ARCADIS
Infrastructure · Water · Environment · Buildings

Imagine the result

HERCULES

Revised Phase I Sampling and Analysis Work Plan

USEPA RCRA 3013(a)
Administrative Order
EPA ID No. MSD 008 182 081
Docket No. RCRA-04-2011-4251
MDEQ AI No. 2022

Hattiesburg, Mississippi

16 December 2011

ARCADIS

John Ellis

John Ellis, P.G.
Principal Scientist/Hydrogeologist

James J Reid

James J. Reid
Principal in Charge

Revised Phase I Sampling and Analysis Work Plan

USEPA RCRA 3013(a) Administrative Order
Hattiesburg, Mississippi

Prepared for:
Hercules Incorporated

Prepared by:
ARCADIS U.S., Inc.
10352 Plaza Americana Drive
Baton Rouge
Louisiana 70816
Tel 225.292.1004
Fax 225.218.9677

Our Ref.:
LA002999.0006.00301A

Date:
16 December 2011

Tables

Figures

Appendices

Appendices

1. Introduction

Hercules Incorporated (Hercules) submits this Revised Phase I Sampling and Analysis Work Plan (Work Plan) pursuant to Paragraph 74 of the May 9, 2011, Administrative Order (the AO) issued by Region 4 of the United States Environmental Protection Agency (USEPA) and USEPA's August 25, 2011, "Review of Phase I Sampling and Analysis Work Plan dated July 14, 2011", August 30, 2011, "Review of Phase I Sampling and Analysis Work Plan, dated July 14, 2011", and December 9, 2011, "Approval of Phase I Work Plan" letters. This submittal addresses items discussed in previous conferences calls between the USEPA, Mississippi Department of Environmental Quality, and/or Hercules and items identified in the December 9, 2011, correspondence from USEPA. The AO was issued pursuant to Section 3013(a) of the Resource Conservation and Recovery Act (RCRA), 42 United States Code §6934(a), and is specific to Hercules' Hattiesburg, Mississippi, site (referred to as the "Site" or the "former Hercules Plant" herein). As discussed during the June 9, 2011, USEPA meeting in Atlanta, Georgia, and subsequent comments conference calls, components of the Phase II activities, as required in Paragraph 75 of the AO, are also addressed in this Work Plan. Specifically, a portion of the groundwater assessment identified as part of Phase II will be conducted under Phase I as required to properly assess the potential migration of Site-related constituents to off-site properties because this may affect the soil gas and indoor air. Additionally, it was agreed during the comments conference calls that many of the comments received on the Phase I Work Plan will be addressed in the Phase II Work Plan currently under development.

1.1 Purpose and Scope

The scope of the AO, and the activities required under the AO, including implementation of the Work Plan, is limited to assessing the presence, magnitude, extent, direction, and rate of movement of the constituents to be monitored under the AO (the "Constituents"). The Work Plan approach includes incorporating and utilizing existing sampling data previously collected as part of Site-related assessments conducted in the area by Hercules, USEPA, or the State of Mississippi (the State) that relate to the purposes of the AO, including assessments to characterize the source(s) of Constituents, characterize the potential pathways of migration of Constituents, define the degree and extent of the presence of any Constituents, and identify actual or potential human and/or ecological receptors. Detected Constituents will be investigated to determine the nature and extent of these Constituents relative to any identified or potential human or ecological receptors.

2. Background

The Hercules Hattiesburg facility began operations in 1923. Throughout the facility's history the operations consisted of extracting and/or working with rosins to produce rosin derivatives, paper chemicals, toxaphene, and Delnav, an agricultural insecticide (miticide). Structures at the Site included offices, a laboratory, a powerhouse, production buildings, a wastewater treatment plant, settling ponds, a landfill, and central loading and packaging areas. The plant began to reduce production in the 1980s. Process operations at the Site were shut down at the end of 2009. Many of the former plant buildings have been demolished. Hercules has had air, storm water, National Pollutant Discharge Elimination System, and State of Mississippi-issued Water Pollution Control (pre-treatment) permits that covered discharges from the Site when it was in operation. Hercules continues to conduct sampling and reporting activities associated with storm water and pre-treatment discharges.

As part of plant demolition and decommissioning activities, Hercules has been working with MDEQ to decommission the on-site wastewater treatment impoundment basin (IB) and is working with MDEQ to obtain approval of the August 2010 IB Decommissioning Work Plan (ARCADIS 2010) and supplemental information provided to MDEQ in January 2011.

Various environmental investigations have been conducted at the Hercules Site since the early 1980s. The work has included geophysical investigations and sampling of soil, groundwater, surface water (Greens Creek), and stream sediment for analysis of various constituents, including volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), metals, cyanide, dioxathion, and dioxenethion.

In 2005, after site investigations conducted under the MDEQ Voluntary Evaluation Program were approved, a Corrective Action Plan (2005 CAP, Groundwater & Environmental Services, Inc. 2005) was submitted to MDEQ. MDEQ approved the 2005 CAP, which called for a remedy that included monitored natural attenuation (MNA) with institutional controls. Additionally, Hercules and MDEQ established a Restricted Use Agreed Order (RUAO, No. 5349 07) in 2008 for management of the Site. The components of the 2005 CAP and RUAO are discussed further in Section 2.3. A monitoring program was implemented and controls were established to restrict the land use and activities on site. The monitoring program for groundwater and surface water is currently conducted on a semiannual basis and consists of water level gauging and analysis of select samples for VOCs (semiannually) and dioxathion/dioxenethion (annually).

2.1 Site Location

The Hercules Site is located on approximately 200 acres of land north of West Seventh Street in Hattiesburg, Forrest County, Mississippi (Figure 1). The Site is located in Township 4 North, Range 13 West, within Sections 4 and 5 just north of Hattiesburg, Mississippi. The geographic coordinates of the Site are 31° 20' 20" North latitude and 89° 18' 25" West longitude. The physical address of the Site is 613 West Seventh Street, Hattiesburg, Mississippi. Figure 2 presents a plan view of the Site depicting the physical layout of the Site.

The Site is bordered to the north by Highway 42, beyond which is the Illinois-Central & Gulf Railroad, as well as various residential and commercial properties. The southern property boundary is bordered by West Seventh Street and by Roseland Park cemetery and Zeon Chemical Corporation to the south-southwest. Across from these locations are residential areas. The eastern and western boundaries are bordered by residential and commercial areas.

The Site is zoned for industrial use and this zoning category is unlikely to change in the future due to the size of the property and available infrastructure, as well as the RUAO. Figure 3 shows the zoning categories for the parcels located in the vicinity of the Hercules Site.

2.2 Previous Investigations

Various investigations have been conducted at the Hercules Site since the early 1980s. The work has included geophysical investigations and sampling of soil, groundwater, surface water, and stream sediment for analysis of various constituents, including VOCs, SVOCs, pesticides, PCBs, metals, cyanide, dioxathion, and dioxenethion. The results of previous investigations are discussed in reports, which have been submitted to or developed by the MDEQ and/or USEPA. Summaries and findings of the non-routine groundwater monitoring reports are included below:

- *Preliminary Assessment,* Mississippi Bureau of Pollution Control, December 1989.

  A state preliminary assessment was completed in December 1989 and indicated two source areas which included approximately 38 acres of contaminated soil and a cluster of six unlined surface impoundments containing approximately 900,000 cubic feet of material. These quantities were defined using five sampling locations. Constituents such as acetone, benzene, toluene, methyl ethyl ketone (MEK), PCBs, cadmium, cobalt, lead, and mercury were identified in the soil and the surface impoundment contained arsenic, benzene, toluene, MEK, and heavy metals.

- *Site Inspection Report*, Black & Veatch (B&V) Waste Science and Technology Corp., April 1993 (commissioned by USEPA).

  In 1992, a site inspection, field investigation, and geophysical survey were conducted by B&V as a contractor for USEPA to collect information regarding potentially hazardous environmental conditions at the Site. The USEPA was concerned about potential releases to groundwater, surface water, soil, and air and the potential threats to human health and ecology. The geophysical survey program was initiated to identify sample locations and evaluate former areas where drums, sludge, boiler ash, and other process wastes were reportedly landfilled, land applied, or buried. Four sediment, two surface water, five surface soil, two subsurface soil, and three groundwater samples were collected from a number of strategic locations selected based on historical information, hydrological data, field observations, and geophysical survey results. All samples were analyzed for parameters in the Target Compound List (TCL) and Target Analyte List including organics, pesticides, PCBs, metals, and cyanide. Surface water sample results summarized in the 1993 B&V report indicated that arsenic and sodium concentrations exceeded background concentrations. The inorganics barium, copper, iron, magnesium, manganese, nickel, and zinc were detected at concentrations above background or the sample quantitation limit. No TCL organics were detected in sediment or surface water samples.

- *Work Plan for Well Installation,* Bonner Analytical Testing Company (BATCO), June 1997; *Installation, Sampling, and Analysis Report,* BATCO, December 1997; and *Quarterly Monitor Well Sampling Event Reports, BATCO, June 1998* through *October 1998.*

  BATCO prepared a report dated December 1, 1998, which presented results of four quarterly groundwater monitoring events conducted between December 1997 and December 1998. BATCO installed six shallow groundwater monitoring wells in December 1987. The wells were competed at depths between 10 and 20 feet below ground surface (ft bgs). The results of the four quarterly sampling events are summarized in the December 1, 1998, report and indicate no significant detections of the eight RCRA metals (low levels of metals were detected above the laboratory method detection limit [MDL] in various wells over the quarterly events, as well as several detections of the non-RCRA metals beryllium, nickel, copper, and zinc). Acetone was detected above the MDL twice in two different wells. MEK and isopropyl benzene were each detected once, and an aromatic hydrocarbon compound was tentatively identified in one well. An organophosphate compound was tentatively identified in all four sampling events in MW-4. In general, MW-4, located near the sludge pits, indicated low levels of metals and the organic compounds discussed above.

- *Site Investigation Work Plan, Eco-Systems, Inc. (Ec*o-Systems), February 1999.

A site investigation was conducted in accordance with the *Site Investigation Work Plan* (Eco-Systems 1999) and additional comments from MDEQ in an approval letter dated April 5, 1999. The activities described in the work plan centered on efforts to determine whether dioxathion, the miticide contained in Delnav, was present in Site soil and groundwater. The investigation also included an evaluation of the groundwater flow regime and refinement of the Site hydrogeologic model.

The scope of the 1999-2000 investigation included the installation of fourteen piezometers, five monitoring wells, and four staff gauges to provide hydrogeologic and groundwater quality information near the former dioxathion production areas and near the former wastewater sludge pits. Piezometers TP-1 through TP-14 were installed to evaluate groundwater flow conditions in the uppermost saturated interval beneath the Site. Monitoring Wells MW-7, MW-8, and MW-9 were installed to assess groundwater quality at points near the former Delnav production areas and Monitoring Wells MW-10 and MW-11 were installed to assess groundwater quality between the sludge disposal pits and Greens Creek.

Prior to the sampling of the new and existing monitoring wells, questions arose regarding the analytical method for dioxathion and the quality of dioxathion for use as a laboratory standard. As a result, Hercules in conjunction with MDEQ's consultant Mississippi State University developed analytical protocols for soil and groundwater. These protocols were documented in the *Sampling and Analysis Protocol for Determination of Dioxathion in Water* (Hercules, 2002).

Because the quality of available analytical standards was questionable, Hercules contracted with Sigma-Aldrich Chemicals to synthesize dioxathion standards. In August 2002, dioxathion of a suitable quality had been manufactured to be used as a laboratory standard and Hercules and MDEQ agreed to a laboratory protocol.

In October 2002, groundwater samples were collected from Wells MW-1, MW-4, MW-5, MW-8, MW-9, and MW-11 for analyses of dioxathion and dioxenethion by both BATCO and Mississippi State Chemical Laboratory to test the newly established protocol. Monitoring Wells MW-5 and MW-6 were also sampled for analysis of VOCs and SVOCs.

Isomers of dioxathion were detected in Wells MW-4, MW-5, MW-8, MW-9, and MW-11; however, no concentrations were detected at concentrations above the MDEQ Tier 1 Target Remediation Goals (TRGs). No VOCs or SVOCs were detected above the MDL in samples collected from MW-5 and MW-6. A complete summary of the sampling/analytical methods and results of the October 2002 sampling was provided in the *Site Investigation Report* (ESI 2003).

In December 2002, groundwater samples were collected for analysis of dioxathion (MW-1 through MW-11), VOCs (MW-4 and MW-7 through MW-11), and SVOCs (MW-7 through MW-11). Samples were analyzed by BATCO and a split sample for MW-11 was collected by MDEQ. Concentrations of dioxathion, dioxenethion, VOCs, and SVOCs were detected at various locations. Various VOCs were detected at concentrations exceeding the TRGs in Wells MW-4, MW-8, MW-9, and MW-11. No other constituents were detected at concentrations above the applicable TRG.

- *Interim Groundwater Monitoring Report,* Eco-Systems, January 2003; and *Site Investigation Report, Eco-Systems,* April 2003.

The *Interim Groundwater Monitoring Report (E*SI 2003) was submitted describing the results of this sampling and recommending confirmation sampling prior to completing the remaining activities outlined in the 1999 Work Plan. In response, the MDEQ issued a letter dated February 3, 2003 approving the proposed confirmation sampling and requesting completion of the work plan tasks. In addition, MDEQ requested submittal of a supplemental work plan for groundwater delineation and a geophysical survey. A summary of the December 2002 sampling was provided in the *Site Investigation Report* (ESI 2003).

On February 11, 2003, groundwater, surface water, and stream sediment samples were collected in accordance with the February 3, 2003, MDEQ request.
Wells MW-4, MW-8, MW-9, and MW-11 were sampled for confirmation of the 2002 VOC results. In addition, surface water and sediment samples were collected from five locations (CM-1 through CM-5) in Greens Creek for analysis of dioxathion and

VOCs. Total organic carbon (TOC) and grain size analyses were also performed on sediment samples. Duplicate samples of surface water and sediment were collected by MDEQ at location CM-3.

VOCs were detected in groundwater at concentrations exceeding the TRGs in Wells MW-4, MW-8, MW-9, and MW-11. The sample collected from MW-8 had the highest reported VOC concentrations.

Various VOCs were detected in each of the samples collected from surface water locations CM-1 (upgradient) through CM-5. The greatest number of VOCs were detected in the surface water sample collected from CM-1 (the westernmost location), possibly indicating an upstream source for VOCs. Dioxathion was detected in surface water at CM-2 and dioxenethion was detected in surface water at CM-3, CM-4 and CM-5.

Various VOCs were detected in each of the samples collected from stream sediment locations CM-1 through CM-5. Similar to results for the surface water samples, the greatest number of VOCs were detected in the sediment sample collected from CM-1 (upgradient). Dioxathion was detected in sediment at CM-1, CM-3, and CM-5. TOC was reported in sediment samples at concentrations ranging between 2 and 7 parts per million (ppm). The sample collected from CM-3 showed primarily silt and clay and the samples collected from CM-4 and CM-5 showed primarily sand and gravel.

A summary of the sampling/analytical methods and results of the February 2003 sampling was provided in the *Site Investigation Report* (ESI 2003).

- *Work Plan for Supplemental Site Investigation,* Eco-Systems, June 2003; and *Supplemental Site Investigation Report, Eco-Sy*stems, November 2003.

A supplemental site investigation was conducted in accordance with the *Work Plan for Supplemental Site Investigation* (ESI June 2003) approved by MDEQ in a letter dated July 11, 2003. The supplemental work plan was prepared at the request of MDEQ to delineate the lateral and vertical extent of constituents of concern (COCs) in groundwater, collect hydrogeologic information, conduct a geophysical investigation to delineate the lateral boundaries of the waste in the former landfill and locate accumulations of buried metal in the landfill and in a potential burial area identified in the western portion of the Site, conduct single-well response tests to provide hydraulic conductivity estimates, and collect surface water and stream sediment from Greens Creek to evaluate locations upstream from previous sampling locations.

To obtain the required data, Hercules advanced eighteen Geoprobe® borings (GP-1 through GP-18) to define the lateral and vertical extent of VOCs in groundwater and to investigate groundwater quality in the vicinity of select piezometers, collected groundwater samples from permanent Monitoring Wells MW-1, MW-4, MW-10, and MW-11 for analysis of VOCs and dioxathion, conducted a geophysical investigation using ground conductivity and magnetic intensity methods at two areas of the Site (former landfill area and small grid area located west of the main plant), and collected surface water samples from two locations (upstream location CM-0 and previous location CM-1) and a stream sediment sample from one location (upstream location CM-0).

The results of the above activities provided a summary of known conditions in the area and further defined the extent of on-site areas.

- *Hattiesburg, Mississippi, Investigations, MDEQ*, April 2004.

  As part of a response to requests by the public, in April 2004, MDEQ conducted a sampling event in the drainage pathways discharging from the Hercules facility. Four sediment samples (two from Greens Creek and two from the former "Hercules Ditch") and three surface water samples (two from Greens Creek and one from the former "Hercules Ditch") were collected and analyzed for VOCs, SVOCs, pesticides/PCBs, metals, and dioxathion. Samples collected from locations S-1 and S-2 were collected from Greens Creek across Highway 42 from the facility. Samples collected from locations S-3 and S-4 were collected downgradient of an on-site process water storage tank (Tank ET-10, referred to in the memo as the "NPDES tank"). No surface water was collected from location S-3 because it was dry.

