitoring to ensure proper documentation of the collected samples is described below. The name for each investigative sample will be based on the following system:

- Two-letter code for site name: WI- Waterloo Industries
- Numerical location identification: MW# - Monitoring well location, S# - Soil sample location, SVS# - soil vapor location, AS# - indoor air location, AA# - ambient air location, DPVE# - DPVE effluent.

For example, groundwater sample from monitoring well MW-1 would be designated as "WI-MW-1".

QC samples will be designated as follows:

- Matrix Spike/Matrix Spike Duplicate – The designation of the sample location where collected with the letters "MS" at the end. For the example above, the MS/MSD samples would be designated as "WI-MW-1-MS".
- Duplicates, field blanks, equipment rinsate blanks, and trip blanks will be designated by using the following nomenclature:
    - The first two-letter code for the site location (WI).
    - A two- or three-letter code: "Dup" for duplicate, "FB" for field blanks, "EB" for equipment blanks, and "TB" for trip blanks. The sampling location from each duplicate sample is collected will be recorded in the field notebook upon collection.
    - A sequential number for each sampling event, beginning with 01 for each type of QC sample.

For example, the first duplicate of the will be designated as "WI-Dup-01" and the first trip blank for the groundwater samples will be "WI-TB".

All of the sample collection information and procedures will be recorded in a dedicated field notebook (see **Section 2.3.2.2**).

2.3.1.2 *Sample Labeling*

After placing the sample into an appropriate container, the field sampler will affix properly completed sample labels. If not printed by computer, the information should be hand-written on the label in capital letters, making sure the number 5 and the letter "S" are clearly different. All samples will be identified with labels that are securely attached to the sample containers (see **Section 2.3.1.3**). Each label will include the following information:

- Unique sample identification, as specified in **Section 2.3.1.1**;
- Site name;
- Name and affiliation of the sampler;
- Date and time of collection;
- Requested analyses; and

- Preservatives used (if any).

2.3.1.3 *Sample Handling and Shipping*

Sample handling and shipping will be performed as follows:

- After sample preservation (where required), wipe off the exterior of the sample containers, complete the sample paperwork as indicated in **Section 2.3.1.2**, tighten the caps, and attach the sample labels to the sample containers.
- For soil or groundwater samples, place the sample containers in a cooler, and place packing material around the samples to minimize the possibility of container breakage. For soil vapor or air samples, place the sample canister back into the laboratory provided shipping container/box.
- Add wet ice sealed in plastic bags to maintain the temperature at 6 °C or below to coolers containing soil or groundwater samples and fill the remaining space in the cooler with additional packing material.
- Enclose COC forms (**Section 2.3.2.2**) and any other shipping or sample documentation accompanying the shipment in a self-sealing plastic bag and place them inside the cooler or shipping container.
- Close the cooler or shipping container and seal it with tape. If a sample cooler has a drain, tape it shut. Seal the coolers or shipping containers with custody seals in such a manner that the custody seal would be broken if the cooler or container were opened. Then, cover the custody seals with clear plastic tape. If the samples will be delivered by the sampling crew to the laboratory, sealing is not required.

The samples will be delivered to the laboratory by ERM personnel, delivered to the laboratory by the laboratory's courier, or shipped to the laboratory via an overnight carrier. The laboratory will be notified at the time of shipment. Soil and groundwater samples may be maintained on ice at 6 °C or below until a full cooler of samples is accumulated, taking respective holding times into account.

2.3.2 *Field-Specific Custody Procedures*

All ERM personnel will follow the field sample custody procedures described below. The field sampler(s) will be personally responsible for

the care and custody of the samples until they are transferred or properly dispatched. As few personnel as possible will handle the samples.

2.3.2.1 Field Notebooks/Documentation

This section presents the procedures to be followed for documenting all field activities.

1. Field notebook entries will describe in as much detail as possible the data- and sample-collection activities performed so that persons going to the Site could reconstruct a particular situation without reliance on memory.

2. Bound field notebooks will be prepared for the field activities performed at the Site. Notebooks will be assigned to the Site project and stored in a secure location when not in use. Each notebook will be permanently labeled with the Site name, ERM project number, and notebook number.

3. The title page of each notebook will contain the following:
   - Notebook number;
   - Project name and number;
   - Project Site address and Site contact telephone number;
   - Emergency telephone numbers;
   - A return address should the notebook get lost;
   - Project start date; and
   - Project end date; when available.

4. Leave four blank pages at the beginning of the field notebook to add a table of contents with page numbers as the work progresses.

5. Begin each day's entry on a new page. At the beginning of each day, record the date, start time, weather, names of all sampling team members present, level of personal protection being used, planned activities for the day, and the signature of the person making the entry.

6. Enter the names of visitors to the Site and the purpose of their visit.

7. Account for times of inactivity as well as multiple tasks performed concurrently. Reference other notebooks with supplemental information.

8. Record measurements made and samples collected (*e.g.*, PID, water quality measurements and soil descriptions), including the instrument used and calibration performed. Duplicate field measurements will also be entered in the notebook.

9. Record the soil boring or groundwater monitoring well number whenever a sample is collected or a measurement is made. The number of the photographs taken, if any, will also be noted.

10. Enter the equipment used to collect samples; the time of sampling; sample number and physical description; depth at which the sample was collected; whether the sample is a grab or a composite (and if composited, how it was composited); volume and number of sample containers; preservation; type of sample (investigative, duplicate, trip blank, etc); the unique sample number corresponding to each duplicate; any deviation from QAPP procedures; and requested analyses. Groundwater Sampling Field Data Forms and COC Forms will also be completed. Copies of the Sampling Field Data Forms and COC Forms are provided in **Appendices C and D**, respectively. Sample designation procedures are presented in **Section 2.3.1.1**.

11. Record any deviations from the sample collection/handling procedures described in the RIP in the field notebooks, along with appropriate explanations.

12. If photos of the Site or the sample locations are taken, enter a photo log that includes the photo number, a description of the cardinal direction of the photo, and a description of what was photographed.

13. Print all entries with waterproof indelible ink and do not make any erasures. If an incorrect entry is made, cross out the information with a single strike mark so that it remains legible; then the responsible individual must initial the error and note the date of the change. The correction must be written adjacent to the error. Do not remove any page, even if mutilated or illegible, from the notebook.

2.3.2.2 *Transfer of Custody and Shipment Procedures*

To provide documentation necessary to trace sample possession from the time of collection to the time of receipt by the analytical laboratory, a COC form will be completed and will accompany each shipment of samples to the laboratory. Example copies of the COC form are provided in

Appendix D. The following sample packaging and shipment procedures will ensure that the samples will arrive at the laboratory with the appropriate COC form:

1. Samples will be accompanied by a properly completed COC form. The sample information will be listed on the COC form. When transferring the possession of samples, the individuals relinquishing and receiving the samples will sign, date, and note the time on the records. This record documents the transfer of custody of samples from the sampler to another person, to a laboratory, or to/from a secure storage area.

2. The field portion of the custody documentation will include the project name, the sample designation, date and time of collection of each sample, whether the sample is grab or composite, medium sampled, number of containers, preservation used, and analyses requested.

3. Samples will be properly packaged for shipment if necessary (samples may be delivered by the sampling crew to the laboratory) and dispatched to the appropriate laboratory for analysis, with a separate signed COC form enclosed in each sample box or cooler. Shipping containers will be secured with tape and custody seals if shipped to the laboratory as described in **Section 2.3.1.3**.

4. If an overnight carrier or courier is used for shipment, their airbill will be used as the record of shipment. Receipts from the airbill will be retained as part of the custody documentation. Commercial carriers are not required to sign off on the COC forms as long as the COC forms are sealed inside the sample coolers and the custody seals remain intact.

2.3.3 Laboratory Chain-of-Custody Procedures

Samples will be received at the laboratory by the Sample Custodian, who will sign and date the form and examine each sample to ensure that no damage occurred during shipment and that the COC form is complete and accurate. The Sample Custodian will also ensure that each sample has been preserved in the manner required by the particular test and stored according to the correct procedure and will note the laboratory ID number on the COC form. The laboratory Sample Custodian will notify the ERM Project Manager of any problems with the samples as received at the laboratory and will provide a copy of the COC form with the laboratory ID numbers added.

The COC procedures to be followed by the laboratory after sample receipt by the Sample Custodian are described in the laboratory's QA manuals in **Appendices A and B**.

2.3.4 *Final Evidence File Custody*

ERM will maintain the final evidence file for the Site sampling activities. ERM's Project Manager will also serve as the evidence file custodian. The contents of the evidence file will be kept in a dedicated file that will have controlled access.

The evidence file will contain originals on paper or electronic copies of all project-related documents, which may include the following, as applicable:

- A set of the approved RIP, Health and Safety Plan, and QAPP;
- Progress reports, addendum documents to project plans, data collection reports, and remediation plans and reports;
- Completed field notebooks, sample field data forms, pictures, boring logs, and well construction logs;
- Laboratory analytical results, including case narratives, summary data sheets, and QC data summaries;
- Laboratory raw data, calibration, and instrument outputs for Level II data packages;
- Any data validation reports;
- Any subcontractor reports;
- Completed sample custody documentation (i.e., COC forms and airbills, as applicable);
- Project-related communications; and
- Other project-related documentation.

ERM will maintain the final evidence file for at least six years after completion of the sampling activities. The evidence file will be offered to Waterloo prior to final disposal of the file contents.

2.4 *ANALYTICAL METHODS*

The samples will be analyzed in a manner consistent with Methods listed in **Table 4** and consistent with **Section 2.6.2**. The reporting limits for each

method and analyte are listed in **Table 1**. Laboratory analysis to be performed using standard turn around times not to exceed 4 weeks for analysis and reporting.

2.5 *QUALITY CONTROL*

2.5.1 *Field Sampling*

The following QC field samples will be collected as a basis for evaluating sampling and analytical procedures.

- Equipment Rinsate Blanks – Equipment rinsate blanks ensure that sampling equipment is clean and that the potential for cross contamination has been minimized. Equipment rinsate blanks will only be collected from non-dedicated sampling equipment that is to be re-used during the project (e.g., pumps, hand augers). As appropriate, equipment rinsate blanks will be collected at a rate of 1 per 20 samples.
- Field Blanks – Field blanks indicate whether the sample containers are clean and contaminants have not been introduced to the sample from background air conditions. Field blanks will consist of distilled water or deionized water poured from one set of containers to the sampling containers at the sampling site. Field blanks will be collected at a frequency of 1 per 20 samples.
- Trip Blanks – Trip blanks are used to assess the potential for VOC contamination of soil or water samples as a result of contaminant migration during sample shipment and storage. Trip blanks will be provided by the laboratory for analysis of VOCs in water samples. The trip blanks will not be opened in the field. One trip blank will accompany each sample cooler that contains soil or water samples for VOC analyses.
- Duplicates – Blind duplicates provide an estimate of the reproducibility of sampling and analytical procedures. Blind duplicates will be included for each matrix at a rate of 1 per 10 samples. The duplicates will be analyzed for the same parameters as the samples. The duplicates will not be identified as duplicates to the laboratory.
- Matrix Spike (MS) and Matrix Spike Duplicates (MSDs) – MS/MSD samples provide information about the effect of the sample matrix on the analytical methodology. MS/MSD samples will be generated for soil and groundwater at a rate of 1 per 20 samples or

less. The samples will be identified as MS/MSD samples so that the laboratory can perform the necessary spike evaluation procedures. The sample locations will target areas that field screening indicates as possibly moderately impacted.

The procedures to be followed to collect the field QC samples are described in **Section 6.0 of the RIP**.

2.5.2 *Laboratory Analysis*

The laboratory responsible for performing soil and groundwater analyses will follow the QC requirements in the corresponding analytical method, including both required and recommended QC checks. If the laboratory QC requirements indicated in its QA Manual (see **Appendices A and B**) are more stringent than those of the methods being used, the most stringent QC requirements will apply, in accordance with the National Environmental Laboratory Accreditation Conference standards. The laboratory's QC limits for duplicates, matrix spikes, and blank spikes (i.e., laboratory control samples), are listed in **Table 1**. The level of QC efforts is presented in **Section 2.6**.

The laboratory will perform the internal QC checks specified in the analytical methods it is following. Depending on the analytical method, the QC checks may include analyzing sample spikes, surrogate spikes, reference samples, laboratory control samples, storage blanks, and/or method blanks. The frequency of QC checks, the compounds to be used for spikes, and the QC acceptance criteria are described, as appropriate, in the USEPA analytical methods to be used and in the QA manuals included as **Appendices A and B** if more stringent than EPA's requirements or recommendations.

The laboratory will document internally that both initial and ongoing instrument and analytical QC criteria have been met. The Level II data packages will contain all of the information required to evaluate compliance with the analytical methods' required and recommended QC checks, instrument tuning, calibration, and sample analysis.

2.6 *INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE REQUIREMENTS*

Routine preventive maintenance will be the responsibility of the individual with direct oversight of the equipment (i.e., ERM for field equipment and the laboratory for laboratory equipment).

2.6.1 *Field Instruments/Equipment*

The field equipment for this project includes items such as PIDs and multi-parameter (pH, temperature, conductivity, etc.) water quality meters. Specific preventative maintenance procedures to be followed for field equipment are those recommended by the manufacturer. In addition, all field equipment will be cleaned at the beginning of each day and between samples to help ensure proper performance.

Field instruments will be checked and calibrated before they are shipped or carried to the field, in accordance with **Section 2.7.1**. These instruments will be checked and calibrated daily before use.

Critical spare parts, such as tape, papers, pH probes, electrodes, and batteries will be kept on site to minimize instrument downtime. Backup instruments and equipment should be available on site or within one-day shipment to avoid delays in the field schedule.

Equipment to be used during the field sampling will be examined to certify that it is in proper operating condition. For equipment owned by ERM, this includes checking the manufacturer's operating manual and the instructions for each instrument to ensure that all maintenance requirements are being observed. Field notes from previous sampling trips will be reviewed so that the notation on any prior equipment problem is not overlooked, and to ensure all necessary repairs to equipment have been carried out. For rental equipment, this second maintenance step is not necessary. Daily preventive maintenance for all instruments will include the following;

1. Check battery strength and/or charge strength before use. Replace or recharge if insufficient.
2. Check any tubing and connections. Ensure that tubing is in good shape, and that all connections are snug. Replace and/or tighten if necessary.
3. Check all electrical connections and wiring. Make sure all connections are clean and tight, and that any wiring is dry and free of cracks and exposed insulation.
4. Check all inlet and outlet filters. If dirty and/or wet, replace before use.

The inspections performed, findings, and solutions (as applicable), will be recorded in the field notebook and in the Sampling Equipment Maintenance and Calibration Log included in **Appendix E**.

2.6.2 *Laboratory Instruments*

As part of their QA/QC programs, routine preventative maintenance programs are conducted by the analytical laboratories to minimize the occurrence of instrument failure and other system malfunctions. Preventative maintenance is discussed in the laboratory QA Manuals included in **Appendices A and B**. All laboratory instruments are maintained in accordance with manufacturers' specifications and schedules. This maintenance is documented in the laboratory instrument service logbook for each instrument. Emergency repair or scheduled manufacturers' maintenance is provided by factory representatives or factory-trained laboratory personnel.

2.7 *INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY*

This section describes procedures for maintaining the accuracy of all the instruments and measuring equipment which are used for conducting field tests and laboratory analyses. These instruments and equipment should be calibrated prior to each use or on a scheduled, periodic basis.

2.7.1 *Field Instruments/Equipment*

Instruments and equipment used to gather, generate, or measure environmental data will be calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of results are consistent with the manufacturer's specifications. Field instruments will include items such as a multi-parameter (pH, temperature, conductivity, etc.) water quality meters, and organic vapor PID. All field personnel will be familiar with the calibration, operation, and maintenance of all field instruments and will maintain their proficiency. Operating procedures outlined in the manual for each instrument will be followed. Calibration details will be recorded in the field notebook and in the Sampling Equipment Maintenance and Calibration Log (see **Appendix E**). **Section 2.6.1** contains the maintenance procedures.

If field equipment should fail, the Field Operations Manager will be contacted immediately and will either provide replacement equipment or have the malfunction repaired immediately.

Calibration of field instruments will be performed according to the manufacturer's procedures at the intervals specified by the manufacturer or more frequently as conditions dictate. In the event that a field instrument cannot be calibrated, it will be returned to the manufacturer or

rental company for service. The water quality meter will be calibrated, at a minimum, on a daily basis. If utilized, the mercury thermometer will be checked before and after each use to see if the readings are consistent and the mercury is still intact. See **Section 6.3 of the RIP** for calibration procedures in case the manufacturers' instructions are not available.

2.7.2 Laboratory Instruments

The laboratory will follow the calibration procedures and frequency for laboratory instrumentation specified in the analytical methods to be used for analysis of ERM's samples, including both required and recommended procedures. Records of calibration, repairs, or replacement will be filed and maintained by the designated laboratory personnel performing QC activities. These records will be filed at the location where the work is performed and will be subject to QA audit. For all instruments, the laboratory will maintain a factory-trained repair staff and in-house spare parts or will maintain service contracts with vendors.

The records of calibration will be kept in accordance with the analytical method and the laboratory's QA Manuals included in **Appendices A and B.**

2.8 INSPECTION/ACCEPTANCE REQUIREMENTS FOR SUPPLIES AND CONSUMABLES

Supplies and consumables (such as calibration gases, deionized water, hoses, and sample containers) will be obtained from reliable suppliers or the laboratory to ensure they will not affect the quality of the data obtained. Supplies and consumables will be inspected by the Field Operations Manager (or designated qualified alternate) prior to use and will be rejected and replaced if determined to be defective.

2.9 NON-DIRECT MEASUREMENTS

An additional database that may be used during the project includes:

- Iowa water-supply well databases, to perform a water-well survey around the facility, and
- Integrated Risk Information System, a USEPA database that contains toxicity factors and effects of chemical parameters.

Other publicly available government-sponsored databases or sources of information may also be used.

2.10 DATA MANAGEMENT PLAN

2.10.1 Documentation Procedures

Procedures to document the field activities are described in **Section 2.3.2.1**. Field notebooks and laboratory data will be kept in a secure location in the offices of ERM in West Des Moines, Iowa, in accordance with **Section 2.3.4**.

2.10.2 Data Reduction

The laboratory will perform data reduction for the analyses that it performs. The procedures followed by the laboratory are included in **Appendices A and B**. Reduction of the laboratory data will ensure that the actual quantities reported are accurate and appropriately qualified. The field data do not require reduction.

ERM will reduce the laboratory data into tables and figures, as appropriate. The reported quantities will be as detected, qualified or not, by the laboratory. Compounds detected in blanks will not be subtracted from the analytical results of investigative samples and will be reported separately.

Field and validated analytical data, as applicable, will be summarized in the reports as follows:

- Depth to water and to free product (if any) will be presented in tables;
- Laboratory data will be summarized in tables and figures; and Laboratory reports will be included in appendices (hard copies or electronic copies on CD ROM or DVD).

Each data summary document (i.e. tables, and figures) will be checked for accuracy after completion. The analytical data tables will contain the sample name, sampling location, sampling date, sample reporting limits for non-detected compounds, and detected analytical results. The data presented in figures will vary depending on the results. In general, figures will be prepared to show at least the main constituents or analytical fractions (e.g., chlorinated volatile organic compounds) detected above the screening levels, if any. Figures such as groundwater

piezometric surface maps and/or figures with the lateral or vertical extent of contamination will be prepared as necessary to aid in the understanding of the data collected.

2.10.3 Reports

Reports will be prepared as indicated in **Section 11.3** of the RIP**.** Reports will be reviewed before submittal to ensure the data and information presented are correct and conclusions are based on sound technical principles.

2.10.4 Record Preservation

Section 2.3.4 specifies the period during which the records regarding the investigations and any remediation will be maintained, and the contents of the final evidence file.

3.0 ASSESSMENT AND OVERSIGHT

3.1 ASSESSMENTS AND RESPONSE ACTIONS

3.1.1 Performance and Systems Audits

ERM's Project Manager will monitor and audit the performance of QA/QC procedures to ensure that sample collection is executed in accordance with this QAPP.

3.1.1.1 Audits of Field Activities

ERM's Project Manager, QAO, or Field Operations Manager will perform internal audits of field activities to ensure compliance with the requirements in the RIP and this QAPP. The following QC procedures will be reviewed during the internal audits and documented in the field notebook:

- Sample collection,
- Decontamination of sampling equipment,
- Field measurement procedures and QC checks,
- Collection of QC samples,
- Custody procedures,
- Preventive maintenance of field instruments,
- Calibration of field instruments, and
- Documentation of field activities.

Any corrective action taken, such as instructions to a sampling team member on how to alter the sample collection or decontamination procedures, will be recorded in the field notebook by the person performing the audit.

These internal audits will occur at the onset of the project to verify that all established procedures are followed. Follow-up internal audits will be conducted at least once every two weeks or at the end of each field sampling event to correct deficiencies and to verify that QA procedures are maintained throughout the field activities.

At this point, no external field audits are planned for the investigative sampling. If conducted, external field audits may include a review of the

same procedures included in the internal audits (**Section 3.1.1.1**). External field audits would be performed by EPA Region 7 representatives or contractors who meet the requirements of the approved HASP.

3.1.1.2 Laboratory Audits

Performance and system audits of the laboratories, including the submittal of third-party performance testing samples, will be conducted according to the laboratory QA Manuals (**Appendices A and B**). The laboratory will notify the ERM QAO of any findings that require corrective actions that cannot be applied at the laboratory (e.g., re-sampling), as indicated in **Section 3.1.2.3**.

In addition, external audits of the analytical laboratories may be performed by Waterloo, ERM's QAO, or an ERM subcontractor. If serious deficiencies are discovered, corrective measures will be undertaken and documented as described in the laboratory QA Manuals. Samples will not be analyzed until major deficiencies have been corrected by the laboratory. No external audits by Waterloo or its contractors are planned at this time.

3.1.1.3 Data Quality Assessment

The quality of the data collected will be assessed as specified in **Sections 4.2.2 and 4.3**.

3.1.2 Corrective Actions

3.1.2.1 Sample Collection/Field Measurements

Technical staff and project personnel will be responsible for reporting all suspected technical or QA non-conformances or suspected deficiencies of any activity or issued document by reporting the situation to the ERM Field Operations Manager or his designee. This person will be responsible for assessing the suspected problems in consultation with the ERM Project Manager or QAO on making a decision based on the potential for the situation to impact the quality of the data. If it is determined that the situation warrants a reportable nonconformance requiring corrective action, then a nonconformance report will be initiated by the Field Operations Manager. A blank Corrective Action Form is included in **Appendix F**.

The Field Operations Manager will be responsible for ensuring that corrective action for non-conformances are initiated by:

- Evaluating all reported non-conformances,
- Controlling additional work on nonconforming items,
- Determining disposition or action to be taken,
- Maintaining a log of non-conformances,
- Reviewing nonconformance reports and corrective actions taken, and
- Ensuring nonconformance reports are included in the final documentation in project files.

If appropriate, the Field Operations Manager will ensure that no additional work that is dependent on the nonconforming activity is performed until the corrective actions are completed. However; no staff member will initiate corrective action without prior communication of findings through the proper channels. Corrective action for field measurements may include:

- Repeat the measurement to check the error,
- Check for all proper adjustments for ambient conditions such as temperature,
- Check the batteries,
- Recalibration,
- Check the calibration,
- Replace the instrument or measurement devices, or
- Stop work (if necessary).

The Field Operations Manager or his designee is responsible for all site activities. In this role, this person is at times required to adjust the site programs to accommodate site-specific needs. When it becomes necessary to modify a program, the responsible person notifies the site manager of the anticipated change and implements the necessary changes after obtaining the approval of the site manager. The Field Operations Manager must approve the change in writing or verbally prior to field implementation, if feasible. If unacceptable, the action taken during the period of deviation will be evaluated in order to determine the significance of any departure from established program practices and action taken. The Field Operations Manager is responsible for the controlling, tracking, and implementing the identified changes.

3.1.2.2 *Laboratory Analyses*

If errors or deficiencies are identified in an analytical system, corrective actions are implemented to return the system to normal operation as defined by the analytical methods and laboratories SOPs. Corrective actions at the laboratory level are described in the laboratory QA Manuals in **Appendices A and B**.

If data validation or QC audits identify unacceptable conditions, the Project Manager will be responsible for developing and initiating corrective action. The Project Coordinator will notify EPA Region 7 of any deficiencies that could affect the project analytical results. The laboratory QA Officer will be notified of the non-conformance and will oversee any corrective action to verify resolution. Corrective action may include:

- Re-analyzing samples if holding time criteria permit,
- Re-sampling and analyzing,
- Evaluating and amending sampling and analytical procedures, and
- Accepting data acknowledging level of uncertainty.

Data inadequacies attributable to site-specific interferences or conditions may require that sampling procedures or analytical methods be modified.

3.1.2.3 *Other Corrective Action*

Problems such as determining that insufficient sample volume is available at the laboratory for analysis are not immediately correctable. If such a problem is encountered, the laboratory QAO will contact ERM's Project Manager, who will then contact the Waterloo Project Manager. These parties will reach an agreement as to the corrective action warranted. ERM's Project Manager will be responsible for implementing the agreed-to action. This same procedure will be followed if audit results or detection of unacceptable data indicate that re-sampling is necessary.

If there is a problem with laboratory performance that is not immediately correctable, the proposed corrective action will be discussed in a proposal by the laboratory's QAO. This report will be presented by ERM's Project Manager to the Waterloo Project Manager. The corrective action will be implemented only after full agreement on the required action has been reached. The laboratory Project Manager will be responsible for implementing any corrective actions under his/her control.

Before implementing significant corrective actions, such as modifying an analytical method, Waterloo's and/or ERM's Project Manager will obtain USEPA's approval.

3.2 REPORTS TO MANAGEMENT

The reports submitted to USEPA Region 7 (described in **Section 11.3** of the RIP) will include the laboratory data packages, which will contain the individual QC sample results in individual pages and the results of any required corrective action in the narrative section. The results of internal field audits and any related corrective actions will be summarized in the QA section of the progress report(s). Any problems serious enough to require significant actions (*e.g.,* changing the analytical procedure that was approved) will be reported to the USEPA Region 7 Project Manager within 5 days of the occurrence.

4.0 DATA VALIDATION AND USABILITY

4.1 DATA REVIEW, VERIFICATION, AND VALIDATION

This section presents the responsibilities and procedures for reducing field and analytical data, validating analytical data, and reporting the results of field data collections and any confirmation sampling performed at the Site.

4.1.1 Data Review

Data review, at a minimum, will include an evaluation of the following:

- Laboratory QA methods (method blanks, lab control samples and duplicates, surrogate recoveries, matrix spikes and duplicates, etc.) to ensure they were performed as required and used to qualify the data appropriately.
- Evaluation of field QC measures (equipment blanks, trip blanks, field duplicate pair agreement, etc.) to ensure they were analyzed as required and assess whether additional data qualifiers are warranted.
- Verification that holding times were met.
- An assessment of any sample chain-of-custody, preservation and shipping issues.
- An assessment of whether the analytical reporting limits met the data quality objectives.
- An overall assessment of whether or not the data are usable for assessing system performance and progress towards the RAOs.

Each data summary document (i.e., boring logs, tables, and figures) will be checked for accuracy, calculation or transformation errors, and data completeness by a person other than the one who prepared the document and/or the ERM Project Manager. The field notebooks and COCs will be used to ensure that all samples collected were analyzed and reported.

4.1.2 Data Verification

Each laboratory and contractor is responsible for reporting the data generated to ERM. As Waterloo's contractor, ERM is responsible for reporting all data generated for the sampling activities to USEPA Region 7. ERM personnel will assess whether the data set met the project

requirements in terms of following the appropriate analytical methods, sample locations, and sampling procedures.

4.1.3 Data Validation

The laboratory will perform internal data validation by ensuring that the samples were analyzed in accordance with the analytical methods requested by ERM and by evaluating any QC outliers. The ERM QAO or designee(s) will be responsible for reviewing all sample collection procedures and laboratory reports to ensure that the field and laboratory QA/QC requirements established in this QAPP have been met. Full independent data validation of the laboratory data for soil and groundwater will not be performed unless any of the laboratory results are suspect. Laboratory results will be considered suspect if the results fall outside of the laboratory QA criteria and are not able to be reconciled by the laboratory or if the results deviate greater than 25% from expected historical ranges. The laboratory will provide Level II data packages containing all information required to allow full data validation, if necessary, in accordance with the requirements indicated in **Section 1.5**.

Field data will not be validated beyond the field checks done before collecting a measurement, because these data will be used in a relative, semi-quantitative sense.

4.2 VERIFICATION AND VALIDATION METHODS

4.2.1 Data Verification

The laboratory procedures for data verification are included in the laboratories QA Manuals in **Appendices A and B**.

The ERM QAO or designee(s) will evaluate the following issues after receipt of the laboratory data and will discuss any problems in the progress report, as indicated in **Section 4.4**:

- Deviations of the sample locations and number of samples in the RIP and the reasons for and effects of the deviations.
- Deviations from the sample collection procedures and the reasons for and effects of the deviations.
- If the samples were analyzed for the correct parameter(s) using the requested analytical method(s). If not, a discussion of the effects on the project objectives will be presented.

- If the field QC samples were collected as indicated in the respective RIP, and the potential effect of the deviations on the quality of the data.
- Deviations of the field instrument calibration procedures and frequency and their potential effects on the quality of the data.

Verification of the data provided by the laboratory and laboratory calibration procedures and frequency will be performed as part of the data validation process described in **Section 4.2.2**.

4.2.2 Data Validation

The laboratory will perform in-house analytical data validation under the direction of the laboratory QAO. The laboratory's validation will be limited to identifying and flagging the laboratory QC outliers in accordance with the specific analytical method used for the analysis. Depending on the analytical method, QC checks will include spiked addition recoveries, surrogate recoveries, laboratory duplicate percent relative differences, established quantitation limits, and any other QC check required or recommended by the analytical method used. The laboratory QAO will also check that proper calibration procedures were followed during the analyses and that data were properly reduced in accordance with the analytical methods used.

If problems that affect the data usability and require rejection of the data are identified as being related to the laboratory performance, the specific samples affected will be re-collected and validated. The USEPA Region 7 Project Manager will be notified if re-sampling is necessary.

4.3 RECONCILIATION WITH DATA QUALITY OBJECTIVES

Numeric DQOs were determined not to be appropriate for this project because the data have to meet the industrial screening levels or additional activities will be required (i.e., there is no "gray" line of compliance). Therefore, no additional data quality assessment is needed to demonstrate compliance with the DQOs.

The purpose of the data assessment steps described in the next subsections is to evaluate if the project-required QC objectives listed in **Section 1.3.2** have been met by the set of laboratory data that was generated. Data assessment to evaluate compliance with the DQIs will be

conducted by ERM's QAO or designee(s). The results will be reported as indicated in **Section 4.4**.

4.3.1 Field Measurement Data

Field data will be assessed through a review of the field results for compliance with the QC criteria specified in this QAPP. Daily instrument calibration and calibration checks will be used to assess the accuracy of the field measurements. Precision will be assessed on the basis of reproducibility by duplicate readings of a single sample or standard. Data completeness will be calculated based on the number of samples collected by using Equation 4-1:

$$\% \text{ Completeness} = \frac{\text{Valid Data Obtained}}{\text{Total Data Planned}} \times 100 \qquad \text{[Equation 4-1]}$$

If the QC objective in **Section 1.3.2.3** was not met, an explanation will be provided in the progress reports.

4.3.2 Laboratory Data

Laboratory results will be assessed for compliance with the required precision, accuracy, sensitivity, and completeness as described in the following subsections. The laboratory data packages will provide the relative percent difference (%RPD) and percent recovery (%R) information required for each analysis in accordance with the analytical methods performed and whether they were exceeded. The results will be evaluated as part of the data validation process described in **Section 4.2.2**.

4.3.2.1 Precision

The precision of laboratory analyses is assessed by comparing the analytical results of MS/MSDs and laboratory control sample and laboratory control sample duplicates (LCS/LCSDs) (depending on the analytical method) for organic analyses, and laboratory duplicate results for inorganic analyses. The relative percent difference (%RPD) will be calculated for each pair of duplicate and investigative sample analyses by using Equation 4-2.

$$\%\text{RPD} = \text{Absolute value of} \frac{S - D}{(S + D)/2} \times 100 \qquad \text{[Equation 4-2]}$$

Where:

S = First sample value (original or MS value), and

D = Second sample value (duplicate, MSD, or LCSD value).

The analytical results of field duplicates will be evaluated as part of the data validation process described in **Section 4.2.2**.

4.3.2.2 Accuracy

The accuracy of the laboratory results will be assessed for compliance with the established QC criteria described the corresponding analytical method by using the analytical results of method blanks, reagent/preparation blanks, and MS/MSD and LCS/LCSD samples. The percent recovery (%R) of MS, MSD, LCS, or LCSD samples will be calculated by using Equation 4-3.

$$\%R = \frac{A - B}{C} \times 100 \qquad \text{[Equation 4-3]}$$

Where:

A = Analyte concentration determined experimentally from the spiked sample,

B = Background level determined by a separate analysis of the unspiked sample, and

C = Amount of the spike added.

4.3.2.3 Completeness

The data completeness of laboratory analytical results will be assessed for compliance with the established QC limit. The completeness is calculated using Equation 4-1.

4.3.2.4 Sensitivity, Representativeness, and Comparability

The achievement of Reporting Limits depends on the instrument's sensitivity and sample matrix effects. Therefore, it is important to monitor the instrument's sensitivity to ensure the data quality through appropriate instrument performance. The instrument's sensitivity will be monitored through the analysis of method blanks, calibration check samples, and laboratory control samples.

Representativeness and comparability will be assessed through an evaluation of whether the data collection procedures followed the requirements of this QAPP.

4.4 DATA VALIDATION AND USABILITY REPORTING

The results of the evaluation performed in accordance with **Sections 4.2 and 4.3** will be summarized in a QA section in the progress reports submitted to USEPA Region 7 (see **Section 11.3 of the RIP**).

Tables

TABLE 1
ANALYTICAL METHOD DETAILS
FORMER WATERLOO INDUSTRIES FACILITY
WATERLOO, IOWA
(Page 1 of 2)

Analyte	MDL	MRL	Units	Surr. %R	DUP RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike %R	Blank Spike RPD	CAS #
Method 8260B Volatile Organic Compounds in Water - Nonpotable										
Benzene	0.11	0.50	µg/L	-	15	53-128	15	74-127	15	71-43-2
Carbon Tetrachloride	0.24	2.00	µg/L	-	32	40-131	32	71-131	20	56-23-5
1,2-Dibromo-3-chloropropane	0.50	5.00	µg/L	-	29	28-143	29	45-131	20	96-12-8
1,1-Dichloroethane	0.21	1.00	µg/L	-	17	56-135	17	71-135	15	75-34-3
cis-1,2-Dichloroethene	0.13	1.00	µg/L	-	16	57-130	16	72-130	15	156-59-2
Hexachlorobutadiene	0.20	5.00	µg/L	-	29	16-134	29	62-134	25	87-68-3
Naphthalene	0.37	5.00	µg/L	-	34	33-134	34	50-129	20	91-20-3
1,1,1,2-Tetrachloroethane	0.21	1.00	µg/L	-	16	56-117	16	72-117	15	630-20-6
1,1,2,2-Tetrachloroethane	0.10	1.00	µg/L	-	18	48-133	18	62-123	15	79-34-5
Tetrachloroethene	0.18	1.00	µg/L	-	20	33-138	20	68-138	20	127-18-4
Trichloroethene	0.19	1.00	µg/L	-	15	49-132	15	73-132	15	79-01-6
1,2,3-Trichloropropane	0.19	1.00	µg/L	-	21	47-135	21	66-124	20	96-18-4
1,2,4-Trimethylbenzene	0.20	1.00	µg/L	-	20	41-126	20	66-126	20	95-63-6
1,3,5-Trimethylbenzene	0.20	1.00	µg/L	-	35	41-128	35	69-128	35	108-67-8
Vinyl chloride	0.10	1.00	µg/L	-	20	67-139	20	67-139	20	75-01-4
Toluene-d8			Surrogate	77-117	-	77-117	-	77-117	-	2037-26-5
Dibromofluoromethane			Surrogate	79-119	-	79-119	-	79-119	-	1868-53-7
4-Bromofluorobenzene			Surrogate	82-122	-	82-122	-	82-122	-	460-00-4
GeoChemical Parameters in Water										
TOC	0.396	1.000	mg/L	-	20	75-125	20	90-110	-	7440-44-0
Iron, Total	0.066	0.100	mg/L	-	20	75-125	20	80-120	-	7439-89-6
Iron, Ferrous	0.066	0.100	mg/L	-	20	75-125	20	80-120	-	15438-31-0
Manganese	0.010	0.010	mg/L	-	20	75-125	20	80-120	-	7439-96-5
Sulfate	0.350	1.000	mg/L	-	15	80-120	15	90-110	-	14808-79-8
Chloride	0.317	1.000	mg/L	-	15	80-120	15	90-110	-	16887-00-6
Nitrite	0.054	0.100	mg/L	-	20	75-125	10	90-110	-	14797-65-0
Nitrate	0.0571	0.100	mg/L	-	20	75-125	20	90-110	-	14797-55-8
BioChemical Parameters in Water (Pace Analytical Microseeps Method AM20GAX)										
Acetylene	0.038	0.500	µg/L	-	20	70-130	-	-	-	74-86-2
Carbon Dioxide	0.27	5.000	mg/l	-	20	70-130	-	-	-	124-38-9
Ethane	0.004	0.100	µg/L	-	20	70-130	-	-	-	74-84-0
Ethene	0.005	0.100	µg/L	-	20	70-130	-	-	-	74-85-1
Hydrogen	0.088	0.600	nM	-	20	70-130	-	-	-	1333-74-0
Methane	0.037	0.500	µg/L	-	20	70-130	-	-	-	74-82-8
Nitrogen	0.203	2.000	mg/l	-	20	70-130	-	-	-	7727-37-9
Oxygen	0.097	0.500	mg/l	-	20	70-130	-	-	-	7782-44-7
Method TO-15 Volatile Organic Compounds in Soil Vapor / Air										
1,1,1-Trichloroethane	0.012	0.08	ppb (v/v)	-	25	-	-	70-130	25	71-55-6
1,1,2,2-Tetrachloroethane	0.024	0.08	ppb (v/v)	-	25	-	-	70-130	25	79-34-5
1,1,2-Trichloro-1,2,2-trifluoroethane	0.012	0.08	ppb (v/v)	-	25	-	-	70-130	25	76-13-1
1,1,2-Trichloroethane	0.021	0.08	ppb (v/v)	-	25	-	-	70-130	25	79-00-5
1,1-Dichloroethane	0.01	0.08	ppb (v/v)	-	25	-	-	70-130	25	75-34-3
1,1-Dichloroethene	0.014	0.08	ppb (v/v)	-	25	-	-	70-130	25	75-35-4
1,2,4-Trichlorobenzene	0.039	0.4	ppb (v/v)	-	25	-	-	60-140	25	120-82-1
1,2,4-Trimethylbenzene	0.025	0.08	ppb (v/v)	-	25	-	-	70-130	25	95-63-6
1,2-Dibromoethane (EDB)	0.018	0.08	ppb (v/v)	-	25	-	-	70-130	25	106-93-4
1,2-Dichloro-1,1,2,2-tetrafluoroethane	0.013	0.08	ppb (v/v)	-	25	-	-	60-140	25	76-14-2
1,2-Dichlorobenzene	0.028	0.08	ppb (v/v)	-	25	-	-	70-130	25	95-50-1
1,2-Dichloroethane	0.019	0.08	ppb (v/v)	-	25	-	-	70-130	25	107-06-2
1,2-Dichloropropane	0.021	0.08	ppb (v/v)	-	25	-	-	70-130	25	78-87-5
1,3,5-Trimethylbenzene	0.026	0.08	ppb (v/v)	-	25	-	-	70-130	25	108-67-8
1,3-Dichlorobenzene	0.026	0.08	ppb (v/v)	-	25	-	-	70-130	25	541-73-1
1,4-Dichlorobenzene	0.026	0.08	ppb (v/v)	-	25	-	-	70-130	25	106-46-7
1,4-Dioxane	0.032	0.2	ppb (v/v)	-	25	-	-	60-140	25	123-91-1
2-Butanone (MEK)	0.08	0.4	ppb (v/v)	-	25	-	-	60-140	25	78-93-3
4-Methyl-2-pentanone (MIBK)	0.018	0.2	ppb (v/v)	-	25	-	-	60-140	25	108-10-1
Acetone	0.54	2	ppb (v/v)	-	25	-	-	60-140	25	67-64-1
Benzene	0.023	0.08	ppb (v/v)	-	25	-	-	70-130	25	71-43-2
Benzyl chloride	0.031	0.16	ppb (v/v)	-	25	-	-	70-130	25	100-44-7
Bromodichloromethane	0.018	0.08	ppb (v/v)	-	25	-	-	70-130	25	75-27-4
Bromoform	0.019	0.1	ppb (v/v)	-	25	-	-	60-140	25	75-25-2
Bromomethane	0.013	0.08	ppb (v/v)	-	25	-	-	70-130	25	74-83-9
Carbon disulfide	0.012	0.2	ppb (v/v)	-	25	-	-	70-130	25	75-15-0
Carbon tetrachloride	0.015	0.08	ppb (v/v)	-	25	-	-	70-130	25	56-23-5
Chlorobenzene	0.02	0.08	ppb (v/v)	-	25	-	-	70-130	25	108-90-7
Chloroethane	0.014	0.08	ppb (v/v)	-	25	-	-	70-130	25	75-00-3
Chloroform	0.015	0.08	ppb (v/v)	-	25	-	-	70-130	25	67-66-3
Chloromethane	0.064	0.2	ppb (v/v)	-	25	-	-	60-140	25	74-87-3
cis-1,2-Dichloroethene	0.024	0.08	ppb (v/v)	-	25	-	-	70-130	25	156-59-2
cis-1,3-Dichloropropene	0.029	0.08	ppb (v/v)	-	25	-	-	70-130	25	10061-01-5
Cyclohexane	0.016	0.2	ppb (v/v)	-	25	-	-	70-130	25	110-82-7
Dibromochloromethane	0.017	0.08	ppb (v/v)	-	25	-	-	70-130	25	124-48-1
Dichlorodifluoromethane	0.027	0.08	ppb (v/v)	-	25	-	-	60-140	25	75-71-8
Ethylbenzene	0.027	0.08	ppb (v/v)	-	25	-	-	70-130	25	100-41-4
Hexachlorobutadiene	0.049	0.4	ppb (v/v)	-	25	-	-	60-140	25	87-68-3
Hexane	0.013	0.2	ppb (v/v)	-	25	-	-	70-130	25	110-54-3
Isopropyl alcohol	0.094	0.8	ppb (v/v)	-	25	-	-	60-140	25	67-63-0
Isopropylbenzene	0.024	0.16	ppb (v/v)	-	25	-	-	70-130	25	98-82-8
Methyl tert-butyl ether	0.068	0.4	ppb (v/v)	-	25	-	-	60-140	25	163-40-44
Methylene Chloride	0.13	0.2	ppb (v/v)	-	25	-	-	70-130	25	75-09-2
m-Xylene & p-Xylene	0.053	0.08	ppb (v/v)	-	25	-	-	70-130	25	179601-23-1
Naphthalene	0.04	0.2	ppb (v/v)	-	25	-	-	60-140	25	91-20-3
o-Xylene	0.024	0.08	ppb (v/v)	-	25	-	-	70-130	25	95-47-6

TABLE 1
ANALYTICAL METHOD DETAILS
FORMER WATERLOO INDUSTRIES FACILITY
WATERLOO, IOWA
(Page 2 of 2)

				Surr.	DUP	Matrix Spike		Blank Spike		
Analyte	**MDL**	**MRL**	**Units**	**%R**	**RPD**	**%R**	**RPD**	**%R**	**RPD**	**CAS #**
Styrene	0.023	0.08	ppb (v/v)	-	25	-	-	70-130	25	100-42-5
Tetrachloroethene	0.016	0.08	ppb (v/v)	-	25	-	-	70-130	25	127-18-4
Tetrahydrofuran	0.025	0.4	ppb (v/v)	-	25	-	-	60-140	25	109-99-9
Toluene	0.12	0.12	ppb (v/v)	-	25	-	-	70-130	25	108-88-3
trans-1,2-Dichloroethene	0.02	0.08	ppb (v/v)	-	25	-	-	70-130	25	156-60-5
trans-1,3-Dichloropropene	0.019	0.08	ppb (v/v)	-	25	-	-	70-130	25	10061-02-6
Trichloroethene	0.014	0.04	ppb (v/v)	-	25	-	-	70-130	25	79-01-6
Trichlorofluoromethane	0.0098	0.08	ppb (v/v)	-	25	-	-	60-140	25	75-69-4
Vinyl acetate	0.054	0.4	ppb (v/v)	-	25	-	-	60-140	25	108-05-4
Vinyl bromide	0.014	0.08	ppb (v/v)	-	25	-	-	60-140	25	593-60-2
Vinyl chloride	0.029	0.08	ppb (v/v)	-	25	-	-	70-130	25	75-01-4
4-Bromofluorobenzene			Surrogate	60-140	-	-	-	60-140	-	460-00-4
Method 8260B Volatile Organic Compounds in Soil										
Naphthalene	0.14	25.0	ug/kg dry wt	-	40	10-147	40	58-145	30	91-20-3
Tetrachloroethene	0.20	5.00	ug/kg dry wt	-	35	33-140	35	55-140	35	127-18-4
Dibromofluoromethane			Surrogate	73-113	-	73-113	-	73-113	-	1868-53-7
Toluene-d8			Surrogate	80-120	-	80-120	-	80-120	-	2037-26-5
4-Bromofluorobenzene			Surrogate	80-120	-	80-120	-	80-120	-	460-00-4

Key:

MDL = Method detection limit
MRL = Method reporting limit
mg/L = Milligrams per liter
ng/L = Nanograms per liter
µg/L = Micrograms per liter
% R = Percent recovery
DUP = Duplicate
RPD = Relative percent difference

TABLE 2
DATA QUALITY OBJECTIVES
FORMER WATERLOO INDUSTRIES FACILITY
WATERLOO, IOWA
(Page 1 of 1)

Step	*Description*
1 State the Problem	Monitor the performance of the selected remedy for the contaminants of concern identified for the site listed in **Table 1**. Previous sampling has indicated that VOCs are present in soil and groundwater onsite at concentrations above the RAOs established for the site. The planning team includes the Waterloo project manager, an ERM project manager, and an ERM risk assessor. The decision makers include the previous list of three people and the EPA Region 7 project manager and risk assessor. Routine (Q2 and Q4) groundwater and indoor/remediation system air sampling is proposed for performance monitoring. Confirmation soil sampling is proposed to be completed upon attainment of the groundwater RAOs. No other schedule applies.
2 Identify the Decision	The results of the sampling and analysis for VOCs described in this QAPP and companion Remedial Implementation Plan (RIP) will be compared to the RAOs.
3 Identify Inputs to the Decision	Previous and current site investigation results and information on subsurface conditions as described in RFI report and the RIP. Groundwater analytical methods will include VOCs (EPA method 8260B); pH (SM4500CI-E); TOC (SM 5310C); nitrate/nitrite (SM4500); iron (ferrous) (SM3500Fe-B); iron (total) and manganese (SW 846 Method 6010C or 6010); and chloride and sulfate (SW 846 Method 9056A). In addition, biochemical analysis using proprietary methods (Pace Analytical Microseeps Method AM20GAX) for dissolved gases (acetylene, carbon dioxide, ethane, ethene, hydrogen, methane, nitrogen and oxygen), will also be performed. Soil analytical methods will include VOCs by EPA Method 8260B. Soil vapor and air analytical methods will include VOCs by EPA Method TO-15. All VOC data will receive a Level 2 data validation to determine compliance with the required methods and the quality and acceptability of the reported data. Sampling results will be assessed against the DQIs requirements to determine if the analytical data are of sufficient quality allow decision making.
4 Define the Boundaries	The boundaries of the monitoring area are defined by the monitoring network described in **Section 5.0** of the RIP. Depending on the results, the monitoring network will be added to or decreased over time to complete the monitoring of the selected remedy.
5 Develop a Decision Rule	If the DQIs meet the requirements and the data validation determines that the analytical data are usable, the data will be compared to the RAOs. Otherwise, samples will be re-collected and re-evaluated. In accordance with the performance criteria listed in **Section 4.4** of the RIP, the evaluation will focus on verifying that natural attenuation is occurring, that the remedy is effectively reducing contaminant concentrations and mass, and controlling contaminant migration. Groundwater sampling results will be compared to the RAOs with trend analysis, geochemical, biochemical, and daughter products chemical data used to evaluate the natural attenuation processes as described in details in **Section 10.0** of the RIP. As described in **Section 13.0** of the RIP, at the completion of the remedial activities on site (once groundwater RAOs are achieved) soil sampling will be performed within AOC 5 to confirm On-Site Soil RAOs have been achieved.
6 Specify Limits on Decision Errors	Limits on the decision errors are not needed because the concentrations for each sample will be compared on a compound by compound basis to the action levels specified under Step 5.
7 Optimize the Design for Obtaining Data	The procedures followed to design the sampling plan are described in **Section 6.0** of the RIP. No random sampling will be performed.

Key:

DQI = Data Quality indicators
PACSRC = Precision, accuracy, completeness, sensitivity, representativeness, and comparability
QAPP = Quality Assurance Project Plan
VOCs = Volatile Organic Compounds
RAOs = Remedial Action Objectives
PMP = Performance Monitoring Plan
RFI = Resource Conservation and Recovery Act (RCRA) Facility Investigation

TABLE 3
MINIMUM DATA PACKAGE CONTENTS AND HIERARCHAL BOOKMARK STRUCTURE
FORMER WATERLOO INDUSTRIES FACILITY
WATERLOO, IOWA
(Page 1 of 1)

Group Bookmark	*Parent Bookmark*	*Child Bookmarks*
Front Matter		Cover Page, List of Samples and Analyses, Sample COCs, Sample Receipt Confirmation form, and SDG Narrative
VOA Analysis (EPA Method 8260B) of Groundwater and/or Soil	Sample Data	Samples in increasing alphanumeric Sample Number order (with supporting raw data)
	QC Summary	Surrogate recovery Summary
		Method Blank
		Laboratory Control Sample Summary
		Matrix Spike/Matrix Spike Duplicate Summary
		BFB data
		Internal Standard Area and RT Summary
	Standards Data	Initial Calibration Data
		CCV Data, including closing CCV
VOA Analysis (EPA Method TO-15) of Soil Vapor and/or Air	Data Summaries	Detection Summary
		Sample Results
		Surrogate Summary
		QC Sample Results
		QC Association
		Certification Summary
		Method Summary
	Organic Sample Raw Data	Method TO-15 Raw Data
		Standards Data (Initial Calibration and CCV Data)
		Raw QC Data
		Low Level Run Logs
		Air Canister Dilution
Inorganic Analysis: iron and manganese (SW846 Method 6010 or 6010C)	Sample Data	Samples in increasing alphanumeric Sample Number order (with supporting raw data)
	QC Summary	Method Blank
		Laboratory Control Sample Summary
		Matrix Spike/Matrix Spike Duplicate Summary
		Instrument run sequence
		Internal Standard Area
	Standards Data	Initial Calibration Data
		CCV/CCB Data, including closing CCV/CCB
Inorganic Analysis: pH (SM4500CI-E), TOC (SM5310C), Nitrate/Nitrite (SM4500), Ferrous Iron (SM 3500FE-D) and Sulfate, Chloride (EPA 9056A)	Sample Data	Samples in increasing alphanumeric Sample Number order (with supporting raw data)
	QC Summary	Method Blank
		Laboratory Control Sample Summary
		Matrix Spike/Matrix Spike Duplicate/Duplicate Summary
		Instrument run sequence, where available
		RT Summary (Anions)
	Standards Data	Initial Calibration Data
		CCV/CCB Data, except pH, including closing CCV/CCB
Supporting Documentation		Chain of Custody, Shipping Documentation, Sample Receipt Checklist

Key:

BFB = Bromofluorobenzene
CCV = ntinuing calibration verification
CCB = Continuing calibration blank
COCs = Chain-of-custody forms
GC/MS = romatograph/ mass spectrometer
QC = Quality Control
RT = Retention time
VOA = Volatile organic analyte

TABLE 4
SAMPLING AND ANALYSIS SUMMARY
FORMER WATERLOO INDUSTRIES FACILITY
WATERLOO, IOWA

Media	Sample Quantity	Frequency	QA/QC Sample Quantity [1]	QA/QC Requirements	Analysis	Container(s) [2]	Preservation	Holding Time [3]	RIP Section
Groundwater	24	Semi-Annual	4	One duplicate per 10 samples; One MS/MSD per 20 samples; One field blank per 20 samples; One equipment rinsate blank per 20 samples; One trip blank per cooler.	VOCs (EPA Method 8260B)	Three 40-mL glass vials	HCl and cool to <6°C	14 days	6.4
Groundwater	7	Annual	1	One duplicate per 10 samples	pH (SM4500CI-E)	One 100-ml glass or poly	cool to <6°C	Immediate	6.4
Groundwater	7	Annual	1	One duplicate per 10 samples	TOC (SM 5310C)	One 60-ml glass or poly	HCl and cool to <6°C	28 days	6.4
Groundwater	7	Annual	1	One duplicate per 10 samples	Nitrate, Nitrite (SM4500)	One 500-ml poly	cool to <6°C	48 hours	6.4
Groundwater	7	Annual	1	One duplicate per 10 samples	Iron (ferrous) (SM 3500Fe-B)	One 500-ml poly	cool to <6°C	not regulated	6.4
Groundwater	7	Annual	1	One duplicate per 10 samples	Iron (Total) and Manganese (SW 846 Method 6010C or 6010)	One 500-ml poly	HNO_3 and cool to <6°C	6 months	6.4
Groundwater	7	Annual	1	One duplicate per 10 samples	Sulfate, Chloride (EPA Method 9056A)	One 100-ml glass or poly	cool to <6°C	28 days	6.4
Groundwater	7	Annual	1	One duplicate per 10 samples	Methane, Ethane, Ethene, Acetylene, Carbon Dioxide, Oxygen, Nitrogen, Hydrogen (Pace Analytical Microseeps AM20GAX)	Two 40-mL glass vials	TSP and cool to <6°C	14 days	6.4
Soil Vapor / Indoor and Ambient Air	4	Semi-Annual (See RIP Section 8.1 for DPVE startup sampling frequency)	1	One duplicate per 10 samples	VOCs (EPA Method TO-15 SIM)	1- lliter Summa Canister for soil vapor, 6-liter Summa canister for indoor air and ambient air	NA	30 days	6.4
DPVE System Effluent	2	See RIP Section 8.1 for DPVE startup sampling frequency	1	One duplicate per 10 samples	VOCs (EPA Method TO-15 SIM)	1-liter Summa canister	NA	30 days	6.4
Soil	4	Soil sample collection upon remedial action completion	1	One duplicate per 10 samples; One MS/MSD per 20 samples; One field blank per 20 samples; One equipment rinsate blank per 20 samples; One trip blank per cooler.	VOCs (EPA Method 8260B)	Laboratory supplied 5035 kit	Methanol and cool to <6°C	14 days	6.4

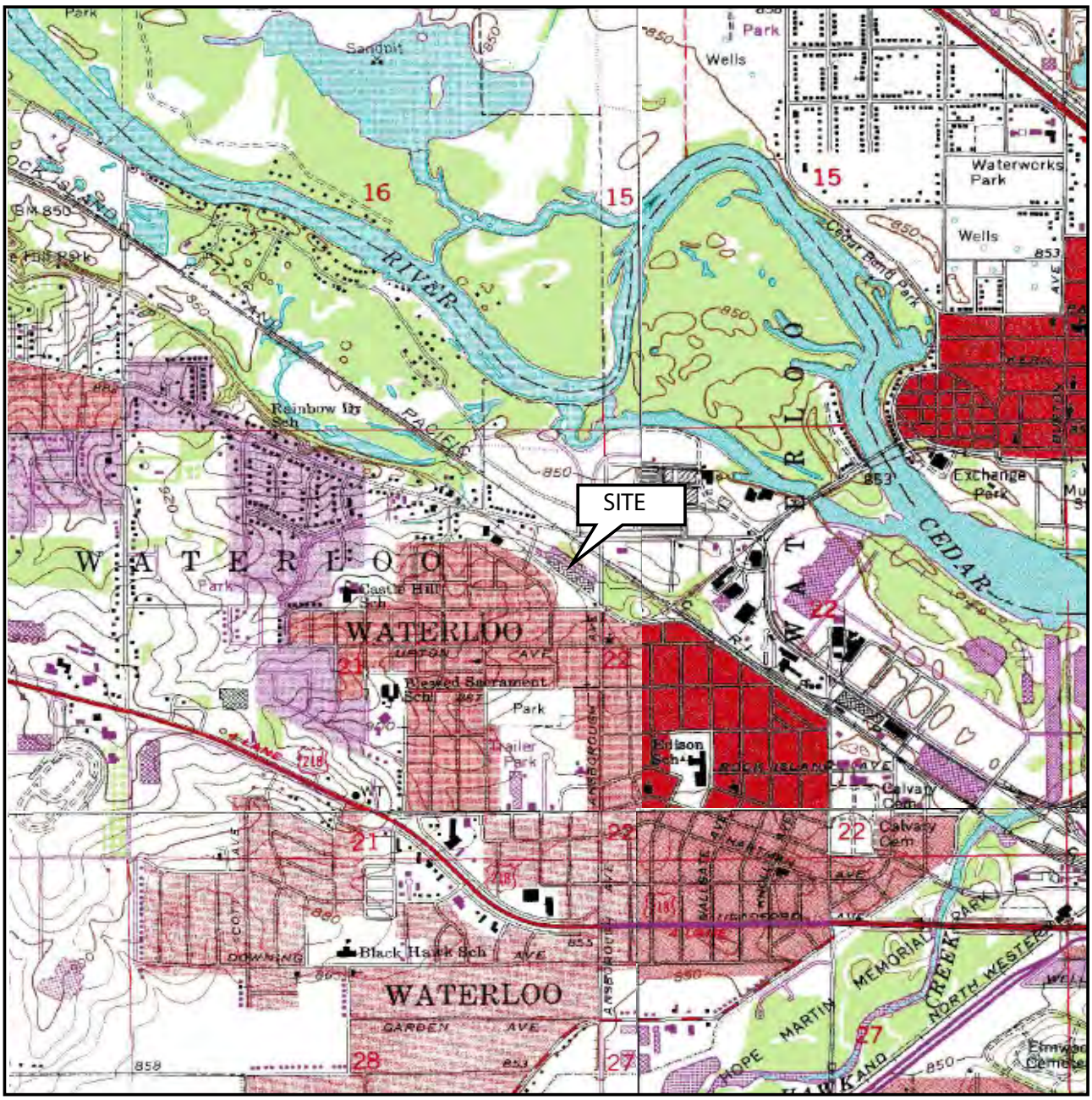
Key:

EPA = Environmental Protection Agency
MS/MSD = Matrix Spike/ Matrix Spike Duplicate
QA/QC = Quality assurance/quality control
VOC = Volatile organic compound

[1] QA/QC sample quantities include all samples listed under QA/QC requirements less equipment blank and trip blank.
[2] Triple the groundwater volume will be collected for samples designated for MS/MSD analysis.
[3] Holding times are from the day of sample collection.

Figures

Source: Cedar Falls, Iowa (1980) United States Geol ogical Survey 7.5 Minute Quadrangle

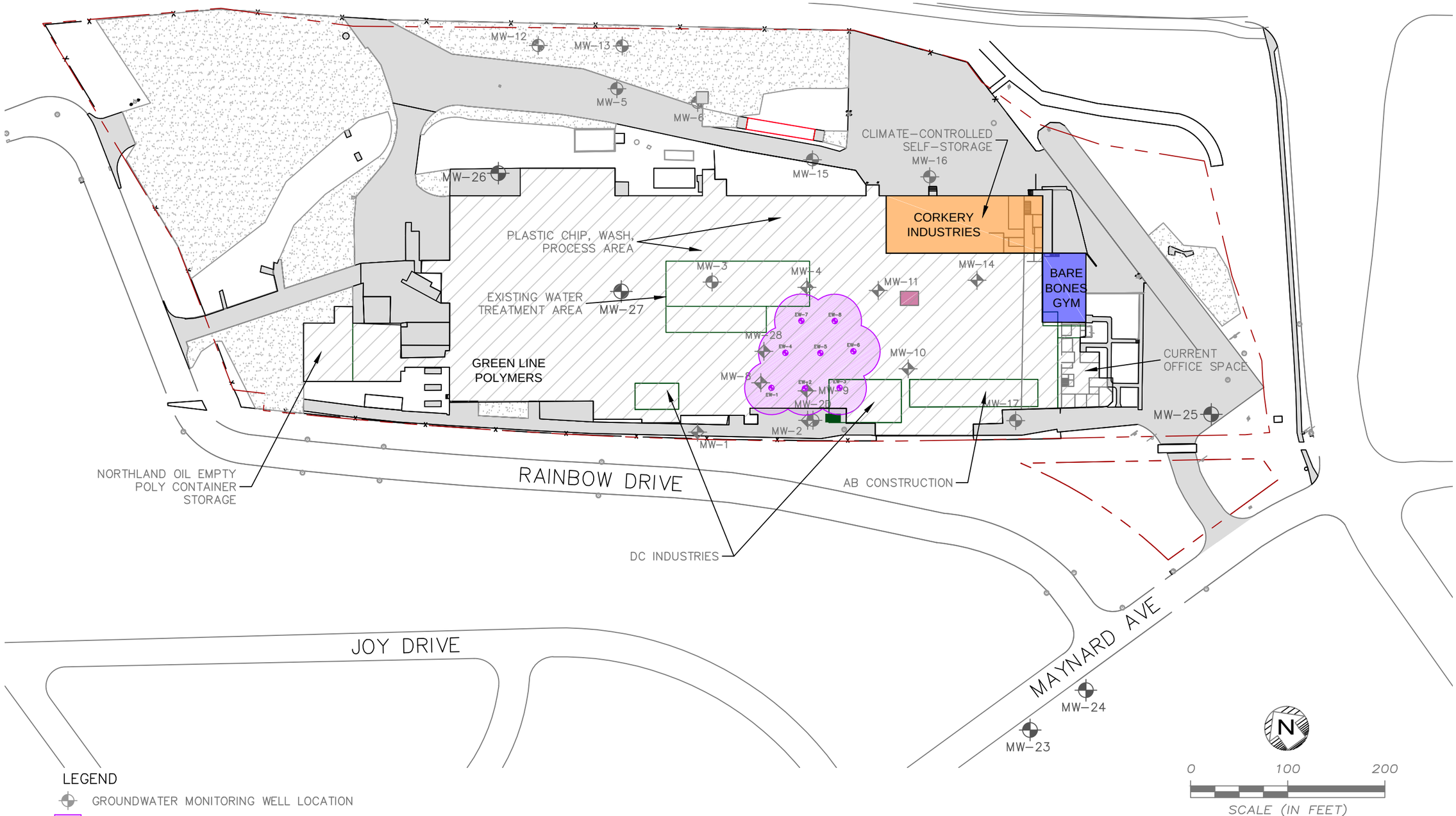


QUADRANGLE LOCATION

FIGURE 1
SITE LOCATION MAP
FORMER WATERLOO INDUSTRIES FACILITY
300 ANSBOROUGH AVE
WATERLOO, IOWA

ERM

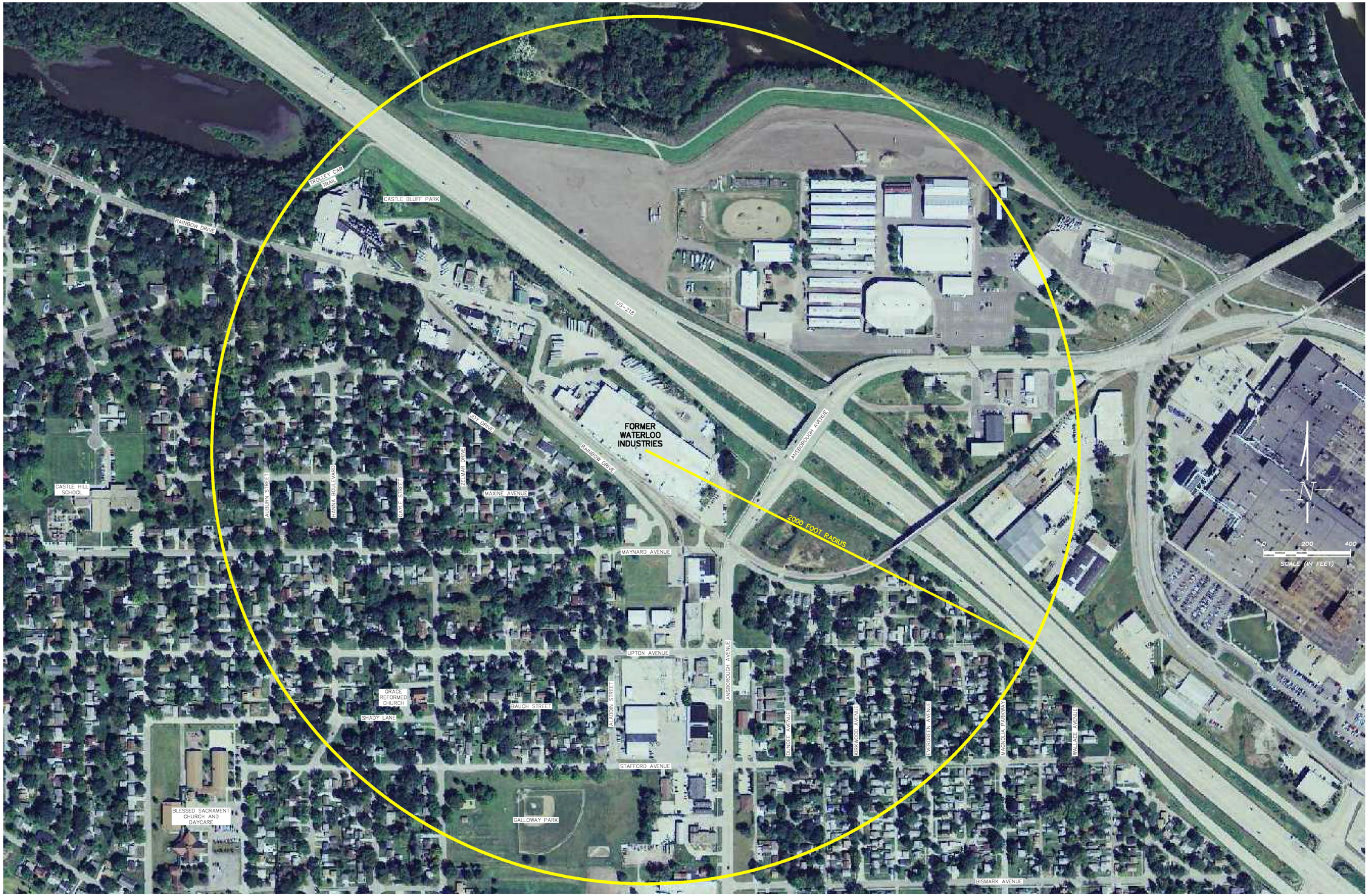
SITE LAYOUT



LEGEND

- GROUNDWATER MONITORING WELL LOCATION
- PROPOSED DPVE TREATMENT AREA
- PROPOSED TREATMENT BUILDING
- PROPOSED DUAL-PHASE EXTRACTION WELL (WITH APPROXIMATELY 25' RADIUS OF INFLUENCE)
- PROPOSED SUB-SLAB DEPRESSURIZATION TREATMENT AREA

Drawn By RMK-GML-ABF	ERM®	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE Waterloo, Iowa	CHK'D BK-Mil
CADD Review JF			0339767
Date Drawn/Rev'd 10/27/2016		Environmental Resources Management	FIGURE 2



Rev.	Date	Description	By	Chk

DRAWN BY RMK | CADD Review FGB | CHECKED BY BK-MIL

Environmental Resources Management

ERM®

FORMER WATERLOO INDUSTRIES FACILITY

300 ANSBOROUGH AVENUE
WATERLOO, IOWA

SITE AND SURROUNDING AREA OVERVIEW

SCALE	PROJECT NUMBER	SHEET	REV.
AS NOTED	0140077	FIGURE 3	
DATE 02/24/2012			

R:\Cadd\CintQ-T\Stinson Morrison Hecker LLC\0140077\0140077-03.dwg, FIG 2-1, 2/24/2012 2:43:55 PM, RMK - HOLLAND

REVISIONS TO BE MADE ON THE CADD FILE ONLY

Appendix A

TestAmerica Quality Systems Manual

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Quality Assurance Manual
Cover Page

TestAmerica Cedar Falls
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Cedar Falls, IA 50613
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Quality Assurance Manual
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SECTION 2. TABLE OF CONTENTS

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2.0	TABLE OF CONTENTS	V1M2 Secs. 4.2.8.3-4.2.8.4		5	3/11/2016	3
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3.1	Introduction And Compliance References	V1M2 Secs. 1.1; 1.2; 2.0; 3.2; 4.1.2; 4.2.4	4.1.2; 4.2.4			12
3.2	Terms And Definitions	V1M2 Secs. 3.0; 4.2.4	4.2.4			12
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REFERENCED CORPORATE SOPs AND POLICIES

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CA-I-P-002	Electronic Reporting and Signature Policy
CA-L-P-002	Contract Compliance Policy
CA-L-S-002	Subcontracting Procedures
CA-Q-M-002	Corporate Quality Management Plan
CA-Q-P-003	Calibration Curves & Selection of Calibration Points
CA-Q-S-001	Solvent and Acid Lot Testing and Approval
CA-Q-S-002	Acceptable Manual Integration Practices
CA-Q-S-006	Detection Limits
CA-Q-S-009	Root Cause Analysis
CA-T-P-001	Qualified Products List
CW-E-M-001	Environmental Health and Safety Manual
CW-F-P-002	Company-Wide Authorization Matrix
CW-F-P-004	Procurement and Contracts Policy
CW-F-S-007	Capital Expenditure, Controlled Purchase Requests, and Fixed Asset Capitalization
CW-L-P-004	Ethics Policy
CW-L-S-002	Internal Investigation of Potential Data Discrepancies and Determination for Data Recall
CW-Q-S-001	Corporate Document Control and Archiving
CW-Q-S-002	Writing a Standard Operating Procedure (SOP)
CW-Q-S-003	Internal Auditing
CW-Q-S-004	Management Systems Review

REFERENCED LABORATORY SOPs AND POLICIES

Doc. Reference	Title
CF-FSS-01	Sampling Procedures
CF-GP-01	Analytical Balance Operation
CF-GP-04	Data Review for Metals
CF-GP-05	Data Review for Wet Chemistry Parameters
CF-GP-06	Data Review for Organic Parameters
CF-GP-07	Thermometer Operation and Calibration
CF-GP-13	Pipette Calibration Verification Procedures
CF-GP-20	Permit and Action Limit Exceedance Procedures
CF-GP-21	Project and Contract Review Procedures for Meeting Regulatory, Accreditation, and Client Requirements
CF-GP-22	Investigating a Performance Test Failure
CF-GP-23	Laboratory Personnel Training
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CF-IH-13	Estimating Measurement Uncertainty for Industrial Hygiene and Environmental Analyses
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CF-SRV-01	Customer Service and Login Procedures
CF-SS-02	Standards Preparation, Documentation, and Tracking
CF-SS-03	Reagents Preparation, Documentation, and Tracking
CF-WD-01	Waste Disposal

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SECTION 3. INTRODUCTION, SCOPE AND APPLICABILITY

3.1 Introduction and Compliance References

TestAmerica Cedar Falls' Quality Assurance Manual (QAM) is a document prepared to define the overall policies, organization objectives and functional responsibilities for achieving TestAmerica's data quality goals. The laboratory maintains a local perspective in its scope of services and client relations and maintains a national perspective in terms of quality.

The QAM has been prepared to assure compliance with The NELAC Institute (TNI) Standard, dated 2009, Volume 1 Modules 2 and 4, and ISO/IEC Guide 17025:2005(E). In addition, the policies and procedures outlined in this manual are compliant with TestAmerica's Corporate Quality Management Plan (CQMP; Document No. CA-Q-M-002) and the various accreditation and certification programs listed in Appendix 3. The CQMP provides a summary of TestAmerica's quality and data integrity system. It contains requirements and general guidelines under which all TestAmerica facilities shall conduct their operations.

The QAM has been prepared to be consistent with the requirements of the following documents:

- EPA 600/4-88/039, *Methods for the Determination of Organic Compounds in Drinking Water,* US EPA, Revised July 1991.
- EPA 600/R-95/131, *Methods for the Determination of Organic Compounds in Drinking Water,* Supplement III, US EPA, August 1995.
- EPA 600/4-79-019, *Handbook for Analytical Quality Control in Water and Wastewater Laboratories,* US EPA, March 1979.
- *Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW-846),* Third Edition, US EPA, September 1986; and as amended by Final Update I, July 1992; Final Update IIA, August 1993; Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996; Final Update IIIA, April 1998; Final Update IIIB, November 2004; and Final Update IV, February 2007.
- Federal Register, 40 CFR Parts 136, 141, 172, 173, 178, 179 and 261.
- EPA 815/R-05/004, *Manual for the Certification of Laboratories Analyzing Drinking Water*, US EPA, January 2005.
- *Statement of Work for Inorganics & Organics Analysis,* SOM and ISM, current versions, US EPA Contract Laboratory Program Multi-media, Multi-concentration.
- *Standard Methods for the Examination of Water and Wastewater*, APHA, 18th, 19th, 20th, 21st, 22nd, and on-line Editions.
- Toxic Substances Control Act (TSCA).

3.2 Terms and Definitions

A Quality Assurance Program is a company-wide system designed to ensure that data produced by the laboratory conforms to the standards set by state and/or federal regulations. The program functions at the management level through company goals and management policies, and at the analytical level through Standard Operating Procedures (SOPs) and quality control. The TestAmerica program is designed to minimize systematic error, encourage constructive, documented problem solving, and provide a framework for continuous improvement within the organization.

Refer to Appendix 2 for the Glossary/Acronyms.

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3.3 Scope / Fields of Testing

The laboratory analyzes a broad range of environmental and industrial samples every month. Sample matrices vary among air, drinking water, influent/effluent water, groundwater, hazardous waste, sludge, and soil. The Quality Assurance Program contains specific procedures and methods to test samples of differing matrices for chemical, physical, and biological parameters. The Program also contains guidelines on maintaining documentation of analytical processes, reviewing results, servicing clients and tracking samples through the laboratory. The technical and service requirements of all analytical requests are thoroughly evaluated before commitments are made to accept the work. Measurements are made using published reference methods or methods developed and validated by the laboratory.

The methods covered by this manual include the most frequently requested methodologies needed to provide analytical services in the United States and its territories. The specific list of test methods used by the laboratory can be found on the company's website (www.testamericainc.com). The approach of this manual is to define the minimum level of quality assurance and quality control necessary to meet these requirements. All methods performed by the laboratory shall meet these criteria as appropriate. In some instances, quality assurance project plans (QAPPs), project-specific data quality objectives (DQOs), or local regulations may require criteria other than those contained in this manual. In these cases, the laboratory will abide by the requested criteria following review and acceptance of the requirements by the Laboratory Director, the Technical Manager(s), and the Quality Assurance (QA) Manager. In some cases, QAPPs and DQOs may specify less stringent requirements. Laboratory management must determine if it is in the lab's best interest to follow the less stringent requirements.

3.4 Management of the Manual

3.4.1 Review Process

The template on which this manual is based is reviewed annually by Corporate Quality Management Personnel to assure that it remains in compliance with Section 3.1. This manual itself is reviewed every two years by senior laboratory management to assure that it reflects current practices and meets the requirements of the laboratory's clients and regulators as well as the CQMP. Occasionally, the manual may need interim changes in order to meet new or changing regulations and operations. The QA Manager will review the changes in the normal course of business and incorporate changes into revised sections of the document. All updates will be reviewed by the senior laboratory management staff. The laboratory updates and approves such changes according to its Document Control & Updating procedures (refer to SOP No. CF-QA-06).

This manual has been assigned the unique document number CF-QA-01. The overall effective date and revision number of this manual is indicated on the Cover Page and left-hand header of subsequent pages. Each section of this manual also has an effective date and revision number, indicated in the right-hand header of each page. When the manual is published, each section shares the same overall effective date and revision number (i.e., if the manual has an overall revision number of 4, the initial revision number of each section is 4.0). If interim changes to the manual occur, the effective date of each applicable section will be updated, and the section revision number will increase incrementally. Section 2 (Table of Contents) of this manual contains the latest effective dates and revision numbers for each section.

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SECTION 4. MANAGEMENT REQUIREMENTS

4.1 Overview

TestAmerica Cedar Falls is a local operating unit of TestAmerica Laboratories, Inc. The organizational structure, responsibilities and authorities of the corporate staff of TestAmerica Laboratories, Inc. are presented in the CQMP. The Cedar Falls laboratory has day-to-day independent operational authority overseen by corporate officers (e.g., Chief Executive Officer (CEO), Executive Vice President (VP) Operations, Corporate Quality, etc.). The laboratory operational and support staff work under the direction of the Laboratory Director. The organizational structure for both Corporate & TestAmerica Cedar Falls is presented in Figure 4-1.

4.2 Roles and Responsibilities

In order for the Quality Assurance Program to function properly, all members of the staff must clearly understand and meet their individual responsibilities as they relate to the quality program. The following descriptions briefly define each role in its relationship to the Quality Assurance Program.

4.2.1 Additional Requirements for Laboratories

The responsibility for quality resides with every employee of the laboratory. All employees have access to the QAM, are trained to this manual, and are responsible for upholding the standards therein. Each person carries out his/her daily tasks in a manner consistent with the goals and in accordance with the procedures in this manual and the laboratory's SOPs. Role descriptions for Corporate personnel are defined in the CQMP. This manual is specific to the operations of the TestAmerica Cedar Falls laboratory.

4.2.2 Vice President of Operations

Each VP of Operations reports directly to the Executive VP of Operations and is a part of the Executive Committee. Each VP of Operations is responsible for the overall administrative and operational management of their respective laboratories. The VP's responsibilities include allocation of personnel and resources, long-term planning, goal setting, and achieving the financial, business, and quality objectives of TestAmerica. The VP's ensure timely compliance with Corporate Management directives, policies, and management systems reviews. The VP's are also responsible for restricting any laboratory from performing analyses that cannot be consistently and successfully performed to meet the standards set forth in this manual.