  Concentrations of toluene below the MDEQ TRGs were detected in soil collected at locations S-3 and S-4. No other constituents were detected in soil and no constituents were detected in surface water. While some trace concentrations of target analytes were detected, the report concluded that "the results of these samples did not detect any compounds above MDEQ's target remediation goal levels."

- *Remedial Action Evaluation,* Eco-Systems, July 2004; *and Corrective Action Plan Revision 01,* Groundwater & En*vironmental Services, Inc., January* 2005.

  A Remedial Action Evaluation was prepared to evaluate and recommend remedial alternatives for the following areas: Sludge Pits, Landfill, Greens Creek, and Groundwater. Each of the remedial alternatives were evaluated with respect to the protection of human health and the environment and based on the following criteria: long-term effectiveness; potential to reduce mobility, toxicity, or volume; short term effectiveness; implementability; and cost efficiency.

  The following conclusions were presented for each evaluated area:

  - Sludge Pits: sludge does not pose a significant risk to human health and the environment; potential direct exposure risk for site workers and wildlife; potential indirect exposure risk resulting from leaching and natural weather events overflowing the pit berms;

  - Landfill: no current risk to human health and the environment; future land use changes could expose landfill materials and/or mobilize constituents from the landfill into the groundwater or nearby surface water;

  - Groundwater: VOCs present in on-site groundwater at concentrations above TRGs; no VOCs above TRGs in off-site groundwater; and

  - Greens Creek: surface water and sediment containing VOCs and dioxathion do not pose a significant risk to human health and the environment; the results from samples collected upstream of Hercules property may indicate an off-site source.

  In the final revised CAP (GES 2005), the primary components of the proposed remedial alternatives consisted of groundwater and surface monitoring networks, deed restrictions, and fencing as summarized below for each evaluated area:

  - Sludge Pits: MNA combined with institutional controls/deed restrictions to restrict current/future land use and ensure that contaminated groundwater does not migrate from the sludge pits at unacceptable levels.

- Landfill: MNA combined with deed restrictions to restrict future land use and ensure that contaminated groundwater does not migrate from the landfill at unacceptable levels.

- Groundwater: MNA combined with deed restrictions to restrict future land use in the area of groundwater containing VOCs in excess of TRGs and to ensure that contaminated groundwater does not migrate from the Site at unacceptable levels.

- Greens Creek: MNA combined with institutional controls/deed restrictions to restrict current/future land use of Greens Creek to ensure that contaminated water does not migrate at unacceptable levels from Greens Creek.

The CAP also called for contingency plans for specific units, if groundwater monitoring indicated a potential release. These contingency plans included such actions as installation of an engineered cap, installation of a horizontal barrier, or implementation of in-situ chemical oxidation. To date, groundwater monitoring results have not indicated a need to implement the contingency plan for any unit.

- *Memorandum, Sludge Sample Analyses, Hattiesburg, Mississippi,* Eco-Systems, October 2008.

  In 2008, Hercules conducted sludge characterization sampling as part of plans to decommission the IB. The initial sampling event conducted on July 1, 2008, included collection of composite samples from the west end of the IB (SS-1), east end of the IB (SS-2) and from the wastewater holding tank (SS-3). Individual sample aliquots were collected from various locations via hand auger and combined in the field to produce composite samples. Prior to collection, each aliquot location was vertically mixed to the extent practicable by advancing and extracting the hand auger from the surface to the limit of the auger rods. Samples were submitted for toxicity characteristic leaching procedure (TCLP) analysis of VOCs, SVOCs, pesticides, PCBs, herbicides, and metals, and also for reactive cyanide, reactive sulfide, pH, and percent solids. Based on the results of this initial sampling, two additional events were conducted to confirm and further characterize sludge at the west end of the IB, where a TCLP benzene concentration (1.3 milligrams per liter [mg/L]) was detected above TCLP limits (0.5 mg/L) in SS-1.

On July 30, 2008, one composite sludge sample (SS-1-073008) was collected to confirm the benzene concentrations detected in SS-1 during the July 1st sampling event. The confirmation sample was collected following the same procedures and from the same general aliquot locations as was completed for the original sample SS-1. Samples were analyzed for TCLP-VOCs by TestAmerica and BATCO. One benzene result (0.586 mg/L) was detected above the TCLP limit in the confirmation sample analyzed by BATCO while the result of the TestAmerica analysis (0.44 mg/L) was below the TCLP limit.

In September 2008, a third sludge sampling event was conducted to investigate whether a potential localized source area for VOCs existed within the western end of the IB. Six discrete soil samples (SS-5 through SS-10) were collected and analyzed for VOCs by TCLP. Three of the samples contained concentrations of benzene below the TCLP limit, while the other three samples (SS-5 at 5.5 mg/L, SS-6 at 3.2 mg/L, and SS-8 at 3.2 mg/L) contained concentrations of benzene above the TCLP limit.

- *Groundwater Assessment Report*, Eco-Systems, November 2009.

  Hercules submitted a work plan to MDEQ in July 2009 to evaluate groundwater conditions near the IB. The work plan outlined the locations and procedures for the installation and sampling of five monitoring wells. MDEQ approved the work plan with revisions in a letter dated July 22, 2009. On September 15-16, 2009, five soil borings were advanced near the IB. Each boring was converted to a monitoring well (MW-20 through MW-24). Groundwater samples were collected from each monitoring well and analyzed for VOCs, SVOCs, pesticides, PCBs, metals, and Delnav. The analytical results were compared to TRGs. Concentrations of VOCs and SVOCs were reported above the TRGs. Pesticides, PCBs, metals, and Delnav groundwater concentrations were reported below TRGs for each of these analyses. Based on the VOC and SVOC results, Wells MW-20 through MW-24 were included in routine groundwater sampling events in 2010.

- *Sludge Characterization and Bench Scale Treatability Work Plan*, ARCADIS, March 2010; *Sludge Characterization and Bench Scale Treatability Report,* ARCADIS, August 2010; *and Response to Sludge Characterization and Bench Scale Treatability Report*, ARCADIS, January 2011.

  The focus of this investigation was to collect data necessary to assess potential options for managing the sludge contained in the IB.

Hercules is currently working with MDEQ toward the approval of a decommissioning plan to remove and properly dispose of the sludge.

- USEPA Sludge Pit Sampling (2010)

  In September 2010, at the request of MDEQ, representatives of the Science and Ecosystem Support Division (SESD) conducted a sampling investigation at the on-site sludge disposal area. Between September 28-29, 2010, SESD representatives collected 13 subsurface waste samples (HERC01 through HERC13) ranging from depths between 0 and 7 ft bgs. Twelve of the locations were collected from the Sludge Pit area (referred to in the SESD report as the “back forty” area). These samples were collected from various areas within the Sludge Pit which are delineated by berms and represent areas where the facility placed sludge at different times. One sample (HERC08) was collected from a lined pond referred to in the SESD report as the “wetlands” area. Samples were collected based on visual observations and results from field screening conducted with a Thermo Toxic Vapor Analyzer 1000B. Samples were analyzed by the SESD laboratory for total VOCs, SVOCs, metals, and/or toxicity characteristics.

  Various VOCs, SVOCs, and metals were detected in the sludge samples. USEPA compared the analytical data to the TRGs for unrestricted soil use and the USEPA Regional Screening Levels (RSLs). Benzene (10 samples), ethylbenzene (1 sample), isopropylbenzene (1 sample), toluene (11 samples), 1,1’-biphenyl (1 samples), naphthalene (7 samples), arsenic (4 samples), Chromium VI (13 samples), and vanadium (9 samples) exceeded the MDEQ TRGs and/or residential USEPA RSLs.

  USEPA analyzed samples with detected total analyte concentrations by the TCLP method. Benzene was above the TCLP regulatory limit of 0.5 mg/L in six of the samples. No other VOCs, SVOCs, or metals failed the TCLP limits or exceeded USEPA or MDEQ regulatory levels. A summary of the investigation activities and analytical results was provided in the *Field Investigation Report* (SESD 2011).

As demonstrated by the chronology of reports presented above, Hercules has worked with MDEQ for more than 20 years to understand the environmental conditions at the Site. Figure 4 is a composite map that shows the location where previous sampling was conducted at the Site. Based on the mutual understanding of Site conditions (i.e., the delineation of impacted areas, an understanding of groundwater flow regimes, exposure pathways), in 2005 MDEQ and Hercules began formalized corrective action and ongoing management activities in a RUAO. Since the implementation of the RUAO, Hercules and MDEQ continued to work together to address environmental issues at the Site not covered by the RUAO.

2.3 Corrective Action Plan and Restrictive Use Agreed Order

The 2005 CAP (Groundwater & Environmental Services, Inc. 2005) summarized the findings of the Site investigations between 1999 and 2003 as follows:

- Delineation of the lateral limits of the Landfill based on geophysical investigation;
- Detection of VOCs in groundwater at concentrations above MDEQ TRGs near the Landfill and other areas of the Site related to industrial operations;
- Presence of VOCs and dioxathion at concentrations less than TRGs in surface water and sediment samples collected from Greens Creek with some indication of upstream off-site sources;
- Presence of VOCs and dioxathion in one of three groundwater monitoring wells located hydraulically downgradient of the sludge pits; and
- No migration of VOCs or dioxathion onto off-site properties via groundwater or surface water.

Additionally, the 2005 CAP presented the following conclusions:

- Sources, source area COC concentrations, and vertical and horizontal extent of groundwater containing COC were defined sufficiently for remedial planning purposes;
- The existing data do not indicate that the Site poses a significant threat to human health and the environment in its current use as a chemical production facility; and
- If changes in land use occur or additional information is obtained, the current risk scenario for the Site could also change.

Based on an evaluation of the data obtained during the previous site investigations, a remedy consisting of MNA and institutional controls was proposed in the 2005 CAP to address the environmental conditions at the Site. In 2005, MDEQ approved the implementation of MNA of groundwater and surface water and institutional controls as proposed in the 2005 CAP. In January 2008, Hercules also entered into a RUAO with MDEQ to restrict the land use and activities on site while constituents in site-wide groundwater attenuate. In conjunction with the RUAO, Hercules executed a Notice of Land Use Restrictions documenting that soil and groundwater contained benzene, chlorobenzene, carbon tetrachloride, chloroform, 1,1,2-dichloroethane, and toluene in excess of MDEQ's TRGs. As a result, the following restrictions were placed on the property:

- There shall be no excavating, drilling, or other activities that could create exposure to contaminated media without approval from MDEQ;
- The groundwater at the Site shall not be used, unless otherwise approved by MDEQ;
- Monitoring wells shall be protected and maintained. In the event that a monitoring well is destroyed or damaged or is no longer needed, a plan for repair, reinstallation or abandonment of the well(s) must be submitted to MDEQ for approval; and
- No wells shall be installed without prior approval from MDEQ.

MDEQ indicated in the RUAO that, "…once the requirements of it have been completed that (1) the Site will be protective of the public health and the environment; and (2) no further corrective action will be required at this time."

The Site has been operated in accordance with the 2005 CAP and RUAO since 2007. Compliance with the RUAO has consisted of routine groundwater sampling and reporting. Since 2007, Hercules has conducted groundwater sampling and submitted routine groundwater monitoring reports to MDEQ in accordance with the RUAO. To date, COC concentrations have not increased at the Site to warrant implementation of contingency plans (capping of the Sludge Pits and/or Landfill) called for in the Remedial Action Plan.

An on-site well network was installed to monitor areas of impacted groundwater identified prior to implementation of the RUAO. Since the implementation of the sampling required by the RUAO, additional wells have been added to the monitoring well network and included in routine sampling events. The most recent additions to the well network are Monitoring Wells MW-20 through MW-24. These wells were installed at the request of MDEQ in the vicinity of the IB. The current configuration of the monitoring network is shown on Figure 5.

Groundwater monitoring data for VOCs and/or dioxathion generated during routine sampling events are submitted to MDEQ. The most recent data submitted to MDEQ to comply with the RUAO, which did not include dioxathion sampling, were developed using samples analyzed in July 2011. These sampling data are included in Table 1. In addition to the prescribed VOC compounds, groundwater samples from selected wells were submitted to accredited analytical laboratories for Appendix IX VOCs, SVOCs, pesticides, herbicides, PCBs, dioxins, furans, metals, sulfide, and cyanide from the July 2011 sampling. These data are also included in Table 1. With the exception of Wells MW-19 and MW-23, exceedances of MDEQ Tier 1 TRGs for groundwater have not been detected in monitoring wells adjacent to Site boundaries. Evaluation of off-site groundwater concentrations in the vicinity of Wells MW-19 and MW-23 will be conducted during the implementation of this Work Plan and is further described in Sections 6.3 (Groundwater) and 6.6 (Soil Gas). Additional on-site groundwater sampling activities will be conducted during the implementation of the Phase II Work Plan required by the AO, which is being submitted under a separate cover.

In addition to the groundwater sampling, the RUAO requires the collection and analysis of surface water samples from Greens Creek during routine monitoring events. Surface water sample CM-00 is collected from surface water entering the Site from Greens Creek. Surface water samples CM-01 through CM-05 are collected downgradient from sample CM-00 in sequential order. The CM-05 sample represents the surface water from Greens Creek as it exits from the Site. These data are presented in Table 2. A review of the surface water data indicates that sporadic detections of COCs have been observed in Greens Creek. COC concentrations in surface water exiting the Site have been less than Tier 1 TRGs since 2005. Evaluation of upstream and downstream surface water concentrations in Greens Creek, other surface water drainage features that exit the Site, and the covered City ditch shown as Drainage C on Figure 6 will be conducted during the implementation of this Work Plan and is further described in Section 6.2 (Surface Water and Sediment). Additional on-site groundwater, soil, surface water, and sediment sampling activities will be conducted during the implementation of the Phase II Work Plan required by the AO.

3. Preliminary Conceptual Site Model

The regional geology, Site-specific geology, known physical characteristics of the Site, and observations made of the community near the Hercules Site were composited into a graphical conceptual site model (CSM) (Figure 7). The graphic CSM highlights potential areas of release (former production operations, wastewater IB, landfill, sludge pits), impacted media, transport mechanisms, and exposure pathways specific to the Site. As shown on the CSM, soil, groundwater, surface water, sediment, and soil gas to indoor air pathways potentially exist at the Site, and, therefore, will be the focus of the data collection efforts of this Phase I Investigation. Additional detail related to the development and use of the CSM to investigate conditions at the Site is provided in the subsections below. Data collected during subsequent phases of investigation will be used to refine and update the CSM so that a better understanding of the nature of impacts, migration pathways, and potential receptors can be constructed.

3.1 Regional Hydrology

The Site is located within the Pine Hills physiographic region of the Coastal Plain physiographic province (Foster 1941). The topography of the region is characterized by a maturely dissected plain which slopes generally to the southeast. The topography is dominated by the valleys of the Bouie and Leaf Rivers coupled with the nearly flat or gently rolling bordering terrace uplands.

The geologic formations beneath the Site are as follows (in descending order):

- Pleistocene alluvial and terrace deposits;
- The Miocene-aged Hattiesburg and Catahoula Sandstone formations;
- The Oligocene-aged Baynes Hammock Sand and Chickasawhay Limestone formations; and
- The Oligocene-aged Bucatunna Clay member of the Byron formation of the Vicksburg group.

The recent-aged alluvial and terrace deposits consist of gravel, silts, and clays. The thicknesses of the alluvial and terrace deposits are variable due to erosion. Based upon driller’s logs of wells located in the vicinity of the Site, thickness of the alluvial and terrace deposits is estimated to be approximately 30 feet on site and extends to 50 feet closer to the rivers. The first groundwater-bearing unit at the Site occurs within the alluvial and terrace deposits.

Beneath the alluvial and terrace deposits lies the Hattiesburg formation, which is comprised predominantly of clay. Regionally within Forrest County, the Hattiesburg formation contains at least two prominent sand beds at depth beneath the clay from which a viable water supply is obtained. Logs from area wells indicate that the Hattiesburg formation ranges from approximately 130 feet to 260 feet in thickness.

The Catahoula sandstone underlies the Hattiesburg formation. It is not exposed near the Site, but is penetrated by numerous wells in the area. A driller's log of a municipal well approximately 1.25 miles northwest of the Site indicated that approximately 770 feet of Catahoula sandstone was encountered.

Near the Site, the Catahoula sandstone overlies the Chickasawhay limestone. Neither the Chickasawhay limestone nor the Bucatunna formation is considered to be a viable aquifer. The Bucatunna formation is comprised of clay and effectively acts as a confining layer for the underlying Oligocene aquifer.

The Miocene aquifer is comprised of both the Hattiesburg and Catahoula sandstone formations. The aquifer system is composed of numerous interbedded layers of sand and clay. Because of their interbedded nature, the Hattiesburg and Catahoula sandstone cannot be reliably separated. The formations dip southeastward approximately 30 feet to 100 feet per mile. While this dip steepens near the coast, the formations thicken. The shallowest portions of the aquifer system are unconfined with the surficial water table ranging from a few inches to greater than 6 ft bgs. Deeper portions of the aquifer are confined, with artesian conditions common.

3.2 Site-Specific Hydrogeology

Surficial soils in the vicinity of the Hercules Site include the Prentice-Urban Land Complex; the Trebloc silt loam; and the Brassfield-Urban Land complex. In general, these soils are described as poorly to moderately well drained and strongly acidic. The parent material from which the soil was derived is mainly marine deposits of sandy, loamy, and clayey material.

Borings installed during Site investigations encountered soils that are generally described as gray and tan, fine-grained sand with varying amounts of silt, clay, and gravel from the surface to depths ranging from 5 ft bgs to greater than 18 ft bgs. These sandy soils are typical of the Pleistocene alluvial and terrace deposits. Underlying the sandy soils is a gray to orange-brown, stiff, silty and/or sandy clay.

Descriptions of the clay are consistent with descriptions of the Miocene Hattiesburg formation.

The Hattiesburg Formation has been encountered in all Site borings that have penetrated the overlying alluvial material indicating the formation is consistent across the Site. An exploratory boring was installed in the northern portion of the Site to obtain Site-specific information for thickness and vertical permeability of the Hattiesburg Formation (EcoSystems 2004). Information obtained from the boring indicates that the Hattiesburg formation is at least 20 feet thick beneath the Site and has a hydraulic conductivity of 1.28 x 10^{-7} centimeters per second (cm/sec).

Water level information is routinely collected from monitoring wells, piezometers, and several Greens Creek staff gauges. Groundwater in the uppermost, saturated interval beneath the Site tends to follow the surface topography. In the former production areas, which are located in the southeastern portion of the Site, the potentiometric surface indicates the presence of a groundwater divide, which trends southwest to northeast. Historical potentiometric surface maps (Appendix A) indicate that groundwater located to the northwest of the divide moves northwestward toward Greens Creek. Groundwater southeast of the divide moves southeastward. On the north side of Greens Creek, the potentiometric surface indicates that groundwater in the uppermost, saturated interval moves generally southward toward Greens Creek.

Slug testing was conducted at on-site Monitoring Wells MW-2 (Northern Area), MW-6 (Former Landfill Area), and MW-7 (Former Production Area) (EcoSystems 2004). See Figure 5 for a map showing these well locations. Estimates of hydraulic conductivity were calculated using methods described by Bouwer & Rice (Bouwer and Rice 1976; Bouwer 1989). Hydraulic conductivity estimates varied from 1.31 x 10^{-3} cm/sec (3.71 feet per day [ft/day]) for MW-6 to 4.19 x 10^{-3} cm/sec (11.9 ft/day) for MW-2 with an average of 2.51 X 10^{-3} cm/sec (7.12 ft/day). Using the mean of the hydraulic conductivity estimates and historic potentiometric data, the estimated horizontal groundwater velocity from three areas of the Site were estimated using Darcy's Law. Darcy's Law can be expressed by the following equation:

$$V = \frac{Ki}{\eta}$$

Where:

V = Average linear groundwater velocity

K = Hydraulic conductivity

i = Hydraulic gradient

η = Effective porosity

Based on a review of historic potentiometric maps and published information, the following inputs were used to calculate the estimated groundwater flow for each area:

Area	Hydraulic Conductivity (ft/day)	Effective Porosity (%)	Hydraulic Gradient (ft/ft)	Groundwater Velocity (ft/day / ft/yr)
Northern Area (MW-2)	11.9	33%	0.006	0.216 / 78.8
Former Landfill Area (MW-6)	3.71	33%	0.03	0.337 / 123
Former Production Area (MW-7)	8.14	33%	0.007	0.173 / 63.0

ft/day	Feet per day.
ft/ft	Feet per feet.
ft/yr	Feet per year.

This analysis determined that the horizontal groundwater velocity ranged from 0.173 ft/day (63 feet per year [ft/yr]) in the Former Production Area (MW-7) to 0.337 ft/day (123 ft/yr) in the Former Landfill Area (MW-6).

3.3 Topography and Surface Water

The topography of the Site ranges from 170 feet mean sea level (ft msl) to 150 ft msl. Surface water drainage patterns at the Site conform generally to the topography. Topography slopes generally to the south in the Sludge Disposal Area and to the north/northwest in the former Industrial Landfill Area and the Former Delnav Production

Area (Figure 5). A topographic divide located south/southwest of the Former Delnav Production Area separates surface water drainage flowing in a northerly direction from surface water that flows in an east to southeasterly direction. The approximate location of the topographic divide is shown on Figure 8. The east-trending, perennial stream Greens Creek and its natural and man-made tributaries are the main surface drainage features in the area (Drainage A). Greens Creek leaves the Site at its northeast corner and subsequently flows into Bouie River, located approximately 1 mile to the north/northeast. Two unnamed intermittent drainage features that originate on Site are also present. One flows from the northeast corner of the Site (Drainage B) and the other flows from the southeastern portion of the Site (Drainage C). These drainage features are depicted on Figure 6. North of the sludge disposal area, a drainage ditch enters the Site from the West. This ditch previously flowed north of the sludge disposal area in a generally southeasterly direction and discharged into Greens Creek. To minimize the off-site flow of surface water in the vicinity of the sludge disposal area, this drainage ditch was rerouted to direct water southward along the Hercules fenceline until it ultimately discharges into Greens Creek.

Elevations of surface water within Greens Creek are significantly lower than the groundwater. This indicates that, while groundwater may contribute to flow in Greens Creek, hydraulic connection between the uppermost saturated interval and Greens Creek is retarded. The retardation of the water moving from the alluvial material to the creek is likely due to silt and clay in the sand adjacent to the creek.

3.4 Preliminary Conceptual Exposure Model

A component of the CSM is a preliminary conceptual exposure model. An exposure model evaluates potential exposure pathways that may result in exposure of a target population. An exposure pathway consists of the following four elements: (1) a source and mechanism of constituent release to the environment; (2) a retention or transport medium for the released constituent; (3) a point of potential contact by the receptor with the impacted medium (the exposure point); and (4) a route of exposure to the receptor at the exposure point (e.g., ingestion, inhalation, or dermal contact).

The conceptual exposure model provides the framework for the exposure assessment. It characterizes the primary and secondary potential sources and their release mechanisms and identifies the primary potential exposure points, receptors, and exposure routes. Exposure points are places or “points” where exposure could potentially occur, and exposure routes are the basic pathways through which constituents may potentially be taken up by the receptor (e.g., ingestion, inhalation, dermal contact).

The conceptual exposure model incorporates the Site-specific analytical data with constituent-specific fate and transport information to identify migration pathways, and activity and use patterns to identify the unique receptors and exposure pathways. Figure 9 identifies the sources, release mechanisms, transport pathways, and potential receptors for the Hattiesburg Site. These are discussed in detail below.

3.4.1 Sources

Operations began at the Hattiesburg Site in 1923. Rosin derivatives, paper chemicals, and Delnav (a miticide), were produced at the Site. Structures at the Site included offices, a laboratory, a powerhouse, production buildings, a wastewater treatment plant, settling ponds, a landfill, and central loading and packaging areas. Site-related constituents associated with these operations have been detected in soil, groundwater, surface water, and sediment on the Hercules property.

3.4.2 Release Mechanisms

Constituents detected in environmental media during the previous Site investigations have included organic constituents, metals, and pesticides. The migration of constituents released in the past is influenced by Site environmental factors and the physical and chemical properties of the constituents.

Constituents could potentially migrate from the former Hercules Plant via several mechanisms. When the Hercules Plant was active, normal permitted operations and potential inadvertent releases could have resulted in distribution of constituents at the Site. Because the Hercules Plant is no longer operational, these types of releases are not expected to occur. The potentially impacted soils at the Site can act as a source of constituents to other media. Migration into air may occur via volatilization or fugitive dust emissions; transport into the surface water can occur via surface runoff and groundwater discharge; and migration into groundwater can occur by infiltrating rainwater through impacted soil with subsequent leaching and transport. One other process that will influence migration is the attenuation of certain constituents through naturally occurring processes.

3.4.3 Potential Receptors

The Site is inactive and thus exposure of current Site workers is not expected to be significant because they do not routinely work around former process areas or disposal locations (landfill, sludge pits) and there are no significant subsurface construction activities; however, in the future, the Site could be redeveloped for industrial use and hypothetical future construction workers and Site workers could be exposed to constituents in soil on the Site. The evaluation of hypothetical future site workers will be a more conservative assessment of site worker exposure because such workers are more likely to work around the Site. It is unlikely that exposure to constituents in groundwater would occur because of restrictions to use of on-site groundwater as a potable water supply.

The Site is surrounded by commercial, industrial, and residential land uses. Data collected during the Phase I and Phase II Site investigations under the AO will be used to evaluate the potential exposure to Site-related constituents. This will include an evaluation of potential exposure to off-site receptors.

3.4.4 Potential Exposure Pathways

There are currently no points of exposure to groundwater on site. Workers on the property could be exposed to constituents in the surface soil through incidental ingestion, dermal contact, and inhalation of vapors or dust. While the presence of trespassers is unlikely, any trespassers on the property could also contact the surface soils and be exposed to Site-related constituents. If the hypothetical trespasser were to wade in the surface water on or leaving the Hercules property, they could contact Site-related constituents in the surface water or sediments. Additionally, aquatic and terrestrial biota are identified as potential receptors.

Shallow groundwater at the property boundary contains Site-related constituents. If Site-related constituents in groundwater extend beyond the property boundary, and groundwater is extracted for some purpose, then the potential exists for this pathway to be complete. Further, if volatile constituents associated with the former Hercules Plant are present off site, these VOCs could migrate from the groundwater into the vapor phase resulting in potential exposure. However, the Notice of Land Use Restrictions filed and recorded with the Forrest County Chancery Clerk's office on February 25, 2008 (Appendix B) prohibits the use of groundwater at the Site.

4. Preliminary Constituents of Concern

Consistent with the AO, the historic operations, past investigation results, and the Appendix IX constituent list were considered to identify preliminary constituents for the Phase I and Phase II investigations. In July 2011, Hercules discussed with MDEQ collecting samples from selected wells and analyzing for the Appendix IX list during the course of routine semiannual groundwater sampling per the RUAO. The Appendix IX analyte list was used in the most recent groundwater sampling of selected wells conducted in July 2011 to assess current conditions relative to this comprehensive analyte list. The laboratory reports from this sampling event are included in Appendix C. The data are provided in tabular format in Tables 1 and 2. An evaluation and screening of the current and historic groundwater and surface water data were conducted to identify the Site-related constituents on which to focus future assessments (Tables 3 and 4). The constituents detected during the previous investigations were compared to the MDEQ TRGs and USEPA RSLs, conservatively assuming the groundwater or surface water would be used as a potable water supply, even though this is unlikely to occur due to the restricted covenant put in place as part of the RUAO and the low yield of the first water-bearing zone.

The following summarizes the process used to evaluate the constituents detected in groundwater and surface water. The groundwater and surface water data from the previous investigations were compared to the screening levels (Tables 3 and 4). The maximum detected concentrations were compared to the TRGs and RSLs. Additionally, the minimum and maximum detection limits were compared to the TRGs and RSLs.

4.1 Groundwater

The groundwater data were evaluated first by class of compounds and then by individual constituents within a class. A discussion of this evaluation is provided below.

4.1.1 Polychlorinated Biphenyls

PCBs were not detected in the groundwater at the Site. The reporting limits were above both the TRGs and RSLs (i.e., screening levels); however, there is no evidence that these constituents were manufactured or used extensively at the plant.

4.1.2 Pesticides

Although there were no detections of toxaphene, there was limited manufacturing of the compound at the Site. Therefore, toxaphene will be included on the analyte list.

Two pesticides, alpha-BHC and gamma-BHC (Lindane), were detected during the most recent routine groundwater sampling. The other pesticides on the Appendix IX analyte list were not detected.

Endosulfan I; endosulfan II; endosulfan sulfate; endrin; endrin aldehyde; endrin ketone; kepone; and methoxyclor did not have reporting limits exceeding the screening levels and there was no manufacturing of these compounds.

4,4’-DDD; 4,4’-DDE; 4,4’-DDT; heptachlor; heptachlor epoxide; and technical grade chlordane had maximum reporting limits above their respective screening levels, but their minimum reporting limits were below their screening levels. There was no manufacturing or known use of these compounds at the Hercules Site.

4-Chlorobenzilate; aldrin; beta-BHC; delta-BHC; dieldrin; and isodrin had reporting limits that exceeded their respective TRGs and RSLs. These compounds were not manufactured or used at the Site.

4.1.3 Herbicides

2,4-D was detected in the groundwater at a concentration below the TRG and RSL. Reporting limits of 2,4,5-T and 2,4,5-TP were below their respective screening levels. These compounds were not manufactured at the Site. The other herbicides on the Appendix IX analyte list were not detected.

4.1.4 Volatile Organic Compounds

The following constituents were detected at concentrations exceeding either their TRG or RSL and were identified as constituents for the analyte list: 1,1-dichloroethene; 1,2-dichloroethane; 1,2-dichloropropane; 4-methyl-2-pentanone; acetone; benzene; bromodichloromethane; carbon tetrachloride; chlorobenzene; chloroform; chloromethane; dibromochloromethane; ethylbenzene (detected above the RSL but not the TRG); methylene chloride; tetrachloroethene; toluene; trichloroethene; and vinyl chloride.

4.1.5 Semivolatile Organic Compounds

The following constituents were detected at concentrations exceeding either their TRG or RSL and were identified as constituents for the analyte list: 1,1’-biphenyl; 1,4-dioxane; naphthalene; 1,4-dichlorobenzene; and 1,2,4-trichlorobenzene.

4.1.6 Inorganics

None of the inorganics detected in the groundwater were reported at concentrations above their TRGs. Arsenic was detected at a maximum concentration exceeding the RSL, but the detections were below the TRG. The maximum chromium concentration of 5 micrograms per liter (µg/L) is below the drinking water standard Thallium’s reporting limits were above the RSL.

Mercury was not detected in groundwater and the detection limits were below the TRG and RSL. Cyanide was not detected in groundwater, and the detection limits were below the TRG and RSL.

4.1.7 Dioxins/Furans

There were no reported detections of 2,3,7,8-TCDD; however, the reporting limits were above the TRG and RSL. The dioxin/furan total toxic equivalent (TEQ) for all samples was reported at 0.00.

4.2 Surface Water

Six surface water sampling locations are routinely monitored. The data are included in Table 1 and the locations are designated with a “CM” followed by the sampling location. The following constituents were detected in surface water (including detections in upgradient sampling locations): 1,1-dichloroethene; 1,2,3-trichlorobenzene; 1,2,4-trimethylbenzene; 1,3,5-trimethylbenzene; 1,2-dichlorobenzene; 1,3-dichlorobenzene; 1,4-dichlorobenzene; 1,2-dichloroethane; 2-chlorotoluene; 4-chlorotoluene; acetone; benzene; bromobenzene; carbon tetrachloride; chlorobenzene; chloroethane; cis-1,2-dichloroethene; ethylbenzene; methyl ethyl ketone; styrene; tetrachloroethene; toluene; trichloroethene; vinyl chloride; dioxenethion; and dioxathion.

cis-1,2-Dichloroethene and vinyl chloride were the only constituents detected in the most recent sampling round. cis-1,2-Dichloroethene was never detected above the screening levels. Vinyl chloride has exceeded the screening level.

MDEQ derived a TRG for total dioxathion. The concentrations of dioxathion were below the screening level. A screening level is not available for the dioxenethion isomer, which is a breakdown product of dioxathion.

The following VOCs were not detected at concentrations above both of the screening levels: 1,1-dichloroethene; 1,2,4-trichlorobenzene; 1,2,4-trimethylbenzene; 1,3,5-trimethylbenzene; 1,2-dichlorobenzene; 1,3-dichlorobenzene; 1,4-dichlorobenzene; 2-chlorotoluene; 4-chlorotoluene; acetone; bromobenzene; carbon tetrachloride; chlorobenzene; methyl ethyl ketone; styrene; and toluene.

4.3 Summary

Based on the evaluations of the July 2011 sampling data and discussions with USEPA, historical analytical data, and a review of the manufacturing processes at the Site, the following analyte list is proposed for the Phase I soil and groundwater assessment activities:

- Appendix IX. VOCs (SW-846 8260B or equivalent drinking water standards):
- Appendix IX. SVOCs (SW-846 8270C or equivalent drinking water standards):
- Appendix IX. Metals (SW-846 6010 or equivalent drinking water standards):
- Appendix IX. Pesticides (USEPA 8081A or equivalent drinking water standards):
- Appendix IX. Herbicides (USEPA 8151 or equivalent drinking water standards):
- Appendix IX. PCBs (USEPA 8082 or equivalent drinking water standards):
- Appendix IX. Dioxins and Furans (USEPA 1613 or equivalent drinking water standards):
- Appendix IX. Dioxathion/Dioxenethion (BATCO 088.1).

All surface water and groundwater samples will be analyzed for VOCs, SVOCs, and metals. Selected surface water and groundwater samples will also be analyzed for pesticides, herbicides, dioxins, furans, and PCBs. This will result in approximately 10 percent of the surface water and groundwater samples being analyzed for the complete list of analytes. Specific locations will be communicated to USEPA and MDEQ after reviewing the Phase I data and prior to conducting Phase II sampling. This preliminary COC list will be revised after completion of the initial investigation. Additionally, modifications to this analyte list will be made to address the soil gas, sub-slab, and indoor air media after the preliminary groundwater sampling is complete.

5. Phase I Project Objectives

5.1 Administrative Order Objectives

The objectives of the Phase I Work Plan are to:

- Determine the presence of Site-related Constituents at off-site locations; and
- Evaluate the nature and extent of Site-related Constituents at off-site locations.

Execution of the activities set forth in this Work Plan will obtain data that can be used to determine if impacts from the Hercules Site exist off site. Media that will be evaluated may include surface water, groundwater, sediment, soil, soil gas, and/or indoor air.

5.2 Data Quality Objectives

Data collected in accordance with the procedures described in this Work Plan will be evaluated in accordance with the objectives described in the Quality Assurance Project Plan (QAPP) included in Appendix D. Data quality objectives (DQOs) established for this project are included in the QAPP. The project activities will be performed as required by the USEPA AO for the investigation of potential environmental impacts at or emanating from the Site.