4.2.3 Laboratory Director (LD) or Designee

The Laboratory Director is responsible for the overall quality, safety, financial, technical, human resource, and service performance of the whole laboratory and reports to his/her respective Vice President (VP) Operations. The Laboratory Director provides the resources necessary to implement and maintain an effective and comprehensive Quality Assurance and Data Integrity Program. Specific responsibilities include, but are not limited to:

- Provides one or more Technical Manager for the appropriate fields of testing. The names of the Technical Managers will be included in the national database. If the Technical Manager is absent for a period of time exceeding 15 consecutive calendar days, the LD must designate another full-time staff member meeting the qualifications of the Technical Manager to temporarily perform this

function. If the absence exceeds 35 consecutive calendar days, the primary accrediting authority must be notified in writing.

- Ensures that all analysts and supervisors have the appropriate education and training to properly carry out the duties assigned to them and ensures that this training has been documented.
- Ensures that personnel are free from any commercial, financial, and other undue pressures which might adversely affect the quality of their work.
- Ensures that TestAmerica's human resource policies are adhered to and maintained.
- Ensures that sufficient numbers of qualified personnel are employed to supervise and perform the work of the laboratory.
- Ensures that appropriate corrective actions are taken to address situations identified as requiring such actions by internal and external performance for procedural audits. Procedures that do not meet the standards set forth in this QAM or laboratory SOPs may be temporarily suspended by the Laboratory Director.
- Reviews and approves all SOPs prior to their implementation and ensures all approved SOPs are implemented and adhered to.
- Pursues and maintains appropriate laboratory certification and contract approvals. Supports ISO 17025 requirements.
- Ensures client-specific reporting and quality control requirements are met.
- Captains the management team, consisting of the QA Manager and Technical Managers as direct reports.

4.2.4 Quality Assurance (QA) Manager or Designee/Quality Assurance Assistant (QAA)

The QA Manager has responsibility and authority to ensure the continuous implementation of the quality system.

The QA Manager reports directly to the Laboratory Director. This position is able to evaluate data objectively and perform assessments without outside (e.g., managerial) influence. Corporate QA may be used as a resource in dealing with regulatory requirements, certifications, and other quality assurance related items. The QA Manager directs the activities of the QA staff to accomplish specific responsibilities, which include, but are not limited to:

- Serves as the focal point for QA/QC in the laboratory.
- Having functions independent from laboratory operations for which they have quality assurance oversight.
- Maintaining and updating the QAM.
- Monitoring and evaluating laboratory certifications; scheduling proficiency testing samples.
- Monitoring and communicating regulatory changes that may affect the laboratory to management.
- Training and advising the laboratory staff on quality assurance/quality control procedures that are pertinent to their daily activities.
- Have documented training and/or experience in QA/QC procedures and the laboratory's Quality System.
- Having a general knowledge of the analytical test methods for which data audit/review is performed (and/or having the means of getting this information when needed).

- Arranging for or conducting internal audits on quality systems and the technical operation.
- The laboratory QA Manager will maintain records of all ethics-related training, including the type and proof of attendance.
- Maintain, improve, and evaluate the corrective action database and the corrective and preventive action systems.
- Notifying laboratory management of deficiencies in the quality system and ensuring corrective action is taken. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs shall be investigated following procedures outlined in Section 12 and if deemed necessary may be temporarily suspended during the investigation.
- Objectively monitor standards of performance in quality control and quality assurance without outside influence.
- Coordination of document control of SOPs, MDLs, control limits, and miscellaneous forms and information.
- Review a percentage of all final data reports for internal consistency. Review of Chain of Custody (COC), correspondence with the analytical request, batch QC status, completeness of any corrective action statements, 5% of calculations, format, holding time, sensibility and completeness of the project file contents.
- Review of external audit reports and data validation requests.
- Follow-up with audits to ensure client QAPP requirements are met.
- Establishment of reporting schedule and preparation of various quality reports for the Laboratory Director, clients and/or Corporate QA.
- Development of suggestions and recommendations to improve quality systems.
- Research of current state and federal requirements and guidelines.
- Captains the QA team to enable communication and to distribute duties and responsibilities.
- Ensuring communication & monitoring standards of performance to ensure that systems are in place to produce the level of quality as defined in this document.
- Evaluation of the thoroughness and effectiveness of training.
- Ensuring the quality system is in compliance with TNI, ISO 17025, and state-specific standards, and AIHA-LAP policies (where applicable).

4.2.5 Technical Manager or Designee

Technical Managers (also known as Operations Managers) report directly to the Laboratory Director. They are accountable for all analyses and analysts under their experienced supervision and for compliance with the TNI Standard, ISO 17025 Standard, state- or client-specific requirements, and AIHA-LAP policies (where applicable). The scope of responsibility ranges from the new-hire process and existing technology through the ongoing training and development programs for existing analysts and new instrumentation. Specific responsibilities include, but are not limited to:

- Exercises day-to-day supervision of laboratory operations for the appropriate field of accreditation and reporting of results. Assists the QA Manager with coordinating, writing, and reviewing preparation of all test methods, i.e., SOPs, with regard to quality, integrity, regulatory and optimum and efficient production techniques, and subsequent analyst training and interpretation of the SOPs

for implementation and unusual project samples. They insure that the SOPs are properly managed and adhered to at the bench.

- Reviewing and approving, with input from the QA Manager, proposals from marketing, in accordance with an established procedure for the review of requests and contracts. This procedure addresses the adequate definition of methods to be used for analysis and any limitations, the laboratory's capability and resources, the client's expectations. Differences are resolved before the contract is signed and work begins. A system documenting any significant changes is maintained, as well as pertinent discussions with the client regarding their requirements or the results of the analyses during the performance of the contract. All work subcontracted by the laboratory must be approved by the client. Any deviations from the contract must be disclosed to the client. Once the work has begun, any amendments to the contract must be discussed with the client and so documented.
- Monitoring the validity of the analyses performed and data generated in the laboratory. This activity begins with reviewing and supporting all new business contracts, insuring data quality, analyzing internal and external non-conformances to identify root cause issues and implementing the resulting corrective and preventive actions, facilitating the data review process (training, development, and accountability at the bench), and providing technical and troubleshooting expertise on routine and unusual or complex problems.
- Providing training and development programs to applicable laboratory staff as new hires and, subsequently, on a scheduled basis. Training includes instruction on calculations, instrumentation management to include troubleshooting and preventive maintenance.
- Enhancing efficiency and improving quality through technical advances and improved LIMS utilization. Capital forecasting and instrument life cycle planning for second generation methods and instruments as well as asset inventory management.
- Coordinating sample management from "cradle to grave," insuring that no time is lost in locating samples.
- Scheduling all QA/QC-related requirements for compliance, e.g., MDLs, etc.
- Captains department personnel to communicate quality, technical, personnel, and instrumental issues for a consistent team approach.
- Coordinates audit responses with the Department Manager and the QA Manager. Evaluates the level of internal/external non-conformances for all departments.
- Continually evaluates production capacity and improves capacity utilization.
- Continually evaluates turnaround time and addresses any problems that may hinder meeting the required and committed turnaround time from the various departments.
- Ensures that preventative maintenance is performed on instrumentation as detailed in the QAM or laboratory SOPs. Responsible for developing and implementing a system for preventative maintenance, troubleshooting, and repairing of instruments, or arranging for the repair of instruments.
- Maintains an adequate and valid inventory of reagents, standards, spare parts, and other relevant resources required to perform daily analysis. Responsible for efficient utilization of supplies and consumables.
- Conduct efficiency and cost control evaluations on an ongoing basis to determine optimization of labor, supplies, overtime, first-run yield, capacity (designed vs. demonstrated), second- and third-generation production techniques/instruments, and long-term needs for budgetary planning.

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- Develop, implement, and enhance calibration and calibration review programs.

4.2.6 Department Manager

The Department Managers work within a department to organize samples after login and distribute them, in the portions needed, to the applicable department. They report directly to the Technical Manager or his/her department. They are knowledgeable about sample preservation and holding time requirements, as well as volume or mass of sample needed for each method. The goal is to deliver the sample or aliquot to the bench as quickly as possible, while complying with all considerations. Specific responsibilities include, but are not limited to:

- Ensures that analysts in his/her department adhere to applicable SOPs and the QAM. They perform frequent SOP and QAM reviews to determine if analysts are in compliance and if new, modified, or optimized measures are feasible and should be added to these documents.
- With regard to analysts, participates in the selection, training, development of objectives and standards of performance, appraisal, scheduling, counseling, and motivation of analysts, and documents these activities in accordance with the systems developed by the QA and HR departments. They evaluate staffing sufficiency and overtime needs.
- Encourage the development of analysts to become cross-trained in various methods and/or operate multiple instruments efficiently while performing maintenance and documentation, self-supervision, and function and a department team.
- Provide guidance to analysts in resolving problems encountered daily during sample preparation and analysis in conjunction with the Technical Manager and/or QA Manager.
- Ensures all logbooks are maintained, current, and properly labeled or archived.
- Reports non-conformance conditions to the Technical Manager, QA Manager, and/or Laboratory Director, as appropriate.

4.2.7 Manager of Project Management (MPM)

The MPM directly reports to the Client Services Director within the Client Services Organization (CSO), and has a dotted line relationship with the Laboratory Director and senior laboratory management. The MPM is accountable for coordinating and managing clients' projects through all phases of laboratory operations. They also supervise the activities of the Project Managers and Project Management Assistants. Specific responsibilities include, but are not limited to, those listed below for Project Manager/Project Management Assistant.

4.2.8 Project Manager (PM) / Project Management Assistant (PMA)

The Project Managers and Project Manager Assistants report to the Manager of Project Management. They are accountable for coordinating and managing client' projects through all phases of laboratory operations, including project setup and maintenance, login review, communication of analytical issues, client account maintenance, reporting, invoicing, bottle orders, client pickups, and identification of workshare facilities. The PM and PMA roles foster and develop client relationships in support of the CSO mission. Specific responsibilities include, but are not limited to:

- Ensures that clients receive the proper sampling supplies, media shipment, and/or equipment rental.
- Ensures that client specifications, when known, are met by communicating project and quality assurance requirements to the laboratory.

- Notifies the Operations Managers and Department Managers of incoming projects and sample delivery schedules.
- Sets up and maintains client projects in LIMS, including reviewing project documentation (permits, QAPPs, etc.), managing purchase orders/contracts, verifying correctness and completeness of method/compound lists, and communicating projects details to operations.
- Has knowledge and familiarity with state and national program requirements, as well as any specific accreditation requirements as they pertain to work mix.
- Assists with quotes and proposals, including project QAPP review with operations and QA, determining lab placement of work (workshare/subcontract), confirming that lab certification(s) meets project requirements, and reviewing client contract requirements.
- Coordinates work that is workshared to other TestAmerica facilities, or work that is subcontracted to laboratories outside the TestAmerica network.
- Communicates any issues to clients for duration of project, including anomalies with sample receipt, chain of custody (COC), and sample analysis. Provide response to client inquiries concerning sample status.
- Monitor the status of all data package projects in-house to ensure timely and accurate delivery. Generates and sends final data packages to clients (report/EDD/invoice), taking into account client-specific requirements, investigating any data anomalies, and communicating all data quality issues.
- Submits client complaints/issues to lab management, and participates in correction action / follow up as needed.

4.2.9 Environmental Health and Safety Coordinator (EHSC)

The duties of the EHSC may be combined with another position in the lab. The EHSC ensures that systems are maintained for the safe operation of the laboratory. Specific responsibilities include, but are not limited to:

- Conduct ongoing necessary safety training and conduct new employee safety orientation.
- Assist in developing and maintaining the Chemical Hygiene Plan/Safety Manual.
- Administer dispersal of Safety Data Sheet (SDS) information.
- Perform regular chemical hygiene and housekeeping instruction; provide personnel training on proper labeling practices and use of personnel protective equipment.
- Serve as chairperson of the laboratory safety committee.
- Oversee the inspection and maintenance of general safety equipment (e.g., fire extinguishers, safety showers, eyewash fountains, etc…) and ensure prompt repairs as needed.
- Measure and record ventilation hood velocities according to the laboratory's schedule and procedures. Follow-up and/or schedule corrective action if fume hoods do not meet laboratory criteria.
- Schedule and supervise fire drills and emergency evacuation drills.
- Determine potential employee exposure to chemicals used in the laboratory. When necessary, conducts initial and subsequent exposure monitoring assessments.
- Determine when a complaint of possible over-exposure is "reasonable" and should be referred for medical consultation.

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- Assist in the internal and external coordination of the medical consultation/monitoring program conducted by TestAmerica's medical consultants.

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4.2.10 Hazardous Waste Coordinator

The duties of the Hazardous Waste Coordinator may be combined with another position in the lab. The Hazardous Waste Coordinator ensures that waste disposal systems and processes are maintained to ensure compliance with all local, state, and federal hazardous waste regulations. Specific responsibilities include, but are not limited to:

- Staying current in knowledge of hazardous waste regulations.
- Maintaining continued training on hazardous waste issues.
- Reviewing and updating annually the Hazardous Waste Contingency Plan in the Environmental Health & Safety Manual (EHSM).
- Auditing staff with regard to compliance with the Hazardous Waste Contingency Plan.
- Contacting the hazardous waste subcontractors for review of procedures and opportunities for minimization of waste.
- Managing waste generated by the facility and organizing waste streams for pickup by a licensed hazardous waste management contractor.

4.2.11 Analysts

Laboratory Analysts are responsible for conducting analysis and performing all tasks assigned to them by the group leader or supervisor. Responsibilities of the analyst include, but are not limited to:

- Performing analyses by adhering to analytical and quality control protocols prescribed by current SOPs, this QAM, and project-specific plans in an honest, accurate, timely, safe, and cost-effective manner.
- Documenting standard and sample preparation; instrument calibration and maintenance; data calculations; sample matrix effects; and any observed non-conformance on worklists, benchsheets, lab notebooks, and/or LIMS.
- Reporting all non-conformance situations, instrument problems, matrix problems, and QC failures which might affect the reliability of the data to their supervisor, the Technical Manager, and or the QA Manager or other member of QA staff.
- Performing 100% primary review of the data generated prior to entering and submitting for secondary level review.
- Suggesting method improvements to their supervisor, the Technical Manager, and/or the QA Manager. These improvements, if approved, will be incorporated. Ideas for the optimum performance of their assigned area (for example, through the proper cleaning and maintenance of instruments and equipment) are encouraged.
- Working cohesively as a team in their department to achieve the goals of accurate results, optimum turnaround time, cost effectiveness, cleanliness, complete documentation, and personal knowledge of environmental analysis.

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4.3 Deputies

The following table defines who assumes the responsibilities of key personnel in their extended absence:

Key Personnel	Deputy
Laboratory Director	1. Corporate Business Controller
QA Manager	1. Laboratory Director 2. QA Assistant
Technical Manager - Organics	1. Department Manager – Organics 2. Laboratory Director
Technical Manager - Inorganics	1. Department Manager – Inorganics 2. Laboratory Director
Technical Manager - IH	1. Project Mgmt. Asst. - IH 2. Laboratory Director
EHS Coordinator	1. Laboratory Director
Hazardous Waste Coordinator	1. Laboratory Director

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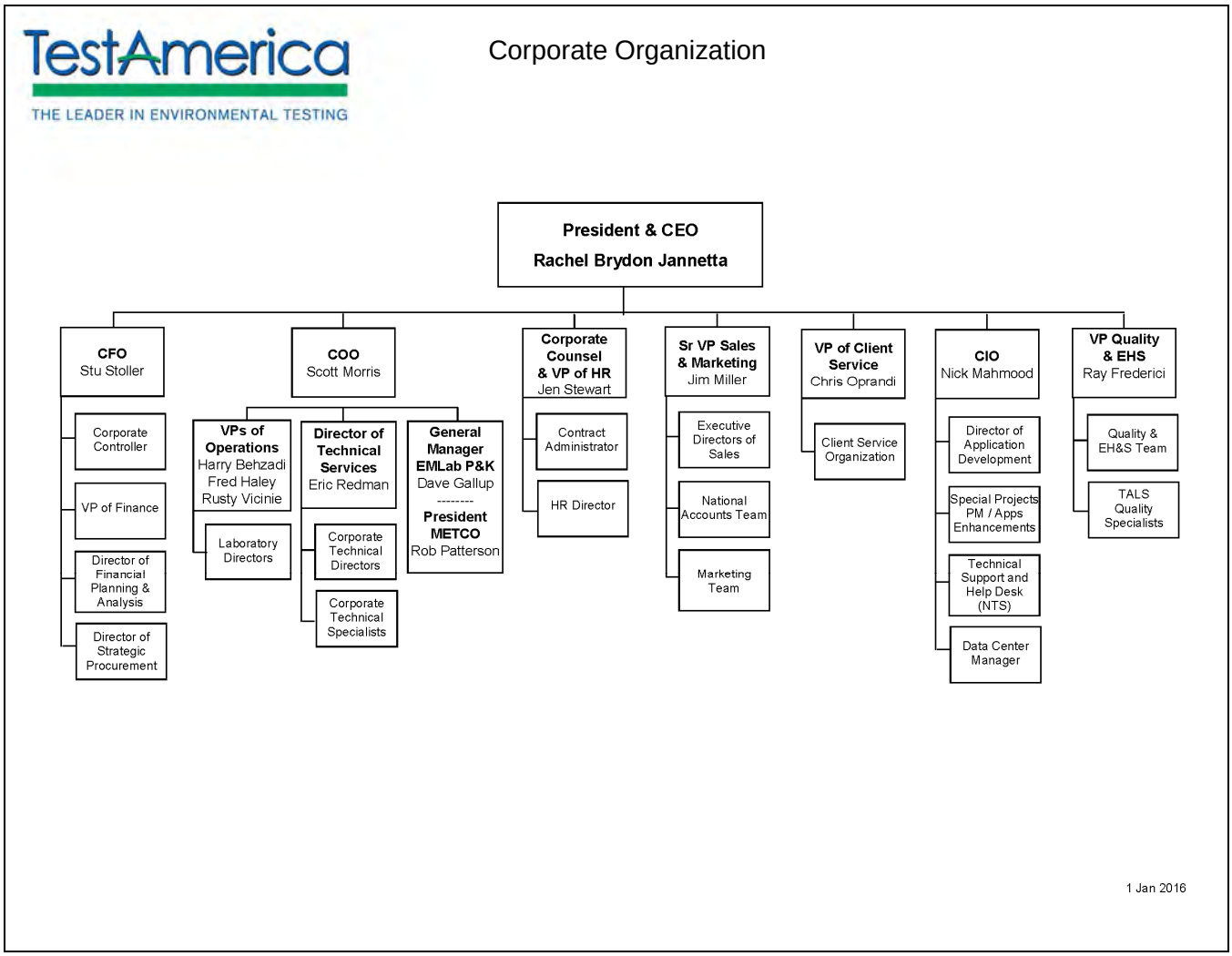
Figure 4-1. Corporate and Laboratory Organization Charts



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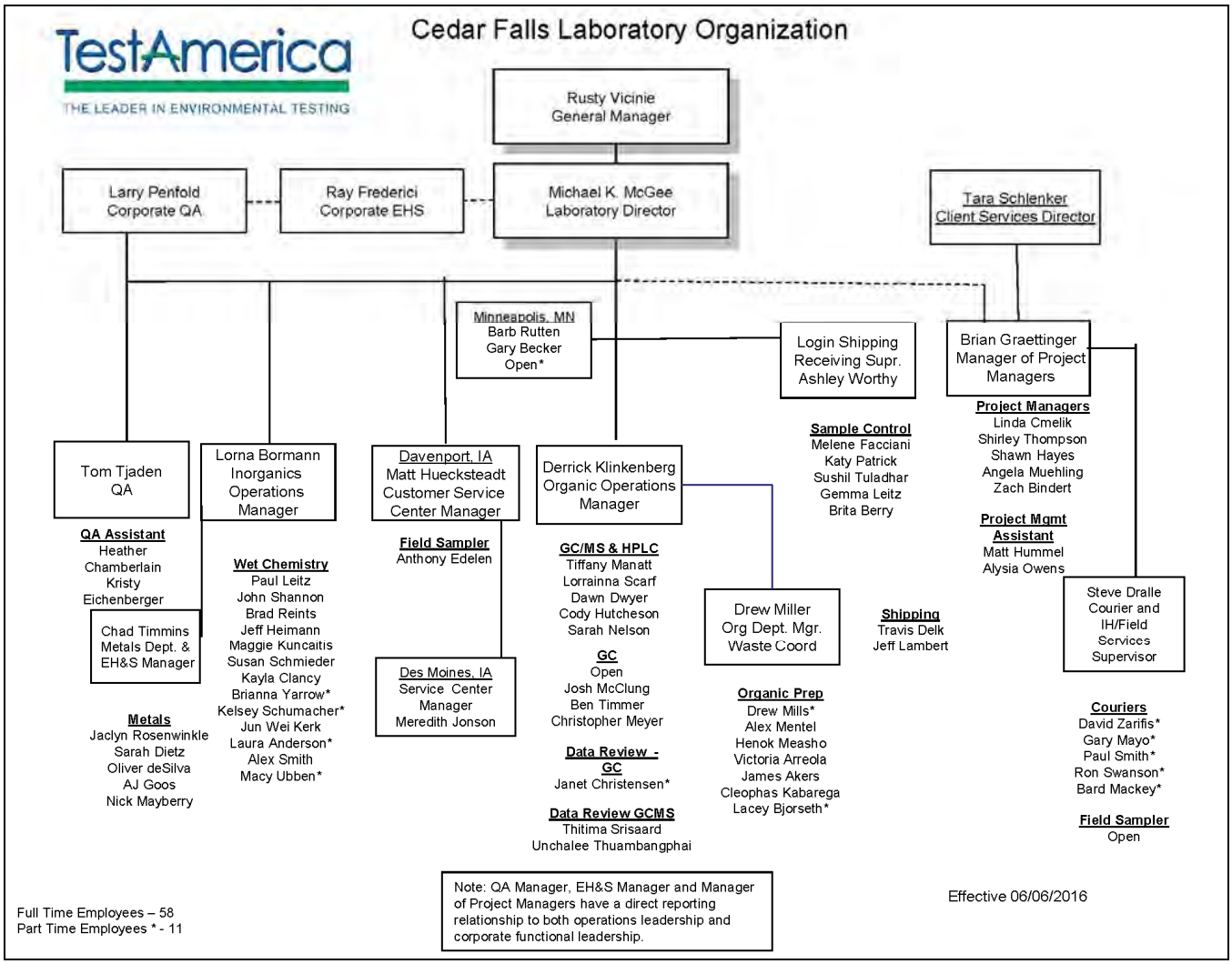

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SECTION 5. QUALITY SYSTEM

5.1 Quality Policy Statement

It is TestAmerica's Policy to:

- Provide data of known quality to its clients by adhering to approved methodologies, regulatory requirements and the QA/QC protocols.
- Effectively manage all aspects of the laboratory and business operations by the highest ethical standards.
- Continually improve systems and provide support to quality improvement efforts in laboratory, administrative and managerial activities. TestAmerica recognizes that the implementation of a quality assurance program requires management's commitment and support as well as the involvement of the entire staff.
- Provide clients with the highest level of professionalism and the best service practices in the industry.
- To comply with the ISO/IEC 17025:2005(E) International Standard, the 2009 TNI Standard, AIHA-LAP, LLC policies, and to continually improve the effectiveness of the management system.

Every staff member at the laboratory plays an integral part in quality assurance and is held responsible and accountable for the quality of their work. It is, therefore, required that all laboratory personnel are trained and agree to comply with applicable procedures and requirements established by this document.

5.2 Ethics and Data Integrity

TestAmerica is committed to ensuring the integrity of its data and meeting the quality needs of its clients. The elements of TestAmerica's Ethics and Data Integrity Program include:

- An Ethics Policy (Corporate Policy No. CW-L-P-004) and Employee Ethics Statements.
- Ethics and Compliance Officers (ECOs).
- A Training Program.
- Self-governance through disciplinary action for violations.
- A confidential mechanism for anonymously reporting alleged misconduct and a means for conducting internal investigations of all alleged misconduct. (Corporate SOP No. CW-L-S-002).
- Procedures and guidance for recalling data if necessary (Corporate SOP No. CW-L-S-002).
- Effective external and internal monitoring system that includes procedures for internal audits (Section 15).
- Produce results, which are accurate and include QA/QC information that meets client pre-defined Data Quality Objectives (DQOs).
- Present services in a confidential, honest and forthright manner.
- Provide employees with guidelines and an understanding of the Ethical and Quality Standards of our Industry.

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- Operate our facilities in a manner that protects the environment and the health and safety of employees and the public.
- Obey all pertinent federal, state and local laws and regulations and encourage other members of our industry to do the same.
- Educate clients as to the extent and kinds of services available.
- Assert competency only for work for which adequate personnel and equipment are available and for which adequate preparation has been made.
- Promote the status of environmental laboratories, their employees, and the value of services rendered by them.

5.3 Quality System Documentation

The laboratory's Quality System is communicated through a variety of documents.

- Quality Assurance Manual – Each laboratory has a lab-specific quality assurance manual.
- Corporate SOPs and Policies – Corporate SOPs and Policies are developed for use by all relevant laboratories. They are incorporated into the laboratory's normal SOP distribution, training and tracking system. Corporate SOPs may be general or technical.
- Work Instructions – A subset of procedural steps, tasks or forms associated with an operation of a management system (e.g., checklists, preformatted bench sheets, forms).
- Laboratory SOPs – General and Technical
- Laboratory QA/QC Policy Memorandums

5.3.1 Order of Precedence

In the event of a conflict or discrepancy between policies, the order of precedence is as follows:

- Corporate Quality Management Plan (CQMP)
- Corporate SOPs and Policies
- Laboratory QA/QC Policy Memorandum
- Laboratory Quality Assurance Manual (QAM)
- Laboratory SOPs and Policies
- Other (Work Instructions (WI), memos, flow charts, etc.)

Note: The laboratory has the responsibility and authority to operate in compliance with regulatory requirements of the jurisdiction in which the work is performed. Where the CQMP conflicts with those regulatory requirements, the regulatory requirements of the jurisdiction shall hold primacy. The laboratory's QAM shall take precedence over the CQMP in those cases.

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5.4 QA/QC Objectives for the Measurement of Data

Quality Assurance (QA) and Quality Control (QC) are activities undertaken to achieve the goal of producing data that accurately characterize the sites or materials that have been sampled. Quality Assurance is generally understood to be more comprehensive than Quality Control. Quality Assurance can be defined as the integrated system of activities that ensures that a product or service meets defined standards.

Quality Control is generally understood to be limited to the analyses of samples and to be synonymous with the term *"analytical quality control"*. QC refers to the routine application of statistically based procedures to evaluate and control the accuracy of results from analytical measurements. The QC program includes procedures for estimating and controlling precision and bias and for determining reporting limits.

Request for Proposals (RFPs) and Quality Assurance Project Plans (QAPP) provide a mechanism for the client and the laboratory to discuss the data quality objectives in order to ensure that analytical services closely correspond to client needs. The client is responsible for developing the QAPP. In order to ensure the ability of the laboratory to meet the Data Quality Objectives (DQOs) specified in the QAPP, clients are advised to allow time for the laboratory to review the QAPP before being finalized. Additionally, the laboratory will provide support to the client for developing the sections of the QAPP that concern laboratory activities.

Historically, laboratories have described their QC objectives in terms of precision, accuracy, representativeness, comparability, completeness, selectivity and sensitivity (PARCCSS).

5.4.1 Precision

The laboratory objective for precision is to meet the performance for precision demonstrated for the methods on similar samples and to meet data quality objectives of the EPA and/or other regulatory programs. Precision is defined as the degree of reproducibility of measurements under a given set of analytical conditions (exclusive of field sampling variability). Precision is documented on the basis of replicate analysis, usually duplicate or matrix spike (MS) duplicate samples.

5.4.2 Accuracy

The laboratory objective for accuracy is to meet the performance for accuracy demonstrated for the methods on similar samples and to meet data quality objectives of the EPA and/or other regulatory programs. Accuracy is defined as the degree of bias in a measurement system. Accuracy may be documented through the use of laboratory control samples (LCS) and/or MS. A statement of accuracy is expressed as an interval of acceptance recovery about the mean recovery.

5.4.3 Representativeness

The laboratory objective for representativeness is to provide data which is representative of the sampled medium. Representativeness is defined as the degree to which data represent a characteristic of a population or set of samples and is a measurement of both analytical and field sampling precision. The representativeness of the analytical data is a function of the procedures used in procuring and processing the samples. The representativeness can be documented by the relative percent difference between separately procured, but otherwise identical samples or sample aliquots.

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The representativeness of the data from the sampling sites depends on both the sampling procedures and the analytical procedures. The laboratory may provide guidance to the client regarding proper sampling and handling methods in order to assure the integrity of the samples.

5.4.4 Comparability

The comparability objective is to provide analytical data for which the accuracy, precision, representativeness and reporting limit statistics are similar to these quality indicators generated by other laboratories for similar samples, and data generated by the laboratory over time.

The comparability objective is documented by inter-laboratory studies carried out by regulatory agencies or carried out for specific projects or contracts, by comparison of periodically generated statements of accuracy, precision and reporting limits with those of other laboratories.

5.4.5 Completeness

The completeness objective for data is 90% (or as specified by a particular project), expressed as the ratio of the valid data to the total data over the course of the project. Data will be considered valid if they are adequate for their intended use. Data usability will be defined in a QAPP, project scope or regulatory requirement. Data validation is the process for reviewing data to determine its usability and completeness. If the completeness objective is not met, actions will be taken internally and with the data user to improve performance. This may take the form of an audit to evaluate the methodology and procedures as possible sources for the difficulty or may result in a recommendation to use a different method.

5.4.6 Selectivity

Selectivity is defined as: The capability of a test method or instrument to respond to a target substance or constituent in the presence of non-target substances. Target analytes are separated from non-target constituents and subsequently identified/detected through one or more of the following, depending on the analytical method:

- extractions (separation),
- digestions (separation),
- interelement corrections (separation),
- use of matrix modifiers (separation),
- specific retention times (separation and identification),
- confirmations with different columns or detectors (separation and identification),
- specific wavelengths (identification),
- specific mass spectra (identification),
- specific electrodes (separation and identification), etc.

5.4.7 Sensitivity

Sensitivity refers to the amount of analyte necessary to produce a detector response that can be reliably detected (Method Detection Limit, MDL) or quantified (Reporting Limit, RL).

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5.5 Criteria for Quality Indicators

The laboratory maintains quality control limits within defined method limit group (MLG) tables in LIMS that summarize the precision and accuracy acceptability limits for performed analyses. These MLG tables include an effective date, are updated each time new limits are generated, and are managed by the laboratory's QA department. Unless otherwise noted, limits within these tables are laboratory generated. Some acceptability limits are derived from US EPA methods when they are required. Where US EPA method limits are not required, the laboratory has developed limits from evaluation of data from similar matrices. Criteria for development of control limits are contained in the laboratory's control limit SOP (CF-QA-04) and Section 24 of this document.

5.6 Statistical Quality Control

Statistically-derived precision and accuracy limits are required by selected methods (such as SW-846) and programs. The laboratory routinely utilizes statistically-derived limits to evaluate method performance and determine when corrective action is appropriate. The analysts are instructed to use the current limits in the laboratory (dated and approved by the Technical Manager and QA Manager) and entered into the Laboratory Information Management System (LIMS). The Quality Assurance department maintains an archive of all limits used within the laboratory. In addition, analysis audit trails in LIMS allow for the historical reconstruction of control limits. If a method defines the QC limits, the method limits are used.

If a method requires the generation of historical limits, the lab develops such limits from recent data in the QC database of the LIMS following the guidelines described in Section 24. All calculations and limits are documented and dated when approved and effective. On occasion, a client requests contract-specified limits for a specific project.

Current QC limits are entered and maintained in the LIMS analyte database. As sample results and the related QC are entered into LIMS, the sample QC values are compared with the limits in LIMS to determine if they are within the acceptable range. The analyst then evaluates if the sample needs to be rerun or re-extracted/rerun or if a comment should be added to the report explaining the reason for the QC outlier.

5.6.1 QC Charts

As the QC limits are calculated, QC charts are generated showing warning and control limits for the purpose of evaluating trends. The QA Manager evaluates these when control limits are updated to determine if adjustments need to be made or for corrective actions to methods. Periodically, lab management may also review control charts to troubleshoot non-conforming QC, such as failed PT results, client-requested investigation, etc. All findings are documented and kept on file.

5.7 Quality System Metrics

In addition to the QC parameters discussed above, the entire Quality System is evaluated on a monthly basis through the use of specific metrics (refer to Section 16). These metrics are used to drive continuous improvement in the laboratory's Quality System.

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SECTION 6. DOCUMENT CONTROL

6.1 Overview

The QA Department is responsible for the control of documents used in the laboratory to ensure that approved, up-to-date documents are in circulation and out-of-date (obsolete) documents are archived or destroyed. The following documents, at a minimum, must be controlled:

- Laboratory Quality Assurance Manual
- Laboratory Standard Operating Procedures (SOP)
- Laboratory Policies
- Work Instructions and Forms
- Corporate Policies and Procedures distributed outside the intranet

Corporate Quality posts Corporate Manuals, SOPs, Policies, Work Instructions, White Papers and Training Materials on the company intranet site. These Corporate documents are only considered controlled when they are read on the intranet site. Printed copies are considered uncontrolled unless the laboratory physically distributes them as controlled documents. A detailed description of the procedure for issuing, authorizing, controlling, distributing, and archiving Corporate documents is found in Corporate SOP No. CW-Q-S-001, *Corporate Document Control and Archiving*. The laboratory's internal document control procedure is defined in SOP No. CF-QA-06.

The laboratory QA Department also maintains access to various references and document sources integral to the operation of the laboratory. This includes reference methods and regulations. Instrument manuals (hard or electronic copies) are also maintained by the laboratory.

The laboratory maintains control of records for raw analytical data and supporting records such as audit reports and responses, logbooks, standard logs, training files, MDL studies, Proficiency Testing (PT) studies, certifications and related correspondence, and corrective action reports. Raw analytical data consists of bound logbooks, instrument printouts, any other notes, magnetic media, electronic data and final reports.

6.2 Document Approval and Issue

The pertinent elements of a document control system for each document include a unique document title and number, pagination, the total number of pages of the item or an 'end of document' page, the effective date, revision number, and the laboratory's name. The QA personnel are responsible for the maintenance of this system.

Controlled documents are authorized by the QA Department. In order to develop a new document, a technical manager submits an electronic draft to the QA Department for suggestions and approval before use. Upon approval, QA personnel add the identifying version information to the document and retains that document as the official document on file. That document is then provided to all applicable operational units (may include electronic access). Controlled documents are identified as such and records of their distribution are kept by the QA Department. Document control may be achieved by either electronic or hardcopy distribution.

The QA Department maintains a list of the official versions of controlled documents.

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Quality System Policies and Procedures will be reviewed at a minimum of every two years—excepting SDWA documents which are reviewed annually—and revised as appropriate. Changes to documents occur when a procedural change warrants.

6.3 Procedures for Document Control Policy

For changes to the QA Manual, refer to SOP No. CF-QA-06. Uncontrolled copies must not be used within the laboratory. Previous revisions and back-up data are stored by the QA department. Electronic copies are stored on the electronic QA archives for the applicable revision.

For changes to SOPs, refer to SOP No. CF-QA-06. The SOP identified above also defines the process of changes to SOPs.

Forms, worksheets, work instructions and information are organized by department in the QA office. There is a table of contents. Electronic versions are kept on a hard drive in the QA department; hard copies are kept in QA files. The procedure for the care of these documents is in SOP CF-QA-06.

6.4 Obsolete Documents

All invalid or obsolete documents are removed, or otherwise prevented from unintended use. The laboratory has specific procedures as described above to accomplish this. In general, obsolete documents are collected from employees according to distribution lists and are marked obsolete on the cover or destroyed. At least one copy of the obsolete document is archived according to SOP No. CF-QA-06.

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SECTION 7. SERVICE TO THE CLIENT

7.1 Overview

The laboratory has established procedures for the review of work requests and contracts, oral or written. The procedures include evaluation of the laboratory's capability and resources to meet the contract's requirements within the requested time period. All requirements, including the methods to be used, must be adequately defined, documented and understood. For many environmental sampling and analysis programs, testing design is site or program specific and does not necessarily "fit" into a standard laboratory service or product. It is the laboratory's intent to provide both standard and customized environmental laboratory services to our clients.

A thorough review of technical and QC requirements contained in contracts is performed to ensure project success. The appropriateness of requested methods, and the lab's capability to perform them must be established. Projects, proposals and contracts are reviewed for adequately defined requirements and the laboratory's capability to meet those requirements. Alternate test methods that are capable of meeting the clients' requirements may be proposed by the lab. A review of the lab's capability to analyze non-routine analytes is also part of this review process.

All projects, proposals and contracts are reviewed for the client's requirements in terms of compound lists, test methodology requested, sensitivity (detection and reporting levels), accuracy, and precision requirements (% Recovery and RPD). The reviewer ensures that the laboratory's test methods are suitable to achieve these requirements and that the laboratory holds the appropriate certifications and approvals to perform the work. The laboratory and any potential subcontract laboratories must be certified, as required, for all proposed tests.

The laboratory must determine if it has the necessary physical, personnel and information resources to meet the contract, and if the personnel have the expertise needed to perform the testing requested. Each proposal is checked for its impact on the capacity of the laboratory's equipment and personnel. As part of the review, the proposed turnaround time will be checked for feasibility.

Electronic or hard copy deliverable requirements are evaluated against the laboratory's capacity for production of the documentation.

If the laboratory cannot provide all services but intends to subcontract such services, whether to another TestAmerica facility or to an outside firm, this will be documented and discussed with the client prior to contract approval (refer to Section 8 for Subcontracting Procedures).

The laboratory informs the client of the results of the review if it indicates any potential conflict, deficiency, lack of accreditation, or inability of the lab to complete the work satisfactorily. Any discrepancy between the client's requirements and the laboratory's capability to meet those requirements is resolved in writing before acceptance of the contract. It is necessary that the contract be acceptable to both the laboratory and the client. Amendments initiated by the client and/or TestAmerica, are documented in writing.

All contracts, QAPPs, Sampling and Analysis Plans (SAPs), contract amendments, and documented communications become part of the project record.

The same contract review process used for the initial review is repeated when there are amendments to the original contract by the client, and the participating personnel are informed of the changes.

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7.2 Review Sequence and Key Personnel

Appropriate personnel will review the work request at each stage of evaluation.

For routine projects and other simple tasks, a review by the Project Manager (PM) or Project Management Assistant (PMA) is considered adequate. Based on information provided to the laboratory by the client, the PM or PMA confirms that the laboratory has any required certifications, that it can meet the clients' data quality and reporting requirements, informs the client if the client's data and/or reporting requirements do not meet certification requirements and that the lab has the capacity to meet the clients turn around needs. The laboratory's Project and Contract Review Procedures for Meeting Regulatory, Accreditation, and Client Requirements SOP (CF-GP-21) governs this procedure. It is recommended that, where there is a sales person assigned to the account, an attempt should be made to contact that sales person to inform them of the incoming samples.

For new, complex, or large projects the proposed contract is given to the Client Relations Manager (CRM) or CRM proposal team, who will decide which lab will receive the work based on the scope of work and other requirements, including certification, testing methodology, and available capacity to perform the work. The contract review process is outlined in TestAmerica's Corporate SOP No. CA-L-P-002, *Contract Compliance Policy*.

This review encompasses all facets of the operation. The scope of work is distributed to the appropriate personnel, as needed based on scope of contract, to evaluate all of the requirements shown above (but not necessarily in the order below:

- Contract Administrator
- VP of Operations
- Laboratory Client Service Manager
- Laboratory Project Manager
- Laboratory and/or Corporate Technical Managers / Directors
- Laboratory and/or Corporate Information Technology Managers/Directors
- Account Executives
- Laboratory and/or Corporate Quality
- Laboratory and/or Corporate Environmental Health and Safety Managers/Directors

The Laboratory Director reviews the formal laboratory quote and makes final acceptance for their facility.

The Sales Director, Contract Administrator, Account Executive, or Client Relationship Manager then submits the final proposal to the client.

In the event that one of the above personnel is not available to review the contract, his or her back-up will fulfill the review requirements.

The Contracts Department maintains copies of all signed contracts.

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7.3 Documentation

Appropriate records are maintained for every contract or work request. All stages of the contract review process are documented and include records of any significant changes. This information is archived on the Bid network drive and on the TANet Oasis intranet. Comments and notes are also maintained in the LIMS for client and individual bids and contracts.

The contract will be distributed to and maintained by the appropriate sales/marketing personnel and the Account Executive. A copy of the contract and formal quote will be filed with the laboratory PM and the Laboratory Director.

Records are maintained of pertinent discussions with a client relating to the client's requirements or the results of the work during the period of execution of the contract. The PM keeps a phone log of conversations with the client. A Quote Log is maintained and distributed to Sales, Project Managers, and the Laboratory Director on a weekly basis. Communications between Sales and Marketing should be captured in Salesforce and pertinent information should be copied to all appropriate Project Management and technical staff. Information regarding specific projects or clients is entered into the laboratory LIMS for reference by all laboratory staff. Documents and other client information are organized in a folder on the Bid server at the TestAmerica Cedar Falls laboratory. This folder and information is accessible to project managers and other staff, as warranted. National client contract information is available on the TANet Oasis intranet.

7.3.1 Project-Specific Quality Planning

Communication of contract specific technical and QC criteria is an essential activity in ensuring the success of site specific testing programs. To achieve this goal, a PM is assigned to each client. It is the PM and PMA's responsibility to ensure that project-specific technical and QC requirements are effectively evaluated and communicated to the laboratory personnel before and during the project. QA department involvement may be needed to assist in the evaluation of custom QC requirements.

Project managers are the primary client contact and they ensure resources are available to meet project requirements. Although PM's do not have direct reports or staff in production, they coordinate opportunities and work with laboratory management and supervisory staff to ensure available resources are sufficient to perform work for the client's project. Project management is positioned between the client and laboratory resources.

Prior to work on a new project, the dissemination of project information and/or project opening meetings may occur to discuss schedules and unique aspects of the project. Items to be discussed may include the project technical profile, turnaround times, holding times, methods, analyte lists, reporting limits, deliverables, sample hazards, or other special requirements. The PM introduces new projects to the laboratory staff through project kick-off meetings or to the supervisory staff during production meetings. These meetings provide direction to the laboratory staff in order to maximize production and client satisfaction, while maintaining quality. In addition, project notes may be associated with each sample batch as a reminder upon sample receipt and analytical processing.

During the project, any change that may occur within an active project is agreed upon between the client/regulatory agency and the PM/laboratory. These changes (e.g., use of a non-standard method or modification of a method) and approvals must be documented prior to implementation. Documentation pertains to any document (e.g., letter, e-mail, variance, contract addendum) which has been acknowledged by both parties.

Such changes are also communicated to the laboratory during production meetings. Such changes are updated to the project notes and are introduced to the managers at these meetings. The laboratory staff is then introduced to the modified requirements via the PM or the individual laboratory Technical Manager. After the modification is implemented into the laboratory process, documentation of the modification is made in the case narrative of the data report(s).

The laboratory strongly encourages client visits to the laboratory and for formal/informal information sharing session with employees in order to effectively communicate ongoing client needs as well as project specific details for customized testing programs.

7.4 Special Services

The laboratory cooperates with clients and their representatives to monitor the laboratory's performance in relation to work performed for the client. It is the laboratory's goal to meet all client requirements in addition to statutory and regulatory requirements. The laboratory has procedures to ensure confidentiality to clients (Section 15 and 25).

Note: ISO/IEC 17025 states that a laboratory "shall afford clients or their representatives cooperation to clarify the client's request". This topic is discussed in Section 7.

The laboratory's standard procedures for reporting data are described in Section 25. Special services are also available and provided upon request. These services include:

- Reasonable access for our clients or their representatives to the relevant areas of the laboratory for the witnessing of tests performed for the client.
- Assist client-specified third party data validators as specified in the client's contract.
- Supplemental information pertaining to the analysis of their samples. Note: An additional charge may apply for additional data/information that was not requested prior to the time of sample analysis or previously agreed upon.

7.5 Client Communication

Project managers and project management assistants are the primary communication link to the clients. They shall inform their clients of any delays in project completion as well as any non-conformances in either sample receipt or sample analysis. Project management will maintain ongoing client communication throughout the entire client project.

Technical/Operations Managers and/or Directors are available to discuss any technical questions or concerns that the client may have.

7.6 Reporting

The laboratory works with our clients to produce any special communication reports required by the contract.

7.7 Client Surveys

The laboratory assesses both positive and negative client feedback. The results are used to improve overall laboratory quality and client service. TestAmerica's Sales and Marketing teams periodically develops lab and client specific surveys to assess client satisfaction. In addition, web surveys are available to provide clients an opportunity for feedback. Feedback received from clients using these

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avenues are generally classified as ‘complaints’ or ‘compliments’ and are discussed at daily production status meetings. In addition, this feedback is reported in the QA Manger’s monthly metrics report submitted to Corporate QA (refer to Section 16, Management Reviews).

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SECTION 8. SUBCONTRACTING OF TESTS

8.1 Overview

For the purpose of this quality manual, the phrase subcontract laboratory refers to a laboratory external to the TestAmerica network of laboratories. The phrase "work sharing" refers to internal transfers of samples between the TestAmerica laboratories. The term outsourcing refers to the act of subcontracting tests.

When contracting with our clients, the laboratory makes commitments regarding the services to be performed and the data quality for the results to be generated. When the need arises to outsource testing for our clients because project scope, changes in laboratory capabilities, capacity or unforeseen circumstances, we must be assured that the subcontract or work sharing laboratories understand the requirements and will meet the same commitments we have made to the client. Refer to TestAmerica's Corporate SOP on Subcontracting Procedures (CA-L-S-002).

When outsourcing analytical services, the laboratory will assure, to the extent necessary, that the subcontract or work sharing laboratory maintains a program consistent with the requirements of this document, the requirements specified in TNI/ISO 17025, any state- or program-specific requirements, and/or the client's Quality Assurance Project Plan (QAPP). All QC guidelines specific to the client's analytical program are transmitted to the subcontractor and agreed upon before sending the samples to the subcontract facility. Additionally, work requiring accreditation will be placed with an appropriately accredited laboratory. The laboratory performing the subcontracted work will be identified in the final report, as will non-TNI accredited work where required.

Project Managers (PMs), Client Service Managers (CSMs), or Account Executives (AEs) for the export lab (TestAmerica laboratory that transfers samples to another laboratory) are responsible for obtaining client approval prior to subcontracting any samples. The laboratory will advise the client of a subcontract arrangement in writing and when possible approval from the client shall be retained in the project folder. Standard TestAmerica Terms & Conditions include the flexibility to subcontract samples within the TestAmerica laboratories. Therefore, additional advance notification to clients for intra-laboratory subcontracting is not necessary unless specifically required by a client contract.

Note: In addition to the client, some regulating agencies (e.g., USDA) or contracts (e.g., certain USACE projects) may require notification prior to placing such work.

8.2 Qualifying and Monitoring Subcontractors

Whenever a PM becomes aware of a client requirement or laboratory need where samples must be outsourced to another laboratory, the other laboratory(s) shall be selected based on the following:

- The first priority is to attempt to place the work in a qualified TestAmerica laboratory;
- Firms specified by the client for the task. (Documentation that a subcontractor was designated by the client must be maintained with the project file. This documentation can be as simple as placing a copy of an e-mail from the client in the project folder);
- Firms listed as pre-qualified and currently under a subcontract with TestAmerica: A listing of all approved subcontracting laboratories is available on the TestAmerica intranet site. Supporting documentation is maintained by corporate offices and by the TestAmerica laboratory originally requesting approval of the subcontract lab. Verify necessary accreditation, where applicable, (e.g., on the subcontractors TNI, A2LA accreditation, or state certification).

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- Firms identified in accordance with the company's Small Business Subcontracting program as small, women-owned, veteran-owned and/or minority-owned businesses;
- TNI or A2LA accredited laboratories.
- In addition, the firm must hold the appropriate certification to perform the work required.

All TestAmerica laboratories are pre-qualified for work sharing provided they hold the appropriate accreditations, can adhere to the project/program requirements, and the client approves sending samples to that laboratory. The client must provide acknowledgement that the samples can be sent to that facility (an e-mail is sufficient documentation or if acknowledgement is verbal, the date, time, and name of person providing acknowledgement must be documented). The originating laboratory is responsible for communicating all technical, quality, and deliverable requirements as well as other contract needs.

When the potential subcontract laboratory has not been previously approved, Account Executives, or PMs may nominate a laboratory as a subcontractor based on need. The decision to nominate a laboratory must be approved by the Laboratory Director. The Laboratory Director requests that the QA Manager or PM begin the process of approving the subcontract laboratory as outlined in Corporate SOP No. CA-L-S-002, *Subcontracting Procedures*. The client must provide acknowledgement that the samples can be sent to that facility (an e-mail is sufficient documentation or if acknowledgement is verbal, the date, time, and name of person providing acknowledgement must be documented).

8.2.1 Once the appropriate accreditation and legal information is received by the laboratory, it is evaluated for acceptability (where applicable) and forwarded to the Corporate Quality Information Manager (QIM) for review. Once all documents are reviewed for completeness, the Corporate QIM will forward the documents to the Purchasing Manager for formal signature and contracting with the laboratory. The approved vendor will be added to the approved subcontractor list on the intranet site and the finance group is concurrently notified for JD Edwards.

8.2.2 The client will assume responsibility for the quality of the data generated from the use of a subcontractor they have requested the lab to use. The qualified subcontractors on the intranet site are known to meet minimal standards. TestAmerica does not certify laboratories. The subcontractor is on our approved list and can only be recommended to the extent that we would use them.

8.2.3 The status and performance of qualified subcontractors will be monitored periodically by the Corporate Contracts and/or Quality Departments. Any problems identified will be brought to the attention of TestAmerica's Corporate Finance or Corporate Quality personnel.

- Complaints shall be investigated. Documentation of the complaint, investigation and corrective action will be maintained in the subcontractor's file on the intranet site. Complaints are posted using the Vendor Performance Report.
- Information shall be updated on the intranet when new information is received from the subcontracted laboratories.
- Subcontractors in good standing will be retained on the intranet listing. The QA Manager will notify all TestAmerica laboratories, Corporate Quality, and Corporate Contracts if any laboratory requires removal from the intranet site. This notification will be posted on the intranet site and e-mailed to all Laboratory Directors, QA Managers, and Sales Personnel.

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8.3 Oversight and Reporting

The PM must request that the selected subcontractor be presented with a subcontract, if one is not already executed between the laboratory and the subcontractor. The subcontract must include terms which flow down the requirements of our clients, either in the subcontract itself or through the mechanism of work orders relating to individual projects. A standard subcontract and the Lab Subcontractor Vendor Package (posted on the intranet) can be used to accomplish this, and Corporate Counsel can tailor the document or assist with negotiations, if needed. The PM responsible for the project must advise and obtain client consent to the subcontract as appropriate, and provide the scope of work to ensure that the proper requirements are made a part of the subcontract and are made known to the subcontractor.

Prior to sending samples to the subcontracted laboratory, the PM confirms their certification status to determine if it's current and scope-inclusive. For TestAmerica laboratories, certifications can be viewed on the company's TotalAccess Database.

The Sample Control department is responsible for ensuring compliance with QA requirements and applicable shipping regulations when shipping samples to a subcontracted laboratory.

All subcontracted samples must be accompanied by a TestAmerica Chain of Custody (COC). A copy of the original COC sent by the client need not be included with samples subcontracted within TestAmerica, because it is available to all location through the LIMS. Client COCs are only forwarded to external subcontractors when samples are shipped directly from the project site to the subcontractor lab. Under routine circumstances, client COCs are not provided to external subcontractors.

Through communication with the subcontracted laboratory, the PM monitors the status of the subcontracted analyses, facilitates successful execution of the work, and ensures the timeliness and completeness of the analytical report.

Non-TNI accredited work must be identified in the subcontractor's report as appropriate. If TNI accreditation is not required, the report does not need to include this information.

Reports submitted from subcontract laboratories are not altered and are included in their original form in the final project report. This clearly identifies the data as being produced by a subcontractor facility. If subcontract laboratory data is incorporated into the laboratory's EDD (i.e., imported), the report must explicitly indicate which lab produced the data for which methods and samples.

Note: The results submitted by a TestAmerica work sharing laboratory may be transferred electronically, and the results reported by the TestAmerica work sharing lab are identified on the final report. The report must explicitly indicate which lab produced the data for which methods and samples. The final report must include a copy of the completed COC for all work sharing reports.

8.4 Contingency Planning

The Laboratory Director may waive the full qualification of a subcontractor process temporarily to meet emergency needs; however, this decision & justification must be documented in the project files, and the 'Purchase Order Terms And Conditions For Subcontracted Laboratory Services' must be sent with the samples and COC. In the event this provision is utilized, the laboratory (e.g., PM) will be required to verify and document the applicable accreditations of the subcontractor. All other quality and accreditation requirements will still be applicable, but the subcontractor need not have signed a subcontract with TestAmerica at the time. The comprehensive approval process must then be initiated within 30 calendar days of subcontracting.

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SECTION 9. PURCHASING SERVICES AND SUPPLIES

9.1 Overview

Evaluation and selection of suppliers and vendors is performed, in part, on the basis of the quality of their products, their ability to meet the demand for their products on a continuous and short term basis, the overall quality of their services, their past history, and competitive pricing. This is achieved through evaluation of objective evidence of quality furnished by the supplier, which can include certificates of analysis, recommendations, and proof of historical compliance with similar programs for other clients. To ensure that quality critical consumables and equipment conform to specified requirements, which may affect quality, all purchases from specific vendors are approved by a member of the supervisory or management staff. Capital expenditures are made in accordance with TestAmerica's Capital Expenditure, Controlled Purchase Requests and Fixed Asset Capitalization procedure, SOP No. CW-F-S-007.

Contracts will be signed in accordance with TestAmerica's Company-Wide Authorization Matrix Policy, Policy No. CW-F-P-002. Request for Proposals (RFPs) will be issued where more information is required from the potential vendors than just price. Process details are available in TestAmerica's Corporate Procurement and Contracts Policy (Policy No. CW-F-P-004). RFPs allow TestAmerica to determine if a vendor is capable of meeting requirements such as supplying all of the TestAmerica facilities, meeting required quality standards, and adhering to necessary ethical and environmental standards. The RFP process also allows potential vendors to outline any additional capabilities they may offer.

9.2 Glassware

Glassware used for volumetric measurements must be Class A or verified for accuracy according to laboratory procedure. Pyrex (or equivalent) glass should be used where possible. For safety purposes, thick-wall glassware should be used where available.

9.3 Reagents, Standards & Supplies

Purchasing guidelines for equipment and reagents must meet the requirements of the specific method and testing procedures for which they are being purchased. Solvents and acids are pre-tested in accordance with TestAmerica's Corporate SOP on Solvent & Acid Lot Testing & Approval, SOP No. CA-Q-S-001. Other laboratory supplies which have the potential to introduce analytical interferences are also pre-tested at the Cedar Falls facility prior to use to ensure that contamination isn't present in significant quantities (e.g., extractable organics that could affect DRO-type analyses).

9.3.1 Purchasing

Chemical reagents, solvents, glassware, and general supplies are ordered as needed to maintain sufficient quantities on hand. Materials used in the analytical process must be of a known quality. The wide variety of materials and reagents available makes it advisable to specify recommendations for the name, brand, and grade of materials to be used in any determination. This information is contained in the method SOP. The analyst may check the item out of the on-site consignment system that contains items approved for laboratory use; or, if the item in not in consignment, the analyst completes the Material Request Sheet when requesting reagents, standards, or supplies.

The analyst must provide the master item number (from the master item list that has been approved by the Technical Manager), item description, package size, catalogue page number, and the quantity

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needed. If an item being ordered is not the exact item requested, approval must be obtained from the Technical Manager prior to placing the order. The purchasing coordinator places the order.

9.3.2 Receiving

It is the responsibility of the purchasing coordinator to receive the shipment. It is the responsibility of the analyst who ordered the materials to document the date materials where received. Once the ordered reagents or materials are received, the analyst compares the information on the label or packaging to the original order to ensure that the purchase meets the quality level specified. Safety Data Sheets (SDSs) are available online through the Company's intranet website. Anyone may review these for relevant information on the safe handling and emergency precautions of on-site chemicals.

9.3.3 Specifications

Methods in use in the laboratory specify the grade of reagent that must be used in the procedure. If the quality of the reagent is not specified, analytical reagent grade will be used. It is the responsibility of the analyst to check the procedure carefully for the suitability of grade of reagent.

Chemicals must not be used past the manufacturer's expiration date and must not be used past the expiration time noted in a method SOP. If expiration dates are not provided, the laboratory may contact the manufacturer to determine an expiration date.

The laboratory assumes a five year expiration date on inorganic dry chemicals and solvents unless noted otherwise by the manufacturer or by the reference source method. Chemicals/solvents should not be used past the manufacturer's or SOPs expiration date unless 'verified' (refer to third item listed below):

- An expiration date **cannot** be extended if the dry chemical/solvent is discolored or appears otherwise physically degraded. The dry chemical/solvent must then be disposed.
- An expiration date **can** be extended if the dry chemical/solvent is found to be satisfactory based on acceptable performance of quality control samples (Continuing Calibration Verification (CCV), Blanks, Laboratory Control Sample (LCS), etc.).
- If the dry chemical/solvent is used for the preparation of standards, the expiration dates can be extended 6 months if the dry chemical/solvent is compared to an unexpired independent source in performing the method and the performance of the dry chemical/solvent is found to be satisfactory. The comparison must show that the dry chemical/solvent meets CCV limits. The comparison studies are maintained in the QA department.

Wherever possible, standards must be traceable to national or international standards of measurement or to national or international reference materials. Records to that effect are available to the user.

Compressed gases in use are checked for pressure and secure positioning daily. To prevent a tank from going to dryness or introducing potential impurities, the pressure should be closely watched as it decreases to approximately 15% of the original reading, at which point it should be replaced. For example, a standard sized laboratory gas cylinder containing 3,000 psig of gas should be replaced when it drops to approximately 500 psig. The quality of the gases must meet method or manufacturer specification or be of a grade that does not cause any analytical interference.

Water used in the preparation of standards or reagents must have a specific conductivity of less than 1.0 µmho/cm (or specific resistivity of greater than 1.0 megohm·cm) at 25°C. The specific conductivity

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is checked and recorded daily. If the water's specific conductivity is greater than the specified limit, the Facility Manager and appropriate Technical Managers must be notified immediately in order to notify all departments, decide on cessation (based on intended use) of activities, and make arrangements for correction.

The laboratory may purchase reagent grade (or other similar quality) water for use in the laboratory. This water must be certified "clean" by the supplier for all target analytes or otherwise verified by the laboratory prior to use. This verification is documented.

Standard lots are verified before first time use if the laboratory switches manufacturers or has historically had a problem with the type of standard.

Purchased bottleware used for sampling must be certified clean and the certificates must be maintained. If uncertified sampling bottleware is purchased, all lots must be verified clean prior to use. This verification must be maintained.

Records of manufacturer's certification and traceability statements are maintained in binders in each laboratory section, and electronic copies are made and filed with the applicable standard in the LIMS. These records include date of receipt, lot number (when applicable), and expiration date (when applicable). Incorporation of the item into the record indicates that the analyst has compared the new certificate with the previous one for the same purpose and that no difference is noted, unless approved and so documented by the Technical Manager or QA Manager.

9.3.4 Storage

Reagent and chemical storage is important from the aspects of both integrity and safety. Light-sensitive reagents may be stored in brown-glass containers. Storage conditions are per the Corporate Environmental Health & Safety Manual (Corp. Doc. No. CW-E-M-001) and method SOPs or manufacturer instructions.

9.4 Purchase of Equipment / Instruments / Software

When a new piece of equipment is needed, either for additional capacity or for replacing inoperable equipment, the analyst or supervisor makes a supply request to the Technical Manager and/or the Laboratory Director. If they agree with the request, the procedures outlined in TestAmerica's Corporate Policy No. CA-T-P-001, *Qualified Products List*, are followed. A decision is made as to which piece of equipment can best satisfy the requirements. The appropriate written requests are completed and purchasing places the order.

Upon receipt of a new or previously-used piece of equipment, an identification name is assigned and added to the equipment list. IT must also be notified so that they can synchronize the instrument for back-ups. Its capability is assessed to determine if it is adequate or not for the specific application. For instruments, a calibration curve is generated, followed by MDLs, Demonstration of Capabilities (DOCs), and other relevant criteria (refer to Section 19). For software, its operation must be deemed reliable and evidence of instrument verification must be retained by the IT Department or QA Department. Software certificates supplied by the vendors are kept on file. The manufacturer's operation manual becomes a controlled document and is retained at the bench.

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9.5 Services

Service to analytical instruments (except analytical balances) is performed on an as-needed basis. Routine preventative maintenance is discussed in Section 20. The need for service is determined by analysts and/or Technical Managers. The service providers that perform the services are approved by the Technical Manager and/or Laboratory Director.

9.6 Suppliers

TestAmerica selects vendors through a competitive proposal / bid process, strategic business alliances or negotiated vendor partnerships (contracts). This process is defined in the Procurement & Contracts Policy (Policy No. CW-F-P-004). The level of control used in the selection process is dependent on the anticipated spending amount and the potential impact on TestAmerica business. Vendors that provide test and measuring equipment, solvents, standards, certified containers, instrument related service contracts or subcontract laboratory services shall be subject to more rigorous controls than vendors that provide off-the-shelf items of defined quality that meet the end use requirements. The JD Edwards purchasing system includes all suppliers/vendors that have been approved for use.

Evaluation of suppliers is accomplished by ensuring the supplier ships the product or material ordered and that the material is of the appropriate quality. This is documented by signing off on packing slips or other supply receipt documents. The purchasing documents contain the data that adequately describe the services and supplies ordered.

Any issues of vendor performance are to be reported immediately by the laboratory staff to the Corporate Purchasing Group by completing a Vendor Performance Report. The Corporate Purchasing Group will work through the appropriate channels to gather the information required to clearly identify the problem and will contact the vendor to report the problem and to make any necessary arrangements for exchange, return authorization, credit, etc.

As deemed appropriate, the Vendor Performance Reports will be summarized and reviewed to determine corrective action necessary, or service improvements required by vendors.

The laboratory has access to a listing of all approved suppliers of critical consumables, supplies, and services. This information is provided through the JD Edwards purchasing system.

9.6.1 New Vendor Procedure

TestAmerica employees who wish to request the addition of a new vendor must complete a J.D. Edwards Vendor Add Request Form.

New vendors are evaluated based upon criteria appropriate to the products or services provided as well as their ability to provide those products and services at a competitive cost. Vendors are also evaluated to determine if there are ethical reasons or potential conflicts of interest with TestAmerica employees that would make it prohibitive to do business with them as well as their financial stability. The QA Department and/or the Technical Services Director are consulted with vendor and product selection that have an impact on quality.

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SECTION 10. COMPLAINTS

10.1 Overview

The laboratory considers an effective client complaint handling processes to be of significant business and strategic value. Listening to and documenting client concerns captures 'client knowledge' that enables our operations to continually improve processes and client satisfaction. An effective client complaint handling process also provides assurance to the data user that the laboratory will stand behind its data, service obligations and products.

A client complaint is any expression of dissatisfaction with any aspect of our business services (e.g., communications, responsiveness, data, reports, invoicing and other functions) expressed by any party, whether received verbally or in written form. Client inquiries, complaints or noted discrepancies are documented, communicated to management, and addressed promptly and thoroughly.

The laboratory has procedures for addressing both external and internal complaints with the goal of providing satisfactory resolution to complaints in a timely and professional manner.

The nature of the complaint is identified, documented and investigated, and an appropriate action is determined and taken. In cases where a client complaint indicates that an established policy or procedure was not followed, the QA Department must evaluate whether a special audit must be conducted to assist in resolving the issue. A written confirmation or letter to the client, outlining the issue and response taken is recommended as part of the overall action taken.

The process of complaint resolution and documentation utilizes the procedures outlined in Section 12 (Corrective Actions) and is first documented by submitting complaints received to the QA department in writing. The QA Manager summarizes the complaints in the monthly QA report to management, along with a summary of any investigations performed and corrective actions taken.

10.2 External Complaints

An employee that receives a complaint initiates the complaint resolution process by first documenting the complaint according to the procedures listed above.

Complaints fall into two categories: correctable and non-correctable. An example of a correctable complaint would be one where a report re-issue would resolve the complaint. An example of a non-correctable complaint would be one where a client complains that their data was repeatedly late. Non-correctable complaints should be reviewed for preventive action measures to reduce the likelihood of future occurrence and mitigation of client impact.

The general steps in the complaint handling process are:

- Receiving and Documenting Complaints
- Complaint Investigation and Service Recovery
- Process Improvement

The laboratory shall inform the initiator of the complaint of the results of the investigation and the corrective action taken, if any.

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10.3 Internal Complaints

Internal complaints include, but are not limited to: errors and non-conformances, training issues, internal audit findings, and deviations from methods. Corrective actions may be initiated by any staff member who observes a nonconformance and shall follow the procedures outlined in Section 12. In addition, Corporate Management, Sales and Marketing, and IT may initiate a complaint by contacting the laboratory or through the corrective action system described in Section 12.

10.4 Management Review

The number and nature of client complaints is reported by the QA Manager to the laboratory and QA Director in the QA Monthly report. Monitoring and addressing the overall level and nature of client complaints and the effectiveness of the solutions is part of the Annual Management Review (Section 16).

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SECTION 11. CONTROL OF NON-CONFORMING WORK

11.1 Overview

When data discrepancies are discovered or deviations and departures from laboratory SOPs, policies, and/or client requests have occurred, corrective action is taken immediately. First, the laboratory evaluates the significance of the nonconforming work. Then, a corrective action plan is initiated based on the outcome of the evaluation. If it is determined that the non-conforming work is an isolated incident, the plan could be as simple as adding a qualifier to the final results and/or making a notation in the case narrative. If it is determined that the nonconforming work is a systematic or improper practices issue, the corrective action plan could include a more in depth investigation and a possible suspension of an analytical method. In all cases, the actions taken are documented using the laboratory's corrective action system (refer to Section 12).

Due to the frequently unique nature of environmental samples, sometimes departures from documented policies and procedures are needed. When an analyst encounters such a situation, the problem is presented to the supervisor for resolution. The supervisor may elect to discuss it with the Technical Manager or have a representative contact the client to decide on a logical course of action. Once an approach is agreed upon, the analyst documents it using the laboratory's corrective action system described in Section 12. This information can then be supplied to the client in the form of a footnote or a case narrative with the report.

Project Management may encounter situations where a client may request that a special procedure be applied to a sample that is not standard lab practice. Based on a technical evaluation, the lab may accept or opt to reject the request based on technical or ethical merit. An example might be a request to report a compound that the lab does not normally report. The lab would not have validated the method for this compound following the procedures in Section 19. The client may request that the compound be reported based only on the calibration. Such a request would need to be approved by the Technical Manager and QA Manager, documented, and included in the project folder. Deviations **must** also be noted on the final report with a statement that the compound is not reported in compliance with TNI (or the analytical method) requirements and the reason. Data being reported to a non-TNI state would need to note the change made to how the method is normally run.

11.2 Responsibilities and Authorities

TestAmerica's Corporate SOP entitled *Internal Investigation of Potential Data Discrepancies and Determination for Data Recall* (SOP No. CW-L-S-002) outlines the general procedures for the reporting and investigation of data discrepancies and alleged incidents of misconduct or violations of TestAmerica's data integrity policies as well as the policies and procedures related to the determination of the potential need to recall data.

Under certain circumstances, the Laboratory Director, a Technical Manager, or a member of the QA department may authorize departures from documented procedures or policies. The departures may be a result of procedural changes due to the nature of the sample; a one-time procedure for a client; QC failures with insufficient sample to reanalyze, etc. In most cases, the client will be informed of the departure prior to the reporting of the data. Any departures must be well documented using the laboratory's corrective action procedures. This information may also be documented in LIMS, logbooks, and/or data review checklists as appropriate. Any impacted data must be referenced in a case narrative and/or flagged with an appropriate data qualifier.

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Any misrepresentation or possible misrepresentation of analytical data discovered by any laboratory staff member must be reported to a member of the facility's Senior Management team within 24 hours. The Senior Management staff is comprised of the Laboratory Director, the QA Manager, and the Technical Managers. The reporting of issues involving alleged violations of the company's Data Integrity or Manual Integration procedures must be conveyed to an Ethics and Compliance Officer (ECO), Exec. Director of Quality & EHS, and the laboratory's Quality Director within 24 hours of discovery.

Whether an inaccurate result was reported due to calculation or quantitation errors, data entry errors, improper practices, or failure to follow SOPs, the data must be evaluated to determine the possible effect.

The Laboratory Director, QA Manager, ECOs, Corporate Quality, Executive VP of Operations, VP of Operations, and the Quality Directors have the authority and responsibility to halt work, withhold final reports, or suspend an analysis for due cause as well as authorize the resumption of work.

11.3 Evaluation of Significance and Actions Taken

For each nonconforming issue reported, an evaluation of its significance and the level of management involvement needed is made. This includes reviewing its impact on the final data, whether or not it is an isolated or systematic issue, and how it relates to any special client requirements.

TestAmerica's Corporate Data Investigation & Recall Procedure (SOP No. CW-L-S-002) distinguishes between situations when it would be appropriate for laboratory management to make the decision on the need for client notification (written or verbal) and data recall (report revision), and when the decision must be made with the assistance of the ECOs and Corporate Management. Laboratory level decisions are documented and approved using the laboratory's standard nonconformance/corrective action reporting in lieu of the data recall determination form contained in TestAmerica's Corporate SOP No. CW-L-S-002.

11.4 Prevention of Non-Conforming Work

If it is determined that the nonconforming work could recur, further corrective actions must be made following the laboratory's corrective action system. Periodically as defined by the laboratory's preventive action schedule, the QA department evaluates nonconformances to determine if any nonconforming work has been repeated multiple times. If so, the laboratory's corrective action process may be followed.

11.5 Method Suspension / Restriction (Stop Work Procedures)

In some cases, it may be necessary to suspend/restrict the use of a method or target compound which constitutes significant risk and/or liability to the laboratory. Suspension/restriction procedures can be initiated by any of the persons noted in Section 11.2, Paragraph 5.

Prior to suspension/restriction, confidentiality will be respected, and the problem with the required corrective and preventive action will be stated in writing and presented to the Laboratory Director.

The Laboratory Director shall arrange for the appropriate personnel to meet with the QA Manager as needed. This meeting shall be held to confirm that there is a problem, that suspension/restriction of the method is required, and will be concluded with a discussion of the steps necessary to bring the

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method/target or test fully back on line. In some cases, that may not be necessary if all appropriate personnel have already agreed there is a problem and there is agreement on the steps needed to bring the method, target or test fully back on line.

The QA Manager will also initiate a corrective action report as described in Section 12 if one has not already been started. A copy of any meeting notes and agreed upon steps should be faxed or e-mailed by the laboratory to the appropriate VP Operations and member of Corporate QA. This fax/e-mail acts as notification of the incident.

After suspension/restriction, the lab will hold all reports to clients pending review. No faxing, mailing or distributing through electronic means may occur. The report must not be posted for viewing on the internet. It is the responsibility of the Laboratory Director to hold all reporting and to notify all relevant laboratory personnel regarding the suspension/restriction (e.g., Project Management, Log-in, etc…). Clients will NOT generally be notified at this time. Analysis may proceed in some instances depending on the non-conformance issue.

Within 72 hours, the QA Manager will determine if compliance is now met and reports can be released, OR determine the plan of action to bring work into compliance, and release work. A team, with all principals involved (Laboratory Director, Technical Manager, QA Manager) can devise a start-up plan to cover all steps from client notification through compliance and release of reports. Project Management, and the Directors of Client Services and Sales and Marketing must be notified if clients must be notified or if the suspension/restriction affects the laboratory's ability to accept work. The QA Manager must approve start-up or elimination of any restrictions after all corrective action is complete. This approval is given by final signature on the completed corrective action report.

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SECTION 12. CORRECTIVE ACTION

12.1 Overview

A major component of TestAmerica's Quality Assurance (QA) Program is the problem investigation and feedback mechanism designed to keep the laboratory staff informed on quality related issues and to provide insight to problem resolution. When nonconforming work or departures from policies and procedures in the quality system or technical operations are identified, the corrective action procedure provides a systematic approach to assess the issues, restore the laboratory's system integrity, and prevent reoccurrence. Corrective actions are documented using Non-Conformance Memos (NCMs) and Corrective Action Reports (CARs) (refer to Figure 12-1).

12.2 General

Problems within the quality system or within analytical operations may be discovered in a variety of ways, such as QC sample failures, internal or external audits, proficiency testing (PT) performance, client complaints, staff observation, etc.

The purpose of a corrective action system is to:

- Identify nonconformance events and assign responsibility(s) for investigating.
- Resolve nonconformance events and assign responsibility for any required corrective action.
- Identify systematic problems before they become serious.
- Identify and track client complaints and provide resolution.

12.2.1 Non-Conformance Memo (NCM) – an application within the LIMS, an NCM can be linked to specific samples/jobs and can be compiled in the report narrative. An NCM is used to document the following types of corrective actions:

- Deviations from an established procedure or policy
- QC outside of limits (non-matrix related)
- Isolated reporting / calculation errors
- General client complaints
- Discrepancies in materials / goods received vs. manufacturer packing slips

12.2.2 Corrective Action Report (CAR) – within a comprehensive database known as iCAT, a CAR is used to document larger, more systemic issues. A CAR is used to document the following types of corrective actions:

- Questionable trends that are found in the review of NCMs
- Issues found while reviewing NCMs that warrant further investigation
- Internal and external audit findings
- Failed or unacceptable PT results
- Corrective actions that cross multiple departments in the laboratory
- Systematic reporting / calculation errors
- Client complaints regarding data quality
- Data recall investigations

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- Identified poor process or method performance trends
- Excessive revised reports or hold time violations

This will provide background documentation to enable root cause analysis and preventive action.

12.3 Closed Loop Corrective Action Process

Any employee in the company can initiate a corrective action. There are four main components to a closed-loop corrective action process once an issue has been identified: Cause Analysis, Selection and Implementation of Corrective Actions (both short and long term), Monitoring of the Corrective Actions, and Follow-up.

12.3.1 Cause Analysis

- Upon discovery of a nonconformance event, the event must be defined and documented. An NCM or CAR must be initiated, someone is assigned to investigate the issue and the event is investigated for cause. Table 12-1 provides some general guidelines on determining responsibility for assessment.
- The cause analysis step is the key to the process, as a long term corrective action cannot be determined until the cause is determined. Refer also to Section 12.3.3, Root Cause Analysis.
- If the cause is not readily obvious, the Technical Manager, Laboratory Director, or QA Manager (or QA designee) is consulted.

12.3.2 Selection and Implementation of Corrective Actions

- Where corrective action is needed, the laboratory shall identify potential corrective actions. The action(s) most likely to eliminate the problem and prevent recurrence are selected and implemented. Responsibility for implementation is assigned.
- Corrective actions shall be to a degree appropriate to the magnitude of the problem identified through the cause analysis.
- Whatever corrective action is determined to be appropriate, the laboratory shall document and implement the changes. The NCM or CAR is used for this documentation.

12.3.3 Root Cause Analysis (RCA)

Root cause analysis is a class of problem solving (investigative) methods aimed at identifying the basic or causal factor(s) that underlie variation in performance or the occurrence of a significant failure. The root cause may be buried under seemingly innocuous events, many steps preceding the perceived failure. At first glance, the immediate response is typically directed at a symptom and not the cause. Typically, RCA would be best with three or more incidents to triangulate a weakness.

The laboratory systematically analyzes and documents the root causes of the more significant problems that are reported. The laboratory identifies, tracks, and implements the corrective actions required to reduce the likelihood of recurrence of significant incidents. The laboratory can trend the root cause data from these incidents to identify root causes that, when corrected, can lead to dramatic improvements in performance by eliminating entire classes of problems.

The investigator identifies the one event associated with a problem and ask why this event occurred. The investigator may brainstorm the root causes of failures; for example, by asking why events occurred or conditions existed; and then why the cause occurred 5 consecutive times until one gets to

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the root cause. For each of these sub events or causes, one asks why it occurred. Repeat the process for the other events associated with the incident. More detailed explanation of root cause analysis can be found in TestAmerica's Corporate SOP No. CA-Q-S-009, *Root Cause Analysis*.

Root cause analysis does not mean the investigation is over. Look at technique, or other systems outside the normal indicators. Often creative thinking will find root causes that ordinarily would be missed, and would continue to afflict the laboratory or operation.

12.3.4 Monitoring of the Corrective Actions

- The Technical Manager and QA Manager are responsible to ensure that the corrective action taken was effective.
- Ineffective actions are documented and re-evaluated until acceptable resolution is achieved. Technical Managers are accountable to the Laboratory Director to ensure final acceptable resolution is achieved and documented appropriately.
- Each NCM and CAR is entered into a database for tracking purposes and a monthly summary of all corrective actions is printed out for review to aid in ensuring that the corrective actions have taken effect.
- The QA Manager reviews monthly NCMs and CARs for trends. Highlights are included in the QA monthly report (refer to Section 16). If a significant trend develops that adversely affects quality, an audit of the area is performed and corrective action implemented.
- Any out-of-control situations that are not addressed acceptably at the laboratory level may be reported to the Corporate Quality Director by the QA Manager, indicating the nature of the out-of-control situation and problems encountered in solving the situation.

12.3.5 Follow-up Audits

- Follow-up audits may be initiated by the QA department and shall be performed as soon as possible when the identification of a nonconformance casts doubt on the laboratory's compliance with its own policies and procedures, or on its compliance with state or federal requirements.
- These audits often follow the implementation of the corrective actions to verify effectiveness. An additional audit would only be necessary when a critical issue or risk to business is discovered.

(Also refer to Section 15.1.4, Special Audits.)

12.4 Technical Corrective Actions

In addition to providing acceptance criteria and specific protocols for technical corrective actions in the method SOPs, the laboratory has general procedures to be followed to determine when departures from the documented policies and procedures and quality control have occurred (refer to Section 11). The documentation of these procedures is through the use of an NCM or CAR.

Table 12-1 includes examples of general technical corrective actions. For specific criteria and corrective actions, refer to the analytical methods or specific method SOPs. The laboratory may also maintain Work Instructions on these items that are available upon request.

Table 12-1 provides some general guidelines for identifying the individual(s) responsible for assessing each QC type and initiating corrective action. The table also provides general guidance on how a data set should be treated if associated QC measurements are unacceptable. Specific procedures are

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included in Method SOPs, Work Instructions, and QAM Sections 19 and 20. All corrective actions are reviewed monthly, at a minimum, by the QA Manager and highlights are included in the QA monthly report.

To the extent possible, samples shall be reported only if all quality control measures are acceptable. If the deficiency does not impair the usability of the results, data will be reported with an appropriate data qualifier and/or the deficiency will be noted in the case narrative. Where sample results may be impaired, the Project Manager is notified by an NCM and appropriate corrective action (e.g., reanalysis) is taken and documented.

12.5 Basic Corrections

When mistakes occur in records, each mistake shall be crossed-out, [not obliterated (e.g. no white-out)], and the correct value entered alongside. All such corrections shall be initialed (or signed) and dated by the person making the correction. In the case of records stored electronically, the original "uncorrected" file must be maintained intact and a second "corrected" file is created.

This same process applies to adding additional information to a record. All additions made later than the initial must also be initialed (or signed) and dated.

When corrections are due to reasons other than obvious transcription errors, the reason for the corrections (or additions) shall also be documented.

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Figure 12-1. Example - Corrective Action Report

Corrective Action Report

Item: C-14-022
Entered: 6/26/2014
Dept.: GCMS Volatiles

Ref1: Phenova HW0414
Ref2: 8260B/C

Issue PT Failure

Missed the following analyte in PT-VOA-SOIL (310-29704-1):

Analyte: Methylene chloride
Result: 12.2 ug/kg
Reference: <9.0 ug/kg
Acceptance Range: ND

Root Cause

The laboratory performed a failure investigation using the PT Corrective Action / Preventive Action checklist. The reported PT result was below the laboraotory's RL. There was an equivalent amount found in the batch method blank. It is assumed the reported value was due entirely to background contamination.

Root Cause Party: Derrick Klinkenberg
Root Cause Date: 9/9/2014

Corrective Action

It is not necessary to report to the MDL on the Volatiles in Soil PT. In future studies, the lab will report to the RL (50 ug/kg).

A known QC sample was ordered and analyzed on 9/2/2014 (sample 310-37720-2). Results were within acceptance criteria.
Methylene Chloride Result: 63.0 ug/kg
Reference: 65.3 ug/kg
Acceptance Range: 30.3 - 96.8 ug/kg

Corrective Action Party: Derrick Klinkenberg
Corrective Action Date: 9/24/2014

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Table 12-1. Example – General Corrective Action Procedures

QC Activity *(Individual Responsible for Initiation/Assessment)*	Acceptance Criteria	Recommended Corrective Action
Initial Instrument Blank [ICB] *(Analyst)*	- Instrument response < RL	- Prepare another blank - If same response, determine cause of contamination: reagents, environment, instrument equipment failure, etc…
Initial Calibration Standards *(Analyst, Technical Managers)*	- Correlation coefficient > 0.99 or standard concentration value - % Recovery within acceptance range - See details in Method SOP	- Reanalyze standards - If still unacceptable, remake standards and recalibrate instrument
Independent Calibration Verification [ICV] (Second Source) *(Analyst, Technical Managers)*	- % Recovery within control limits	- Remake and reanalyze standard - If still unacceptable, then remake calibration standards or use new primary standards and recalibrate instrument
Continuing Calibration Standards [CCV] *(Analyst, Data Reviewer)*	- % Recovery within control limits	- Reanalyze standard - If still unacceptable, then recalibrate and rerun affected samples
Matrix Spike / Matrix Spike Duplicate [MS/MSD] *(Analyst, Data Reviewer)*	- % Recovery within limits in LIMS - % RPD within limits in LIMS	- If the acceptance criteria for duplicates or matrix spikes are not met because of matrix interferences, the acceptance of the analytical batch is determined by the validity of the LCS - If the LCS is within acceptable limits the batch is acceptable - The results of the duplicates, matrix spikes and the LCS are reported with the data set - For matrix spike or duplicate results outside criteria the data for that sample shall be reported with qualifiers

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QC Activity ***(Individual Responsible for Initiation/Assessment)***	**Acceptance Criteria**	**Recommended Corrective Action**
Laboratory Control Sample (LCS) *(Analyst, Data Reviewer)*	- % Recovery within limits in LIMS	- Batch must be re-prepared and re-analyzed. This includes any allowable marginal exceedances When not using marginal exceedances, the following exceptions apply: 1) when the acceptance criteria for the positive control are exceeded high (i.e., high bias) and there are associated samples that are non-detects, then those non-detects may be reported with data qualifying codes; 2) when the acceptance criteria for the positive control are exceeded low (i.e., low bias), those sample results may be reported if they exceed a maximum regulatory limit/decision level with data qualifying codes **Note:** If there is insufficient sample or the holding time cannot be met, contact client and report with flags
Surrogates *(Analyst, Data Reviewer)*	- % Recovery within limits of method or within three standard deviations of the historical mean	- Individual sample must be repeated. Place comment in LIMS. - Surrogate results outside criteria shall be reported with qualifiers.
Method Blank (MB) *(Analyst, Data Reviewer)*	< Reporting Limit [1]	- Reanalyze blank. - If still positive, determine source of contamination. If necessary, reprocess (i.e. digest or extract) entire sample batch. Report blank results. - Qualify the result(s) if the concentration of a targeted analyte in the MB is at or above the reporting limit AND is > 1/10 of the amount measured in the sample.
Proficiency Testing (PT) Samples *(QA Manager, Technical Manager(s))*	- Criteria supplied by PT Supplier	- Any failures or warnings must be investigated for cause. Failures may result in the need to repeat a PT sample to show the problem is corrected. The laboratory has an SOP (CF-GP-22) that describes this process
Internal / External Audits *(QA Manager, Technical Manager(s), Laboratory Director)*	- Defined in Quality System documentation such as SOPs, QAM, etc.	- Nonconformances must be investigated through CAR system and necessary corrections must be made.

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QC Activity ***(Individual Responsible for Initiation/Assessment)***	**Acceptance Criteria**	**Recommended Corrective Action**
Reporting / Calculation Errors (Depends on issue – possible individuals include: *Analysts, Data Reviewers, Project Managers, Technical Managers, QA Manager, Corporate QA, Corporate Management*)	- SOP CW-L-S-002, Internal Investigation of Potential Data Discrepancies and Determination for Data Recall	- Corrective action is determined by type of error. Follow the procedures in SOP CW-L-S-002
Client Complaints *(Project Managers, Lab Director, Sales and Marketing)*	- Determined on a case-by-case basis	- Corrective action is determined by the type of complaint. For example, a complaint regarding an incorrect address on a report will result in the report being corrected and then follow-up must be performed on the reasons the address was incorrect (e.g., LIMS project needs to be updated).
QA Monthly Report (Refer to Section 16 for an example) *(QA Manager, Lab Director, Technical Manager(s))*	- QAM, SOPs	- Corrective action is determined by the type of issue. For example, CARs for the month are reviewed and possible trends are investigated
Health and Safety Violation *(EHSC, Lab Director, Technical Manager(s))*	- Environmental Health and Safety Manual (EHSM)	- Nonconformance is investigated and corrected through the Environmental Health and Safety Coordinator's CAR system

Notes:

1. Except as noted here for certain compounds, the method blank should be below the reporting limit (RL). Concentrations up to five times the RL will be allowed for the ubiquitous laboratory and reagent contaminants: methylene chloride, toluene, acetone, 2-butanone and phthalates **provided** they appear in similar levels in the reagent blank and samples. This allowance presumes that the RL is significantly below any regulatory limit to which the data are to be compared and that blank subtraction will not occur. For benzene and ethylene dibromide (EDB) and other analytes for which regulatory limits are extremely close to the RL, the method blank must be below the RL.

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SECTION 13. PREVENTIVE ACTION / IMPROVEMENT

13.1 Overview

The laboratory's preventive action programs improve or eliminate potential causes of nonconforming product and/or nonconformance to the quality system. This preventive action process is a proactive and continuous process of improvement activities that can be initiated through feedback from clients, employees, business providers, and affiliates. The QA Department has the overall responsibility to ensure that the preventive action process is in place, and that relevant information on actions is submitted for management review.

Dedicating resources to an effective preventive action system emphasizes the laboratory's commitment to its Quality Program. It is beneficial to identify and address negative trends before they develop into complaints, problems and corrective actions. Additionally, the laboratory continually strives to improve customer service and client satisfaction through continuous improvements to laboratory systems.

Opportunities for improvement may be discovered during management system reviews, review of the monthly QA Metrics Report, evaluation of internal or external audits, results & evaluation of proficiency testing (PT) performance, review of control charts and QC results, data analysis & review processing operations, client complaints, staff observation, etc.

The monthly Management Systems Metrics Report shows performance indicators in all areas of the laboratory and quality system. These areas include revised reports, corrective actions, audit findings, internal auditing and data authenticity audits, client complaints, PT samples, holding time violations, SOPs, ethics training, etc. The metrics report is reviewed monthly by laboratory management, Corporate QA, and Executive Committee. These metrics are used in evaluating the management and quality system performance on an ongoing basis and provide a tool for identifying areas for improvement.

Items identified as continuous improvement opportunities to the management system may be issued as goals from the annual management systems review, recommendations from internal audits, white papers, Lesson Learned, Technical Services audit report, Technical Best Practices, or as Corporate or management initiatives.

The laboratory's corrective action process is integral to implementation of preventive actions. A critical piece of the corrective action process is the implementation of actions to prevent further occurrence of a non-compliance event. Historical review of corrective action and non-conformnaces provides a valuable mechanism for identifying preventive action opportunities.

13.1.1 The following elements are part of a preventive action system:

- Identification of an opportunity for preventive action or process improvment.
- Process for the preventive action or improvement.
- Define the measurements of the effectiveness of the process once undertaken.
- Execution of the preventive action or improvement.
- Evaluation of the plan using the defined measurements.
- Verification of the effectiveness of the preventive action or improvement.

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- Close-Out by documenting any permanent changes to the Quality System as a result of the preventive action or process improvement. Documentation of preventive action or process improvment is incorporated into the monthly QA reports, corrective action process, and management review.

13.1.2 Any preventive action or process improvement undertaken or attempted shall be taken into account during the annual Management Systems Review (Section 16). A highly detailed report is not required; however, a summary of successes and failures within the preventive action program is sufficient to provide management with a measurement for evaluation.

13.2 Management of Change

The Management of Change process is designed to manage significant events and changes that occur within the laboratory. Through these procedures, the potential risks inherent with a new event or change are identified and evaluated. The risks are minimized or eliminated through pre-planning and the development of preventive measures. The types of changes covered under this system include: facility changes, major accreditation changes, addition or deletion to division's capabilities or instrumentation, key personnel changes, and Laboratory Information Management System (LIMS) changes.

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SECTION 14. CONTROL OF RECORDS

The laboratory maintains a records management system appropriate to its needs and that complies with applicable standards or regulations as required. The system produces unequivocal, accurate records that document all laboratory activities. The laboratory retains all original observations, calculations and derived data, calibration records and a copy of the analytical report for a minimum of five (5) years after it has been issued.

14.1 Overview

The laboratory has established procedures for identification, collection, indexing, access, filing, storage, maintenance and disposal of quality and technical records. A record index is listed in Table 14-1. Quality records are maintained by the QA department in a database (Access), which is backed up as part of the regular laboratory backup. Records are of two types; either electronic or hard copy paper formats depending on whether the record is computer or hand generated (some records may be in both formats). Technical records are maintained in the LIMS by Corporate IT personnel.

Table 14-1. Record Index

	Record Types [1]:	Retention Time:
Technical Records	- Raw Data - Logbooks[2] - Standards - Certificates - Analytical Records - MDLs/IDLs/DOCs - Lab Reports	7 Years from analytical report issue*
Official Documents	- Quality Assurance Manual (QAM) - Work Instructions - Policies - SOPs - Policy Memorandums - Manuals	7 Years from document retirement date*
QA Records	- Internal & External Audits/Responses - Certifications - Corrective/Preventive Actions - Management Reviews - Method & Software Validation / Verification Data - Data Investigation	7 Years from archival* **Data Investigation:** 7 years or the life of the affected raw data storage whichever is greater (beyond 7 years if ongoing project or pending investigation)
Project Records	- Sample Receipt & COC Documentation - Contracts and Amendments - Correspondence - QAPP - SAP - Telephone Logbooks - Lab Reports	7 Years from analytical report issue*

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	Record Types [1]:	Retention Time:
Administrative Records	Finance and Accounting	10 years
	EH&S Manual, Permits	7 years
	Disposal Records	Indefinitely
	Employee Handbook	Indefinitely
	Personnel files, Employee Signature & Initials, Administrative Training Records (e.g., Ethics)	Refer to HR Manual
	Administrative Policies Technical Training Records	7 years

[1] Record Types encompass hardcopy and electronic records.
[2] Examples of Logbook types: Maintenance, Instrument Run, Preparation (standard and samples), Standard and Reagent Receipt, Archiving, Balance Calibration, Temperature (hardcopy or electronic records).
* Exceptions listed in Table 14-2.

14.1.1 Record Storage

All records are stored and retained in such a way that they are secure and readily retrievable at the laboratory facility or an offsite location (Midwest Mini-Storage) that provides a suitable environment to prevent damage or deterioration and to prevent loss. All records shall be protected against fire, theft, loss, environmental deterioration, and vermin. In the case of electronic records, electronic or magnetic sources, storage media are protected from deterioration caused by magnetic fields and/or electronic deterioration.

Access to the data is limited to laboratory and company employees and shall be documented with an access log. Records archived off-site are stored in a secure location where a record is maintained of any entry into the storage facility for the purpose of retrieving data. Whether on-site or off-site storage is used, logs are maintained in each storage box to note removal and return of records. Retention of records are maintained on-site at the laboratory for at least 6 months after their generation and moved offsite for the remainder of the required storage time. Records are maintained for a minimum of seven years unless otherwise specified by a client or regulatory requirement.

For raw data and project records, record retention shall be calculated from the date the project report is issued. For other records, such as Controlled Documents, QA, or Administrative Records, the retention time is calculated from the date the record is formally retired. Records related to the programs listed in Table 14-2 have lengthier retention requirements and are subject to the requirements in Section 14.1.3.

14.1.2 Programs with Longer Retention Requirements

Some regulatory programs have longer record retention requirements than the standard record retention time. These are detailed in Table 14-2 with their retention requirements. In these cases, the longer retention requirement is enacted. If special instructions exist such that client data cannot be destroyed prior to notification of the client, the container or box containing that data is marked as to who to contact for authorization prior to destroying the data.

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Table 14-2. Special Record Retention Requirements

Program	[1]Retention Requirement
Drinking Water – All States	5 years (project records) 10 years - Radiochemistry (project records)
Drinking Water Lead and Copper Rule	12 years (project records)
FIFRA – 40 CFR Part 160	Retain for life of research or marketing permit for pesticides regulated by EPA
Housing and Urban Development (HUD) Environmental Lead Testing	10 years
Michigan Department of Environmental Quality – all environmental data	10 years
TSCA - 40 CFR Part 792	10 years after publication of final test rule or negotiated test agreement

[1] Note: Extended retention requirements must be noted with the archive documents or addressed in facility-specific records retention procedures.

14.1.3 The laboratory has procedures to protect and back-up records stored electronically and to prevent unauthorized access to or amendment of these records. All analytical data is maintained as hard copy or in a secure readable electronic format. For analytical reports that are maintained as copies in PDF format, refer to Section 19.14.1 for more information.

14.1.4 The record keeping system allows for historical reconstruction of all laboratory activities that produced the analytical data, as well as rapid recovery of historical data. Records stored off site should be accessible within 2 days of a request for such records. The history of the sample from when the laboratory took possession of the samples must be readily understood through the documentation. This shall include inter-laboratory transfers of samples and/or extracts.

- The records include the identity of personnel involved in sampling, sample receipt, preparation, and testing. All analytical work contains the initials (at least) of the personnel involved. The laboratory's copy of the COC is stored with the work order sheet generated by the LIMS. The chain of custody would indicate the name of the sampler. If any sampling notes are provided with a work order, they are kept with this package.

- All information relating to the laboratory facilities equipment, analytical test methods, and related laboratory activities, such as sample receipt, sample preparation, or data verification are documented.

- The record keeping system facilitates the retrieval of all working files and archived records for inspection and verification purposes (e.g., set format for naming electronic files, set format for what is included with a given analytical data set). Instrument data is stored sequentially by instrument. A given day's analyses are maintained in the order of the analysis. Run logs are maintained for each instrument or method; a copy of each day's run log or instrument sequence is stored with the data to aid in re-constructing an analytical sequence. Where an analysis is performed without an instrument, bound logbooks or bench sheets are used to record and file data; these documents are then scanned and filed with the data in LIMS. Standard and reagent information is entered into the LIMS for each method as required.

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- Changes to hardcopy records shall follow the procedures outlined in Section 12 and 19. Changes to electronic records in LIMS or instrument data are recorded in audit trails.

- The reason for a signature or initials on a document is clearly indicated in the records such as "sampled by," "prepared by," "reviewed by", or "analyzed by".

- All generated data except those that are generated by automated data collection systems, are recorded directly, promptly and legibly in permanent dark ink.

- Hard copy data may be scanned into PDF format for record storage as long as the scanning process can be verified in order to ensure that no data is lost and the data files and storage media must be tested to verify the laboratory's ability to retrieve the information prior to the destruction of the hard copy that was scanned.

- Also refer to Section 19.14.1 'Computer and Electronic Data Related Requirements'.

14.2 Technical and Analytical Records

14.2.1 The laboratory retains records of original observations, derived data and sufficient information to establish an audit trail, calibration records, staff records, and a copy of each analytical report issued, for a minimum of seven years unless otherwise specified by a client or regulatory requirement. The records for each analysis shall contain sufficient information to enable the analysis to be repeated under conditions as close as possible to the original. The records shall include the identity of laboratory personnel responsible for the sampling, performance of each analysis, and reviewing results.

14.2.2 Observations, data, and calculations are recorded real-time and are identifiable to the specific task.

14.2.3 Changes to hardcopy records shall follow the procedures outlined in Section 12 and 19. Changes to electronic records in LIMS or instrument data are recorded in audit trails.

The essential information to be associated with analysis, such as strip charts, tabular printouts, computer data files, analytical notebooks, and run logs, include:

- laboratory sample ID code;
- date of analysis; time of analysis is also required if the holding time is seventy-two (72) hours or less, or when time critical steps are included in the analysis (e.g., drying times, incubations, etc.); instrumental analyses have the date and time of analysis recorded as part of their general operations. Where a time-critical step exists in an analysis, location for such a time is included as part of the documentation in LIMS, in a specific logbook, or on a benchsheet;
- instrumentation identification and instrument operating conditions/parameters. Operating conditions/parameters are typically recorded in instrument maintenance logs where available;
- analysis type;
- all manual calculations and manual integrations;
- analyst's or operator's initials/signature;
- sample preparation including cleanup, separation protocols, incubation periods or subculture, ID codes, volumes, weights, instrument printouts, meter readings, calculations, reagents;

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- test results;
- standard and reagent origin, receipt, preparation, and use;
- calibration criteria, frequency and acceptance criteria;
- data and statistical calculations, review, confirmation, interpretation, assessment, and reporting conventions;
- quality control protocols and assessment;
- electronic data security, software documentation and verification, software and hardware audits, backups, and records of any changes to automated data entries; and
- method performance criteria including expected quality control requirements. These are indicated both in the LIMS and on specific analytical report formats.

14.2.4 All receipt, preparation, storage, analysis, and reporting of samples or monitoring of support equipment logbooks shall undergo documented supervisory or peer review on a monthly basis.

14.3 Laboratory Support Activities

In addition to documenting all the above-mentioned activities, the following are retained QA records and project records (previous discussions in this section relate where and how these data are stored):

- all original raw data, whether hard copy or electronic, for calibrations, samples and quality control measures, including analysts' work sheets and data output records (chromatograms, strip charts, and other instrument response readout records);
- a written description or reference to the specific test method used which includes a description of the specific computational steps used to translate parametric observations into a reportable analytical value;
- copies of final reports;
- archived SOPs;
- correspondence relating to laboratory activities for a specific project;
- all corrective action reports, audits and audit responses;
- proficiency test results and raw data; and
- results of data review, verification, and crosschecking procedures.

14.3.1 Sample Handling Records

Records of all procedures to which a sample is subjected while in the possession of the laboratory are maintained. These include but are not limited to records pertaining to:

- sample preservation including appropriateness of sample container and compliance with holding time requirements;
- sample identification, receipt, acceptance or rejection, and login;
- sample storage and tracking including shipping receipts, sample transmittal / COC forms; and
- procedures for the receipt and retention of samples, including all provisions necessary to protect the integrity of samples.

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14.4 Administrative Records

The laboratory also maintains the administrative records in either electronic or hard copy form. Refer to Table 14-1.

14.5 Records Management, Storage and Disposal

All records (including those pertaining to test equipment), certificates, and reports are safely stored, held secure and in confidence to the client. Certification related records are available upon request.

All information necessary for the historical reconstruction of data is maintained by the laboratory. Records that are stored only on electronic media must be supported by the hardware and software necessary for their retrieval.

Records that are stored or generated by computers or personal computers have hard copy, write-protected backup copies, or an electronic audit trail controlling access.

The laboratory has a record management system (a.k.a., document control) for control of laboratory notebooks, instrument logbooks, standards logbooks, and records for data reduction, validation, storage and reporting. Laboratory notebooks are issued on a per analysis basis, and are numbered sequentially. All data are recorded sequentially within a series of sequential notebooks. Bench sheets are filed sequentially. Standards are maintained in the LIMS – no logbooks are used to record that data. Records are considered archived when noted as such in the records management system.

14.5.1 Transfer of Ownership

In the event that the laboratory transfers ownership or goes out of business, the laboratory shall ensure that the records are maintained or transferred according to client's instructions. Upon ownership transfer, record retention requirements shall be addressed in the ownership transfer agreement and the responsibility for maintaining archives is clearly established. In addition, in cases of bankruptcy, appropriate regulatory and state legal requirements concerning laboratory records must be followed. In the event of the closure of the laboratory, all records will revert to the control of the corporate headquarters. Should the entire company cease to exist, as much notice as possible will be given to clients and the accrediting bodies who have worked with the laboratory during the previous 5 years of such action.

14.5.2 Records Disposal

Records are removed from the archive and destroyed after 7 years unless otherwise specified by a client or regulatory requirement. On a project specific or program basis, clients may need to be notified prior to record destruction. Records are destroyed in a manner that ensures their confidentiality such as shredding, mutilation or incineration. (Refer to Tables 14-1 and 14-2).

Electronic copies of records must be destroyed by erasure or physically damaging off-line storage media so no records can be read.

If a third party records management company is hired to dispose of records, a "Certificate of Destruction" is required.

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SECTION 15. AUDITS

15.1 Internal Audits

Internal audits are performed to verify that laboratory operations comply with the requirements of the lab's quality system and with the external quality programs under which the laboratory operates. Audits are planned and organized by the QA staff. Personnel conducting the audits should be independent of the area being evaluated. Auditors will have sufficient authority, access to work areas, and organizational freedom necessary to observe all activities affecting quality and to report the assessments to laboratory management and, when requested, to corporate management.

Audits are conducted and documented as described in the TestAmerica Corporate SOP on performing Internal Auditing, SOP No. CW-Q-S-003. The types and frequency of routine internal audits are described in Table 15-1. Special or ad hoc assessments may be conducted as needed under the direction of the QA staff.

Table 15-1. Types of Internal Audits and Frequency

Description	Performed by	Frequency
Quality Systems Audits	QA Department, QA approved designee, or Corporate QA	All areas of the laboratory annually
QA Technical Audits	Joint responsibility: a) QA Manager or designee b) Technical Manager or Designee (Refer to CW-Q-S-003)	Technical Audits Frequency: 50% of methods annually
SOP Method Compliance	Joint responsibility: a) QA Manager or designee b) Technical Manager or Designee (Refer to CW-Q-S-003)	SOP Compliance Review Frequency: • All SOPs within a 2-year period • All SDWA SOPs annually
Special	QA Department or Designee	Surveillance or spot checks performed as needed (e.g., to confirm corrective actions from other audits)
Performance Testing	Analysts with QA oversight	Two successful per year for each TNI-field of testing or as dictated by regulatory requirements

15.1.1 Annual Quality Systems Audit

An annual quality systems audit is required to ensure compliance to analytical methods and SOPs, TestAmerica's Data Integrity and Ethics Policies, TNI quality systems, AIHA-LAP policies, client and state requirements, and the effectiveness of the internal controls of the analytical process, including but not limited to data review, quality controls, preventive action, and corrective action. The completeness of earlier corrective actions is assessed for effectiveness & sustainability. The audit is divided into sections for each operating or support area of the lab, and each section is comprehensive for a given area. The area audits may be performed on a rotating schedule throughout the year to ensure adequate coverage of all areas. This schedule may change as situations in the laboratory warrant.

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15.1.2 QA Technical Audits

QA technical audits are based on client projects, associated sample delivery groups, and the methods performed. Reported results are compared to raw data to verify the authenticity of results. The validity of calibrations and QC results are compared to data qualifiers, footnotes, and case narratives. Documentation is assessed by examining run logs and records of manual integrations. Manual calculations are checked. Where possible, electronic audit miner programs (Chrom AuditMiner) are used to identify unusual manipulations of the data deserving closer scrutiny. QA technical audits will include all methods within a two-year period.

15.1.3 SOP Method Compliance

Compliance of all SOPs with the source methods and compliance of the operational groups with the SOPs will be assessed by the Technical Manager or qualified designee at least every two years. (Annually for methods and administrative SOPs related to drinking water programs.) It is also recommended that the work of each newly hired analyst is assessed within 3 months of working independently, (i.e., completion of method IDOC). In addition, as analysts add methods to their capabilities (new IDOC), it is recommended that a review of the analyst's work products be performed within 3 months of completing the documented training.

15.1.4 Special Audits

Special audits are conducted on an as needed basis, generally as a follow up to specific issues such as client complaints, corrective actions, PT results, data audits, system audits, validation comments, regulatory audits or suspected ethical improprieties. Special audits are focused on a specific issue, and report format, distribution, and timeframes are designed to address the nature of the issue.

15.1.5 Performance Testing

The laboratory participates semi-annually in performance audits conducted through the analysis of PT samples provided by a third party. The laboratory generally participates in the following types of PT studies: drinking water, non-potable water, and solid/soil. The laboratory also participates in quarterly performance testing for industrial hygiene programs.

It is TestAmerica's policy that PT samples be treated as typical samples in the production process. Furthermore, where PT samples present special or unique problems, in the regular production process they may need to be treated differently, as would any special or unique request submitted by any client. The QA Manager must be consulted and in agreement with any decisions made to treat a PT sample differently due to some special circumstance.

Written responses to unacceptable PT results are required. In some cases it may be necessary for blind QC samples to be submitted to the laboratory to show a return to control.

15.2 External Audits

External audits are performed when certifying agencies or clients conduct on-site inspections or submit performance testing samples for analysis. It is TestAmerica's policy to cooperate fully with regulatory authorities and clients. The laboratory makes every effort to provide the auditors with access to personnel, documentation, and assistance. Laboratory supervisors are responsible for providing corrective actions to the QA Manager who coordinates the response for any deficiencies discovered during an external audit. Audit responses are due in the time allotted by the client or agency performing

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the audit. When requested, a copy of the audit report and the labs corrective action plan will be forwarded to Corporate Quality.

The laboratory cooperates with clients and their representatives to monitor the laboratory's performance in relation to work performed for the client. The client may only view data and systems related directly to the client's work. All efforts are made to keep other client information confidential.

15.2.1 Confidential Business Information (CBI) Considerations

During on-site audits, auditors may come into possession of information claimed as business confidential. A business confidentiality claim is defined as "a claim or allegation that business information is entitled to confidential treatment for reasons of business confidentiality or a request for a determination that such information is entitled to such treatment." When information is claimed as business confidential, the laboratory must place on (or attach to) the information at the time it is submitted to the auditor, a cover sheet, stamped or typed legend or other suitable form of notice, employing language such as "trade secret", "proprietary" or "company confidential". Confidential portions of documents otherwise non-confidential must be clearly identified. CBI may be purged of references to client identity by the responsible laboratory official at the time of removal from the laboratory. However, sample identifiers may not be obscured from the information. Additional information regarding CBI can be found in within the 2009 TNI standards.

15.3 Audit Findings

Audit findings are documented using the corrective action process and database. The laboratory's corrective action responses for both types of audits (internal and external) may include action plans that could not be completed within a predefined timeframe. In these instances, a completion date must be set and agreed to by operations management and the QA Manager.

Developing and implementing corrective actions to audit findings is the responsibility of the manager or supervisor where the finding originated. Findings that are not corrected by specified due dates are reported monthly to management in the QA monthly report. When requested, a copy of the audit report and the lab's corrective action plan will be forwarded to Corporate Quality.

If any audit finding casts doubt on the effectiveness of the operations or on the correctness or validity of the laboratory's test results, the laboratory shall take timely corrective action, and shall notify clients in writing if the investigations show that the laboratory results have been affected. Once corrective action is implemented, a follow-up audit is scheduled to ensure that the problem has been corrected.

Clients must be notified promptly in writing, of any event such as the identification of defective measuring or test equipment that casts doubt on the validity of results given in any test report or amendment to a test report. The investigation must begin within 24-hours of discovery of the problem and all efforts are made to notify the client within two weeks after the completion of the investigation.

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SECTION 16. MANAGEMENT REVIEWS

16.1 Quality Assurance Report

A comprehensive QA Report shall be prepared each month by the laboratory's QA Department and forwarded to the Laboratory Director, Technical Managers, their Quality Director as well as the VP of Operations. All aspects of the QA system are reviewed to evaluate the suitability of policies and procedures. During the course of the year, the Laboratory Director, VP of Operations, or Corporate QA may request that additional information be added to the report.

On a monthly basis, Corporate QA compiles information from all the monthly laboratory reports. The Corporate Quality Directors prepare a report that includes a compilation of all metrics and notable information and concerns regarding the QA programs within the laboratories. The report also includes a listing of new regulations that may potentially impact the laboratories. This report is presented to the Senior Management Team and VPs of Operations.

16.2 Annual Management Review

The senior lab management team (Laboratory Director, Technical Managers, and QA Manager) conducts a review annually of its quality systems and LIMS to ensure its continuing suitability and effectiveness in meeting client and regulatory requirements and to introduce any necessary changes or improvements. It will also provide a platform for defining goals, objectives, and action items that feed into the laboratory planning system. Corporate Operations and Corporate QA personnel may be included in this meeting at the discretion of the Laboratory Director. The LIMS review consists of examining audits, complaints, ands concerns that have been raised through the year that are related to the LIMS. The laboratory will summarize any critical findings that cannot be solved by the lab and report them to Corporate IT.

This management systems review (guided by Corporate SOP No. CW-Q-S-004 & Work Instruction No. CW-Q-WI-003) uses information generated during the preceding year to assess the "big picture" by ensuring that routine actions taken and reviewed on a monthly basis are not components of larger systematic concerns. The monthly review should keep the quality systems current and effective; therefore, the annual review is a formal senior management process to review specific existing documentation. Significant issues from the following documentation are compiled or summarized by the Laboratory Director and QA Manager prior to the review meeting:

- Matters arising from the previous annual review.
- Prior monthly QA reports issues.
- Laboratory QA metrics.
- Review of report reissue requests.
- Review of client feedback and complaints.
- Issues arising from any prior management or staff meetings.
- Minutes from prior senior lab management meetings. Issues that may be raised from these meetings include:
    - Adequacy of staff, equipment and facility resources.
    - Adequacy of policies and procedures.
    - Future plans for resources and testing capability and capacity.

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- The annual internal double blind PT program sample performance.
- Compliance to the Ethics Policy and Data Integrity Plan. Including any evidence/incidents of inappropriate actions or vulnerabilities related to data Integrity.

A report is generated by the QA Manager and management. The report is distributed to the appropriate VP of Operations and the Quality Director. The report includes, but is not limited to:

- The date of the review and the names and titles of participants.
- A reference to the existing data quality related documents and topics that were reviewed.
- Quality system or operational changes or improvements that will be made as a result of the review [e.g., an implementation schedule including assigned responsibilities for the changes (Action Table)].

Changes to the quality systems requiring update to the laboratory QA Manual shall be included in the next revision of the QA Manual.

16.3 Potential Integrity Related Managerial Reviews

Potential integrity issues (data or business related) must be handled and reviewed in a confidential manner until such time as a follow-up evaluation, full investigation, or other appropriate actions have been completed and issues clarified. TestAmerica's Corporate Data Investigation/Recall SOP shall be followed (SOP No. CW-L-S-002). All investigations that result in finding of inappropriate activity are documented and include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients.

TestAmerica's CEO, Executive VP of Operations, VP of Client & Technical Services, VPs of Operations, and Quality Directors receive a monthly report from the Exec. Director of Quality & EHS summarizing any current data integrity or data recall investigations. The VPs of Operations are also made aware of progress on these issues for their specific labs.

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SECTION 17. PERSONNEL

17.1 Overview

The laboratory's management believes that its highly qualified and professional staff is the single most important aspect in assuring a high level of data quality and service. The staff consists of professionals and support personnel as outlined in the organization chart in Section 4, Figure 4-1.

All personnel must demonstrate competence in the areas where they have responsibility. Any staff that is undergoing training shall have appropriate supervision until they have demonstrated their ability to perform their job function on their own. Staff shall be qualified for their tasks based on appropriate education, training, experience and/or demonstrated skills as required.

The laboratory employs sufficient personnel with the necessary education, training, technical knowledge, and experience for their assigned responsibilities.

All personnel are responsible for complying with all QA/QC requirements that pertain to the laboratory and their area of responsibility. Each staff member must have a combination of experience and education to adequately demonstrate a specific knowledge of their particular area of responsibility. Technical staff must also have a general knowledge of lab operations, test methods, QA/QC procedures, and records management.

Laboratory management is responsible for formulating goals for lab staff with respect to education, training, and skills and ensuring that the laboratory has a policy and procedures for identifying training needs and providing training of personnel. The training shall be relevant to the present and anticipated responsibilities of the lab staff.

The laboratory only uses personnel that are employed by, or under contract to, the laboratory. Contracted personnel, when used, must meet competency standards of the laboratory and work in accordance to the laboratory's quality system.

17.2 Education and Experience Requirements for Technical Personnel

The laboratory makes every effort to hire analytical staffs that possess a college degree (AA, BA, BS) in an applied science with some chemistry in the curriculum. Exceptions can be made based upon the individual's experience and ability to learn. Some accreditation programs (e.g., AIHA-LAP) have specific education requirements that must be satisfied for management staff, analysts, and technicians. Selection of qualified candidates for laboratory employment begins with documentation of minimum education, training, and experience prerequisites needed to perform the prescribed task. Minimum education and training requirements for TestAmerica employees are outlined in job descriptions and are generally summarized for analytical staff in the table below.

The laboratory maintains job descriptions for all personnel who manage, perform, or verify work affecting the quality of the environmental testing the laboratory performs. Job Descriptions are located on the TestAmerica intranet site's Human Resources web-page. (Also see Section 4 for key position descriptions/responsibilities.)

Experience and specialized training are occasionally accepted in lieu of a college degree (basic lab skills such as using a balance, colony counting, aseptic or quantitation techniques, etc., are also considered).

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As a general rule for analytical staff:

Specialty	Education	Experience
Extractions, Digestions, some electrode methods (pH, DO, Redox, etc.), or Titrimetric and Gravimetric Analyses	H.S. Diploma	On the job training (OJT)
GFAA, CVAA, FLAA, Single component or short list Chromatography (e.g., Fuels, BTEX-GC, IC)	A college degree in an applied science or 2 years of college and at least 1 year of college chemistry	Or 2 years of prior analytical experience
ICP, ICPMS, Long List or complex chromatography (e.g., Pesticides, PCB, Herbicides, HPLC, etc.), GCMS	A college degree in an applied science or 2 years of college chemistry	Or 5 years of prior analytical experience
Spectra Interpretation	A college degree in an applied science or 2 years of college chemistry	And 2 years relevant experience Or 5 years of prior analytical experience
Technical Managers – **General**	Bachelor's Degree in an applied science or engineering with 24 semester hours in chemistry An advanced (MS, PhD.) degree may substitute for one year of experience	And 2 years experience in environmental analysis of representative analytes for which they will oversee
Technical Managers - **Microbiology**	Bachelor's degree in applied science with at least 16 semester hours in general microbiology and biology An advanced (MS, PhD.) degree may substitute for one year of experience	And 2 years experience in environmental analysis of representative analytes for which they will oversee

When an analyst does not meet these requirements, they can perform a task under the direct supervision of a qualified analyst, peer reviewer, or Technical Manager, and they are considered an analyst in training. The person supervising an analyst in training is accountable for the quality of the analytical data and must review and approve data and associated corrective actions. The initials of both the supervisor and the analyst in training must appear in the technical records.

17.3 Training

The laboratory is committed to furthering the professional and technical development of employees at all levels.

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Orientation to the laboratory's policies and procedures, in-house method training, and employee attendance at outside training courses and conferences all contribute toward employee proficiency. Below are examples of various areas of required employee training:

Required Training	Time Frame	Employee Type
Environmental Health & Safety	Prior to lab work	All
Ethics – New Hires	1 week of hire	All
Ethics – Comprehensive	90 days of hire	All
Data Integrity	30 days of hire	Technical and PMs
Quality Assurance	90 days of hire	All
Ethics – Comprehensive Refresher	Annually	All
Initial Demonstration of Capability (IDOC)	Prior to unsupervised method performance	Technical
Continuing Demonstration of Capability (CDOC)	Annually	Technical

The laboratory maintains records of relevant authorization/competence, education, professional qualifications, training, skills, and experience of technical personnel (including contracted personnel), as well as the date that approval/authorization was given. These records are kept on file at the laboratory. Also refer to "Demonstration of Capability" in Section 19.

The training of technical staff is kept up to date by:

- Each employee must have documentation in their training file that they have read, understood and agreed to follow the most recent version of the laboratory QA Manual and SOPs in their area of responsibility. This documentation is updated as SOPs are updated.
- Documentation from any training courses or workshops on specific equipment, analytical techniques or other relevant topics are maintained in their training file.
- Documentation of proficiency (refer to Section 19).
- An Ethics Agreement signed by each staff member (renewed each year) and evidence of annual ethics training.
- A Confidentiality Agreement signed by each staff member signed at the time of employment.
- Human Resources maintains documentation and attestation forms on employment status & records; benefit programs; timekeeping/payroll; and employee conduct (e.g., ethics violations). This information is maintained in the employee's secured personnel file.

Further details of the laboratory's training program are described in the laboratory's training SOP (CF-GP-23, *Personnel Training*).

17.4 Data Integrity and Ethics Training Program

Establishing and maintaining a high ethical standard is an important element of a Quality System. Ethics and data integrity training is integral to the success of TestAmerica and is provided for each employee at TestAmerica. It is a formal part of the initial employee orientation within 1 week of hire followed by technical data integrity training within 30 days, comprehensive training within 90 days, and

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an annual refresher for all employees. Senior management at each facility performs the ethics training for their staff.

In order to ensure that all personnel understand the importance TestAmerica places on maintaining high ethical standards at all times; TestAmerica has established a Corporate Ethics Policy (Policy No. CW-L-P-004) and an Ethics Statement. All initial and annual training is documented by signature on the signed Ethics Statement demonstrating that the employee has participated in the training and understands their obligations related to ethical behavior and data integrity.

Violations of this Ethics Policy will not be tolerated. Employees who violate this policy will be subject to disciplinary actions up to and including termination. Criminal violations may also be referred to the Government for prosecution. In addition, such actions could jeopardize TestAmerica's ability to do work on Government contracts, and for that reason, TestAmerica has a Zero Tolerance approach to such violations.

Employees are trained as to the legal and environmental repercussions that result from data misrepresentation. Key topics covered in the presentation include:

- Organizational mission and its relationship to the critical need for honesty and full disclosure in all analytical reporting.
- Ethics Policy
- How and when to report ethical/data integrity issues including confidential reporting.
- Record keeping.
- Discussion regarding data integrity procedures.
- Specific examples of breaches of ethical behavior (e.g. peak shaving, altering data or computer clocks, improper macros, etc., accepting/offering kickbacks, illegal accounting practices, unfair competition/collusion)
- Internal monitoring. Investigations and data recalls.
- Consequences for infractions including potential for immediate termination, debarment, or criminal prosecution.
- Importance of proper written narration/data qualification by the analyst and project manager with respect to those cases where the data may still be usable but are in one sense or another partially deficient.

Additionally, a data integrity hotline (1-800-736-9407) is maintained by TestAmerica and administered by the Corporate Quality Department.

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SECTION 18. ACCOMMODATIONS AND ENVIRONMENTAL CONDITIONS

18.1 Overview

The laboratory is a 12,000 ft^2 secure laboratory facility with controlled access and designed to accommodate an efficient workflow and to provide a safe and comfortable work environment for employees. All visitors sign in and are escorted by laboratory personnel. Access is controlled by various measures.

The laboratory is equipped with structural safety features. Each employee is familiar with the location, use, and capabilities of general and specialized safety features associated with their workplace. The laboratory provides and requires the use of personnel protective equipment (PPE) including safety glasses, protective clothing, and gloves. OSHA and other regulatory agency guidelines regarding required amounts of bench and fume hood space, lighting, ventilation (temperature and humidity controls), access, and safety equipment are met or exceeded.

Traffic flow through sample preparation and analysis areas is minimized to reduce the likelihood of contamination. Adequate floor space and bench top area is provided to allow unencumbered sample preparation and analysis space. Sufficient space is also provided for storage of reagents and media, glassware, and portable equipment. Ample space is also provided for refrigerated sample storage before analysis and archival storage of samples after analysis. Laboratory HVAC and deionized water systems are designed to minimize potential trace contaminants.

The laboratory is separated into specific areas for sample receiving, shipping, sample preparation, volatile organic sample analysis, non-volatile organic sample analysis, inorganic sample analysis, microbiological sample analysis, and administrative functions.

18.2 Environment

Laboratory accommodation, test areas, energy sources, and lighting are adequate to facilitate proper performance of tests. The facility is equipped with heating, ventilation, and air conditioning (HVAC) systems appropriate to the needs of environmental testing performed at this laboratory.

The environment in which these activities are undertaken does not invalidate the results or adversely affect the required accuracy of any measurements.

The laboratory provides for the effective monitoring, control and recording of environmental conditions that may affect the results of environmental tests as required by the relevant specifications, methods, and procedures.

When any of the method or regulatory required environmental conditions change to a point where they may adversely affect test results, analytical testing will be discontinued until the environmental conditions are returned to the required levels.

Environmental conditions of the facility housing the computer network and LIMS are regulated to protect against raw data loss. Servers are connected to uninterruptible power supply (UPS) systems in the event of power loss.

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18.3 Work Areas

There is effective separation between neighboring areas when the activities therein are incompatible with each other. Examples include:

- Microbiological culture handling and sample incubation areas.
- Volatile organic chemical handling areas, including sample preparation and waste disposal, and volatile organic chemical analysis areas.
- Closed areas for GCMS analytical work.
- Designated areas for waste disposal and chemical storage.
- Continuous climate regeneration through active fume hoods.

Access to and use of all areas affecting the quality of analytical testing is defined and controlled by secure access to the laboratory building as described below in the Building Security section.

Adequate measures are taken to ensure good housekeeping in the laboratory and to ensure that any contamination does not adversely affect data quality. These measures include regular cleaning to control dirt and dust within the laboratory. Work areas are available to ensure an unencumbered work area. Work areas include:

- Access and entryways to the laboratory.
- Sample receipt areas.
- Sample storage areas.
- Chemical and waste storage areas.
- Data handling and storage areas.
- Sample processing areas.
- Sample analysis areas.

Refer to the following documents and procedures for specific requirements for microbiological laboratory facility requirements.

- Standard Methods, Online Edition, 9020B, Sec. 2
- TNI V1M5, 1.7.3.7.a

18.4 Floor Plan

A floor plan can be found in Appendix 1.

18.5 Building Security

Building keys and alarm codes are distributed to employees as necessary.

Employees wear assigned labcoats that have their names sewn on the front while on the premises.

Visitors to the laboratory sign in and out in a visitor's logbook. A visitor is defined as any person who visits the laboratory who is not an employee of the laboratory. In addition to signing into the laboratory,

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the Environmental, Health and Safety Manual contains requirements for visitors and vendors. There are specific safety forms that must be reviewed and signed. Visitors (with the exception of company employees) are escorted by laboratory personnel at all times, or the location of the visitor is noted in the visitor's logbook. Signs are posted in the laboratory designating employee-only areas: "Notice – Authorized Personnel Only".

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SECTION 19. TEST METHODS AND METHOD VALIDATION

19.1 Overview

The laboratory uses methods that are appropriate to meet our clients' requirements and that are within the scope of the laboratory's capabilities. These include sampling, handling, transport, storage and preparation of samples, and, where appropriate, an estimation of the measurement of uncertainty as well as statistical techniques for analysis of environmental data. A complete listing of the laboratory's methods/capabilities can be found on the world wide web (internet) at:

http://www.testamericainc.com/services/analytical/analyticalservices.aspx

Instructions are available in the laboratory for the operation of equipment as well as for the handling and preparation of samples. All instructions, Standard Operating Procedures (SOPs), reference methods, and manuals relevant to the working of the laboratory are readily available to all staff. Deviations from published methods are documented (with justification) in the laboratory's approved SOPs. SOPs are submitted to clients for review at their request. Significant deviations from published methods require client approval and regulatory approval where applicable.

19.2 Standard Operating Procedures (SOPs)

The laboratory maintains SOPs that accurately reflect all phases of the laboratory such as assessing data integrity, corrective actions, handling customer complaints, as well as all analytical methods and sampling procedures. The method SOPs are derived from the most recently promulgated/approved, published methods and are specifically adapted to the laboratory facility. Modifications or clarifications to published methods are clearly noted in the SOPs. All SOPs are controlled in the laboratory.

- All SOPs contain a revision number, effective date, and appropriate approval signatures. Controlled copies are available to all staff.
- Procedures for writing an SOP are incorporated by reference to TestAmerica's Corporate SOP entitled *Writing a Standard Operating Procedure*, document no. CW-Q-S-002.
- SOPs are reviewed at a minimum of every 2 years (annually for Drinking Water SOPs), and where necessary, revised to ensure continuing suitability and compliance with applicable requirements.

19.3 Laboratory Methods Manual

For each test method, the laboratory shall have available the published referenced method as well as the laboratory developed SOP.

Note: If more stringent standards or requirements are included in a mandated test method or regulation than those specified in this manual, the laboratory shall demonstrate that such requirements are met. If it is not clear which requirements are more stringent, the standard from the method or regulation is to be followed. Any exceptions or deviations from the referenced methods or regulations are noted in the specific analytical SOP.

The laboratory maintains an SOP Index for both technical and non-technical SOPs. Technical SOPs are maintained to describe a specific test method. Non-technical SOPs are maintained to describe functions and processes not related to a specific test method.

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19.4 Selection of Methods

Since numerous methods and analytical techniques are available, continued communication between the client and laboratory is imperative to assure the correct methods are utilized. Once client methodology requirements are established, this and other pertinent information is summarized by the Project Manager. These mechanisms ensure that the proper analytical methods are applied when the samples arrive for log-in. For non-routine analytical services (e.g., special matrices, non-routine compound lists), the method of choice is selected based on client needs and available technology. The methods selected should be capable of measuring the specific parameter of interest, in the concentration range of interest, and with the required precision and accuracy.

19.4.1 Sources of Methods

Routine analytical services are performed using standard EPA-approved methodology. In some cases, modification of standard approved methods may be necessary to provide accurate analyses of particularly complex matrices. When the use of specific methods for sample analysis is mandated through project or regulatory requirements, only those methods shall be used.

When clients do not specify the method to be used or methods are not required, the methods used will be clearly validated and documented in an SOP and available to clients and/or the end user of the data.

The analytical methods used by the laboratory are those currently accepted and approved by the U. S. EPA and the state or territory from which the samples were collected. Method references include:

- *Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act; Analysis and Sampling Procedures; 40CFR Part 136 as amended by Method Update Rule; May 18, 2012.*
- *Methods for Chemical Analysis of Water and Wastes*, EPA 600/4-79/020, revised March 1983 where applicable.
- *Methods for the Determination of Inorganic Substances in Environmental Samples*, EPA 600/R-93/100, August 1993.
- *Methods for the Determination of Metals in Environmental Samples*, EPA 600/4-91/010, June 1991; and *Supplement I*: EPA 600/R-94/111, May 1994.
- *Technical Notes on Drinking Water Methods*, EPA 600/R-94/173, October 1994.
- *Wastewater Laboratory Procedures & Chemistry*, EPA 907/9-75/002, June 1975.
- *NIOSH Manual of Analytical Methods*, 4th Edition, August 1994.
- IDEXX Laboratories, Inc. (www.idexx.com).
- *Standard Methods for the Examination of Water and Wastewater*, 18th/19th /20th/21st/22nd & On-line Editions; Eaton, A.D., Clesceri, L.S., Greenberg, A.E., Rice, E.N. Eds; American Water Works Association, Water Pollution Control Federation, American Public Health Association: Washington, D.C.
- *Test Methods for Evaluating Solid Waste Physical/Chemical Methods* (SW-846) Third Edition, September 1986; Final Update I, July 1992; Final Update IIA, August 1993; Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996; Final Update IIIA, April 1998; Final Update IIIB, November 2004; Final Update IV, February 2007; New Test Methods On-line (www.epa.gov/SW-846).
- *Annual Book of ASTM Standards*, ASTM International, West Conshohocken, PA.
- "Methods for Determination of Inorganic Substances in Water and Fluvial Sediments" (Book 5, Chapter A1), *Techniques of Water-Resources Investigations of the United States Geological Survey*, U.S. Department of the Interior, Denver, CO, Revised 1989 unless otherwise stated.

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- *Manual for the Certification of Laboratories Analyzing Drinking Water*, EPA 815/R-05/004, January 2005.
- Code of Federal Regulations (CFR) 40, Parts 136, 141, 172, 173, 178, 179 and 261.
- *OA-1, Method for Determination of Volatile Petroleum Hydrocarbons (Gasoline)*, Revision 7/27/93, University Hygienic Laboratory, Iowa City, IA.
- *OA-2, Extractable Petroleum Products (and Related Low Volatility Organic Compounds)*, Revision 7/27/93, University Hygienic Laboratory, Iowa City, IA.
- *Modified GRO - Method for Determining Gasoline Range Organics*, PUBL-SW-140, Wisconsin DNR, September 1995.
- *Modified DRO - Method for Determining Diesel Range Organics*, PUBL-SW-141, Wisconsin DNR, September 1995.
- *Method 1664, Revision A: n-Hexane Extractable Material (HEM; Oil and Grease) and Silica Gel Treated n-Hexane Extractable Material (SGT-HEM; Non-polar Material) by Extraction and Gravimetry*, USEPA Office of Water, EPA 821/R-98/002, February 1999.
- *Method 1664, Revision B: n-Hexane Extractable Material (HEM; Oil and Grease) and Silica Gel Treated n-Hexane Extractable Material (SGT-HEM; Non-polar Material) by Extraction and Gravimetry*, USEPA Office of Water, EPA 821/R-10/001, February 2010.

The laboratory reviews updated versions to all the aforementioned references for adaptation based upon capabilities, instrumentation, etc., and implements them as appropriate. As such, the laboratory strives to perform only the latest versions of each approved method as regulations allow or require.

Other reference procedures for non-routine analyses may include methods established by specific states (e.g., Underground Storage Tank methods), research bodies, or equipment manufacturers. Sample type, source, and the governing regulatory agency requiring the analysis will determine the method utilized.

The laboratory shall inform the client when a method proposed by the client may be inappropriate or out of date. After the client has been informed, and they wish to proceed contrary to the laboratory's recommendation, it will be documented.

19.4.2 Demonstration of Capability

Before the laboratory may institute a new method and begin reporting results, the laboratory shall confirm that it can properly operate the method. In general, this demonstration does not test the performance of the method in real world samples, but in an applicable and available clean matrix sample. If the method is for the testing of analytes that are not conducive to spiking, demonstration of capability may be performed on quality control samples.

A demonstration of capability (DOC, Lab SOP No. CF-GP-23) is performed whenever there is a change in instrument type (e.g., new instrumentation), matrix, method, or personnel (e.g., analyst hasn't performed the test within the last 12 months).

Note: The laboratory shall have a DOC for all analytes included in the methods that the laboratory performs, and proficiency DOCs for each analyst shall include all analytes that the laboratory routinely performs. Addition of non-routine analytes does not require new DOCs for all analysts if those analysts are already qualified for routine analytes tested using identical chemistry and instrument conditions.

The initial demonstration of capability must be thoroughly documented and approved by the Technical Manager and QA Manager prior to independently analyzing client samples. All associated documentation must be retained in accordance with the laboratories archiving procedures.
The laboratory must have an approved SOP, demonstrate satisfactory performance, and conduct an MDL study (when applicable). There may be other requirements as stated within the published method or regulations (i.e., retention time window study).

Note: In some instances, a situation may arise where a client requests that an unusual analyte be reported using a method where this analyte is not normally reported. If the analyte is being reported for regulatory purposes, the method must meet all procedures outlined within this QA Manual (SOP, MDL, and Demonstration of Capability). If the client states that the information is not for regulatory purposes, the result may be reported as long as the following criteria are met:

- The instrument is calibrated for the analyte to be reported using the criteria for the method and ICV/CCV criteria are met (unless an ICV/CCV is not required by the method or criteria are per project DQOs).
- The laboratory's nominal or default reporting limit (RL), which is equal to the quantitation limit (QL), must be at or above the lowest non-zero standard in the calibration curve and must be reliably determined. Project RLs are client specified reporting levels which may be higher than the QL. Results reported below the QL must be qualified as estimated values. Also see Section 19.6.1.3, Relationship of Limit of Detection (LOD) to Quantitation Limit (QL).
- The client request is documented and the lab informs the client of its procedure for working with unusual compounds. The final report must be footnoted something to the effect of: *Reporting Limit based on the low standard of the calibration curve.*

19.4.3 Initial Demonstration of Capability (IDOC) Procedures

The procedure for completing an IDOC is summarized below. For a full description, refer also to the laboratory SOP CF-GP-23, *Personnel Training*.

19.4.3.1 The analyte(s) shall be spiked in a volume of clean matrix sufficient to prepare four aliquots at the concentration specified by a method or the laboratory SOP.

19.4.3.2 At least four aliquots shall be prepared (including any applicable clean-up procedures) and analyzed according to the test method (either concurrently or over a period of days).

19.4.3.3 Using all of the results, calculate the means and the standard deviations of the percent recovery for each parameter of interest.

19.4.3.4 When it is not possible to determine the mean and standard deviations, such as for presence, absence and logarithmic values, the laboratory will assess performance against criteria described in the Method SOP.

19.4.3.5 Compare the information obtained above to the corresponding acceptance criteria for precision and accuracy in the test method (if applicable) or in laboratory generated acceptance criteria (LCS or interim criteria) if there is no mandatory criteria established. If any one of the parameters do not meet the acceptance criteria, the performance is unacceptable for that parameter.

19.4.3.6 When one or more of the tested parameters fail at least one of the acceptance criteria, the analyst must proceed according to either option listed below:

- Locate and correct the source of the problem and repeat the test for all parameters of interest beginning with 19.4.3.2 above.
- Beginning with 19.4.3.2 above, repeat the test only for all parameters that failed to meet criteria. Repeated failure, however, will confirm a general problem with the measurement system. If this occurs, locate and correct the source of the problem and repeat the test for all compounds of interest beginning with 19.4.3.1 above.

Note: Results of successive LCS analyses can be used to fulfill the DOC requirement.

A certification statement (refer to Figure 19-1 as an example) shall be used to document the completion of each initial demonstration of capability. A copy of the certification is archived in the analyst's training folder.

Methods on line prior to the effective date of this Section shall be updated to the procedures outlined above as new analysts perform their demonstration of capability. A copy of the new record will replace that which was used for documentation in the past. At a minimum, the precision and accuracy of four mid-level laboratory control samples must have been compared to the laboratory's quality control acceptance limits.

19.5 Laboratory Developed Methods and Non-Standard Methods

Any new method developed by the laboratory must be fully defined in an SOP and validated by qualified personnel with adequate resources to perform the method. Method specifications and the relation to client requirements must be clearly conveyed to the client if the method is a non-standard method (not a published or routinely accepted method). The client must also be in agreement to the use of the non-standard method.

19.6 Validation of Methods

Validation is the confirmation by examination and the provision of objective evidence that the particular requirements for a specific intended use are fulfilled.

All non-standard methods, laboratory designed/developed methods, standard methods used outside of their scope, and major modifications to published methods must be validated to confirm they are fit for their intended use. The validation will be as extensive as necessary to meet the needs of the given application. The results are documented with the validation procedure used and contain a statement as to the fitness for use.

19.6.1 Method Validation and Verification Activities for All New Methods

While method validation can take various courses, the following activities can be required as part of method validation. Method validation records are designated QC records and are archived accordingly.

19.6.1.1 Determination of Method Selectivity

Method selectivity is the demonstrated ability to discriminate the analyte(s) of interest from other compounds in the specific matrix or matrices from other analytes or interference. In some cases to achieve the required selectivity for an analyte, a confirmation analysis is required as part of the method.

19.6.1.2 Determination of Method Sensitivity

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Sensitivity can be both estimated and demonstrated. Whether a study is required to estimate sensitivity depends on the level of method development required when applying a particular measurement system to a specific set of samples. Where estimations and/or demonstrations of sensitivity are required by regulation or client agreement, such as the procedure in 40 CFR Part 136 Appendix B, under the Clean Water Act, these shall be followed.

19.6.1.3 Relationship of Limit of Detection (LOD) to the Quantitation Limit (QL)

An important characteristic of expression of sensitivity is the difference in the LOD and the QL. The LOD is the minimum level at which the presence of an analyte can be reliably concluded. The QL is the minimum concentration of analyte that can be quantitatively determined with acceptable precision and bias. For most instrumental measurement systems, there is a region where semi-quantitative data is generated around the LOD (both above and below the estimated MDL or LOD) and below the QL. In this region, detection of an analyte may be confirmed but quantification of the analyte is unreliable within the accuracy and precision guidelines of the measurement system. When an analyte is detected below the QL, and the presence of the analyte is confirmed by meeting the qualitative identification criteria for the analyte, the analyte can be reliably reported, but the amount of the analyte can only be estimated. If data is to be reported in this region, it must be done so with a qualification that denotes the semi-quantitative nature of the result.

19.6.1.4 Determination of Interferences

A determination that the method is free from interferences in a blank matrix is performed.

19.6.1.5 Determination of Range

Where appropriate to the method, the quantitation range is determined by comparison of the response of an analyte in a curve to established or targeted criteria. Generally the upper quantitation limit is defined by highest acceptable calibration concentration. The lower quantitation limit or QL cannot be lower than the lowest non-zero calibration level, and can be constrained by required levels of bias and precision.

19.6.1.6 Determination of Accuracy and Precision

Accuracy and precision studies are generally performed using replicate analyses, with a resulting percent recovery and measure of reproducibility (standard deviation, relative standard deviation) calculated and measured against a set of target criteria.

19.6.1.7 Documentation of Method

The method is formally documented in an SOP. If the method is a minor modification of a standard laboratory method that is already documented in an SOP, a SOP attachment describing the specific differences in the new method is acceptable in place of a separate SOP.

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19.6.1.8 Continued Demonstration of Method Performance

Continued demonstration of Method Performance is addressed in the SOP. Continued demonstration of method performance is generally accomplished by batch specific QC samples such as LCS, method blanks, or PT samples.

19.7 Method Detection Limits (MDL) / Limits of Detection (LOD)

Method detection limits (MDL) are initially determined in accordance with 40 CFR Part 136, Appendix B or alternatively by other technically acceptable practices that have been accepted by regulators. MDL is also sometimes referred to as Limit of Detection (LOD). The MDL theoretically represents the concentration level for each analyte within a method at which the analyst is 99% confident that the true value is not zero. The MDL is determined for each analyte initially during the method validation process and updated as required in the analytical methods, whenever there is a significant change in the procedure or equipment, or based on project specific requirements. Generally, the analyst prepares at least seven replicates of solution spiked at one to five times the estimated method detection limit (most often at the lowest standard in the calibration curve) into the applicable matrix with all the analytes of interest. The replicates must be divided between at least 3 separate preparation and analysis batches, on 3 separate days. If there are multiple instruments that will be given the same MDL, at least 2 replicates must be analyzed on each instrument. Each of these aliquots is extracted (including any applicable clean-up procedures) and analyzed in the same manner as the samples.

Refer to laboratory SOP No. CF-QA-05, *Determination of Method Detection Limits*, for details on the laboratory's MDL process. This document is based on Corporate SOP No. CA-Q-S-006, *Detection Limits*.

19.8 Instrument Detection Limits (IDL)

The IDL is sometimes used to assess the reasonableness of the MDLs or in some cases required by the analytical method or program requirements. IDLs are most used in metals analyses but may be useful in demonstration of instrument performance in other areas.

IDLs are calculated to determine an instrument's sensitivity independent of any preparation method. IDLs are calculated either using 7 replicate spike analyses, like MDL but without sample preparation, or by the analysis of 10 instrument blanks and calculating 3x the absolute value of the standard deviation.

If IDL is > than the MDL, it may be used as the reported MDL.

19.9 Verification of Detection and Reporting Limits

Once an MDL is established, it must be verified, on each instrument, by analyzing a quality control sample (prepared as a sample) at no more than 3 times the calculated MDL for single analyte analyses (e.g. most wet chemistry methods, Atomic Absorption, etc.) and no more than 4 times the calculated MDL for multiple analyte methods (e.g. GC, GCMS, ICP, etc.). The analytes must be qualitatively identified. This verification does not apply to methods that are not readily spiked (e.g. pH, turbidity, etc.) or where the lab does not report to the MDL. If the MDL does not verify, then the lab will not report to the MDL, or redevelop their MDL or use the level where qualitative identification is established. MDLs must be verified at least annually.

When the laboratory establishes a quantitation limit, it must be initially verified by the analysis of a low level standard or QC sample at the reporting limit. The analytes must be quantitatively recovered within

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specified criteria (typically ±40% of the true value, unless tighter criteria is specified in the method). For organic and wet chemistry analyses, the quantitation limit must be verified each time the instrument is calibrated, or monthly at a minimum. For metals analyses, the quantitation limit must be verified each analytical run sequence.

19.10 Retention Time Windows

Most organic analyses and some inorganic analyses use chromatography techniques for qualitative and quantitative determinations. For every chromatography analysis or as specific in the reference method, each analyte will have a specific time of elution from the column to the detector. This is known as the analyte's retention time. The variance in the expected time of elution is defined as the retention time window. As the key to analyte identification in chromatography, retention time windows must be established on every column for every analyte used for that method. These records are kept with the files associated with an instrument for later quantitation of the analytes. Complete details are available in the laboratory SOPs.

19.11 Evaluation of Selectivity

The laboratory evaluates selectivity by following the checks within the applicable analytical methods, which include mass spectral tuning, second column confirmation, ICP interelement interference checks, chromatography retention time windows, sample blanks, spectrochemical, atomic absorption or fluorescence profiles, co-precipitation evaluations, and specific electrode response factors.

19.12 Estimation of Uncertainty of Measurement

19.12.1 Uncertainty is "a parameter associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand" (as defined by the International Vocabulary of Basic and General Terms in Metrology, ISO Geneva, 1993, ISBN 92-67-10175-1). Knowledge of the uncertainty of a measurement provides additional confidence in a result's validity. Its value accounts for all the factors which could possibly affect the result, such as adequacy of analyte definition, sampling, matrix effects and interferences, climatic conditions, variances in weights, volumes, and standards, analytical procedure, and random variation. Some national accreditation organizations require the use of an "expanded uncertainty": the range within which the value of the measurand is believed to lie within at least a 95% confidence level with the coverage factor k=2.

19.12.2 Uncertainty is not error. Error is a single value, the difference between the true result and the measured result. On environmental samples, the true result is never known. The measurement is the sum of the unknown true value and the unknown error. Unknown error is a combination of systematic error, or bias, and random error. Bias varies predictably, constantly, and independently from the number of measurements. Random error is unpredictable, assumed to be Gaussian in distribution, and reducible by increasing the number of measurements.

19.12.3 The minimum uncertainty associated with results generated by the laboratory can be determined by using the Laboratory Control Sample (LCS) accuracy range for a given analyte. The LCS limits are used to assess the performance of the measurement system since they take into consideration all of the laboratory variables associated with a given test over time (except for variability associated with the sampling and the variability due to matrix effects). The percent recovery of the LCS is compared either to the method-required LCS accuracy limits or to the statistical, historical, in-house LCS accuracy limits.

19.12.4 For a full discussion on how the laboratory determines measurement uncertainty, refer to laboratory SOP No. CF-IH-13, *Estimating Measurement Uncertainty for Industrial Hygiene and Environmental Analyses*.

19.12.5 In the case where a well-recognized test method specifies limits to the values of major sources of uncertainty of measurement (e.g., 524.2, 525, etc.), specifies the form of presentation of calculated results, and the laboratory follows the method exactly as written, no further discussion of uncertainty is required.

19.13 Sample Reanalysis Guidelines

Because there is a certain level of uncertainty with any analytical measurement, a sample re-preparation (where appropriate) and subsequent analysis (hereafter referred to as 'reanalysis') may result in either a higher or lower value from an initial sample analysis. There are also variables that may be present (e.g., sample homogeneity, analyte precipitation over time, etc.) that may affect the results of a reanalysis. Based on the above comments, the laboratory will reanalyze samples at a client's request with the following caveats. Client-specific Contractual Terms & Conditions for reanalysis protocols may supersede the following items.

- Homogenous samples: If a reanalysis agrees with the original result to within the RPD limits for MS/MSD or Duplicate analyses, or within ± 1 reporting limit for samples ≤ 5x the reporting limit, the original analysis will be reported. At the client's request, both results may be reported on the same report but not on two separate reports.

- If the reanalysis does not agree (as defined above) with the original result, then the laboratory will investigate the discrepancy and reanalyze the sample a third time for confirmation if sufficient sample is available.

- Any potential charges related to reanalysis are discussed in the contract terms and conditions or discussed at the time of the request. The client will typically be charged for reanalysis unless it is determined that the lab was in error.

- Due to the potential for increased variability, reanalysis may not be applicable to non-homogenous, Encore, and sodium bisulfate preserved samples. Consult the Technical Manager, QA Manager, and/or Laboratory Director if unsure.

19.14 Control of Data

The laboratory has policies and procedures in place to ensure the authenticity, integrity, and accuracy of the analytical data generated by the laboratory.

19.14.1 Computer and Electronic Data Related Requirements

The three basic objectives of our computer security procedures and policies are shown below. The laboratory is currently running TALS which is a custom in-house developed LIMS system that has been highly customized to meet the needs of the laboratory. It is referred to as LIMS for the remainder of this section. The LIMS utilizes MS SQL Server which is an industry standard relational database platform. It is referred to as Database for the remainder of this section.

19.14.1.1 **Maintain the Database Integrity:** Assurance that data is reliable and accurate through data verification (review) procedures, password-protecting access, anti-virus protection, data change requirements, as well as an internal LIMS permissions procedure.

- LIMS Database Integrity is achieved through data input validation, internal user controls, and data change requirements.
- Spreadsheets and other software developed in-house must be verified with documentation through hand calculations prior to use. Cells containing calculations must be lock-protected and controlled.
- Instrument hardware and software adjustments are safeguarded through maintenance logs, audit trails and controlled access.

19.14.1.2 **Ensure Information Availability:** Protection against loss of information or service is ensured through scheduled back-ups, stable file server network architecture, secure storage of media, line filter, Uninterruptible Power Supply (UPS), and maintaining older versions of software as revisions are implemented.

19.14.1.3 **Maintain Confidentiality:** Ensure data confidentiality through physical access controls such as password protection or website access approval when electronically transmitting data.

19.14.2 Data Reduction

The complexity of the data reduction depends on the analytical method and the number of discrete operations involved (e.g., extractions, dilutions, instrument readings and concentrations). The analyst calculates the final results from the raw data or uses appropriate computer programs to assist in the calculation of final reportable values.

For manual data entry, e.g., Wet Chemistry, the data is reduced by the analyst and then verified by the Technical Manager, Department Manager, or alternate analyst prior to updating the data in LIMS. The spreadsheets, printouts, or any other type of applicable documents are signed by the analyst, and secondary data review checklists are signed by the alternate reviewer to confirm the accuracy of the manual entry(s).

Manual integration of chromatographic peaks will be documented and reviewed, and the raw data will be flagged in accordance with the TestAmerica Corporate SOP No. CA-Q-S-002, *Acceptable Manual Integration Practices*.

Analytical results are reduced to appropriate concentration units specified by the analytical method, taking into account factors such as dilution, sample weight or volume, etc. Blank correction will be applied only when required by the method or per manufacturer's indication; otherwise, it should not be performed. Calculations are independently verified by appropriate laboratory staff. Calculations and data reduction steps for various methods are summarized in the respective analytical SOPs or program requirements.

19.14.2.1 All raw data must be retained in the worklist folder, computer file (if appropriate), and/or runlog. All criteria pertinent to the method must be recorded. The documentation is recorded at the time observations or calculations are made and must be signed or initialed/dated (month, day, and year). It must be easily identifiable who performed which tasks if multiple people were involved.

19.14.2.2 In general, concentration results are reported in milligrams per liter (mg/L) or micrograms per liter (µg/L) for liquids, and milligrams per kilogram (mg/Kg) or micrograms per kilogram (µg/Kg) for solids. For values greater than 10,000 mg/L, results can be reported in percent (e.g., 10,000 mg/L = 1%). Units are defined in each analytical SOP.

19.14.2.3 Rounding rules: round off by dropping digits that are not significant. If the digit 6, 7, 8, or 9 is dropped, increase preceding digit by one unit; if the digit 0, 1, 2, 3, or 4 is dropped, do not alter the preceding digit. If the digit 5 is dropped, round off preceding digit to the nearest even number: thus 2.25 becomes 2.2 and 2.35 becomes 2.4.

19.14.2.4 In reporting, the analyst or the instrument output records the raw data result using values that are expected to be known definitely, except for the last digit, which may be in doubt. Such a number is said to contain only significant figures. If final calculations are performed external to LIMS, the results should be entered in LIMS with at least three significant figures. In general, results are reported to 2 significant figures on the final report.

19.14.2.5 For those methods that do not have an instrument printout or an instrumental output compatible with the LIMS System, the raw results and dilution factors are entered directly into LIMS by the analyst, and the software calculates the final result for the analytical report. LIMS has a defined significant figure criterion for each analyte.

19.14.2.6 The laboratory strives to import data directly from instruments or calculation spreadsheets to ensure that the reported data are free from transcription and calculation errors. For those analyses with an instrumental output compatible with the LIMS, the raw results and dilution factors are transferred into LIMS electronically after reviewing the quantitation report, and removing unrequested or poor spectrally-matched compounds. The analyst prints a copy of what has been entered to check for errors. This printout and the instrument's printout of calibrations, concentrations, retention times, chromatograms, and mass spectra, if applicable, are retained with the data file. The data file is stored in a monthly folder on the instrument computer; periodically, this file is transferred to the server and, eventually, to a tape file.

19.14.3 Logbook / Worksheet Use Guidelines

Logbooks and worksheets are filled out 'real time' and have enough information on them to trace the events of the applicable analysis/task (e.g., calibrations, standards, analyst, sample ID, date, time on short holding time tests, temperatures when applicable, calculations are traceable, etc.).

- Corrections are made following the procedures outlined in Section 12.
- Logbooks are controlled by the QA department. A record is maintained of all logbooks in the lab.
- Unused portions of pages must be "Z"'d out, signed and dated.
- Worksheets are created with the approval of the Technical Manager/QA Manager at the facility. The QA Manager controls all worksheets following the procedures in Section 6.

19.14.4 Review / Verification Procedures

Review procedures for various departments are outlined in several SOPs (CF-SRV-01, CF-GP-04, CF-GP-05, CF-GP-06, and CF-GP-20) to ensure that reported data are free from calculation and transcription errors, that QC parameters have been reviewed, and evaluated before data is reported. The laboratory also abides by a Corporate SOP discussing manual integrations to ensure the authenticity of the data (TestAmerica Corporate SOP No. CA-Q-S-002). The general review concepts are discussed below, more specific information can be found in the SOPs.

19.14.4.1 Log-In Review - The data review process starts at the sample receipt stage. Sample control personnel review chain-of-custody forms and project instructions from the project management group. This is the basis of the sample information and analytical instructions

entered into the LIMS. The log-in instructions are reviewed by the personnel entering the information, and a second level review is conducted by the project management staff.

19.14.4.2 First Level Data Review - The next level of data review occurs with the analysts. As data are generated, analysts review their work to ensure that the results meet project and SOP requirements. First level reviews include inspection of all raw data (e.g., instrument output for continuous analyzers, chromatograms, spectra, and manual integrations), evaluation of calibration/calibration verification data in the day's analytical run, evaluation of QC data, and reliability of sample results. The analyst transfers data into LIMS, data qualifiers are added as needed. All first level reviews are documented.

19.14.4.3 Second Level Data Review – All analytical data are subject to review by a second qualified analyst or supervisor. Second level reviews include inspection of all raw data (e.g., instrument output, chromatograms, and spectra) including 100% of data associated with any changes made by the primary analyst, such as manual integrations or reassignment of peaks to different analytes, or elimination of false negative analytes. The second review also includes evaluation of initial calibration/calibration verification data in the day's analytical run, evaluation of QC data, reliability of sample results, qualifiers and NCM narratives. Manual calculations are checked in second level review. All second level reviews are documented.

Issues that deem further review include the following:

- QC data are outside the specified control limits for accuracy and precision
- Reviewed sample data does not match with reported results
- Unusual reporting limit/detection limit changes are observed
- Samples having unusually high results
- Samples exceeding a known regulatory limit
- Raw data indicating some type of contamination or poor technique
- Inconsistent peak integration
- Transcription errors
- Results outside of calibration range

19.14.4.4 Unacceptable analytical results may require reanalysis of the samples. Any problems are brought to the attention of the Laboratory Director, Project Manager, QA Manager, Technical Manager, or Supervisor for further investigation. Corrective action is initiated whenever necessary.

19.14.4.5 The results are then entered or directly transferred into the computer database and a hard copy report (or an electronic PDF report) is printed for the client.

19.14.4.6 As a final review prior to the release of the report, the Project Manager/Project Management Assistant reviews the results for appropriateness and completeness. This review and approval ensures that client requirements have been met and that the final report has been properly completed. The process includes, but is not limited to, verifying that the COC is followed, cover letters/ narratives are present, flags are appropriate, and project specific

requirements are met. The Project Manager/Project Management Assistant may also evaluate the validity of the results for different test methods given expected chemical relationships.

19.14.4.7 Any project that requires a data package is subject to a tertiary data review for transcription errors and acceptable quality control requirements. The Project Manager then signs the final report. The accounting personnel also check the report for any clerical or invoicing errors. When complete, the report is sent out to the client.

19.14.4.8 A visual summary of the flow of samples and information through the laboratory, as well as data review and validation, is presented in Figure 19-2.

19.14.5 Manual Integrations

Computerized data systems provide the analyst with the ability to re-integrate raw instrument data in order to optimize the interpretation of the data. Though manual integration of data is an invaluable tool for resolving variations in instrument performance and some sample matrix problems, when used improperly, this technique would make unacceptable data appear to meet quality control acceptance limits. Improper re-integrations lead to legally indefensible data, a poor reputation, or possible laboratory decertification. Because guidelines for re-integration of data are not provided in the methods and most methods were written prior to widespread implementation of computerized data systems, the laboratory trains all analytical staff on proper manual integration techniques using TestAmerica's Corporate SOP (CA-Q-S-002) as the guideline for our internal procedures.

19.14.5.1 The analyst must adjust baseline or the area of a peak in some situations, for example when two compounds are not adequately resolved or when a peak shoulder needs to be separated from the peak of interest. The analyst must use professional judgment and common sense to determine when manual integrating is required. Analysts are encouraged to ask for assistance from a senior analyst or manager when in doubt.

19.14.5.2 Analysts shall not increase or decrease peak areas for the sole purpose of achieving acceptable QC recoveries that would have otherwise been unacceptable. The intentional recording or reporting of incorrect information (or the intentional omission of correct information) is against company principles and policy and is grounds for immediate termination.

19.14.5.3 Client samples, performance evaluation samples, and quality control samples are all treated equally when determining whether or not a peak area or baseline should be manually adjusted.

19.14.5.4 All manual integrations receive a second level review. Manual integrations must be indicated on an expanded scale "after" chromatograms such that the integration performed can be easily evaluated during data review. Expanded scale "before" chromatograms are also required for all manual integrations on QC parameters (calibrations, calibration verifications, laboratory control samples, internal standards, surrogates, etc.) unless the laboratory has another documented corporate approved procedure in place that can demonstrate an active process for detection and deterrence of improper integration practices.

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Figure 19-1. Example - Demonstration of Capability Documentation

Analyst Demonstration of Capability

TestAmerica Cedar Falls

10/23/2014

Preparation Method(s):	Distill/Ammonia
Analytical Method(s):	350.1
Matrix:	Water
Method Description:	Nitrogen, Ammonia
Preparation SOP No:	CF-WCA-13
Analytical SOP No:	CF-WCA-13

We, the undersigned, CERTIFY that:

1. The analyst identified above, using the cited test method with the specifications in the cited SOP, which is in use at this facility for the analysis of samples under the laboratory's Quality Assurance Plan, has completed the Demonstration of Capability (DOC).
2. The test method(s) was performed by the analyst identified on this certificate.
3. A copy of test method(s) and laboratory SOPs are available for all personnel on-site. **These documents have been reviewed by the analyst as part of this DOC.**
4. The data associated with the demonstration of capability are true, accurate, complete and self-explanatory.
5. All raw data necessary to reconstruct and validate these analyses have been retained at the facility. The associated information is organized and available for review.

Analyst	**Signature**	**Date**
Technical Manager	**Signature**	**Date**
Quality Assurance Manager	**Signature**	**Date**

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Figure 19-1. Example - Demonstration of Capability Documentation, continued

Analyst Demonstration of Capability

ANALYST DEMONSTRATION OF CAPABILITY

Method 350.1 **Laboratory:** TestAmerica Cedar Falls
Method Desc: Nitrogen, Ammonia
Analyst: [redacted] **Limit Group:** WC 350.1 - All - iQC_QC

Current Limits			Demonstration of Capability		
Recovery	Precision	RPD	Recovery	Precision	RPD

Ammonia **Analysis Dates:** 7/23/2014 to 10/23/2014

All values within Control limits

LCL	UCL	Std Dev	RPD	Units	Mean	Std Dev	Units		Amount	Amount/RL
90	110	15	20	%	102.2:	2.563293	%	Pass	4.002312	8

Laboratory ID	Anal Date	Batch	Smp	Analyst	Prep Analyst	Result	Units	Spike Amount	RL	% Rec	% D	In Rec Limits?
LCS 310-57494/2-A	08/18/2014	57934	24	[redacted]	[redacted]	4.082	mg/L	4.002312	0.500	102		Pass
LCS 310-57517/2-A	08/18/2014	57934	45			4.197	mg/L	4.002312	0.500	105		Pass
LCS 310-57627/2-A	08/18/2014	57934	55			3.955	mg/L	4.002312	0.500	99		Pass
LCS 310-57641/2-A	08/18/2014	57934	89			4.133	mg/L	4.002312	0.500	103		Pass

Precision = standard deviation of percent recoveries of spiked control samples.