6. Phase I Environmental Investigation

The scope of work for the investigation described below is designed to meet the requirements of the AO. All field work will be conducted in accordance with the Health and Safety Plan included in Appendix E. All non-dedicated sampling equipment will be decontaminated prior to use in accordance with the USEPA SESD guidance document SESDPROC-205-R1 (Appendix F).

6.1 Drinking Water Wells

The AO requires that Hercules perform “an inventory of all wells on and within a 4-mile radius of the Site, and a schedule for sampling of all such wells either on or within a 0.5-mile radius of the Facility.” Details of the well inventory were discussed at a June 9, 2011, technical meeting and the USEPA provided clarification that the inventory should include public and private drinking water, irrigation, and production supply wells where water is extracted for human consumption or where humans may come in direct contact with the water. Other types of wells such as those used for groundwater monitoring, environmental remediation, injection, or dry wells would not need to be included in the inventory. The water wells located within the 0.5-mile radius of the Site will be sampled. These wells, identified from a database search, are shown on Figure 6. Water wells located outside of the 0.5-mile radius will be evaluated consistent with the decision matrix provided on Figure 10.

Initial response actions performed by Hercules shortly after receiving the AO included performing a public records search of registered wells that exist within a 4-mile radius of the Site. This initial well inventory, conducted by Environmental Data Resources, Inc. (EDR), identified a total of 806 well records within the search radius. The Site property boundary as defined in Exhibits 2 and 3 of the AO was provided to EDR. The search was conducted on data contained in the following public databases:

- Public Water Systems data from the Federal Reporting Data System;
- Public Water Systems Violation and Enforcement Data;
- MS Radon;
- National Radon Database;
- U.S. Geological Survey (USGS) Water Wells;
- USGS Public Wells;
- Permitted Wells;

- USGS Private Wells;
- Health Department Wells; and
- Oil and Gas Well Location Listing.

A figure showing the wells identified by EDR within 4 miles of the Site is included in Appendix G. The well inventory search radius was refined to show only the registered wells that exist on or within a 0.5-mile radius of the Site and those wells are listed in Table 5 and shown on Figure 6. The EDR map erroneously lists Wells 173 and 212 as being located within the 0.5-mile radius of the Site; however, these wells are 217 feet and 100 feet farther than the 0.5-mile radius from the Site, respectively. This initial public records survey indicates that 20 wells potentially exist within a 0.5-mile radius of the Site; however, there may be other wells within this radius that are not listed in public records or these wells may not be present. Further investigation into the existence of wells in the area will be performed as described in the following sections.

6.1.1 Identification of Drinking Water Well Locations

An initial evaluation of public records has already been performed as described above to identify public and private drinking water wells within the search radii specified in the Order. Site records indicated that historical well surveys including the 1993 B&V Waste Science and Technology Corporation report (1993 B&V) have also been performed. The 1993 B&V report documented that five municipal suppliers of potable water having wells within 4 miles of the Site existed at that time. Seventeen public supply wells were identified in the EDR well survey. The locations of the identified public supply wells are shown in Appendix G.

Hercules is also in the process of performing a neighborhood survey of residents and businesses located within a 0.5-mile radius of the Site by distributing a questionnaire to collect information on the presence and use of public and private wells. A copy of the questionnaire is provided in Appendix H. The questionnaire was mailed to 1,809 addresses (residents and businesses) located within the 0.5-mile radius to inform them of the importance of the survey and requested that respondents provide information regarding wells on their property. As of September 12, 2011, 389 questionnaires had been returned. The address information was obtained from the City of Hattiesburg and questionnaires were sent to the owners of the parcels. A summary of the responses is included in Appendix H. Parcels where the owner stated a well was present are shown on Figure 11.

The survey will be further supported by performing a “windshield” survey” of properties within the 0.5-mile radius to look for signs typically associated with private water well use (staining on structures and sidewalks, small enclosures or well houses, etc.). Well verification may be performed using a door-to-door follow-up survey to further support either a questionable windshield survey observation or a response from the questionnaire that requires clarification. Data collected from survey responses, the windshield survey, and from other public information sources mentioned above will be compiled into a geographic information system database for use in determining wells that may require sampling.

6.1.2 Water Well Sampling Procedure

Hercules will pursue access to properties where private or public potable wells, irrigation wells, and process water wells exist within the 0.5-mile radius of the Site. Specifically excluded from the well sampling effort are groundwater monitoring wells installed in response to environmental investigations not related to the Site, heat pump wells, injection wells, or other non-contact groundwater withdrawal points. Figure 11 provides the location of known or suspected wells within the 0.5-mile radius and additional data will be collected and reviewed to identify other wells that may exist within 0.5 mile of the Site. Access agreements will be presented to each well owner for review and approval. The sampling event will be scheduled with the well owner once the access agreement is signed. No samples will be collected without the owner's signed access agreement.

The sampling team will perform a short interview with the owner during the sampling event to ascertain information regarding the well and water use at the property. Interviews will be conducted with the owners (or their current tenants) using a form developed to record specific information on the well and each form will be added to the data record for the investigation. A copy of the interview form is provided in Appendix I.

It is Hercules’ intent, for wells that are equipped with an operable pump system, to use the existing pumping system for purging the well and samples will be collected from a valve or spigot in the piping system. For public or private wells to be sampled that do not have an operable pump in place, a method for properly purging and sampling the well (either pump or bailer) will be developed based on specific construction details of the well to be sampled.

Hercules will utilize USEPA SESD guidance document SESDPROC-305-R1, as appropriate, during the collection of water samples for laboratory analysis. Conditions that require deviations from practices in the guidance will be documented in field books, well sampling sheets, and final reports that will become part of the project records. Samples that are collected from water wells will be preserved, handled, and shipped in accordance with SESDPROC-305-R1 and the project-specific QAPP. The analytical program for the water well program is discussed in Section 7 and the evaluation process is described in Section 8.

6.1.3 Schedule of Sampling

Well sampling will be initiated upon approval of this Work Plan for properties where the owner has granted access to the property to collect water samples. The existing well database, responses to private well questionnaires, and county tax records will be reviewed to determine the name and address of properties where wells may exist. Parcels that will be verified as having wells are identified on Figure 11. Access agreements will be presented to the property owner for review and approval and the sampling event will be scheduled once access agreements are obtained. A preliminary schedule for private well sampling is included as Table 6. No samples will be collected without the owner's signed access agreement.

6.2 Surface Water and Sediment

A survey will be conducted to identify any wetlands, creeks, lakes, or other surface water bodies, including any ditches (collectively called “water bodies”), located on and within a 0.5-mile radius of the Site. A preliminary evaluation of the potential for these water bodies to be used for public recreational purposes or which may contain threatened and endangered (T&E) species will be included in this survey. Based on the location and hydrogeologic characteristics of these water bodies, the water bodies that could potentially be connected to discharges from the facility will be identified for sampling and analysis of surface water and sediment.

Preliminary analysis of surface water on the Site has identified three major drainages which will, at a minimum, be sampled during implementation of Phase I under the AO, as described below. Other water bodies, not currently identified, which are identified in the survey and which may be influenced by the Site, will be considered for sampling in a similar manner.

6.2.1 Identification of Surface Water and Sediment Sampling Locations

Initial actions performed by Hercules in response to the AO included performing a review of available maps, historical reports, and related resources that identify surface water features within and beyond the 0.5-mile search radius specified by USEPA. There are numerous small drainage features on the Hercules Site that collect storm water runoff from rain events but these ditches are typically dry except in periods of heavy rainfall. A detailed evaluation of hydrologic setting at the Site was performed by B&V and summarized in 1993 B&V Report. The report concluded that, and as discussed in Section 3.3, Topography and Surface Water, the Site is predominantly drained by three waterways, which include:

- The perennial Greens Creek, which flows in an easterly direction (Drainage A);
- An unnamed, intermittent drainage ditch that flows in a northerly direction and exits the northeast corner of the Hercules Site, crosses North Main Street, and flows within a culvert below a neighboring industrial facility until it daylights approximately 1,000 feet northeast of the Hercules property line (Drainage B); and
- An unnamed, intermittent drainage ditch located in the southeastern portion of the Site, which flows south of the Site's wastewater treatment plant and exists in both closed-culvert and open conditions along its generally easterly flow path (Drainage C).

Figure 6 provides an illustration of these three main drainage features. The Site's three drainage pathways flow northeast for 1.0 to 1.2 miles before entering the Bouie River, which flows in a southeasterly direction (B&V 1993). Depending on which pathway surface water enters the Bouie River from the Site, it then travels between 0.9 and 1.9 miles southeast and enters the Leaf River. The Bouie and Leaf Rivers are utilized for sport and commercial fishing according to the 1993 B&V report; however, the report states that Greens Creek is too small to be used for fishing or swimming. The use determination of Greens Creek, including human activity patterns in and around the creek, will be confirmed during Phase I sampling activities.

In accordance with the AO, the off-site portions of the surface water features identified in historical reports and those sampled by MDEQ in 2004 (MDEQ 2004) will be the focus of the proposed sediment and surface water sampling program outlined in this Work Plan. The on-site portions of the identified surface water features will be sampled during implementation of an approved Phase II Work Plan, as required by the AO.

Off-site surface water and sediment sampling will be conducted within 0.5 mile of the Site at the locations shown on Figure 12. The rationale for selecting these sampling locations is included in Table 7. Sampling of surface water and sediment locations outside of the 0.5-mile radius of the Site will be conducted following the logic contained in the decision flow chart shown on Figure 13.

Potential surface water and sediment sample collection locations along the reaches of the three drainage features are shown on Figure 12. Three co-located surface water and sediment samples (where possible) will be collected within the facility boundary to evaluate Constituent concentrations on Hercules property. Each drainage will be sampled along its flow path on 500-foot intervals until a distance of 2,640 feet is reached from the Hercules property boundary. In the case of Greens Creek, which originates upgradient of the Site, five co-located surface water and sediment samples will be collected on the upstream reach on 500-foot intervals until the 0.5-mile boundary is reached. Some adjustment in the sampling interval may be needed along the flow path to optimize areas where both surface water and sediment exist. Sampling will not be performed in closed culverts or conveyances that are not readily accessible and open to the surface. Surface soil samples will be collected at 500-foot intervals along the culverted portion of Drainage C to evaluate the potential for current exposure resulting from historic flows. These samples will be collected from the 0 to 1 ft bgs interval using a clean, stainless steel hand auger. Proposed surface water and sediment sample locations are shown on Figure 12. Access agreements will be presented to each landowner for review and approval. The sampling event will be scheduled with the landowner once the access agreement is signed. No samples will be collected without the owner's signed access agreement. Details of the sample collection procedures and analytical parameters are provided in the following sections of this Work Plan.

At each surface water and sediment sampling location, a screening-level assessment of surface water use, habitat, and potential for T&E species will be performed to capture visual observations at the time of the sampling.

6.2.2 Surface Water Sampling Procedure

The USEPA SESD guidance document SESDPROC-201-R1 will be utilized during the collection of surface water samples for laboratory analysis. Surface water sampling will be performed and documented in accordance with procedures outlined in the document and with the standard operating procedure (SOP) provided in Appendix J. Where conflicts exist between the two guidance documents, the SESD guidance will prevail. Conditions that require deviations from practices in the guidance will be documented in field books, surface water sampling sheets, and final reports that will become part of the project records. Surface water samples will be preserved, handled, and shipped in accordance with SESDPROC-201-R1 and the project-specific QAPP. The analytical program for the surface water program is discussed in Section 7 and the evaluation process is described in Section 8.

6.2.3 Sediment Sampling Procedure

The USEPA SESD guidance document SESDPROC-200-R2 will be utilized during the collection of sediment samples for laboratory analysis. Sediment sampling will be performed and documented in accordance with procedures outlined in the document and with the SOP provided in Appendix K. Where conflicts exist between the two guidance documents, the SESD guidance will prevail. Conditions that require deviations from practices in the guidance will be documented in field books and sediment sampling sheets that will become part of the project records. Sediment samples will be preserved, handled, and shipped in accordance with SESDPROC-200-R2 and the project-specific QAPP. The analytical program for the sediment program is discussed in Section 7 and the evaluation process is described in Section 8.

6.2.4 Schedule of Sampling

Surface water and sediment sampling will be initiated in all reaches of the drainage features upon approval of this Work Plan and obtaining access agreements for off-site sampling locations. A review of county tax records will be performed to determine which proposed sampling locations identified on Figure 12, if any, will require private property access. Access agreements will be presented to the property owner for review and approval. The sampling event will be scheduled once all access agreements are obtained. A preliminary schedule for surface water and sediment sampling is included as Table 6. No samples will be collected without the owner's signed access agreement.

6.3 Groundwater (Temporary and Permanent Wells)

Temporary or permanent groundwater monitoring wells will be installed and sampled to investigate the presence of Site-related Constituents in groundwater:

Step 1: Install pre-packed well screens using direct push technology to collect screening-level groundwater data.

Step 2: Based on a review of the screening level groundwater data, install permanent monitoring wells, if required, to collect shallow groundwater confirmation samples.

This section describes the sampling activities that will be performed to evaluate Constituents in groundwater.

6.3.1 Identification of Groundwater Sampling Locations

Based on Hercules' preliminary evaluation of the CSM, to address USEPA comments during the June 9, 2011, meeting, and to augment the monitoring data (Tables 1 and 2) collected during routine groundwater monitoring events, groundwater screening data from the upper water-bearing zone will be collected in the locations depicted on Figures 12 and 14:

- Sample AO-GP-01 will be collected near the northwestern property boundary (near the sludge pits).
- Samples AO-GP-03 and AO-GP-04 will be collected near the southwestern property boundary (near TP-7).
- Samples AO-GP-20 and AO-GP-21 will be collected near the western corner of the southernmost property boundary.
- Samples AO-GP-22, AO-GP-23, and AO-GP-24 will be collected near the eastern corner of the southernmost property boundary (near TP-2).
- Sample AO-GP-27 will be collected near the western property boundary adjacent to Greens Creek.
- Samples AO-GP-19, AO-GP-25, AO-GP-26, AO-GP-28, AO-GP-29, and AO-GP-30 will be collected near the eastern property boundary near Wells MW-19, MW-22, and MW-23.
- Sample AO-GP-31 will be collected near the northeastern property boundary.
- Samples AO-GP-32 and AO-GP-33 will be collected near the northern property boundary.

The rationale for selecting the groundwater sampling locations shown on Figure 14 is provided in Table 8. The actual groundwater sample locations will be determined in the field and will be based on utility clearances and property access. Access agreements will be presented to each landowner for review and approval. The sampling event will be scheduled with the landowner once the access agreement is signed. No samples will be collected without the owner's signed access agreement.

Groundwater samples collected using pre-packed well screens are considered screening-level data, suitable for obtaining an understanding of groundwater quality.

6.3.2 Groundwater Sampling Procedure

The USEPA SESD guidance document SESDPROC-301-R1 will be utilized during the collection of groundwater samples for laboratory analysis. Groundwater sampling will be performed and documented in accordance with procedures outlined in the document and with the SOP provided in Appendix L. Where conflicts exist between the two guidance documents, the SESD guidance will prevail. Conditions that require deviations from practices in the guidance will be documented in field books, surface water sampling sheets, and final reports that will become part of the project records. Groundwater samples will be preserved, handled, and shipped in accordance with SESDPROC-301-R1 and the project-specific QAPP. The analytical program for the groundwater sampling program is discussed in Section 7 and the evaluation process is described in Section 8.

Groundwater samples from the first water-bearing zone will be collected by installing temporary groundwater monitoring wells completed with pre-packed well screens using a direct push technology (DPT) drilling rig. In addition, depth-to-water measurements and ground-surface elevations at each well point will be determined to assess the direction and gradient of groundwater flow. All groundwater samples from the temporary wells will be collected in accordance with the procedures specified in the SOP provided in Appendix L. Additional details of the Phase I well installation program are provided in this section.

Small-diameter (3/4-inch internal diameter) polyvinyl chloride wells equipped with 10 feet of pre-packed well screen will be installed in the locations illustrated on Figure 14 so that groundwater quality samples can be collected. The screened interval of these temporary monitoring wells will be set so that approximately 2 feet of the screened interval is above the static water table and 8 feet is below the water table. This will ensure that the screen interval intersects both the saturated and unsaturated zones of the shallow aquifer. Following utility clearing, a DPT rig will be used to collect continuous soil samples using a macro-core sampler from the ground surface to a depth equivalent to the base of the first water-bearing zone. After the cores are collected, they will be opened and immediately screened with an organic vapor analyzer (OVA) equipped with a flame-ionization detector (FID) or photoionization detector (PID) to field-assess concentrations of VOCs. The lithology will be logged at each location in accordance with the ASTM International (ASTM) 2488-09a, Description and Identification of Soils (ASTM 2009). At the completion of the boring, all soil cores will be laid adjacent to each other with the shallowest core on the left and deepest on the right so that a photograph can be taken of the entire cored section. The USEPA guidance document for monitoring well installation is included as Appendix M (SESDGUID-101-R0).

Permanent groundwater monitoring wells may be installed to facilitate the collection of shallow groundwater samples and the measurement of groundwater elevations, if deemed necessary based on an evaluation of the groundwater screening data. A temporary well will be converted to a permanent well depending upon whether any reported constituent concentrations from that well, or in the vicinity, are greater than applicable regulatory standards. In addition, the impact of plugging and abandoning a temporary well would have on the spatial coverage of the monitoring well network will be considered in the determination to remove or convert a temporary well to a permanent well. The preferred alternative is to convert the temporary well pre-packed screens into permanent wells, but in some instances the original pre-packed screens may be removed and a monitoring well installed adjacent to the screening location. The wells will be screened so that the top of the well screen is just above the water table. All monitoring wells will be installed and developed in accordance with the procedures specified in the SOP provided in Appendix M. Procedures for both the conversion of Geoprobe® temporary wells to permanent wells and installation of traditional wells are provided in the SOP.

A groundwater sample will be collected from each of the groundwater monitoring wells (either temporary or permanent) following installation and well development. Samples from the monitoring wells will be collected using low-flow/low-stress sampling techniques in accordance with the procedures specified in the SOP.

Hercules will utilize USEPA SESD guidance document SESDPROC-301-R2 during the collection of groundwater samples for laboratory analysis. Monitoring well purging and sampling will be performed and documented in accordance with procedures outlined in the document. Conditions that require deviations from practices in the guidance will be documented in field books and groundwater sampling sheets that will become part of the project records. Samples that are collected from temporary or permanent monitoring wells will be preserved, handled, and shipped in accordance with SESDPROC-301-R2 and the project-specific QAPP. The analytical program for the groundwater program is discussed in Section 7 and the evaluation process is described in Section 8.

6.3.3 Schedule of Sampling

Groundwater sampling will be initiated upon approval of this Work Plan and obtaining access agreements for off-site sampling locations. A review of county tax records will be performed to determine which proposed sampling locations identified on Figure 12, if any, will require private property access. Access agreements will be presented to the property owner for review and approval. A preliminary schedule for groundwater sampling is included as Table 6. No samples will be collected without the owner's signed access agreement.

6.4 Soil

The AO requires that soil sampling be conducted during the implementation of Phase II activities. Hercules will also collect soil samples during the groundwater sampling activities proposed in Phase I, as described below.

6.4.1 Identification of Soil Sampling Locations

Soil sampling locations during the Phase I investigation will coincide with drilling to support groundwater sampling, as discussed above to evaluate soil quality in shallow (0 to 2 ft bgs) and subsurface soil (greater than 2 ft bgs). Soil samples will be collected from the following intervals and retained for chemical analyses:

- The soil sample exhibiting the highest OVA reading[1];
- The soil sample collected at the soil/groundwater interface;

---

[1] If no OVA readings above background are recorded for the soil samples collected at a particular probehole, the soil sample collected from the 0 to 2 ft bgs interval will be retained.

- The soil sample at the base of the probehole; and

- Soil samples that are visibly stained.

Details of soil sample collection techniques are provided in the following sections and maps showing proposed soil sampling locations during Phase I are provided as Figures 12 and 14.

6.4.2 Soil Sampling Procedure

The USEPA SESD guidance document SESDPROC-300-R1 will be utilized during the collection of soil samples for laboratory analysis. Soil sampling will be performed and documented in accordance with procedures outlined in the document and with the SOP provided in Appendix N. Where conflicts exist between the two guidance documents, the SESD guidance will prevail. Conditions that require deviations from practices in the guidance will be documented in field books, soil sampling sheets, and final reports that will become part of the project records. Soil samples will be preserved, handled, and shipped in accordance with SESDPROC-300-R1 and the project-specific QAPP. The analytical program for the soil program is discussed in Section 7 and the evaluation process is described in Section 8

6.4.2.1 Lithologic Logging

The lithology of the soil samples collected will be described through visual observations of the soil/bedrock cores using the Unified Soil Classification System (USCS) and/or the ASTM Standard D 2488 for Description and Identification of Soils. The Boring/Well Construction Log (Appendix O) will be used to record lithologic logging observations. The following logging sequence will be used for the description of unconsolidated materials:

- Describe major soil type and percentage;

- Describe composition of the soil;

- Describe the moisture, texture, and color of the soil;

- Document other geologic observations such as bedding characteristics, structure and orientation, and primary and secondary permeability/porosity (if possible); and

- Document observations on drilling progress including sample interval loss and recovery.

Samples will be preserved according to the selected analytical method. Specific method preservation requirements, size, and type of sample containers to be used, and holding times for each parameter are contained in the QAPP.

6.4.2.2 Direct Push Borings and Sample Collection

Direct-push soil sampling consists of hydraulically pushing or driving a small-diameter, hollow steel rod to a target depth and collecting a soil or groundwater sample. The equipment necessary for the collection of samples using the direct push technique is self-contained or a vehicle-mounted unit. The steel probe rods, 3 to 5 feet in length, are threaded for easy connection and have tight seals to provide a continuous length of rod. The rods are hydraulically driven or hammered to target depths. The steel rods can be driven to depths of up 150 feet through unconsolidated sediments.

6.4.3 Soil Sample Collection

The following procedures will be used during the collection of soil samples from direct push borings:

1. Record borehole location and intended sample depth intervals on the Boring/Well Construction Log.

2. Line the steel soil sampler core barrel with an acetate, polyethylene, or Teflon liner and attach sampler to end of steel rods.

3. Hydraulically push or drive the soil sampler and rods to intended depth.

4. Open the core barrel and disassemble, revealing the soil core sample within the liner.

5. Remove a portion of the liner over the entire length of the core using an appropriate cutting tool.

6. Screen soils immediately in the field using an OVA (e.g., PID, FID) to document the levels of organic vapors present. To collect volatile organic headspace readings, place the soil sample in a sealed plastic bag approximately two-thirds full allowing

for approximately 30 percent headspace. Place the bag in a dry area, which is as close to room temperature (70º F) as practicable. After 10 minutes, use a PID or FID to measure the vapors that accumulate in the bag due to off-gassing from the sample. Base PID/FID usage on the target analytes. If a PID is used, select the appropriate lamp based on the target analyte. Record the measurement on the Sample/Core Log (Appendix O).

7. Collect soil sample(s) for laboratory analysis based on the selection of sampling intervals discussion in Section 6.4.1. If a soil sample is needed for the analysis of VOCs from an interval that was not automatically sampled (e.g., the interval with the highest OVA reading may not coincide with a previously collected sample interval), install a second boring in the vicinity of the initial boring for the collection of the required sample. Don a clean pair of disposable gloves immediately prior to sample collection. VOC samples will be collected directly from the target depth interval of the soil core to minimize disturbance using an EnCore™ sampler or equivalent (Terra Core). Transfer the remaining soil from the target depth interval to a stainless steel bowl. Mix the soil using a stainless steel spoon until the sample is visually uniform. Remove any debris or larger rocks observed during mixing using the spoon. Collect non-VOC analysis samples from the bowl and place in appropriate sample container, label the container, and place on ice. Note on the field sample log the depth interval from which the sample aliquot was collected. The container and preservative requirements for soil samples are outlined in Appendix D).

8. Extract from the liners the portion of the soil core not submitted to the laboratory for analysis and use for logging purposes.

9. Describe the soil samples in the field. The lithology of the soil will be described by a qualified and experienced ARCADIS representative through visual observations of the soil core using the USCS or ASTM designation.

10. Place all soil cuttings in drums or roll-off box.

11. Properly decontaminate all down-hole sampling equipment prior to subsequent use in consecutive sample collection in accordance with the procedures contained in SESDPROC-205-R1.

6.4.4 Schedule of Sampling

Soil sampling will be conducted at the locations where drilling for groundwater sampling is to be conducted. Soil sampling will be conducted concurrently with groundwater sampling. Soil sampling will be initiated upon approval of this Work Plan and obtaining access agreements for off-site sampling locations. A review of county tax records will be performed to determine which proposed sampling locations, if any, will require private property access. Access agreements will be presented to the property owner for review and approval. A preliminary schedule for soil sampling is included as Table 6. No samples will be collected without the owner's signed access agreement.

6.5 Vapor Intrusion Evaluation

The vapor intrusion pathway will be evaluated consistent with the sample decision flow chart provided on Figure 15. This approach starts with a broad view of the potential pathway, characterizing sampling media one step at a time originating with groundwater, then progressing to soil gas, sub-slab, and indoor air evaluations, as appropriate. The key is to focus the sampling efforts on those areas or buildings with the greatest potential for indoor air exposure to Site-related constituents. Generally, buildings within 100 feet of the source (in this case groundwater) will be the focal point of any further investigation; however, if the groundwater exhibits concentrations below screening levels that are protective of indoor air exposures, then further evaluation would not be warranted.

The following sections describe the specific procedures for screening shallow groundwater data and for collecting and evaluating soil gas data near the edge of the delineated shallow groundwater plume. Soil gas data will be screened using USEPA RSLs assuming a 0.1 attenuation factor moving from soil gas to indoor air. If soil gas samples exceed the screening levels, sub-slab soil gas and indoor air sampling in buildings will be warranted.

6.5.1 Groundwater Screening

The first step in the evaluation of the vapor intrusion pathway is the comparison of shallow (water table) groundwater data to calculated groundwater screening levels (SLs) protective of indoor air exposure. These SL values have been calculated using the most recent USEPA residential indoor air RSLs (June 2011 table) consistent with USEPA (2002) guidance as follows:

$$C_{gw} = C_{ia} \times CF \times 1/HLC * 1/AF$$

Where:

C_{gw} = groundwater to indoor air screening level (or groundwater SL)

C_{ia} = concentration in indoor air (residential air concentrations from the USEPA RSL table)

CF = conversion factor (0.001 m^3/L)

HLC = Henry's Law Constant (unitless and constituent-specific)

AF = attenuation factor (0.001)

If the calculated groundwater SL is below a federal drinking water standard such as the Maximum Contaminant Level (MCL), the MCL will be used as the criteria instead. The calculation of groundwater SLs are presented in Table 9. Groundwater SLs were calculated corresponding to a target cancer risk level of 1×10^{-6} (1 in 1,000,000) or a Hazard Quotient (HQ) of 1.0 for screening purposes, although the entire Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) target risk range (1×10^{-6}) and an HQ of 1 may be considered prior to sampling additional environmental media. If Constituents are identified that are not listed in Table 9, appropriate screening levels will be calculated using the same methodology as presented above.

Recent shallow Site groundwater data from 2009 and 2010 were compared to the groundwater SLs calculated as described above. The results of this initial screening are presented in Table 10. Groundwater wells with Constituents exceeding the calculated residential groundwater SLs at a 1×10^{-6} risk or an HQ of 1.0 include MW-19, MW-21, MW-22, and MW-23 located on the southeast side of the Site. Constituents detected in groundwater wells to the north, west, southwest, and northeast are all non-detect or present at concentrations below the calculated screening criteria, except MW-8, MW-13, and MW-17 located in the central portion of the Site which contain Constituents that exceed the conservative groundwater SLs.

The initial screening of current groundwater data indicates that additional evaluation of constituents in shallow groundwater is warranted for the southeastern portion of the Site for the vapor intrusion exposure pathway. Soil gas samples will be collected along the southeast portion of the Site at selected locations (Figure 14). In addition, shallow groundwater samples will be collected as described in Section 6.3 until concentrations are below either the calculated groundwater SLs or the MCLs, whichever is greater. At the completion of the shallow plume delineation and initial soil gas sampling, Hercules will determine if additional soil gas samples should be collected within a 0.5-mile radius of the Site or if the data indicate that no further evaluation of the vapor intrusion exposure pathway is warranted.

6.6 Soil Gas

Soil gas sampling will be conducted in public right-of-ways, easements, and/or private property to assist in the delineation and evaluation of the vapor intrusion exposure pathway. The overall goal of the soil gas sampling program is to confirm that VOCs associated with historical plant operations are not migrating within the vadose zone at concentrations that could be of concern for vapor intrusion. As noted above, a focused number of soil gas samples will be collected from the southeast portion of the Site. Additional soil gas samples may be collected based on the results of shallow groundwater and soil gas sampling and screening as outlined in Figure 15 and Section 6.6.4.

6.6.1 Identification of Soil Gas Sampling Locations

Soil gas samples will be collected in the public right-of-way or private property near the southeastern boundary of the Site, approximately 1 to 2 feet above the water table. The exact location of the samples will be determined in the field and will be subject to subsurface utility restrictions and access agreements. A total of three soil gas samples will be initially collected southeast of the Site at the locations shown on Figure 14. The rationale for selecting the sampling locations shown on Figure 14 is included in Table 11. Additional soil gas samples may be collected based on the results of shallow groundwater delineation, initial soil gas sampling, and the decision logic shown on Figure 15. Additional sample locations will be provided to USEPA and MDEQ for approval in advance of any sampling.

6.6.2 Soil Gas Sampling Procedure

Soil gas sampling probes will be installed as temporary (or semi-permanent) points consistent with the SOP SESDPROC-307-R2. Specifically, 6-inch stainless steel screens (or implants) will be installed using a DPT drilling rig. An extraction pit will be created around the stainless steel screen using either glass beads (as specified in the SOP) or clean sand. The sample probe will be finished at the ground surface with a temporary well cover. Soil gas samples will be collected approximately 24 hours after sample port installation and after the sample probe has been allowed to come to equilibrium. At this time, the vapor probe will be connected to a sample container (i.e., SUMMA® canister) at ground surface. All samples will be collected at a flow rate no greater than 200 milliliters per minute or 30 minutes for a 6-liter SUMMA® canister. After the prescribed sampling period, the sample containers will be closed and disconnected.

Soil gas samples will be preserved, handled, and shipped in accordance with SESDPROC-307-R2 and the project-specific QAPP. The analytical program for the soil gas program is discussed in Section 7 and the evaluation process is described in Section 8.

During the soil gas sampling, potentially affected homes near the soil gas locations will be evaluated to determine the building construction. This information will supplement data available from tax assessor records regarding home construction.

6.6.3 Schedule of Sampling

Soil gas sampling, if required, will be initiated upon receipt of an access agreement or permit to sample in the right-of-way from the City of Hattiesburg and any private property. The sampling event will be scheduled once all access agreements are obtained. A preliminary schedule for soil gas sampling is included as Table 6.

6.6.4 Soil Gas Screening

Soil gas data collected will be evaluated using multiple lines of evidence, as follows:

- Evaluation of potential background sources of Constituents detected in soil gas;
- Comparison to conservative SLs (i.e., soil gas SLs); and
- Evaluation of the CSM to assess how Site-specific conditions may affect interpretation of the results.

As a first step in the analysis of the soil gas data, an analysis of potential background sources of Constituents detected in soil gas will be conducted to assess whether the Constituent is related to the Hercules Site, or may be the result of an alternate source in the vicinity of the sampling point. If Constituents are clearly not identifiable as being Site-related, a petition for no further analysis will be made to USEPA/MDEQ.

For potentially Site-related Constituents, soil gas SLs will be calculated from the USEPA residential air (or indoor air) RSLs (current date is May 2011) as follows:

$$C_{sg} = C_{ia} \times AF$$

Where:

C_{sg} = soil gas to indoor air screening level (or soil gas SL)

C_{ia} = concentration in indoor air (residential air RSL from current RSL table)

AF = attenuation factor (0.01)

The soil gas results will then be compared to the calculated soil gas SLs at a target risk range of 1×10^{-6} and an HQ of 1. If all Constituent concentrations are below the soil gas SLs, then no further evaluation may be necessary. If any Constituent concentrations exceed a soil gas SL, then sub-slab soil gas and indoor air sampling may be warranted. As part of this process, the CSM will be evaluated and a determination made if there are any Site-specific factors (i.e., geology, hydrogeology, and building construction) that could influence the interpretation of the data. The results of the soil gas screening will be used to identify the next step in the evaluation of the vapor intrusion pathway (i.e., sub-slab soil gas and/or indoor air sampling).

6.7 Sub-slab, Soil Gas, and Indoor Air

Based on the soil gas sampling results and data evaluation, a sub-slab soil gas and indoor air sampling program may be implemented. Sub-slab soil gas and indoor air sampling will be initially focused on buildings within a 0.5-mile radius of the Site, but may be extended beyond the 0.5-mile radius based on data results.

6.7.1 Identification of Potential Indoor Air Sampling Locations

Soil gas, sub-slab, and/or indoor air sample locations will be selected, as necessary, based on the results of soil gas sampling and analysis.

6.7.2 Sub-slab, Soil Gas, and Indoor Air Sampling Procedure

Soil gas, sub-slab, and/or indoor air sampling will be conducted consistent with SOPs provided in Appendix P, SESDPROC-303-R4, and SESDPROC-307-R2, as appropriate. Prior to sampling, a Site reconnaissance will be conducted at each building. The overall goal of the Site reconnaissance is to complete a building survey that identifies construction conditions, heating, ventilation, and air conditioning operation, any preferential vapor migration pathways (i.e., sump pump), and products that are stored or used within the building. Any products that contain Site-related VOCs will be requested to be removed from the occupied structure 48 hours prior to sampling. A copy of the building survey and product inventory form is provided as an attachment to the SOP.

Indoor air samples may also be collected at all buildings where a sub-slab soil gas sample will be obtained. Indoor air samples will be collected using SUMMA® canisters. Indoor air samples will be preserved, handled, and shipped in accordance with SESDPROC-303-R1, SESDPROC-307-R2, and the project-specific QAPP. The analytical program for the indoor air program is discussed in Section 7 and the evaluation process is described in Section 8.

6.7.3 Schedule of Sampling

Soil gas, sub-slab, and/or indoor air sampling will be initiated after completion of soil gas sampling and analysis and obtaining access agreements for off-site sampling locations. Access agreements will be presented to the property owner for review and approval. The sampling event will be scheduled once access agreements are obtained. No samples will be collected without the owner's signed access agreement.