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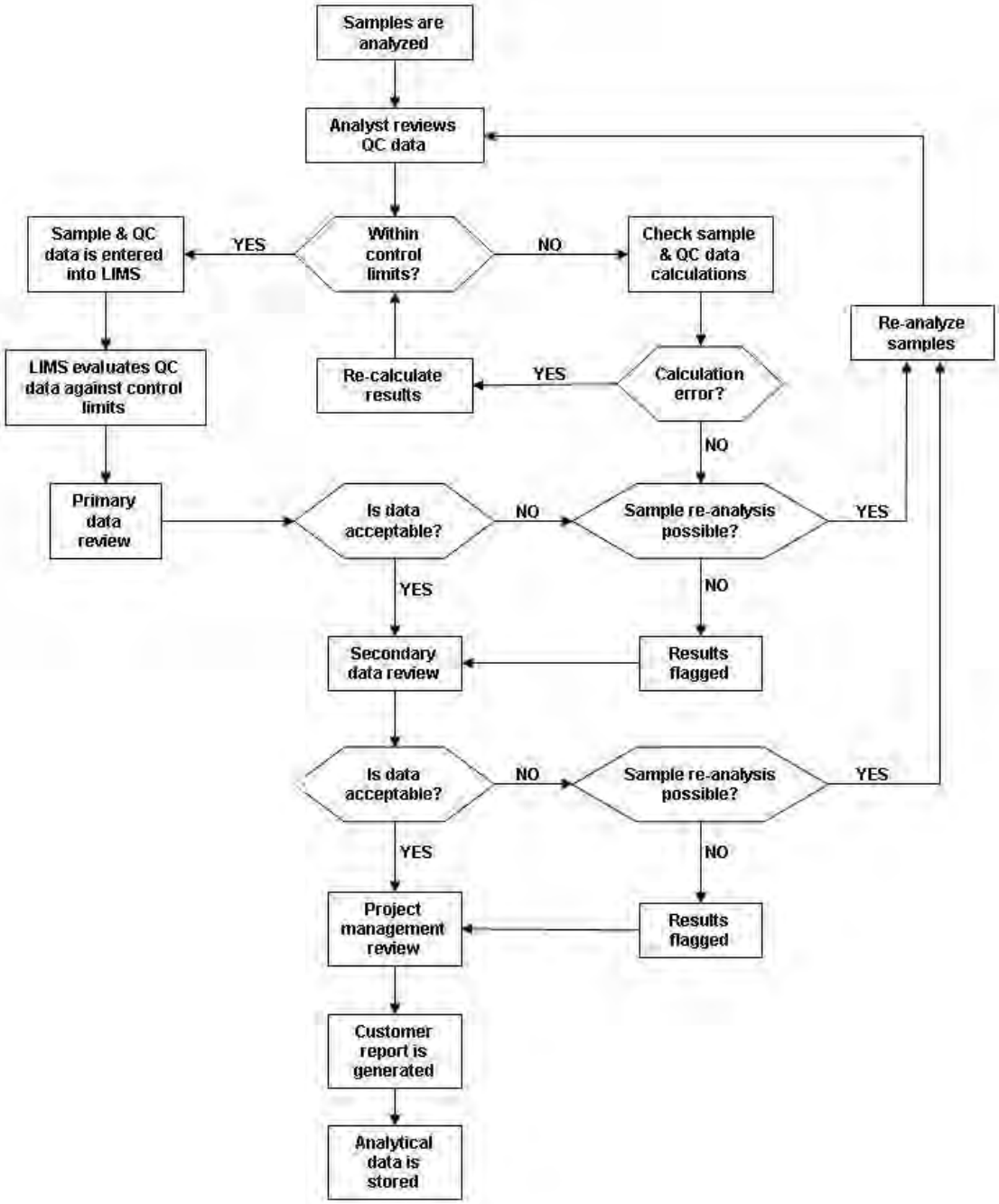
Figure 19-2. Example: Work Flow



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SECTION 20. EQUIPMENT AND CALIBRATIONS

20.1 Overview

The laboratory purchases the most technically advanced analytical instrumentation for sample analyses. Instrumentation is purchased on the basis of accuracy, dependability, efficiency and sensitivity. Each laboratory is furnished with all items of sampling, preparation, analytical testing and measurement equipment necessary to correctly perform the tests for which the laboratory has capabilities. Each piece of equipment is capable of achieving the required accuracy and complies with specifications relevant to the method being performed. Before being placed into use, the equipment (including sampling equipment) is calibrated and checked to establish that it meets its intended specification. The calibration routines for analytical instruments establish the range of quantitation. Calibration procedures are specified in laboratory SOPs. A summary of laboratory instrumentation is presented in Table 20-1. The QA department maintains a master list of all instrumentation currently in use at the laboratory.

Equipment is only operated by authorized and trained personnel. Manufacturer's instructions for equipment use are readily accessible to all appropriate laboratory personnel.

20.2 Preventive Maintenance

The laboratory follows a well-defined maintenance program to ensure proper equipment operation and to prevent the failure of laboratory equipment or instrumentation during use. This program of preventive maintenance helps to avoid delays due to instrument failure.

Routine preventive maintenance procedures and frequency, such as cleaning and replacements, should be performed according to the procedures outlined in the manufacturer's manual. Qualified personnel must also perform maintenance when there is evidence of degradation of peak resolution, a shift in the calibration curve, loss of sensitivity, or failure to continually meet one of the quality control criteria.

Table 20-2 lists examples of scheduled routine maintenance. It is the responsibility of each Technical Manager to ensure that instrument maintenance logs are kept for all equipment in his/her department. Preventative maintenance procedures may also be outlined in analytical SOPs or instrument manuals. (Note: for some equipment, the log used to monitor performance is also the maintenance log. Multiple pieces of equipment may share the same log as long as it is clear as to which instrument is associated with an entry.)

Instrument maintenance logs are controlled and are used to document instrument problems, instrument repair, and maintenance activities. Maintenance logs shall be kept for all major pieces of equipment. Instrument maintenance logs may also be used to specify instrument parameters.

- Documentation must include all major maintenance activities such as contracted preventive maintenance and service and in-house activities such as the replacement of electrical components, lamps, tubing, valves, columns, detectors, cleaning, and adjustments.
- Each entry in the instrument log includes the analyst's initials, the date, a detailed description of the problem (or maintenance needed/scheduled), a detailed explanation of the solution or maintenance performed, and a verification that the equipment is functioning properly (state what was used to determine a return to control. e.g. CCV run on *'date'* was acceptable, or instrument recalibrated on 'date' with acceptable verification, etc.) must also be documented in the instrument records.

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- When maintenance or repair is performed by an outside agency, service receipts detailing the service performed can be affixed into the logbooks adjacent to pages describing the maintenance performed. This stapled-in page must be signed across the page entered and the logbook so that it is clear that a page is missing if only half a signature is found in the logbook.

If an instrument requires repair (subjected to overloading or mishandling, gives suspect results, or otherwise has shown to be defective or outside of specified limits) it shall be taken out of operation and tagged as out-of-service or otherwise isolated until such a time as the repairs have been made and the instrument can be demonstrated as operational by calibration and/or verification or other test to demonstrate acceptable performance. The laboratory shall examine the effect of this defect on previous analyses.

In the event of equipment malfunction that cannot be resolved, service shall be obtained from the instrument vendor manufacturer, or qualified service technician, if such a service can be tendered. If on-site service is unavailable, arrangements shall be made to have the instrument shipped back to the manufacturer for repair. Back up instruments, which have been approved, for the analysis shall perform the analysis normally carried out by the malfunctioning instrument. If the back-up is not available and the analysis cannot be carried out within the needed timeframe, the samples shall be subcontracted.

At a minimum, if an instrument is sent out for service or transferred to another facility, it must be recalibrated and the laboratory MDL verified (using an MDLV) prior to return to lab operations.

20.3 Support Equipment

This section applies to all devices that may not be the actual test instrument, but are necessary to support laboratory operations. These include but are not limited to: balances, ovens, refrigerators, freezers, incubators, water baths, field sampling devices, temperature measuring devices, thermal/pressure sample preparation devices, and volumetric dispensing devices if quantitative results are dependent on their accuracy, as in standard preparation and dispensing or dilution into a specified volume. All raw data records associated with the support equipment are retained to document instrument performance. The acceptability for use or continued use is determined by the analysis or application for which the instrument is used. All support instruments requiring calibration are labeled to indicate the status of calibration including the date of the last calibration, the date of next calibration due, and the calibration factor (if applicable).

20.3.1 Weights and Balances

The accuracy of the balances used in the laboratory is checked every working day, before use. All balances are placed on stable counter tops.

Each balance is checked prior to initial serviceable use with four certified ASTM class 1 weights spanning its range of use (weights that have been calibrated to ASTM class 1 weight tolerances may also be used for daily verification). ASTM class 1 weights used only for calibration of other weights (and no other purpose) are inspected for corrosion, damage or nicks at least annually and if no damage is observed, they are calibrated at least every 5 years by an outside calibration laboratory. Any weights (including ASTM class 1) used for daily balance checks or other purposes are recalibrated/recertified annually to NIST standards (this may be done internally if laboratory maintains “calibration only” ASTM class 1 weights).
All balances are serviced annually by a qualified service representative, who supplies the laboratory with a certificate that identifies traceability of the calibration to the NIST standards.

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Any external calibration service used must be a calibration provider accredited to ISO/IEC 17025 by a recognized accreditation body.

All of this information is recorded in logs, and the recalibration/recertification certificates are kept on file in the QA department. Additional information on the calibration and verification of balances is included in laboratory SOP No. CF-GP-01, *Analytical Balance Operation*.

20.3.2 pH, Conductivity, and Turbidity Meters

The pH meters used in the laboratory are accurate to ± 0.1 pH units, and have a scale readability of at least 0.05 pH units. The meters automatically compensate for the temperature, and are calibrated with at least two working range buffer solutions before each use.

Conductivity meters are also calibrated before each use with a known standard to demonstrate the meters do not exceed an error of 1% or one µmhos/cm.

Turbidity meters are also calibrated before each use. All of this information is documented in logs.

Consult individual pH, Conductivity, and Turbidity SOPs for further information.

20.3.3 Thermometers

All liquid-column thermometers such as mercury or alcohol thermometers are calibrated on an annual basis with a NIST-traceable thermometer. Digital thermometers, thermocouples, and other similar electronic temperature measuring devices are calibrated quarterly. IR thermometers are calibrated on a semi-annual basis, and should be calibrated over the full range of use, including ambient (20-30°C), iced (4°C), and frozen (0°C to -5°C), per the Drinking Water Manual. Each day of use a single check of the IR thermometer should be made by checking the temperature of a bottle of water at the temperature of interest that contains a calibrated thermometer.

The mercury NIST thermometer is recalibrated every five years (unless thermometer has been exposed to temperature extremes or apparent separation of internal liquid) by an approved outside service and the provided certificate of traceability is kept on file. The digital NIST thermometer is recalibrated every year. The NIST thermometer(s) have increments of 1 degree (0.5 degree or less increments are required for drinking water microbiological laboratories), and have ranges applicable to method and certification requirements. The NIST traceable thermometer is used for no other purpose than to calibrate other thermometers.

All of this information is documented in logbooks. Monitoring method-specific temperatures, including incubators, heating blocks, water baths, and ovens, is documented in method-specific logbooks. More information on this subject can be found in laboratory SOP No. CF-GP-07, *Thermometer Operation and Calibration*.

20.3.4 Refrigerators/Freezer Units, Waterbaths, Ovens and Incubators

The temperatures of all refrigerator units and freezers used for sample and standard storage are monitored each working day.

Ovens, waterbaths and incubators are monitored on days of use.

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All of this equipment has a unique identification number, and is assigned a unique thermometer for monitoring.

Sample storage refrigerator temperatures are kept between > 0°C and ≤ 6°C.

Specific temperature settings/ranges for other refrigerators, ovens waterbaths, and incubators can be found in method-specific SOPs.

All of this information is documented in daily temperature logbooks and method-specific logbooks.

20.3.5 Autopipettors, Dilutors, and Syringes

Mechanical volumetric dispensing devices including burettes (except class A glassware and glass microliter syringes) are given unique identification numbers and the delivery volumes are verified gravimetrically, at a minimum, on a quarterly basis.

For those dispensers that are not used for analytical measurements, a label can be applied to the device stating that it is not calibrated. Any device not regularly verified cannot be used for any quantitative measurements. More detail on the laboratory's procedures for verifying pipette performance can be found in laboratory SOP CF-GP-13, *Pipette Calibration Verification Procedures*.

Micro-syringes are purchased from Hamilton Company. Each syringe is traceable to NIST. The laboratory keeps on file a "Trueness and Precision Statement of Conformance" from Hamilton attesting established precision and accuracy.

20.3.6 Autoclaves

Each batch processed in the autoclave is marked with autoclave tape. The autoclave tape must turn dark to verify sterilization temperatures were achieved. An autoclave thermometer is also used to verify autoclave temperatures with every batch. The duration and temperatures reached during each autoclave batch are recorded in the autoclave logbook.

Sterilization is also verified monthly with "temptubes." A temptube is a small culture tube that contains a solid pellet. The temptube is processed through a normal sterilization cycle. The pellet in the tube must be completely melted as verification that temperatures sufficient for sterilization were maintained for the proper duration.

The autoclave's internal timing device is checked quarterly against a stopwatch to verify the actual time elapsed. The results of this test are documented in the Bacteria QA Logbook.

A spore check is performed on the autoclave on a monthly basis according to the following procedure:

- A sealed ampoule containing *Geobacillus stearothermophilus* and Bromocresol Purple (pH indicator) is put through a normal autoclave sterilization cycle. After autoclaving, the autoclaved test ampoule is incubated for 48 hours at 55-60°C along with a control ampoule which has NOT been autoclaved. The control ampoule should show a positive test by exhibiting a color change to or toward yellow and/or turbidity. If the control ampoule does not show a positive result the test should be considered invalid.
- A successful sterilization cycle would result in the test ampule having no color change or turbidity (remains purple) after incubation. A failed sterilization is indicated by a color change to or toward yellow and/or turbidity in the test ampule.

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- The test results are documented in the Bacteria QA Logbook.

20.3.7 Field Sampling Devices

20.3.7.1 Soil Gas Sampling Pumps

The laboratory provides sampling pumps for soil gas sample collection by clients. Each sampling pump is assigned a unique identification number in order to keep track of the calibration. This number is also recorded on the sampling documentation.

The sampling pump calibration process is described in laboratory SOP No. CF-IH-06, *Calibration of Sampling Pumps*.

20.3.7.2 Auto Sampling Devices (ISCO)

Each Auto Sampler (ISCO) is assigned a unique identification number in order to keep track of the calibration. This number is also recorded on the sampling documentation.

The Auto Sampler is calibrated monthly by setting the sample volume to 100mL and recording the volume received. The results are filed in a logbook. The Auto Sampler is programmed to run three (3) cycles and each of the three cycles is measured into a graduated cylinder to verify 100mL are received.

If the RSD (Relative Standard Deviation) among the 3 cycles is greater than 10%, the procedure is repeated and if the result is still greater than 10%, then the Auto Sampler is taken out of service until it is repaired and calibration verification criteria can be met. The results of this check are kept in a logbook.

20.4 Instrument Calibrations

Calibration of analytical instrumentation is essential to the production of quality data. Strict calibration procedures are followed for each method. These procedures are designed to determine and document the method detection limits, the working range of the analytical instrumentation, and any fluctuations that may occur from day to day. In general, calibration generation and review will be in compliance with laboratory analytical SOPs, Corporate SOP No. CA-Q-P-006 (*Calibration Curves & Selection of Calibration Points)*.

Sufficient raw data records are retained to allow an outside party to reconstruct all facets of the initial calibration. Records contain, but are not limited to, the following: calibration date, method, instrument, analyst(s) initials or signatures, analysis date, analytes, concentration, response, and type of calibration (e.g., average calibration/response factor, linear or non-linear regression, or other calculations that may be used to reduce instrument responses to concentration.)

Sample results must be quantitated from the initial calibration and may not be quantitated from any continuing instrument calibration verification unless otherwise required by regulation, method or program.

If the initial calibration results are outside of the acceptance criteria, corrective action is performed and any affected samples are reanalyzed if possible. If the reanalysis is not possible, any data associated with an unacceptable initial calibration will be reported with appropriate data qualifiers (refer to Section 12).

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Note: Instruments are calibrated initially and as needed after that and at least annually.

20.4.1 Calibration Standards

Calibration standards are prepared using the procedures indicated in the Reagents and Standards section of the determinative method SOP. If a reference method does not specify the number of calibration standards, a minimum of 3 calibration points (exception being ICP and ICP/MS methods) will be used.

Standards for instrument calibration are obtained from a variety of sources. All standards are traceable to national or international standards of measurement, or to national or international standard reference materials.

The lowest concentration calibration standard that is analyzed during an initial calibration must be at or below the stated reporting limit (RL) for the method based on the final volume of extract (or sample). It is not required for the lowest concentration calibration standard to be at the method detection limit (MDL).

The other concentrations define the working range of the instrument/method or correspond to the expected range of concentrations found in actual samples that are also within the working range of the instrument/method. Results of samples not bracketed by initial instrument calibration standards (within calibration range to at least the same number of significant figures used to report the data) must be reported as having less certainty, e.g., defined qualifiers or flags (additional information may be included in the case narrative). The exception to these rules is ICP methods or other methods where the referenced method does not specify two or more standards.

All initial calibrations are verified with a standard obtained from a second source and traceable to a national standard, when available (or vendor certified different lot if a second source is not available). This standard is known as the Initial Calibration Verification (ICV) standard. For unique situations, such as air analysis where no other source or lot is available, a standard made by a different analyst at a different time or a different preparation would be considered a second source. This verification occurs immediately after the calibration curve has been analyzed, and before the analysis of any other samples.

20.4.1.1 Calibration Verification

The calibration relationship established during the initial calibration must be verified initially and at least daily as specified in the laboratory method SOPs in accordance with the referenced analytical methods and in the 2009 TNI Standard. The process of calibration verification applies to both external standard and internal standard calibration techniques, as well as to linear and non-linear calibration models. Initial calibration verification is with a standard source secondary (second source standard) to the calibration standards, but continuing calibration verifications may use the same source standards as the calibration curve.

Note: The process of calibration verification referred to here is fundamentally different from the approach called "continuing calibration" in some methods. As described in those methods, the calibration factors or response factors calculated during calibration are used to update the calibration factors or response factors used for sample quantitation. This approach, while employed in other EPA programs, amounts to a daily single-point calibration.

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All target analytes and surrogates, including those reported as non-detects, must be included in periodic calibration verifications for purposes of retention time confirmation and to demonstrate that calibration verification criteria are being met, per 2009 TNI Std. EL-V1M4 Sec. 1.7.2.

All samples must be bracketed by periodic analyses of standards that meet the QC acceptance criteria (e.g., calibration and retention time). The frequency is found in the determinative methods or SOPs.

Note: If an internal standard calibration is being used (i.e., GCMS) then bracketing standards are not required, only daily verifications at the beginning of the analytical batch are needed. The results from these verification standards must meet the calibration verification criteria and the retention time criteria (if applicable).

Generally, the initial calibrations must be verified at the beginning of each 12-hour analytical shift during which samples are analyzed (some methods may specify more or less frequent verifications). The 12-hour analytical shift begins with the injection of the calibration verification standard (or the MS tuning standard in MS methods). The shift ends after the completion of the analysis of the last sample, QC, or standard that can be injected within 12-hours of the beginning of the shift.

A continuing instrument calibration verification (CCV) must be repeated at the beginning and, for methods that have quantitation by external calibration models, at the end of each analytical batch. Some methods have more frequent CCV requirements see specific SOPs. Most Inorganic methods require the CCV to be analyzed after ever 10 samples or injections, including matrix or batch QC samples.

Note: If an internal standard calibration is being used (basically GCMS) then bracketing standards are not required, only daily verifications are needed. The results from these verification standards must meet the calibration verification criteria and the retention time criteria (if applicable).

If the results of a CCV are outside the established acceptance criteria and analysis of a second consecutive (and immediate) CCV fails to produce results within acceptance criteria, corrective action shall be performed. Once corrective actions have been completed & documented, the laboratory shall demonstrate acceptable instrument / method performance by analyzing two consecutive CCVs, or a new initial instrument calibration shall be performed.

Sample analyses and reporting of data may not occur or continue until the analytical system is calibrated or calibration verified. However, data associated with an unacceptable calibration verification may be fully useable under the following special conditions:

a). when the acceptance criteria for the CCV are exceeded high (i.e., high bias) and the associated samples within the batch are non-detects, then those non-detects may be reported with a footnote or case narrative explaining the high bias. Otherwise the samples affected by the unacceptable CCV shall be re-analyzed after a new calibration curve has been established, evaluated, and accepted; or

b). when the acceptance criteria for the CCV are exceeded low (i.e., low bias), those sample results may be reported if they exceed a maximum regulatory limit/decision level. Otherwise the samples affected by the unacceptable CCV shall be re-analyzed after a new calibration curve has been established, evaluated, and accepted.

Samples reported by the 2 conditions identified above will be appropriately flagged.

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20.4.1.2 Verification of Linear and Non-Linear Calibrations

Calibration verification for calibrations involves the calculation of the percent drift or the percent difference of the instrument response between the initial calibration and each subsequent analysis of the verification standard. These calculations are available in the laboratory method SOPs. Verification standards are evaluated based on the % difference from the average CF or RF of the initial calibration or based on % drift if a linear or quadratic curve is used.

Regardless of whether a linear or non-linear calibration model is used, if initial verification criterion is not met, then no sample analyses may take place until the calibration has been verified or a new initial calibration is performed that meets the specifications listed in the method SOPs. If the calibration cannot be verified after the analysis of a single verification standard, then adjust the instrument operating conditions and/or perform instrument maintenance, and analyze another aliquot of the verification standard. If the calibration cannot be verified with the second standard, then a new initial calibration is performed.

- When the acceptance criteria for the calibration verification are exceeded high, i.e., high bias, and there are associated samples that are non-detects, then those non-detects may be reported. Otherwise, the samples affected by the unacceptable calibration verification shall be reanalyzed after a new calibration curve has been established, evaluated, and accepted.

- When the acceptance criteria for the calibration verification are exceeded low, i.e., low bias, those sample results may be reported if they exceed a maximum regulatory limit/decision level. Otherwise, the samples affected by the unacceptable verification shall be reanalyzed after a new calibration curve has been established, evaluated, and accepted.

20.5 Tentatively Identified Compounds (TICs) – GC/MS Analysis

For samples containing components not associated with the calibration standards, a library search may be made for the purpose of tentative identification. The necessity to perform this type of identification will be determined by the purpose of the analyses being conducted. Data system library search routines should not use normalization routines that would misrepresent the library or unknown spectra when compared to each other.

Note: If the TIC compound is not part of the client target analyte list but is calibrated by the laboratory and is both qualitatively and/or quantitatively identifiable, it should not be reported as a TIC. If the compound is reported on the same form as true TICs, it should be qualified and/or narrated that the reported compound is qualitatively and quantitatively (if verification in control) reported compared to a known standard that is in control (where applicable).

For example, the RCRA permit or waste delisting requirements may require the reporting of non-target analytes. Only after visual comparison of sample spectra with the nearest library searches may the analyst assign a tentative identification.

20.6 GC/MS Tuning

Prior to any GCMS analytical sequence, including calibration, the instrument parameters for the tune and subsequent sample analyses within that sequence must be set. This does not apply to selected ion monitoring (SIM) analysis.

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Prior to tuning/auto-tuning the mass spec, the parameters may be adjusted within the specifications set by the manufacturer or the analytical method. These generally do not need any adjustment but it may be required based on the current instrument performance. If the tune verification does not pass it may be necessary to clean the source or perform additional maintenance. Any maintenance is documented in the maintenance log.

Table 20-1. Example: Instrumentation List

Organics			Metals			
GC	GC/MS	HPLC	ICP	ICPMS	GFAA	Hg
9	9	1	2	1	1	1

General Chemistry					
IC	TOC	UV/Vis	ISE	Autoanalyzer	BOD Analyzer
2	1	2	4	2	1

Table 20-2. Example: Schedule of Routine Maintenance

Preventative Maintenance Procedures For Laboratory Equipment

Instrument/ Equipment Type	Maintenance	Frequency
Gas Chromatograph	Replace Gas line dryers and filters	As needed*
	Replace Gas cylinders	As needed*
	Check or adjust column gas flow and/or detector make-up flow	As needed*
	Replace Injection port Septa	Daily*
	Replace Injection port liners/re-silonize liners	GC, As needed; GC/MS, Daily*
	Replace injection port liner o-ring	GC, As needed; GC/MS, Daily*
	Replace inlet seal and ring	GC, As needed, GC/MS, Daily*
	Replace column ferrules	GC, As needed, GC/MS, Daily*
	Clip column ends, injector (daily) and detector (as needed)	GC, As needed; GC/MS, Daily*
	Replace syringes on autosamplers	As needed*
	Replace heated-zones heaters and sensors	As needed*
	Replace inlet assembly	As needed*
	Fill solvent rinse and empty solvent rinse-waste vials (on autosampler tower)	Daily or as needed
	Replace column	As needed*
Flame Ionization Detector (FID)	Clean/replace jet	As needed*
	Clean collector	As needed*
	Check and/or adjust gas flows	As needed*
	Replace graphite ferrule	After each cleaning (OI detectors only)
Electron Capture Detector (ECD)	Perform wipe test	Every six months*
	Remove and send to authorized agency for cleaning	As needed*
	Check and/or adjust gas flows	As needed*
	Replace gas supply cylinders	As needed*

* Date and Maintenance performed are recorded in the Maintenance Log of the instrument/equipment

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Preventative Maintenance Procedures For Laboratory Equipment

Instrument/ Equipment Type	Maintenance	Frequency
Photoionization Detector (PID)	Clean window	As needed*
	Replace o-ring seat	As needed*
	Replace Lamp	As needed*
	Check and/or adjust gas flows	As needed*
	Adjust Lamp power supply intensity	As needed*
Mass Spectrometer (MS)	Clean source, replace source parts, replace filaments	As needed*
	Clean analyzer	As needed*
	Replace electron multiplier	As needed*
	Clean or replace glass jet separator, replace transfer line from jet separator to MS	As needed*
	Change rough pump oil	After each source cleaning
	Refill calibration compound (PFTBA) vial	As needed
Purge and Trap Equipment	Refill rinse water supply/Empty rinse water waste	Weekly or as needed
	Refill spiking solutions vials	As needed
	Rinse sparge tubes	After each sample
	Clean or replace 6-port valve	As needed*
	Replace Transfer lines (from Autosampler to LSC and from LSC to GC)	As needed*
	Adjust gas flows and pressures	As needed
	Perform leak check	As needed
Graphite Furnace, Atomic Absorption (GFAA)	Change Graphite contact rings	As needed*
	Clean quartz windows	As needed
	Change graphite tubes and platforms	As needed*
	Refill rinse water	Daily
	Check water cooler water level and filter	Monthly
	Change argon and other gases	As needed*
	Clean or replace sampling probe	As needed
Total Organic Carbon (TOC)	Clean UV Reactor Chamber	Weekly*
	Clean Sparger Tube	Weekly*
	Clean Mist Trap	Weekly*
	Refill rinse/reagent water	As needed
	Clean Gas/Liquid Separator	Weekly*
	Change Liquid in Gas/Liquid Separator	As needed
	Replace Components of Chlorine Scrubber	Weekly*
	Change compressed gas tanks	As needed*
	Replace NDIR Detector	As needed*
	Replace UV Reactor	As needed*
	Replace Tubing	As needed
Inductively Coupled Plasma, Atomic Emission Spectrometer (ICP-AES)	Replace Peristaltic pump tubing	Daily
	Clean autosampler, change tubing	As needed*
	Clean nebulizer and torch assembly	As needed*
	Replace nitrogen and argon tanks	As needed*
	Refill rinse water receptacle	Daily
	Empty waste receptacle	Daily
	Check for internal standard and sample flow through peristaltic pump tubing	As often as possible
	Replace internal standard solution receptacle	As needed
	Operate and check vents	Daily

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Instrument/ Equipment Type	Maintenance	Frequency
Inductively Coupled Plasma, Atomic Emission Spectrometer (ICP-AES), cont.	Perform Hg alignment	Daily*
	Check water level and water filter on recirculating-cooling unit, refill and replace filter	Check daily, refill and replace as needed
	Check purge windows	Daily, replace as needed
	Replace nebulizer and o-rings	As needed*
	Replace torch	As needed*
	Replace mixing chambers	As needed*
	Clean or replace air filters	Monthly
	Check pneumatic filters	Weekly, replace as needed
	Perform wave calibration (UV and Vis)	Quarterly*
	Calibrate Detector	Quarterly*
Inductively Couple Plasma, Mass Spectrometer (ICP-MS)	Replace Peristaltic pump tubing	Weekly
	Clean autosampler, change tubing	As needed*
	Clean nebulizer and torch assembly	Weekly*
	Replace torch	As needed*
	Clean cones	Weekly*
	Refill rinse water receptacle	Daily
	Empty waste receptacle	Daily
	Check for internal standard and sample flow through peristaltic pump tubing	As often as possible
	Replace internal standard solution receptacle	As needed
	Check water level and water filter on recirculating-cooling unit, refill and replace filter	Check daily, refill and replace as needed
High Pressure Liquid Chromatography (HPLC)	Replace pre-column filter	As needed*
	Refill Solvent reservoirs	Daily or as needed
	Reverse column and rinse with solvents	Daily or as needed*
	Replace column	As needed*
	Clean solvent reservoir filters	As needed*
	Replace ball-valve cartridges on high pressure pump	As needed*
	Replace DAD flow cell windows	As needed*
	Check system solvent pressure	Daily
pH Meters	Clean or replace electrode	As needed
	Refill electrode electrolyte	As needed
Balance	Clean pan and platform	Before each use
	Check Level bubble	Daily
	Check calibration	Daily
	Check sensitivity	Weekly
	Cleaning and calibration by authorized service	Annually
Conductivity Meter	Clean probe	As needed
Dissolved Oxygen Meter	Replace membrane	As needed
	Clean probe	As needed
ZHE vessels	Replace o-rings and screens	As needed
ZHE and TCLP Tumblers	Check Rotation Rate	Monthly
Spectrophotometers	Clean and check tubing	As needed
Burettes and Pipets	Clean and check calibration	Monthly*
Thermometers	Check calibration	Annually, Quarterly for Digitals, Semiannual for IR Thermometer*
Ovens	Check and/or adjust temperature, record temperature on log sheet	Daily

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Instrument/ Equipment Type	Maintenance	Frequency
Refrigerators and Freezers	Check and/or adjust temperature, record temperature on log sheet	Daily
	Defrost freezers	As needed
Lachat, Flow Injection Analyzer	Replace* or Rinse 100mL syringes on autosampler	Daily
	Replace tubes on autodilutor	As needed*
	Clean autosampler surfaces	As needed
	Spray silicone on cloth and rub on pump rollers	As needed
	Clean or replace o-rings and ports on valves	As needed*
	Clean union and T's on manifold and replace o-rings on manifold	As needed
	Dry and clean detector surfaces	As needed
	Replace flow cell o-rings and flares	As needed*
	Replace manifold tubing	As needed*
FIMS Analyzer	Adjust pump timing	As needed
	Change Argon supply tank	As needed*
	Change drying tube	Daily or as needed
	De-clog drying tube and/or reductant tubing	Daily or as needed
	Change system tubing	2-3 weeks*
	Rinse tubing prior to operation and following operation	Daily
	Clean optical cell	As needed (when aperture is out of line)

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SECTION 21. MEASUREMENT TRACEABILITY

21.1 Overview

Traceability of measurements shall be assured using a system of documentation, calibration, and analysis of reference standards. Laboratory equipment that are peripheral to analysis and whose calibration is not necessarily documented in a test method analysis or by analysis of a reference standard shall be subject to ongoing certifications of accuracy. At a minimum, these must include procedures for checking specifications of ancillary equipment: balances, thermometers, temperature, Deionized (DI) and Reverse Osmosis (RO) water systems, automatic pipettes and other volumetric measuring devices (refer to Section 20.3). With the exception of Class A Glassware and Glass microliter syringes, quarterly accuracy checks are performed for all mechanical volumetric devices. Wherever possible, subsidiary or peripheral equipment is checked against standard equipment or standards that are traceable to national or international standards. Class A Glassware and Glass microliter syringes should be routinely inspected for chips, acid etching or deformity (e.g., bent needle). If the Class A glassware or syringe is suspect, the accuracy of the glassware will be assessed prior to use.

21.2 NIST-Traceable Weights and Thermometers

Reference standards of measurement shall be used for calibration only and for no other purpose, unless it can be shown that their performance as reference standards would not be invalidated.

For NIST-traceable weights and thermometers, the laboratory requires that all calibrations be conducted by a calibration laboratory accredited by A2LA, NVLAP (National Voluntary Laboratory Accreditation Program), or another accreditation organization that is a signatory to a MRA (Mutual Recognition Arrangement) of one or more of the following cooperations – ILAC (International Laboratory Accreditation Cooperation) or APLAC (Asia–Pacific Laboratory Accreditation Cooperation). A calibration certificate and scope of accreditation is kept on file at the laboratory.

21.3 Reference Standards / Materials

Reference standards/materials, where commercially available, are traceable to certified reference materials. Commercially prepared reference standards, to the extent available, are purchased from vendors that are accredited to ISO Guide 34 and ISO/IEC Guide 17025. All reference standards from commercial vendors shall be accompanied with a Certificate of Analysis (COA) that includes at least the following information:

- Manufacturer
- Analytes or parameters calibrated
- Identification or lot number
- Calibration method
- Concentration with associated uncertainties
- Purity

If a standard cannot be purchased from a vendor that supplies a COA, the purity of the standard is documented by analysis. The receipt of all reference standards must be documented. Reference standards are labeled with a unique standard identification number and expiration date. All documentation received with the reference standard is retained as a QC record and references the standard identification number.

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All reference, primary, and working standards/materials, whether commercially purchased or laboratory prepared, must be checked regularly to ensure that the variability of the standard or material from the 'true' value does not exceed method requirements. The accuracy of calibration standards is checked by comparison with a standard from a second source. In cases where a second standard manufacturer is not available, a vendor certified different lot is acceptable for use as a second source. For unique situations, such as air analysis where no other source or lot is available, a standard made by a different analyst would be considered a second source. The appropriate Quality Control (QC) criteria for specific standards are defined in laboratory SOPs. In most cases, the analysis of an Initial Calibration Verification (ICV) or LCS (where there is no sample preparation) is used as the second source confirmation. These checks are generally performed as an integral part of the analysis method (e.g. calibration checks, laboratory control samples).

All standards and materials must be stored and handled according to method or manufacturer's requirements in order to prevent contamination or deterioration. Refer to the Corporate Environmental Health & Safety Manual (CW-E-M-001) or laboratory SOPs. For safety requirements, please refer to method SOPs and the laboratory Environmental Health and Safety Manual.

Standards and reference materials shall not be used after their expiration dates unless their reliability is verified by the laboratory and their use is approved by the QA Manager. The laboratory must have documented contingency procedures for re-verifying expired standards.

21.4 Documentation and Labeling of Standards, Reagents, and Reference Materials

Reagents must be at a minimum the purity required in the test method. The date of reagent receipt and the expiration date are documented. The lots for most of the common solvents and acids are tested for acceptability prior to company-wide purchase. Refer to TestAmerica's Corporate SOP (CA-Q-S-001), *Solvent and Acid Lot Testing and Approval*.

All manufacturer or vendor supplied Certificate of Analysis or Purity must be retained, stored appropriately, and readily available for use and inspection. These records are maintained in the appropriate area (e.g., metals, Organics, etc.) and are also scanned into the LIMS. Alternatively, these records are also retrievable online from most vendors' websites, based on part number and lot number. Records must be kept of the date of receipt and date of expiration of standards, reagents and reference materials. In addition, records of preparation of laboratory standards, reagents, and reference materials must be retained, stored appropriately, and be readily available for use and inspection. For detailed information on documentation and labeling, refer to laboratory SOP CF-SS-02, *Standard Preparation, Documentation, and Tracking*, and CF-SS-03, *Reagent Preparation, Documentation, and Tracking*.

Commercial materials purchased for preparation of calibration solutions, spike solutions, etc., are usually accompanied with an assay certificate or the purity is noted on the label. If the assay purity is 96% or better, the weight provided by the vendor may be used without correction. If the assay purity is less than 96% a correction will be made to concentrations applied to solutions prepared from the stock commercial material.

21.4.1 All standards, reagents, and reference materials must be labeled in an unambiguous manner. Standards are logged into the laboratory's LIMS system, and are assigned a unique identification number. The following information is typically recorded in the electronic database within the LIMS:

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- Unique standard ID
- Description of standard
- Department
- Preparer's name
- Final volume and number of vials prepared
- Container number(s)
- Solvent type and lot number
- Preparation Date
- Expiration Date
- Standard source type (Source or Intermediate)
- Standard type (spike, surrogate, other)
- Parent standard ID (if applicable)
- Parent Standard Analyte Concentration (if applicable)
- Parent Standard Amount used (if applicable)
- Component Analytes
- Final concentration of each analyte
- Comment box (text field)

Records are maintained electronically for standard and reference material preparation. These records show the traceability to purchased stocks or neat compounds. These records also include method of preparation, date of preparation, expiration date and preparer's name or initials. Preparation procedures are provided in the Method SOPs.

21.4.2 All standards, reagents, and reference materials must be clearly labeled with a minimum of the following information:

- Expiration Date (include prep date for reagents)
- Standard ID (from LIMS)
- Special Health/Safety warnings if applicable

Records must also be maintained of the date of receipt for commercially purchased items or date of preparation for laboratory prepared items. For items supplied through consignment, the date of receipt is equivalent to the date the item was taken out of consignment.

Special Health/Safety warnings must also be available to the analyst. This information is always available in the material's Safety Data Sheet (SDS), and may also be documented on the container itself.

21.4.3 In addition, the following information may be helpful:

- Date opened (for multi-use containers, if applicable)
- Description of standard (if different from manufacturer's label or if standard was prepared in the laboratory)
- Recommended Storage Conditions
- Concentration (if applicable)
- Initials of analyst preparing standard or opening container

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All containers of prepared reagents must include an expiration date and an ID number to trace back to preparation. Procedures for preparation of reagents can be found in the Method SOPs. Standard ID numbers must be traceable through associated logbooks, worksheets and preparation/analytical batch records.

All reagents and standards must be stored in accordance to the following priority: 1) with the manufacturer's recommendations; 2) with requirements in the specific analytical methods as specified in the laboratory SOP.

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SECTION 22. SAMPLING

22.1 Overview

The laboratory provides limited sampling services. Sampling procedures are described in laboratory SOP CF-FSS-01, *Sampling Procedures*. The laboratory typically provides the following field services:

- Groundwater Sampling
- Wastewater Sampling
- Potable Sampling
- Waste Sampling
- Soil Sampling
- Field Parameter Analysis (pH, Chlorine, Temperature)
- Cleaning and Decontamination of Field Equipment

22.2 Sampling Containers

The laboratory offers clean sampling containers for use by clients. These containers are obtained from reputable container manufacturers and meet EPA specifications as required. Certificates of cleanliness for bottles and preservatives are provided by the supplier and maintained at the laboratory. Alternatively, the certificates may be maintained by the supplier and available to the laboratory on-line.

22.2.1 Preservatives

Upon request, preservatives are provided to the client in pre-cleaned sampling containers. In some cases containers may be purchased pre-preserved from the container supplier. Whether prepared by the laboratory or bought pre-preserved, the grades of the preservatives are at a minimum:

- Hydrochloric Acid – Reagent ACS (Certified VOA Free) or equivalent
- Methanol – Purge and Trap grade
- Nitric Acid – Instra-Analyzed or equivalent
- Sodium Bisulfate – ACS Grade or equivalent
- Sodium Hydroxide – Instra-Analyzed or equivalent
- Sulfuric Acid – Instra-Analyzed or equivalent
- Sodium Thiosulfate – ACS Grade or equivalent

22.3 Definition of Holding Time

The date and time of sampling documented on the COC form establishes the day and time ‘zero’. As a general rule, when the maximum allowable holding time is expressed in “days” (e.g., 14 days, 28 days), the holding time is based on calendar day measured. Holding times expressed in “hours” (e.g., 8 hours, 24 hours, etc.) are measured from date and time zero. Holding times for analysis include any necessary reanalysis. However, there are some programs that determine holding time compliance based on the date and specific time of analysis compared to the time of sampling regardless of how long the holding time is.

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The holding time of composite samples has been defined as starting at the end of sample compositing, not at the collection of the first sample aliquot in the composite. The EPA interprets the hold time to be the period of time that has elapsed between the end of sampling and the beginning of analysis.

22.4 Sampling Containers, Preservation Requirements, Holding Times

The preservation and holding time criteria specified in the laboratory SOPs are derived from the source documents for the methods. If method required holding times or preservation requirements are not met, the reports will be qualified using a flag, footnote, or case narrative. As soon as possible or "ASAP" is an EPA designation for tests for which rapid analysis is advised, but for which neither EPA nor the laboratory have a basis for a holding time.

22.5 Sample Aliquots / Subsampling

Taking a representative sub-sample from a container is necessary to ensure that the analytical results are representative of the sample collected in the field. The size of the sample container, the quantity of sample fitted within the container, and the homogeneity of the sample need consideration when sub-sampling for sample preparation. It is the laboratory's responsibility to take a representative subsample or aliquot of the sample provided for analysis.

Analysts should handle each sample as if it is potentially dangerous. At a minimum, safety glasses, gloves, and lab coats must be worn when preparing aliquots for analysis.

Guidelines on taking sample aliquots & sub-sampling are located in the laboratory SOP CF-GP-24, *Sub-Sampling and Sample Homogenization*. Occasionally, clients may supply specific instructions on taking sample aliquots and sample homogenization in QAPPs, Work Instructions, etc. In these situations the laboratory will follow the instructions provided by the client. If a client provides a document outlining sub-sampling protocols, it is made a controlled document and kept in the QA department.

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SECTION 23. HANDLING OF SAMPLES

Sample management procedures at the laboratory ensure that sample integrity and custody are maintained and documented from sampling/receipt through disposal.

23.1 Chain of Custody (COC)

The COC form is the written documented history of any sample and is initiated when bottles are sent to the field, or at the time of sampling. This form is completed by the sampling personnel and accompanies the samples to the laboratory where it is received and stored under the laboratory's custody. The purpose of the COC form is to provide a legal written record of the handling of samples from the time of collection until they are received at the laboratory. It also serves as the primary written request for analyses from the client to the laboratory. The COC form acts as a purchase order for analytical services when no other contractual agreement is in effect. An example of a COC form may be found in Figure 23-1.

23.1.1 Field Documentation

The information the sampler needs to provide at the time of sampling on the container label is:

- Sample identification
- Date and time
- Preservative

During the sampling process, the COC form is completed and must be legible (see Figure 23-1). This form includes information such as:

- Client name, address, phone number and fax number (if available)
- Project name and/or number
- The sample identification
- Date, time and location of sampling
- Sample collectors name
- The matrix description
- The container description
- The total number of each type of container
- Preservatives used
- Analysis requested
- Requested turnaround time (TAT)
- Any special instructions
- Purchase Order number or billing information (e.g. quote number) if available
- The date and time that each person received or relinquished the sample(s), including their signed name.

When the sampling personnel deliver the samples directly to TestAmerica personnel, the samples are stored in a cooler with ice, as applicable, and remain solely in the possession of the client's field technician until the samples are delivered to the laboratory personnel. The sample collector must assure that each container is in his/her physical possession or in his/her view at all times, or stored in such a place and manner to preclude tampering. The field technician relinquishes the samples in

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writing on the COC form to the sample control personnel at the laboratory or to a TestAmerica courier. When sampling personnel deliver the samples through a common carrier (e.g., Fed-Ex, UPS), the COC relinquished date/time is completed by the field personnel and samples are released to the carrier. Samples are only considered to be received by lab when personnel at the fixed laboratory facility have physical contact with the samples.

Note: Independent couriers are not required to sign the COC form. The COC is usually kept in the sealed sample cooler. The receipt from the courier is stored in log-in by date; it lists all receipts each date.

23.2 Sample Receipt

Samples are received at the laboratory by designated sample receiving personnel and a unique laboratory project identification number is assigned. Each sample container shall be assigned a unique sample identification number that is cross-referenced to the client identification number such that traceability of test samples is unambiguous and documented. Each sample container is affixed with a durable sample identification label. Sample acceptance, receipt, tracking and storage procedures are summarized in the following sections. Refer also to SOP CF-SRV-01, *Customer Service and Login Procedures*, for further information.

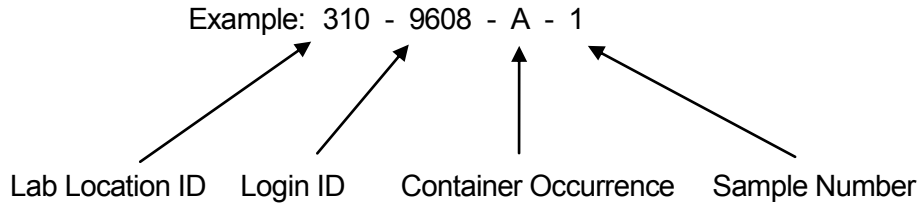
23.2.1 Laboratory Receipt

When samples arrive at the laboratory, sample receiving personnel inspect the coolers and samples. The integrity of each sample must be determined by comparing sample labels or tags with the COC and by visual checks of the container for possible damage. A cooler receipt form is filled out (see Figure 23-3). Any non-conformance, irregularity, or compromised sample receipt must be documented in the LIMS and brought to the immediate attention of the client. The COC, shipping documents, documentation of any non-conformance, irregularity, or compromised sample receipt, record of client contact, and resulting instructions become part of the project record.

23.2.1.1 Unique Sample Identification

All samples that are processed through the laboratory receive a unique sample identification to ensure that there can be no confusion regarding the identity of such samples at anytime. This system includes identification for all samples, subsamples and subsequent extracts and/or digestates.

The laboratory assigns a unique identification (e.g., Sample ID) code to each sample container received at the laboratory. This Primary ID is made up of the following information (consisting of 4 components):



The above example states that TestAmerica Cedar Falls laboratory (Location 310). Login ID is 9608 (unique to a particular client/job occurrence). The container code indicates it is the first container (“A”) of Sample 1.

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If the primary container goes through a prep step that creates a "new" container, then the new container is considered secondary and gets another ID. An example of this being a client sample in a 1-Liter amber bottle is sent through a Liquid/Liquid Extraction and an extraction vial is created from this step. The vial would be a SECONDARY container. The secondary ID has 5 components.

Example: 310 - 9608 - A - 1 - **A** ← **Secondary Container Occurrence**

The above example, 310-9608-A-1-A, would indicate the PRIMARY container went through a step that created the first occurrence of a Secondary container.

With this system, a client sample can literally be tracked throughout the laboratory in every step from receipt to disposal.

23.3 Sample Acceptance Policy

The laboratory has a written sample acceptance policy (Lab Document No. CF-SH-WI-002) that clearly outlines the circumstances under which samples shall be accepted or rejected. An example of this document is included in Figure 23-2. These circumstances include:

- A COC filled out completely;
- Samples must be properly labeled;
- Proper sample containers with adequate volume for the analysis (Sampling Guide) and necessary QC;
- Samples must be preserved according to the requirements of the requested analytical method (Sampling Guide);
- Sample holding times must be adhered to (Sampling Guide);
- The project manager will be notified if any sample is received in damaged condition.

Data from samples which do not meet these criteria are flagged and/or narrated on the final report and the nature of the variation from policy is defined.

23.3.1 After inspecting the samples, the sample receiving personnel sign and date the COC form, make any necessary notes of the samples' conditions and store them in appropriate refrigerators or storage locations.

23.3.2 Any deviations from these checks that question the suitability of the sample for analysis, or incomplete documentation as to the tests required will be resolved by consultation with the client. If the sample acceptance policy criteria are not met, the laboratory shall either:

- Retain all correspondence and/or records of communications with the client regarding the disposition of rejected samples, or
- Fully document any decision to proceed with sample analysis that does not meet sample acceptance criteria.

Once sample acceptance is verified, the samples are logged into the LIMS according SOP No. CF-SRV-01, Customer Service and Login Procedures.

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23.4 Sample Storage

In order to avoid deterioration, contamination, or damage to a sample during storage and handling, from the time of receipt until all analyses are complete, samples are stored in refrigerators, freezers, or protected locations suitable for the sample matrix. In addition, samples to be analyzed for volatile organic parameters are stored in separate refrigerators designated for volatile organic parameters only. Samples are never to be stored with reagents, standards or materials that may create contamination.

To ensure the integrity of the samples during storage, refrigerator blanks are maintained in the volatile sample refrigerators and analyzed every two weeks.

Analysts and technicians retrieve the sample container allocated to their analysis from the designated refrigerator and place them on carts, analyze the sample, and return the remaining sample or empty container to the refrigerator from which it originally came. All unused portions of samples, including empty sample containers, are returned to the secure sample control area. All samples are kept in the refrigerators for two to four weeks after analysis, which meets or exceeds most sample holding times. After two to four weeks the samples are moved to the sample archive area where they are disposed of. Special arrangements may be made to store samples for longer periods of time. This extended holding period allows additional metal analyses to be performed on the archived sample and assists clients in dealing with legal matters or regulatory issues.

Access to the laboratory is controlled such that sample storage need not be locked at all times unless a project specifically demands it. Samples are accessible to laboratory personnel only. Visitors to the laboratory are prohibited from entering the refrigerator and laboratory areas unless accompanied by an employee of TestAmerica.

23.5 Hazardous Samples and Foreign Soils

This laboratory does not knowingly accept soil samples from foreign countries, U.S. territories, or areas within the United States that are under Federal quarantine.

Please refer to laboratory SOP No. CF-SRV-01 and Section 13 of the Environmental, Health, and Safety Manual (EHSM) for the handling of hazardous samples.

23.6 Sample Shipping

In the event that the laboratory needs to ship samples, the samples are placed in a cooler with enough ice to ensure the samples remain just above freezing and at or below 6.0°C during transit. The samples are carefully surrounded by packing material to avoid breakage (yet maintain appropriate temperature). A trip blank is enclosed for those samples requiring water/solid volatile organic analyses (see Note). The chain-of-custody form is signed by the sample control technician and attached to the shipping paperwork. Samples are generally shipped overnight express or hand-delivered by a TestAmerica courier to maintain sample integrity. All personnel involved with shipping and receiving samples must be trained to maintain the proper chain-of-custody documentation and to keep the samples intact and on ice. The EHSM contains additional shipping requirements.

Note: If a client does not request trip blank analysis on the COC or other paperwork, the laboratory will not analyze the trip blanks that were supplied. However, in the interest of good client service, the laboratory will advise the client at the time of sample receipt that it was noted that they did not request analysis of the trip blank; and that the laboratory is providing the notification to verify that they are not inadvertently omitting a key part of regulatory compliance testing.

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23.7 Sample Disposal

Samples should be retained for a minimum of 30 days after the project report is sent, however, provisions may be made for earlier disposal of samples once the holding time is exceeded. Some samples are required to be held for longer periods based on regulatory or client requirements (e.g., 60 days after project report is sent). The laboratory must follow the longer sample retention requirements where required by regulation or client agreement. Several possibilities for sample disposal exist: the sample may be consumed completely during analysis, the sample may be returned to the customer or location of sampling for disposal, or the sample may be disposed of in accordance with the laboratory's waste disposal procedures (SOP: CF-WD-01, *Waste Disposal).* All procedures in the laboratory EHSM are followed during disposal. Samples are normally maintained in the laboratory no longer than two months from receipt unless otherwise requested. Unused portions of samples found or suspected to be hazardous according to state or federal guidelines may be returned to the client upon completion of the analytical work.

If a sample is part of a known litigation, the affected legal authority, sample data user, and/or submitter of the sample must participate in the decision about the sample's disposal. All documentation and correspondence concerning the disposal decision process must be kept on file. Pertinent information includes the date of disposal, nature of disposal (such as sample depletion, hazardous waste facility disposal, return to client), and names of individuals who conducted the arrangements and physically completed the task. A Waste Disposal Record should be completed.

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Figure 23-1. Example: Chain of Custody (COC)

TestAmerica Cedar Falls
704 Enterprise Drive

Cedar Falls, IA 50613
phone 319.277.2401 fax 319.277.2425

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Regulatory Program: ☐ DW ☐ NPDES ☐ RCRA ☐ Other:

TestAmerica Laboratories, Inc.

Client Contact	Project Manager:	Site Contact:	Date:	COC No:
Your Company Name here	Tel/Fax:	Lab Contact:	Carrier:	_____ of _____ COCs
Address	Analysis Turnaround Time			Sampler:
City/State/Zip	☐ CALENDAR DAYS ☐ WORKING DAYS			For Lab Use Only:
(xxx) xxx-xxxx Phone	TAT if different from Below _____			Walk-in Client:
(xxx) xxx-xxxx FAX	☐ 2 weeks			Lab Sampling:
Project Name:	☐ 1 week			
Site:	☐ 2 days			Job / SDG No.:
P O #	☐ 1 day			

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	# of Cont.	Filtered Sample (Y / N)	Perform MS / MSD (Y / N)	Sample Specific Notes:

Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other _____

Possible Hazard Identification:
Are any samples from a listed EPA Hazardous Waste? Please List any EPA Waste Codes for the sample in the Comments Section if the lab is to dispose of the sample.

☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)

☐ Return to Client ☐ Disposal by Lab ☐ Archive for _____ Months

Special Instructions/QC Requirements & Comments:

Custody Seals Intact: ☐ Yes ☐ No | Custody Seal No.: | Cooler Temp. (°C): Obs'd:_____ Corr'd:_____ | Therm ID No.:_____

Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received in Laboratory by:	Company:	Date/Time:

Form No. CA-C-WI-002, Rev. 4.3, dated 12/05/2013

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Figure 23-2. Example: Sample Acceptance Policy

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

704 ENTERPRISE DRIVE • CEDAR FALLS, IA 50613
800-750-2401 • 319-277-2425 FAX

Sample Acceptance Policy

All incoming work will be evaluated against the criteria listed below. When applicable, data from any samples that do not meet the criteria listed below will be noted on the laboratory report defining the nature and substance of the variation. In these instances, the client will be notified either by e-mail, telephone, or fax as soon as possible after the receipt of the samples.

Per State and/or Federal Regulation, the client is responsible to ensure that samples are shipped in accordance with DOT/IATA requirements, and that radioactive materials may only be delivered to licensed facilities. Any samples containing (or suspected to contain) Source, Byproduct, or Special Nuclear Material as defined by 10 CFR should be delivered directly to facilities licensed to handle such radioactive material. Natural material or ores containing naturally occurring radionuclides may be delivered to any TestAmerica facility or courier as long as the activity concentration of the material does not exceed 270 pCi/g alpha or 2700 pCi/g beta (49 CFR Part 173).

1) Samples must arrive with labels intact with a Chain of Custody (COC) filled out completely. The following information must be recorded:
   - Client name, address, phone number, and fax number (if available)
   - Project name and/or number
   - Sample Identification
   - Date, time, and location of sampling
   - Collector's name
   - Sample matrix description
   - Sample container description
   - Number of each type of container
   - Preservatives used
   - Analysis requested
   - Requested turnaround time (TAT)
   - Special instructions, as necessary
   - Purchase Order number or billing information (e.g., quote number), if available
   - The date and time that each person received or relinquished the sample(s), including their signed name
   - The date and time of receipt must be must be recorded between the last person to relinquish the samples and the person who receives the samples in the lab. These date and times must be exactly the same.
   - Information must be legible
2) Sample(s) must be properly labeled:
   - Use durable labels (labels provided by TestAmerica are preferred)
   - Include a unique identification number
   - Include sampling date, time, and sampler's ID
   - Include preservative used
   - Information must be legible in indelible ink
3) Proper sample containers with adequate volume for the analysis and necessary QC are required for each analysis requested. For information or additional guidance on sample containers, refer to your Project Manager and/or TestAmerica Corporate QA document no. CA-Q-WI-025, *Sample Reference Guide*.

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Figure 23-2. Example: Sample Acceptance Policy, continued

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Sample Acceptance Policy

4) Samples must be preserved according to the requirements of the requested analytical method. For information or additional guidance on sample preservation, refer to your Project Manager and/or TestAmerica Corporate QA document no. CA-Q-WI-025, *Sample Reference Guide*.

5) Most analytical methods require chilling samples to 4℃. For these methods, the criteria are met if the samples are chilled to at or below 6℃ and above 0℃ (exceptions to the chilling requirement would include samples submitted for metals analysis or bulk asbestos samples). For methods with other temperature criteria (e.g., some bacteriological methods require <10℃), the samples must arrive within ±2℃ of the required temperature or within the method-specified range.

   - Samples that are hand-delivered to the laboratory immediately after collection may not have had time to cool sufficiently. In this case, the samples shall be considered acceptable as long as there is evidence that the cooling process has begun (i.e., received on ice).
   - If sample analysis is begun within fifteen (15) minutes of collection, thermal preservation is not required.
   - Thermal preservation is not required in the field if the laboratory receives and refrigerates the sample with fifteen (15) minutes of collection.

6) Chemical preservation will be verified prior to analysis and documented, either in sample control or at the analysts' level. The Project Manager will be notified immediately if there is a discrepancy. If analysis will still be performed, all affected results will be flagged to indicate improper preservation.

7) Sample Holding Times:

   - TestAmerica will make every effort to analyze samples within the regulatory holding time (HT). Samples must be received at the laboratory with enough time to perform the sample analysis. Except for short hold time analyses (≤48 hr HT), samples must be received with at least 48 hrs (working days) remaining on the holding time to ensure analysis.
   - Analyses that are designated as "field" analyses (e.g., pH, Dissolved Oxygen, Residual Chlorine, Carbon Dioxide, Sulfite, Redox Potential) should be analyzed ASAP by field sampling personnel (within 15 minutes of sampling) prior to delivering to the lab. However, if the analyses are to be performed in the laboratory, TestAmerica will make every effort to analyze the samples within 24 hours from receipt at the testing laboratory (excluding weekends). Samples analyzed in the laboratory for field parameters will be qualified on the final report with an 'HF' to indicate holding time exceedance.
   - For information or further guidance on sample holding times, refer to your Project Manager and/or TestAmerica Corporate QA document no. CA-Q-WI-025, *Sample Reference Guide*.

8) All samples submitted for volatile organic analyses should have a Trip Blank submitted with the samples. If requested, TestAmerica will supply a Trip Blank with all bottle orders containing volatile organic analyses.

9) The Project Manager will be notified if any sample is received in damaged condition. TestAmerica will then contact the client with the details of the sample condition upon receipt and request further instruction from the client.

10) Recommendations for packing samples for shipment:

   - Pack samples on ice rather than "Blue" ice packs
   - Soil samples should be placed in plastic, sealable bags. The containers often have dirt around the top of the jar and do not seal very well, thus are prone to intrusion from the water from melted ice.
   - Water samples are best wrapped with bubble wrap or bubble sleeves, and then placed in plastic, sealable bags.
   - Fill extra cooler space with bubble wrap.

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Figure 23-3. Example: Cooler Receipt Form

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Place COC scanning label here

Cooler/Sample Receipt and Temperature Log Form

Client Information	
Client:	
City/State:	Project:
Receipt Information	
Date/Time Received:	Received By:
Delivery Type: ☐ UPS ☐ FedEx ☐ FedEx Ground ☐ US Mail ☐ Spee-Dee ☐ TA Courier ☐ TA Field Services ☐ Client Drop-off ☐ Other:_____	
Condition of Cooler/Containers	
Sample(s) received in Cooler? ☐ Yes ☐ No	*If yes:* Cooler ID:
Multiple Coolers? ☐ Yes ☐ No	*If yes:* Cooler # _____ of _____
Cooler Custody Seals Present? ☐ Yes ☐ No	*If yes:* Cooler custody seals intact? ☐ Yes ☐ No
Sample Custody Seals Present? ☐ Yes ☐ No	*If yes:* Sample custody seals intact? ☐ Yes ☐ No
Trip Blank Present? ☐ Yes ☐ No	*If yes:* Which VOA samples are in cooler? ↓
Temperature Record	
Coolant: ☐ Wet ice ☐ Blue ice ☐ Dry ice ☐ Other:_____ ☐ NONE	
Thermometer ID:	Correction Factor (°C):
• **Temp Blank Temperature** – If no temp blank, or temp blank temperature above criteria, proceed to Sample Container Temperature	
Uncorrected Temp (°C):	Corrected Temp (°C):
• Sample Container Temperature	
Sample ID(s) & bottle type used:	
Uncorrected Temp (°C):	Corrected Temp (°C):
Exceptions Noted	
1) If temperature exceeds criteria, was sample(s) received same day of sampling? ☐ Yes ☐ No a) *If yes:* Is there evidence that the chilling process began? ☐ Yes ☐ No	
2) If temperature is <0°C, are there obvious signs that the integrity of sample containers is compromised? (e.g., bulging septa, broken/cracked bottles?) ☐ Yes ☐ No	
NOTE: If yes, contact PM before proceeding. If no, proceed with login	
Additional Comments	

Document: CF-LG-WI-002
Revision: 22
Date: 11/27/2015

TestAmerica-Cedar Falls

General temperature criteria is 0 to 6°C
Bacteria temperature criteria is 0 to 10°C

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SECTION 24. ASSURING THE QUALITY OF TEST RESULTS

24.1 Overview

In order to assure our clients of the validity of their data, the laboratory continuously evaluates the quality of the analytical process. The analytical process is controlled not only by instrument calibration as discussed in Section 20, but also by routine process quality control measurements (e.g. Blanks, Laboratory Control Samples (LCS), Matrix Spikes (MS), duplicates (DUP), Surrogates, Internal Standards (IS)). These quality control checks are performed as required by the method or regulations to assess precision and accuracy. Quality control samples are to be treated in the exact same manner as the associated field samples being tested. In addition to the routine process quality control samples, Proficiency Testing (PT) Samples (concentrations unknown to laboratory) are analyzed to help ensure laboratory performance.

24.2 Controls

Sample preparation or pre-treatment is commonly required before analysis. Typical preparation steps include homogenization, particle size reduction, solvent extraction, sonication, acid digestion, distillation, reflux, evaporation, drying, ashing, concentration, and/or cleanup. During these pre-treatment steps, samples are arranged into discreet manageable groups referred to as preparation (prep) batches. Prep batches provide a means to control variability in sample treatment. Control samples are added to each prep batch to monitor method performance and are processed through the entire analytical procedure with investigative/field samples.

24.3 Negative Controls

Table 24-1. Example - Negative Controls

Control Type	Details
Method Blank (MB)	Used to assess preparation and analysis for possible contamination during the preparation and processing steps.
	The specific frequency of use for method blanks during the analytical sequence is defined in the specific standard operating procedure for each analysis. Generally it is 1 for each batch of samples; not to exceed 20 environmental samples.
	The method blank is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (e.g., Reagent water, Ottawa sand, glass beads, etc.) and is processed along with and under the same conditions as the associated samples. The method blank goes through all of the steps of the process (including as necessary: filtration, clean-ups, etc.).
	Reanalyze or qualify associated sample results when the concentration of a targeted analyte in the blank is at or above the reporting limit as established by the method or by regulation, AND is greater than 1/10 of the amount measured in the sample.
Calibration Blanks	Prepared and analyzed along with calibration standards where applicable. They are prepared using the same reagents that are used to prepare the standards. In some analyses the calibration blank may be included in the calibration curve.

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Table 24-1. Example - Negative Controls

Control Type	Details
Instrument Blanks	Blank reagents or reagent water that may be processed during an analytical sequence in order to assess contamination in the analytical system. In general, instrument blanks are used to differentiate between contamination caused by the analytical system and that caused by the sample handling or sample prep process. Instrument blanks may also be inserted throughout the analytical sequence to minimize the effect of carryover from samples with high analyte content.
Trip Blank [1]	Trip Blanks are required to be submitted by the client with each shipment of samples requiring aqueous and solid volatiles analyses (or as specified in the client's project plan). Additionally, trip blanks may be prepared and analyzed for volatile analysis of air samples, when required by the client. A trip blank may be purchased (certified clean) or is prepared by the laboratory by filling a clean container with pure deionized water that has been purged to remove any volatile compounds. Appropriate preservatives are also added to the container. The trip blank is sent with the bottle order and is intended to reflect the environment that the containers are subjected to throughout shipping and handling and help identify possible sources if contamination is found. The field sampler returns the trip blank in the cooler with the field samples.
Field Blanks [1]	Field Blanks are sometimes used for specific projects by the field samplers. A field blank prepared in the field by filling a clean container with pure reagent water and appropriate preservative, if any, for the specific sampling activity being undertaken. (EPA OSWER)
Equipment Blanks [1]	Equipment Blanks are also sometimes created in the field for specific projects. An equipment blank is a sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures. (TNI)
Holding Blanks	Holding Blanks also referred to as refrigerator or freezer blanks, are used to monitor the sample storage units for volatile organic compounds during the storage of VOA samples in the laboratory

[1] When known, these field QC samples should not be selected for matrix QC as it does not provide information on the behavior of the target compounds in the field samples. Usually, the client sample ID will provide information to identify the field blanks with labels such as "FB", "EB", or "TB."

Evaluation criteria and corrective action for these controls are defined in the specific standard operating procedure for each analysis.

24.3.1 **Negative Controls for Microbiological Methods** – Microbiological Methods utilize a variety of negative controls throughout the process to ensure that false positive results are not obtained. These controls are critical to the validity of the microbiological analyses. Some of these negative controls are:

Table 24-2. Example - Negative Controls for Microbiology

Control Type	Details
Sterility Checks (Media)	Sterility Checks for media are analyzed for each lot of pre-prepared media, ready-to-use media and for each batch of medium prepared by the laboratory.
Filtration Blanks	Filtration Blanks are run at the beginning and end for each sterilized filtration unit used in a filtration series. For pre-sterilized single use funnels a sterility check is performed on at least one funnel per lot.
Sterility Checks (Sample Containers)	Sterility Checks for sample containers are performed on at least one container per lot of purchased, pre-sterilized containers. If containers are prepared and sterilized by the laboratory, one container per sterilization batch is checked. Container sterility checks are performed using non-selective growth media.

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Table 24-2. Example - Negative Controls for Microbiology

Control Type	Details
Sterility Checks (Dilution Water)	Sterility Checks for dilution water are performed on each batch of dilution water prepared by the laboratory and on each batch of pre-prepared dilution water. All checks are performed using non-selective growth media.
Sterility Checks (Filters)	Sterility Checks for filters are performed on at least one filter from each new lot of membrane filters using non-selective growth media.

Negative culture controls demonstrate that a media does not support the growth of non-target organisms and ensures that there is not an atypical positive reaction from the target organisms. Prior to the first use of the media, each lot of pre-prepared selective media or batch of laboratory prepared selective media is analyzed with at least one known negative culture control as appropriate to the method.

24.4 Positive Controls

Control samples (e.g., QC indicators) are analyzed with each batch of samples to evaluate data based upon **(1)** Method Performance: Laboratory Control Sample (LCS), which entails both the preparation and measurement steps; and **(2)** Matrix Effects: Matrix Spike (MS) [Matrix spikes are not applicable to air], or Sample Duplicate (DU or DUR), which evaluates field sampling accuracy, precision, representativeness, interferences, and/or the effect of the matrix on the method performed. Each regulatory program and each method within those programs specify the control samples that are prepared and/or analyzed with a specific batch

Note that frequency of control samples vary with specific regulatory, methodology and project specific criteria. Complete details on method control samples are as listed in each analytical SOP.

24.4.1 Method Performance Control - Laboratory Control Sample (LCS)

The LCS measures the accuracy of the method in a blank matrix and assesses method performance independent of potential field sample matrix affects in a laboratory batch.

The LCS is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (for example: Reagent water, Ottawa sand, glass beads, etc.) and is processed along with and under the same conditions as the associated samples. The LCS is spiked with verified known amounts of analytes or is made of a material containing known and verified amounts of analytes, taken through all preparation and analysis steps along with the field samples. Where there is no preparation taken for an analysis (such as in aqueous volatiles), or when all samples and standards undergo the same preparation and analysis process (such as orthophosphate), an ICV is reported as the LCS.

Certified pre-made reference material purchased from a NIST/A2LA accredited vendor may also be used for the LCS when the material represents the sample matrix or the analyte is not easily spiked (e.g. solid matrix LCS for metals, TDS, etc.).

The specific frequency of use for LCS during the analytical sequence is defined in the specific standard operating procedure for each analysis. It is generally 1 for each batch of samples; not to exceed 20 environmental samples.

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If the mandated or requested test method, or project requirements, do not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample (and Matrix Spike) where applicable (e.g. no spike of pH). However, in cases where the components interfere with accurate assessment (such as simultaneously spiking chlordane, toxaphene and PCBs in Method 608), the test method has an extremely long list of components or components are incompatible, at a minimum, a representative number of the listed components (see below) shall be used to control the test method. The selected components of each spiking mix shall represent all chemistries, elution patterns and masses, permit specified analytes and other client requested components. However, the laboratory shall ensure that all reported components are used in the spike mixture within a one-year time period.

- For methods that have 1-10 target analytes, spike all components.
- For methods that include 11-20 target analytes, spike at least 10 or 80%, whichever is greater.
- For methods with more than 20 target analytes, spike at least 16 components.
- Exception: Due to analyte incompatibility in pesticides, Toxaphene and Chlordane are only spiked at client request based on specific project needs.
- Exception: Due to analyte incompatibility between the various PCB aroclors, aroclors 1016 and 1260 are used for spiking as they cover the range of all of the aroclors. Specific aroclors may be used by request on a project specific basis.

24.4.2 Positive Controls for Microbiological Methods

- Each lot of pre-prepared media (including chromofluorogenic reagent) and each batch of laboratory prepared media is tested with a pure culture of known positive reaction.
- In addition, every analytical batch also contains a pure culture of known positive reaction.
- A pure culture of known negative reaction is also tested with each analytical batch to ensure specificity of the procedure.

24.5 Sample Matrix Controls

Table 24-3. Sample Matrix Control

Control Type	Details	
Matrix Spikes (MS)	Use	Assess the effect sample matrix of the spiked sample has on the precision and accuracy of the results generated by the method used;
	Typical Frequency [1]	At a minimum, with each matrix-specific batch of samples processed, an MS is carried through the complete analytical procedure. Unless specified by the client, samples used for spiking are randomly selected and rotated between different client projects. If the mandated or requested test method does not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample and Matrix Spike. Refer to the method SOP for complete details
	Description	Essentially a sample fortified with a known amount of the test analyte(s).

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Control Type	Details	
Surrogate	Use	Measures method performance to sample matrix (organics only).
	Typical Frequency [1]	Are added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. The recovery of the surrogates is compared to the acceptance limits for the specific method. Poor surrogate recovery may indicate a problem with sample composition and shall be reported, with data qualifiers, to the client whose sample produced poor recovery.
	Description	Are similar to matrix spikes except the analytes are compounds with properties that mimic the analyte of interest and are unlikely to be found in environment samples.
Duplicates[2]	Use	For a measure of analytical precision, with each matrix-specific batch of samples processed, a matrix duplicate (DU or DUR) sample, matrix spike duplicate (MSD), or LCS duplicate (LCSD) is carried through the complete analytical procedure.
	Typical Frequency [1]	Duplicate samples are usually analyzed with methods that do not require matrix spike analysis.
	Description	Performed by analyzing two aliquots of the same field sample independently or an additional LCS.
Internal Standards	Use	Are spiked into all environmental and quality control samples (including the initial calibration standards) to monitor the qualitative aspect of organic and some inorganic analytical measurements.
	Typical Frequency [1]	All organic and ICP methods as required by the analytical method.
	Description	Used to correct for matrix effects and to help troubleshoot variability in analytical response and are assessed after data acquisition. Possible sources of poor internal standard response are sample matrix, poor analytical technique or instrument performance.

[1] See the specific analytical SOP for type and frequency of sample matrix control samples.
[2] LCSD's are normally not performed except when regulatory agencies or client specifications require them. The recoveries for the spiked duplicate samples must meet the same laboratory established recovery limits as the accuracy QC samples. If an LCSD is analyzed both the LCS and LCSD must meet the same recovery criteria and be included in the final report. The precision measurement is reported as "Relative Percent Difference" (RPD). In the case of microbiology, the precision measurement obtained from the DUR is reported as a range of logarithms. Poor precision between duplicates (except LCS/LCSD) may indicate non-homogeneous matrix or sampling.

24.6 Acceptance Criteria (Control Limits)

As mandated by the test method and regulation, each individual analyte in the LCS, MS, or Surrogate Spike is evaluated against the control limits published in the test method. Where there are no established acceptance criteria, the laboratory calculates in-house control limits with the use of control charts or, in some cases, utilizes client project specific control limits. When this occurs, the regulatory or project limits will supersede the laboratory's in-house limits.

Note: For methods, analytes and matrices with very limited data (e.g., unusual matrices not analyzed often), interim limits are established using available data or by analogy to similar methods or matrices.

Once control limits have been established, they are verified, reviewed, and updated if necessary on an annual basis unless the method requires more frequent updating. Control limits are established per method (as opposed to per instrument) regardless of the number of instruments utilized.

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Laboratory generated percent recovery acceptance (control) limits are generally established by taking ±3 Standard Deviations (99% confidence level) from the average recovery of a minimum of 20-30 data points (more points are preferred).

- Regardless of the calculated limit, the limit should be no tighter than the Calibration Verification (ICV/CCV). (Unless the analytical method specifies a tighter limit).
- In-house limits cannot be any wider than those mandated in a regulated analytical method. Client or contract required control limits are evaluated against the laboratory's statistically derived control limits to determine if the data quality objectives (DQOs) can be achieved. If laboratory control limits are not consistent with DQOs, then alternatives must be considered, such as method improvements or use of an alternate analytical method.
- The lowest acceptable recovery limit will be 10% (the analyte must be detectable and identifiable). Exception: The lowest acceptable recovery limit for Benzidine will be 5% and the analyte must be detectable and identifiable.
- The maximum acceptable recovery limit will be 150%.
- The maximum acceptable RPD limit will be 35% for waters and 40% for soils. The minimum RPD limit is 10%.

24.6.1 The lab must be able to generate a current listing of their control limits and track when the updates are performed. In addition, the laboratory must be able to recreate historical control limits. Refer also to laboratory SOP No. CF-QA-04, *Quality Control Limits Summary*.

24.6.2 A LCS that is within the acceptance criteria establishes that the analytical system is in control and is used to validate the process. Samples that are analyzed with an LCS with recoveries outside of the acceptance limits may be determined as out of control and should be reanalyzed if possible. If reanalysis is not possible, then the results for all affected analytes for samples within the same batch must be qualified when reported. The internal corrective action process (see Section 12) is also initiated if an LCS exceeds the acceptance limits. Sample results may be qualified and reported without reanalysis if:

- The analyte results are below the reporting limit and the LCS is above the upper control limit.
- If the analytical results are above the relevant regulatory limit and the LCS is below the lower control limit.

24.6.3 If the MS/MSDs do not meet acceptance limits, the MS/MSD and the associated spiked sample is reported with a qualifier for those analytes that do not meet limits. If obvious preparation errors are suspected, or if requested by the client, unacceptable MS/MSDs are reprocessed and reanalyzed to prove matrix interference. A more detailed discussion of acceptance criteria and corrective action can be found in the lab's method SOPs and in Section 12.

24.6.4 If a surrogate standard falls outside the acceptance limits, if there is not obvious chromatographic matrix interference, reanalyze the sample to confirm a possible matrix effect. If the recoveries confirm or there was obvious chromatographic interference, results are reported from the original analysis and a qualifier is added. If the reanalysis meets surrogate recovery criteria, the second run is reported (or both are reported if requested by the client).

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24.7 Additional Procedures to Assure Quality Control

The laboratory has written and approved method SOPs to assure the accuracy of the test method including calibration (see Section 20), use of certified reference materials (see Section 21) and use of PT samples (see Section 15).

A discussion regarding MDLs, Limit of Detection (LOD) and Limit of Quantitation (LOQ) can be found in Section 19.

- Use of formulae to reduce data is discussed in the method SOPs and in Section 20.
- Selection of appropriate reagents and standards is included in Section 9 and 21.
- A discussion on selectivity of the test is included in Section 5.
- Constant and consistent test conditions are discussed in Section 18.
- The laboratories sample acceptance policy is included in Section 23.

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SECTION 25. REPORTING RESULTS

25.1 Overview

The results of each test are reported accurately, clearly, unambiguously, and objectively in accordance with State and Federal regulations as well as client requirements. Analytical results are issued in a format that is intended to satisfy customer and laboratory accreditation requirements as well as provide the end user with the information needed to properly evaluate the results. Where there is conflict between client requests and laboratory ethics or regulatory requirements, the laboratory's ethical and legal requirements are paramount, and the laboratory will work with the client during project set up to develop an acceptable solution. Refer to Section 7.

A variety of report formats are available to meet specific needs.

In cases where a client asks for simplified reports, there must be a written request from the client. There still must be enough information that would show any analyses that were out of conformance (QC out of limits). Review of reported data is included in Section 19.

25.2 Test Reports

Analytical results are reported in a format that is satisfactory to the client and meets all requirements of applicable accrediting authorities and agencies. A variety of report formats are available to meet specific needs. The report is printed on company letterhead (either electronic or hard-copy), reviewed, and signed by the appropriate project manager or his/her designee. At a minimum, the standard laboratory report shall contain the following information:

25.2.1 A report title (e.g., Analytical Report) with a "sample results" column header.

25.2.2 Each report cover page printed on company letterhead, which includes the laboratory name, address, and telephone number.

25.2.3 A unique identification of the report (e.g., job number) and on each page an identification in order to ensure the page is recognized as part of the report and a clear identification of the end.

Note: Page numbers of report are represented as page # of ##. Where the first number is the page number and the second is the total number of pages.

25.2.4 A copy of the Chain of Custody (COC).

Any COCs involved with Subcontracting are included.

25.2.5 The name and address of client and a project name/number, if applicable.

25.2.6 Client project manager or other contact

25.2.7 Description and unambiguous identification of the tested sample(s) including the client identification code.

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25.2.8 Date of receipt of sample, date and time of collection, and date(s) of test preparation and performance, and time of preparation or analysis if the required holding time for either activity is less than or equal to 72 hours.