7. Analytical Program

The DQOs for all data collection are described in Section 5.2 and the QAPP in Appendix D. The Constituent and analytical methods that will be used to complete the assessments of the various media are included in the QAPP. The detection limits that will be used as the reporting limits will be the selected laboratory's method detection limits for the instruments utilized in their particular laboratory.

Appropriate quality assurance and quality control (QA/QC) samples will be prepared as groundwater, surface water, sediment, soil gas, and indoor air samples are being collected. The QA/QC samples will include:

- Trip blanks (1 per day per cooler for VOC samples);
- Field blanks (1 per day or 1 per 20 samples, whichever is less);
- Rinse blanks (1 per day or 1 per 20 samples, whichever is less);
- Field duplicates (1 per 20 samples); and
- Matrix spike/matrix spike duplicate samples (1 per 20 samples or 1 per week).

The sampling personnel will complete a chain-of-custody form that will accompany the samples to the laboratory. Additional information on the QA/QC program is provided in the QAPP in Appendix D.

8. Data Evaluation

Data generated during this assessment will be managed in accordance with the procedures identified in the QAPP (Appendix D). The data verification process outlined in the QAPP will ensure that data collected during the assessment activities meet the DQOs and are acceptable for evaluation.

The lower of the USEPA RSLs and MDEQ Tier 1 TRG standards and screening levels will be used to evaluate the analytical data to determine if concentrations are protective of human health and the environment. Detections of Constituents will be evaluated using the decision matrices provided for the targeted media (Drinking Water, Figure 10; Surface Water and Sediment, Figure 13; Groundwater, Figure 10; and Indoor Air, Figure 15).

If maximum detected concentrations of the Constituent are below USEPA and MDEQ standards or screening levels for any medium, then the Constituent is dropped from further consideration because there will be no excess risk to human health and adverse effects would not be expected to occur.

9. Reporting

At a minimum, quarterly progress reports will be submitted to USEPA and MDEQ during the assessment activities. During periods of increased activity, monthly progress reports will be submitted to USEPA and MDEQ. The progress reports will consist of the following:

- Summary of work performed during the reporting period;
- Discussion of work expected to be performed in the next reporting period;
- Summary of investigation results received during the reporting period; and
- Issues that have arisen and/or been resolved.

Upon completion of field activities and analytical data validation, a project final report will be prepared. The final report will document all field activities and present an interpretation of drinking water, groundwater, surface water, sediment, soil, soil gas, and indoor air conditions. Appropriate tables, figures, and appendices will be included in the report to support the text. The report will present a risk evaluation of the data focusing on the areas of investigation and will conclude by presenting recommendations for a path forward.

10. Project Schedule

An estimated schedule for the implementation of this Work Plan is included in Table 6. Implementation will begin upon receiving approval of the Work Plan from USEPA and MDEQ. The duration of assessment activities will be dependent on obtaining property access and field conditions. In the event additional time is required due to unforeseen issues, the schedule will be adjusted accordingly.

11. Project Team

The Project Management Plan (PMP) included in Appendix Q contains the roles and responsibilities of supervisory personnel included on the Project Team. In addition, the roles and responsibilities of parties that may be subcontracted to provide services during the implementation of this Work Plan are also included in the PMP.

12. References

ARCADIS. 2010. Sludge Characterization and Bench Scale Treatability Work Plan. March 1.

ARCADIS. 2010. Sludge Characterization and Bench Scale Treatability Report. August 1.

ARCADIS. 2010. Impoundment Basin Decommissioning Work Plan. August 20.

ARCADIS. 2011. Response to Sludge Characterization and Bench Scale Treatability Report. January 7.

B&V Waste Science and Technology Corp. 1993. Site Inspection Report. April 29.

BATCO. 1997. Work Plan for Well Installation. June.

BATCO. 1997. Installation, Sampling, and Analysis Report. December.

Bouwer, H., and R.C. Rice. 1976. A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers With Completely or Partially Penetrating Wells. Water Resources Research, Vol. 12, No. 3. June.

Bouwer, H. 1989. The Bouwer and Rice Slug Test – An Update. Groundwater, Vol. 27, No. 3. May-June.

Eco-Systems. 1999. Site Investigation Work Plan. February.

Eco-Systems. 2003. Interim Groundwater Monitoring Report. January.

Eco-Systems. 2003. Site Investigation Report. April.

Eco-Systems. 2003. Work Plan for Supplemental Site Investigation. June.

Eco-Systems. 2003. Supplemental Site Investigation Report. November.

Eco-Systems. 2004. Remedial Action Evaluation. July.

Eco-Systems. 2009. Groundwater Assessment Report. November.

Foster, Vellora M. 1941. Forrest County Mineral Resources, Mississippi State Geological Survey Bulletin, No. 44.

Groundwater & Environmental Services, Inc. 2005. Corrective Action Plan Revision 1. January 20.

MDEQ. 2002. Mississippi Department of Environmental Quality Risk Evaluation Procedures for Voluntary Cleanup and Redevelopment of Brownfield Sites.

MDEQ. 2004. Hattiesburg, Mississippi, Investigations.

Mississippi Bureau of Pollution Control. 1989. Preliminary Assessment. December.

USEPA. 2002. OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance). EPA530-D-02-004. November.

Tables

Figures

Appendix A

Historical Potentiometric Maps

Appendix B

Notice of Land Use Restrictions

Appendix C

Analytical Data (July 2011)

ARCADIS

Appendix D

Quality Assurance Project Plan

Appendix E

Health and Safety Plan

ARCADIS

Appendix F

Field Equipment Cleaning and
Decontamination Standard Operating
Procedures

ARCADIS

Appendix G

EDR Well Search Map

Appendix H

Community Well Questionnaire and
Summarized Community Responses

ARCADIS

Appendix I

Well Owner/Operator Interview Form

Appendix J

Surface Water Sampling Standard Operating Procedures

ARCADIS

Appendix K

Sediment Sampling Standard
Operating Procedures

Appendix L

Groundwater Sampling Standard Operating Procedures

ARCADIS

Appendix M

Monitor Well Installation Standard Operating Procedures

Appendix N

Soil Sampling Procedures

Appendix O

Field Forms

Appendix P

Soil Gas, Sub-slab, and Indoor Air Sampling Standard Operating Procedures

Appendix Q

Project Management Plan

Table 1. Summary of July 2011 Groundwater Analytical Results, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

Location ID: Date Collected:	CAS #	EPA RSL TAP WATER	MDEQ_GW	UNITS	MW-02 07/27/11	MW-03 07/27/11	MW-04 07/27/11	MW-05 07/28/11	MW-06 07/28/11	MW-07 07/28/11	MW-08 07/26/11	MW-09 07/28/11	MW-10 07/27/11	MW-11 07/27/11	MW-12 07/27/11	MW-13 07/26/11	MW-14 07/28/11
PEST/PCB-EPA 8081A/8082																	
4,4'-DDD	72-54-8	2.80E-01	2.79E-01	µg/L	<0.099	NA	<0.1	NA	NA	NA	<0.1 [<0.098]	NA	NA	NA	<0.099	<0.1	NA
4,4'-DDE	72-55-9	2.00E-01	1.97E-01	µg/L	<0.099	NA	<0.1	NA	NA	NA	<0.1 [<0.098]	NA	NA	NA	<0.099	<0.1	NA
4,4'-DDT	50-29-3	2.00E-01	1.97E-01	µg/L	<0.099	NA	<0.1	NA	NA	NA	<0.1 [<0.098]	NA	NA	NA	<0.099	<0.1	NA
4-Chlorobenzilate	510-15-6	6.10E-01	2.48E-01	µg/L	<0.5	NA	<0.51	NA	NA	NA	<0.51 [<0.49]	NA	NA	NA	<0.5	<0.51	NA
Aldrin	309-00-2	4.00E-03	3.94E-03	µg/L	<0.05	NA	<0.051	NA	NA	NA	<0.051 [<0.049]	NA	NA	NA	<0.05	<0.051	NA
Alpha-BHC	319-84-6	1.10E-02	1.06E-02	µg/L	<0.05	NA	<0.051	NA	NA	NA	**0.61 [0.75]**	NA	NA	NA	<0.05	**0.25**	NA
Aroclor-1016	12674-11-2	9.60E-01	9.57E-01	µg/L	<0.99	NA	<1	NA	NA	NA	<1 [<0.98]	NA	NA	NA	<0.99	<1	NA
Aroclor-1221	11104-28-2	6.80E-03	3.35E-02	µg/L	<2	NA	<2	NA	NA	NA	<2 [<2]	NA	NA	NA	<2	<2	NA
Aroclor-1232	11141-16-5	6.80E-03	3.35E-02	µg/L	<0.99	NA	<1	NA	NA	NA	<1 [<0.98]	NA	NA	NA	<0.99	<1	NA
Aroclor-1242	53469-21-9	3.40E-02	3.35E-02	µg/L	<0.99	NA	<1	NA	NA	NA	<1 [<0.98]	NA	NA	NA	<0.99	<1	NA
Aroclor-1248	12672-29-6	3.40E-02	3.35E-02	µg/L	<0.99	NA	<1	NA	NA	NA	<1 [<0.98]	NA	NA	NA	<0.99	<1	NA
Aroclor-1254	11097-69-1	3.40E-02	3.35E-02	µg/L	<0.99	NA	<1	NA	NA	NA	<1 [<0.98]	NA	NA	NA	<0.99	<1	NA
Aroclor-1260	11096-82-5	3.40E-02	3.35E-02	µg/L	<0.99	NA	<1	NA	NA	NA	<1 [<0.98]	NA	NA	NA	<0.99	<1	NA
Beta-BHC	319-85-7	3.70E-02	3.72E-02	µg/L	<0.05	NA	<0.051	NA	NA	NA	<0.051 [<0.049]	NA	NA	NA	<0.05	<0.051	NA
Delta-BHC	319-86-8	- -	- -	µg/L	<0.05	NA	<0.051	NA	NA	NA	<0.051 [<0.049]	NA	NA	NA	<0.05	<0.051	NA
Dieldrin	60-57-1	4.20E-03	4.19E-03	µg/L	<0.099	NA	<0.1	NA	NA	NA	<0.1 [<0.098]	NA	NA	NA	<0.099	<0.1	NA
Endosulfan I	959-98-8	- -	- -	µg/L	<0.05	NA	<0.051	NA	NA	NA	<0.051 [<0.049]	NA	NA	NA	<0.05	<0.051	NA
Endosulfan II	33213-65-9	- -	- -	µg/L	<0.099	NA	<0.1	NA	NA	NA	<0.1 [<0.098]	NA	NA	NA	<0.099	<0.1	NA
Endosulfan Sulfate	1031-07-8	- -	- -	µg/L	<0.099	NA	<0.1	NA	NA	NA	<0.1 [<0.098]	NA	NA	NA	<0.099	<0.1	NA
Endrin	72-20-8	1.10E+01	2.00E+00	µg/L	<0.099	NA	<0.1	NA	NA	NA	<0.1 [<0.098]	NA	NA	NA	<0.099	<0.1	NA
Endrin Aldehyde	7421-93-4	- -	- -	µg/L	<0.099	NA	<0.1	NA	NA	NA	<0.1 [<0.098]	NA	NA	NA	<0.099	<0.1	NA
Endrin Ketone	53494-70-5	- -	- -	µg/L	<0.099	NA	<0.1	NA	NA	NA	<0.1 [<0.098]	NA	NA	NA	<0.099	<0.1	NA
Gamma-BHC (Lindane)	58-89-9	6.10E-02	2.00E-01	µg/L	<0.05	NA	<0.051	NA	NA	NA	**0.3 [0.45]**	NA	NA	NA	<0.05	<0.051	NA
Heptachlor	76-44-8	1.50E-02	4.00E-01	µg/L	<0.05	NA	<0.051	NA	NA	NA	<0.051 [<0.049]	NA	NA	NA	<0.05	<0.051	NA
Heptachlor Epoxide	1024-57-3	7.40E-03	2.00E-01	µg/L	<0.05	NA	<0.051	NA	NA	NA	<0.051 [<0.049]	NA	NA	NA	<0.05	<0.051	NA
Isodrin	465-73-6	- -	- -	µg/L	<0.05	NA	<0.051	NA	NA	NA	<0.051 [<0.049]	NA	NA	NA	<0.05	<0.051	NA
Kepone	143-50-0	6.70E-03	- -	µg/L	<0.99 *	NA	<1 *	NA	NA	NA	<1 [<0.98]	NA	NA	NA	<0.99 *	<1	NA
Methoxychlor	72-43-5	1.80E+02	4.00E+01	µg/L	<0.099	NA	<0.1	NA	NA	NA	<0.1 [<0.098]	NA	NA	NA	<0.099	<0.1	NA
Technical Chlordane	57-74-9	- -	2.00E+00	µg/L	<0.5	NA	<0.51	NA	NA	NA	<0.51 [<0.49]	NA	NA	NA	<0.5	<0.51	NA
Toxaphene	8001-35-2	6.10E-02	3.00E+00	µg/L	<5	NA	<5.1	NA	NA	NA	<5.1 [<4.9]	NA	NA	NA	<5	<5.1	NA
Herb-EPA 8151A																	
2,4,5-T	93-76-5	3.70E+02	3.65E+02	µg/L	<0.51	NA	<0.51	NA	NA	NA	<0.51 [<0.5]	NA	NA	NA	<0.51	<0.5	NA
2,4,5-TP	93-72-1	2.90E+02	5.00E+01	µg/L	<0.51	NA	<0.51	NA	NA	NA	<0.51 [<0.5]	NA	NA	NA	<0.51	<0.5	NA
2,4-D	94-75-7	3.70E+02	7.00E+01	µg/L	<0.51	NA	<0.51	NA	NA	NA	<0.51 [<0.5]	NA	NA	NA	<0.51	<0.5	NA
Volatile Organics-EPA 8260B																	
1,1,1,2-Tetrachloroethane	630-20-6	5.20E-01	4.06E-01	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
1,1,1-Trichloroethane	71-55-6	9.10E+03	2.00E+02	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
1,1,2,2-Tetrachloroethane	79-34-5	6.70E-02	5.27E-02	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
1,1,2-Trichloroethane	79-00-5	2.40E-01	5.00E+00	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
1,1-Dichloroethane	75-34-3	2.40E+00	7.98E+02	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
1,1-Dichloroethene	75-35-4	3.40E+02	7.00E+00	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
1,2,3-Trichloropropane	96-18-4	7.20E-04	6.23E-03	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
1,2-Dibromo-3-chloropropane	96-12-8	3.20E-04	2.00E-01	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
1,2-Dibromoethane	106-93-4	6.50E-03	5.00E-02	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
1,2-Dichloroethane	107-06-2	1.50E-01	5.00E+00	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
1,2-Dichloropropane	78-87-5	3.90E-01	5.00E+00	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
2-Butanone	78-93-3	7.10E+03	1.91E+03	µg/L	<10	<10	<10	<10	<10	<10	<500 [<500]	<10 [<10]	<10	<10 [<10]	<10	<100	<10
2-Chloro-1,3-butadiene	126-99-8	1.60E-02	1.43E+01	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
2-Hexanone	591-78-6	4.70E+01	1.46E+03	µg/L	<10	<10	<10	<10	<10	<10	<500 [<500]	<10 [<10]	<10	<10 [<10]	<10	<100	<10
3-Chloropropene	107-05-1	6.50E-01	- -	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
4-Methyl-2-pentanone	108-10-1	2.00E+03	1.39E+02	µg/L	<10	<10	<10	<10	<10	<10	<500 [<500]	<10 [<10]	<10	<10 [<10]	<10	<100	<10
Acetone	67-64-1	2.20E+04	6.08E+02	µg/L	<25	<25	<25	<25	<25	<25	<1,300 [<1,300]	<25 [<25]	<25	<25 [<25]	<25	<250	<25
Acetonitrile	75-05-8	1.30E+02	1.25E+02	µg/L	<40	<40	<40	<40	<40	<40	<2,000 [<2,000]	<40 [<40]	<40	<40 [<40]	<40	<400	<40
Acrolein	107-02-8	4.20E-02	4.16E-02	µg/L	<20	<20	<20	<20	<20	<20	<1,000 [<1,000]	<20 [<20]	<20	<20 [<20]	<20	<200	<20
Acrylonitrile	107-13-1	4.50E-02	3.67E-02	µg/L	<20	<20	<20	<20	<20	<20	<1,000 [<1,000]	<20 [<20]	<20	<20 [<20]	<20	<200	<20
Benzene	71-43-2	4.10E-01	5.00E+00	µg/L	<1	<1	<1	<1	<1	<1	**4,600 [5,100]**	<1 [<1]	<1	<1 [<1]	<1	**390**	<1
Bromodichloromethane	75-27-4	1.20E-01	1.68E-01	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
Bromoform	75-25-2	8.50E+00	8.48E+00	µg/L	<1	<1	<1	<1 *	<1 *	<1 *	<50 [<50]	<1 * [<1 *]	<1	<1 * [<1]	<1	<10	<1 *
Bromomethane	74-83-9	8.70E+00	8.52E+00	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
Carbon Disulfide	75-15-0	1.00E+03	1.04E+03	µg/L	<2	<2	<2	<2	<2	<2	<100 [<100]	<2 [<2]	<2	<2 [<2]	<2	<20	<2
Carbon Tetrachloride	56-23-5	4.40E-01	5.00E+00	µg/L	<1	<1	<1	<1 *	<1	<1	**2,600 [2,700 *]**	<1 [<1]	<1	<1 * [<1]	<1	**620**	<1 *
Chlorobenzene	108-90-7	9.10E+01	1.00E+02	µg/L	<1	<1	<1	<1	<1	<1	**220 [240]**	<1 [<1]	<1	<1 [<1]	<1	24	<1
Chloroethane	75-00-3	2.10E+04	3.64E+00	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
Chloroform	67-66-3	1.90E-01	1.55E-01	µg/L	<1	<1	<1	<1	<1	<1	**640 [640]**	<1 [<1]	<1	<1 [<1]	<1	**210**	<1
Chloromethane	74-87-3	1.90E+02	1.43E+00	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1