25.2.9 Date reported or date of revision, if applicable.

25.2.10 Method of analysis including method code (EPA, Standard Methods, etc.).

25.2.11 Method reporting limits.

25.2.12 Method detection limits (if requested)

25.2.13 Definition of data qualifiers and reporting acronyms (e.g. ND).

25.2.14 Sample results.

25.2.15 QC data consisting of method blank, surrogate, LCS, and MS/MSD recoveries and control limits.

25.2.16 Condition of samples at receipt including temperature. This may be accomplished in a narrative or by attaching sample login sheets (Refer to Sec. 25.2.4 – Item 3 regarding additional addenda).

25.2.17 A statement to the effect that the results relate only to the items tested and the sample(s) as received by the laboratory.

25.2.18 A signature and title of the person(s) accepting responsibility for the content of the report and date of issue. Signatories are appointed by the Lab Director.

25.2.19 When TNI accreditation is required, the lab shall certify that the test results meet all requirements of TNI or provide reasons and/or justification if they do not.

25.2.20 Where applicable, a narrative to the report that explains the issue(s) and corrective action(s) taken in the event that a specific accreditation or certification requirement was not met.

25.2.21 When soil samples are analyzed, a specific identification as to whether soils are reported on a “wet weight” or “dry weight” basis.

25.2.22 Appropriate laboratory certification number for the state of origin of the sample, if applicable.

25.2.23 If only part of the report is provided to the client (client requests some results before all of it is complete), it must be clearly indicated on the report (e.g., partial report, or preliminary report). A complete report must be sent once all of the work has been completed.

25.2.24 Any non-TestAmerica subcontracted analysis results are provided as a separate report on the official letterhead of the subcontractor. All TestAmerica subcontracting is clearly identified on the report as to which laboratory performed a specific analysis.

25.2.25 A Certification Summary Report, where required, will document that, unless otherwise noted, all analytes tested and reported by the laboratory were covered by the noted certifications.

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Note: Refer to the Corporate SOP on Electronic Reporting and Signature Policy (No. CA-I-P-002) for details on internally applying electronic signatures of approval.

25.3 Reporting Level or Report Type

The laboratory offers four levels of quality control reporting. Each level, in addition to its own specific requirements, contains all the information provided in the preceding level. The packages provide the following information in addition to the information described above:

- Level I is a report with the features described in Section 25.2 above.
- Level II is a Level I report plus summary information, including results for the method blank, percent recovery for laboratory control samples and matrix spike samples, and the RPD values for all MSD and sample duplicate analyses.
- Level III contains all the information supplied in Level II, but presented on the CLP-like summary forms, and relevant calibration information. A Level II report is not included, unless specifically requested. No raw data is provided.
- Level IV is the same as Level III with the addition of all raw supporting data.

In addition to the various levels of QC packaging, the laboratory may also provide data packages in diskette deliverable form. Initial reports may be provided to clients by facsimile. Faxed reports are followed by hardcopy, if requested by the client. Procedures used to ensure client confidentiality are outlined in Section 25.6.

25.3.1 Electronic Data Deliverables (EDDs)

EDDs are routinely offered as part of TestAmerica's services in addition to the test report as described in Section 25.2. When NELAP accreditation is required and both a test report and EDD are provided to the client, the official version of the test report will be the combined information of the report and the EDD. The Cedar Falls laboratory offers a variety of EDD formats including EQUIS (client-specific formats), Illinois EPA, MPCA, Missouri TerraBase, Excel (multiple formats), and Text files.

EDD specifications are submitted to the IT department by the PM for review and undergo the contract review process. Once the facility has committed to providing data in a specific electronic format, the coding of the format may need to be performed. This coding is documented and validated. The validation of the code is retained by the IT staff coding the EDD.

EDDs shall be subject to a review to ensure their accuracy and completeness. If EDD generation is automated, review may be reduced to periodic screening if the laboratory can demonstrate that it can routinely generate that EDD without errors. Any revisions to the EDD format must be reviewed until it is demonstrated that it can routinely be generated without errors. If the EDD can be reproduced accurately and if all subsequent EDDs can be produced error-free, each EDD does not necessarily require a review.

25.4 Supplemental Information for Test

The lab identifies any unacceptable QC analyses or any other unusual circumstances or observations such as environmental conditions and any non-standard conditions that may have affected the quality of a result. This is typically in the form of a footnote or a qualifier and/or a narrative explaining the discrepancy in the front of the report.

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Numeric results with values outside of the calibration range, either high or low, are qualified as 'estimated'.

Where quality system requirements are not met, a statement of compliance/non-compliance with requirements and/or specifications is required, including identification of test results derived from any sample that did not meet TNI sample acceptance requirements such as improper container, holding time, or temperature.

Where applicable, a statement on the estimated uncertainty of measurements; information on uncertainty is needed when a client's instructions so require.

Opinions and Interpretations - The test report contains objective information, and generally does not contain subjective information such as opinions and interpretations. If such information is required by the client, the Laboratory Director will determine if a response can be prepared. If so, the Laboratory Director will designate the appropriate member of the management team to prepare a response. The response will be fully documented, and reviewed by the Laboratory Director, before release to the client. There may be additional fees charged to the client at this time, as this is a non-routine function of the laboratory.

Note: Review of data deliverable packages for submittal to regulatory authorities requires responses to non-conforming data concerning potential impact on data quality. This necessitates a limited scope of interpretation, and this work is performed by the QA Department. This is the only form of "interpretation" of data that is routinely performed by the laboratory.

When opinions or interpretations are included in the report, the laboratory provides an explanation as to the basis upon which the opinions and interpretations have been made. Opinions and interpretations are clearly noted as such and where applicable, a comment should be added suggesting that the client verify the opinion or interpretation with their regulator.

25.5 Environmental Testing Obtained From Subcontractors

If the laboratory is not able to provide the client the requested analysis, the samples would be subcontracted following the procedures outlined in the Corporate SOP on Subcontracting (SOP No. CA-L-S-002).

Data reported from analyses performed by a subcontractor laboratory are clearly identified as such on the analytical report provided to the client. Results from a subcontract laboratory outside of TestAmerica are reported to the client on the subcontract laboratory's original report stationary and the report includes any accompanying documentation.

25.6 Client Confidentiality

In situations involving the transmission of environmental test results by telephone, facsimile or other electronic means, client confidentiality must be maintained.

TestAmerica will not intentionally divulge to any person (other than the Client or any other person designated by the Client in writing) any information regarding the services provided by TestAmerica or any information disclosed to TestAmerica by the Client. Furthermore, information known to be potentially endangering to national security or an entity's proprietary rights will not be released.

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Note: This shall not apply to the extent that the information is required to be disclosed by TestAmerica under the compulsion of legal process. TestAmerica will, to the extent feasible, provide reasonable notice to the client before disclosing the information.

Note: Authorized representatives of an accrediting authority are permitted to make copies of any analyses or records relevant to the accreditation process, and copies may be removed from the laboratory for purposes of assessment.

25.6.1 Report deliverable formats are discussed with each new client. If a client requests that reports be faxed or e-mailed, the reports should be faxed with a cover sheet or e-mailed with a note that includes a confidentiality statement similar to the following:

This material is intended only for the use of the individual(s) or entity to which it is addressed, and may contain information that is privileged and confidential. If you are not the intended recipient, or the employee or agent responsible for delivering this material to the intended recipient, you are hereby notified that any dissemination, distribution or copying of this communication is strictly prohibited. If you have received this communication in error, please notify us immediately by telephone at 1-800-750-2401 (or for e-mails: please notify us immediately by e-mail or by phone (1-800-750-2401) and delete this material from any computer).

25.7 Format of Reports

The format of reports is designed to accommodate each type of environmental test carried out and to minimize the possibility of misunderstanding or misuse.

25.8 Amendments to Test Reports

Corrections, additions, or deletions to reports are only made when justification arises through supplemental documentation. Justification is documented using the laboratory's corrective action system (refer to Section 12).

The revised report is retained on the document server in the LIMS, as is the original report and all other project documents. The revised report can be accessed through PM Desktop under the Job Number in the Deliverable folder. The revised deliverable is identified as Rev(1) next to the report which as been revised. Any further revisions would be identified as Rev(2), Rev(3), etc.

When the report is re-issued, a notation of "Revision: 1" is printed on the cover/signature page of the report. A brief explanation of reason for the re-issue is placed at the top of the Job Narrative page. If further revisions of the same report are necessary, the revision number is incremented each time (e.g., Revision: 2, Revision: 3, etc.).

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25.9 Policies on Client Requests for Amendments

25.9.1 Policy on Data Omissions or Reporting Limit Increases

Fundamentally, our policy is simply to not omit previously reported results (including data qualifiers) or to not raise reporting limits and report sample results as ND. This policy has few exceptions. Exceptions are:

- Laboratory error.
- Sample identification is indeterminate (confusion between COC and sample labels).
- An incorrect analysis (not analyte) was requested (e.g., COC lists 8315 but client wanted 8310). A written request for the change is required.
- Incorrect limits reported based on regulatory requirements.
- The requested change has absolutely *no possible* impact on the interpretation of the analytical results and there is *no possibility* of the change being interpreted as misrepresentation by anyone inside or outside of our company.

25.9.2 Multiple Reports

TestAmerica does not issue multiple reports for the same work order where there is different information on each report (this does not refer to copies of the same report) unless required to meet regulatory needs and approved by QA.

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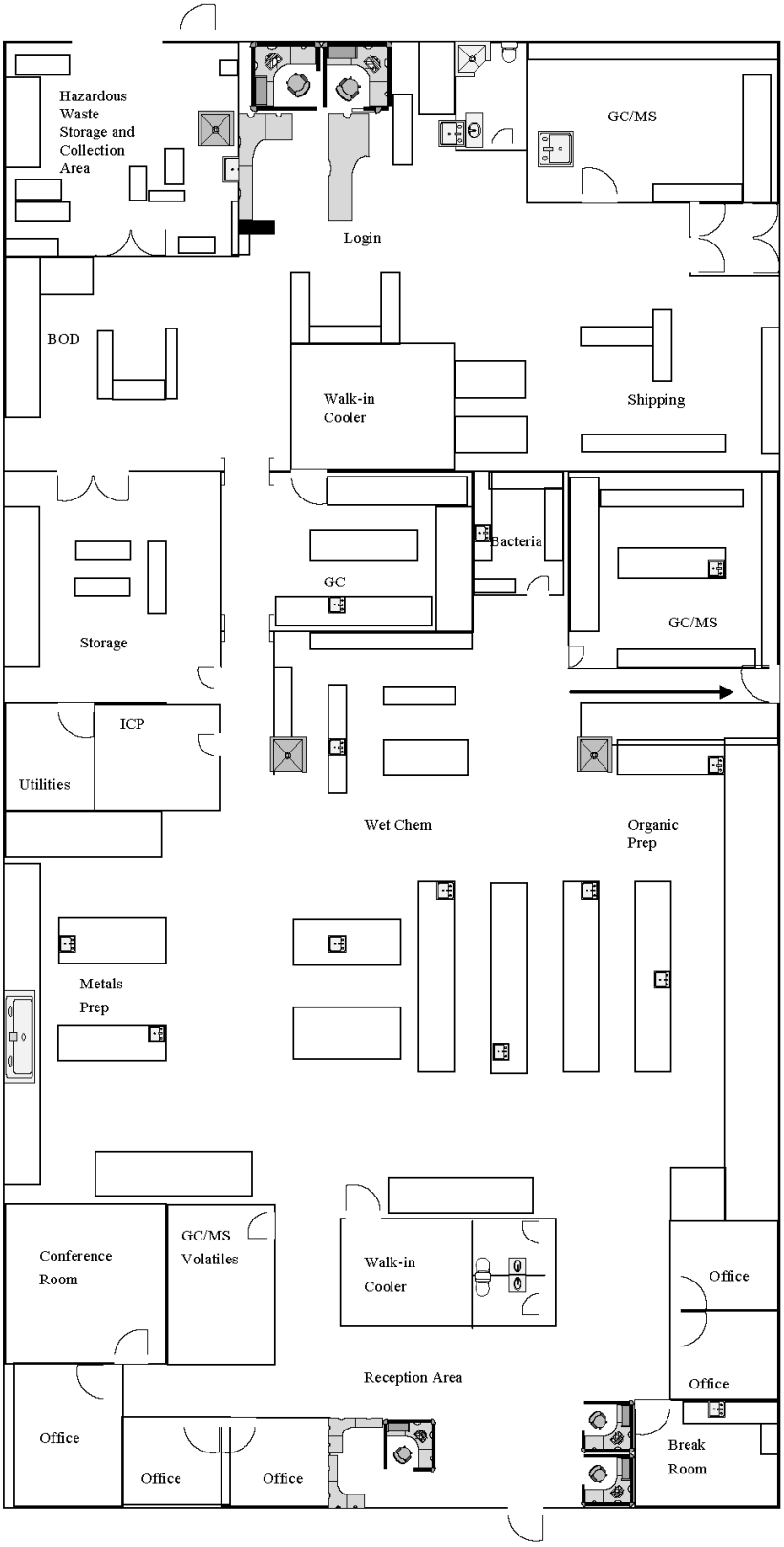
Appendix 1. Laboratory Floor Plan



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Appendix 2. Glossary/Acronyms (EL-V1M2 Sec. 3.1)

Glossary:

Acceptance Criteria: Specified limits placed on characteristics of an item, process, or service defined in requirement documents. (ASQC)

Accreditation: The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory.

Accuracy: The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator. (QAMS)

Analyst: The designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

Analytical Uncertainty: A subset of Measurement Uncertainty that includes all laboratory activities performed as part of the analysis. (TNI)

Anomaly: A condition or event, other than a deficiency, that may affect the quality of the data, whether in the laboratory's control or not.

Assessment: The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its systems to defined criteria (to the standards and requirements of laboratory accreditation). (TNI)

Audit: A systematic and independent examination of facilities, equipment, personnel, training, procedures, record-keeping, data validation, data management, and reporting aspects of a system to determine whether QA/QC and technical activities are being conducted as planned and whether these activities will effectively achieve quality objectives. (TNI)

Batch: Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A **preparation batch** is composed of one (1) to twenty (20) environmental samples of the same quality systems matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be twenty-four (24) hours. An **analytical batch** is composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various quality system matrices and can exceed twenty (20) samples. (TNI)

Bias: The systematic or persistent distortion of a measurement process, which causes errors in one direction (i.e., the expected sample measurement is different from the sample's true value). (TNI)

Blank: A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results. (ASQC)

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Calibration: A set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards. (TNI)

1) In calibration of support equipment the values realized by standards are established through the use of reference standards that are traceable to the International System of Units (SI).

2) In calibration according to methods, the values realized by standards are typically established through the use of Reference Materials that are either purchased by the laboratory with a certificate of analysis or purity, or prepared by the laboratory using support equipment that has been calibrated or verified to meet specifications.

Calibration Curve: The mathematical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response. (TNI)

Calibration Standard: A substance or reference material used to calibrate an instrument (QAMS)

Certified Reference Material (CRM): A reference material accompanied by a certificate, having a value, measurement uncertainty, and stated metrological traceability chain to a national metrology institute. (TNI)

Chain of Custody (COC) Form: Record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and types of containers; the mode of collection; the collector; time of collection; preservation; and requested analyses. (TNI)

Compromised Samples: Those samples which are improperly sampled, insufficiently documented (chain of custody and other sample records and/or labels), improperly preserved, collected in improper containers, or exceeding holding times when delivered to a laboratory. Under normal conditions, compromised samples are not analyzed. If emergency situation require analysis, the results must be appropriately qualified.

Confidential Business Information (CBI): Information that an organization designates as having the potential of providing a competitor with inappropriate insight into its management, operation or products. TNI and its representatives agree to safeguard identified CBI and to maintain all information identified as such in full confidentiality.

Confirmation: Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to Second Column Confirmation; Alternate wavelength; Derivatization; Mass spectral interpretation; Alternative detectors or Additional Cleanup procedures. (TNI)

Conformance: An affirmative indication or judgment that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements. (ANSI/ASQC E4-1994)

Correction: Actions necessary to correct or repair analysis specific non-conformances. The acceptance criteria for method specific QC and protocols as well as the associated corrective actions. The analyst will most frequently be the one to identify the need for this action as a result of calibration checks and QC sample analysis. No significant action is taken to change behavior, process or procedure.

Corrective Action: The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence. (ISO 8402)

Data Audit: A qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data re of acceptable quality (i.e., that they meet specified acceptance criteria).

Data Reduction: The process of transforming the number of data items by arithmetic or statistical calculations, standard curves, and concentration factors, and collation into a more useable form. (TNI)

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Deficiency: An unauthorized deviation from acceptable procedures or practices, or a defect in an item (ASQC), whether in the laboratory's control or not.

Demonstration of Capability: A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision. (TNI)

Document Control: The act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly, and controlled to ensure use of the correct version at the location where the prescribed activity if performed. (ASQC)

Duplicate Analyses: The analyses or measurements of the variable of interest performed identically on two subsamples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory. (EPA-QAD)

Equipment Blank: Sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures.

External Standard Calibration: Calibrations for methods that do not utilize internal standards to compensate for changes in instrument conditions.

Field Blank: Blank prepared in the field by filing a clean container with pure de-ionized water and appropriate preservative, if any, for the specific sampling activity being undertaken (EPA OSWER)

Field of Accreditation: Those matrix, technology/method, and analyte combinations for which the accreditation body offers accreditation.

Holding Times: The maximum time that samples may be held prior to analyses and still be considered valid or not compromised. (40 CFR Part 136)

Internal Standard: A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical test method. (TNI)

Internal Standard Calibration: Calibrations for methods that utilize internal standards to compensate for changes in instrument conditions.

Instrument Blank: A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination. (EPA-QAD)

Instrument Detection Limit (IDL): The minimum amount of a substance that can be measured with a specified degree of confidence that the amount is greater than zero using a specific instrument. The IDL is associated with the instrumental portion of a specific method only, and sample preparation steps are not considered in its derivation. The IDL is a statistical estimation at a specified confidence interval of the concentration at which the relative uncertainty is ± 100%. The IDL represents a range where qualitative detection occurs on a specific instrument. Quantitative results are not produced in this range.

Laboratory Control Sample (however named, such as laboratory fortified blank, spiked blank, or QC check sample): A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes, taken through all preparation and analysis steps of the procedure unless otherwise noted in a reference method. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

An LCS shall be prepared at a minimum of 1 per batch of 20 or less samples per matrix type per sample extraction or preparation method except for analytes for which spiking solutions are not available such as total

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suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen or turbidity. The results of these samples shall be used to determine batch acceptance.

Least Squares Regression (1st Order Curve): The least squares regression is a mathematical calculation of a straight line over two axes. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The regression calculation will generate a correlation coefficient (r) that is a measure of the "goodness of fit" of the regression line to the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, r must be greater than or equal to 0.990 for organics and 0.995 for inorganics.

Limit(s) of Detection (LOD) [a.k.a., Method Detection Limit (MDL)]: A laboratory's estimate of the minimum amount of an analyte in a given matrix that an analytical process can reliably detect in their facility. (TNI)

LOD Verification [a.k.a., MDL Verification]: A processed QC sample in the matrix of interest, spiked with the analyte at no more than 3X the LOD for single analyte tests and 4X the LOD for multiple analyte tests and processed through the entire analytical procedure.

Limit(s) of Quantitation (LOQ) [a.k.a., Reporting Limit]: The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. (TNI)

(QS) Matrix: The component or substrate that contains the analyte of interest. For purposes of batch and QC requirement determinations, the following matrix distinctions shall be used:

Aqueous: Any aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine. Includes surface water, groundwater effluents, and TCLP or other extracts.

Drinking Water: Any aqueous sample that has been designated as a potable or potential potable water source.

Saline/Estuarine: Any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake.

Non-Aqueous Liquid: Any organic liquid with <15% settleable solids.

Biological Tissue: Any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin.

Solids: Includes soils, sediments, sludges, and other matrices with >15% settleable solids.

Chemical Waste: A product or by-product of an industrial process that results in a matrix not previously defined.

Air & Emissions: Whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbent tube, impinger solution, filter, or other device. (TNI)

Matrix Spike (spiked sample or fortified sample): A sample prepared, taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a referenced method, by adding a known amount of target analyte to a specified amount of sample for which an independent test result of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

Matrix Spike Duplicate (spiked sample or fortified sample duplicate): A replicate matrix spike prepared and analyzed to obtain a measure of the precision of the recovery for each analyte.

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Method Blank: A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.

Method Detection Limit: The minimum concentration of a substance (an analyte) that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte. (40 CFR Part 136, Appendix B)

Negative Control: Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results.

Non-conformance: An indication, judgment, or state of not having met the requirements of the relevant specifications, contract, or regulation.

Observation: A record of phenomena that (1) may assist in evaluation of the sample data; (2) may be of importance to the project manager and/or the client, and yet not at the time of the observation have any known effect on quality.

Performance Audit: The routine comparison of independently obtained qualitative and quantitative measurement system data with routinely obtained data in order to evaluate the proficiency of an analyst or laboratory.

Positive Control: Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects.

Precision: The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms. (TNI)

Preservation: Any conditions under which a sample must be kept in order to maintain chemical and/or biological integrity prior to analysis. (TNI)

Proficiency Testing: A means of evaluating a laboratory's performance under controlled conditions relative to a given set of criteria through analysis of unknown samples provided by an external source. (TNI)

Proficiency Testing Program: The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results and the collective demographics and results summary of all participating laboratories. (TNI)

Proficiency Test Sample (PT): A sample, the composition of which is unknown to the laboratory and is provided to test whether the laboratory can produce analytical results within specified acceptance criteria. (TNI)

Quality Assurance: An integrated system of management activities involving planning, implementation, assessment, reporting and quality improvement to ensure that a process, item or service is of the type of quality needed and expected by the client. (TNI)

Quality Assurance [Project] Plan (QAPP): A formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved. (EAP-QAD)

Quality Control: The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality; also the system of activities and checks used to ensure that measurement systems are maintained within prescribed

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limits, providing protection against "out of control" conditions and ensuring that the results are of acceptable quality. (TNI)

Quality Control Sample: A sample used to assess the performance of all or a portion of the measurement system. One of any number of samples, such as Certified Reference Materials, a quality system matrix fortified by spiking, or actual samples fortified by spiking, intended to demonstrate that a measurement system or activity is in control. (TNI)

Quality Manual: A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users. (TNI)

Quality System: A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC activities. (TNI)

Raw Data: The documentation generated during sampling and analysis. This documentation includes, but is not limited to, field notes, electronic data, magnetic tapes, untabulated sample results, QC sample results, print outs of chromatograms, instrument outputs, and handwritten records. (TNI)

Record Retention: The systematic collection, indexing and storing of documented information under secure conditions.

Reference Material: Material or substance one or more properties of which are sufficiently homogeneous and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials. (TNI)

Reference Standard: Standard used for the calibration of working measurement standards in a given organization or a given location. (TNI)

Sampling: Activity related to obtaining a representative sample of the object of conformity assessment, according to a procedure.

Second Order Polynomial Curve (Quadratic): The 2nd order curves are a mathematical calculation of a slightly curved line over two axis. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The 2nd order regression will generate a coefficient of determination (COD or r^2) that is a measure of the "goodness of fit" of the quadratic curvature the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, r^2 must be greater than or equal to 0.99.

Selectivity: The ability to analyze, distinguish, and determine a specific analyte or parameter from another component that may be a potential interferent or that may behave similarly to the target analyte or parameter within the measurement system. (TNI)

Sensitivity: The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. (TNI)

Spike: A known mass of target analyte added to a blank, sample or sub-sample; used to determine recovery efficiency or for other quality control purposes.

Standard: The document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of standard setting and meets the approval requirements of standard adoption organizations procedures and policies. (TNI)

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Standard Operating Procedures (SOPs): A written document which details the method for an operation, analysis, or action, with thoroughly prescribed techniques and steps. SOPs are officially approved as the methods for performing certain routine or repetitive tasks. (TNI)

Storage Blank: A blank matrix stored with field samples of a similar matrix (volatiles only) that measures storage contribution to any source of contamination.

Surrogate: A substance with properties that mimic the analyte of interest. It is unlikely to be found in environment samples and is added to them for quality control purposes.

Surrogate compounds must be added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. Poor surrogate recovery may indicate a problem with sample composition and shall be reported to the client whose sample produced poor recovery. (QAMS)

Systems Audit (also Technical Systems Audit): A thorough, systematic, qualitative on-site assessment of the facilities, equipment, personnel, training, procedures, record keeping, data validation, data management, and reporting aspects of a total measurement system. (EPA-QAD)

Technical Manager: A member of the staff of an environmental laboratory who exercises actual day-to-day supervision of laboratory operations for the appropriate fields of accreditation and reporting of results

Technology: A specific arrangement of analytical instruments, detection systems, and/or preparation techniques.

Traceability: The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical constants or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughout the project back to the requirements for the quality of the project. (TNI)

Trip Blank: A blank matrix placed in a sealed container at the laboratory that is shipped, held unopened in the field, and returned to the laboratory in the shipping container with the field samples.

Uncertainty: A parameter associated with the result of a measurement that characterizes the dispersion of the value that could reasonably be attributed to the measured value.

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Acronyms:

CAR – Corrective Action Report
CCV – Continuing Calibration Verification
CF – Calibration Factor
CFR – Code of Federal Regulations
COC – Chain of Custody
CVAA – Cold Vapor Atomic Absorption spectrophotometry
DOC – Demonstration of Capability
DQO – Data Quality Objectives
DU – Duplicate
DUR – Duplicate Range of Logarithms
EHS – Environment, Health and Safety
EPA – Environmental Protection Agency
FIA – Flow Injection Analysis
GC – Gas Chromatography
GC/MS – Gas Chromatography/Mass Spectrometry
GFAA – Graphite Furnace Atomic Absorption spectrophotometry
HPLC – High Performance Liquid Chromatography
ICP – Inductively Coupled Plasma Atomic Emission Spectroscopy
ICP/MS – ICP/Mass Spectrometry
ICV – Initial Calibration Verification
IDL – Instrument Detection Limit
IH – Industrial Hygiene
IS – Internal Standard
LCS – Laboratory Control Sample
LCSD – Laboratory Control Sample Duplicate
LIMS – Laboratory Information Management System
LOD – Limit of Detection
LOQ – Limit of Quantitation
MDL – Method Detection Limit
MDLV – MDL Verification Check Standard
MRL – Method Reporting Limit Check Standard
MS – Matrix Spike
MSD – Matrix Spike Duplicate
NCM – Non-Conformance Memo
NELAP - National Environmental Laboratory Accreditation Program
PT – Performance Testing
QAM – Quality Assurance Manual
QA/QC – Quality Assurance / Quality Control
QAPP – Quality Assurance Project Plan
RF – Response Factor
RPD – Relative Percent Difference
RSD – Relative Standard Deviation
SD – Standard Deviation
SDS – Safety Data Sheet *(formerly Material Safety Data Sheet, or MSDS)*
SOP – Standard Operating Procedure
TAT – Turn-Around-Time
TNI – The NELAC Institute
VOA – Volatile Organic Analysis
VOC – Volatile Organic Compound

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Appendix 3. Laboratory Certifications, Accreditations, Validations

TestAmerica Cedar Falls maintains accreditations, certifications, and approvals with numerous state and national entities. Programs vary but may include on-site audits, reciprocal agreements with another entity, performance testing evaluations, review of the QA Manual, Standard Operating Procedures, Method Detection Limits, training records, etc. At the time of this QA Manual revision, the laboratory has accreditation/certification/licensing with the following organizations:

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

TestAmerica Certifications

Laboratory	Program	Authority	Identification	Expiration Date
TestAmerica Cedar Falls	IHLAP	AIHA-LAP, LLC	101044	11/01/2016
TestAmerica Cedar Falls	NELAP	Illinois	200024	11/29/2016
TestAmerica Cedar Falls	NELAP	Kansas	E-10341	01/31/2015 *
TestAmerica Cedar Falls	NELAP	Minnesota	019-999-319	12/31/2016
TestAmerica Cedar Falls	NELAP	Oregon	IA100001	09/29/2016
TestAmerica Cedar Falls	State Program	Georgia	N/A	09/29/2016
TestAmerica Cedar Falls	State Program	Iowa	007	12/01/2015 *
TestAmerica Cedar Falls	State Program	Minnesota (Petrofund)	3349	08/22/2016
TestAmerica Cedar Falls	State Program	North Dakota	R-186	09/29/2016

Page 1 of 1 2/18/16

* Certification Valid - Laboratory is Pending Renewal with the Program Authority

For more information, or to contact a local TestAmerica representative nearest you, please visit our website at www.testamericainc.com

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The certificates and accredited parameter lists are available for each State/Program at www.testamericainc.com under Analytical Services Search – Certifications.

Appendix B

Pace Analytical Quality Systems Manual

Pace Analytical Energy Services, LLC.
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412-826-5245

QUALITY SYSTEMS MANUAL

Controlled Copy No. _____

Signatures of Final Approval:

Aaron Peacock
General Manager

11/19/15
Date

Charlotte Washlaski
Quality Manager

11/19/15
Effective Date

Organizational Units

Natural Attenuation

Petroleum Forensics

Molecular Diagnostics

CSIA

Review Date: October 27, 2015

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1.0 Introduction, Purpose, and Scope

1.1 Introduction

Pace Analytical Energy Services (PAES) recognizes its crucial role in providing reliability and excellence in the environmental analytical industry. The laboratory provides information necessary for engineering, industrial, and regulatory clients to make informed judgments and applicable policy decisions. PAES' management acknowledges that uncompromising dedication to quality is fundamental to remaining a competitive force in the analytical services market.

1.2 Purpose

The purpose of this Quality Systems Manual is to outline a program of policies, procedures, and documentation, which assures that our analytical services meet a defined standard of quality on an ongoing basis. This document defines the standards under which all laboratory operations will be performed. As supplemented by Standard Operating Procedures (SOPs), the Quality Systems Manual describes the laboratory's organization, objectives, and operating philosophy.

PAES Quality Systems Manual contains references to the laboratory's policies and operational procedures that have been established in order to meet the quality requirements of the TNI Standards and the following Quality Policy Statement.

The laboratory shall continually improve the effectiveness of its management system through the use of the quality policy, quality objectives, audit results, analysis of data, corrective and preventive actions and management review.

1.2.1 PAES' Quality Policy Statement

PAES is an organization that provides information and environmental services to a very diverse client base. In all processes from initial customer contact to project completion, PAES aim is to offer clients a reliable product of the best quality that is delivered in a timely manner at a reasonable price. This Policy Statement represents a top level management commitment and shall be achieved using the following goals:

1. Production of accurate information.
2. Adherence to an ethical standard that demands continuous honesty and integrity.
3. Achievement of customer satisfaction.
4. Establishment of a documented trail to support the results.
5. Maintenance of a pleasant working environment where employees are treated equitably and fairly.

These goals are fundamental to all of PAES' actions.

The Standard Operating Procedures and PAES Quality Systems Manual detail the procedures for achieving these goals. Management personnel are charged with ensuring all applicable procedures are completed in the spirit of the Quality Policy. They are available to all employees to assist in applying these principles and to advise appropriate action. It is the responsibility of each PAES employee to consistently act as directed by the five goals of quality. Further, it is their responsibility to consult their immediate superior for direction if an issue arises for which the response is unclear.

If PAES' Management realizes that these goals are not achievable but the validity and appropriateness of client results is not jeopardized, we will inform affected clients of the situation and allow them to alter their employ of PAES' services accordingly. If the client's data are to be negatively impacted where the validity of the results is in question, or a clients' project is operationally or legally jeopardized, the following procedures shall be followed:

1. Concerned operations will be suspended.

2. Affected clients will be notified.

3. Alternative procedures for securing the requested services will be employed until the corrective actions are completed to a level that is consistent with PAES' documented procedures and is satisfactory to management.

To achieve these quality goals, all laboratory data must be properly documented, legally defensible, and supported by statistically defined and verifiable confidence limits. Falsification of data under any circumstance is unacceptable and is grounds for termination. PAES follows the Pace Analytical Employee Handbook which provides policies and procedures to help employees avoid involvement in any activities that would diminish confidence in PAES competence, impartiality, judgment and/or operational integrity.

PAES uses EPA-approved methodologies such as those found in Standard Methods and SW-846, whenever methods are available. If an EPA-approved method has not been specified, PAES will select an industry recognized and validated method for use or will develop an internal method based upon thorough research and good scientific methods. In all instances of scientific innovation, PAES recognizes the value of a firm commitment to quality and integrity.

1.3 Scope of Quality Systems Manual

This document serves as both the PAES, Inc. Quality Systems Manual and the PAES Laboratory Quality Assurance Plan. It contains both quality assurance policies and quality control procedures that are followed to ensure and document the quality of analytical data. This manual provides detail concerning quality management requirements employed at PAES for the documented acquisition of samples, analysis of those samples via specific tests, the reporting of that data to the client, and the ultimate disposal of samples.

1.4 Scope of Services

PAES offers a comprehensive scope of laboratory analytical services to environmental consultants, industries, governmental agencies, and municipalities. The scope of services include:

Wastewater and storm water

- Ion analysis via Ion Chromatography
- Wet Chemistry analyses for pH and TOC/DOC

In Situ Remediation Analyses

- Dissolved Gas (Oxygen, Nitrogen, Carbon Dioxide, Methane, Ethane and Ethene)
- Volatile Fatty Acids (Lactic, Pyruvic, Formic, Acetic Propanoic, Butyric Acids)
- Ion Chromotography Analyses of sulfate, ferric iron, ferrous iron and divalent manganese
- Compound Specific Isotope Analysis (CSIA) of VOCs in groundwater and vapor

Soil Vapor Extraction Analyses

- VOC's in vapor
- nitrogen, oxygen, carbon dioxide and methane in vapor

Shale Gas Analyses

- Compositional Analysis (nitrogen, oxygen, argon, carbon dioxide, C1-C6)
- Carbon isotopic ratio ($^{13}C/^{12}C$ or $\delta^{13}C$) of methane, ethane
- Hydrogen isotopic ratio ($^{2}H/^{1}H$ or $\delta^{2}H$) of methane

Petroleum Forensics

- C3-C10 Gasoline Range Hydrocarbons
- Oxygenates in product
- GC/MS Full Scan analyses
- Extended PAH analyses
- Whole oil analyses
- Boiling Range Distribution of Petroleum Fractions
- EDB and Organic Lead

Molecular Diagnostics

- MicroArray
- qPCR
- DNA extraction

Training Seminars

1.5 Certifications

PAES holds the following certifications:

- National Environmental Laboratory Accreditation Program (NELAP): Pennsylvania
- Connecticut
- Virginia
- South Carolina
- Texas
- New York
- New Jersey
- New Hampshire
- West Virginia

Specific parameter lists for the various certifications are available from the Customer Service Department upon request.

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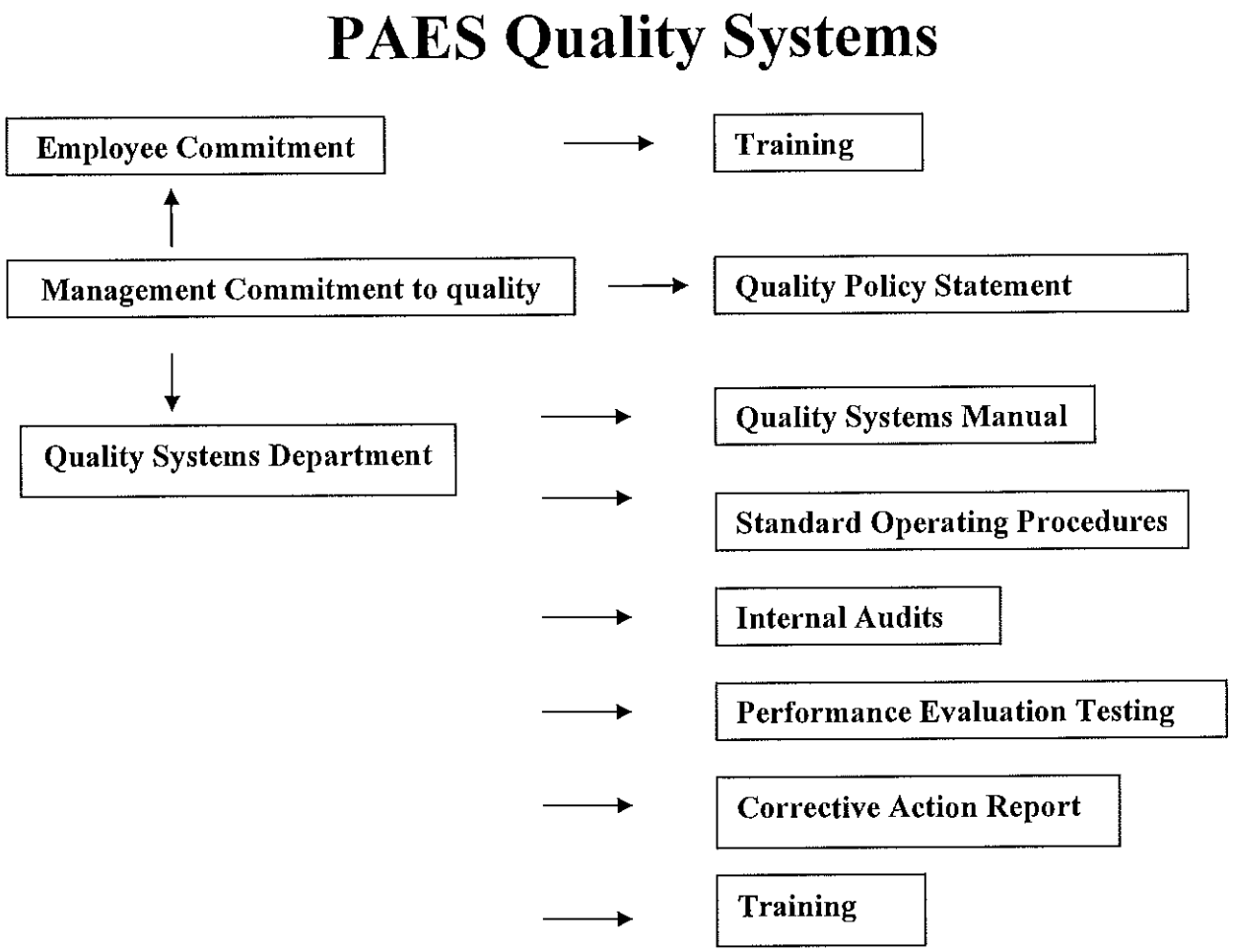
2.0 Quality Systems – Establishment and Audits

2.1 Establishment of a Quality System

Pace Analytical Energy Services (PAES) has established a quality system based upon the fundamentals of good laboratory practices and the requirements outlined in the TNI Standard of the National Environmental Laboratory Accreditation Program. Although PAES provides a variety of environmental services, PAES' Quality System has been designed according to the type, range, and volume of analytical testing activities undertaken in the laboratories. This section describes PAES' Quality System and outlines the policy and procedures for implementing corrective action when non-conforming work or departures from policies and procedures occur.

2.2 Elements of PAES Quality System



This flowchart shows the general elements of PAES Quality Systems. Each area of this flowchart is addressed or referenced in this Quality Systems Manual.

2.2.1 Quality Manual Review

The PAES Quality Systems Manual is reviewed annually for accuracy and applicability. These records are maintained in the Quality Systems Department Office. All revisions will be conducted in accordance with PAES Standard Operating Procedure for Document Control.

2.2.1.1 Document Control

Document control procedures are specified in PAES Standard Operating Procedure for Document Control. The Standard Operating Procedure outlines document control procedures for generating, formatting, revising, approving, tracking, distributing, indexing, archiving, and destroying controlled documents, including the Quality Systems Manual.

2.2.2 Internal Audits

Technical audits serve to verify compliance with method-specific procedures including operations related to test methods. Any audit that is conducted on an operation that is involved with data generation and the assurance of its quality is a technical audit. System audits function to verify compliance with the laboratory's quality system. Types of procedures that would be reviewed as a part of a systems audit could include: (1) response to complaints; (2) sample tracking methodologies; and (3) sample acceptance policies.

The Quality Systems Department will coordinate all technical and system audits. Audits shall be conducted by individuals who are independent of the activity to be audited. All internal auditors shall be trained and qualified in the areas in which they will be conducting the audit.

2.2.2.1 Audit Frequency

Internal Audits are scheduled and may be conducted by the Quality Systems Department or their designees, and may either be scheduled or unannounced. PAES conducts internal technical audits and internal system audits at least annually. The audits are conducted to insure that PAES' operations continue to comply with the Quality Systems requirements specified in the Quality Systems Manual and Standard Operating Procedures. The Quality Systems Department maintains an audit schedule to ensure that all fields of accreditation covered by the laboratory quality system are audited. Internal audits of its activities must verify that its operations continue to comply with the requirements of the management system.

2.2.2.2 Procedures for Internal Audits

Audits will be conducted on analytical groups or systems according to the annual audit schedule posted in the Quality Systems Department Office. Immediately prior to starting the audit

Operations will be notified. PAES' Standard Operating Procedure ADM-4 for Internal Laboratory Audits outlines the specific procedures for conducting an internal audit.

According to the SOP, the audit is performed using the appropriate audit check sheet as a guide. The audit check sheet will be selected and used as the auditing guide for the area that is to be audited. The audit check sheets delineate the activities and records that will be reviewed. The sheet is completed and additional notes are made by the auditor based upon observations, interviews, and record reviews.

2.2.2.3 Internal Audit Findings and Corrective Action

Using the audit check sheets and supplementary notes, an Internal Audit Report (Figure 2-1) is prepared by the Quality Systems Department. The Internal Audit Report contains an overall summary of the audit, including both items of a positive nature, as well as deficiencies. A follow-up evaluation section is also included. The cause of each deficiency is determined using Root Cause Analysis. Root Cause Analysis is the foundation upon which all Corrective Action is based. This process and an example are outlined in Figure 2-2 in this Quality Systems Manual.

Corrective Action based upon the root cause analysis is indicated on a Corrective Action Report (see Figure 2-3). A Corrective Action Report is prepared for each deficiency listed on the Internal Audit Report. The Internal Audit Report and Corrective Action Report are forwarded to the appropriate Department Head for corrective action. A follow-up audit is conducted and documented.

If the audit was of a technical nature, the Audit Report will be forwarded to the Laboratory Manager. The Laboratory Manager will meet with the specific Department Manager the first business day once the audit findings are received. The audit will be discussed along with the recommendations for corrective action. Corrective action is expected to take place immediately or as soon as possible following the audit. A follow-up audit of any deficient area(s) will be conducted within 60-120 days of audit completion, or as soon as corrective action is completed in order to monitor the effectiveness of corrective action. This timeframe is just a guide.

Where any audit findings or defective measuring or test equipment may cast doubt on the correctness or validity of the laboratory's calibrations or test results, PAES shall take corrective action as specified in PAES' Quality Policy Statement. If the subsequent investigation shows that laboratory results have been affected, the affected client shall be notified in writing by the Customer Service Office.

2.2.2.4 Work Stoppage

The Quality Systems Department has the authority to stop any work that is found to be unsatisfactory or to prevent reporting of unjustifiable results. The work will not be ordered to commence until corrective action is taken that insures satisfactory work and reliable results according to the Quality Systems Department's discretion.

2.2.3 Performance Evaluation Audits

Performance evaluation audits enable PAES to measure the precision, accuracy, and comparability of laboratory-generated data through the use of blind reference materials. PAES participates in performance evaluation studies required by the EPA and several state agencies. Performance evaluation studies are completed as required to maintain necessary certifications, and as required as an integral part of an internal audit at the Quality Systems Department's discretion.

Performance evaluation studies for all accredited parameters are planned for testing at least twice each year. The Quality Systems office maintains EXCEL spreadsheets of results so that trends are easily noticeable.

In situations where the analyst is to know that a performance evaluation is being conducted, the analyst prepares the samples according to the instructions provided. If the PE is to be a blind audit, the Quality Systems Department prepares the samples. The samples are analyzed as soon as possible after opening the vials to avoid sample deterioration. Prior to reporting the results to the appropriate agency, the General Manager/Assistant General Manager and the Quality Systems Manager evaluate results of the performance evaluation samples.

2.2.3.1 Performance Evaluation Findings and Corrective Action

Once the evaluation report from the Performance Evaluation Provider or appropriate agency is received, the Quality Manager forwards the findings to the Laboratory Manager/Assistant General Manager. Unacceptable results are investigated to determine the root cause of the failures. The following points are addressed during the investigation:

- Potential for reporting/calculation errors
- Preparation of calibration standards
- Evaluation of quality control data associated with the analysis
- Evaluation of analytical technique and instrument performance

Additional Performance Evaluation samples may be submitted for analysis if the Quality Systems Department determines it is necessary to ensure that an analytical method, technique, or instrument performance problem is corrected.

2.2.4 External Audits

External Audits are conducted as necessary to retain laboratory certifications or at a client's request. The Quality Systems Department is the liaison between PAES and an external auditor. The Quality Systems Department is responsible for notifying the laboratory staff of upcoming audits. This notification will include the agency that will perform the audit, the reason for the audit, the dates involved, and the areas of concern.

During the audit, laboratory personnel will be available to the auditor as requested, as will any documentation necessary for the auditor to obtain sufficient information to effectively evaluate the laboratory. If laboratory information of a proprietary nature is necessary to complete an audit, the auditor will be required to complete and sign PAES Confidentiality Agreement.

2.2.4.1 External Audit Findings and Corrective Action

The Quality Systems Department will prepare a report summarizing the findings of the post audit meeting. Following review of this report, any deficiencies noted by the auditor will be addressed immediately. Corrective action will be taken to eliminate the cause of a deficiency and to prevent recurrence. The Corrective Action process shall identify and implement corrective actions to eliminate the root cause of the deficiency. The development and implementation of a corrective action plan shall not be contingent upon the receipt of the external auditor's report.

When the External Audit Report is received at PAES, deficiencies will be addressed in the order of their priority as determined by the auditor. The Quality Systems Department will prepare a response plan for correcting the reported deficiencies and will submit a Corrective Action Plan to the auditing agency. Corrective action will be taken according to the timetable outlined by the plan.

2.2.5 Quality Systems Audit

Laboratory Management shall conduct a review of the Quality System and its testing and calibration activities. This review shall be conducted to ensure the Quality System's suitability and effectiveness and to introduce any necessary changes or improvements in the quality system and laboratory operations. This review shall be conducted annually by the GM/AGM and/or their designee's.

The review will be conducted in the same manner as an Internal Systems Audit, but the auditors will be made up of the GM/AGM and/or their designee's. PAES' Standard Operating Procedure ADM-4 includes an Audit Check Sheet for the Quality Systems Audit, which outlines the review procedure.

2.2.5.1 Quality Systems Audit Findings and Corrective Action

The review findings shall be documented on an Audit Report Form and submitted to the Quality Systems Department for review. Corrective Action Reports will be generated for the audit deficiencies and will be resolved as necessary. A timeline for resolution is specified on the Corrective Action Report and the review findings become an item for discussion by the GM/AGM and/or their designee's where they ensure the corrective actions are completed.

2.2.5.2 Quality Systems Report

Regular discussions of quality assurance issues are necessary to provide a forum in which upper management are informed of problems and changes that affect the laboratory operations. The Quality Systems Department regularly provides a report to the Assistant General Manager to

discuss quality issues. This report serves as a general review of factors affecting quality and will include the following topics at a minimum:

- Personnel changes
- Instrument changes
- Internal and External Audit findings
- Certification changes
- Testing and calibration activities
- Quality System implementation activities and progress

2.2.6 Review of Laboratory Management System

The laboratory must conduct a review of the management system. This review shall be conducted by top management. This should include the GM/AGM, the Quality Manager, and any others as determined by the GM/AGM. Reference SOP S-ALL-Q-015 for procedures.

2.3 Additional Quality Control Checks

In addition to periodic audits, PAES ensures the quality of results provided to clients by implementing additional checks to monitor the quality of the laboratory's analytical activities. Some of these checks are as follows:

- Use of certified standards in many of our quality control samples
- Replicate testing using the same test methods
- Participation in Proficiency Testing

2.4 Audit and Review Documentation

All audit records shall be kept on file in the Quality Systems Department Office. These records shall be available for external auditors, as well as, individuals involved in a Managerial Review of the PAES Quality System. This documentation will include:

- Audit Check Sheets
- Audit Report Forms
- Corrective Action Reports

2.5 Corrective Action

An integral part of PAES' Quality Systems Program is the system for identifying, reporting, and correcting deficiencies in the laboratory operation. There are several areas in the laboratory that may require corrective action. It is the responsibility of every employee to be aware of potential problems and to notify the appropriate personnel of situations requiring corrective action.

2.5.1 Problem Isolation and Identification

Identification and isolation of problems in the laboratory are not always easy tasks. The need to perform corrective action may become apparent at any point of the analytical process. Corrective action should be initiated and documented as soon as a problem becomes evident. The analyst at the bench detects some situations such as malfunctioning equipment. Corrective action for these situations takes the form of repairing the instrument, either internally or through the use of a service call. The corrective action is documented in the instrument maintenance log and the data obtained just prior to the failure is closely scrutinized for acceptability.

Other situations may not be easily identifiable. For example, systematic drift or sensitivity fluctuations may not be identified until the time that data is validated. Other occurrences that may trigger the need for corrective action include the following:

- Recoveries for surrogates, matrix spike, matrix spike duplicates, and laboratory control standards outside of acceptance limits.
- Percent differences for duplicate analyses outside acceptance limits.
- Trends noted in quality control data.

Out of control events that concern sample analysis and data generation must be documented in a Case Narrative, which becomes a permanent part of the client's project file and final data report.

2.5.2 Sample Handling Problems

Problems involving sample handling may include missing or broken containers, discrepancies between the chain of custody and actual shipment, improperly preserved bottles, insufficient volume, and missed holding times. When one of these problems is identified, a Non-Conformance Form is completed and acted upon in accordance with the Standard Operating Procedure for Sample Receiving. If necessary, the client is contacted to discuss possible resolutions to the problem. The Non-Conformance Form becomes a part of the client's permanent file.

2.5.3 Sample Analysis Problems

Problems incurred during sample analysis may bring procedures and data into question. These problems may include the following:

- Unacceptable calibration
- Improper procedures
- Unacceptable blank, LCS, and/or surrogate recovery
- Quantitation error
- Required QC not performed
- Retention time shifts

Resolving these problems may include preparing and analyzing the samples a second time, re-calibrating the instrument, or making new standard solutions and reagents. Standard Operating procedures detail corrective action steps that are specific to an analytical procedure. The documentation becomes part of the client's permanent file.

The person identifying the problem documents the situation and identifies possible sources of the problem. If this individual can immediately correct the situation, for example, by re-calibrating the instrument, they will do so and document the action that was taken in the case narrative. If the problem cannot be corrected immediately, the person documents the situation and notifies the Laboratory Manager. The Laboratory Manager is responsible for ensuring that the appropriate corrective actions are followed.

2.5.4 Corrective Action Reports

A Corrective Action Report (CAR) will be completed for each audit deficiency, legitimate issue reported, and any systemic out of control event that occurs. PAES has instituted a procedure for reporting when departures from documented policies, procedures, and quality control have occurred. The CAR is a means for anyone in the company to communicate quality concerns to the Technical Department. These forms are a part of PAES' Quality System, which provide an avenue for all employees to reflect a genuine concern for quality throughout the company. The CAR is also used to document Customer Complaints and initiate the process of resolving those complaints. All items pertaining to the Customer complaint shall be recorded on the CAR including investigation results and resolution to the satisfaction of the client. All Corrective Action Reports that deal with Customer Complaints shall be kept on file in the Quality Systems Department office.

All CAR's will be followed up to ensure that the corrective actions taken have been effective. The Quality Systems Department is responsible for maintaining a supply of forms. To track the corrective action, each CAR will be given a unique identifier in the form of YY-XXXX where:

- YY = the year in which the CAR was initiated and
- XXXX = is the sequential number of the record starting with 0001

2.5.4.1 Corrective Action Report Initiation and Procedures

A Corrective Action Report may be generated by anyone in the company who discovers and can correct a systemic out of control event. There are two types of situations in which an employee will generate a CAR. First, when the root cause is obvious to the person who discovered the out of control event, and secondly when the root cause is not obvious.

In the first situation, the person who discovers an out of control event shall institute and document corrective action by completing the top portion of the CAR (above the dotted line). They will enter their name, the current date, a description of the event that needs corrective action, and the specific corrective action that was taken. The analyst or Department Manager shall be notified of the event and the corrective action necessary to solve the non-conformance. The person who completes the corrective action shall sign the form and forward it to their immediate supervisor for a signature. The form will then be forwarded to the Quality Systems Department for cataloging. If additional action is required, the form shall be returned to the department concerned and returned to the Quality Department when corrective action is complete.

If the root cause is not immediately obvious, the Quality Systems Department shall be notified immediately to assist in Root Cause Analysis and determining the appropriate corrective action.

The Quality Systems Department will forward a copy of the CAR to the Laboratory Manager. If it is determined that the client needs to be notified of the incident, the Quality Systems Department shall forward a copy of the CAR to the Customer Service Department and they shall notify, in writing, any client whose work may have been affected within 48 hours of identifying the problem.
.

2.5.4.2 External Audits and Performance Evaluation Studies

The Quality Systems Department will initiate CAR(s) in response to third party audits and deficiencies on performance evaluation studies. In the case of third party audits, if the resolution to the finding is easily identifiable, the Quality Systems Department will discuss the situation with the Laboratory Manager and the corrective action will be implemented. If the finding concerns a procedural change or is interdisciplinary, the Quality Systems Department will form a task team to investigate the problem and develop an appropriate course of action. The task team's findings will be presented to the Quality Systems Department for discussion and possible implementation. Once a corrective action plan is implemented, the situation will be monitored for a reasonable period of time to ensure that the action has been effective.

The Quality Systems Department will prepare a report for management that summarizes all corrective actions (See Figure 2-4). The report will provide a brief description of the problem, the steps that are being taken to correct the situation, and the status of the item.

2.6 Preventive Actions

The preferred course of laboratory quality and improvement is to identify opportunities for improvement rather than react to the occurrence of problems or complaints. PAES is continually seeking ways to improve its performance and product. When these areas are identified, a plan is developed by the department managers. Preventative actions are implemented according to the time table specified in the plan. Preventive action procedures include follow-up actions and applications of controls in order to ensure effectiveness. The laboratory seeks both negative and positive feedback from its customers. Feedback provides acknowledgement, corrective actions when needed, and opportunities for improvement. A statement printed on the front page of all final reports gives an avenue for customers to provide comments to us on our performance. Random surveys may also be used as a
means to gather feedback from customers. This information is forwarded to the Quality Systems Department.

2.7 Management Arrangements for Permitting Departures from Documentcd Procedures or Standard Specifications

It is PAES management's intent to ensure that documented procedures are followed. Rarely, a situation may occur that requires a departure from documented quality procedures. When this type of situation occurs, the Quality Systems Department and Laboratory Manager, and any other

manager whose department may be affected, will discuss and unanimously agree upon the action to be taken. The departure will be documented in memo form and kept on file in the Quality Systems Department Office. Corrective action will be taken as soon as possible to prevent the necessity of the departure from reoccurring.

Review Date: October 27, 2015

Figure 2-1

Internal Audit Report

Audit Date: _____ **Department:** _____

Auditors: _____

Supervisor: _____ **Employee Present:** _____

Audit Summary:

Areas of Excellence:

Deficiencies:

Suggestions:

Quality Manager: **Date:**

Follow-up evaluation: (use back of sheet, if necessary)

Completed by: **Date:**

Figure 2-2

Root Cause Analysis

Deficiencies are always analyzed from the non-conformance back to the root cause as follows:

Flow Diagram	Example
Deficiency	Results of a laboratory standard out of compliance
↓	↓
Direct Cause	Mistake made in measuring the reagent
↓	↓
Contributing Causes	Analyst failed to use Class A Glassware and didn't know how to pipette correctly.
↓	↓
Root Cause(s)	Lack of training Lack of supervision

Figure 2-3

Corrective Action Report **CAR#**

Initiated by: **Date:**

Description of the event needing corrective action and corrective action required.

Root Cause:
This Corrective Action must be acted upon in the time frame indicated below:

Immediately ___One Week ___Two Weeks ___ 30 Days_____ Est. Date: _____

Corrective Action Taken: **Due Date:**

Action Completed by: _____ **Date:** _____

Supervisor Review: _____ **Date:** _____

Project #: _____ **Sample Numbers:** _____

Additional Action: is___ is not ___ necessary. Customer Contact: is___ is not ___ necessary.

Action Closed: _____ **Date:** _____

Follow-up evaluation: **Date:** _____ **Completed by:** _____

Figure 2-4

Quality Systems Update and Corrective Action Summary Report **Date:**_____

CAR #	Date	Summary	Resolution	Responsibility

Quality System

PE's:

Internal Audits:

External Audits:

SOP review/revision:

Certification status:

Quality System Manual review/revision:

This report was presented to PAES AGM/GM on _____. The AGM/GM reviewed it and, as necessary, discussed the appropriate directives that would improve the quality system.

Signature: _____ Date: _____

3.0 Organization and Management

Since PAES is a business that must compete in a marketplace characterized by merger and consolidation, it is even more important to have an efficient organization with well-defined responsibilities. The purpose of this section is to describe the organization and management structure of PAES, interdepartmental and intradepartmental relationships, and to detail employee responsibilities and qualifications.

3.1 PAES Organization

Organizations must have a framework within which to achieve their objectives. Organizational structure determines the configuration of positions, duties, and channels through which performance is controlled and authority is delegated. It is crucial that a company use a structure that enables it to realize competitive advantages.

In order for PAES to achieve its stated objectives for the quality of its analytical services, all employees must be able to function within a structure that provides an emphasis on quality from a technical standpoint. A functional organizational structure is specifically suited to this purpose.

3.1.1 Organizational Structure

PAES' organizational structure is functional. This type of structure is centralized, which restricts decision-making authority to higher levels of management. Company organization is departmental and is specialized and arranged according to function. The Quality Systems Department reports directly to the Assistant General Manager. PAES' Organizational Chart is depicted in Figure 3-1.

3.1.2 Interdepartmental Relationships

Responsibility and dedication to quality laboratory practices and procedures begin at the highest level of management. It is the duty of Senior Management to assure that the framework is in place to provide quality systems guidelines. It is the duty of PAES managers to implement the policies and procedures and to see that they drive the activities of the laboratory.

3.1.2.1 Natural Attenuation Services

The Laboratory Manager oversees all analytical departments responsible for providing analyses to support natural attenuation monitoring. The Laboratory Manager works with the analytical work groups in the laboratory to meet quality and turnaround objectives. The Manager for IC analyses coordinates the activities for analysts responsible for anion, cation, and LLVFA determinations. This responsibility includes final review of raw and QC data. The Laboratory Manager has direct supervision for analysts involved with determinations for wet chemistry parameters, volatile organics, fatty acids by GC, and dissolved and permanent gas determinations. His position includes data review, final report technical review, and implementation of the QC program.

3.1.2.2 CSIA Services

The Director of CSIA services directs the activities of the CSIA analytical staff in regards to routine analytical procedures and method development for isotope analyses.

3.1.2.3 Petroleum Forensics Services

The Assistant General Manager has direct supervision for the analysts in the forensics department.

3.1.2.4 Molecular Diagnostics Services

The Assistant General Manager has direct supervision for the analysts in the molecular diagnostics department.

3.1.2.5 Client Services

The Client Services department serves as a liason between the customer and laboratory staff. Personnel within the department provide quotes, prepare and ship bottle orders, and perform completion review of final reports.

3.1.2.6 Quality Systems Department

The Quality Systems Department operates outside of the scope of the analytical departments in lines of authority. Responsibility for the Quality Systems Department falls upon the Quality Systems Manager who reports directly to the General Manager. The Quality Systems Manager is responsible for the development, implementation, communication and maintenance of quality systems policies and procedures. A primary goal is to achieve joint cooperation of the operational functions within the company while addressing regulatory requirements in an effective, timely and responsible manner.

The Quality Systems Department is administratively responsible for quality assurance and quality control, and may serve as the Quality Systems Manager's representative in his absence.

3.1.3 Intradepartmental Relationships

The Quality Systems department has a quality assurance and quality control role to fulfill within each department at PAES. Discrepancies in quality in any department will be relayed from the Quality Systems Manager to the appropriate department using a format that is appropriate for the type of discrepancy and recommending an appropriate corrective action using a Corrective Action Report.

3.2 Personnel Qualifications

All of PAES employees are responsible for complying with the applicable job specific quality assurance and quality control requirements. All staff are to familiarize themselves with the quality documentation and implement the policies and procedures contained in this Manual in their work. Each staff member, including contracted and additional technical and key support personnel should they be required, must demonstrate a combination of formal education and experience to satisfactorily perform their particular function, as well as, a general knowledge of laboratory operation, quality assurance, quality control, test methods, and records management. All personnel are placed in a work group or department with adequate supervision that ensures the employee works in accordance with the laboratory's Quality System. Documentation of employee proficiency for specific job functions and test methods is maintained in the Quality Assurance Analyst's Office.

The Laboratory Manager, based upon specific educational and experience requirements, makes laboratory job assignments. Laboratory analysts are assigned a job classification according to the level of formal education and related laboratory experience they possess.

Basic duties of key staff (those included in Figure 3-1) are discussed below. Complete job descriptions for some key staff are contained in Appendix A of this Quality Systems Manual.

3.2.1 Director of Business Integration/General Manager

The Director of Business Integration/General Manager is responsible for overall company performance. He is responsible for new business development and the financial integrity of the company. Additionally, he approves capital expenditures and evaluates current market conditions to maintain the laboratory's competitiveness.

3.2.2 Director of Specialty Services

The Director of Specialty Services works closely with the Director of Business Integration/General Manager to identify potential new markets and shares the responsibility for the financial integrity of the laboratory with the Director of Business Integration/General Manager.

3.2.3 Assistant General Manager

The Assistant General Manager is responsible for day to day operations of the laboratory, ensuring policies and procedures are adhered to as well as being the point of contact for the Director of Business Integration/General Manager.

3.2.4 Director of CSIA Services

The Director of CSIA Services is responsible for implementing and enforcing laboratory policies and procedures within the CSIA department. He is responsible for the daily operation of the CSIA analytical department and is responsible for overseeing the routine expenditures in the CSIA department.

3.2.5 Laboratory Manager

The Laboratory Manager is responsible for ensuring that PAES' goals of providing accurate and verifiable analyses are met. It is the Laboratory Manager's responsibility to ensure that all analytical personnel have the required qualifications and training for their positions. Once qualified personnel are in place, the Laboratory Manager, in conjunction with the Quality Department, will be responsible for assuring that all employees are thoroughly familiar with the Quality Systems Manual and accepted laboratory practices. The Laboratory Manager oversees the daily management of the laboratory staff. A major component of this particular responsibility is the integrity of laboratory reports. The Laboratory Manager, or a qualified designee will review and approve all outgoing reports. In the absence of the Laboratory Manager, the Assistant General Manager will assume these responsibilities.

3.2.6 Quality Systems Manager

The Quality Systems Manager is ultimately responsible for ensuring that the data produced by the laboratory are technically sound and of the highest quality possible. The Quality Systems Manager serves as the focal point for quality assurance and quality control and is responsible for the oversight and/or review of quality control data. This position notifies laboratory management of deficiencies in the quality system and monitors corrective action. The Quality Systems Manager reports directly to the General Manager.

3.2.7 Manager of Client Services

The Manager of Client Services provides direction and supervision to ensure that clients receive the best service possible. This position reviews proposal submittals and proposes pricing strategies for potential projects. This position reports to the Assistant General Manager.

3.2.8 Quality Assurance Analyst

The Quality Assurance Analyst assists the Quality Systems Manager to ensure that PAES Quality Systems Policies and Procedures are being followed. This is accomplished by: (1) Reviewing data validation procedures; (2) Alerting the analysts should the need for corrective action exist; (3) Performing internal audits; (4) Establishing a periodic schedule for analyzing performance evaluation samples; and (5) Maintaining Quality Control records. The Quality Assurance Analyst reports to the Quality Systems Manager.

3.2.9 Sample Receiving Client Service Tech

The Sample Receiving Client Service Tech is responsible for properly receiving and logging-in all samples received at PAES and ensuring that storage and documentation requirements are met. This position also unpacks and marks the samples with the correct internal laboratory identification number so that the client's samples can be tracked through the laboratory. The Sample Receiving

Client Service Tech is responsible for documenting all discrepancies between samples received and accompanying chains of custody and for notifying customer service so that the client may be contacted. The Sample Receiving Client Service Tech reports to the Manager of Client Services.

3.2.10 Laboratory Analyst

Laboratory Analysts are responsible for retrieving samples from Sample Receiving and observing all internal custody requirements. The analysts shall ensure that aliquots analyzed are representative of the entire sample. All analyses shall be conducted according to PAES Standard Operating Procedures. Responsibilities also include following good laboratory practices in carrying out duties assigned, and complying with all safety regulations applicable to their respective laboratories. Analysts report directly to the Lab Manager.

3.2.11 Project Manager

The Project Manager is responsible for overseeing in-house analytical projects. It is the Project Manager's responsibility to accurately communicate project requirements to the Laboratory Manager so that projects are logged-in, analyzed, and reported in the format, timeframe, and within the project-specific protocols required by the client. This position reports to the Manager of Client Services.

3.2.12 Bottle Preparation Client Service Tech

The Bottle Preparation Client Service Tech is responsible for accurately preparing sample containers in a timely and safe manner according to client specification. The Bottle Preparation Client Service Tech also maintains records of standing orders and ensures they are prepared for the courier and for shipment when appropriate. This position also prepares purchase orders for ordering supplies as needed. The Bottle Preparation Client Service Tech also maintains the Bottle Preparation room and storage area in a neat and orderly manner. This position reports to the Manager of Client Services.

3.3 Contract Review, Design Control, and Quality Planning

The Client Services Department shall start the review of all new work that comes in to the laboratory. Appropriate sections of any request for work shall be reviewed by each department concerned to determine if PAES has adequate facilities and resources to complete the work in the contract appointed time frame. Each department is to indicate whether their department can or cannot meet the contract requirements, via email to the Customer Service Office. If a department cannot meet the requirements of the contract or scope of work, the department is to indicate the reason(s) for that decision.

The client shall be informed and a resolution discussed if the laboratory review of capability indicates any potential conflict, deficiency, lack of accreditation status, or inability on the

laboratory's part to complete the clients work. Any differences shall be resolved to the satisfaction of the laboratory and the client prior to commencement of work.

All contract documents are forwarded to the Corporate Counsel for review. Any exceptions or suggestions with the contract language noted by the Counsel will be forwarded to the client for their approval. Once a mutually acceptable agreement is reached, the General Manager or their designee with approval, will sign the contract and/or purchase order.

In the event that the contract needs amended after work has commenced, the same contract review procedures shall be repeated and any changes shall be communicated to all affected personnel.

Review Date: October 28, 2015

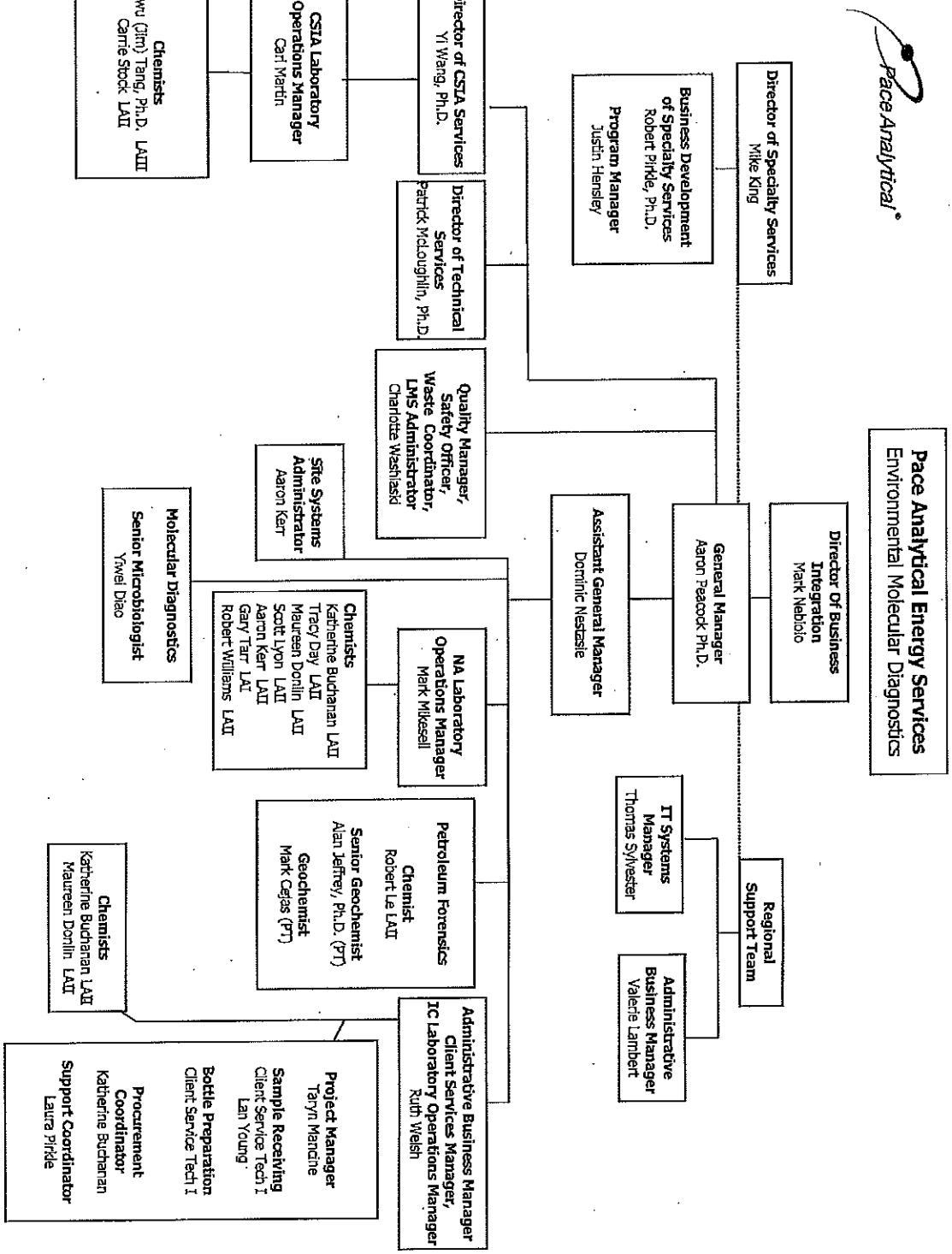

Pace Analytical
Pace Analytical Energy Services
Environmental Molecular Diagnostics
Director of Specialty Services
Mike King
Director Of Business Integration
Mark Nebiolo
Business Development of Specialty Services
Robert Pirkle, Ph.D.
Program Manager
Justin Hensley
General Manager
Aaron Peacock Ph.D.
Assistant General Manager
Dominic Nestasie
Director of CSTA Services
Yi Wang, Ph.D.
Director of Technical Services
Patrick McLoughlin, Ph.D.
Quality Manager, Safety Officer, Waste Coordinator, LMS Administrator
Charlotte Washiaski
CSTA Laboratory Operations Manager
Carl Martin
Chemists
Jianwu (Jim) Tang, Ph.D. LAII
Carrie Stock LAII
Site Systems Administrator
Aaron Kerr
Molecular Diagnostics
Senior Microbiologist
Yiwei Diao
NA Laboratory Operations Manager
Mark Mikesell
Chemists
Katherine Buchanan LAII
Tracy Day LAII
Maureen Donlin LAII
Scott Lyon LAII
Aaron Kerr LAII
Gary Tarr LAI
Robert Williams LAII
Petroleum Forensics
Chemist
Robert Le LAII
Senior Geochemist
Alan Jeffrey, Ph.D. (PT)
Geochemist
Mark Cejas (PT)
IT Systems Manager
Thomas Sylvester
Administrative Business Manager
Valerie Lambert
Regional Support Team
Administrative Business Manager
Client Services Manager,
IC Laboratory Operations Manager
Ruth Welsh
Chemists
Katherine Buchanan LAII
Maureen Donlin LAII
Project Manager
Taryn Mancine
Sample Receiving
Client Service Tech I
Lan Young
Bottle Preparation
Client Service Tech I
Procurement Coordinator
Katherine Buchanan
Support Coordinator
Laura Pirkle
Last Revised – October 27, 2015
Last Reviewed – October 27, 2015

Figure 3-1

4.0 Sample Management

The purpose of this section is to outline and reference procedures for the type and use of sample containers, the preservation of the samples, sample shipping, sample receipt, sample custody, sample log in, sample disposal, and analytical subcontracting. A list of analytical procedures conducted by PAES is found in Tables 4-1 and 4-2 at the end of this section. Certifications are found in Table 4-3.

4.1 Sample Containers and Preservation

In order to provide the best possible service for the client and to obtain the required sample volume, PAES prefers to provide the sampling containers. Sample containers are constructed of either polyethylene or glass. Containers are purchased that are pre-cleaned and ready for use. Certified clean containers can be provided if project specifications require. Preservatives are added to most sample containers prior to shipping to the client, either by the bottle preparation client service tech, or the by the vendor. Clients are encouraged to completely fill each container in order to provide adequate sample volume.

For DoD projects: All bottles, reagents, solvents, and supplies used in DoD projects will be verified or certified by the supplier to meet or exceed standard specifications for environmental tests concerned. Verification must be kept on file to qualify each bottle, reagent, solvent and supply.

4.2 Sample Packing and Shipping

Samples are either hand carried to the laboratory or shipped using commercial carriers. Samples should always be shipped to the laboratory daily using a reliable overnight shipping service.

The chain of custody is used to establish the identity of samples and to provide proof of possession of the samples by PAES. Chains of custody are supplied to the client with the sample bottle order. The following information should be recorded, by the client, on the chain of custody.

- Client Name, Address, and Phone Number
- Project Name
- Project Number
- Sample Identification, Collection Date and Time, Number of Containers
- Specific Analytical Requirements
- Sample Matrix
- To whom the analytical data shall be submitted
- Relinquish signature

Ice should be added so that a temperature of above freezing but $\leq 6^{o}C$ is maintained during shipment. Samples should be packed inside a large bag and the bag should be sealed. Bags of ice

should be placed on top of the bag and should not be in direct contact with the sample containers. Cooler temperatures are taken electronically and recorded upon receipt by the laboratory.

The chain of custody should be enclosed in the zip lock bag, and taped to the inside lid of the cooler.

A copy of PAES' Sample Acceptance Policy is included with each client bottle order (see below). In order to expedite the sample log in process, please be sure to include and accurately complete all paperwork that should accompany samples to the laboratory.

Sample Acceptance Policy

1. Samples that are shipped to PAES must be accompanied by proper, full, and complete documentation. This documentation shall be marked on a chain of custody and shall include: sample identification, the location, date and time of collection, sampler's name, preservation type, sample type, specific parameters to be analyzed, and any special remarks concerning the sample.

2. Sample labels shall be supplied by PAES or the client. Those labels must be water resistant and completed using indelible ink. Each sample label must include a unique identification number that links it to the chain of custody documentation.

3. Samples shall be in the proper containers with the preservatives that are specific to the type of analysis required.

4. All samples must be received within specified holding times. Clients are requested to notify a PAES' Customer Service Representative if samples with short holding times are being shipped.

5. Samples must arrive at PAES with sufficient volume to conduct the requested analyses. All bottles should be filled completely.

6. When problems with samples or documentation are found during the sample receiving process, a Non-Conformance Form is completed by the Sample Custodian and forwarded to the Customer Service Office. A Customer Service Representative will make every attempt to contact the client as soon as possible to make decisions concerning those discrepancies. The Non-Conformance Form is kept as a permanent part of the project file.

7. If the client cannot be reached, a message will be left either on voice mail, with a receptionist, or via email for the client to return the phone call. The samples will be placed in a storage refrigerator and held until a PAES' Customer Service Representative gets a response from the client. (Exceptions will be made when samples are received that have short holding times and the samples are from a client with whom PAES has regular and frequent dealings. Or when the samples have short holding times and the samples are from a client with whom PAES has a signed contract, work order, or purchase order.)

4.3 Sample Custody

PAES takes custody of the samples when they are received at the laboratory or picked up at a client site by a PAES' employee. All samples are maintained in access-controlled areas until work is

started. The person responsible for either the sample preparation or analysis will retrieve the sample(s) from the storage area and return them when the function is complete.

4.3.1 Samples Requiring Secure Storage

For samples requiring locked storage and strict custody protocols (e.g. samples as evidence), the samples are locked in a temperature controlled sample storage cooler. When evidentiary samples are to be analyzed, the Sample Receiving Client Service Tech initiates a sample tracking record (Figure 4-2), and the analyst signs them out using the complete sample number as generated by the LIMS to identify the samples taken.

After analysis, all remaining sample, sample extracts, or the empty sample container are returned to secure storage, signed back in on the sample tracking record, and placed back in the secure storage area. Entries are made to the form each time a sample is removed and returned to the storage areas. Whenever sample preparations are completed, the sample preparation group adds them to the tracking record. All records of evidentiary samples are maintained until the client authorizes destruction.

4.3.2 Sample Receipt Protocols

The Sample Receiving Client Service Tech, or designee, signs for each shipment, and a copy of the shipping documents is retained. Specific sample receipt procedures are addressed in PAES Standard Operating Procedure for Sample Receipt. A brief outline follows:

- Shipment containers are inspected, opened, and monitored for temperature, if applicable.
- Temperature is recorded on the Chain of Custody.
- Shipment containers are unpacked and samples reconciled with the chain of custody.
- Chain of Custody is signed.
- Non-conformances are resolved with the client.
- Samples are logged in to PAES LIMS system.

Specific sample log in procedures are outlined in PAES Standard Operating Procedure for HORIZON LIMS. PAES LIMS assigns a unique internal project number and sequential sample numbers. These numbers are used to track the project through the laboratory. The sample numbers are transferred to each sample container using a computer-generated label. These numbers are documented on the chain of custody form and verified by the Sample Receiving Client Service Tech. A cooler receipt form is generated and placed in the project file along with the chain of custody and other related documentation.

All documentation relating to the project is maintained in the project file and retained in the laboratory for five years following the date the project is completed.

4.3.3 Resolution of Non-conformances

Sample receipt non-conformances are resolved according to PAES Standard Operation Procedure for Sample Receipt (SOP-S2). In nearly all cases, the client is contacted for the resolution decision and documentation.