Table 1. Summary of July 2011 Groundwater Analytical Results, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

Location ID: Date Collected:	CAS #	EPA RSL TAP WATER	MDEQ_GW	UNITS	MW-02 07/27/11	MW-03 07/27/11	MW-04 07/27/11	MW-05 07/28/11	MW-06 07/28/11	MW-07 07/28/11	MW-08 07/26/11	MW-09 07/28/11	MW-10 07/27/11	MW-11 07/27/11	MW-12 07/27/11	MW-13 07/26/11	MW-14 07/28/11
cis-1,2-Dichloroethene	156-59-2	7.30E+01	7.00E+01	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
cis-1,3-Dichloropropene	10061-01-5	- -	- -	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
Dibromochloromethane	124-48-1	1.50E-01	1.26E-01	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
Dibromomethane	74-95-3	8.20E+00	6.08E+01	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
Dichlorodifluoromethane	75-71-8	2.00E+02	3.48E+02	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
Ethyl Methacrylate	97-63-2	5.30E+02	5.48E+02	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
Ethylbenzene	100-41-4	1.50E+00	7.00E+02	µg/L	<1	<1	<1	<1	<1	<1	**55 [61]**	<1 [<1]	<1	<1 [<1]	<1	<10	<1
Iodomethane	74-88-4	- -	- -	µg/L	<5	<5	<5	<5	<5	<5	<250 [<250]	<5 [<5]	<5	<5 [<5]	<5	<50	<5
Isobutanol	78-83-1	1.10E+04	1.83E+03	µg/L	<40	<40	<40	<40	<40	<40	<2,000 [<2,000]	<40 [<40]	<40	<40 [<40]	<40	<400	<40
Methacrylonitrile	126-98-7	1.00E+00	1.04E+00	µg/L	<20	<20	<20	<20	<20	<20	<1,000 [<1,000]	<20 [<20]	<20	<20 [<20]	<20	<200	<20
Methyl Methacrylate	80-62-6	1.40E+03	1.42E+03	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
Methylene Chloride	75-09-2	4.80E+00	5.00E+00	µg/L	<5	<5	<5	<5	<5	<5	**340 [350]**	<5 [<5]	<5	<5 [<5]	<5	<50	<5
Pentachloroethane	76-01-7	7.50E-01	- -	µg/L	<5	<5	<5	<5	<5	<5	<250 [<250]	<5 [<5]	<5	<5 [<5]	<5	<50	<5
Propionitrile	107-12-0	- -	- -	µg/L	<20	<20	<20	<20	<20	<20	<1,000 [<1,000]	<20 [<20]	<20	<20 [<20]	<20	<200	<20
Styrene	100-42-5	1.60E+03	1.00E+02	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
Tetrachloroethene	127-18-4	1.10E-01	5.00E+00	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
Toluene	108-88-3	2.30E+03	1.00E+03	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
trans-1,2-Dichloroethene	156-60-5	1.10E+02	1.00E+02	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
trans-1,3-Dichloropropene	10061-02-6	- -	- -	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
trans-1,4-Dichloro-2-butene	110-57-6	1.20E-03	- -	µg/L	<2	<2	<2	<2	<2	<2	<100 [<100]	<2 [<2]	<2	<2 [<2]	<2	<20	<2
Trichloroethene	79-01-6	2.00E+00	5.00E+00	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
Trichlorofluoromethane	75-69-4	1.30E+03	1.29E+03	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
Vinyl Acetate	108-05-4	4.10E+02	4.12E+02	µg/L	<2	<2	<2	<2	<2	<2	<100 [<100]	<2 [<2]	<2	<2 [<2]	<2	<20	<2
Vinyl Chloride	75-01-4	1.60E-02	2.00E+00	µg/L	<1	<1	<1	<1	<1	<1	<50 [<50]	<1 [<1]	<1	<1 [<1]	<1	<10	<1
Xylenes (total)	1330-20-7	2.00E+02	1.00E+04	µg/L	<2	<2	<2	<2	<2	<2	<100 [<100]	<2 [<2]	<2	<2 [<2]	<2	<20	<2
Semivolatile Organics-EPA 8270C																	
1,1'-Biphenyl	92-52-4	8.30E-01	3.04E+02	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
1,2,4,5-Tetrachlorobenzene	95-94-3	1.10E+01	1.10E+01	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
1,2,4-Trichlorobenzene	120-82-1	2.30E+00	7.00E+01	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
1,2-Dichlorobenzene	95-50-1	3.70E+02	6.00E+02	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
1,3,5-Trinitrobenzene	99-35-4	1.10E+03	1.10E+03	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
1,3-Dichlorobenzene	541-73-1	- -	5.48E+00	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
1,3-Dinitrobenzene	99-65-0	3.70E+00	3.65E+00	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
1,4-Dichlorobenzene	106-46-7	4.30E-01	7.50E+01	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
1,4-Dioxane	123-91-1	6.70E-01	6.09E+00	µg/L	<9.9	NA	**23**	NA	NA	NA	**13,000 [9,400]**	NA	NA	NA	<12	**470**	NA
1,4-Naphthoquinone	130-15-4	- -	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
1-Naphthylamine	134-32-7	- -	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
2,2'-Oxybis(1-Chloropropane)	108-60-1	3.20E-01	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
2,3,4,6-Tetrachlorophenol	58-90-2	1.10E+03	1.10E+03	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
2,4,5-Trichlorophenol	95-95-4	3.70E+03	3.65E+03	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
2,4,6-Trichlorophenol	88-06-2	6.10E+00	6.09E+00	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
2,4-Dichlorophenol	120-83-2	1.10E+02	1.10E+02	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
2,4-Dimethylphenol	105-67-9	7.30E+02	7.30E+02	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
2,4-Dinitrophenol	51-28-5	7.30E+01	7.30E+01	µg/L	<49	NA	<52	NA	NA	NA	<5,200 [<2,500]	NA	NA	NA	<62	<250	NA
2,4-Dinitrotoluene	121-14-2	2.20E-01	7.30E+01	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
2,6-Dichlorophenol	87-65-0	- -	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
2,6-Dinitrotoluene	606-20-2	3.70E+01	3.65E+01	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
2-Acetylaminofluorene	53-96-3	1.80E-02	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
2-Chloronaphthalene	91-58-7	2.90E+03	4.87E+02	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
2-Chlorophenol	95-57-8	1.80E+02	3.04E+01	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
2-Methylnaphthalene	91-57-6	1.50E+02	1.22E+02	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
2-Methylphenol	95-48-7	1.80E+03	1.83E+03	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
2-Naphthylamine	91-59-8	3.70E-02	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
2-Nitroaniline	88-74-4	3.70E+02	4.17E-01	µg/L	<49	NA	<52	NA	NA	NA	<5,200 [<2,500]	NA	NA	NA	<62	<250	NA
2-Nitrophenol	88-75-5	- -	4.16E-01	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
2-Picoline	109-06-8	- -	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
3 & 4 Methylphenol	15831-10-4	- -	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
3,3'-Dichlorobenzidine	91-94-1	1.50E-01	1.49E-01	µg/L	<59	NA	<63	NA	NA	NA	<6,200 [<3,000]	NA	NA	NA	<75	<290	NA
3,3'-Dimethylbenzidine	119-93-7	6.10E-03	7.28E-03	µg/L	<20	NA	<21	NA	NA	NA	<2,100 [<1,000]	NA	NA	NA	<25	<98	NA
3-Methylcholanthrene	56-49-5	9.80E-04	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
3-Nitroaniline	99-09-2	- -	- -	µg/L	<49	NA	<52	NA	NA	NA	<5,200 [<2,500]	NA	NA	NA	<62	<250	NA
4,6-Dinitro-2-methylphenol	534-52-1	2.90E+00	3.65E+00	µg/L	<49	NA	<52	NA	NA	NA	<5,200 [<2,500]	NA	NA	NA	<62	<250	NA
4-Aminobiphenyl	92-67-1	3.20E-03	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
4-Bromophenyl-phenylether	101-55-3	- -	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
4-Chloro-3-Methylphenol	59-50-7	3.70E+03	7.30E+04	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
4-Chloroaniline	106-47-8	3.40E-01	1.46E+02	µg/L	<20	NA	<21	NA	NA	NA	<2,100 [<1,000]	NA	NA	NA	<25	<98	NA

Table 1. Summary of July 2011 Groundwater Analytical Results, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

Location ID:		EPA RSL			MW-02	MW-03	MW-04	MW-05	MW-06	MW-07	MW-08	MW-09	MW-10	MW-11	MW-12	MW-13	MW-14
Date Collected:	CAS #	TAP WATER	MDEQ_GW	UNITS	07/27/11	07/27/11	07/27/11	07/28/11	07/28/11	07/28/11	07/26/11	07/28/11	07/27/11	07/27/11	07/27/11	07/26/11	07/28/11
4-Chlorophenyl-phenylether	7005-72-3	- -	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
4-Nitroaniline	100-01-6	3.40E+00	- -	µg/L	<49	NA	<52	NA	NA	NA	<5,200 [<2,500]	NA	NA	NA	<62	<250	NA
4-Nitrophenol	100-02-7	- -	2.92E+02	µg/L	<49	NA	<52	NA	NA	NA	<5,200 [<2,500]	NA	NA	NA	<62	<250	NA
4-Nitroquinoline-1-oxide	56-57-5	- -	- -	µg/L	<20	NA	<21	NA	NA	NA	<2,100 [<1,000]	NA	NA	NA	<25	<98	NA
4-Phenylenediamine	106-50-3	6.90E+03	6.94E+03	µg/L	<2,000	NA	<2,100	NA	NA	NA	210,000 [<100,00	NA	NA	NA	<2,500	<9,800	NA
5-Nitro-o-toluidine	99-55-8	7.50E+00	2.03E+00	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
7,12-Dimethylbenz(a)anthracene	57-97-6	8.60E-05	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
a,a'-Dimethylphenethylamine	122-09-8	- -	- -	µg/L	<2,000	NA	<2,100	NA	NA	NA	210,000 [<100,00	NA	NA	NA	<2,500	<9,800	NA
Acenaphthene	83-32-9	2.20E+03	3.65E+02	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Acenaphthylene	208-96-8	- -	2.19E+03	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Acetophenone	98-86-2	3.70E+03	4.16E-02	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Aniline	62-53-3	1.20E+01	1.17E+01	µg/L	<20	NA	<21	NA	NA	NA	<2,100 [<1,000]	NA	NA	NA	<25	<98	NA
Anthracene	120-12-7	1.10E+04	4.34E+01	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Aramite	140-57-8	2.70E+00	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Benzo(a)anthracene	56-55-3	2.90E-02	9.17E-02	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Benzo(a)pyrene	50-32-8	2.90E-03	2.00E-01	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Benzo(b)fluoranthene	205-99-2	2.90E-02	9.17E-02	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Benzo(g,h,i)perylene	191-24-2	- -	1.10E+03	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Benzo(k)fluoranthene	207-08-9	2.90E-01	9.17E-01	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Benzyl Alcohol	100-51-6	3.70E+03	1.10E+04	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
bis(2-Chloroethoxy)methane	111-91-1	1.10E+02	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
bis(2-Chloroethyl)ether	111-44-4	1.20E-02	9.20E-03	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
bis(2-Ethylhexyl)phthalate	117-81-7	4.80E+00	6.00E+00	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Butylbenzylphthalate	85-68-7	3.50E+01	2.69E+03	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Chrysene	218-01-9	2.90E+00	9.17E+00	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Diallate	2303-16-4	1.10E+00	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Dibenzo(a,h)anthracene	53-70-3	2.90E-03	9.17E-03	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Dibenzofuran	132-64-9	3.70E+01	2.43E+01	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Diethylphthalate	84-66-2	2.90E+04	2.92E+04	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Dimethoate	60-51-5	7.30E+00	- -	µg/L	<9.9 *	NA	<10 *	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12 *	<49	NA
Dimethylphthalate	131-11-3	- -	3.65E+05	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Di-n-Butylphthalate	84-74-2	3.70E+03	3.65E+03	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Di-n-Octylphthalate	117-84-0	- -	2.00E+01	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Dinoseb	88-85-7	3.70E+01	7.00E+00	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Disulfoton	298-04-4	1.50E+00	1.46E+00	µg/L	<9.9 *	NA	<10 *	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12 *	<49	NA
Ethyl Methanesulfonate	62-50-0	- -	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Ethyl Parathion	56-38-2	2.20E+02	2.19E+02	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Famphur	52-85-7	- -	- -	µg/L	<9.9 *	NA	<10 *	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12 *	<49	NA
Fluoranthene	206-44-0	1.50E+03	1.46E+03	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Fluorene	86-73-7	1.50E+03	2.43E+02	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Hexachlorobenzene	118-74-1	4.20E-02	1.00E+00	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Hexachlorobutadiene	87-68-3	8.60E-01	8.59E-01	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Hexachlorocyclopentadiene	77-47-4	2.20E+02	5.00E+01	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Hexachloroethane	67-72-1	4.80E+00	4.78E+00	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Hexachlorophene	70-30-4	1.10E+01	1.10E+01	µg/L	<4,900	NA	<5,200	NA	NA	NA	520,000 [<250,00	NA	NA	NA	<6,200	<25,000	NA
Hexachloropropene	1888-71-7	- -	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Indeno(1,2,3-cd)pyrene	193-39-5	2.90E-02	9.17E-02	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Isophorone	78-59-1	7.10E+01	7.05E+01	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Isosafrole	120-58-1	- -	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Methapyrilene	91-80-5	- -	- -	µg/L	<2,000	NA	<2,100	NA	NA	NA	210,000 [<100,00	NA	NA	NA	<2,500	<9,800	NA
Methyl Methanesulfonate	66-27-3	6.80E-01	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Methyl Parathion	298-00-0	9.10E+00	9.13E+00	µg/L	<9.9 *	NA	<10 *	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12 *	<49	NA
Naphthalene	91-20-3	1.40E-01	6.20E+00	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Nitrobenzene	98-95-3	1.20E-01	3.53E+00	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
N-Nitrosodiethylamine	55-18-5	1.40E-04	4.46E-04	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
N-Nitrosodimethylamine	62-75-9	4.20E-04	1.31E-03	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
N-Nitroso-di-n-butylamine	924-16-3	2.40E-03	1.89E-03	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
N-Nitroso-di-n-propylamine	621-64-7	9.60E-03	9.57E-03	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
N-Nitrosodiphenylamine	86-30-6	1.40E+01	1.37E+01	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
N-Nitrosomethylethylamine	10595-95-6	3.10E-03	3.04E-03	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
N-Nitrosomorpholine	59-89-2	1.00E-02	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
N-Nitrosopiperidine	100-75-4	7.20E-03	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
N-Nitrosopyrrolidine	930-55-2	3.20E-02	3.19E-02	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
o,o,o-Triethylphosphorothioate	126-68-1	- -	- -	µg/L	<9.9	NA	22	NA	NA	NA	3,400 [3,300]	NA	NA	NA	<12	190	NA
o-Toluidine	95-53-4	- -	2.79E-01	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
p-Dimethylaminoazobenzene	60-11-7	1.50E-02	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA

Table 1. Summary of July 2011 Groundwater Analytical Results, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