Several possibilities may exist for resolving sample receipt problems. All decisions are the client's responsibility. Once a resolution is determined, the solution is noted on the non-conformance form and one or more of the following actions will occur:

- The log-in process will continue
- Written documentation will be requested from the client
- The sample(s) will be returned
- The sample(s) will be disposed

Throughout the problem resolution process, the sample will either be kept in a secure area or will be in view of the sample receipt personnel. All records generated during this process become a part of the client's permanent file.

When a client decides to proceed with analyses of samples that do not meet acceptance criteria, that decision shall be fully documented on the non-conformance form and the analysis data shall be "qualified" using a narrative on the final data report.

4.4 Sample Storage and Recovery

Samples requiring refrigeration are placed into temperature-controlled coolers that are maintained above freezing but ≤ 6°C. The cooler temperature is recorded each working day. The walk-in cooler, volatiles storage cooler, and CSIA storage cooler, use a Min/Max thermometer, and are recorded once a day. Temperature logs are maintained for each cooler.

All samples for volatile analysis are segregated in a cooler away from other samples. All samples are stored separately from standards, reagents, food, and other potentially contaminating sources.

4.5 Sample Disposal

Once samples are analyzed, they are moved from a primary to a secondary storage area. Samples are stored in secondary storage areas for thirty days following the date an analytical report is generated. Samples are disposed or returned according to the procedures outlined in the PAES Standard Operating Procedure for Waste Disposal.

4.6 Subcontracting Analytical Samples

PAES' Laboratory Manager or designee will notify the Project Manager when samples or extracts need to be sent to a subcontract laboratory, the number of samples to be sent, and the duration of the need for subcontract services for services routinely provided at the PAES facility. The Project Manager will notify the client in writing of the intent to subcontract samples. The Project Manager

will schedule the work with the subcontract laboratory and arrange the specifics of shipping the samples.

The Project Manager shall monitor the progress of the analytical work and receive the analytical data from the subcontract laboratory.

In the event of expedited turnaround that cannot be met by PAES, the Project Manager shall initiate the subcontract laboratory procedure in order to meet the client's need.

4.6.1 Subcontract Laboratory Approval

The following procedures are in place to ensure that laboratories that are to be used for subcontracting analytical samples meet minimum requirements for quality as specified by the Quality Systems Department. Prior to approval of a subcontract laboratory, the Quality Systems Department shall request the following information from the laboratory:

- List of current certifications and expiration dates of each.
- Copy of the Quality Assurance Plan for the subcontract facility.

Once this material has been received, it shall be reviewed by the Quality Systems Department and a decision will be made concerning the approval of the subcontract laboratory.

For DoD projects: All subcontracting of DoD projects will be to approved DoD laboratories.

4.6.2 Client Notification of Subcontract Laboratory

There are various reasons why a subcontract laboratory may be used including, but not limited to, an expedited turnaround time, laboratory capacity, and special analysis. All clients shall be notified in writing when any samples are to be sent to a subcontract laboratory.

Where the laboratory subcontracts any part of the testing that is covered under NELAC, this work shall be subcontracted to a NELAC accredited laboratory. The laboratory performing the subcontracted work is indicated on the final report and non-NELAC accredited work is clearly identified.

TABLE 4-1

Container, Preservation, and Holding Time Requirements
(EPA Methods for Chemical Analysis of Water and Wastes Table I and SW-846 3rd ed. Revision 4, Tables 2-40A, 2-40B)

Parameter	Method	Container (1)	Preservative (2)(3)	Maximum Holding Time (4)
Anions by IC	SW846-9056	G, VOA with butyl septa	Cool to above freezing but ≤6°C, unpreserved	48 hours for NO_2, NO_3 28 days for other anions
TOC/DOC	SW846-9060 SM 5310 C	P	Cool to above freezing but ≤6°C , H_2SO_4 to pH< 2	28 days
pH	SM 4500 H+	P	Cool to above freezing but ≤6°C	Immediate

1. AG - amber glass, G - glass, P – polyethylene.
2. Sample preservation should be performed immediately upon sample collection. Composite samples may be preserved by maintaining at ≤6°C until sample splitting and collection is completed.
3. If the dissolved content is to be measured, samples should be filtered on site immediately before adding preservatives.
4. The holding times listed are the maximum times that samples may be held before analysis and still be considered valid under EPA regulations. Holding times are measured from the time the sample is collected.

Table 4-2

Bioremediation Indicator Parameters and Risk Analysis Test Methods
These parameters are analyzed using PAES' Methods.

Parameter	Method	Container	Preservative	Maximum Holding Time
Hydrogen by Bubble Strip	SM9/AM20Gax	22 cc vapor vial with stopper septum	None	14 days
Light hydrocarbons by Bubble Strip	SM9/AM20Gax	22 cc vapor vial with stopper septum	None	14 days
Permanent gases by Bubble Strip	SM9/AM20Gax	22 cc vapor vial with stopper septum	None	14 days
Light hydrocarbons in water: Methane, Ethane Ethene	PM01/AM20Gax RSK-175	40 ml Clear VOA vial with butyl septum	Trisodium Phosphate or Benzalkonium Chloride & Cool to above freezing but ≤6°C	14 days
Permanent gases in water: Oxygen, Nitrogen, Carbon Dioxide	PM01/AM20Gax	40 ml Amber VOA vial with butyl septum	Benzalkonium Chloride & Cool to above freezing but ≤6°C	14 days
Light hydrocarbons in vapor	AM20Gax	22 cc vapor vial with flat septum	None	14 days
Permanent gases in vapor	AM20Gax	22 cc vapor vial with flat septum	None	14 days
Hydrocarbons in vapor	AM4.02	22 cc vapor vial with flat septum	None	Unspecified
Chlorinated hydrocarbons in vapor	AM4.02	22 cc vapor vial with flat septum	None	Unspecified
Total inorganic carbon in water	PM01/AM20Gax	40 ml Clear VOA vial with butyl septum	Cool to above freezing but ≤6°C	14 days
Volatile Fatty Acids	AM21G	40 ml Clear	Cool to above freezing but ≤6°C	21 days
Low Level VFA	AM23G	40 ml Amber with butyl septum	Cool to above freezing but ≤6°C Benzalkonium chloride	14 days

Table 4-2
Petroleum Forensics Methods

Analysis	Method	Container	Preservative	Maximum Holding Time
Parent and Alkylated PAHs	8270(SIM) Modified	P - 2 x 40ml VOA Vials S - 1 x 4oz jar W – 2 x 1L Glass	Unpreserved Ice, maintained at 6°C	Unlimited If solid or water – 14 days.
C3-C36 Whole Oil	ASTM D3328 (GC/FID)	2 x 40ml VOA Vials	Unpreserved	Unlimited Cannot analyze on water or soils
C8-C40 Full Scan	ASTM D5739 (GC/MS)	P – 2 x 40ml VOA Vials S – 1 x 4oz jar W – 2 x 1L Glass	P – NONE S or W – ice, maintained at 6°C	Unlimited If solid or water – 14 days.
Simulated Distillation	ASTM 2887	2 x 40ml VOA Vials	NONE	Unlimited Cannot analyze on water or soils
Oxygenated Blending Agents	EPA 1624 Modified	2x40mL VOA vials W – 2x40mL VOA vials	P – NONE W – HCL; ice, maintained at 6°C	Unlimited If water – 14 days
Organic Lead and Lead Scavengers	GC/ECD	2x40mL VOA vials	NONE	Unlimited Cannot analyze on water or soils
C3-C10 PIANO	GC/MS	2x40mL VOA vials W – 2x40mL VOA vials S – 1 x 4oz jar	P – NONE W – HCL; ice, maintained at 6°C	Unlimited If solid or water – 14 days

Table 4-2
Molecular Diagnostics Methods

Analysis	Method	Container	Preservative	Maximum Holding Time
BER Array	SOP for BER Array	S-1x4oz jar S-1x50mL Falcon tube W-1x1 filtration tube	Unpreserved Ship on ice Maintain at -20°C	Unlimited
Target Species present test	SOP for PCR	S-1x4oz jar S-1x50mL Falcon tube W-1x1 filtration tube	Unpreserved Ship on ice Maintain at -20°C	Unlimited
Target Genes present test	SOP for PCR	S-1x4oz jar S-1x50mL Falcon tube W-1x1 filtration tube	Unpreserved Ship on ice Maintain at -20°C	Unlimited
Target Species quantity test	SOP for QPCR	S-1x4oz jar S-1x50mL Falcon tube W-1x1 filtration tube	Unpreserved Ship on ice Maintain at -20°C	Unlimited
Target Genes quantity test	SOP for QPCR	S-1x4oz jar S-1x50mL Falcon tube W-1x1 filtration tube	Unpreserved Ship on ice Maintain at -20°C	Unlimited

Table 4-3

NELAC Accredited Parameters/Methods

Primary NELAC: Pennsylvania
Secondary NELAC: NY, NJ, NH, VA, CT, SC, TX, WV
(Not all states accredit all parameters.)

Parameter	Method
Chloride	SW846-9056
Nitrate	SW846-9056
Nitrite	SW846-9056
Sulfate	SW846-9056
TOC/DOC	SW846-9060, SM 5310C
pH	SM 4500H+
Light Hydrocarbons	RSK175M
Volatile Fatty Acids	PAES SOP-AM23G

Call Quality Department for state-specific analyte list.

Figure 4-1
Chain of Custody Form

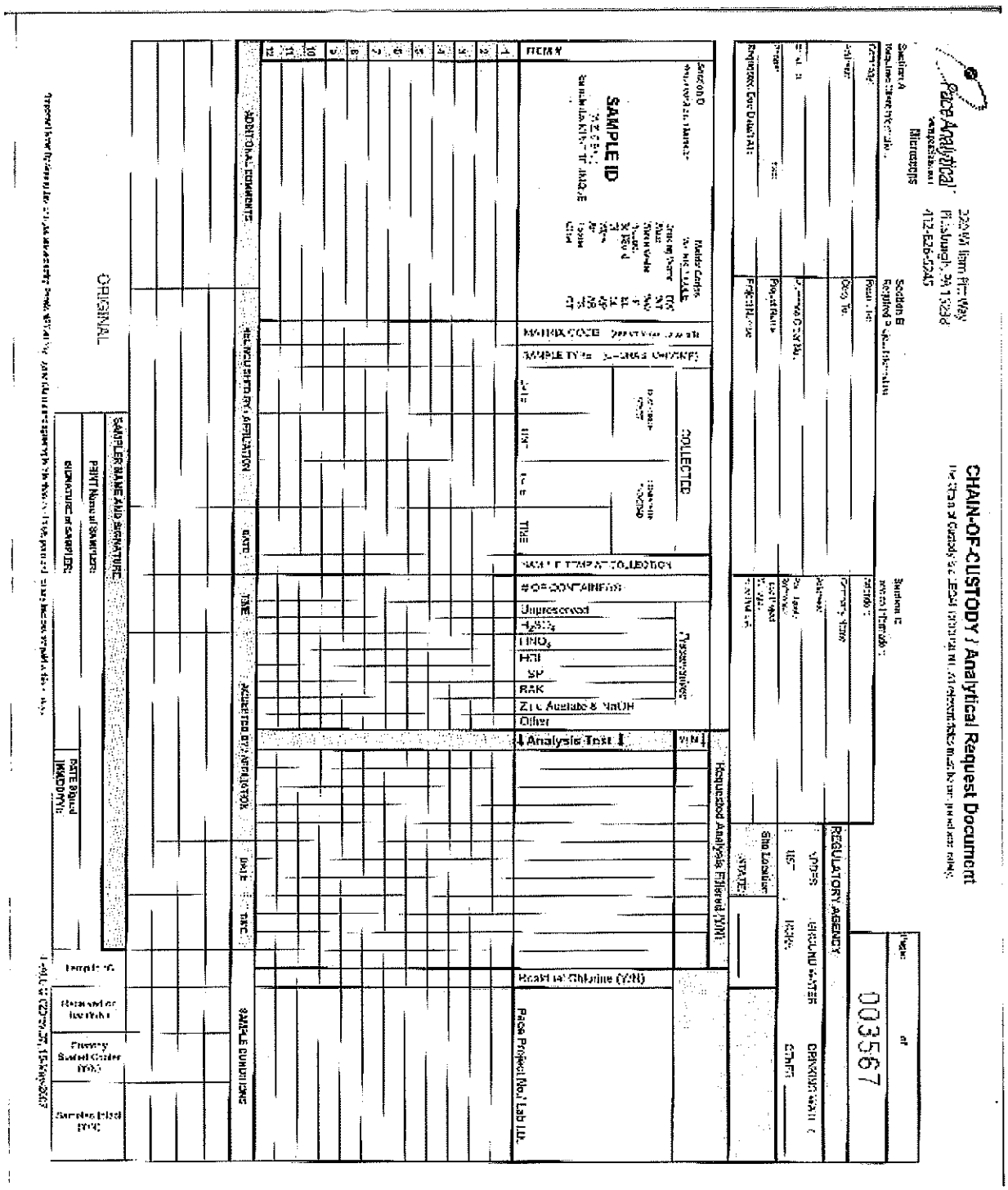


Figure 4-2

Sample Tracking Record

Client Name: _____ **Page** _____ **of** _____

Client Project Number: _____

Bottle Type Circle or Highlight (Sample Receiving Only)	Cations	Nutrient	TIC	VFA			
	G. Chem.	VOA	Soils	LLVFA			
	TOC/DOC	Petro	Diss. Gas	Hydrogen			
	Anions	Micro	Vapor	CSIA			

Sample Receiving only to mark above dotted line

Sample Numbers	**Removed from Storage**			**Bottle**	**Returned or Placed in Storage**		
	By	**Date**	**Time**	**Type**	**By**	**Date**	**Time**

Enter Bottle Type From List Above In Proper Column

5.0 Facilities, Instrumentation, and Materials Procurement

5.1 Facility Description

Pace Analytical Energy Services (PAES) is located in the University of Pittsburgh's Applied Research Center (UPARC). The complex consists of 58 separate buildings, which house over 120 companies. The Oxford Development Company provides management for the UPARC facility including building maintenance and safety support. Oxford Development's maintenance personnel are on-site and respond quickly and efficiently to all internal environmental or air quality issues. Specialized maintenance staff is on-call to respond to ventilation, heating, cooling, lighting, or other problems that may occur.

Laboratory temperatures are controlled by the permanent heating and air-conditioning systems in the UPARC complex. Where the cooling systems have not been efficient enough to maintain correct temperature and humidity requirements for proper instrument function, PAES has installed additional units as needed.

When environmental conditions jeopardize the results of environmental tests, the analyst shall notify the Laboratory Manager immediately of the problem. If the problem cannot be resolved immediately the Laboratory Manager shall order a stoppage of all work until either the problem is resolved, or another area of the laboratory can be utilized to continue testing.

PAES is located in Building B-1 and has offices and laboratories on the first, second, third and fourth floors.

5.1.2 Laboratory Areas

The following table specifies the locations of the individual laboratories and workspaces in the building in which PAES is housed.

First Floor

- Bottle Preparation — Room 108
- Sample Receiving — Room 115/117
- CSIA Laboratory — Room 126/128
- CSIA Laboratory — Room 127

Second Floor

- Dissolved Gas Laboratory — Room 220/222
- Vapor Laboratory — Room 221
- Instrument Laboratory/Wet Chemistry — Room 213
- LIMS Center — Room 218

Third Floor

- Molecular Diagnostics Laboratory — Room 306/308

Fourth Floor

- CSIA Laboratory — Room 424/426
- Petroleum Forensics Laboratory — Room 425

5.1.3 Building and Laboratory Security

Employee access into the UPARC complex is controlled through key-card turn-styles where each individual that works in the complex has a unique code for entry. UPARC Security is aware of who is on-site or off-site at any given time. PAES laboratory areas are controlled through keyed entry to prevent employees from other firms housed in the complex from gaining access to PAES laboratories. Each employee is issued a key that will open doors to rooms occupied by PAES. During normal working hours, the laboratory areas are kept unlocked. After normal business hours the rooms are locked to prevent unauthorized personnel entry.

A UPARC Security Force monitors the facility twenty-four hours a day with a series of video cameras. The guards also make rounds by foot and vehicle during afternoon and night shifts. Visitors cannot gain access to the complex except through the Main Security Gate. All visitors are required to register at the main gate and obtain a visitor's pass before entering the complex. UPARC Security notifies PAES upon the visitor's arrival to verify admittance. Visitors are directed to PAES Reception Office. The visitor is then escorted, by a PAES employee to the PAES front office to sign the visitors log, and is then directed to the employee or laboratory they intend to visit.

5.2 Instrumentation

Instrumentation must be properly calibrated and maintained to produce reliable and reproducible results. This section of the Quality Systems manual defines minimally acceptable standards for installation, calibration, and maintenance of analytical instruments used in the laboratory. Fully detailed procedures are instrument specific and are available in the individual instruments' Operator Manuals.

A list of PAES' Instrumentation is included in Figure 5-1. This list is updated whenever equipment is placed in service or removed from service.

5.2.1 Installation and Set-up

All new instrumentation must be included in the Quality Systems program prior to being used for sample analysis. When new equipment is ordered, the Laboratory Manager and the Technical Director determine the preparations that the laboratory must make to accommodate the equipment. This plan includes descriptions of facility modifications that may be required, personnel

responsible for installation (manufacturer or PAES employee), performance criteria that need to be met, and training procedures that will be followed.

Data generated during installation and set-up will be included in the maintenance log for the instrument. This data may become important later for troubleshooting and diagnostic checks. Operator manuals supplied by the manufacturer are maintained in the laboratory for reference.

5.2.2 Calibration

Calibration procedures for instrumentation are thoroughly documented and routinely followed to provide assurance that the data produced are reliable and accurate. Specific calibration procedures and frequency are detailed in the individual Standard Operating Procedures.

Initial calibration involves comparing instrumental response to various concentration levels of the analytes of interest. The calibration curve will contain a minimum of five points (or better), excluding a blank. The lowest point of the curve should be equal to or lower than the reporting limit. The most concentrated standard should be below but near the upper concentration limit of the linear range. All standards are prepared from solutions of certified concentrations. All calibrations are checked against a "second source" obtained from, preferably a different vendor, but at least a different lot. All calibrations are followed by an initial calibration blank to verify that system contaminants and carry-over are not present. For organic analyses, surrogates are added to each blank and standard. In addition, internal standards are also added for some organic analyses.

If the initial instrument calibration results are outside established acceptance criteria, corrective actions are performed. These criteria and the corrective action are specified in individual Standard Operating Procedures. Data associated with unacceptable initial instrument calibration is not reported.

5.2.2.1 Calibration Verification

If an initial instrument calibration is not performed on the day of analysis, the validity of the initial calibration is verified prior to sample analysis by running continuing instrument calibration verification standards with each analytical batch. Continuing instrument calibration verifications must be run at the beginning and end of each analytical batch.

5.2.3 Instrument Maintenance

Maintenance of analytical instruments is carried out under the direction of the Laboratory Manager and may include regularly scheduled preventive maintenance, or maintenance on an as-needed basis due to instrument malfunction. Maintenance activities for instrumentation are documented in Instrument Maintenance Logs. This documentation becomes a part of the laboratory's permanent records.

Regular maintenance of support equipment, such as balances, thermometers, and fume hoods is conducted annually and more often if required. Maintenance on other support equipment, such as

ovens and refrigerators is conducted on an as needed basis. The analysts are responsible for ensuring that temperatures of ovens and refrigerators are checked and recorded twice daily. The Laboratory Manager is notified if the temperature is outside of the range of use of the specific piece of support equipment, and the equipment is scheduled for maintenance.

Records of maintenance to support equipment are also documented in Maintenance Logbooks. Each piece of support equipment does not necessarily have its own logbook. Maintenance logbooks may be shared with equipment that is housed in the same laboratory area.

5.2.3.1 Out of Service Instruments

In the event that an instrument cannot be calibrated or is determined to be out of order, an out of service or out of calibration tag is placed on it. The analyst is responsible for ensuring the equipment is tagged. This tag shall be removed when the instrument is repaired and ready for use.

5.2.3.2 Instrument Repair

Unexpected repairs resulting from instrument failure are scheduled immediately after the malfunction is observed. Instrument failures are detected through direct observations and by evaluation of the response of verification standards throughout the analytical run. The Instrumentation Specialist is responsible for deciding if laboratory personnel can make the repair or if an outside contractor is required.

Data obtained during instrument failure are not entered into the LIMS for reporting to the client. Complete records of the repairs are maintained in the Instrument Maintenance Logbooks. These records may include notes taken by laboratory personnel during repair and a copy of the service call record. Acceptable instrument performance must be verified before samples can be analyzed.

5.3 Materials Procurement

The purpose of this section is to define requirements for the procurement of materials needed to support laboratory operations.

5.3.1 Purchase of Laboratory materials/Supplies

The laboratory shall purchase necessary supplies by recognizing that all items used in the performance and successful completion of an accurate analysis fall into two categories:

1. **Hardware and Associated Durable Equipment**

These laboratory materials would be those associated to the physical components needed to successfully operate the appropriate analyzer for any given test or set of tests. These materials, more often than not, will be purchased directly from the manufacturer of the analyzer. In such cases where vital materials have been discontinued or become available from an alternate source, the laboratory may purchase such items from other vendors. The providers of such materials will

not be evaluated by any documented procedure or collection of associated quality documents. All materials required in this category must first be approved by the Laboratory Manger(s), Technical Director . Ultimately the successful completion of accurate testing, around the requirements of each individual analytical Standard Operating Procedure, shall determine each vendor's acceptance in this category.

2. Reference Materials and Consumable Laboratory Supplies

These laboratory materials would be those associated to the direct determination of unknown target analyte concentrations present in the samples collected and submitted by our customers. These materials can be purchased from a wide variety of suppliers. The laboratory shall maintain a list of acceptable vendors from which these materials can be purchased. Each vendor in this category shall undergo an initial acceptance procedure and annual renewal by the Quality Systems Department. The Procurement Coordinator will ensure that each vendor provide adequate documentation such that the laboratory can assure a level of conformance with industry guidelines. Such documentation could be related to, but not limited to, a vendor's ISO certification or Quality Assurance Plan. All reference materials will be purchased with Certificates of Analysis. This documentation shall be maintained in each lab area in which the reference material will be used.

5.3.2 Placing Orders

The purchasing of routine supplies necessary for the completion and accuracy of any given test procedure are initiated by the analysts, as needed. Any non-routine laboratory materials/supplies selected by the analysts should be reviewed and approved by the Laboratory Manager(s), Technical Director, prior to purchase. All purchasing is initiated by completion of the Purchase Order Form. Vendor's name, Item(s) reference number, description of the item, quantity requested, date required, and the accounting category, will be filled out by the individual requesting the supplies. The Purchase Order Form is then delivered to the Procurement Coordinator, where a unique purchase order reference number is assigned to each order. It will be the responsibility of the Procurement Coordinator to purchase such supplies from the acceptable list of vendors, as described in Section 5.3.1. No other vendors shall be used in the purchase of laboratory materials/supplies, without specific approval of the Quality Department.

All orders must be signed by the requestor and approved by the supervisor prior to submission to the Procurement Coordinator. Orders received after noon may not be ordered until the next business day due to vendor order acceptance timeframes. Custom standards may require a 4-6 week lead time to be shipped. Any orders over $2500.00 require Corporate approval. Submit a copy of the vendor's quote to the Procurement Coordinator, who will submit it to the AGM/GM and the Administrative Business Manager for submission to Corporate for approval.

After the order is placed by the Procurement Coordinator, the Purchase Order Form is submitted to the Administrative Business Manager for filing.

5.3.3 Receipt of Materials

Supplies or materials are received by the Sample Receiving Client Technician, who in turn, calls the Procurement Coordinator. The Procurement Coordinator compares the materials received to the packing list. Any discrepancies are noted on the packing list and a call is placed by the Procurement Coordinator to the vendor to resolve any issues. If there are no issues and the order is complete as ordered, the Procurement Coordinator submits the packing slip to the Administrative Business Manager. The packing slip is then attached to the corresponding Purchase Order Form and kept on file by the Administrative Business Manager

The materials and associated documentation (i.e. Certificates of Analysis or Purity) are picked up by the Department that placed the order.

All Safety Data Sheets are kept in the lab area where the supplies are being used.

Review Date: October 28, 2015

Figure 5-1
PAES Instrument and Equipment List

Natural Attenuation

EDONORS

Dionex Ion Chromatograph Model ISC 2000 with Degasser (Serial 08120332); Gradient Eluent Generator; AS-AP Autosampler (Serial 14092562), Columns.

Dionex Ion Chromatograph Model ISC 2100 with Degasser (Serial 14092120); Gradient Eluent Generator; AS-AP Autosampler (Serial 14092562), Columns.

Varian 3400 Gas Chromatograph (Serial 10272) with Varian 8100 Autosampler (Serial 1371)

Thermo-Fisher Scientific Ultra Trace GC (Serial 620120045) with TriPlus RSH Liquid Autosampler (Serial 241284)

Risk Analysis

Agilent 6890 Gas Chromatograph (Serial US10347026) with Agilent G1888 Headspace Autosampler (serial IT40220036).

Hewlett Packard 5890 Series A Gas Chromatograph (Serial 2536A05842) with Tekmar 7000 Autosampler (Serial 91099014/91135007)

Hewlett Packard 5890 Series II (Serial 3336A51836) with Tekmar 7000/7050 Autosampler (Serial 91346008/91346016)

Thermo-Fisher Scientific Ultra Trace GC (Serial 620120028) with TriPlus RSH Headspace Autosampler (Serial 237682)

Three Proprietary GCs

GOW MAC Series 580 Gas Chromatograph (Serial 580-200)

Ohaus Discovery Analytical Balance Model # DV215CD (Serial 1128122704)

Wet Chemistry/EACCEPTORS

Dionex ISC 3000 Ion Chromatograph with dual Autosamplers, columns, and ovens with conductivity and UV-VIS detectors

OI Analytical Aurora 1030 TOC Analyzer (Serial J025730751) with Autosampler (Serial E019788198)

Denver Instruments Model SI-4002 Top Loading Balance

Spectronic 20G Colorimeter

Spectronic 20D Colorimeter

Orion 601A pH Meter

Sartorius Model 1612 Analytical Balance

CSIA

Tekmar Aqua Tek 70 Autosampler (Serial US 06151001)

Tekmar Velocity XPT Purge and Trap (Serial US 06191003)

Entech 7100A Pre-concentrator (Serial 1304)

Thermo Trace GC Ultra Gas Chromatograph (Serial 200510408)

Thermo GC-Combustion III Interface (Serial 111201-175)

Thermo GC /TC Reactor OD (Serial 108520-349)

Thermo Delta V Plus Isotope Ratio Mass Spectrometer (Serial 8018)

Thermo-Electron GC (Serial 10603008) with DSQ II Mass Spectrometer (Serial 100442); Varian Archon Autosampler (Serial 14655) and Tekmar Velocity Concentrator (Serial US6047001)

Thermo Delta V Plus isotope ration mass spectrometer

Thermo Conflo IV interface

Thermo GC Isolink interface

Agilent 7890A GC System

Tekmar Aquatek 100 autosampler

Tekmar Stratum Purge and Trap concentrator

Entech 5400 Thermal Transfer System

Entech SL2 Perconcentrator

Agilent 6890N GC (Serial US10226064)

Agilent 5973N MSD (Serial US63810430)

Teledyne Tekmar Aquatek100 Autosampler (Serial US11348004) and Stratum Concentrator (Serial US11327002)

GC/MS Chemstation Datasystem (SN 2UA71516GF)

Agilent 6890N GC (serial # US10232118)

Agilent 7890A GC (serial # CN12121090)

Agilent 5975C MSD (serial # US12157802)

Agilent G4513A autosampler (serial # CN12090144)

Isoprime – GC interface (serial # 10/007)

Isoprime IRMS reference box (serial # 10/008)

Isoprime IRMS (serial # JB166)

EuroVector Elemental Analyzer (serial # 8429)

UPS (Model # TX90-10K)

UPS (Model # T90-EBP920)

Pacific Air Jun-Air Compressor Model 6 (serial # 1010200822)

Supelco 29541-U High Capacity Gas Purifier (serial # 1312955/1A-22)

Fisher Scientific Ultrasonic cleaner (serial # RUA030263007)

Eppendorf Centrifuge 5810R (serial # 581101849)

New Brunswick Scientific Innova 2000 Platform shaker (serial # 300544191)

Pelton & Crane Sterilizer (serial # AF - 005387)

Zymark TurboVap LV evaporator (serial # 04384)

Petroleum Forensics

HP Agilent 7890A GC/5975 MS System (Serial # CN12091092)

HP Agilent 6890 GC/5973 MS System (Serial # US00008852)

HP Agilent 6890 GC/5973 MS System (Serial # US00006875)

HP Agilent 6890N GC System (Serial # US10347026)

HP Agilent 6890 GC System (Serial # US00001417)

HP Agilent 5890 GC System

HP Agilent 5890 GC/5971 MS System

Tekmar LCS 2000 Purge and Trap

ESI Autosampler

Polyscience Refrigerated Recirculator

Zymark TurboVap 500 Concentrator

Sargent-Welch SWT-603D Scale (Serial # T0121781)

Molecular Diagnostics

Nuare Biosafety Cabinet (Serial # 140024091310)

MPBio FastPrep-24 Shaker (Serial # 15040480)

Eppendorf 5427 Centrifuge (Serial # 5427DP621099)

FOTODYNE 1-1430 UV Instrument (Serial # FRG1-0615-1173)

Fisher Scientific FB300 Power Supply (Serial # CI596150102560)

Roche LightCycler 480II/96 QPCR Instrument (Serial # 29818)

HP rp5700 Computer (serial # CZC1164K0C)

Thermo NanoDrop 2000/2000c Spectrophotometer (Serial # R108)

Akonni DX2100 Microarray Imager (Serial # 3968)

Akonni Thinkpad T420 Computer (Serial # 3744)

Akonni Q-Cycler96 DNA Analysis (Serial # 3934)

Esco SCR-2A2 PCR Cabinet (Serial # 2013-84203)

VWR ULT-86 Upright Freezer (Serial # 833020-697)

Heraeus Incubator (Serial # 26286080)

6.0 Data Quality

6.1 Data Quality Objectives

PAES conducts analysis on environmental samples for clients who rely on the data in order to make decisions concerning environmental problems, environmental monitoring, and in many cases to investigate the feasibility of cutting edge remedial technologies. The necessity of high quality data is essential so that the best decisions can be made in the interest of both the environment and the client. PAES believes data quality objectives are applied to a project from the initial sampling to the final data validation process. On a laboratory scale, PAES' data quality objectives are reflected in individual Technical Standard Operating Procedures as quality control acceptance criteria.

Quality control sample acceptance criteria is generated using one of following three methods:

- A minimum of twenty data points are manually collected and entered into an EXCEL spreadsheet. The average percent recovery and/or relative percent difference (RPD) is calculated, whichever is applicable. Acceptance criteria are generated using the standard deviation of the average percent recovery and RPD. Three standard deviations comprise the acceptance range around the average percent recovery and above the RPD.
- Calculated electronically by the LIMS database and expressed in the Control Chart Program.
- Taken from EPA method-specific recommendations in the absence of laboratory-generated criteria.

Acceptance criteria generated from the implementation of control charts, either manually or LIMS generated are evaluated annually or more often. If it is determined that the acceptance criteria has changed to a broader set of limits, the reason for the change is evaluated for error to ensure the analytical method is still in control. When warranted, corrective action shall be instituted by the Quality Systems office or the Operations Department.

All analytical data including quality control results are checked in accordance with the Standard Operating Procedure for Data Integrity, Review and Validation. Performance Evaluation studies are conducted twice a year and the results are reviewed by management. All failed PE samples are followed up with Corrective Actions.

To maintain the quality of laboratory data and to ensure that laboratory procedures are under control, a variety of internal batch quality control samples are analyzed. The data from those samples are used to calculate statistics that help determine precision, accuracy, and to track potential bias. In addition, performance evaluation studies are conducted regularly as well as random submission of blind quality control samples. Certified reference standards are used, as well, to ensure that quality is maintained.

6.2 Internal Batch Quality Control

Batch quality control sample types and frequencies are recommended in published methods and specified in PAES Technical Standard Operating Procedures. In general, a batch of samples consists of twenty samples or fewer (as recommended by analytical methods) that are analyzed at the same time. Typically, a set of internal quality control samples is analyzed once for each batch of clients' samples. The types of internal batch quality control samples are discussed below.

6.2.1 Initial and Continuing Calibration Verification Standards

Initial and continuing calibration standards verify the ratio of instrument response to the analyte amount. Typically, initial calibration verification and continuing calibration standards are made from stock solutions, which are different from the stock used to prepare the initial calibration standards.

6.2.2 Calibration Blank

A calibration blank is a 'clean' sample made from an appropriate matrix and/or solvent. The calibration blank is analyzed to insure that there is no contamination in any part of the analytical system, or to establish a baseline if that "contamination" is expected and known to be of consistent concentration. Calibration blanks are analyzed after each initial, continuing, and calibration verification standard. The analytical result of the blank must be below the laboratory's quantitation limit or project specific requirements in order for analysis to proceed. If the result of the analysis is above the acceptance limit, the source of contamination must be identified and eliminated. The one exception involves the presence of common laboratory solvents as defined by the EPA.

6.2.3 Method (Preparation) Blanks

Method blanks are reagent water or, for solid/waste matrices, sand, or other appropriate material, or an appropriate solvent carried through the entire analytical process to monitor potential contamination that may or may not be introduced during sample preparation and processing. For organic analyses, surrogates and internal standards are added to the method blank.

Method blanks are analyzed at the beginning of the batch and prior to sample analysis. If the analytes of interest are below the laboratory's quantitation limit or project specific limit, sample analysis can proceed. If analyte concentrations are found above the acceptance limits, the source of the contamination must be identified and corrected. The reagents used for sample preparation must be checked for contamination and the samples associated with the method blank must be prepared again and reanalyzed if necessary.

6.2.4 Duplicates

Duplicates are analyzed to assess precision of the analytical procedure. Samples for batch duplicate analyses are selected at random, ensuring that the selection is rotated among client samples so that various matrix problems may be noted and/or addressed. If the sample requires

that an aliquot be removed and placed in another container in order to conduct the duplicate analysis, a representative aliquot is collected using one of the following options discussed below in Subsection 6.3.4.

Precision of the analyses may vary due to the matrix effects of the sample. If the precision is outside established control limits, the duplicate analysis is repeated. If the precision is still outside established control limits and all other quality control checks are within control, a matrix effect is assumed.

6.2.5 Matrix Spike/Matrix Spike Duplicates

Matrix spike and spike duplicate samples are analyzed to determine the extent of matrix bias or matrix interference on analyte recovery and to determine sample-to-sample precision. Analytes stipulated by the method, by regulations, or by other requirements must be spiked into the sample. If not supplied by the client, the analyst may choose these samples at random. Percent recoveries are calculated for each of the analytes detected. The relative percent difference between the samples is calculated and used to assess analytical precision.

Recovery data is highly dependent upon matrix effects. If acceptable recoveries are observed, it is determined that matrix is having no significant affect on the analytical procedure and that sample preparation and analysis have been performed correctly. Whenever precision, calibration, and system quality control checks are acceptable, large or small matrix spike recoveries are attributed to matrix effects. Because samples are spiked prior to analysis, the concentration of the analyte of interest in the sample may be so high that the spike amount is insignificant. In these cases, spike recovery is meaningless and is not calculated.

6.2.6 Laboratory Control Samples

Laboratory control samples are samples that are spiked with a specific concentration of known reference materials, independent of the calibration standards that are carried through the entire analytical process. These standards are used to assess the accuracy of the analytical process. Where possible, acceptance limits are statistically based upon actual laboratory data. If results are outside acceptance limits, corrective action must be performed before sample analyses can proceed.

6.2.7 Surrogate Standards

Surrogates are organic compounds which are similar to analytes of interest in chemical composition, extraction, and chromatography, but which are not normally found in environmental samples. These compounds are spiked into all blanks, standards, samples and spiked samples prior to organic analysis.

If surrogate recovery is not within acceptance limits, corrective action is instituted and reanalysis of those samples occurs.

6.2.8 Insufficient Sample Volume

When there is insufficient client sample volume in a batch to conduct quality control samples for precision, then a laboratory control sample and laboratory control sample duplicate are analyzed.

6.3 Measurements of Data Quality

Data quality measurements vary from parameter to parameter, are represented as warning and control limits, and are displayed along with associated data on control charts. The following types of measurements are utilized by PAES to insure the highest quality data is being provided.

6.3.1 Precision

Precision is a measure of the degree of mutual agreement among individual measurements made under prescribed conditions. Precision of laboratory data is determined through duplicate analyses of samples or matrix spikes and spike duplicates, and is calculated for PAES purposes, as either the range or relative percent difference (RPD) of the measurements.

6.3.1.1 Range

Range is defined as the difference between the highest and the lowest value reported for a sample. Range is used in the laboratory as recommended in published regulatory methods. The formula for calculating range is as follows:

$$Range = HighestValue - LowestValue$$

6.3.1.2 Relative Percent Difference

Relative percent difference (RPD) is used for all of the analytical methods at the laboratory where sample duplicates are analyzed and where both matrix spikes and matrix spike duplicates are analyzed. If one or both measurements are less than the reporting limit, precision is not calculated. The formula for calculating relative percent difference is as follows:

$$RPD = \frac{|A-B|}{\frac{A+B}{2}} \times 100\%$$

6.3.2 Accuracy

Accuracy is the measurement of agreement between a measurement and the true value. It is calculated as the percent recovery of standards and spikes. Accuracy is calculated as the percent recovery of laboratory control samples, matrix spikes, and in organic chemistry surrogate recoveries.

6.3.2.1 Percent Recovery

Percent recovery is used for all of the analytical methods at the laboratory where laboratory control samples, matrix spikes, and/or surrogates are analyzed. The formula for calculating percent recovery is as follows:

$$\%\text{Recovery} = \frac{Measurement}{TrueValue} \times 100\%$$

6.3.3 Bias

Bias is defined as a systematic error due to the experimental method that causes the measured values to deviate from the true value. Bias is determined by plotting the average percent recovery and the average relative percent difference on a control chart. A bias is suspected when seven successive data points are plotted on the same side of the average. This is considered an out of control event.

6.3.4 Representativeness

Representativeness is defined as data that accurately and precisely reflect the sampling points or environmental conditions. Numerous items throughout sampling and sample handling must be controlled to maximize representativeness. These include sample collection, preservation, and holding times. Since PAES does not perform sample collection, PAES cannot accept responsibility for representativeness of sample collection.

When an aliquot must be removed from the sample container for analysis or for making batch quality control samples, one of the following two options are used in order to obtain a representative aliquot:

1) If the analysis won't be compromised by agitation, then the sample is stirred, mixed, crushed, blended, as needed, and the aliquot is removed from sample container and placed in another container.

2) If the analysis may be compromised by shaking or mixing the sample, then portions of the aliquot are taken from different places within the original sample container ensuring that the aliquot is as representative as possible of the original sample.

In some cases where a sample cannot be homogenized, the client will be contacted and a course of action will be decided upon according to a mutually agreed upon decision.

6.3.5 Comparability

Comparability is the confidence level with which one set of data can be compared to a related set of data. PAES uses EPA recommended methodology, whenever feasible, participates in internal and external performance evaluation programs, and uses standard reference materials for sample analysis as means of enhancing comparability.

6.4 Validation of Methods

Validation is the confirmation by examination and the provision of objective evidence that the particular requirements for a specific intended use are fulfilled.

PAES validates non standard and laboratory-designed/developed methods, standard methods used outside their intended scope, and amplifications and modifications of standard methods to confirm that the methods are fit for the intended use. The laboratory keep records of results obtained, the procedures used, and a statement that the method is fit for the intended use.

As requests come in they are reviewed to see if they can be satisfied by the standard methods or by our own internally developed nonstandard methods. If the answer is no, a brief search is done for appropriate laboratories and the Technical Director reviews the results to see if a.) any laboratories that have been found can properly fill the clients request, b.) if there is justification for PAES to develop and market an analysis that can fulfill the request. When an analysis is developed, a calibration must be completed along with preparation of an SOP, complete training including an IDOP and a full MDL study. All of these are documented and the records are retained.

6.5 Uncertainty

There are so many sources of uncertainty in a concentration measurement. Certainly, the collection of the sample is a very large source of uncertainty. The particular technique of collection is another, and the location of the points chosen for sampling is a third. Of course, there is uncertainty in analytical measurements as well, and all laboratory analytical procedures are specifically designed to minimize or otherwise control that uncertainty. As such, analytical uncertainty is very likely a minor contribution to the overall uncertainty of any measurement. However, analytical uncertainty is important. There are many potential causes. Some of the most common are enumerated below, along with a brief discussion on how PAES minimizes the effect of each:

- Human factors- by maintaining SOPs which are analysis-not analyst-dependant, and by engaging in training and yearly CDOP's, PAES tries to minimize the analyst-to-analyst variable.
- Accommodations and environmental conditions-Perhaps the biggest variable here is ambient temperature. In our wet chemistry, and one of our non-traditional laboratories, there is manually controlled heating and cooling. In one of our non-traditional analyses rooms there is additional, automated cooling. Since volatiles

are extremely temperature sensitive, both our volatiles analysis laboratory and our CSIA laboratory are furnished with large capacity air conditioning systems.

- Environmental test calibration and method validation-The vast majority of our analytical activities are specifically designed to address these issues. Specifically, it should be pointed out that all of our tests are calibrated with externally certified standards, and then double-checked with a "second source" standard when possible. Additionally, since we utilize many of our own analytical tests, we have strong emphasis on method validation. For a method to be validated here, it must either pass a successful calibration and then be verified against an external source. The method must be successfully brought through an IDOP and then regularly produce valid matrix spike, matrix spike duplicate and sample duplicate analyses, if applicable.
- Equipment-Before a new piece of equipment is routinely used, an IDOP must be successfully completed using that equipment. This minimizes the potential for un-controlled equipment fluctuations.
- Measurement traceability-If an analytical system is internally calibrated, we maintain records of that calibration, including the certificate of analysis of the standards used in that calibration. If the system was externally calibrated, the records of that external calibration are also supplied.

Finally, to measure the total analytical uncertainty we routinely perform LCS's. (LCS's are chosen because they are submitted to the entire analytical procedure.) The typical acceptance range for an LCS recovery is 80-120%, but the LCS performed with a batch and the SOP for the particular measurement technique should be consulted for specifics.

Review Date: October 29, 2015

7.0 Data Handling

PAES maintains records that enable the re-creation of the specific conditions under which data are produced, and method specific Standard Operating Procedures outline procedures for data collection, reduction, validation, and reporting. This section discusses, in general, PAES data handling procedures.

On occasion when a client requests analyses that PAES is not equipped to perform, capacity issues prevent the laboratory from meeting requested turnarounds, or in the event of an instrument failure, a subcontract laboratory may be used. A list of routinely utilized subcontract laboratories is presented in Exhibit 1 at the end of this section. There may be times when an emergency situation occurs or a client may request the use of a subcontractor not currently listed on Exhibit 1. When those situations occur, the name of the subcontractor will be added during the next annual review for all recurring projects.

For cases when the client requests analyses that PAES is unable to perform, the Project Manager notifies the Laboratory Manager of the need to locate a subcontract lab. The Project Manager is responsible for contacting potential subcontract laboratories to determine where the samples will be sent. For routinely requested analyses, standard agreements are in place with the subcontractor. Whenever applicable, subcontract laboratories will be NELAC-approved. Other factors that affect the decision include turnaround, cost, and ability to provide the required data deliverables. Once the decision is made, the Project Manager notifies the client. For cases when the internal problems require the use of a subcontractor, the Laboratory Manager will notify the Project Managers of the situation, what samples are affected, and the proposed resolution. The Project Managers will then contact each affected client to obtain approval prior to samples being shipped to the subcontractor.

All samples that require subcontracted analyses are prepared for shipment by the Project Manager. A chain of custody is prepared detailing the sample identification, collection date and time, as available, requested analyses, requested due date, and any other special instructions pertinent to the sample shipment. The samples are packed in a cooler with sufficient ice to maintain the appropriate temperature during shipment. All samples for subcontracted analyses are shipped so that the samples arrive the next business day.

All data received from the subcontract laboratory follow the same guidelines detailed in this section, with the Laboratory Manager filling the analyst's role and review performed by the NA Laboratory Manager.

7.1 Data Collection

All laboratory employees are responsible for maintaining laboratory records and documenting them in sufficient detail to recreate analyses. Manually entered data are made using permanent ink. Corrections are indicated by drawing a single line through the incorrect entry, dating and initialing the correction, and coding the reason for the correction. The use of correction fluid or tape, erasure, or other means of making corrections is prohibited. The following information is

recorded at the bench either manually or printed out via the data system interfaced with the analytical instrument.

- Method performed.
- Analysis date.
- Analysis time.
- Analyst signature or initials on computer printouts.
- Instrument Identification and settings.
- Analytical sequence consisting of a chronological listing of the processing for each standard, quality control check, and sample recorded in an analytical sequence, run log, or data sheet.
- The laboratory sample number.
- Quality control sample type.
- Standard identification and volume used for all calibration standards.
- True value and lot number of all spiked quality control samples.
- Dilutions including actual initial and final volumes.
- Sample aliquot and final volume.
- Instrument reading.
- Final results with units.
- Calculations for all quality control checks.
- Narrative describing any unusual observances.

If an analysis extends over more than one shift or day, each person responsible for part of the analysis records the date and time their portion of the analysis was initiated.

7.2 Data Reduction

Reducing raw data into a presentable form is the responsibility of the analyst performing the determination. The actual equations used to calculate final results are found in the analytical methods. The following general rounding rules are used for the calculations:

- Data is not rounded until the final answer is obtained.
- To round a figure, the number of significant figures is determined. If the figure to the right of the immediate right-most significant figure is greater than 5, round up. If this figure is less than 5, truncate the result after the last reportable figure. If this figure is equal to 5 and there are non-zero digits to the right, round up. If the figure is equal to 5 and there are no non-zero digits to the right, round up when the preceding figure is odd, and truncate when the preceding figure is even.

7.3 Data Validation

Each analyst initials and dates the data that is generated in the laboratory. All data generated by the laboratory undergoes either an independent peer review or other designated individual to ensure compliance with accepted quality control standards prior to data entry. The purpose of this

review is to check for precision, accuracy, and completeness. The following items are verified during this review. Not all items are applicable to each test.

- Holding times.
- Proper measurement units.
- Instrument tune and initial calibration criteria.
- Proper number of calibration standards and blanks.
- Surrogate and spike percent recoveries.
- Comparison of quality control sample results to acceptance criteria.
- Corrective action for out of control conditions.

After this review, all data that is not instrument-interfaced directly with the Laboratory Information Management System (LIMS), is manually entered into the database. All manually entered data undergoes a review upon entry. The Laboratory Manager attempts to review approximately 10% of all laboratory data. Either the Quality Systems Manager or his designee will review 10% of all DoD data packages. This review is part of the oversight program and does not have to be completed in "real time." Project Managers complete the data validation process by reviewing final reports for completeness prior to submission to the client.

7.4 Laboratory Information Management System/HORIZON

The laboratory currently operates and maintains a Horizon LIMS system. This system is the point of collection for all of the laboratory data. The integrity of laboratory data is of the utmost importance. This system has built-in security levels that keep individual access on an "as needed" basis and does not allow for access beyond what is necessary for the completion of individual duties. Specific operation and management of the LIMS system is outlined in the LIMS Standard Operating Procedure that is maintained by the Laboratory.

7.5 Report Preparation

7.5.1 Horizon LIMS

After all of the data has been entered into the LIMS, a draft copy of the final report is generated and the following items are reviewed by the Laboratory Manager or their designee:

- Client name and address.
- Analytical results, units, and reportable figures.
- Appropriate data qualifiers are applied as required according to the following table.
- Inter-parametric relationships.
- Data reasonableness in respect to sample information.

Data Qualifiers
HORIZON LIMS

Qualifier	Description
J	Estimated value-result is >MDL but <PQL
U	Component was analyzed for but not detected
G*	Analyses were performed by subcontract lab

* each available sub-lab has a specific designation, this qualifier will vary between individual laboratories.

Following the review, if results are acceptable the Laboratory Manager, or designee makes the determination to generate a final report. The final report is electronically stamped with the assigned Project Manager's signature and printed. The report is forwarded to the Project Manager who conducts a general review for completeness and releases it to the client. The draft copy and signed final copy are electronically stored for future reference.

7.6 Final Report Modifications

Once a laboratory final report is generated and sent to the client, it can be modified under the following circumstances, depending on which LIMS processed the clients project:

- An electronic or hard copy of the original unedited report is kept on file in the laboratory. In the case of electronic records and/or files, either a pdf is generated of the original report prior to the editing, or a paper copy of the original report is placed in the project file.
- The reissued report must have a statement in the comments section that specifies the modification(s) and indicates the date of report reissue.
- An electronic or hard copy of the reissued report is retained for future reference and stored with the original report.

Data review of report modifications is conducted in accordance with PAES Standard Operating Procedure for Data Review and Validation.

7.7 Record Retention

A signature record of all employees is maintained in the Training Records Manual kept in the Quality Systems Office.

All raw data and reports for analytical projects are kept for a full five (5) years. After this time the records are destroyed. A Record Release Checklist is posted in the storage area. A destruction date

will be recorded on that form when a particular years' records are destroyed. Records are kept onsite in a locked storage area and maintained in accordance with PAES Standard Operating Procedure for Document Control. The area is inspected monthly.

The LIMS database, which retains all electronic records that have been entered from the date of the LIMS inception, is backed up each day. The tape on which this backup is stored is maintained in a secure location off-site.

All critical data on personal computers is backed up on the internal network S drive. The network is backed up on tape and stored at a secure location off-site.

7.8 Service to the Client and Confidentiality

Clients are welcome to an on-site visit to PAES Laboratories in order to discuss client needs or requests, and also to monitor the laboratory's performance in relation to ongoing client projects. All efforts are made to maintain client confidentiality while providing service to other clients.

All client data, whether from privately owned or government organizations, and all correspondence is considered confidential information and shall not be released to anyone other than the client without the expressed written permission of the client. These transactions shall be handled by the Customer Service Office.

7.9 Records Dispensation

In the unlikely event that the laboratory records are lost or being destroyed, either because the laboratory transfers ownership or goes out of business, all clients will be notified in writing and requested to notify PAES concerning the dispensation of their records.

Exhibit 1

Subcontractor Laboratories

Name	Requested Analyses
Pace Analytical Services Greensburg, PA	Semivolatile organics, Pesticides, PCB's, Herbicides, Volatiles by 8260 and 624, EDB by 8011,Gasoline and Diesel Range Organics, Wet Chemistry Parameters, Metals.
Pace Analytical Services Indianapolis, IN	8021 volatiles
Pace Analytical Services Minneapolis, MN	TO-14 Suma canisters
Alternative Testing Laboratory Latrobe, PA	Silicon, Percent Chloride on Ash, Total Carbon, Sulfur
Pace Analytical Services Seattle, Washington location	All analyses for DoD projects
Test America Nashville, TN	Formaldehyde

Name	Requested Analyses
Test America Pittsburgh, PA	Anions (9056), TOC Walkley Black, Lloyd Kahn
Geochemical Testing Somerset, PA	NEPO
University of OK	CSIA-Hydrogen, CSIA-Chlorine, CSIA-Chlorinated (soil gas-Vapor)
Northern Arizona University Flagstaff, AZ	$\delta D + \delta^{18}O$ analysis
University of Pittsburgh Pittsburgh, PA	Nitrate/Ammonia Isotopes ($\delta^{15}N + \delta^{18}O$)
Tetra Tech Fort Collins, CO	Boron isotope analysis
Syracuse University Syracuse, NY	$^{87}Sr/^{86}Sr$ analysis
Isotech Champaign, IL	Tritium, and C-14 age dating

Name	Requested Analyses
Environmental Analytical Service San Luis Obispo, CA	Gas composition C2-C10
Clark Laboratories Jefferson Hills, PA	Viscosity
Molecular Research Shallowater, TX	DNA amplification

8.0 Measurement Traceability

Traceability of measurements and standards is ensured in the laboratory by using balance calibration weights that are traceable to national standards, calibrating thermometers using an NIST calibrated thermometer, and by the use of certified standard solutions.

8.1 Reagents and Standards

The purity of the materials required in analytical chemistry varies with the type of analysis, the parameter being measured, and the sensitivity of the detection system. In general analytical reagent grade is satisfactory for most inorganic analyses. Other analyses, such as trace organic, may require special ultra-pure reagents. In cases were the method does not specify the purity of the reagent, it is intended that analytical reagent grade be used. The labels on the container are checked and the contents examined to verify that the purity of the reagents meets the needs of the particular method involved.

8.1.1 Reagent and Standard Preparation

Reagents are prepared and standardized with the utmost of care against reliable primary standards. They are re-standardized or prepared fresh as often as required by their stability as specified by method and other reference sources. Stock and working standard solutions are checked regularly for signs of deterioration.

Standard preparation procedures are specific to the analytical determination being made and are defined in detail in specific technical Standard Operating Procedures, regulatory methods, and in the laboratory's Standards Logbooks.

8.1.2 Reagent and Standard Labeling and Storage

Standard solutions are labeled with the compound name, lot number, preparation date, and expiration date. The analysts store reagents and solvents in a manner that prevents contamination and deterioration prior to their use. Standard solutions are stored in compatible containers.

PAES Standard Operating Procedure for Analytical Standards and Reference Materials (SOP-ADM 15) gives detailed instructions for handling, storing, labeling, and documenting standards and reference materials.

8.1.3 Standards Preparation Logbook

Standard Preparation Logbooks are issued as controlled documents to every analyst or laboratory in which they will be used. These logbooks are used to document standard preparation procedures, dates, lot numbers, concentrations, manufacturer, expiration date, and any other information that may be necessary in order to re-create or track a particular standard. The compound or element name and/or formula are documented along with the final concentration or normality. The

description of how reagents and standards are prepared may be referenced from a previous description if the exact procedure is used.

8.1.4 Traceability of Standards

The traceability of each purchased stock standard is easily accessible. Certificates of analysis of each standard are maintained in a binder in the laboratory until the standard is depleted or disposed. The certificate is then given to the quality manager for archiving. The traceability of each laboratory prepared standard is entered into standard logbooks.

For DoD projects: All bottles, reagents, solvents, and supplies used in DoD projects will be verified or certified by the supplier to meet or exceed standard specifications for environmental tests concerned. Verification must be kept on file to qualify each bottle, reagent, solvent and supply.

8.2 Thermometers

All of the laboratory thermometers in use are calibrated annually using a thermometer that is traceable to NIST. Thermometer calibration is outlined in PAES Standard Operating Procedure for Calibration of Thermometers.

8.3 Weights and Balances

All balances are calibrated before use with Class I NIST traceable weights that are calibrated annually. Balances are serviced and calibrated by an outside contractor annually. Additional information is outlined in PAES Standard Operating Procedures for Calibration of Weights and Balances.

9.0 Training Program

Training for laboratory personnel is accomplished at several levels. Areas for which training is conducted include new employee orientation, laboratory safety, specific task training, analytical procedure training, laboratory ethics, and other technical training courses as the need arises.

Analytical training, while addressed in general in this manual, is addressed specifically in the Standard Operating Procedure for Administering and Documenting Training in Laboratory Procedures and Instrumentation.

9.1 New Employee Orientation

Orientation is conducted to familiarize new employees with company policies, quality system procedures, facilities, coworkers, laboratory ethics, and laboratory safety. The Department Managers are responsible for notifying the various departments of the start date of all new employees.

9.2 Laboratory Safety

Upon hire, each employee is required to read the laboratory's Chemical Hygiene Plan (safety manual), is issued a pair of safety glasses, and is instructed in basic laboratory safety requirements. Documentation of safety training is updated and maintained by PAES' Safety Officer.

9.3 Task Training

Task training must be successfully completed for employees to perform the following tasks without direct supervision:

- Sample Receiving
- Bottle Preparation
- Customer Service
- Data Entry

Task training is conducted by the Department Manager of the department concerned. During this training, the trainer works closely with the trainee to ensure that all pertinent points of procedures are addressed. If the procedure is outlined in a Standard Operating Procedure (SOP), the trainee is charged with reading the SOP and the trainer will ensure that the training covers all aspects of the SOP. For training to be considered complete, proficiency in the task must be demonstrated to the trainer.

9.4 Analytical Method Training

Prior to conducting analysis on client samples, all analysts must demonstrate their proficiency through initial technical training. Analytical proficiency must be demonstrated annually thereafter.

All analytical method training must be conducted by an analyst who is certified in the method for which training is required.

For individual analyst training in sample preparation and analysis, initial training and proficiency is demonstrated through the analysis of a set of 4 consecutively run mid-range standards or an Initial Demonstration of Proficiency (IDOP). When an analysis involves a work group (i.e. semivolatile preparation and analysis), a team approach to the IDOP applies. When each individual completes their part in the successful analysis of the IDOP, the analytical team is considered competent to conduct the analysis on client samples.

For continued demonstrations of capability for individuals and work groups, one of the following procedures may be used:

1) Another IDOP
2) Four consecutively run laboratory control samples that fall within laboratory/method acceptance criteria.
3) Acceptable analysis of Performance Evaluation samples.
4) Acceptable analysis of blind quality control sample.

Training documentation is maintained in the Quality Department office. See Exhibit 9-1 for a flow diagram of analytical method training. A Demonstration of Capability Certification Statement (Exhibit 9-2) shall be maintained for each method in which an employee is certified. This documentation is kept in the Employee Training Records in the Quality Department office. PAES is also utilizing the Pace Corporate LMS on-line training system to track IDOP's and as a means to access all Pace Corporate documents.

9.5 Laboratory Ethics Training

All employees shall receive initial and annual ethics training. The training shall be conducted by PAES' management or designated trained personnel. The training shall include the contents of the Ethics Program in its entirety, including employee and supervisory responsibilities, examples of unethical behavior, disciplinary action for unethical actions, and a means to report unethical actions. The power point presentation of the Ethics Training Program is located on the Pace Corporate LMS on-line training system.

Documentation of Ethics Program Training is kept in the Quality Department office and in the LMS system. All employees are required to sign and date the Ethics and Data Integrity training in the LMS.

9.6 Other Technical Training

Other types of technical training are conducted on an as-needed basis and may include training on new instruments, new procedures, or new equipment. Training may be conducted by PAES' employees

9.7 External Training

Employees are encouraged to continue their education through the use of symposia and seminars conducted by professional societies, regulatory agencies, and equipment manufacturers. These courses serve as one way for laboratory personnel to remain current on regulatory trends, analytical procedures, and advances in instrumentation. Documentation of external training will be added to the analysts' training records and in the LMS.

Review Date: October 29, 2015

Exhibit 9-1

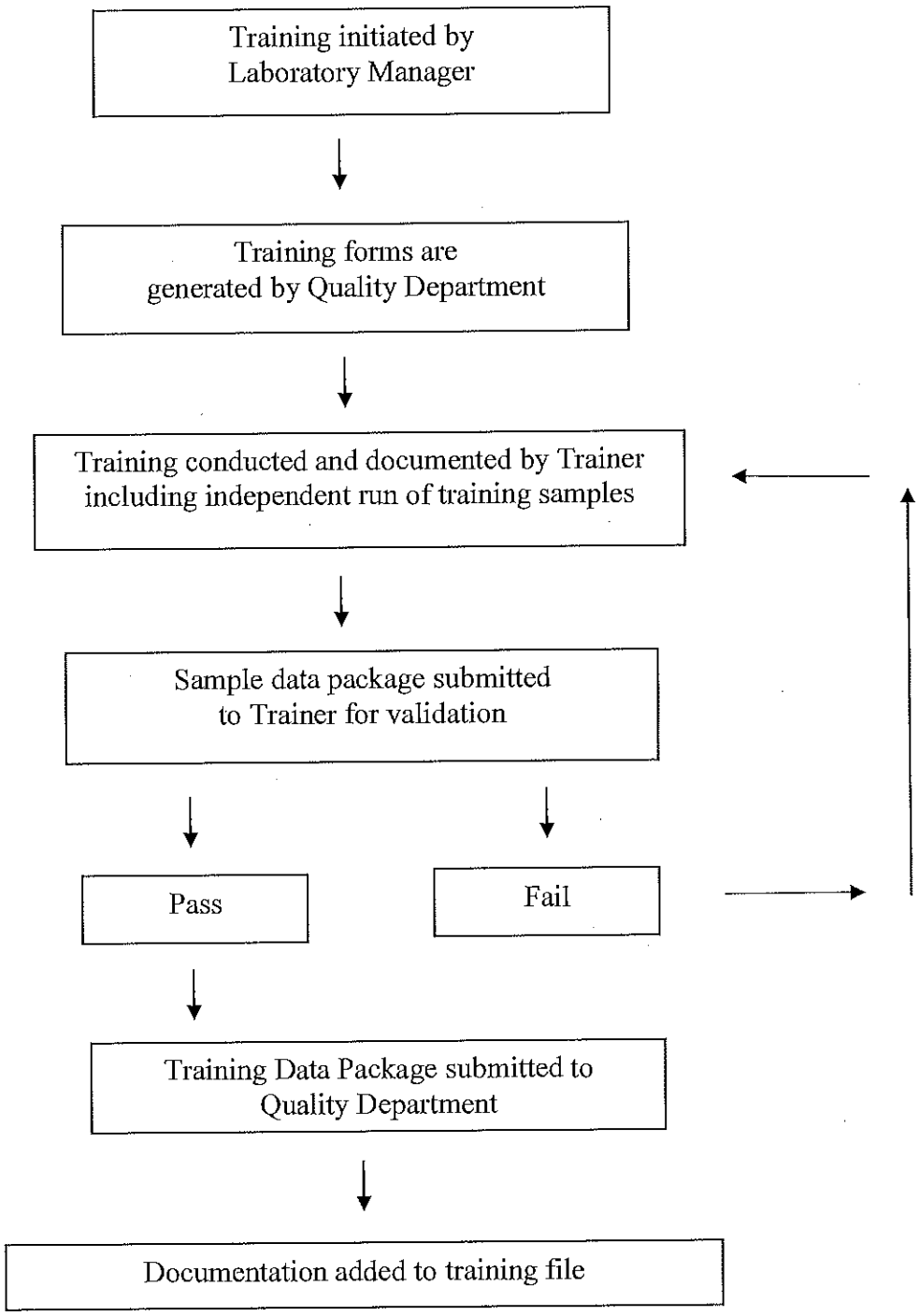

Training initiated by Laboratory Manager
Training forms are generated by Quality Department
Training conducted and documented by Trainer including independent run of training samples
Sample data package submitted to Trainer for validation
Pass
Fail
Training Data Package submitted to Quality Department
Documentation added to training file

Exhibit 9-2

Demonstration of Capability Certification Statement

Date: _____

Pace Analytical Energy Services, LLC
220 William Pitt Way
Pittsburgh, PA 15238

Analyst Name: _____

Matrix: (laboratory pure water, soil, air, matrix spike)

Analyte (or group)	Method Number	SOP #	Revision #

I, the undersigned, CERTIFY that:

1. The analyst(s) identified above, using the cited test method (s), which is in use at this facility for the analyses of samples under the National Environmental Laboratory Accreditation Program, have met the Demonstration of Capability.

2. The test method was performed by the analyst(s) identified on this certification.

3. A copy of the test method and the laboratory-specific SOPs are available for all personnel on-site.

4. The data associated with the demonstration of capability are true, accurate, complete, and self-explanatory.

5. All raw data (including a copy of this certification form) necessary to reconstruct and validate these analyses have been retained at the facility, and that the associated information is well-organized and available for review by authorized assessors.

_____ _____
Charlotte Washlaski Date
Quality Manager

Administrative Business Manager

General Description: This exempt managerial position is responsible to and reports to the Assistant General Manager to provide ongoing periodic financial reports and business reviews as the business cycle requires and demands.

Educational Requirements: This position requires a Bachelors Degree in Business.

Job Responsibilities:

- Prepare monthly financial statements for review.
- Reconcile bank statements.
- Prepare monthly budget performance reviews.
- Account Receivable tracking and resolution.
- Cash management recommendations and review.
- Payroll processing activities.
- Insurance review.
- Office Management.

Assistant General Manager

General Description: This exempt managerial position is responsible for guiding a team that is charged with the product line performance as a business unit. The team includes departments dealing with dissolved gases, vapor, electron donors, electron acceptors, general chemistry, CSIA, petroleum forensics and molecular diagnostics.

Educational Requirements: This position requires a bachelor's degree in Chemistry or related field and three years+ of product and product instrumentation experience or ten+ years of relevant product and product instrumentation experience.

Job Responsibilities:

- Manage the integration of routine and development of activity within the different department.
- Manage and operate the LIMS System.
- Advise the GM of capital equipment needs.
- Recommend specific capital equipment for purchase or lease.
- Maintain budgetary restraints for profitability.
- Make personnel recommendations to the GM.
- Responsible for laboratory code of conduct and staff disciplinary action.

Department Laboratory Operations Manager

General Deseription: This exempt managerial position is responsible for overseeing the daily management of the laboratory operations and operations' staff. This position reports to the Assistant General Manager.

Educational Requirements: This position requires a Bachelor's Degree in Chemistry or a related field with a minimum of ten years of experience.

Job Responsibilities:

1. Provide supervision and direction to all department personnel.
2. Manage the size of the department efficiently in accordance with available workload and communicate staffing requirements to the Assistant General Manager.
3. Responsible for scheduling work and laboratory personnel to ensure efficient use of time and resources.
4. Manage routine product generation within the laboratory, including but not limited to scheduling of sample screening and analyses, evaluation of preliminary results, assessment of quality, and preparation of client reports.
5. Responsible for ensuring that the highest degree of technical quality possible is represented in outgoing final analytical data reports.
6. Ensure that laboratory work assignments are coordinated with work assignments of other groups in the company.
7. Work in conjunction with the Technical Director to provide input and support for instrumentation needs.
8. Coordinate with the Quality Systems Manager to develop, review and implement Standard Operating Procedures.
9. Support and enforce the specific methods, policies, and procedures outlined in PAES' Standard Operating Procedures and Quality Systems Manual.
10. Coordinate and ensure MDLs, and PQLs are updated in the LIMS as required.
11. Responsible for the administration of the Chemical Hygiene Plan within the laboratory.

Quality Systems Manager

General Description: This exempt managerial position carries the responsibility for providing leadership and direction to ensure that the laboratory function at the highest level of quality possible in accordance with regulatory and certification requirements.

Educational Requirements: This position requires a Bachelor's degree in chemistry or a related discipline and/or a minimum of five years of laboratory experience.

Job Responsibilities:

1. Provide leadership and direction for the laboratory's Quality Systems Program.
2. Provide supervision and delegate tasks to the Quality Assurance Analyst.
3. Keep current on regulatory requirements to ensure that Standard Operating Procedures for analyses are in compliance with applicable regulations.
4. Conduct laboratory quality audits according to the annual schedule.
5. Serve as liaison between Microseeps aud Regulatory Agencies.
6. Provide leadership and direction for developing and maintaining all Laboratory Standard Operating Procedures and the Quality Systems Manual.
7. Work with the Quality Assurance Analyst and the Laboratory Manager to discern and correct issues leading to poor quality and, if deemed necessary stop unsatisfactory work or prevent reporting of unjustifiable results.

Technical Director

General Description: The Technical Director is responsible for directing and managing an ongoing research and development program that insures the laboratory is ready to respond to leading edge technology needs.

Educational Requirements: This position requires a graduate degree in chemistry or a related discipline and a minimum of ten years of laboratory experience.

Job Responsibilities:

1. Provide assistance with interpretation of client data needs and data reports in cooperation with the Customer Service Department.

2. Assist clients in defining data needs, constructing sampling plans and interpreting data reports via non-binding suggestions and selected references to published documents.

3. Prepare and present presentations at seminars, workshops, or conferences.

4. Develop written material for company personnel to provide client assistance and education.

5. Identify emerging analytical needs and develop conceptual models for analytical methods to support those emerging client needs.

6. Develop conceptual analytical methods into routine procedures for lab personnel to implement.

7. Ensure that new method development is fully documented by compiling a complete package of experimental data in a form that is organized, summarized, and that can be validated.

8. When new analytical methods have become routine procedures, transfer responsibility to the Laboratory Manager.

9. Responsible for knowing industry trends and emerging opportunities.

Client Services Manager

General Description: This exempt managerial position is responsible for directing the activities of the Customer Service Staff, Bottle Preparation, and Sample Receiving. This position is ultimately responsible for ensuring customer service satisfaction. This position reports directly to the Assistant General Manager.

Educational Requirements: This position requires 10+ years of environmental laboratory management experience.

Job Responsibilities:

1. Responsible for overall management of the Customer Service Department which includes the traditional customer service functions, bottle preparation, shipping and sample receiving.

2. Responsible for direct involvement with clients in all extraordinary issues such as late reports, missing shipments, inappropriate charges, etc..

3. Responsible to direct all inquiries to the proper department.

4. Responsible for customer care code of conduct and disciplinary action.

5. Knowledgeable of all the functions of a Customer Service Representative.

6. Oversee the review of contracts.

7. Oversee purchasing for Bottle Preparation.

8. Act as liaison with other departments to ensure interdepartmental communication.

9. Ensure customer complaints are resolved to the customer's satisfaction.

Quality Assurance Analyst

General Description: This exempt position is responsible for assisting the Quality Systems Manager to ensure that the Quality Systems Policies and Procedures are implemented in accordance with the Quality Systems Manual and PAES Standard Operating Procedures. This position reports to the Quality Systems Manager.

Educational Requirements: This position requires a Bachelor's Degree and 2 years of laboratory experience.

Job Responsibilities:

1. Administratively responsible for the Quality Systems Program as directed by the Quality Systems Manager.
2. Prepare an annual schedule of laboratory audits.
3. Prepare audit reports and necessary corrective action to the Laboratory Manager.
4. Follow up on all corrective action reports until appropriate action has been taken.
5. Establish a schedule, order supplies, coordinate, and submit final analytical data for performance evaluation studies.
6. Maintain, control, and update the Quality Systems Manual and all of PAES' Standard Operating Procedures.
7. Ensure new Operation's Department employees receive required training and orientation and maintain the documentation of the training.
8. Ensure appropriate studies are conducted when necessary i.e. Initial Demonstrations of Proficiency and MDL's.
9. Ensure that all lab thermometers are calibrated as required.
10. Annually send out scale weights, radiation screening instrument, and NIST thermometer for calibration.
11. Coordinate annual inspections for certifications of balances and fume hoods.

Procurement Coordinator

General Description: This exempt position is responsible for all aspects of purchasing and supply receipt and reconciliation. This position reports to the Administrative Business Manager.

Education Requirements: This position requires a high school diploma and two years of laboratory experience. A basic knowledge of chemistry and laboratory analytical procedures is required.

Job Responsibilities:

1. Purchase, track, receive, and distribute supplies for the laboratory.

Sample Custodian

General Description: This exempt position is responsible for all aspects of sample custody from sample receipt to storage until final disposal. This position reports directly to the Client Services Manager.

Education Requirements: This position requires a high school diploma and two years of laboratory experience. A basic knowledge of chemistry and laboratory analytical procedures is required.

Job Responsibilities:

1. Receive and inspect samples and sample containers and sign appropriate documents according the Standard Operating Procedure for Sample Receiving and the Quality Systems Manual.

2. Record all necessary information on chain of custody.

3. In the event of any discrepancies or non-conformance issues with the above procedures, immediately complete a non-conformance form and submit it to customer service.

4. Notify Customer Service Rep upon receipt of client samples when requested.

5. Accurately log samples into LIMS ensuring that all required fields are completed for the level of analysis required.

6. Label all sample containers.

7. Initiate transfer of samples as soon after receipt as possible to appropriate storage areas, ensuring that all samples are maintained at the appropriate temperature at all times.

8. Notify analysts immediately upon receipt of samples with short holding times.

9. Control and monitors access to and storage of samples in secure storage.

Staff or Laboratory Analyst

General Description: This exempt position is responsible for the timely analysis and custody of client samples. Job responsibilities cover a broad range of duties and responsibilities depending on employee education and experience. This position reports directly to Manager of their department.

Educational Requirements: This position covers a range of educational levels from a high-school education with on-the-job training to a Ph.D. in Chemistry or a related field. Analysts must pass Initial Demonstrations of Proficiency for every analytical method before independent analysis can be conducted.

Physical Requirements: This position requires the ability to lift 20 pounds and the ability to stand for extended periods of time.

Job Responsibilities:

1. In matters concerning order and priority of analysis, this position is accountable to, and will take direction from the Manager of their department.

2. Keep all workspaces neat, clean, and organized.

3. Obtain samples from Sample Receiving.

4. Observe internal chain of custody requirements for all samples taken from Sample Receiving.

5. Ensure all aliquots analyzed are representative of the entire sample.

6. Analyze samples according to Microseeps Standard Operating Procedures (SOP) and or the applicable Standard or EPA Methods.

7. Observe and practice applicable quality control procedures in accordance with the Laboratory Quality Systems Manual and specific SOPs. This includes analyzing required quality control samples, ensuring results are within specified acceptance limits, and initiating corrective action when results are outside of acceptable parameters.

8. Analyze samples arriving with short holding times within the applicable time frame.

9. Review peer analytical data for completeness and accuracy where possible.

10. Responsible for making accurate entries into logbooks.

11. Conduct equipment preventative maintenance according to the Equipment Maintenance SOP.

12. Maintain supply inventory and notify lead analyst when laboratory supplies are needed.

13. Comply with all Health and Safety Procedures outlined in the Chemical Hygiene Plan.

14. Work with the Health and Safety Officer to help correct suspected unsafe practices, situations, or working spaces.

15. Identify any problems with samples, equipment, or procedures that will affect the integrity of analysis and report them to the Manager of their department.

Customer Service Representative

General Description: This exempt position is responsible for marketing, inside sales, and project management. This position reports to the Client Services Manager.

Educational Requirements: This position requires a minimum of five years of customer service experience in the laboratory, environmental, or chemistry field.

Job Responsibilities:

1. Generates quotes.
2. Serves as the liaison between clients and the technical departments.
3. Takes bottle orders from clients.
4. Enter projects into the LIMS.
5. Manage projects as required according to client contracts.
6. Signs final data reports acknowledging that the reports are being sent.
7. Contact clients as required by Non-Conformance Forms.
8. Arrange rush and special analytical projects with Laboratory Manager.
9. Coordinate initial review of contracts.
10. Serve as PAES representative to the client and as such, conduct themselves with the highest standard of ethics, is responsive to clients' needs, and portrays a level of professionalism for which PAES is known.
11. Create, generate, and disseminate company information to clients as requested.
12. Review invoices for accuracy.

LIMS Administrator

General Description: The LIMS Administrator position is responsible for the overall development, testing, maintenance, documentation, and support of all Electronic Data Deliverable (EDD) related processes, code and transactions. The Customer Service Assistant aspect of the position is responsible for specific customer service activities as they relate to the coordination of project work and consistently provides work on a timely basis.

Educational Requirements: This position requires High School education plus an Associate degree in Information Technology. Two years experience working with Electronic Data Interchange processes. Must also possess strong skills with SQL scripting and SQL Stored Procedures, as well as abilities with Microsoft SQL Server, Enterprise Manager, and Query Analyzer.

Job Responsibilities:

1. Provide technical support for all EDD related implementations.
2. Analyze client requirements, specify design, and develop new EDD solutions.
3. Modify and enhance existing EDD related code or procedures.
4. Provide customer support and correct reported problems with EDDs.
5. Utilize and develop procedures for EDD checking utilities, formatting applications and other tools as necessary.
6. Develop and publish documentation and procedures regarding proper uses and operations of the EDD environment as well as individual EDD requirements, structure, code, and results.
7. Perform training for responsible parties on the use of EDD related processes.
8. Work with customers, staff, external IT consultants and managers for both new development and problem determination/resolution.
9. Assure the highest levels of stability, integrity, reliability, performance, security, and availability of EDDs consistent with the resources available and the established change control policies, and prescribed procedures.

10. Use established user request and problem management tool to track requests and follow up to resolution and closure.

11. Perform special projects or other duties as required.

12. Review and check project files when received from login for correctness and completeness.

13. Review and prepare data packages by paginating data, scanning reports, and burning CDs.

14. Prepare and send Excel reports and invoices to clients electronically.

15. Receive and fill out bottle orders for clients when taking client calls.

16. Answering the telephone when required for customer satisfaction.

Bottle Preparation Technician

General Description: This non-exempt position consists of up to forty hours of work per week in completing bottle preparation activities. This position reports to the Client Services Manager.

Educational Requirements: High School Diploma with knowledge in basic chemistry. Computer skills are required, as well as, competencies in basic math, reading, and writing.

Physical Requirements: The position requires a maximum lifting capacity of 40 pounds with the ability to lift and carry large and bulky objects. The job skills also require a full range of motion for bending over and straightening.

Job Responsibilities:

1. Properly assemble, prepare, preserve, package and ship orders following Company Standard Operating Procedures in a cost effective and timely manner.

2. Inventory, order, track, and stock all necessary bottle preparation supplies.

3. Track, maintain, and fill all standing bottle orders for pick-up, delivery, and shipment.

4. Keep accurate records and files of standing orders, supply orders, and inventories.

5. Practice open communication in all instances with the Customer Service department in order to assure clients get the best possible service.

6. Maintain a neat, clean, and organized work and storage area.

7. Wear safety glasses while in bottle preparation room, and other protective clothing such as gloves and smocks when using chemicals, handling samples, and cleaning coolers.

8. Serve as courier for pick-up or delivery when necessary.

9. Clean and dry all coolers that arrive prior to placing them in storage.

10. Obtain stock preservatives.

Review Date: October 29, 2015

REFERENCES

U.S. Environmental Protection Agency, 1986, Test Methods for Evaluating Solid Waste, SW-846. , 3rd. ed., Office of Solid Waste and Emergency Response, Washington, DC.

U.S. Environmental Protection Agency, 1983, Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio.

Standard Methods for the Examination of Water and Wastewater, 20th ed., 1998.

The NELAC Institute, 2009, TNI Standard, Volume 1.

Department of Defense Quality Systems Manual For Environmental Laboratories. Version 3.

Review Date: October 29, 2015

Appendix C

Groundwater Sampling Field Data Form

Low-Flow Groundwater Sampling Form

Project: _____

Project #: _____

Site: _____

Well ID:	
Date:	
Sampling Personnel:	
Weather Conditions:	
Time:	

Total Depth (T.D.)[1]:	Screen Length:
Depth to Water (D.T.W):	Well Diameter:
Total Volume Purged:	Casing Type:
Purge Rate:	Sampling Device:
Tubing Type:	Measuring Point: TOC
Pump Intake (ft below M.P.):	color: odor:

Time: (min)	**DTW: (feet)**	**Purge Rate**	**Temp (°C)**	**pH s.u.**	**Cond (uS/cm)**	**DO (mg/L)**		**ORP mV**	**Turb NTU**
Stabilization Criteria[2]	**(see note below)[3]**	**ml/min**	**+/-** 2 degrees	**+/-** 0.1 s.u.	**+/-** 5%	**+/-** 10%			

Sampling Time:

Samples Collected: Analysis Requested: Preservative: Holding Time: Lab:

Notes:

(1) - Do not measure depth to bottom of well until after purging and sampling to reduce resuspending fines that may be resting on the well bottom.
(2) - Stabilization criteria based on three most recent consecutive measurements.
(3) - If recovery rates are too slow and drawdown in the well is measured at one foot or more, the well will be purged to dryness. Once the water level in the well has recovered to 90% of the static level measured prior to purging, a sample will be collected using a bailer with double check valve and bottom emptying device. Sample collection using bailers, if necessary, will be conducted in accordance with US EPA sampling guidance.
(4) or 1 NTU, whichever is greater.

Appendix D

Chain-of-Custody Forms

TestAmerica Cedar Falls
704 Enterprise Drive

Cedar Falls, IA 50613-6907
phone 319.277.2401 fax 319.277.2425

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Regulatory Program: ☐ DW ☐ NPDES ☐ RCRA ☐ Other:

TestAmerica Laboratories, Inc.

Client Contact	Project Manager:	Site Contact:	Date:	COC No:
	Tel/Fax:	Lab Contact:	Carrier:	_____ of _____ COCs
	Analysis Turnaround Time			Sampler:
	☐ CALENDAR DAYS ☐ WORKING DAYS			For Lab Use Only:
Phone:	TAT if different from Below _____			Walk-in Client:
Fax:	☐ 2 weeks			Lab Sampling:
Project Name:	☐ 1 week			
Site:	☐ 2 days			Job / SDG No.:
P O #	☐ 1 day			

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	# of Cont.	Filtered Sample (Y / N)	Perform MS / MSD (Y / N)																		Sample Specific Notes:

Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other _____

Possible Hazard Identification:
Are any samples from a listed EPA Hazardous Waste? Please List any EPA Waste Codes for the sample in the Comments Section if the lab is to dispose of the sample.

☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)

☐ Return to Client ☐ Disposal by Lab ☐ Archive for_____ Months

Special Instructions/QC Requirements & Comments:

Custody Seals Intact: ☐ Yes ☐ No | Custody Seal No.: | Cooler Temp. (°C): Obs'd:_____ Corr'd:_____ Therm ID No.:_____

Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received in Laboratory by:	Company:	Date/Time:

CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed accurately.

Pace Analytical®
www.pacelabs.com

Page:	of

Section A **Required** Client Information:	Section B **Required** Project Information:	Section C Invoice Information:
Company:	Report To:	Attention:
Address:	Copy To:	Company Name:
		Address:
Email To:	Purchase Order No.:	Pace Quote Reference:
Phone: / Fax:	Project Name:	Pace Project Manager:
Requested Due Date/TAT:	Project Number:	Pace Profile #:

REGULATORY AGENCY

☐ NPDES ☐ GROUND WATER ☐ DRINKING WATER
☐ UST ☐ RCRA ☐ OTHER _____

Site Location
STATE: _____

Section D
Required Client Information

SAMPLE ID
(A-Z, 0-9 / ,-)
Sample IDs MUST BE UNIQUE

Matrix Codes
MATRIX / CODE

Drinking Water	DW
Water	WT
Waste Water	WW
Product	P
Soil/Solid	SL
Oil	OL
Wipe	WP
Air	AR
Tissue	TS
Other	OT

Requested Analysis Filtered (Y/N)

ITEM #	SAMPLE ID	MATRIX CODE (see valid codes to left)	SAMPLE TYPE (G=GRAB C=COMP)	COLLECTED: COMPOSITE START DATE	COLLECTED: COMPOSITE START TIME	COLLECTED: COMPOSITE END/GRAB DATE	COLLECTED: COMPOSITE END/GRAB TIME	SAMPLE TEMP AT COLLECTION	# OF CONTAINERS	Preservatives: Unpreserved	H_2SO_4	HNO_3	HCl	NaOH	$Na_2S_2O_3$	Methanol	Other	Analysis Test (Y/N)												Residual Chlorine (Y/N)	Pace Project No./ Lab I.D.
1																															
2																															
3																															
4																															
5																															
6																															
7																															
8																															
9																															
10																															
11																															
12																															

ADDITIONAL COMMENTS	RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME	SAMPLE CONDITIONS			

SAMPLER NAME AND SIGNATURE		Temp in °C	Received on Ice (Y/N)	Custody Sealed Cooler (Y/N)	Samples Intact (Y/N)
PRINT Name of SAMPLER:					
SIGNATURE of SAMPLER:	DATE Signed (MM/DD/YY):				

*Important Note: By signing this form you are accepting Pace's NET 30 day payment terms and agreeing to late charges of 1.5% per month for any invoices not paid within 30 days.

Appendix E

Sampling Equipment Maintenance and Calibration Log

APPENDIX E
SAMPLING EQUIPMENT MAINTENANCE AND CALIBRATION LOG

Date(s) of Use: _____ **Project Name:** _____

Sampler's Name(s): _____ **Project Number:** _____

Site: _____

Equipment Type [1]	Model Number	Manufacturer	Rental Company	Date Received	Inspection, Maintenace or Calibration				Manufacturer's Instructions or FSP/ QAPP Procedure? [2]	Comments
					Date	I	M	C		

Key: C = Calibration; I = Inspection; M = Maintenance; PID = Photoionization detector; SOP = Standard operating procedure

[1] Water quality meter, water level meter, PID, submersible pump, etc.

[2] Indicate document and section or SOP number if no manufacturer's instructions are available.

Appendix F

Corrective Action Form

CORRECTIVE ACTION FORM

Date: _____ Activity: _____

Problem/Question reported by: _____

Sample Number(s), if applicable: _____

Description of Problem: _____
_____
_____
_____
_____
_____
_____
_____

Summary of Corrective Action(s): _____
_____
_____
_____
_____
_____
_____
_____

Is this a recurring problem? _____

Should the Standard Operating Procedure be modified or updated? _____

Approval of Lab or Field Project Manager or Quality Assurance Officer? _____

Distribution: (check all that are appropriate)

Waterloo Project Manager _____
ERM Partner-in-Charge _____
ERM Project Manager _____
ERM Quality Assurance Officer _____
Laboratory Project Manager _____
Laboratory Quality Assurance Officer _____
EPA Region 7 Project Manager _____

Appendix G

Internal Document Distribution Log

APPENDIX G
INTERNAL DOCUMENT DISTRIBUTION LOG
FORMER WATERLOO INDUSTRIES FACILITY
WATERLOO, IOWA

Document Name	*Summary of the Change(s)*	*Approval Date*	*Name of the ERM Staff Member Receiving the Document*	*Date when the Document Was Received*

Appendix B

Health and Safety Plan

This Level 2 health and safety plan (HASP) is intended to provide health and safety guidelines for project work meeting one or more of the following criteria:

- Some likelihood of physical and/or chemical hazard exposure (e.g., sampling, use of equipment and tools);
- Number of job tasks is five or greater;
- Use of subcontractors;
- Work meets the definition of being "high hazard", which includes, but is not limited to:
    - Activities that could have an adverse effect on the environment (e.g., use of bulk liquid storage tanks, generators, etc.);
    - Air or boat transport via charter or non-commercial carrier/vendor;
    - Confined space entry;
    - Construction;
    - Demolition, Decontamination and Demolition (DDD) operations;
    - Diving;
    - Excavations, trenching, drilling, or other ground disturbance activities (i.e., activities requiring subsurface clearance [SSC] operations);
    - Hazardous energy control operations;
    - Hot work (e.g., welding, flame cutting, or other spark-producing activities);
    - Injection well operations;
    - Off-shore or over water work (including oil platform visits);
    - Rigging and lifting operations; and
    - Work at heights in excess of four feet.

The HASP should be developed with input from the project team and reviewed with all ERM project personnel, including subcontractors. A signed copy of the HASP must be maintained at the project site during work and must be archived in the project files.

H&S Team review is required for the Level 2 HASP. You can e-mail completed plans requiring review to the ERM North America HASP Review Team (ERMNASafetyLeads@erm.com). This HASP must be reviewed by the Project Manager and reviewed/approved by the Partner in Charge (PIC) and updated as warranted to address changes in scope, hazards present, project personnel, etc. At a minimum, HASPs must be reviewed annually or if the scope of work changes. Updated HASPs should also be sent to the H&S Team for review and PIC for approval.

Administrative Information

This document has been developed for the sole use of ERM staff. Subcontractors and other project participants must develop their own HASP.

This document is valid for a maximum time period of one year after completion. The document must be reviewed if the scope of work or nature of site hazards changes and must be updated as warranted.

Project Name: Former Waterloo Industries Facility	Site Name & Location: 300 Ansborough Ave, Waterlook IA
Client Contact and Phone: Dennis McKinney, Fortune Brands, Inc. (847) 484-4589	GMS Project #: 0339767
Health & Safety Plan Date: 8/15/16	Revision Number and Date: Click here to enter text.
Field Work Start Date: Click here to enter text.	Anticipated Field Work End Date: Click here to enter text.
Project Manager: Mark Seaman	Partner In Charge: Chris Weggeman
Field Safety Officer: Click here to enter text.	Additional ERM Personnel on site: Click here to enter text.

H&S Team Review

Reviewer Name: Click here to enter text. Review Date: Click here to enter a date.	Signature File:

Site Description and Scope of Work

Include relevant background information regarding the site, such as location, size, type of facility, topography, weather, infrastructure, security, previous site use, etc. Describe nature and extent of any soil/air/water/groundwater contamination. Describe any other aspects of the site that may potentially affect the health, safety, or security of on-site personnel.

Include a description of work to be completed during the project. From this, develop a list of tasks to be completed by ERM personnel, as well as a list of tasks to be completed by subcontractor personnel.

Site Description: The former Waterlook manufacturing facility property consists of approximately 10.3 acres located at the southwest corner of the intersection of Ansborough Avenue and Highway 218 in Waterloo, Iowa. The Property has one main building comprised of several additions, and several small storage buildings. The ground surface around the buildings is covered by parking areas, driveways, railroad right-of-ways, landscaped areas, and city streets.

Manufacturing operations have been conducted at the facility from 1946 to 1997 . The building currently contains a recycling operation which utilizes warehouse, water treatment, and material processing equipment onsite, as well as limited self-storage space, and a gym.

Project Background and Scope of Work	
Include list of tasks to be completed by ERM personnel during this project, and a separate list of tasks to be completed by any contractors at the site. A site-specific Job Hazard Analysis (JHA; ERM Form S1-ERM-002-FM4) must be completed for each task to be performed. Contractors must provide their own HASP and a JHA for each task they will perform for ERM review. ***A JHA template and reference/example JHAs for more common tasks can be found at: Americas H&S Page - JHAs.***	
ERM Scope of Work: Corrective action to include pilot testing of dual-phase extraction system and sub-slab depressurization system. Specific tasks include oversight of remedial system installation (concrete coring, extraction point installation and mechanical connections to vacuum equipment, soil vapor probe installation, operation of portable blower/fan, soil handling), and groundwater sampling.	
ERM Task 1: Mobilize to/from site	☒ JHA Attached?
ERM Task 2: Soil and Groundwater Sampling	☒ JHA Attached?
ERM Task 3: Oversight of remedial system installation	☐ JHA Attached?
ERM Task 4: Click here to enter text.	☐ JHA Attached?
ERM Task 5: Click here to enter text.	☐ JHA Attached?
ERM Task 6: Click here to enter text.	☐ JHA Attached?
ERM Task 7: Click here to enter text.	☐ JHA Attached?
Contractor Scope of Work: Concrete coring, extraction point installation and mechanical connections to vacuum equipment, soil vapor probe installation, operation of portable blower/fan, soil handling, and groundwater sampling.	
Contractor Task 1: Click here to enter text.	☐ JHA Reviewed?
Contractor Task 2: Click here to enter text.	☐ JHA Reviewed?
Contractor Task 3: Click here to enter text.	☐ JHA Reviewed?
Contractor Task 4: Click here to enter text.	☐ JHA Reviewed?
Contractor Task 5: Click here to enter text.	☐ JHA Reviewed?
Contractor Task 6: Click here to enter text.	☐ JHA Reviewed?
Contractor Task 7: Click here to enter text.	☐ JHA Reviewed?

Contractor(s) to be used:	Approved under Contractor Management Program?
1. Test America Laboratory	☒ Yes ☐ No
2. Remedial System Contractor (TBD)	☒ Yes ☐ No
3. Pace Analytical	☒ Yes ☐ No
4. Click here to enter text.	☐ Yes ☐ No
5. Click here to enter text.	☐ Yes ☐ No

Site/Project General Information

Site Type (check all applicable boxes)

☒	Industrial	☐	Hazardous waste release (Hazwoper)
☐	Residential	☐	Remote or Inactive Facility*
☐	Unsecured	☐	Other (specify): Click here to enter text.
☐	Coastal/offshore (on or near water)	☐	Other (specify): Click here to enter text.

*ERM Form S3-NAM-029-FM6 (*Undeveloped, Remote, or Inactive Sites*) must be completed and attached to this document.

Main Project Hazards (check all applicable boxes)

☐	Aerial Lift Use (e.g., Scissor Lifts, Cherry Pickers)[1]	☐	Helicopter/Fixed Wing Aircraft Transportation[3]
☐	All-Terrain Vehicle Use[1]	☒	High Noise (>85 dBA)
☐	ASTs/USTs	☐	Hot Work (Welding, Cutting, Brazing)[2]
☐	Biological Hazards	☐	International Travel[4]
☐	Chemical Exposure Potential (including asbestos)	☒	Long Distance/Duration Driving[5]
☐	Chemical Mixing/Injection	☐	Mining (Surface/Underground)
☐	Compressed Gas	☒	Natural Hazards (Plants, Animals, Insects)
☐	Confined Space Entry[2]	☐	Off-Shore Platform Work[6]
☒	Construction[1]	☐	Overhead Power Lines
☐	Control of Hazardous Energy (i.e., Lockout/Tagout)[2]	☐	Portable/Fixed Ladders
☐	DDD Operations[1]	☐	Radiation (Ionizing/Non-ionizing)
☐	Diving[1]	☐	Rigging/Lifting[2]
☒	Ergonomics/Material Handling	☐	Scaffold Use
☒	Excavation/Trenching/Drilling[2]	☐	Shift Work (e.g., night work)
☐	Extended or Nonstandard Work Shifts (>14 hours)	☐	Short Service Employees
☒	Extreme Weather	☒	Slips/Trips
☐	Explosives Use[1]	☒	Subsurface Clearance (Buried Utilities)[2]
☐	Falls from height (>4 feet)[1]	☐	Working on/over Water (including transport)[1]
☐	Forklift/Industrial Truck Use[1]	☐	Unexploded Ordnance/Munitions and Explosives of Concern (UXO/MEC)[1]
☒	Hand/Power Tool Use		
☐	Heavy Equipment Use	☐	Other (specify): Click here to enter text.

1 High hazard work requiring H&S team coordination. Additional control measures may be required beyond JHA.

2 Permit-required high hazard work requiring H&S Team coordination and ERM or equivalent client-required permit to be completed.

3 If traveling using a helicopter or fixed wing aircraft, ERM employees are required to follow the provisions of ERM Standard S1-ERM-009-ST (*Fixed Wing Aircraft and Helicopter Safety*).

4 A Travel Risk Assessment (TRA) is required for all international travel (with the sole exception of travel to a Low Risk country where ERM has a permanent office). Consult ERM Standard S1-ERM-005-ST.

5 If driving more than 500 km (310 miles) in a single day, driving in excess of 4.5 hours in a single day, or driving in a remote location, a Journey Management Plan (see ERM Standard S1-ERM-008-PR) is required and should be appended to this HASP.

6 If traveling to/from and working on an off shore platform, ERM employees are required to follow the provisions of ERM Standard S1-ERM-006-ST (*Offshore Platform Safety*).

Chemical Products Used or Stored On-Site

For each chemical product identified, a Safety Data Sheet (SDS) must be attached to this HASP.

☒ Alconox or Liquinox	☐ Household bleach (NaOCl)
☒ Hydrocholoric acid (HCl)	☒ Calibration gas
☐ Nitric acid (HNO_3)	☒ Other (specify): Helium
☐ Sulfuric acid (H_2SO_4)	☐ Other (specify): Click here to enter text.
☐ Sodium hydroxide (NaOH)	☐ Other (specify): Click here to enter text.
☐ Isopropyl alcohol	☐ Other (specify): Click here to enter text.

Note: Eyewash solution must be readily available on all project sites where materials are used or stored that pose a risk of getting into the eyes via splashing or through contact with airborne gases, vapors, dusts, or mists. This includes sample preservatives. The eyewash unit, whether stationary or portable, must be large enough to provide at least 15 minutes of eye flushing.

Regulated Chemicals of Concern

Check any chemicals known or suspected to be present on the site to which the ERM team may be exposed. These chemicals include OSHA-regulated potential carcinogens (29 CFR 1910.1003 through 1016) as well as those chemicals for which OSHA has established specific respiratory protection requirements (29 CFR 1910.134). If any of these chemicals are present on site, contact your H&S team member for guidance and describe any additional protective measures to be taken, as necessary.

☐ Friable asbestos	☐ Hexavalent chromium
☐ 3,3'-Dichlorobenzidine	☐ Coke oven emissions
☐ Benzidine	☐ Ethylene oxide
☐ Beta-Propiolactone	☐ 1,2-Butadiene
☐ N-Nitrosomethylamine	☐ Methyl chromoethyl ether
☐ Lead	☐ Beta-Naphthylamine
☒ Benzene	☐ Ethyleneimine
☐ Acrylonitrile	☐ 4-Dimethylaminoazobenzene
☐ Methylenedianiline	☐ Inorganic arsenic
☐ 4-Nitrobiphenyl	☐ Cadmium
☐ alpha-Naphthylamine	☐ 1,2-Dibromo-3-chloropropane
☐ bis-Chloromethyl ether	☐ Formaldehyde
☐ 4-Aminodiphenyl	☐ Methylene chloride
☐ 2-Acetyaminoflourene	☐ **No ERM exposure to these compounds**
☒ Vinyl chloride	

Known or Suspected Chemicals of Concern

The following section must be filled out for all confirmed or suspected chemicals present on the site to which the ERM team may reasonably be exposed. Information on each chemical must be provided to all team members.

Material name: Tetrachloroethene		Highest reported concentration*: 6.6 mg/L	
Primary hazards: incompatible with strong oxidizers and caustic sodas		Exposure symptoms: irritation of eyes, skin, nose, and throat; nausea; dizziness; headache; drowsiness	
OSHA Exposure Limits**	NIOSH Exposure Limits**	ACGIH Exposure Limits**	IDLH Level**:
PEL: 100 ppm	REL:	TLV:	150 ppm
STEL:	STEL:	STEL:	Ionization Potential (in eV):
Other:	Other:	Other:	9.32
Material name: Benzo(a)pyrene		Highest reported concentration*: 1.5 mg/kg	
Primary hazards: Combustible - avoid open flames		Exposure symptoms: irritation of eyes, skin, nose, and throat; dizziness; headache; weakness	
OSHA Exposure Limits**	NIOSH Exposure Limits**	ACGIH Exposure Limits**	IDLH Level**:
PEL: Click here to enter text.	REL: Click here to enter text.	TLV: Click here to enter text.	Click here to enter text.
STEL: Click here to enter text.	STEL: Click here to enter text.	STEL: Click here to enter text.	Ionization Potential (in eV):
Other: Click here to enter text.	Other: Click here to enter text.	Other: Click here to enter text.	Click here to enter text.
Material name: Click here to enter text.		Highest reported concentration*: Click here to enter text.	
Primary hazards: Click here to enter text.		Exposure symptoms: Click here to enter text.	
OSHA Exposure Limits**	NIOSH Exposure Limits**	ACGIH Exposure Limits**	IDLH Level**:
PEL: Click here to enter text.	REL: Click here to enter text.	TLV: Click here to enter text.	Click here to enter text.
STEL: Click here to enter text.	STEL: Click here to enter text.	STEL: Click here to enter text.	Ionization Potential (in eV):
Other: Click here to enter text.	Other: Click here to enter text.	Other: Click here to enter text.	Click here to enter text.
Material name: Click here to enter text.		Highest reported concentration*: Click here to enter text.	
Primary hazards: Click here to enter text.		Exposure symptoms: Click here to enter text.	
OSHA Exposure Limits**	NIOSH Exposure Limits**	ACGIH Exposure Limits**	IDLH Level**:
PEL: Click here to enter text.	REL: Click here to enter text.	TLV: Click here to enter text.	Click here to enter text.
STEL: Click here to enter text.	STEL: Click here to enter text.	STEL: Click here to enter text.	Ionization Potential (in eV):
Other: Click here to enter text.	Other: Click here to enter text.	Other: Click here to enter text.	Click here to enter text.

For additional chemicals, refer to S3-NAM-029-FM9 (Additional Known or Suspected Chemicals of Concern).
*Specify units and sample medium; **Specify units
OSHA Permissible Exposure Limits (PEL) and Short Term Exposure Limits (STEL); https://www.osha.gov/dsg/annotated-pels/
NIOSH Recommended Exposure Limits (REL), STELs, and Immediately Dangerous to Life and Health (IDLH); http://www.cdc.gov/niosh/npg/
ACGIH Threshold Limit Values (TLV) and STELs; contact your Division H&S Leader for additional information on these values.

Personal Protective Equipment

Req = Required PPE for one or more tasks to be performed; required on site at all times. NA = Not applicable to this project.

Equipment	Req	NA	Supplies	Req	NA
Steel-toed Boots	☒	☐	Inner Chemical Gloves	☐	☐
Outer Disposable Boots	☐	☒	Outer Chemical Gloves	☐	☐
Long Sleeve Shirt/Pants	☒	☐	Leather or Kevlar Gloves	☐	☐
Tyvek Suit	☐	☒	Safety Glasses/Goggles	☒	☐
Poly-Coated Tyvek Suit	☐	☒	Face Shield	☐	☒
Fully Encapsulated Chemical Suit	☐	☒	Hearing Protection	☒	☐
Flame Resistant Clothing/Coveralls	☐	☒	Half-face Respirator	☐	☒
High Visibility Traffic Vest	☒	☐	Full-face Respirator	☐	☒
Hard Hat	☒	☐	If either half or full-face respirator checked: • Define cartridge type: Click here to enter text. • Define cartridge change frequency: Click here to enter text.		
Other (specify): Click here to enter text.	☐	☐			

Respirator selection should be based on the Assigned Protection Factor (APF) and the Maximum Use Concentration (MUC). To determine the appropriate respirator selection, the lowest appropriate published exposure guideline should be known. The Division H&S Leader or project H&S consultant can provide assistance in defining the APF and MUC, as necessary. They can also assist in defining actions levels and cartridge change schedules when air-purifying respirators are used. Note that cartridge change schedules must be outlined above and in the JHA for any task requiring respiratory protection.

Use of respiratory protection requires three elements: training in respiratory protection techniques, completion of medical surveillance confirming that you are fit to wear a respirator, and fit testing with the make and model of respirator you will be using. Refer to S3-NAM-026-PR (*Respiratory Protection*) for additional information.

Training, Medical Surveillance, and Safety Supplies

Req = Required; requirements are based on the specific tasks performed in the field and the type of environments, chemicals, or hazards encountered. NA = Not applicable to this project.

Training	Req	NA	Medical Surveillance**	Req	NA
40-Hour Hazwoper	☒	☐	Medical Clearance	☒	☐
Current 8-hour Hazwoper Refresher	☒	☐	Respirator Clearance and Fit Test	☐	☒
8-Hour Hazwoper Supervisor*	☐	☒	Blood Lead and ZPP	☐	☒
Current First Aid/CPR	☒	☐	Other (specify): Click here to enter text.	☐	☐
40-Hour MSHA New Miner	☐	☒	Other (specify): Click here to enter text.	☐	☐
Current 8-hour MSHA Refresher	☐	☒	**Safety Supplies**	**Req**	**NA**
ERM Field Safety Officer (FSO)	☒	☐	First Aid Kit	☒	☐
DDD Practice FSO/DM	☐	☒	Eyewash Solution (15 minute flush)	☒	☐
Subsurface Clearance (SSC)	☒	☐	Air Horn	☐	☒
EPA Hazardous Waste	☐	☒	Decontamination Supplies	☒	☐
Hazmat/Dangerous Goods Shipping	☐	☒	Fire Extinguisher	☒	☐
International Traveler	☐	☒	Potable Water	☐	☒
Other (specify): Click here to enter text.	☐	☐	Toilets	☐	☒
Other (specify): Click here to enter text.	☐	☐	Other (specify): Click here to enter text.	☐	☐

*Provides specialized training to serve as an on-site manager supervising employees engaged in work covered by 29 CFR 1910.120.

**Physical examination requirements should be discussed with Workcare well in advance of project to allow adequate time to schedule exams.

Monitoring Equipment

All monitoring equipment on site must be calibrated per manufacturer specifications (including daily bump tests) and results recorded. Under stable conditions, measurements must be made in the breathing zone at least once every 30 minutes.

Combustible Gas Indicator	Reading	Action Guideline	Comments
Check if required: ☐	0 to 10% LEL	Monitor. Evacuate if confined space.	Click here to enter text.
Model: Click here to enter text.	10 to 25% LEL	Potential fire or explosion hazard.	
Task number(s): Click here to enter text.	>25% LEL	Fire/explosion hazard. Evacuate.	

Oxygen Meter	Reading	Action Guideline	Comments
Check if required: ☐	>23.5%	Fire hazard. Evacuate.	Click here to enter text.
Model: Click here to enter text.	23.5 to 19.5%	Normal oxygen levels.	
Task number(s): Click here to enter text.	<19.5%	Oxygen deficient conditions. Evacuate.	

Radiation Survey Meter	Reading	Action Guideline	Comments
Check if required: ☐	Normal background	Proceed with normal operations.	Annual exposure not to exceed 1250 mrem per quarter. Background reading must be taken in an area known to be free of radiation sources.
Model: Click here to enter text.	3x background	Notify Radiation Safety Officer.	
Task number(s): Click here to enter text.	>3x background	Radiological hazard. Evacuate.	

Photoionization Detector	Reading	Action Guideline	Comments
Check if required: ☒	Any response below 5 ppm, sustained for 1 minute	Level "D" PPE is acceptable up to the action level. For response above established background level(s), appropriate level PPE requirements must be met.	The action level for upgrading the level of protection is typically ½ the lowest published exposure limit for the potential COCs at the site. For COCs with extremely low exposure limits (e.g., <5 ppm), contact your Division H&S Leader for guidance on action levels. See end of this section for additional information on respirator selection.
Model: 10.6 eV	>5 ppm to 500 ppm, sustained for 1 minute	Level "C" is acceptable as appropriate.	
Task number(s): 2	Greater than >500 ppm above background, sustained for 1 minute	Stop work. Tasks requiring Level B or Level A PPE are not anticipated during this project. If Level B or Level A PPE is needed, as determined by the FSO and/or the PM, the Division H&S Leader will be notified and the HASP will be revised.	

Flame Ionization Detector	Reading	Action Guideline	Comments
Check if required: ☐	Any response below Click here to enter text. ppm, sustained for 1 minute	Level "D" PPE is acceptable up to the action level. For response above established background level(s), appropriate level PPE requirements must be met.	The action level for upgrading the level of protection is typically ½ the lowest published exposure limit for the potential COCs at the site. For COCs with extremely low exposure limits (e.g., <5 ppm), contact your Division H&S Leader for guidance on action levels. See end of this section for additional information on respirator selection.
Model: Click here to enter text.	Click here to enter text. ppm to Click here to enter text. ppm, sustained for 1 minute	Level "C" is acceptable as appropriate.	
Task number(s): Click here to enter text.	Greater than Click here to enter text. ppm above background, sustained for 1 minute	Stop work. Tasks requiring Level B or Level A PPE are not anticipated during this project. If Level B or Level A PPE is needed, as determined by the FSO and/or the PM, the Division H&S Leader will be notified and the HASP will be revised.	
Colorimetric Detector Tubes	**Reading**	**Action Guideline**	**Comments**
Check if required: ☐	Specify: Click here to enter text.	Specify: Click here to enter text.	Click here to enter text.
Model: Click here to enter text.			
Task number(s): Click here to enter text.			
Other (specify): Click here to enter text.	**Reading**	**Action Guideline**	**Comments**
Check if required: ☐	Specify: Click here to enter text.	Specify: Click here to enter text.	Click here to enter text.
Model: Click here to enter text.			
Task number(s): Click here to enter text.			

Work Zones

Complete if exclusion zones are necessary because of chemical and/or equipment hazards. Describe the set-up of these zones. Include landmarks, dimensions (as necessary), and whether they are for equipment or personnel decontamination.

Exclusion Zone: Required due to heavy equipment /construction hazards. Exclusion perimeter surrounding construction area will be identified and delineated with barricades and caution tape. Only ERM personnel and subcontractors will be allowed inside perimeter.

Contamination Reduction Zone: N/A

Support Zone: N/A

Site Access/Control

Describe procedures for limiting unauthorized entry to the work zone(s). Describe any security requirements.

Access Control Procedures: Site is an active facility. Entry into the work area will be restricted by hazard communication

Decontamination Procedures

Describe procedures for the decontamination of personnel and equipment.

Personnel: Good personal hygiene with frequent hand washing and frequent glove changes.

Equipment: Equipment decontamination will be performed at a designated outdoor area of the site through steam cleaning/pressure washing (heavy equipment) or Alconox and distilled water wash (sampling equipment/tools).

Spill Prevention and Response ***Ensure all chemical containers on site are labeled and lids are secured when not in use. When transferring chemicals from one container to another, or when refueling vehicles or equipment, provide containment beneath the transfer point to capture potential spills. Immediately report all chemical spills to the PIC/PM and submit an ECS entry with 24 hours.***
Will ERM staff or ERM-hired contractors possess containerized chemicals on the project site? ☒ Yes ☐ No
Will container size be greater than or equal to one gallon? ☐ Yes ☒ No
If the answer to both of these questions is Yes, follow the requirements outlined in ERM Procedure S3-NAM-042-PR (*Spill Prevention and Response*)?
Waste Management Planning
Will ERM's project activities generate waste materials? ☒ Yes ☐ No
Will ERM undertake some level of contractual responsibility for handling waste for the client? ☒ Yes ☐ No
If the answer to either of these questions is Yes, follow the requirements outlined in ERM Procedure S3-NAM-038-PR (*Waste Management Planning*).
Describe any waste reduction/minimization techniques to be used on the site: Click here to enter text.
Client-Specific Emergency Response ***In the event of an emergency, client-specific emergency response procedures may take precedence over ERM established procedures.*** ***While engaging in field-related activities on an active client site, measures they have in place to signal either emergency response or evacuation need to be reviewed and documented.*** ***Once completed, this summary should be discussed with all visitors, contractors, and others subject to HASP review upon site visit.***
Contributing factor initiating emergency response (process, material, weather): Facility-specific evacuation/emergency response procedures will be discussed on-site with facility representative prior to initiation of work and documented below.
Lights and/or sounds associated with evacuation: Click here to enter text.
Drill requirements for contractors on-site: Click here to enter text.
Initial and alternative muster points: Click here to enter text.
Specific evacuation procedures: Click here to enter text.
Method for accounting for site visitors: Click here to enter text.
PPE and spill kit requirements (if emergency response is spill related): Click here to enter text.

Map associated with evacuation attached? ☐ Yes ☐ No

Emergency Contacts

All ERM employees are empowered to pause or stop work to address any unsafe acts/conditions, questions, concerns or changed conditions. All work-related safety events should be shared with the project team and promptly entered into the Event Communication System (ECS).

FOR ALL MEDICAL EMERGENCIES, CALL 911 OR THE LOCAL EMERGENCY NUMBER.

For ALL non-emergency incidents resulting in any injury or illness, you must:

- *Give appropriate first aid care to the injured or ill individual and secure the scene.*
- *Immediately notify the PM, PIC, and the H&S Team.*
- *At direction of PM, PIC, or H&S Team, call WorkCare Incident Intervention at (888) 449-7787 (available 24 hours/7 days per week in US only).*
- *Clients may have their own procedures which we may need to follow.*

For all incidents (injuries, illnesses, spills, fires, property damage, etc.) and significant near misses, enter the event into ECS within 24 hours.

Contact	Name	Location	Phone
Hospital (attach map)	Allen Hospital	1825 Logan Ave, Waterloo, IA	911/319-235-3941
Police	Waterloo Police Dept	715 Mulberry St, Waterloo, IA	911/319-291-4340
Fire	Waterloo Fire Rescue (Station 4)	1200 Ansborough Ave, Waterloo, IA	911/319-291-4464
Incident Intervention	WorkCare	NA	888-449-7787
Partner-in-Charge	Chris Weggeman	Minneapolis, MN	Work: 612-347-7160 Cell: 651-270-0194
Project Manager	Mark Seaman	Des Moines, IA	Work: 515-223-8225 Cell: 515-681-1025
Field Manager (if not PM)	Click here to enter text.	Click here to enter text.	Work: Click here to enter text. Cell: Click here to enter text.
Field Safety Officer (if not PM)	Click here to enter text.	Click here to enter text.	Work: Click here to enter text. Cell: Click here to enter text.
SSC Experienced Person	Darron deBoer	Overland Park, KS	Work: 913-981-9413 Cell: 913-904-4686
Division H&S Contact	Dan Wilkens	St. Louis, MO	Work: 314-733-4491 Cell: 314-313-8750
Region H&S Director	Click here to enter text.	Click here to enter text.	Work: Click here to enter text.

			Cell: Click here to enter text.
Subcontractor Contact	TBD	Click here to enter text.	Work: Click here to enter text.
			Cell: Click here to enter text.
Client Contact	Dennis McKinney	Click here to enter text.	Work: (847) 484-4589
			Cell: Click here to enter text.
Additional Contact	Click here to enter text.	Click here to enter text.	Work: Click here to enter text.
			Cell: Click here to enter text.

Acknowledgement

I have read, understood, and agree with the information set forth in this health and safety plan (HASP), and will follow guidance in the plan and in ERM's Document Control System (DCS). I understand the training and medical monitoring requirements (if any) for conducting activities covered by this HASP and have met these requirements.

ERM has prepared this plan solely for the purpose of protecting the health and safety of ERM employees. Contractors, visitors, and others at the site are required to follow provisions in this document at a minimum, but must refer to the organization's health and safety program for their protection.

Printed Name	Signature	Organization	Date
Approval Signatures		**Project Manager**	**Date**

Signatures in this section indicate the signing employee will comply with and enforce this HASP, as well as procedures and guidelines established in ERM's DCS. Signatures also indicate that any subcontractors performing work under contract to ERM have met the minimum safety standards in S3-NAM-030-PR (Contractor Management).	Typed Name: Click here to enter text. Signature File:	Click here to enter a date.
	Partner-in-Charge	**Date**
	Typed Name: Click here to enter text. Signature File:	Click here to enter a date.

Attachments ***Check all appropriate documents to be attached to this HASP.***	
☒ Site-specific JHAs for all tasks (including contractors)	☒ Map of route to hospital with turn-by-turn instructions
☒ Subsurface Clearance (SSC) Project Plan	☒ Facility site map(s)
☒ Site Safety Meeting Form (S3-NAM-029-FM5)	☒ SNAP Cards
☒ Vehicle Inspection Forms (S1-ERM-008-FM2)	☐ Project/Field Audit Checklist (M1-ERM-016-FM3)
☒ Journey Management Plans (S1-ERM-008-FM1)	☐ Industrial Hygiene Sample Data (S3-NAM-005-FM1)
☒ Safety Data Sheets (SDS) for chemicals brought to site	☒ Ambient Air Monitoring Form (S3-NAM-005-FM2)
☐ Information on chemicals of concern (ICSC cards or like)	☐ Client-specific requirements
☐ PLAN Risk Assessment	☐ Other: Click here to enter text.
Applicable ERM Safety Standards/Procedures ***Check all that procedures/standards that are applicable to this project. Refer to the standards/procedures for guidance and, where applicable, use forms, work instructions, and guideline documents associated with these standards/procedures in the completion of site work. Copies of all standards/procedures must be procured from ERM's Document Control System.***	
Global (Tier I) Standards/Procedures	
☐ Short Service Employees (S1-ERM-003-PR)	☐ Travel Risk Assessment (S1-ERM-005-ST)
☐ Offshore Platform Safety (S1-ERM-006-ST)	☒ Subsurface Clearance Standard (S1-ERM-007-ST)
☒ Driver and Vehicle Safety (S1-ERM-008-PR)	☐ Fixed Wing Aircraft/Helicopter Travel (S1-ERM-009-ST)
Local (Tier III) Standards/Procedures	
☐ Demolition (S3-NAM-004-PR)	☐ Excavation and Trenching (S3-NAM-008-PR)
☐ Fall Protection (S3-NAM-009-PR)	☐ Setting Occ. Exposure Guidelines (S3-NAM-010-PR)
☒ Hazard Communication (S3-NAM-011-PR)	☐ Ladder Safety (S3-NAM-012-PR)
☒ Cold Stress (S3-NAM-013-PR)	☐ Hearing Conservation (S3-NAM-014-PR)
☒ Heat Stress (S3-NAM-015-PR)	☐ Incident Reporting and Investigation (S3-NAM-016-PR)
☒ Medical Services (S3-NAM-019-PR)	☐ Medical Surveillance (S3-NAM-020-PR)
☒ Personal Protective Equipment (S3-NAM-021-PR)	☐ Hot Work (S3-NAM-023-PR)
☐ Regulatory Inspection (S3-NAM-024-PR)	☐ Respiratory Protection (S3-NAM-026-PR)
☒ Contractor Management (S3-NAM-030-PR)	☒ Contractor Management (S3-NAM-030-PR)
☐ High Risk Activity Driving (S3-NAM-031-PR)	☒ Hand Tools/Portable Power Equipment (S3-NAM-033-PR)
☐ Electrical Safety (S3-NAM-035-PR)	☒ Incident/Illness Management (S3-NAM-037-PR)
☒ Waste Management Planning (S3-NAM-038-PR)	☐ Energy Isolation (S3-NAM-039-PR)
☐ Working Over Water (S3-NAM-041-PR)	☐ Spill Prevention and Response (S3-NAM-042-PR)
☒ Fatigue Management (S3-NAM-044-PR)	☒ Cutting Tools and Hand Safety (S3-NAM-047-PR)
☐ Lone Worker (S3-NAM-048-PR)	☐ Compressed Gas Cylinders (S3-NAM-049-PR)

See It; Own It; Share It	Stop Work Authority
It means that: • **We know that we have a responsibility to look out for each other, to intervene when necessary, to be proactive and to help keep safety issues from becoming problems.** • **We also look out for ourselves. If we recognize that a situation is unsafe, we are expected to stop what we're doing, reassess the situation and consult with others if necessary before proceeding safely.** • **We assign no blame to anyone who raises safety issues.** • **We strive to learn lessons from the large and small events that are part of our daily experience.**	**It is ERM policy that all ERM and ERM Contractor employees have the authority, without fear of reprimand or retaliation to:** • **Immediately stop any work activity that presents a danger to the site team or the public.** • **Get involved, question and rectify any situation or work activity that is identified as not being in compliance with the HASP or with broader ERM health and safety policies.** • **Report any unsafe acts or conditions to supervision or, preferably, intervene to safely correct such acts or conditions themselves.**

	Applicability:	Form	Document Number:	Version:
ERM	North America		S3-NAM-029-FM5	2
	Title:	**Site Safety Meeting Form**	**Last Revision Date:**	6/24/15

Project Name/ Location:			**Phone:**		
Project Number:		**Date:**		**Time:**	
Meeting Leader:					

Today's Work Tasks(s)	**Conducted By:**

1. **Review relevant sections of the Health and Safety Plan (HASP), Job Hazard Analyses (JHAs) for planned tasks, and any other applicable procedures. Discuss potential hazards of planned work and control measures to be used to eliminate or reduce risks (including PPE). Pay specific attention to overlapping/ simultaneous operations.**
2. **Review emergency response procedures including emergency phone numbers, location of emergency equipment (fire extinguishers, first aid kit, AED, eyewashes, safety showers, etc.), exit routes, muster points, methods of conducting head count at muster point, and identity of first responders trained in first aid/CPR.**
3. **Does everyone fully understand the task(s)? Are there any changes that need to be assessed? Use SNAP cards to assess risks associated with changed or unplanned tasks.**
4. **Remind the team that everyone on the job site is empowered to stop work if something is unsafe or if there are any questions or concerns regarding safety.**

What tools and equipment are required for today's tasks? Have they been inspected and are they in good condition?

What training/qualifications/experience is necessary for today's assigned tasks?

List any new or Short Service personnel on site today:

Discuss any recent incidents, near misses, field inspection findings, or other safety observations (or observations from similar tasks performed at other sites):

Additional Safety Meeting Topics (check those discussed)
☐ What client safety rules or procedures are applicable to today's activities?
☐ How will you communicate with others on site? How will you communicate with the PIC and PM?
☐ What are the potential impacts of planned activities to visitors, nearby workers, or the public?
☐ Who do you contact if you have questions or before deviating from written procedures?
☐ What happens and who do you contact if there is an injury or other emergency? If working at an active facility, how will you be alerted of an emergency and what will you do?
☐ Where is nearest medical facility and how would we get an injured employee there? If medical help is more than five minutes away, is at least one person on site trained in first aid/CPR? How do you contact them?
☐ Do you have any medical condition or allergy that the project team needs to be aware of? Write this down and keep it in your pocket for reference in the event of an emergency.
☐ Are any work permits required?
☐ Has anything unexpected or out-of-the-ordinary occurred on this job recently to share?
☐ Is there anything different about today's operations as compared to yesterday or previous days?
☐ What is the worst that could happen if something goes wrong today?
☐ What activities occurring today could result in hand injuries? Is everyone aware that the use of fixed open-blade knives is not permitted?
☐ What natural hazards are present (including plants, animals, and insects)?
☐ What areas of the site have slip/trip/fall hazards? Can these be avoided? Are everyone's work boots in good shape?
☐ Other items:

Meeting Attendees (including employees, contractors, and visitors)

Name	Company	Sign-In*	Sign-Out**

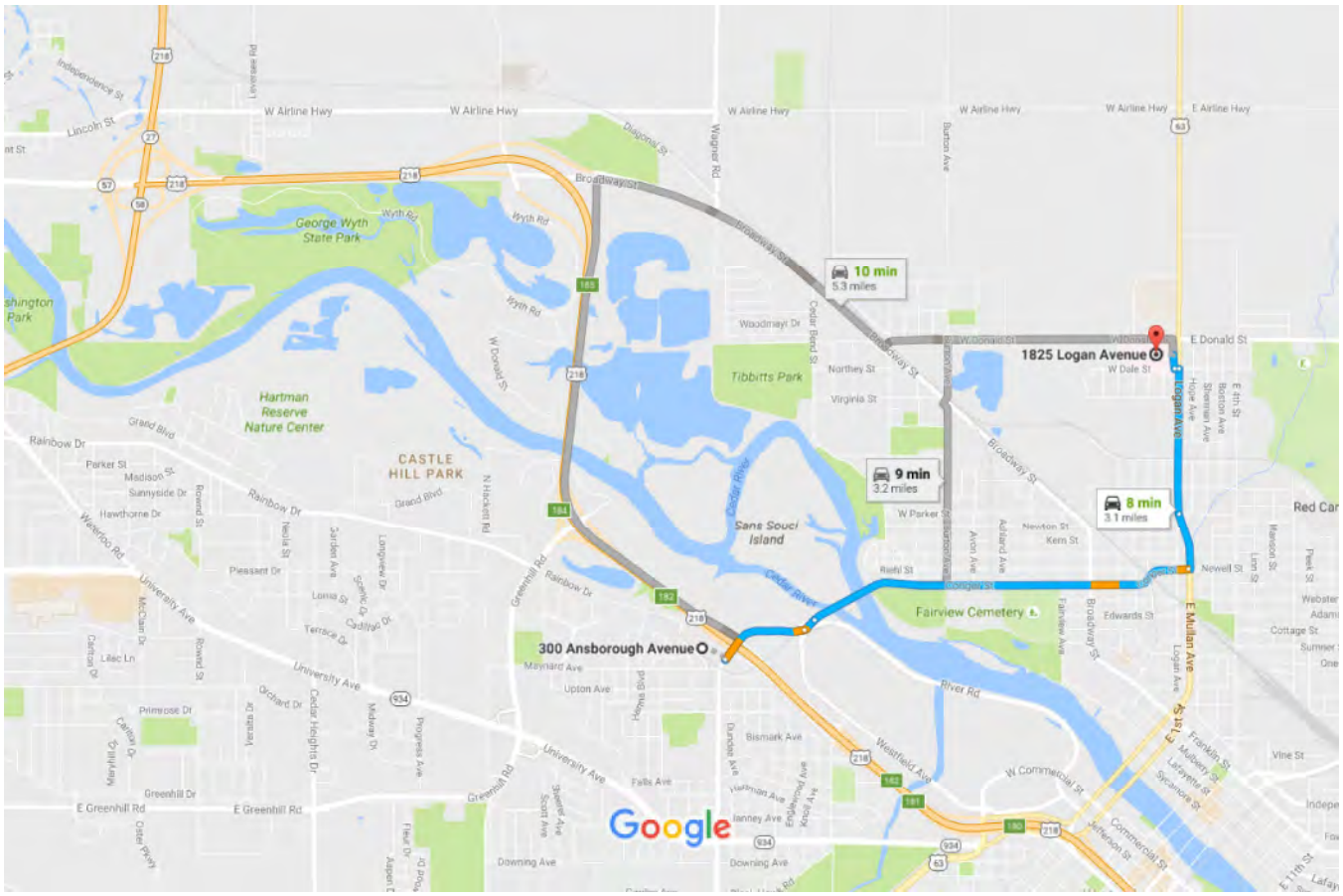
* Signature/initials in this space verify that the employee is fit for performing work.

** Signature/initials in this space verify that the employee was uninjured during the workday.

Google Maps

300 Ansborough Ave, Waterloo, IA 50701 to 1825 Logan Avenue, Waterloo, IA

Drive 3.1 miles, 8 min



Map data ©2016 Google 2000 ft

300 Ansborough Avenue

Waterloo, IA 50701

1. Head northeast on Ansborough Ave toward Trolley Car Trail — 0.4 mi
2. Use the 2nd from the left lane to turn left onto W Conger St — 344 ft
3. Continue straight to stay on W Conger St — 1.7 mi
4. Turn left onto E Mullan Ave — 0.3 mi
5. Continue onto Logan Ave — 0.6 mi
6. Turn left onto W Dale St — 105 ft

7. Turn right

322 ft

1825 Logan Avenue

Waterloo, IA 50703

These directions are for planning purposes only. You may find that construction projects, traffic, weather, or other events may cause conditions to differ from the map results, and you should plan your route accordingly. You must obey all signs or notices regarding your route.

Perform

Conditions 1-4 require that you **STOP WORK** and consult with a second person. Conditions 5-9, proceed with caution.

1. Refer to the appropriate partner to decide.
2. Ask a specialist with more knowledge to advise.
3. Consult with your supervisor before starting.
4. Discuss with a colleague to assist.

---

5. How can risk be reduced?
6. Look for another way to do the job if possible.
7. Re-check your safety controls (JSA, SWMS, PPE, Procedures).
8. Re-check the area before proceeding.
9. Proceed with the usual level of safety awareness.

M1-ERM-004-FM1, Version 6

Scan

Take two minutes to: scan **LOW** scan **MEDIUM** scan **HIGH**

Safety AT ERM
Risk Management

ERM

Activity Level Risk Review

Notice

Notice the hazards and the quality of the control measures in place.
Ask yourself the following questions…

1. Have I looked and identified all the hazards? ☐ Yes ☐ No
2. Will the job be done as already discussed? ☐ Yes ☐ No
3. Are the resources I need available? (PPE, tools, people) ☐ Yes ☐ No
4. Can the job be done without causing an incident? ☐ Yes ☐ No
5. Is everything the same since I last did this task? ☐ Yes ☐ No
6. Are others protected from my activities in the area? ☐ Yes ☐ No
7. Have I identified emergency devices and locations and do I know what to do? ☐ Yes ☐ No
8. Do I have safe access to and from my work area? ☐ Yes ☐ No
9. Is my work area clean and tidy? ☐ Yes ☐ No

If you answered NO to any of the above then consider this when you ANALYZE

Analyze

What is the most likely adverse consequence from an incident?
What is the probability of this type of incident occurring?

Probability of an incident	Exposure to the risk
Almost certain	
Has happened	
Possible	
Heard of	Weekly
Unlikely	Daily
Almost impossible	Current Task

Consequence/Outcome Injury	Impact
Multiple fatalities	Catastrophic
Fatality	Major
Disability	Significant
Serious (LTI)	Serious
Medical Treatment	Moderate
First Aid	Minor

1. Purpose and Scope

This document establishes the minimum requirements for subsurface obstruction and utility clearance [collectively, Subsurface Clearance (SSC)], and applies to all ERM project-related ground disturbance activities. This document is supported by the mandatory requirements in the *Global Subsurface Clearance Process Document* (S1-ERM-007-WI).

2. Roles and Responsibilities

Business Unit Managing Partner (BU MP). Review and either approve or reject any waiver associated with the SSC process for projects under their control. Ensure field verification audits are conducted in accordance with the *Global Subsurface Clearance Process Document.*

Partner in Charge (PIC). Ensure all elements of the SSC process are implemented on their project; determine if a project site meets the criteria for a Remote/Greenfield site.

Project Manager (PM). Ensure a qualified SSC Experienced Person (EP) participates in all projects involving ground disturbance activities.

SSC Experienced Person (EP). Lead the execution of the SSC Process on projects not considered Remote/Greenfield; complete required SSC documentation and field forms; be present in the field during all clearance activities.

3. Definitions

Critical Zone: 10 feet (3 meters) distance in all directions from the surface projection of:

- All known or suspected underground pipes, cables, conduits, drains, galleries, edges of tanks, or any other useful property; and
- Aboveground structures with associated subsurface pipes and/or cables.

Ground Disturbance Activities: activities which require penetration of the ground surface and/or the drilling, coring, or removal of engineered surfaces.

Point Disturbance: ground disturbance activities associated with soil borings; well installation; well over-drilling; or digging small test pits.

Remote/Greenfield Site: a site (or portion of a site) meeting the requirements in Appendix F of the *Global Subsurface Clearance Process Document*, as determined by the PIC.

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4. Requirements

4.1 Subsurface Clearance

No ground disturbance activities, with the exception of Remote/Greenfield sites, shall occur without at least one person in the field being a designated SSC EP. This is subject to waiver when only hand digging will occur in the uppermost 1 foot (0.3 meters) below ground surface. The SSC EP is responsible for ensuring that the SSC Process as defined in the *Global Subsurface Clearance Process Document* is fully implemented.

No ground disturbance activities are permitted within the Critical Zone unless a waiver is granted and the Subsurface Clearance Location Disturbance Permit has been completed.

All point disturbance activities require physical clearance, unless a waiver is granted, and shall meet the following minimum requirements:

- 125% of the outer diameter (OD) of the largest downhole tool to the following depth:
  - i. 2 feet (0.6 meters) beyond the bottom of the frost line at the site, or:
  - ii. Inside Critical Zones:
    - To 2 feet (0.6 meters) deeper than the known or suspected invert elevation of the subsurface structure, or
    - If the depth of the service is unknown, physical clearance should be performed to 8 feet (2.4 meters).
  - iii. Outside Critical Zones: 5 feet (1.5 meters).

For all excavation and trenching, mechanical digging is prohibited within 2 feet (0.6 meter) of subsurface structures. There can be no waiver of this requirement.

4.2 Remote/Greenfield Site

It is the responsibility of the PIC to ensure that the Remote/Greenfield Subsurface Clearance Process, as defined in the *Global Subsurface Clearance Process Document* is fully implemented.

Mechanical digging is prohibited if the site is to be cleared using the Remote/Greenfield Subsurface Clearance Process. There can be no waiver of this requirement.

4.3 Training Requirements

It is the responsibility of the project PIC to ensure that all ERM employees working on or managing projects are trained in accordance with the *Global Subsurface Clearance Process Document.*

SSC EPs shall complete competency testing as described in the *Global Subsurface Clearance Process Document*.

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All personnel training required by this standard shall be documented in ERM Academy.

4.4 Issuance of a Waiver

There are five waivers to the SSC Process that may potentially be issued:

1. Waive the requirement for an SSC EP to be present on site, when ONLY hand digging will occur in the uppermost 1 foot (0.3 meters) below ground surface;
2. Waive the requirement for Public Utility markouts (where allowed by law);
3. Waive the requirement for Private Utility markouts;
4. Waive the requirement for full physical clearance of point disturbance locations; and
5. Allow ground disturbance activities within Critical Zones.

Both the Project PIC and BU MP (or designee) must approve any waivers; all waivers shall be documented in the Subsurface Clearance Project Plan.

4.5 Field Verification Auditing

It is the responsibility of the BU MP to ensure that field verification audits are completed in accordance with the *Global Subsurface Clearance Process Document.* Identified findings shall be managed in accordance with the *Event and Non-conformance Management Procedure* (M1-ERM-015-PR).

5. References

- S1-ERM-007-WI - Global Subsurface Clearance Process Document
- M1-ERM-015-PR - Event and Non-conformance Management Procedure

Document Control Information

Original Effective Date: 1 April 2015

Approved by: Gary Beswick on 21 January 2016

Approval Signature: _____

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Revision History

Section	Version: Reason for Revision	Date
All	1.0: New document.	29 Dec 2014
3, 4.1, 4.2, 4.4	1.1: changed definition of ground disturbance; changed definition of point disturbance, added waiver for shallow hand digging; revised language for clarity.	15 May 2015
5	2.0 – corrected link to SSC Global Process document	21 Jan 2016

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ERM Vehicle Safety Checklist

Date	Operator	Project#	Mileage
Vehicle Make/Model License#			Company Vehicle? ☐ Y ☐ N

I. Inspection	Before Driving: OK	Deficient	N/A	Comments
<u>Prior to Use, and Weekly Thereafter</u> for all vehicles used for field work.				
All glass and mirrors	☐	☐	☐	
Engine Fluids (oil, radiator coolant)	☐	☐	☐	
Headlights (incl Hi/Lo lights)	☐	☐	☐	
Horn	☐	☐	☐	
Instrumentation warning lights	☐	☐	☐	
Misc. vibration, noise, loose parts (requires comment)	☐	☐	☐	
Overall vehicle cleanliness/damage	☐	☐	☐	
Reverse warning/alarm	☐	☐	☐	
Seatbelts for all seats	☐	☐	☐	
Tail Lights / Brake lights	☐	☐	☐	
Tires - visual condition/tread/pressure	☐	☐	☐	
Turn signal / hazard lights	☐	☐	☐	
Under vehicle – leaks	☐	☐	☐	
Windshield cleanliness and lack of damage/cracks	☐	☐	☐	
Windshield wipers & fluid	☐	☐	☐	

Required H&S supplies/ equipment	☐ Anti-lock brakes	☐ Air bags	☐ First aid kit	☐ Reflective safety vest (for all occupants)	☐ Spare tire and jack – in good condition	☐ Roadside warning (triangles or flares)
Optional H&S supplies/equipment	☐ Jumper cables	☐ Fire Extinguisher	☐ Torch / flashlight	☐ Camera		

Name & signature of reviewer : ……

Safety Reminders

1. Drive defensively - scan road ahead and anticipate actions of other drivers.
2. Ensure sufficient rest before and during the trip. Take a 15 minute break after every 2 hours of continuous driving.
3. Seat belts to be worn by all passengers and driver at all times.
4. Adjust seat / mirrors / headrest / steering wheel and ensure clean windows with no obstructions; Secure loose items.
5. Eliminate distractions – do not use mobile phones or any other electronic devices while driving. Refer to ERM's ***Global Policy on Mobile/Cellular Telephone and Personal Digital Assistant (PDA) Use While in a Vehicle.***
6. Secure all loose loads.
7. Obey all posted road signs and speed limits.
8. Maintain safe following distance - use "3-second rule." in good weather conditions. Adjust speed / following distance for adverse road/weather conditions.
9. Do not consume any alcohol or drugs, or any other substance or medication that could impair their ability to drive. Refer to ERM's ***Global Policy on Drug and Alcohol Use***.

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1. Project Information

Name/Location	
Project Number	
Date/Time	

2. Instrument Information

Type	
Brand	
Model	

3. Calibration Details (use one form per instrument per day)

Type	Calibration Gas Value	Measured Result	Correction Factor (CF) Needed?[1] (Yes/No)
Fresh Air	NA		NA
Zero Gas			NA
Span Gas #1:			
Span Gas #2:			
Span Gas #3:			
Span Gas #4:			

4. Monitoring Results

Time	Contaminant	Location	Result	CF (if needed)	Adjusted Result (Result x CF)

Time	Contaminant	Location	Result	CF (if needed)	Adjusted Result (Result x CF)

5. Completion[2]

Name	
Signature	

6. Notes

1. Correction factors (CF) may be needed for instrumentation where the span gas used is different from the chemical of concern (COC) being evaluated. Many air monitors, such as photoionization detectors (PIDs), are broadband instruments which will respond to all gases which the detector will ionize. Because the instrument will respond differently to the span gas than the COC, a CF can be applied to adjust the reading, producing a result more indicative of actual COC concentrations.

   The CF for a compound is developed under laboratory conditions by the manufacturer and is the ratio of the instrument response to the calibration gas over the instrument response to the COC. Therefore, the true concentration of the COC can be obtained by multiplying the monitor response by the CF. The instrument manufacturer's documentation will provide a list of CFs where applicable.

   Note that some instrumentation is designed to adjust for CFs automatically and produce true readings. Consult instrument documentation to determine if this is a feature of your instrument.

2. Retain completed form in project files.

1. Purpose

The purpose of this document is to define work practices to protect employees exposed to gas hazards in the ERM workplace.

2. Scope

This document covers all ERM North America employees who may be exposed to gas hazards at or above defined regulatory exposure limits in the course of completing job duties at client locations.

3. Training and Information

ERM employees who may potentially be exposed to hazardous chemicals in a gaseous state shall receive training and information on the chemical of concern at the time of their initial assignment and annually thereafter. The training shall include, at a minimum, the characteristics of the gaseous chemical, the acute and chronic health effects of exposure, and the appropriate personal protective equipment (PPE) to be used when in contact. Training shall be documented in ERM's Academy Learning Management System (LMS).

4. Site Specific Plans

Site-specific health and safety plans (HASP) will be prepared to address project level exposures to all contaminants of concern at client facilities, including gas hazards. The project HASP, associated Job Hazard Analyses (JHAs), and project work plans will be prepared prior to initiation of project activities where gaseous chemical exposures may occur. Development of these project safety documents will be done in accordance with S3-NAM-029-PR (***Project Health and Safety***).

An important element of the project HASP is the site-specific emergency action plan (EAP). Due to the nature of gas hazards, ERM will ensure that all employees who may potentially be exposed to these hazards in the workplace are fully aware of the provisions of the site-specific HASP, JHAs, and EAP. ERM employees will participate in any emergency drills required by ERM or the client to ensure familiarity with alarms, muster points, and evacuation protocols.

5. Equipment

ERM employees who may be potentially exposed to gas hazards will use a portable direct-reading air monitor to identify airborne concentrations of the chemical in question. A functioning monitor will be available at all times while the employee is within the boundaries of the gas hazard area.

All direct-reading air monitors will be calibrated in accordance with manufacturer's specifications. Calibration information will be noted on a sticker on the monitor. Daily bump tests will be performed to ensure that the monitor and associated alarms are functioning properly prior to use, unless a complete calibration of the monitor is completed. Calibration and bump tests will be completed in accordance with S3-NAM-043-GU1 (***Calibration and Testing of Direct-Reading Portable Air Monitors***).

1. Purpose and Scope

This procedure is designed to ensure that information necessary for the safe use, handling, and storage of hazardous chemicals is provided and made available to all ERM employees. This document applies to all ERM employees and covers all ERM work activities.

2. Roles and Responsibilities

Regional Health and Safety (H&S) Director: Responsible for ensuring that a written hazard communication program is prepared, implemented, and regularly evaluated for applicability.

Partner in Charge (PIC): Responsible for the following elements:

- Ensure this program is implemented, understood, and followed by employees under their charge and working on their projects;
- Ensure, in conjunction with the Branch Manager/Project Manager, that employees are properly trained in accordance with this procedure;
- Ensure that any site-specific health and safety plans (HASP) address hazard communication elements as described herein; and
- Correct any deficiencies in the implementation of this program as identified by the Division H&S Leader.

Branch Manager/Project Manager: Responsible for the following elements:

- Maintain a master inventory of all chemicals brought to and/or used in the workplace;
- Ensure that current Safety Data Sheets (SDS) for each chemical on the inventory are readily available to all employees;
- Ensure that all chemical containers are properly labeled upon receipt at the workplace and that labels are not defaced ore moved from the container until it is empty;
- Ensure that each ERM employee and affected ERM contractors are familiar with the chemicals present in the work area and their associated hazards; and
- Ensure that, when working on client sites, the client informs the project team of the location of applicable SDS or provides a copy of applicable SDS.

Division H&S Leader: Responsible for the following elements:

- Monitor new employees for completion of appropriate training;
- Assist PICs, Branch Managers, and Project Managers in the implementation of this program, as needed, and

- Evaluate compliance with this program during office and project audits.

Employee: Responsible for the following elements:

- Complete all ERM-required initial and update training;
- Follow all hazard control information provided on SDS and chemical labels; and
- Notify their Branch Manager/Project Manager if unlabeled chemicals are observed in the workplace.

3. Definitions

- Globally Harmonized System (GHS) – A system for standardizing and harmonizing the classification and labelling of chemicals
- Hazardous Materials Identification System (HMIS) – A numerical hazard rating that incorporates colors to convey broad health warning information for chemical users.
- National Fire Protection Association (NFPA) Diamond – A labeling system used by emergency response personnel to quickly and easily define the risks associated with hazardous materials.
- Safety Data Sheet (SDS) – A document that contains information on the potential hazards of, and how to work safely with, a chemical product.

4. Procedure

4.1 Labeling

Labels on all containers of chemicals, whether used, handled, or stored in the field or on ERM property, will minimally provide the following information:

- A product or chemical identifier;
- Appropriate hazard warnings (i.e., words, statements, pictures, and/or symbols) which provide general information regarding chemical hazards; and
- The identification of the manufacturer, distributor, or supplier of the chemical.

A container is defined as a bag, barrel, bottle, box, can, cylinder, drum, pail, vessel, or storage tank containing a hazardous chemical. Pipes or piping systems, as well as engines, fuel tanks, and other operating systems in a vehicle, are not considered to be containers.

Portable containers into which chemicals are transferred from labeled containers do not have to be labeled providing:

- The person who transferred the chemical into the portable container is the only person who will use the chemical; and
- All of the chemical in the portable container will be used completely by the end of the work shift.

Labels will be legible, in English, and prominently displayed at all times. In addition to English, labels may be presented in other languages. However, if a label is in only one language, that language shall be English. If non-English speaking employees are present in the work area, all labels will be available and presented in their language as well as English.

Sites which utilize chemicals governed by this procedure will periodically audit chemical containers to ensure that labels are present, intact, and legible. Examples of labeling formats, such as the GHS, HMIS, and NFPA systems, are provided in S3-NAM-011-WI1 (***Examples of Common Labeling Systems***).

4.2 Chemical Inventory

A chemical inventory must be maintained at any office or project site where chemicals are in use. The inventory must be updated and revised as chemicals are received or depleted. The name/identifier of the chemical as it appears on the chemical inventory must allow employees to be able to match the chemical with the SDS.

The chemical inventory for field projects will be incorporated into the project-specific HASP. The chemical inventory for office locations will be incorporated into the office-specific Emergency Action Plan (EAP).

4.3 Safety Data Sheets

The SDS provides written information on the chemicals of concern to the employees. The minimum data which must appear on an SDS is provided in S3-NAM-011-WI2 (***Safety Data Sheet Composition***).

For field projects, Project Managers will determine during HASP development if ERM employees will use chemicals during execution of the project. During this development and review period, the Project Manager will evaluate any new products which are proposed to be used at the site to determine if they contain extremely hazardous or carcinogenic chemicals. If so, the Project Manager will work with the Division H&S Leader to identify potential alternatives. Any new chemical products which will be introduced throughout the course of the job will be similarly evaluated. The SDS for any chemical used on a project site will be attached to the HASP and will be readily available at the site.

For offices, Branch Managers will evaluate any new products which are proposed to be used at the office to determine if they contain extremely hazardous or carcinogenic chemicals. If so, the Branch Manager will work with the Division H&S Leader to identify potential

alternatives. The SDS for any chemical used in the office will be attached to the EAP and will be readily available at the site.

SDS will be made available, upon request, to any ERM employee, contractor, or client. Upon receipt of an SDS, the Project Manager/Branch Manager shall review the SDS to ensure it is written in English, is legible, appears to be complete (in accordance with the requirements outlined in S3-NAM-011-WI2), and is current, with an effective date of less than five years. Older SDS will be replaced with updated sheets when they are received.

4.4 Contractors

The Project Manager will provide the following information to contractors prior to the start of any work at a client's site:

- Chemicals to which they may be exposed, including any soil or groundwater contaminants;
- Hazards associated with specific chemicals;
- Measures taken to reduce the hazard, including use of personal protective equipment (PPE);
- Location of the SDS;
- Locations of any applicable safety equipment, including first aid supplies, safety showers, and/or eye wash stations; and
- Emergency response procedures.

Prior to starting work, the contractor will provide the Project Manager with information about any chemicals brought onto the client's site. This information should include, at a minimum, the name of the chemical, the associated hazards, and any PPE required. Contractors will have a legible SDS for each chemical brought onto the project site.

4.5 Employee Training and Information

Training of all employees potentially exposed to hazardous materials on the job will be conducted as follows:

- Before new employees begin their jobs; and
- Whenever new chemicals are introduced into the workplace.

This training will include:

- Applicable regulatory requirements (including state or province-specific requirements, where applicable);
- Elements of this program;

- Location of the program, chemical inventory, and SDS;
- Chemicals used in their work areas and the associated hazards (chemical, physical, and health);
- How to detect the presence or release of chemicals, including monitoring techniques, visual indicators, or odors;
- Protective measures to be used, including safe work/handling practices, use of PPE, and emergency response procedures;
- How to read and use SDS and labels; and
- How to obtain additional hazard information.

Where non-English speaking workers are employed, provisions for training in the appropriate language will be arranged.

All initial training will be documented electronically via ERM's Academy Learning Management System (LMS). Documentation will include a brief description of the training and the trainer's name, and will be retained throughout the duration of the employee's tenure with the organization. Information on project-specific chemical hazards, labeling requirements, etc. will be documented as part of daily safety meetings at the project site using S3-NAM-029-FM5 (***Site Safety Meeting Form***).

4.6 Non-Routine Tasks

Occasionally, ERM employees may be required to perform non-routine field tasks which include exposure to hazardous chemicals. Prior to any non-routine work involving hazardous chemicals, the Project Manager will ensure that each affected employee is given information about the hazards presented by the chemicals, as well as the protective measures which will be utilized during the work.

4.7 Procedure Availability

The most recent version of the procedure will be available electronically at all times to employees and their designated representatives through ERM's Document Control System (DCS).

5. References

- ERM Form S3-NAM-011-FM1 (Chemical Inventory Sheet)
- ERM Work Instruction S3-NAM-011-WI1 (Examples of Common Labeling Systems)
- ERM Procedure S3-NAM-029-PR (Project Health and Safety)
- ERM Procedure S3-NAM-006-PR (Emergency Action Plans)

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Revision History

Section	Reason for Revision	Date
All	Changed format; updated to meet state and federal regulations	6/2/15

1. Purpose and Scope

This procedure establishes minimum requirements for work in environments where exposures to cold stress are encountered and provides guidance to evaluate and control these stressors. This procedure is applicable to all North American operations, and will be made available to employees at the work site upon request.

2. Roles and Responsibilities

Partner in Charge (PIC): Responsible for the following elements:

- Ensure this procedure is implemented, understood, and followed by employees under their charge and working on their projects; and
- Correct any deficiencies in the implementation of this procedure as identified by the Division Health and Safety (H&S) Leader or other staff member.

Project Manager: Responsible for the following elements:

- Perform observations of ERM work processes to assess employee compliance with this procedure;
- Stop work where deviations from this procedure are observed; and
- Correct, in conjunction with the PIC and the Division H&S Leader, any observed deficiencies in the implementation of this procedure.

Division H&S Leader: Responsible for the following elements:

- Evaluate implementation of this procedure during health and safety plan reviews and project audits; and
- Communicate identified deficiencies to the PIC.

3. Definitions

- **Temperature:** The dry bulb temperature in degrees Fahrenheit (°F) or Celsius (°C).
- **Frostbite:** Injury caused by freezing of the skin and underlying tissues.
- **Hypothermia:** A medical emergency that occurs when the body loses heat faster than it can produce it, creating a dangerously low internal body temperature, typically less than 95 °F (35 °C).

4. Procedure

Cold stress can present a significant hazard to workers and can result in hypothermia or frostbite. Several factors incorporate the harmful effects of cold, including wet clothing, smoking, drinking alcoholic beverages, fatigue, emotional stress and certain diseases and medications.

4.1 Classification and Prevention

4.1.1 Hypothermia

Hypothermia is a potentially life threatening condition which results in a drop in the body's core temperature. At lower body temperatures, the body can react by a reduction in mental awareness, reduced rational decision making, loss of consciousness, and death.

The signs and symptoms of hypothermia include shivering, dizziness, numbness, confusion, weakness, impaired judgment, impaired vision and drowsiness. The stages of hypothermia are shivering, apathy, loss of consciousness, decreasing pulse and breathing rates, and death

First aid measures for hypothermia include calling emergency medical services and moving the victim to a warm area and into dry clothing.

4.1.2 Frostbite

Frostbite is the most common injury caused by cold. It happens when ice crystals form in body tissues, usually the nose, ears, chin, cheeks, fingers, or foes. This restricts blood flow to the injured parts. The effect is worse if the frostbitten parts are thawed and then refrozen.

Signs and symptoms of frostbite include an initial slight flushing of the skin. The skin color then changes to white and then grayish blue. Pain is sometimes felt early but later goes away. The frostbitten parts feel very cold and numb, and the victim may not be aware of the injury. In severe cases, frostbite may result in blisters or gangrene.

First aid measures for frostbite include moving the victim to a warm area and placing the frozen parts in warm water (100 to 105 °F/37.8 to 40.5 °C). Handle them gently and do not rub or massage them. Loosely bandage the injured parts. Seek prompt medical attention.

4.2 Recognition, Prevention, and Control

The first signs of cold stress are pain in the extremities. Severe shivering may result as body temperature drops.

Protection from cold stress must be considered in addition to provisions for personal protective equipment. Provisions for insulating dry clothing must be provided, regularly inspected, and replaced as required.

Wind chill can substantially reduce the cooling rate experienced by personnel. Prevention of excessive cooling exacerbated by wind chill condition requires increased insulation value of the protective work clothing. The effects of wind chill and temperature can be referenced in S3-NAM-013-WI1 (***Equivalent Chill Temperatures***).

The following work practices should be followed to minimize the effects of cold stress conditions:

- Wear adequate layers of insulating dry clothing. Keep a change of dry clothes available in case clothing becomes wet. Ensure adequate supplies of cold weather gear are available and stocked.
- Use the buddy system to look for signs of cold stress.
- If appropriate, use windshields to reduce the effects of wind.
- Heated warming shelters should be available when the equivalent chill temperature (ECT) is less than 20°F (-29°C). See S3-NAM-013-WI1 for additional information.
- To prevent dehydration, which can increase the susceptibility of workers to cold injuries, warm sweet drinks and soups should be provided. Coffee and soft drink intake should be limited due to the diuretic effects.
- Consult S3-NAM-013-WI2 (Work/Warm-up Schedule) for guidance on applications of work/warming regimens in extreme cold situations (-15 °F/-26 °C).
- Ensure regularly-used travel pathways are kept as clear of snow and ice as practicable.
- Be aware of the hazards of unstable snow and ice buildup, and avoid working close to areas of accumulated snow and ice whenever possible

4.3 Training Requirements

Worker training should be provided to discuss the hazards of cold stress environments and to review preventative work practices. Training is conducted during daily tailgate safety meetings when working in cold environments. This ensures more effective and timely training than a once-annual session. The training should include:

- Proper clothing and PPE requirements;
- Recognition, prevention, and first aid treatment of frostbite and hypothermia, including a discussion of re-warming procedures;
- Suggested work/rest regimens and eating/drinking habits; and
- Safe work practices in cold stress environments.

5. References

- ERM Work Instruction S3-NAM-013-WI1 (Equivalent Chill Temperatures)
- ERM Work Instruction S3-NAM-013-WI2 (Work/Warm-up Schedule)

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Revision History

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All	New document.	6/8/15

1. Purpose and Scope

This procedure establishes minimum requirements for work in environments where exposures to heat stress are encountered and provides guidance to evaluate and control these stressors. This procedure is applicable to all North American operations, and will be made available to employees at the work site upon request.

2. Roles and Responsibilities

Partner in Charge (PIC): Responsible for the following elements:

- Ensure this procedure is implemented, understood, and followed by employees under their charge and working on their projects; and
- Correct any deficiencies in the implementation of this procedure as identified by the Division Health and Safety (H&S) Leader or other staff member.

Project Manager: Responsible for the following elements:

- Perform observations of ERM work processes to assess employee compliance with this procedure;
- Stop work where deviations from this procedure are observed; and
- Correct, in conjunction with the PIC and the Division H&S Leader, any observed deficiencies in the implementation of this procedure.

Division H&S Leader: Responsible for the following elements:

- Evaluate implementation of this procedure during health and safety plan reviews and project audits; and
- Communicate identified deficiencies to the PIC.

3. Definitions

- **Acclimatization** – The temporary adaptation of the body to work in the heat. Acclimatization peaks in most people within 4 to 14 days of regular work for at least two hours per day in the heat.
- **Heat Illness** – A serious medical condition resulting from the body's inability to cope with a particular heat load; includes heat cramps, heat rash, heat exhaustion, and heat stroke.

- **Environmental risk factors for heat illness** – Working conditions that create the possibility that heat illness could occur, including air temperature, relative humidity, radiant heat from the sun and other sources, conductive heat sources such as the ground, air movement, workload severity and duration, protective clothing and personal protective equipment worn by employees (e.g., impervious clothing vs. standard work attire).
- **Personal risk factors for heat illness** – Factors such as an individual's age, degree of acclimatization, health, water consumption, alcohol consumption, caffeine consumption, and use of prescription medications that affect the body's water retention or other physiological responses to heat.
- **Shade** – Blockage of direct sunlight. One indicator that blockage is sufficient is when objects do not cast a shadow in the area of blocked sunlight. Shade is not adequate when heat in the area of shade defeats the purpose of shade, which is to allow the body to cool. For example, a car sitting in the sun does not provide acceptable shade to a person inside it, unless the car is running with air conditioning. Shade may be provided by any natural or artificial means that does not expose employees to unsafe or unhealthy conditions and that does not deter or discourage access or use.
- **Temperature** – The dry bulb temperature in degrees Fahrenheit (°F) or Celsius (°C).

4. Procedure

4.1 Classification and Prevention

4.1.1 Heat Stroke

- Condition: (a) Hot dry red skin, (b) high and rising core temperature 105°F (40 °C) and over; and (c) brain disorders, including mental confusion, loss of consciousness, convulsions, or coma, as core temperature continues to rise. Fatal is treatment is delayed.
- Predisposing Factors: (a) Sustained exertion in heat by non-acclimatized workers; (b) obesity and lack of physical fitness; (c) recent alcohol intake; (d) dehydration; (e) individual susceptibility; and (f) chronic cardiovascular disease in the elderly.
- Corrective Actions: Immediate and rapid cooling by immersion in chilled water with massage or by wrapping in wet sheet with vigorous fanning with cool dry air. Avoid overcooling. Treat shock if present. Seek medical attention.
- Prevention: Medical screening of workers. Selection based on health and physical fitness. Acclimatization for 8 to 14 days by graded work and heat exposure. Monitoring workers during sustained work in severe heat environments.

4.1.2 Heat Exhaustion

- Clinical Features: (a) Fatigue, nausea, headache, giddiness; (b) skin clammy and moist, complexion pale, muddy, or with hectic flush; and (c) may faint on standing, with rapid pulse and low blood pressure.
- Predisposing Factors: (1) Sustained exertion in heat, (2) lack of acclimatization, and (3) failure to replace water and/or salt lost in sweat.
- Treatment: Remove to cooler environment. Provide fluids with electrolytes such as Gatorade™ or equivalent. Seek medical attention.
- Prevention: Acclimatize workers using a breaking-in schedule for 1 to 2 weeks. Supplement dietary salt only during acclimatization. Ensure ample drinking water, Gatorade™ or equivalent is available at all times and taken frequently during the day.

4.1.3 Heat Cramps

- Clinical Features: Painful spasms of muscles used during work (arms, legs, or abdominal). Onset can occur during or after work hours.
- Predisposing Factors: (1) Heavy sweating during hot work and (2) drinking large volumes of water without replacing salt loss.
- Treatment: Drinking liquids with salt supplement such as Gatorade™ or equivalent. Seek medical attention.
- Prevention: Adequate salt intake with meals. In un-acclimatized persons, provide salted (0.1 percent) drinking water.

4.1.4 Heat Rash

- Clinical Features: Profuse tiny raised red blisters on affected areas. Pricking sensations during heat exposure.
- Predisposing Factors: Unrelieved exposure to humid heat with skin continuously wet with un-evaporated sweat.
- Treatment: Seek medical attention.
- Prevention: Cooled resting and sleeping quarters to allow skin to dry between heat exposures.

4.2 Prevention Procedures

Working in a hot environment requires that employers take precautions and provide adequate protection to prevent heat stress. The following procedures should be utilized on ERM project sites to recognize and prevent heat stress conditions.

4.2.1 Monitoring and Risk Evaluation

- Track the weather forecast for the job site and use forecasted information to plan daily activities. Forecasts may be obtained from National Weather Service, Weather Channel, local news, or other available reliable source.
- Review this procedure at daily tailgate safety meetings, including:
  - Encouraging employees to drink plenty of water and not wait until they are thirsty,
  - Reminding employees of their right to take a cool-down rest in the shade when necessary,
  - Establishing the number and schedule of water and rest breaks, and
  - Reviewing the signs and symptoms of heat illness and emergency response procedures in the project-specific health and safety plan (HASP) with all workers onsite.
- Use a thermometer to measure the outdoor temperature in an area where there is no shade. While the temperature measurement must be taken in an area with full sunlight, the bulb or sensor of the thermometer should be shielded while taking the measurement (e.g., with the hand or some other object) from direct contact by sunlight.
- The U.S. Occupational Safety and Health Administration (OSHA) has made available a Heat Safety Tool for use on smartphones (https://www.osha.gov/SLTC/heatillness/heat_index/heat_app.html). The tool allows workers and supervisors to calculate the heat index for their worksite and, based on the heat index, display a risk level to outdoor workers. The tool also provides reminders about the measures that should be taken at that risk level to protect workers from heat-related illness.

4.2.2 Establishing Work Assignments and Work/Rest Regimens

- Make assignments for work involving physical labor and heat stress based on physical fitness level of available labor pool. Employees newly exposed to heat should begin their work level at 50% of suggested work schedule and increase level by 10% per day to allow for acclimatization.
- An employee who has been newly assigned to a high heat area should be closely observed by the supervisor or Field Safety Officer (FSO) for the first 14 days of the employee's employment.
- Supervision and the “buddy system” should be used to carefully observe workers in heat stress environments to evaluate each individual’s susceptibility to heat stress. Any employee exhibiting signs of heat stress should be promptly investigated.

- All employees shall be closely observed by the supervisor or FSO during a heat wave. For purposes of this section, "heat wave" means any day in which the predicted high temperature for the day will be at least 80 °F (27 °C) and at least 10 °F (5 °C) higher than the average high daily temperature in the preceding five days.
- Initiate a modified work/rest regimen when ambient temperatures and protective clothing create a potential heat stress hazard. If ambient temperatures are greater than or equal to 75°F, the following work/rest regimen is recommended (guidelines assume light to moderate work):

Temperature	Work Period	Rest Period
75 – 80 °F/24 – 27 °C	90 Minutes	15 Minutes
80 – 85 °F/27 – 29 °C	60 Minutes	15 Minutes
85 – 90 °F/29 – 32 °C	45 Minutes	15 Minutes
90 – 95 °F/32 – 35 °C	30 Minutes	15 Minutes

- Rest periods should be taken in a shaded area as described in Section 4.2.3 with open air movement, if available, as this will considerably reduce the effects of heat stress.
- Employees shall be allowed and encouraged to take a preventative cool-down rest in the shade for a period of no less than five minutes at a time when they feel the need to do so to protect themselves from overheating. Such access to shade shall be permitted at all times. An individual employee who takes a preventative cool-down rest:
  - Shall be monitored and asked if he or she is experiencing symptoms of heat illness;
  - Shall be encouraged to remain in the shade; and
  - Shall not be ordered back to work until any signs or symptoms of heat illness have abated, but in no event less than five minutes in addition to the time needed to access the shade.
- If an employee exhibits signs or reports symptoms of heat illness while taking a preventative cool-down rest or during a preventative cool-down rest period, the supervisor or FSO shall provide appropriate first aid or emergency response, as outlined in Section 4.2.5.
- Schedule physically demanding and strenuous tasks, or tasks requiring full-body chemical protection, for early in the day, if possible.
- Protective clothing inhibits the transfer of heat between the body and the surrounding environment. This can increase the onset of heat stress symptoms. The following

1. Purpose and Scope

This document establishes safe work procedures to be used by ERM to minimize injury resulting from various occupational hazards through the use of personal protective equipment (PPE). Other types of hazard mitigation – including elimination, substitution, engineering controls, and administrative controls – are the best methods of hazard mitigation; however, in many cases the nature of consulting requires the use of PPE to supplement or replace those methods.

This procedure is applicable to all ERM operations. Note that respiratory protection (***S3-NAM-026-PR***) and hearing protection (***S3-NAM-014-PR***) are covered in other procedures.

2. Roles and Responsibilities

Partner in Charge (PIC): Responsible for the following elements:

- Ensure this program is implemented, understood, and followed by employees under their charge; and
- Correct any deficiencies in the implementation of this procedure as identified by the Division Health and Safety (H&S) Leader.

Project Manager/Supervisor: Responsible for the following elements:

- Implement program during any project activities where the use of PPE is determined to be necessary;
- Perform observations of ERM work processes to assess whether or not employees are operating in accordance with this procedure; and
- Correct, in conjunction with the PIC and the Division H&S Leader, any observed deficiencies in the implementation of this procedure.

Division H&S Leader: Responsible for the following elements:

- Evaluate implementation of PPE during health and safety plan reviews and project audits; and
- Communicate identified deficiencies to the PIC.

Employee: Responsible for complying with the requirements stated within the procedure.

3. Definitions

None.

4. Procedure

4.1 Hazard Assessments

The PPE requirements for any work task will be addressed in the appropriate planning document, including health and safety plans (HASP) and job hazard analyses (JHA). Hazard assessments are performed by considering multiple basic types of hazards which may be able to the work scope. These include, but may not be limited to, impacts, heat or cold, penetration, dusts, compression, radiation, chemical hazards, and electrical hazards.

Site-specific HASPs will include information outlining the actual PPE requirements for the project, including those required by client-specific mandate. All project team members will be briefed on the elements of the site-specific HASP prior to participating in field activities. This briefing will include information on what PPE is required for the various project tasks.

A completed JHA addresses both the hazards specific to a job task and the appropriate controls, which may include PPE. All project team members are required to review the JHA prior to commencement of task-specific activities.

4.2 PPE Selection

Once hazards have been identified and evaluated though the hazard assessment process, the process of selecting PPE includes:

- Becoming familiar with the potential hazards and the types of PPE available to mitigate those hazards;
- Comparing available PPE to hazards associated with the project site;
- Selecting PPE meeting any applicable regulatory and client requirements that ensures a level of protection greater than the minimum required to protect employees; and
- Fitting the employees with proper, comfortable, and well-fitting PPE and instructing them on its use and care.

If conditions change on a project site or PPE fails for any reason, the PPE originally selected for employee protection must be re-evaluated. Re-evaluation should include the following elements:

- Levels of exposure, established through appropriate site monitoring;
- Adequacy of PPE originally selected;
- Number of hours PPE must be worn;
- Adequacy of training and fitting of PPE;
- Adequacy of PPE program records;
- Recommendations for H&S program improvement and modification; and

- Coordination with the overall H&S program.

4.2.1 Eye and Face Protection

When hazards present as a result of flying particulates, molten metal, liquid chemicals that are highly acidic or basic, chemical gases or vapors, or ionizing or nonionizing radiation, a combination of safety glasses, safety goggles, and/or face shields should be worn. For employees who wear prescription glasses, S3-NAM-021-WI1 (***Prescription Safety Eyewear***) provides additional details regarding purchase and care of prescription safety glasses.

4.2.2 Foot Protection

In most field situations, protective footwear should be worn by employees performing work in the field. Employees performing ancillary work activities, such as client meetings or work in the office environment at a client site, are not required to wear protective footwear unless client requirements dictate their use. S3-NAM-021-WI2 (***Protective Footwear***) provides additional details regarding selection and purchase.

4.2.3 Hand Protection

Gloves provide protection against a wide variety of hazards, including chemical exposure, burns, cuts, and other hand injuries. S3-NAM-047-PR (***Safe Use of Cutting Tools***) provides additional information on gloves types providing protection from cuts.

4.2.4 Head Protection

Hard hats approved by the American National Standards Institute (ANSI)/International Safety Equipment Association (ISEA) must be worn whenever a hazard exists from falling objects or other impact/bump hazards. The inner suspension of the hard hat must be inspected regularly and must ensure that at least 1 to 1-1/4” of gap exists between the suspension and the hard hat shell. ERM employees required to wear hard hats shall generally utilize Type 1 Class G (General) hard hats, although other types and classes may be appropriate based on site conditions.

4.3 Training

Employees shall receive training on PPE. Training topics include, but are not limited to:

- Routes of exposure;
- Categories of exposure;
- Selection of chemical protective clothing;
- Eye and face protection;
- Hand protection;

- Foot protection;
- Head protection;
- Limitations of PPE;
- Storage, cleaning, and maintenance of PPE;
- Proper donning and doffing procedures;
- Adjusting PPE and determining proper fit; and
- Disposal of PPE.

Retraining will be conducted if any of the following occur:

- Employee observed not using appropriate PPE for task;
- Employee observed using PPE in a manner that is inconsistent with previous training;
- Changes in types of PPE used; and
- New hazards identified at the site which required the use of a different level or type of PPE.

All training is tracked in ERM's Academy learning Management System (LMS).

4.4 Usage, Storage, and Maintenance

All PPE must be kept clean and properly maintained by the employee to whom it is assigned. PPE will be inspected, cleaned, and maintained by employees at regular intervals as part of their normal job duties. Project Managers are responsible for ensuring compliance with cleaning of PPE by employee working on their projects.

In ERM's typical role on projects, PPE does not become grossly contaminated. During projects where chemical contamination of PPE occurs, PPE will be decontaminated (if it is to be reused) or discarded in accordance with waste management practices for the project site. If gross contamination with liquid chemicals occurs, employees will immediately stop work and proceed to the decontamination area. Details of PPE and equipment decontamination are specified for each project in the site-specific HASP and/or JHA.

Change rooms and shower rooms are not typically required for ERM projects due to several factors, including the short duration and non-permanency of the projects. In the event change rooms and shower rooms are required for a project, details will be included in the site-specific HASP.

All PPE will be inspected prior to use and any damaged or defective PPE will not be used. All damaged or defective PPE will be immediately discarded.

4.5 ERM-Provided PPE

ERM provides PPE to our employees in accordance with applicable regulatory standards. Prescription safety glasses and protective footwear are subsidized (see ***S3-NAM-021-WI1*** and ***S3-NAM-021-WI2***, respectively). Employees are discouraged from providing their own PPE. Employees are responsible for ensuring that ERM-provided PPE is maintained and replaced as needed. During routine inspections of field-based activities, the Field Safety Officer (FSO), Project Manager, or Division HSSE Leader will observe the condition of employee PPE.

5. References

- ERM Work Instruction S3-NAM-021-WI1 (***Prescription Protective Eyewear***)
- ERM Work Instruction S3-NAM-021-WI2 (***Protective Footwear***)
- ERM Work Instruction S3-NAM-021-WI3 (***Selection, Care, and Use of Flame-Resistant Clothing***)
- ERM Procedure S3-NAM-047-PR (***Safe Use of Cutting Tools***)

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All	New document.	2/10/15
All	Reformatted to meet ERM Global standards; language changes for clarity	1/14/16

consideration should be evaluated when protective clothing is worn in heat stress environments.

- More frequent rest breaks in the shade;
- Worker rotation to provide frequent breaks in cool areas;
- Wear ice vests or vortex tubes, if practical; and
- Schedule changes to accommodate work at night or early morning hours.

4.2.3 Provision of Water and Shade

- Employees shall have access to potable drinking water that is fresh, pure, suitably cool, and provided to employees free of charge. The water shall be located as close as practicable to the areas where employees are working. Where drinking water is not plumbed or otherwise continuously supplied, it shall be provided in sufficient quantity at the beginning of the work shift to provide one quart per employee per hour for drinking for the entire shift. Supervisors or FSOs may begin the shift with smaller quantities of water if they have effective procedures for replenishment during the shift as needed to allow employees to drink one quart or more per hour. The frequent drinking of water shall be encouraged.
- When the outdoor temperature in the work area exceeds 80 °F (27 °C), the supervisor or FSO must establish and maintain one or more areas with shade at all times while employees are present that are either open to the air or provided with ventilation or cooling. The amount of shade present shall be at least enough to accommodate 25% of the number of employees on recovery or rest periods, so that they can sit in a normal posture fully in the shade without having to be in physical contact with each other. The shade must be located as close as practicable to the areas where employees are working.
- When the outdoor temperature in the work area does not exceed 80 °F (27 °C), the supervisor or FSO must either provide shade or provide timely access to shade upon an employee's request.
- Where it is infeasible or unsafe to have a shade structure, or otherwise to have shade present on a continuous basis, the project team may utilize alternative procedures for providing access to shade if the alternative procedures provide equivalent protection. Cooling measures other than shade (e.g., use of misting machines) may be provided in lieu of shade if these measures are at least as effective as shade in allowing employees to cool.

4.2.4 High Heat Procedures

When the temperature equals or exceeds 95 °F (35 °C), the following procedures will be implemented to the extent practicable:

- Ensuring that effective communication by voice, observation, or electronic means is maintained so that employees at the work site can contact a supervisor or the FSO when necessary. An electronic device, such as a cell phone or text messaging device, may be used for this purpose only if reception in the area is reliable.
- Observing employees for alertness and signs or symptoms of heat illness. The ERM project team must ensure effective employee observation/monitoring by implementing one or more of the following:
  - Supervisor or FSO observation of 20 or fewer employees,
  - Mandatory buddy system,
  - Regular communication with sole employee such as by radio or cellular phone, or
  - Other effective means of observation.
- Designating one or more employees on each worksite as authorized to call for emergency medical services, and allowing other employees to call for emergency services when no designated employee is available.
- Reminding employees throughout the work shift to drink plenty of water.
- Reviewing the heat stress procedures at daily tailgate safety meetings, encouraging employees to drink plenty of water, and reminding employees of their right to take a cool-down rest when necessary.

4.2.5 Emergency Response Procedures

- If a supervisor or FSO observes, or any employee reports, any signs or symptoms of heat illness, the supervisor or FSO must take immediate action commensurate with the severity of the illness.
- When an employee displays possible signs or symptoms of heat illness, the supervisor or FSO will check the employee and determine whether resting in the shade and drinking cool water will suffice or if emergency service providers will need to be called. WorkCare Incident Intervention (888-449-7787) should also be contacted to provide guidance on appropriate care.
- An employee exhibiting signs or symptoms of heat illness must be monitored and not left alone or sent home without being offered onsite first aid and/or being provided with emergency medical services in accordance with the site HASP.
- If the signs or symptoms are indicators of severe heat illness (such as, but not limited to, decreased level of consciousness, staggering, vomiting, disorientation, irrational behavior or convulsions, incoherent speech, red and hot face), the supervisor or FSO must implement emergency response procedures outlined in the HASP. Emergency

service providers must be contacted immediately, and while the ambulance is in route, initiate first aid (follow guidance in Section 4.1.1).

- In the event a heat stress related incident or near miss occurs, the supervisor or FSO will notify the PIC and PM and report the event following guidelines in the HASP.

4.3 Training Requirements

All field employees, including supervisors, shall be provided training on heat stress and working in hot environments in the language that they understand. Training shall be provided prior to working in hot environments and will be documented in ERM's Academy Learning Management System (LMS). Employee training to recognize heat stress conditions and the methods necessary to prevent and treat heat stress include:

- The environmental and personal risk factors for heat illness, as well as the added burden of heat load on the body caused by exertion, clothing, and personal protective equipment.
- How to monitor weather reports and how to respond to hot weather advisories.
- The procedures for providing water, shade, cool-down rests, and access to first aid as well as the employees' right to stop work without retaliation.
- The importance of frequent consumption of small quantities of water, up to four cups per hour, when the work environment is hot and employees are likely to be sweating more than usual in the performance of their duties.
- The concept, importance, and methods of acclimatization.
- The different types of heat illness, the common signs and symptoms of heat illness, and appropriate first aid and/or emergency responses to the different types of heat illness.
- The importance to employees of immediately reporting any symptoms or signs of heat illness in themselves or in co-workers.
- ERM procedures contained in the HASP for responding to signs or symptoms of possible heat illness, including how emergency medical services will be provided should they become necessary.

5. References

- California Division of Occupational Safety and Health (Cal/OSH) Heat Illness Prevention Standard – California Labor Code Section 226.7

Document Control Information

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Approval Signature: _____

Revision History

Section	Reason for Revision	Date
All	New document.	4/26/10
All	Reformatted document. Edits for clarity; addition of new regulatory information,	6/5/15
4.2.1; 4.2.2; 5	Deleted references to ACGIH TLVs; language added confusion to implementation of procedure	6/8/16

1. Purpose and Scope

This procedure describes:

- Contractor health, safety, security, and environmental (HSSE) performance expectations;
- The pre-evaluation process for approval of contractors, their safety programs, and their insurance documents;
- The evaluation of contractor safety performance while working for ERM; and
- The responsibilities of the ERM project team with respect to implementation of this program and oversight of contractor safety.

The procedure applies to all ERM work activities which are contracted to an outside firm, except those specifically excluded elsewhere in this document. This procedure does not apply to third party contractors which may be working on the same site as ERM, but do not have a contractual relationship with ERM.

2. Roles and Responsibilities

Partner in Charge (PIC): Responsible for the following elements:

- Ensure a contractor management program is implemented, understood, and followed by employees under their charge and working on their projects;
- Appoint a Project Manager/Supervisor who will manage all aspects of conformance with the procedure;
- Approve and execute contractor agreements for each contractor working on ERM projects/sites and may participate in negotiations, as necessary;
- Assess, in conjunction with the Project Manager/Supervisor, the performance of ERM contractors based on observations and assessments in the field;
- Correct, in conjunction with the Project Manager/Supervisor, any observed deficiencies in the performance of the ERM contractor; and
- Correct any deficiencies in the implementation of the program as identified by the Division HSSE Leader.

Project Manager/Supervisor: Responsible for the following elements:

- Perform observations of contractor work processes to assess whether or not the contractor is operating in accordance with applicable health and safety requirements;

- Verify contractors are approved to provide services to ERM as established by ERM's Global Contractor Management Program.;
- Communicate ERM and client driven HSE requirements to project contractors by providing the standard contractor agreement or a project- or client-specific contractor agreement during project planning or scoping;
- Understand and confirm the competency of ERM contractor staff who will be providing field project support;
- Request required documentation from contractors as defined in any project-specific agreements (i.e., Contractor Health and Safety Plans, Job Hazard Analyses (JHAs), work procedures, etc.);
- Interact with and mentor contractors during the working relationship;
- Evaluate best practices provided by contractor personnel for potential inclusion in project work planning;
- Stop work where deviations from accepted health and safety requirements are observed;
- Correct, in conjunction with the PIC and the Division HSSE Leader, any observed deficiencies in the performance of the contractor;
- Work with the contractor to complete incident investigations and, where needed, root cause evaluations, for incidents and high-value near misses which occur on ERM job sites; and
- Contact ERM Legal in the event of serious or repeated breaches of health and safety requirements and assess whether action is warranted under the contract.

Division HSSE Leader: Responsible for the following elements:

- Evaluate implementation of these policies during health and safety plan reviews and project audits; and
- Communicate identified deficiencies to the PIC.

ERM Staff: Responsible for the following elements:

- Attend and interact with contractors during safety meetings to ensure that the scope of work, risks and precautions are understood by all project participants;
- Raise any concerns of job performance with the project management and contractors as established in the project communications plan, including implementing stop work authority if there is an imminent risk of injury or property damage; and
- Utilize the Event Communication System (ECS) to report any incidents, near misses, unsafe acts and conditions and remarkable safe behaviors observed during work with contractors.

3. Definitions

A contractor is defined as a person or company engaged by ERM for work or services billed to a project, or work or services for ERM in an ERM office. The term "contractor" may include contractors, subcontractors, consultants, sub-consultants, vendors, and suppliers.

Companies that provide a professional service to ERM such as accounting, legal or professional services, travel planning, taxis, etc., or who provide a supply service to ERM offices, such as non-operated equipment rental, coffee vending, food vending, water cooler vending, etc. are not considered contractors under this procedure.

4. Procedure

4.1 Contractor Prequalification and Selection

Contractors desiring to perform work for ERM shall be required to be pre-qualified in accordance with ERM's Global Contractor Management Program. In the USA, Pacific Industrial Contractor Screening (PICS), a third-party service provider, qualifies and maintains updated information about suppliers and contractors based on the requirements of its clients. Contractors will submit a variety of information to PICS, including insurance limits, OSHA logs, safety and training programs, bonding capability, and diversity information. Potential contractors also have to agree to adhere to ERM's policies, including our Anti-Bribery and Corruption (ABC) Policy and Business Conduct and Ethics Agreement, and Subsurface Clearance Program (as applicable).

PICS shall evaluate the information provided by the proposed contractor and compares it to a detailed list of requirements provided by ERM. Information submitted by the contractor must be updated at least annually.

ERM's minimum safety criteria for US firms are as follows:

- No fatalities in the past 5 years;
- A Total Recordable Incidence Rate (TRIR) at or below the industry average for the past 3 years based on North American Industrial Classification System (NAICS) code;
- A Days Away/Restricted/Transfer (DART) rate at or below the industry average for the past 3 years based on NAICS code;
- An Experience Modification Rate (EMR) at or below 1.0 for the past 3 years; and
- No open or unresolved regulatory citations within the past 3 years.

Companies that service ERM offices such as coffee vendors, vending machine companies, water cooler vendors, etc. do not have to be qualified under this procedure. Additionally, retailers providing point-of-sale purchases (e.g., purchase of a tool from Home Depot) do not have to be qualified under this procedure.

Further information on prequalification can be found on the Contractor Prequalification Health and Safety Prequalification Process section of the Americas Health and Safety page on Minerva.

4.2 Contractor Interactions/Expectations

The Project Manager/Supervisor must ensure that the contractor is provided with necessary information to work safely, including, but not limited to:

- ERM contact name and phone number;
- ERM health and safety requirements;
- Client health and safety requirements (including any drug and alcohol policies);
- Site-specific emergency action plans; and
- Safety information from other ERM contractors or third-party contractors at the site.

The Project Manager/Supervisor must ensure that contractor personnel participate in site-related safety meetings, including pre-job meetings, safety orientations, daily tailgate safety meetings, and any job-related safety inspections.

Contractors must conform to all regulatory and policy driven HSSE requirements. Contractors are contractually and legally responsible for providing personnel who are qualified to meet or exceed the expectations of ERM and customer work scopes. Contractor agreements are used to clearly define contractor accountabilities and responsibilities.

Contractors are expected to conform to their internal HSE policies and requirements as well as those of ERM and ERM clients. Where conflicts exist between these policies and requirements, contractors must adhere to the most stringent policy and requirement. Where needed, the contractor should have the capability to develop additional safety procedures or hazard assessments for work that is performed exclusively by their employees and for which they may have superior knowledge.

Contractors will provide, upon request and at the time of proposing services, a description of their HSSE system, as well as resumes, training certificates, course rosters, and other documents confirming contractor employee qualifications and competencies. ERM or our selected pre-qualification vendors may audit these systems and documentation for conformance with defined expectations. Contractors will be provided the opportunity to close any gaps identified during this evaluation and Project Managers/Supervisors will ensure gaps are closed before work begins.

4.3 Assessment of Contractor Performance

The Project Manager/Supervisor should regularly assess the contractor's operations to determine their level of compliance with applicable health and safety requirements. This should also include a review of required health and safety documentation. Assessment can be performed directly by the Project Manager/Supervisor or delegated to appropriate field staff. ERM's Health and Safety Guidance Document #33 (Health and Safety Audits) or equivalent must be used to conduct and document contractor operations.

Where ERM personnel observe safety events (i.e., incidents, near misses, unsafe acts/conditions) related to contractor operations, they should bring the events to the attention of ERM's Project

Manager/Supervisor as well as the contractor management team for immediate resolution. Events should also be posted in ERM's Event Communication System (ECS). Staff shall take the opportunity to also note remarkable safe behaviors to leverage positive activities for continuous improvement in projects.

The Project Manager/Supervisor will evaluate the contractor's performance following completion of the contracted work activities. If a contractor's performance is such that the PIC or the Project Manager/Supervisor feels that they should be barred from further use by ERM, a formal variance should be sent to the Division Managing Director (DMD) providing the reasons for the request. The DMD will make a decision regarding the contractor after consultation with appropriate ERM team members and can decide to change the contractor's approval flag status in ERM's Global Contractor Management System.

5. References

- PICS – www.picsauditing.com/
- ERM PICS Representative – Angela Wittman (awittman@picsauditing.com; 832-547-2710)
- ERM Health and Safety Guidance Document 33 (Health and Safety Audits)
- ERM Master Contractor Selection Flowchart
- ERM Variance Request Flowchart
- ERM Contractor Management Program Frequently Asked Questions (FAQs) Document

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Approval Signature: _____

Revision History

Section	Reason for Revision	Date
All	New document	3/6/14
All	Revised format to meet new Global SMS requirements	7/3/14
All	Changed “subcontractor” to “contractor” throughout; addressed comments of Regional H&S Director	8/1/14
4.2	Updated to include transmission of client’s drug and alcohol policies	5/19/15

1. Purpose and Scope

This procedure establishes minimum requirements for work with hand tools and portable powered equipment. The purpose of this procedure is to ensure that hand tools and portable power equipment meet minimum safety requirements, are used in a the manner for which they are intended, and are maintained in a safe condition. This procedure is applicable to all North American operations.

2. Roles and Responsibilities

Partner in Charge (PIC): Responsible for the following elements:

- Ensure this procedure is implemented, understood, and followed by employees under their charge and working on their projects; and
- Correct any deficiencies in the implementation of this procedure as identified by the Division Health and Safety (H&S) Leader or other staff member.

Project Manager: Responsible for the following elements:

- Perform observations of ERM work processes to assess employee compliance with this
- procedure;
- Stop work where deviations from this procedure are observed; and
- Correct, in conjunction with the PIC and the Division H&S Leader, any observed deficiencies in the implementation of this procedure.

Division H&S Leader: Responsible for the following elements:

- Evaluate implementation of this procedure during project audits; and
- Communicate identified deficiencies to the PIC..

3. Definitions

Portable Power Equipment: Electric, pneumatic, gasoline or explosive-actuated hand tools.

Ground Fault Circuit interrupters (GFCI): A device that shuts off an electric power circuit when it detects that current is flowing along an unintended path, such as through water or a person.

Underwriters Laboratories (UL): A global product safety testing and certification organization.

4. Procedure

4.1 General Equipment Requirements

- All hand and portable power tools shall be maintained in safe working order and used only for the task for which they were designed.
- Hand and portable power tools, power supplies, and flexible cord sets (extension cords) shall be inspected prior to each use to identify any defects. Damaged or defective tools shall be immediately removed from service and identified through tagging or lockout of controls.
- Tool surfaces and handles shall be kept clean and free of dirt, grime, and excess oil to prevent slipping.
- Tools shall be cleaned and properly stored when not in use to prevent possible injuries and tool damage.
- Non-sparking tools shall be used in atmospheres with fire or explosive characteristics.
- Eye protection shall be used at all times during tool operation. Additional personal protective equipment (PPE) appropriate to the tool operation or work task shall be required and used, including face shields, hearing protection, respiratory protection and protective gloves.

4.2 Hand Tool Use

- Do not force tools beyond their capacity or use cheater bars or other instruments to increase their capacity.
- Do not use hand tools as pry bars.
- Do not throw tools from place to place or person to person.
- Do not drop tools from heights.
- Ensure that hands, fingers, and other body parts are out of the line of fire during tool usage.
- Brace yourself when using the tool in case the tool slips.

4.2 Portable Power Tool Use

- Loose clothing, long hair, loose jewelry, rings and chains are not allowed while working with power tools.
- Hands shall be kept clear of all cutting, rotating, or moving parts of powered tools.

- Portable power tools shall be safety tested and certified by Underwriters Laboratories (UL) or an equivalent authority.
- Electric power tools must be either double-insulated or equipped with a 3-wire grounded wiring and plug.
- Adapters which interrupt the continuity of the equipment grounding connection shall not be used.
- Tools shall only be used with a GFCI or a GFCI adapter. Do not handle wet cords and power tools unless they have been deenergized.
- Guards and safety devices provided by tool manufacturers shall not be removed or modified in any way which may interfere with their intended function.
- Portable equipment shall be handled in a manner which will not cause damage. Flexible electric cords shall not be used for raising or lowering the equipment and cords should not be fastened in any way that potentially damages the outer jacket or insulation.

5. References

- Occupational Health and Safety Adminsitration (OSHA) Regulation 29 CFR 1910 Subpart P (Hand and Portable Powered Tools and Other Hand-Held Equipment)
- OSHA Regulation 29 CFR 1926 Subpart I (Tools – Hand and Power)

Document Control Information

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Revision History

Section	Reason for Revision	Date
All	New document.	6/29/2015

1. Purpose and Scope

This document establishes the procedures for implementing ERM's incident management strategy in the event of an injury or illness. Developing a strong incident management process is an essential part of promptly responding to occupational injuries and illnesses. This document applies to all ERM field and office locations.

2. Roles and Responsibilities

Partner in Charge (PIC): Responsible for the following elements:

- Ensure the procedure is implemented, understood, and followed by employees under their charge and working on their projects; and
- Correct deficiencies in the implementation of the procedure as identified by the Division Health, Safety, Security, and Environment (HSSE) Leader.

Project Manager (PM)/Supervisor/Branch Manager (BM): Responsible for the following elements:

- Perform observations of ERM work processes to assess whether or not employees are operating in accordance with the procedure; and
- Correct, in conjunction with the PIC and the Division HSSE Leader, any observed deficiencies in the implementation of the procedure.

Division HSSE Leader: Responsible for the following elements:

- Evaluate implementation of the procedure by Division personnel during ECS reviews; and
- Communicate identified deficiencies to the PIC and Divisional management teams.

Employee: Responsible for the following elements:

- Report work-related injuries/illnesses as soon as possible to their PM/Supervisor/BM;
- Comply with the requirements of the procedure during response to injury/illness events;
- Work with the ERM management, HSSE, and Human Resources (HR) teams to ensure the best outcome for the employee; and
- Notify the ERM management, HSSE, and HR teams of any change in injury/illness status, as well as providing copies of any appropriate paperwork supporting these changes from medical professionals.

3. Definitions

- Work-related injury/illness – An injury or illness that arises out of and in the course of employment.
- Injury – A wound caused by an external force that affects a specific part of function of the body and has an identifiable time and place.
- Illness – Systemic infections, exposure to hazardous materials, repeated stress and strain, and/or other repeated exposures to conditions that result in harm or loss of function, but do not meet the definition of an injury.

4. Procedure

4.1 Pre-Injury Management

4.1.1 Work Site Evaluation

Project sites and offices shall evaluate a location for the potential to cause an injury or illness. This evaluation must consider the following, at a minimum:

- The types of injury or illness that could reasonably occur under given site conditions;
- The location of emergency and non-emergency medical centers;
- The anticipated response time for local emergency services (e.g., ambulance, paramedics, site emergency teams, etc.);
- The presence of hazardous materials or conditions;
- The types of training needed for employees to respond to identified hazards;
- The type of training needed for first aid responders; and
- The type of first aid supplies required for potential response to site hazards.

4.1.2 Risk Assessment

A written Work Activity Risk Assessment (WARN) health and safety plan (HASP) must be prepared for all field projects. The HASP must contain contact information, including maps and phone numbers, for the nearest emergency medical services/hospital location, as well as for potentially needed emergency services (e.g., fire department, police, ambulance) and for Workcare, ERM's medical services provider. Advance contact with ambulance services to ensure they are familiar with location, access routes, and hospital locations is advised in remote or new locations.

An Emergency Action Plan (EAP) must be prepared for all ERM office locations. Since ERM offices are typically located in well-populated urban centers, the location of specific emergency medical services locations are not required to be posted in the EAP; however, emergency contact

information for potentially needed emergency services, building management staff, and Workcare must be provided.

4.1.3 First Aid Services

The availability and application of first aid services, including first aid kits, is discussed in Section 4.1 of ERM H&S Procedure S3-NAM-019-PR (***Medical Services***).

4.1.4 First Aid Responders

Expectations regarding the availability of first aid responders in both field and office settings are discussed in Section 4.1.1 of ERM Procedure S3-NAM-019-PR (***Medical Services***). Trained first aid responders should be designated in such a fashion that employees know who they are and how to contact them.

4.1.5 Eyewash Facilities

If corrosive materials are used, eyewash and body flush facilities must be provided. Where possible, these should provide large quantities of clean water. The water source must be pressure controlled and clearly identified.

4.2 Post-Injury Management

4.2.1 Transportation

When employees require urgent medical attention as the result of a work-related injury/illness, transportation shall be provided to the urgent care facility via ambulance or similar method (if a critical condition) or ERM vehicle. Employees should not be permitted to drive themselves unless safe to do so.

4.2.2 Treatment of Critical Injury/Illness

In the event of a critical injury or illness, employees must be seen by a medical professional as quickly as possible. For purposes of this procedure, critical injuries shall include, but not be limited to:

- Uncontrolled bleeding or significant blood loss;
- Chest pains;
- Breathing difficulty;
- Known or suspected bone fractures;
- Known or suspected internal injuries;
- Known or suspected overexposure to chemical, biological, or radiological hazards;
- Severe electric shock or electrocution;
- Second, third, or fourth degree thermal, chemical, electrical, or radiation burns;
- Loss of consciousness; or

- Sudden behavioral changes, including confusion, disorientation, or aggression.

In these situations, an ERM employee should always accompany the injured or ill employee to medical care. The accompanying employee should contact Workcare, ERM's medical consultant, as soon as possible to alert them to the injury. Where necessary, Workcare's occupational physicians will provide peer-to-peer interaction with emergency room physicians to ensure appropriate care is provided to our employees. The accompanying employee shall also be responsible for maintaining contact with appropriate ERM management and H&S team members to alert them to issues relating to the injured/ill employee and their condition.

4.2.3 Treatment of Non-critical Injury/Illness

In the event of a non-critical injury or illness, employees must call Workcare's Incident Intervention service (available 24 hours per day, 7 days per week). When contacted, an occupational nurse or physician provides medical advice to the injured or ill employee, which may include a referral to a medical clinic. If referral is required, Workcare's occupational physicians will provide peer-to-peer interaction with medical clinic physicians to ensure the level of care and treatment is appropriate to the symptoms presented. The employee is also responsible for maintaining contact with appropriate ERM management and H&S team members to alert them to issues relating to their condition.

4.2.4 Workers' Compensation

A workers' compensation claim will be filed for each instance where work-related medical treatment is provided to ERM employees. The HR team will be responsible for filing these claims, and will be informed by Workcare whenever a referral to a medical clinic is made for an ERM employee. Additionally, HR staff will:

- Serve as a point of contact for the workers' compensation insurance carrier adjuster; and
- Work with ERM providers to coordinate disability benefits associated with work-related injury/illness.

4.2.5 Return to Work

Employee supervisors, after consultation with the Division HSSE Leader and the HR team, may assign an employee who is recovering from a work-related injury or illness transitional employment during their recovery period, if such employment exists. Transitional employment includes temporary modified, restricted, or light duty work covering the time from the injury/illness until the release to full duty by the doctor. Each case will be evaluated individually.

Application of any transitional employment must be documented in writing and signed by a medical doctor before any action can be taken. The change in status will only be allowed for the period of time designated by the doctor. The employee must continue to comply with all doctor-mandated appointments and treatment during this time. Any changes in duty status as a result of an appointment or treatment visit must be provided to the employee supervisor in writing.

At a minimum, and regardless of the employee's current case status (i.e., lost time, restricted duty, etc.), the employee's supervisor will maintain contact with the employee on a weekly basis

A written work release for full and unrestricted duty from a medical doctor is required before the injured/ill employee may return to their original job duties.

5. References

- ERM Work Instruction S3-NAM-037-WI1 (***Injury/Illness Management Flow Chart***)

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Approval Signature: _____

Revision History

Section	Reason for Revision	Date
All	Revised and edited to meet new Global SMS requirements and update procedures	8/5/14
All	Changed “Case Management” to “Injury/Illness Management”.	12/30/14
Intro, 4, 5	Updated Applicability. Updated references in Sections 4 and 5.	1/12/16

	Applicability:	Form	Document Number:	Version:
ERM	North America		S3-NAM-038-FM1	2
	Title:	**Pre-Mobilization Activities**	**Last Revision Date:**	6/25/15

		Date Completed	Completed By	Applicable Regulatory References
General				
1	Estimate the expected quantities of each different waste type that may be generated during the job.			
2	Evaluate the potential for recycling/reuse of any wastes generated, as well as any requirements for such.			
3	Determine containment/cover/storage requirements for each type of waste.			
4	Verify which wastes will be placed in client-provided containers for management by the client and which waste ERM will need to containerize.			
5	Develop plan for segregating wastes as needed to facilitate proper handling and ultimate disposal or recycling.			
6	Instruct members of the project team that will be responsible for waste management activities on the requirements for proper waste handling and disposal as established in the project-specific waste management plan.			
Transport				
1	Verify if the waste material is hazardous or nonhazardous. If you are unsure how to make this determination, consult an ERM waste characterization expert.			
2	Verify that all analytical data needed to properly characterize each waste type has been collected.			
3	Verify waste shipment origin, destination, and transit route are within the country of origin only.			
4	Verify proposed disposal facility is on client-approved waste site list (if applicable) and qualified for type of waste.			
5	Verify transporter is licensed to haul the waste and that they have the correct State and Federal numbers.			
6	Verify who will sign the waste profiles and manifest prior to submittal to disposal facility.			
7	If client is not signing profiles or manifest, verify that a "Letter of Authorization" from the client has been completed and signed, identifying ERM as the authorized entity for the manifesting.			
8	If ERM is authorized to sign manifests for the project, and any of the waste are classified as hazardous, identify specific personnel with proper DOT (or other) training.			

	Applicability:	Form	Document Number:	Version:
ERM	North America		S3-NAM-038-FM2	2
	Title:	**Project Execution Activities**	**Last Revision Date:**	6/25/15

		Date Completed	Completed By	Applicable Regulatory References
Profile: To be completed when a new waste profile is prepared.				
1	Verify waste profile exists and proposed disposal facility has accepted profile. If not, prepare profile as indicated.			
2	Obtain waste profile form from selected waste disposal facility.			
3	Determine/obtain waste code(s).			
4	If requested by disposal facility, assemble analytical and/or TCLP data characterizing the constituent makeup of the waste (to be submitted with final profile).			
5	Verify waste profile will be signed by a DOT HM 126-trained and client-authorized employee or representative.			
6	If client is not signing profile, verify "Authorized Agent on behalf of" is written on the signature line on the profile.			
7	ERM Project Manager has reviewed the profile.			
8	ERM Partner-In-Charge has reviewed the profile.			
9	Submit profile to disposal facility for review and approval.			
Transport: To be completed in the field at the time of transport for disposal or recycling.				
1	Verify waste manifest is prepared correctly:			
	• Use Federal Uniform Hazardous Waste Manifest for hazardous waste and the disposal facilities' approved manifest for nonhazardous waste.			
	• Verify manifest will be signed by a DOT HM 126 trained and client-authorized employee representative.			
	• Verify "Authorized Agent on behalf of" is written on the signature line of the manifest.			
2	Verify that appropriate labels have been placed on the waste containers prior to transport.			
3	Verify correct quantity for disposal is written on manifest.			
4	Verify transporter signed and dated manifest.			
5	Verify that an authorized signature and current dates are on the manifest.			
6	Verify you have the generator's copy of the manifest with the transporter's signature.			

1. Purpose and Scope

This procedure outlines general planning steps that should be followed on projects where ERM's activities (or those of ERM's contractors) are likely to create wastes or where ERM has taken some contractual responsibility for handling waste for the client. ERM generally does not generate significant hazardous or non-hazardous waste as part of its operations, since ERM's role is typically limited to supporting waste management activities of the client (owner or responsible party). In those situations, ERM does not direct or control waste management activities, but will use the waste management plan developed by the client.

This procedure is not intended to address all possible waste management situations. Project-specific adjustments may need to be made as appropriate depending on specific circumstances.

2. Roles and Responsibilities

Partner in Charge (PIC): Responsible for the following elements:

- Ensure this procedure is implemented, understood, and followed by employees under their charge and working on their projects; and
- Correct any deficiencies in the implementation of this procedure.

Project Manager: Responsible for the following elements:

- Perform observations of ERM work processes to assess employee compliance with this procedure;
- Stop work where deviations from this procedure are observed; and
- Correct, in conjunction with the PIC, any observed deficiencies in the implementation of this procedure.

3. Definitions

None.

4. Procedure

For projects described in Section 1, a waste management plan specific to the project activities should be developed. The plan should address the following basic elements:

- Assessment of the nature and type of waste;
- Estimate of the amount of each waste that may be created;

- Evaluation of the proper handling, storage, transportation and disposal methods appropriate to manage the various wastes;
- Sampling, analysis, and proper characterization of any wastes and interface with the client to confirm storage, transportation, and disposal requirements; and
- Arrangement for proper manifesting and transportation of the materials.

The waste management plan will be reviewed and approved by the PIC and, where necessary, the client prior to execution.

4.1 Pre-Mobilization

Prior to mobilizing to the field, a project health and safety plan (HASP) must be developed, in accordance with S3-NAM-029-PR (***Project Health and Safety***) to assess the potential hazards associated with the operations that will be undertaken during the project. As part of the review of project hazards, the ERM Project Manager and PIC will evaluate the project scope to assess whether the project will likely involve waste generation by ERM or if ERM will be directly responsible for managing wastes.

If the evaluation indicates that ERM or its contractors will be generating wastes or will be responsible for waste management, the applicable portions of S3-NAM-038-FM1 (***Pre-Mobilization Activities***) will be factored into the project-specific waste management plan. The form provides guidance on the subtasks that generally should be followed during the pre-mobilization phase of the project to address waste management requirements.

Depending on the complexity of the project and client requirements, S3-NAM-038-FM1 may be replaced with a more detailed document that addresses each element in S3-NAM-038-FM1, as needed. The documentation will then be combined with the project execution phase (Section 4.2) to complete the project-specific waste management plan.

4.2 Project Execution

The waste management plan must anticipate activities to be conducted in project execution and set the stage for carrying them out within the framework of the overall plan. A general proposed format for including the necessary components in the plan to address such activities is presented in S3-NAM-038-FM3 (***Project Execution Activities***).

Following the project execution phase and depending on the nature of the project, it may be appropriate to prepare a waste management report. Such a report would provide a discussion on the types, amounts, and disposition of wastes that were handled during the work. The specific format and content of such a report should be discussed with and approved by the client.

5. References

- ERM Form S3-NAM-038-FM1 – ***Pre-Mobilization Activities***
- ERM Form S3-NAM-038-FM2 – ***Project Execution Activities***
- ERM Procedure S3-NAM-029-PR – ***Project Health and Safety***

Document Control Information

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Policy Approval by: Mark Hickey

Approval Signature: _____

Revision History

Section	Reason for Revision	Date
All	New document.	6/9/11
All	Reformatted document. Revision of document language in several areas.	6/25/15

1. Purpose and Scope

This document provides information on the calibrating and testing of direct-reading portable monitors. These instruments are designed to alert employees to the presence of toxic gases, vapors, and particulates; oxygen-deficient atmospheres; and combustible atmospheres. Examples may include photoionization detectors (PIDs), single gas monitors, multi-gas meters, particulate/handheld aerosol monitors, etc. Inaccuracies in the instrument due to improper maintenance and calibration can lead to hazardous atmospheric conditions which may cause serious injuries, illnesses, or death.

2. Definitions

Calibration – A test measuring an instrument's accuracy relative to a known traceable standard.

Bump test – Qualitative check in which a challenge agent is passed over an instrument's sensors at a concentration and exposure time sufficient to active all alarm settings. The purpose of the bump test is to confirm that the test gas can get to the sensor(s) and that the instrument's alarms are functional. The bump test does not does not provide a measure of the instrument's accuracy.

Response Time – The amount of elapsed time between the exposure of an instrument to the atmosphere and the corresponding display of the final observed value based on conditions at the time of measurement.

Zeroing – A procedure which resets the instrument's reference points. Depending on the instrument, this may require either introduction of a zero air gas (gas containing no or minimal traces of the gas or vapor the instrument is designed to detect) or installation of a zero air filter (a filter designed to remove all particulate from the measured atmosphere).

3. Calibration Procedures

There are two methods for verifying the accuracy of a direct read instrument – a calibration check and a full calibration. Each of these methods is appropriate in certain situations.

The employee should begin by zeroing the instrument. The process of zeroing should be described in the instrument manufacturer's calibration instructions. This helps to ensure that the calibration is accurate.

A calibration check verifies that the sensor(s) and alarms respond within the manufacturer's acceptable limits by exposing the instrument to a test gas. The employee conducting the calibration check compares the instrument reading to the concentrations indicated on the test gas cylinder. If the instrument's response is within the acceptable range of the test gas concentration, then the calibration check has verified the instrument's accuracy. The acceptable range is typically ± 10-20% of the test-gas concentration; however, this range is set by the instrument manufacturer and the manufacturer's guidelines should be reviewed prior to the calibration check.

If the calibration check results are not within the acceptable range, the employee should perform a full calibration. A full calibration adjusts the instrument's reading to coincide with a known concentration (i.e., certified standard) of test gas.

In all cases, employees performing instrument calibration must follow the manufacturer's guidelines for the specific instrument involved. This would include using the type and concentration of test gas, flow regulators, flow tubing, and calibration adapters (if needed) mandated by the manufacturer. It would also include allowing for the appropriate response time for the instrument to reach the values anticipated by the calibration gas.

Note that certain instruments cannot be field calibrated (e.g., handheld aerosol monitors). Follow manufacturer's guidelines for setting up these instruments for field use and performing factory calibrations at required frequencies.

4. Bump Tests

At a minimum, bump tests should be conducted each day prior to use of a calibrated instrument. The bump test may be replaced with a calibration check where warranted. If an instrument fails a bump test, a full calibration should be performed.

5. Additional Information

- Sensor responsiveness may vary with workplace environmental conditions, such as temperature and humidity. Where possible, operators should calibrate sensors in environmental conditions that are similar to the actual workplace conditions. Follow the manufacturer's guidelines for proper calibration.
- Test gas used for calibration gas should always be certified using a standard traceable to the National Institute of Standards and Technology (NIST). The provider of the test gas should be able to provide a certificate of analysis for every cylinder of test gas.
- Calibration test gases may remain stable for only a limited amount of time. Look for an expiration date on any test gas used. Never use a test gas after its expiration date.
- Instruments may experience calibration drift as the sensors age. This means that the sensor can still detect the calibration gas, but may not be able to do so accurately. This problem can be exacerbated by exposure to extreme environmental conditions, elevated concentrations of airborne contaminants, or heavy shock or vibration. It can also occur through harsh storage or operating conditions or gradual degradation of internal components. Frequently, this condition will cause failure messages to appear or will limit the ability of the employee to accurately adjust the sensor readings. If at any time the employee suspects the instrument is experiencing calibration drift, it should be returned for service by qualified personnel.

1. Purpose and Scope

This document establishes procedures to assist in reducing the potential for ERM employee fatigue by providing criteria for anticipation, recognition, treatment, and management. This document applies to all ERM employees and covers all ERM work activities.

2. Roles and Responsibilities

Partner in Charge (PIC): Responsible for the following elements:

- Ensure this program is implemented, understood, and followed by employees under their charge and working on their projects;
- Ensure, in conjunction with the Project Manager/Supervisor, that employees are properly trained in fatigue management and monitored for fatigue and fatigue-producing factors in their assigned tasks; and
- Correct any deficiencies in the implementation of this program as identified by the Division Health, Safety, Security, and Environment (HSSE) Leader.

Project Manager/Supervisor: Responsible for the following elements:

- Monitor the performance and behavior of the employees they supervise;
- Work with the Division HSSE Leader to develop project-specific fatigue management guidelines for inclusion in site-specific health and safety plans where significant fatigue-producing activities may occur, including work days in excess of 14 hours and work weeks in excess of 60 hours;
- Contact the PIC and the Division HSSE Leader if presented with information that indicates an employee may be fatigued; and
- Keep information related to an employee's medical condition confidential at all times.

Division HSSE Leader: Responsible for the following elements:

- Monitor new employees for completion of appropriate training;
- Review safety observations, near misses, injuries, and incidents that have occurred which may have occurred as a result of fatigue and use as opportunities to revise project-specific fatigue management procedures;
- Work with the Project Manager/Supervisor to develop project specific fatigue management guidelines for inclusion in site-specific health and safety plans where significant fatigue-producing activities may occur, including work days in excess of 14 hours and work weeks in excess of 60 hours; and

- Assist PICs and Project Managers/Supervisors in the implementation of this program, as needed.

Employee: Responsible for the following elements:

- Maintain a safe working environment in accordance with ERM and client-specific polices (as warranted);
- Complete all ERM and client-required initial and annual training to perform their specific work assignments;
- Manage their health in a manner that allows them to perform their work assignments safely;
- Arrive to work fit for duty and ready to complete their work assignments following established safe working practices and procedures and in a safe and effective manner throughout their scheduled work hours;
- Alert their Project Manager/Supervisor if they are not fit for duty or if their fitness for duty deteriorates during the course of their work hours due to fatigue; and
- Notify their Project Manager/Supervisor or appropriate Human Resources (HR) Manager if they observe a co-worker acting in a manner that indicates the coworker may be unfit for duty.

3. Definitions

Fatigue includes mental and/or physical exhaustion which prevents a person from being able to function normally. It is typically caused by a lack of restful sleep, but may also be associated with prolonged periods of physical and/or mental exertion without sufficient time to recover.

Fatigue can be caused by work-related stresses, non-work related stresses, or a combination of both. ERM impacts work-related fatigue, as it determines the type of work, the number of work hours and the number of employees assigned to a task, and the work environment. The employee has control over non-work related fatigue including their health, family responsibilities, and lifestyle.

Fatigue, and the level to which it impacts an employee, is associated with a number of factors. These include:

- The quantity and quality of rest obtained before and after a working day;
- The time of day in which work takes place;
- The amount of time spent in work-related activities;
- The type of work and the environment in which it is performed;

- The physical and mental demands of work;
- Extended travel and travel across time zones;
- Personal activities away from work, such as sports, family commitments, or second jobs;
- Disruption of normal circadian rhythms (daily rhythmic activity cycles);
- Individual factors, including existing medical conditions, illnesses, or sleep disorders; and
- Extreme alcohol intake or sleep deprivation

4. Procedure

4.1 Fatigue Recognition

Employees are expected to carry out their work activities in a manner that does not risk the health and safety of themselves, their fellow employees, or any other personnel on the site (e.g., contractors, clients, the public, etc.). If an employee feels that they are unable to perform their work activities safely due to the effects of fatigue, they are required to stop work immediately and notify their supervisor.

Similarly, if an employee suspects a co-worker (including contractors or clients working with the employee) of suffering from the effects of fatigue, they are required to intervene on behalf of the affected person, stopping work and notifying their supervisor.

Characteristics that may assist in the identification of fatigue may include, but are not limited to:

1. Physical Symptoms
   a. Bloodshot eyes
   b. Poor coordination
   c. Slower movements
   d. Slower than normal response to verbal queries/commands or radio communications
2. Cognitive Function Symptoms
   a. Distraction from task
   b. Poor or lapsed concentration
   c. Inability to complete tasks
   d. Short-term memory loss

   e. Nodding off momentarily
   f. Fixed gaze
   g. Reports of blurred vision
3. Emotional/Behavioral Symptoms
   a. Appears depressed
   b. Does not care about work
   c. Easily frustrated with task/irritability
   d. Increased or noticeable level of unexplained or unusual absente

4.2 Fatigue Treatment

Where fatigue has been identified, employees are suggested to take action to treat the underlying causes of the fatigue. Suggestions include:

1. Getting adequate, regular and consistent amounts of sleep each night. A minimum of seven hours is recommended.
2. Eating well-balanced and healthy meals.
3. Ensuring adequate consumption of water throughout the day.
4. Exercising regularly.
5. Maintaining a reasonable work and personal schedule.
6. Avoiding alcohol, smoking, and drugs. Note that stimulants, including caffeine, may provide temporary relief from certain types of fatigue, but can increase the problem when the effect wears off.
7. Changing stressful circumstances through vacation or personal leave.
8. Contacting ERM's Employee Assistance Program (EAP) for fatigue-related issues beyond normal personal health care (e.g., addictive issues, family concerns, etc.).

When driving, employees should follow the fatigue avoidance techniques identified in Section 4.2 of ERM Procedure S1-ERM-008-PR (***Driver and Vehicle Safety***)..

4.3 Fatigue Management

4.3.1 Project Manager/Supervisor Responsibilities

Project Managers/Supervisors are responsible for managing fatigue in the work place. They are expected to:

1. Identify potential fatigue-producing factors at work and inform employees how they will be managed;
2. Monitor employees for signs of fatigue;
3. Provide employees with sufficient breaks for food, water, and rest;
4. Consult with employees regarding fatigue factors when extended work periods or shift work is anticipated;
5. Minimize early morning starts before 6:00 AM local time (except where shift work is required), as early start times give employees less time to get adequate sleep;
6. Minimize late evening work after 8:00 PM local time (except where shift work is required), as employee alertness tends to wane after these hours;
7. Attempt to limit extended work days to a maximum of 14 hours and extended work weeks to 60 hours;
8. Schedule work such that employees are given sufficient time to get a continuous 7 to 8 hour period of sleep in each 24 hours, and at least 50 hours every seven days, where shift work is required;
9. Supply adequate supervision for jobs that are physically or mentally demanding, repetitive, or require high vigilance;
10. Remove obviously fatigued workers from activities where there is a risk to safety and health; and
11. After providing an adequate rest break, consider rotating obviously fatigued workers to tasks that create a much lower immediate risk or advise them to go home (note that if driving home presents a further fatigue risk, the Project Manager/Supervisor should provide transportation to ensure the employee reaches home safely).

4.3.2 Employee Responsibilities

Employees are responsible for managing personal fatigue in the work place. Employees are expected to:

1. Report to work well-rested and mentally alert;
2. Manage personal lifestyle decisions in a manner that enables fitness for duty, including getting sufficient rest and sleep to recover from prior work duties, and managing personal, commuting, medical, and health issues;
3. Manage use of any drugs, including over-the-counter medications or prescriptions, which may affect their ability to perform work safely;
4. Seek medical advice for personal conditions affecting sleep, such as apnea or insomnia;
5. Notify your manager or supervisor when you are feeling fatigued;
6. Take adequate rest breaks for the working conditions;
7. Contact ERM's EAP if you need additional assistance for fatigue-related issues; and
8. Inform Project Manager/Supervisor when you suspect a co-worker of being fatigued.

4.4 Recordkeeping

Copies of any Project Manager/Supervisor notes and any documentation completed as part of a fatigue-based fitness for duty investigation will be maintained by the Division HR Manager.

5. References

- ERM Procedure S1-ERM-008-PR (***Driver and Vehicle Safety***)

Document Control Information

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Policy Approval by: Mark Hickey

Approval Signature: _____

Revision History

Section	Reason for Revision	Date
All	New document.	3/3/15

1. Purpose and Scope

This procedure is designed to ensure that ERM employees have formally considered the potential risks associated with the use of cutting tools, including but not limited to knives, shears, snips, scissors, core sleeves, tubing cutters, pruning tools, paper cutters, and hand-held electric saws. The procedure applies to all ERM work activities which involve the use of these tools within offices, equipment storage areas, or field trailers as used by ERM employees, contractors, and consultants.

2. Roles and Responsibilities

Partner in Charge (PIC): Responsible for the following elements:

- Ensure this procedure is implemented, understood, and followed by employees under their charge and working on their projects;
- See to the performance of periodic inspections in the office and at projects to identify appropriate tools and procedures; and
- Correct any deficiencies in the implementation of this procedure as identified by the Division Health and Safety (H&S) Leader or other staff member.

Project Manager/Branch Manager: Responsible for the following elements:

- Perform observations of ERM work processes to assess employee compliance with this procedure;
- Stop work where deviations from this procedure are observed; and
- Correct, in conjunction with the PIC and the Division H&S Leader, any observed deficiencies in the implementation of this procedure.

Employees: Responsible for the following elements:

- Perform all work in accordance with this procedure; and
- Formally assess risks from use of cutting tools and take actions to effectively manage identified hazards prior to starting work.

Division H&S Leader: Responsible for the following elements:

- Evaluate implementation of this procedure during health and safety plan reviews and project audits; and
- Communicate identified deficiencies to the PIC.

3. Definitions

Fixed open bladed knife: Any knife where the normal use and position of the tool creates an unguarded knife or razor edge.

4. Procedure

4.1 Hazard Assessment

ERM requires that hazard assessments be performed for all activities, including those that involve the use of cutting tools. A Job Hazard Analysis form (S1-ERM-002-FM4) should be used to identify and document the hazards and associated control measures, including selection of the most appropriate cutting tool(s) to be used. When considering how to manage cut/puncture hazards associated with cutting tool use, a recommended best practice is to apply the following control measures listed in order of priority:

- Eliminate or avoid the hazard.
- Reduce the hazard by using safer cutting tool(s)/equipment or other engineering controls.
- Limit who is permitted to use cutting tools and/or locations they are sued, and train those employees only.
- Train all employees on the proper use of cutting tools.
- Utilize personal protective equipment (PPE) such as cut-resistant gloves. This should be considered the last line of defense and used in conjunction with other control measures.

4.2 Cutting Tool Selection

- Use the cutting tools designed for the job.
- Do not use inadequate, inappropriate, or unsafe tools simply because they are available. Take the time to acquire the correct tool for the job.
- Use scissors/snips, safety cutters with guarded, concealed, or self-retracting blades; or other safety cutting devices without open or exposed blades whenever possible. Examples include the following:

Safety cutter for opening packages

Snips

Guarded utility knife

Concealed blade cutters

Sheet cutter/letter opener

Core sleeve cutters

Tubing cutter

- Fixed open-bladed knives (FOBKs) are dangerous tools, but they are used so routinely that their hazards are often underestimated or ignored. Examples include pocket knives (including Leatherman and similar multi-tools), utility knives, box cutters (including cutters with spring loaded blades), and X-acto knives.

The uncontrolled and unsafe use of FOBKs is a common factor in hand injuries (lacerations) reported within our industry. **For this reason, FOBKs are prohibited from being used unless they are determined to be the safest tool for the task**. This determination should be made in consultation with the PIC, Project Manager/Branch Manager, and Division H&S Leader. Note that some clients prohibit the use of FOBKs altogether; therefore, client expectations must be clearly known and understood.

- If FOBKs are to be used, their safe use must be documented in written job procedures (e.g. JHA), the blade must be locked when in use and protected when not in use, personnel must have received training on how to correctly and safely use the tool, and cut-resistant gloves must be worn during use. FOBKs that cannot be locked in the open position shall not be used.
- Kitchen knives used in designated kitchen areas for food preparation may be used without the requirement to document in a written job procedure or provide formal training; however their use should be consistent with other guidance outlined in Section 4.3.
- Paper shears pose a significant hazard and should only be used if no practicable alternative exists; a JHA has been prepared and reviewed by the H&S team; and only trained employees are permitted to use it. The procedure must include locking the shear in the closed position when not in active use, and preferably includes the use of cut-resistant gloves unless safety interlocks are incorporated into the design. Options to purchase shears with safety interlocks must be considered at the first available opportunity

4.3 Safe Cutting Tool Use

- Train personnel in the correct way to use cutting tools prior to use.
- Use the designated safest cutting tool for the task and ensure it is sharp.
- Inspect cutting tools prior to use to confirm they are in good condition and safe to sue.
- **Always cut away from your hands and body**, keeping all body parts behind the blade and out of the "line of fire".
- Ensure you and other people in the area are out of the “line of fire” of the cutting tool’s path/potential path (in event of tool slippage, etc.).
- Put the object to be cut in a vise or on a flat surface, or use another tool to hold the object instead of holding in your hand or against your body (e.g., do not hold the object to be cut against your thigh).

- If the cutting tool is designed to be used with two hands, then it must be held with two hands. Saws-alls and drills are designed to be held with two hands, but are commonly incorrectly held with one hand during use.
- Use the buddy system. Utilizing a co-worker to assist in cutting activities can often reduce hazards associated with cutting lumber, tubing, and piping.
- Always return cutting tools to an appropriate storage location. **Do not place cutting tools on the ground!**

4.4 Personal Protective Equipment

Gloves that are appropriate for specific task hazards and, in good condition, can prevent some injuries; however, gloves (and all PPE) are considered as a final barrier against potential injury. Gloves must be used in conjunction with other control mechanisms (see Section 4.1) as well as the appropriate cutting tool for the job.

Specific glove requirements for tasks to be performed on site must be stated in the JHA or equivalent written job procedure. Common glove types and levels of protection are as follows:

Glove Type	Protects From	Common Uses
Cotton, canvas cloth	Minor abrasions, chafing	Light duty (e.g., sweeping)
Leather, Aramid fiber, HexArmor™	Abrasions, punctures, minor lacerations	Handling rough, rigid or abrasive materials; working with hand and power tools (unless they may get caught)
Leather reinforced with metal or metal stitching	Abrasions, lacerations	Handling sharp-edged tools/equipment
Metal mesh, Stainless Core (stainless steel woven into material), Kevlar, HexArmor™	Lacerations and abrasions associated with glancing/slicing cuts	Using cutting tools; handling sharp/jagged tools and materials.
Nitrile-coated knit gloves	Chemicals, punctures	Clearing demolition and other uncontrolled debris

More information may be obtained from your local PPE provider or at the links below:

- http://www.grainger.com/Grainger/static/cut-resistant-glove-301.html
- http://rs.nationalsafetyinc.com/company_79/Understanding%20Cut%20resistance.pdf

Cut-resistant gloves must be worn when using FOBKs, at a minimum.

When several hazards are encountered that one glove will not provide adequate protection against, gloves should be layered accordingly. For example, when handling contaminated materials with sharp edges, inner nitrile gloves may be worn to protect against chemical hazards with outer cut-resistant gloves to protect against cuts and abrasions.

Protective gloves must be inspected before each use to ensure that they are not torn, punctured, or made ineffective in any way (e.g., wet/water soaked or dirty gloves can become slippery).

5. References

- ERM Form S1-ERM-002-FM4 (Job Hazard Analysis)

Document Control Information

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Approval Signature: _____

Revision History

Section	Reason for Revision	Date
All	New document.	10/23/13
All	Reformatted document. Minor edits for clarity.	6/1/15

Appendix C

Material Management Plan

Materials Management Plan

Former Water Industries Facility
300 Ansborough Avenue
Waterloo, Iowa

8 February 2017
(Revised 3 April 2017)

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1.0 BACKGROUND

1.1 INTRODUCTION

On behalf of Waterloo Industries, Inc. (Waterloo), Environmental Resources Management (ERM) has prepared this Materials Management Plan ("MMP") for the Waterloo facility located at 300 Ansborough Avenue (the "Site") (**Figure 1**). A site layout map is provided as **Figure 2.** This MMP describes the procedures to be followed during excavation of soils located throughout the facility. The MMP addresses potential human health and environmental risks related to the presence of volatile organic compounds ("VOCs") in the subsurface soils.

This MMP, which is Appendix C of the Site's RIP, contains notification protocols and soil management procedures associated with limited soil excavation that may be associated with the construction of dual phase extraction and sub-slab depressurization system (SSDS). This MMP is to be implemented by Waterloo at the time of any excavation within the facility that will proceed to depths greater than 3 inches below the bottom of the asphalt or concrete slabs for as long as the RIP is in place.

1.2 MATERIALS MANAGEMENT PLAN OBJECTIVES

The objective of this MMP is to address mitigation of human health and environmental risks from the presence of VOCs in the subsurface. All work will be performed in accordance with the Site-Specific Health and Safety Plan (HASP), which is Appendix B of the Site's RIP. This MMP does not include procedures to protect employees from physical hazards (excavation wall cave in, working around heavy equipment, utility-related hazards, etc.). Physical hazards should be addressed by the contractor performing the work in a separate document (e.g., excavation procedures or contractor-specific chemical and physical hazards HASP).

1.3 EXCAVATION NOTIFICATIONS

Waterloo will provide written notification to the EPA (30 days prior) of the intention to excavate subsurface soils prior to initiation of field activities. Additionally, if the excavation is the result of an emergency issue (such as a water main break), the EPA will be notified by telephone or email within 48 hours of the emergency issue. In accordance with the RIP established in 2016, the written notification will include:

- Names and address of firm performing and responsible for the excavation work.

- Location of the site at which excavation will occur and the Site's EPA ID number.
- Scheduled starting date of the excavation.
- Estimated quantity of soil to be excavated.
- A reference to the RIP and a description of its requirements.

The EPA notice will be addressed to:

EPA Region 7
AWMP/WRAP

Attn: Mr. Daniel Gravatt

11201 Renner Blvd.
Lenexa, KS 66219
Phone: (913) 551-7324
E-mail: Gravatt.daniel@epa.gov

2.0 EXCAVATION PROCEDURES

All site employees conducting excavation activities will be required to meet the requirements of the HASP included as Appendix B of the RIP. The HASP establishes limits to air concentrations that would require halting the excavation activities and implementing engineering controls and, if the engineering controls are not sufficient to control the risks, having properly trained and medically cleared workers don protective equipment before resuming excavation activities.

A designated work area boundary shall be established with barricades and caution tape for excavation activities. Initially, the designated work area boundary will be established at a setback of at least twenty feet from the excavation. The work area boundary will be adjusted based on the air monitoring results.

Air monitoring procedures, equipment, and action guidelines are outlined in the HASP and the following associated documents (included in Appendix B of the RIP):

- S3-NAM-005-WI3: *Exposure to Gas Hazards*
- S3-NAM-043-GU1: *Calibration and Testing of Direct-Reading Portable Air Monitors*
- S3-NAM-005-FM2: *Ambient Air Monitoring Form*

Activities will be performed in a manner that prevents exposure of the public via dust or vapor emissions and contamination of surface water (such as ditches or depressed areas) or groundwater via runoff or storm water.

3.0 MANAGEMENT OF IMPACTED MATERIALS

3.1 GENERAL

An environmental professional (EP), with the health and safety training indicated in the HASP and with training and at least two years of experience in environmental media sample screening and collection shall be present during all excavation activities to monitor the materials removed, which include, but are not limited to soil, debris, and groundwater. The EP will identify potentially impacted materials using professional judgment and a variety of industry-standard techniques: visual observation (e.g., discolored/stained material not associated with typically clean material), olfactory observation (odors), and use of a hand-held photo-ionization detector (PID).

Laboratory analyses will be required if any of the techniques listed above indicates the potential for the materials to be impacted and the need for characterization via laboratory analyses.

Any excavated material that will require off-site disposal will be disposed of at a commercial facility, the materials shall be characterized in accordance with applicable local, state, and federal regulations and as required by the disposal facility.

Documents and procedures pertaining to waste planning and management are included in the HASP as:

- S3-NAM-038-PR: *Waste Management Planning*
- S3-NAM-038-FM1: *Pre-Mobilization Activities*
- S3-NAM-038-FM2: *Project Execution Activities*

3.2 DISPOSAL FACILITIES

Any excavated soil or solid material that is determined to be impacted must be:

- Transported by appropriately licensed transporters in accordance with applicable local, state, and federal regulations.
- Disposed of at an appropriately permitted facility in conformance with applicable local, State, and Federal regulations.

In addition, if hazardous materials are being shipped off site, the hazardous waste generator requirements of State and Federal regulations must be met.

3.3 *IMPACTED SOIL AND SOLID MATERIALS*

If impacted soils or other solid materials (concrete, gravel, asphalt, bricks, etc.) within the remedial areas are excavated, the following storage, transportation, and general housekeeping procedures shall be met, at a minimum:

- Prevent contact of the excavated materials with the ground or rainfall.
- Minimize dust production during material management.
- Prevent dust production and draining of impacted liquid during storage or transport.
- Prevent dispersion of impacted material via runoff.
- Remove loose material/decontaminate transport and construction vehicles prior to leaving the Site.
- Remove impacted materials from asphalt or concrete surfaces to prevent contact of the impacted materials with runoff. Washing of the impacted materials into the storm or sanitary sewer shall not be performed without securing a permit from the local storm or sanitary sewer authority and/or EPA.
- No impacted material shall be placed on the ground without a liner and a cover at the Site or at any other facility without EPA's permission. An impermeable liner is required if the impacted material has concentrations that exceed the soil to groundwater migration RSLs. The cover must prevent contact with the impacted material and evaporation of chemicals from the impacted material to the ambient air.

3.4 *IMPACTED GROUNDWATER*

If potentially impacted groundwater is encountered within an excavation, the water may be pumped or otherwise conveyed to a temporary or permanent storage tank where it will remain until it is properly characterized for future off-site disposal.

3.5 *IMPACTED STORM WATER*

Contact of impacted excavated materials with storm water shall be prevented to the extent practicable. If storm water contacts impacted excavated materials, it shall be managed in the same manner as potentially impacted groundwater.

If necessary according to federal, state, and local regulations, a storm water permit for construction activities shall be obtained.

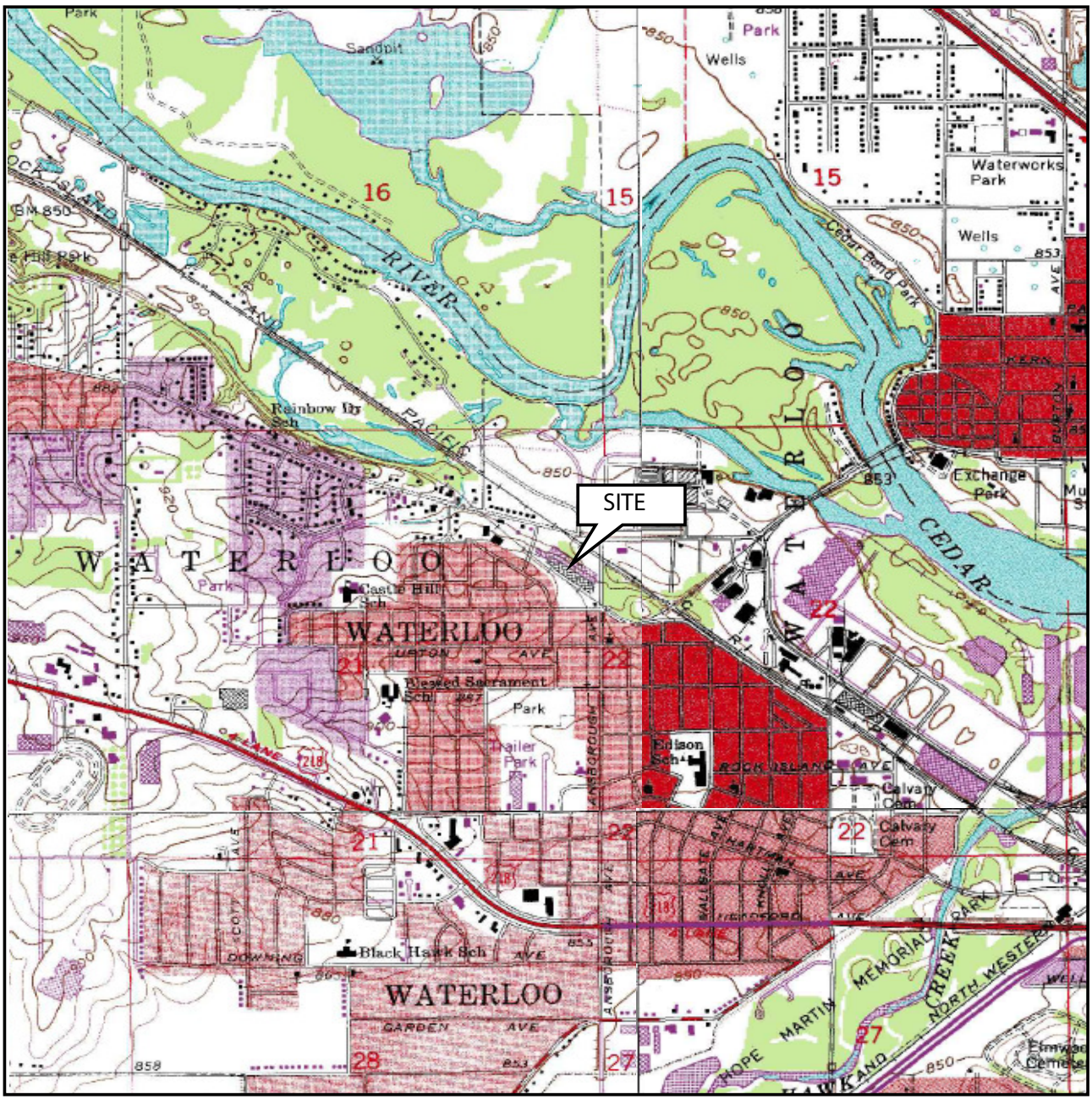
3.6 EQUIPMENT DECONTAMINATION WASTE

All decontamination water and solid materials produced during decontamination will be managed as if they were potentially impacted. Decontamination of excavation equipment and hand tools will include dry removal of materials from equipment (brush, shovel etc.) followed by cleaning by high pressure wash. Decontamination should be performed on plastic within a structure that allows for capture of the soil and water generated from the decontamination process.

4.0 DOCUMENTATION AND REPORTING

Upon EPA's request, Waterloo shall provide EPA with documentation for the disposal of waste materials generated as the result of excavation activities. In the event that excavation activities occur, a brief summary of those activities will be included as part of the annual report described in Section 10.3 of the RIP.

Source: Cedar Falls, Iowa (1980) United States Geol ogical Survey 7.5 Minute Quadrangle

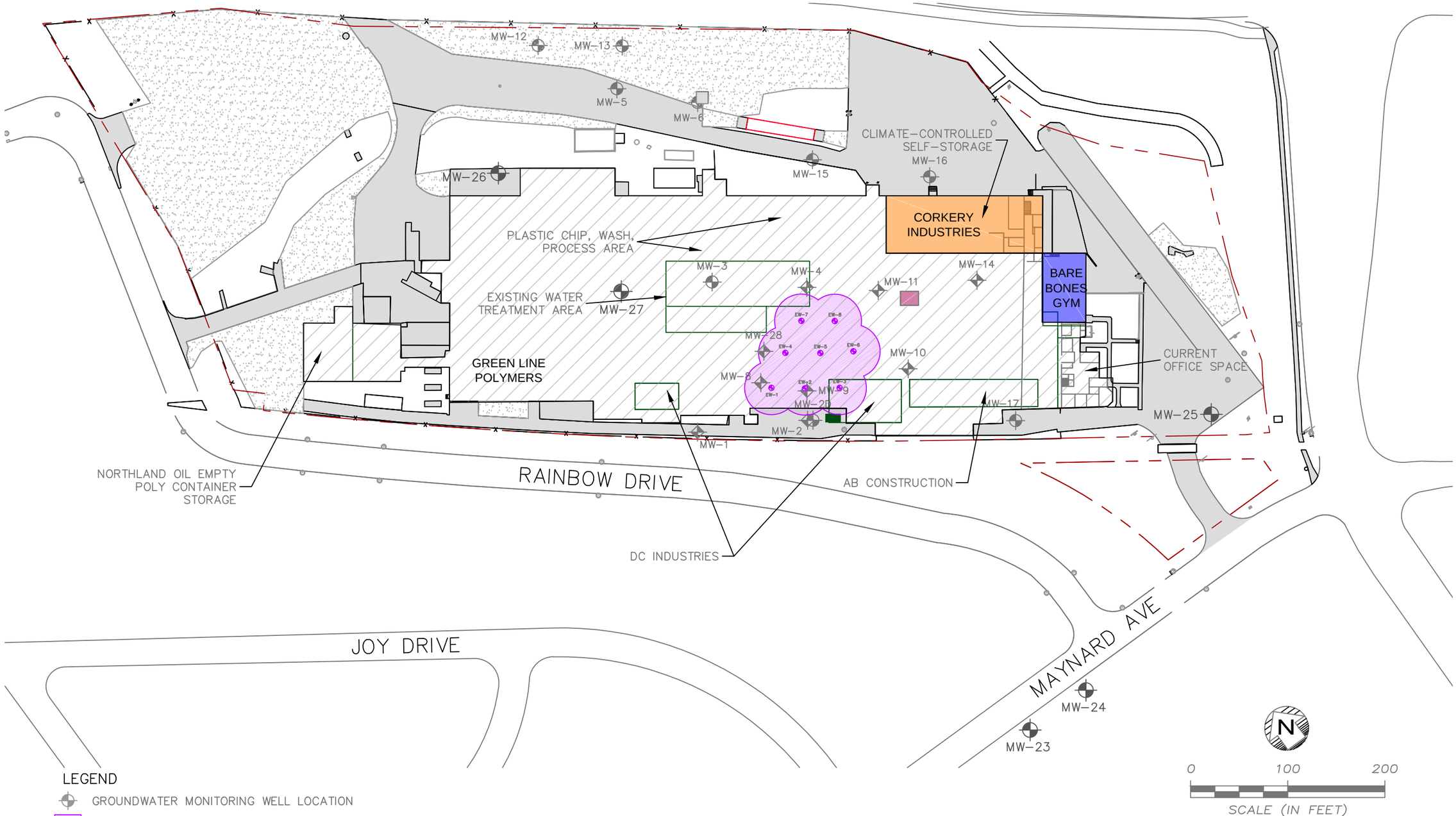


QUADRANGLE LOCATION

FIGURE 1
SITE LOCATION MAP
FORMER WATERLOO INDUSTRIES FACILITY
300 ANSBOROUGH AVE
WATERLOO, IOWA

ERM

SITE LAYOUT



LEGEND

- GROUNDWATER MONITORING WELL LOCATION
- PROPOSED DPVE TREATMENT AREA
- PROPOSED TREATMENT BUILDING
- PROPOSED DUAL-PHASE EXTRACTION WELL (WITH APPROXIMATELY 25' RADIUS OF INFLUENCE)
- PROPOSED SUB-SLAB DEPRESSURIZATION TREATMENT AREA

Drawn By RMK-GML-ABF	ERM®	FORMER WATERLOO INDUSTRIES 300 ANSBOROUGH AVENUE Waterloo, Iowa	CHK'D BK-Mil
CADD Review JF			0339767
Date Drawn/Rev'd 10/27/2016		Environmental Resources Management	FIGURE 2

Appendix D

Performance Monitoring Forms

Appendix D - Form A

Former Waterloo Industries facility

Waterloo Iowa- DPVE System

Monitoring Check List

Monitoring Point Description	Sample Location	Reading	Units	Normal Operating Range	Action Taken or Needed
Vacuum applied to header 1 wells	P101		inches of H2O	35-50	
Vacuum applied to header 2 vent wells	P100		inches of H2O	35-50	
Combined System Vacuum	P102		inches of H2O	40-55	
	P103		inches of H2O	50-65	
Inlet filter differential pressure	DPI 104		inches of H2O	<15	
Blower discharge air temperature	TI 400		degrees Fahrenheit	90-125	
Date			**Data Collected by:**		

Appendix D- Form B1: DPVE Detailed System Monitoring Form

HYDRITE CHEMICAL - WATERLOO, IA
Soil Vent System Monitoring

Date: PN:
Sampler:

Sample Point	Vac (-) (In. H_2O)	PID (ppmv)	Δ P	TEMP (^oF)
EW-1				
EW-2				
EW-3				
EW-4				
EW-5				
EW-6				
EW-7				
EW-8				
Inside Equipment Building				
Influent; header 1	(P102)		(FE102)	(TI400)
Influent; header 2	(P103)			
Vapor Phase Carbon				
Influent	(P104)			(TI401)
Effluent from Primary	(P105)			
Effluent from Secondary	(P106)			

Appendix E

Environmental Covenant Agreement

Pending EPA Review and Approval

Appendix F

Financial Cost Estimate

Pending EPA Review and Approval