Location ID:		EPA RSL			MW-02	MW-03	MW-04	MW-05	MW-06	MW-07	MW-08	MW-09	MW-10	MW-11	MW-12	MW-13	MW-14
Date Collected:	CAS #	TAP WATER	MDEQ_GW	UNITS	07/27/11	07/27/11	07/27/11	07/28/11	07/28/11	07/28/11	07/26/11	07/28/11	07/27/11	07/27/11	07/27/11	07/26/11	07/28/11
Pentachlorobenzene	608-93-5	2.90E+01	2.92E+01	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Pentachloronitrobenzene	82-68-8	2.60E-01	2.58E-01	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Pentachlorophenol	87-86-5	1.70E-01	1.00E+00	µg/L	<49	NA	<52	NA	NA	NA	<5,200 [<2,500]	NA	NA	NA	<62	<250	NA
Phenacetin	62-44-2	3.10E+01	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Phenanthrene	85-01-8	- -	1.10E+03	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Phenol	108-95-2	1.10E+04	2.19E+04	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Phorate	298-02-2	7.30E+00	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Pronamide	23950-58-5	2.70E+03	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Pyrene	129-00-0	1.10E+03	1.83E+02	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Pyridine	110-86-1	3.70E+01	3.65E+01	µg/L	<49	NA	<52	NA	NA	NA	<5,200 [<2,500]	NA	NA	NA	<62	<250	NA
Safrole	94-59-7	9.80E-02	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Sulfotep	3689-24-5	1.80E+01	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Thionazin	297-97-2	- -	- -	µg/L	<9.9	NA	<10	NA	NA	NA	<1,000 [<510]	NA	NA	NA	<12	<49	NA
Dioxins-EPA 8290																	
2,3,7,8-TCDD	1746-01-6	5.20E-01	3.00E+01	pg/L	<10	NA	<10	NA	NA	NA	<11 [<10]	NA	NA	NA	<9.8	<10	NA
Total TEQ	- -	- -	- -	pg/L	0.00	NA	0.00	NA	NA	NA	0.00	NA	NA	NA	0.00	0.00	NA
Inorganics-EPA 6020																	
Antimony	7440-36-0	1.50E+01	6.00E+00	µg/L	<5	NA	<5	NA	NA	NA	<5 [<5]	NA	NA	NA	<5	<5	NA
Arsenic	7440-38-2	4.50E-02	5.00E+01	µg/L	**2.9**	NA	<2.5	NA	NA	NA	**42 [44]**	NA	NA	NA	<2.5	**5.7**	NA
Barium	7440-39-3	7.30E+03	2.00E+03	µg/L	76	NA	110	NA	NA	NA	260 [260]	NA	NA	NA	120	49	NA
Beryllium	7440-41-7	7.30E+01	4.00E+00	µg/L	<0.5	NA	<0.5	NA	NA	NA	<0.5 [<0.5]	NA	NA	NA	<0.5	<0.5	NA
Cadmium	7440-43-9	- -	5.00E+00	µg/L	<0.5	NA	<0.5	NA	NA	NA	<0.5 [<0.5]	NA	NA	NA	<0.5	<0.5	NA
Chromium	7440-47-3	- -	- -	µg/L	<5	NA	<5	NA	NA	NA	<5 [<5]	NA	NA	NA	<5	<5	NA
Cobalt	7440-48-4	1.10E+01	2.19E+03	µg/L	4.2	NA	<0.5	NA	NA	NA	<0.5 [<0.5]	NA	NA	NA	3.4	1.5	NA
Copper	7440-50-8	1.50E+03	1.30E+03	µg/L	<5	NA	<5	NA	NA	NA	<5 [<5]	NA	NA	NA	<5	<5	NA
Lead	7439-92-1	- -	1.50E+01	µg/L	<1.5	NA	<1.5	NA	NA	NA	<1.5 [<1.5]	NA	NA	NA	<1.5	<1.5	NA
Nickel	7440-02-0	7.30E+02	7.30E+02	µg/L	<5	NA	<5	NA	NA	NA	<5 [<5]	NA	NA	NA	9.7	<5	NA
Selenium	7782-49-2	1.80E+02	5.00E+01	µg/L	<2.5	NA	<2.5	NA	NA	NA	<2.5 [<2.5]	NA	NA	NA	<2.5	<2.5	NA
Silver	7440-22-4	1.80E+02	1.83E+02	µg/L	<1	NA	<1	NA	NA	NA	<1 [<1]	NA	NA	NA	<1	<1	NA
Thallium	7440-28-0	3.70E-01	2.00E+00	µg/L	<1	NA	<1	NA	NA	NA	<1 [<1]	NA	NA	NA	<1	<1	NA
Tin	7440-31-5	2.20E+04	2.19E+04	µg/L	<5	NA	<5	NA	NA	NA	<5 [<5]	NA	NA	NA	<5	<5	NA
Vanadium	7440-62-2	- -	2.56E+02	µg/L	<10	NA	<10	NA	NA	NA	<10 [<10]	NA	NA	NA	<10	<10	NA
Zinc	7440-66-6	1.10E+04	1.10E+04	µg/L	<20	NA	<20	NA	NA	NA	<20 [<20]	NA	NA	NA	34	41	NA
Inorganics-EPA 7470A																	
Mercury	7439-97-6	6.30E-01	2.00E+00	µg/L	<0.2	NA	<0.2	NA	NA	NA	<0.2 [<0.2]	NA	NA	NA	<0.2	<0.2	NA
Miscellaneous-9034																	
Sulfide	18496-25-8	- -	- -	mg/L	<1	NA	1.1	NA	NA	NA	5 [17]	NA	NA	NA	<1	<1	NA
Miscellaneous9012A																	
Cyanide	57-12-5	7.30E-01	2.00E-01	mg/L	<0.01	NA	<0.01	NA	NA	NA	<0.01 [<0.01]	NA	NA	NA	<0.01	<0.01	NA

Notes:

Boldface type	Compound detected.
*	Laboratory duplicate analysis was outside control limits.
<	Less than.
- -	Standard not promulgated.
▨	Shaded cells indicate that the reported result exceeds the EPA RSL or MDEQ_GW.
EPA	U.S. Environmental Protection Agency.
MDEQ	Mississippi Department of Environmentl Quality.
MDEQ_GW	MDEQ Tier 1 Target Remediation Goal.
mg/L	Milligrams per liter.
µg/L	Micrograms per liter.
NA	Not analyzed.
RSL	Regional Screening Level.
TEQ	Toxic equivalent.

Table 1. Summary of July 2011 Groundwater Analytical Results, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

Location ID: **Date Collected:**	**CAS #**	**EPA RSL TAP WATER**	**MDEQ_GW**	**UNITS**	**MW-15** **07/28/11**	**MW-16** **07/28/11**	**MW-17** **07/26/11**	**MW-18** **07/27/11**	**MW-19** **07/26/11**	**MW-20** **07/27/11**	**MW-21** **07/26/11**	**MW-22** **07/27/11**	**MW-23** **07/26/11**	**MW-24** **07/27/11**
PEST/PCB-EPA 8081A/8082														
4,4'-DDD	72-54-8	2.80E-01	2.79E-01	µg/L	NA	NA	<0.99	NA	<0.099	NA	NA	NA	<0.099	NA
4,4'-DDE	72-55-9	2.00E-01	1.97E-01	µg/L	NA	NA	<0.99	NA	<0.099	NA	NA	NA	<0.099	NA
4,4'-DDT	50-29-3	2.00E-01	1.97E-01	µg/L	NA	NA	<0.99	NA	<0.099	NA	NA	NA	<0.099	NA
4-Chlorobenzilate	510-15-6	6.10E-01	2.48E-01	µg/L	NA	NA	<4.9	NA	<0.49	NA	NA	NA	<0.49	NA
Aldrin	309-00-2	4.00E-03	3.94E-03	µg/L	NA	NA	<0.49	NA	<0.049	NA	NA	NA	<0.049	NA
Alpha-BHC	319-84-6	1.10E-02	1.06E-02	µg/L	NA	NA	**1.5 p**	NA	<0.049	NA	NA	NA	<0.049	NA
Aroclor-1016	12674-11-2	9.60E-01	9.57E-01	µg/L	NA	NA	<9.9	NA	<0.99	NA	NA	NA	<0.99	NA
Aroclor-1221	11104-28-2	6.80E-03	3.35E-02	µg/L	NA	NA	<20	NA	<2	NA	NA	NA	<2	NA
Aroclor-1232	11141-16-5	6.80E-03	3.35E-02	µg/L	NA	NA	<9.9	NA	<0.99	NA	NA	NA	<0.99	NA
Aroclor-1242	53469-21-9	3.40E-02	3.35E-02	µg/L	NA	NA	<9.9	NA	<0.99	NA	NA	NA	<0.99	NA
Aroclor-1248	12672-29-6	3.40E-02	3.35E-02	µg/L	NA	NA	<9.9	NA	<0.99	NA	NA	NA	<0.99	NA
Aroclor-1254	11097-69-1	3.40E-02	3.35E-02	µg/L	NA	NA	<9.9	NA	<0.99	NA	NA	NA	<0.99	NA
Aroclor-1260	11096-82-5	3.40E-02	3.35E-02	µg/L	NA	NA	<9.9	NA	<0.99	NA	NA	NA	<0.99	NA
Beta-BHC	319-85-7	3.70E-02	3.72E-02	µg/L	NA	NA	<0.49	NA	<0.049	NA	NA	NA	<0.049	NA
Delta-BHC	319-86-8	- -	- -	µg/L	NA	NA	<0.49	NA	<0.049	NA	NA	NA	<0.049	NA
Dieldrin	60-57-1	4.20E-03	4.19E-03	µg/L	NA	NA	<0.99	NA	<0.099	NA	NA	NA	<0.099	NA
Endosulfan I	959-98-8	- -	- -	µg/L	NA	NA	<0.49	NA	<0.049	NA	NA	NA	<0.049	NA
Endosulfan II	33213-65-9	- -	- -	µg/L	NA	NA	<0.99	NA	<0.099	NA	NA	NA	<0.099	NA
Endosulfan Sulfate	1031-07-8	- -	- -	µg/L	NA	NA	<0.99	NA	<0.099	NA	NA	NA	<0.099	NA
Endrin	72-20-8	1.10E+01	2.00E+00	µg/L	NA	NA	<0.99	NA	<0.099	NA	NA	NA	<0.099	NA
Endrin Aldehyde	7421-93-4	- -	- -	µg/L	NA	NA	<0.99	NA	<0.099	NA	NA	NA	<0.099	NA
Endrin Ketone	53494-70-5	- -	- -	µg/L	NA	NA	<0.99	NA	<0.099	NA	NA	NA	<0.099	NA
Gamma-BHC (Lindane)	58-89-9	6.10E-02	2.00E-01	µg/L	NA	NA	<0.49	NA	<0.049	NA	NA	NA	<0.049	NA
Heptachlor	76-44-8	1.50E-02	4.00E-01	µg/L	NA	NA	<0.49	NA	<0.049	NA	NA	NA	<0.049	NA
Heptachlor Epoxide	1024-57-3	7.40E-03	2.00E-01	µg/L	NA	NA	<0.49	NA	<0.049	NA	NA	NA	<0.049	NA
Isodrin	465-73-6	- -	- -	µg/L	NA	NA	<0.49	NA	<0.049	NA	NA	NA	<0.049	NA
Kepone	143-50-0	6.70E-03	- -	µg/L	NA	NA	<9.9	NA	<0.99	NA	NA	NA	<0.99	NA
Methoxychlor	72-43-5	1.80E+02	4.00E+01	µg/L	NA	NA	<0.99	NA	<0.099	NA	NA	NA	<0.099	NA
Technical Chlordane	57-74-9	- -	2.00E+00	µg/L	NA	NA	<4.9	NA	<0.49	NA	NA	NA	<0.49	NA
Toxaphene	8001-35-2	6.10E-02	3.00E+00	µg/L	NA	NA	<49	NA	<4.9	NA	NA	NA	<4.9	NA
Herb-EPA 8151A														
2,4,5-T	93-76-5	3.70E+02	3.65E+02	µg/L	NA	NA	<0.51	NA	<0.5	NA	NA	NA	<0.5	NA
2,4,5-TP	93-72-1	2.90E+02	5.00E+01	µg/L	NA	NA	<0.51	NA	<0.5	NA	NA	NA	<0.5	NA
2,4-D	94-75-7	3.70E+02	7.00E+01	µg/L	NA	NA	<0.51	NA	<0.5	NA	NA	NA	10 D	NA
Volatile Organics-EPA 8260B														
1,1,1,2-Tetrachloroethane	630-20-6	5.20E-01	4.06E-01	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
1,1,1-Trichloroethane	71-55-6	9.10E+03	2.00E+02	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
1,1,2,2-Tetrachloroethane	79-34-5	6.70E-02	5.27E-02	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
1,1,2-Trichloroethane	79-00-5	2.40E-01	5.00E+00	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
1,1-Dichloroethane	75-34-3	2.40E+00	7.98E+02	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
1,1-Dichloroethene	75-35-4	3.40E+02	7.00E+00	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
1,2,3-Trichloropropane	96-18-4	7.20E-04	6.23E-03	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
1,2-Dibromo-3-chloropropane	96-12-8	3.20E-04	2.00E-01	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
1,2-Dibromoethane	106-93-4	6.50E-03	5.00E-02	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
1,2-Dichloroethane	107-06-2	1.50E-01	5.00E+00	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
1,2-Dichloropropane	78-87-5	3.90E-01	5.00E+00	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
2-Butanone	78-93-3	7.10E+03	1.91E+03	µg/L	<10	<10	<2,000	<10	<10	<10	<500	<10	<1,000	<10
2-Chloro-1,3-butadiene	126-99-8	1.60E-02	1.43E+01	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
2-Hexanone	591-78-6	4.70E+01	1.46E+03	µg/L	<10	<10	<2,000	<10	<10	<10	<500	<10	<1,000	<10
3-Chloropropene	107-05-1	6.50E-01	- -	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
4-Methyl-2-pentanone	108-10-1	2.00E+03	1.39E+02	µg/L	<10	<10	<2,000	<10	<10	<10	<500	21	**1,100**	<10
Acetone	67-64-1	2.20E+04	6.08E+02	µg/L	<25	<25	<5,000	<25	<25	<25	<1,300	<25	<2,500	<25
Acetonitrile	75-05-8	1.30E+02	1.25E+02	µg/L	<40	<40	<8,000	<40	<40	<40	<2,000	<40	<4,000	<40
Acrolein	107-02-8	4.20E-02	4.16E-02	µg/L	<20	<20	<4,000	<20	<20	<20	<1,000	<20	<2,000	<20
Acrylonitrile	107-13-1	4.50E-02	3.67E-02	µg/L	<20	<20	<4,000	<20	<20	<20	<1,000	<20	<2,000	<20
Benzene	71-43-2	4.10E-01	5.00E+00	µg/L	<1	<1	**3,600**	<1	**54**	<1	**3,200**	**10**	**8,800**	<1
Bromodichloromethane	75-27-4	1.20E-01	1.68E-01	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
Bromoform	75-25-2	8.50E+00	8.48E+00	µg/L	<1 *	<1 *	<200	<1	<1	<1	<50	<1 *	<100	<1
Bromomethane	74-83-9	8.70E+00	8.52E+00	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
Carbon Disulfide	75-15-0	1.00E+03	1.04E+03	µg/L	<2	<2	<400	<2	<2	<2	<100	<2	390	<2
Carbon Tetrachloride	56-23-5	4.40E-01	5.00E+00	µg/L	<1	<1 *	**25,000 ***	<1	**3.5**	<1	<50	<1 *	<100	<1
Chlorobenzene	108-90-7	9.10E+01	1.00E+02	µg/L	<1	<1	**770**	21	9.9	<1	**150**	8.7	**140**	<1
Chloroethane	75-00-3	2.10E+04	3.64E+00	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
Chloroform	67-66-3	1.90E-01	1.55E-01	µg/L	<1	<1	**3,000**	<1	**3.3**	<1	**4,300**	<1	**3,200**	<1
Chloromethane	74-87-3	1.90E+02	1.43E+00	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1

Table 1. Summary of July 2011 Groundwater Analytical Results, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

Location ID: Date Collected:	CAS #	EPA RSL TAP WATER	MDEQ_GW	UNITS	MW-15 07/28/11	MW-16 07/28/11	MW-17 07/26/11	MW-18 07/27/11	MW-19 07/26/11	MW-20 07/27/11	MW-21 07/26/11	MW-22 07/27/11	MW-23 07/26/11	MW-24 07/27/11
cis-1,2-Dichloroethene	156-59-2	7.30E+01	7.00E+01	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
cis-1,3-Dichloropropene	10061-01-5	- -	- -	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
Dibromochloromethane	124-48-1	1.50E-01	1.26E-01	µg/L	<1	<1	<200	<1	<1	<1	<50	<1 *	<100	<1
Dibromomethane	74-95-3	8.20E+00	6.08E+01	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
Dichlorodifluoromethane	75-71-8	2.00E+02	3.48E+02	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
Ethyl Methacrylate	97-63-2	5.30E+02	5.48E+02	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
Ethylbenzene	100-41-4	1.50E+00	7.00E+02	µg/L	<1	<1	<200	<1	1.3	<1	<50	<1	<100	<1
Iodomethane	74-88-4	- -	- -	µg/L	<5	<5	<1,000	<5	<5	<5	<250	<5	<500	<5
Isobutanol	78-83-1	1.10E+04	1.83E+03	µg/L	<40	<40	<8,000	<40	<40	<40	<2,000	<40	<4,000	<40
Methacrylonitrile	126-98-7	1.00E+00	1.04E+00	µg/L	<20	<20	<4,000	<20	<20	<20	<1,000	<20	<2,000	<20
Methyl Methacrylate	80-62-6	1.40E+03	1.42E+03	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
Methylene Chloride	75-09-2	4.80E+00	5.00E+00	µg/L	<5	<5	<1,000	<5	<5	<5	<250	<5	<500	<5
Pentachloroethane	76-01-7	7.50E-01	- -	µg/L	<5	<5	<1,000	<5	<5	<5	<250	<5	<500	<5
Propionitrile	107-12-0	- -	- -	µg/L	<20	<20	<4,000	<20	<20	<20	<1,000	<20	<2,000	<20
Styrene	100-42-5	1.60E+03	1.00E+02	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
Tetrachloroethene	127-18-4	1.10E-01	5.00E+00	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
Toluene	108-88-3	2.30E+03	1.00E+03	µg/L	<1	<1	<200	<1	2.4	<1	**2,600**	1.1	**1,300**	<1
trans-1,2-Dichloroethene	156-60-5	1.10E+02	1.00E+02	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
trans-1,3-Dichloropropene	10061-02-6	- -	- -	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
trans-1,4-Dichloro-2-butene	110-57-6	1.20E-03	- -	µg/L	<2	<2	<400	<2	<2	<2	<100	<2	<200	<2
Trichloroethene	79-01-6	2.00E+00	5.00E+00	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
Trichlorofluoromethane	75-69-4	1.30E+03	1.29E+03	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
Vinyl Acetate	108-05-4	4.10E+02	4.12E+02	µg/L	<2	<2	<400	<2	<2	<2	<100	<2	<200	<2
Vinyl Chloride	75-01-4	1.60E-02	2.00E+00	µg/L	<1	<1	<200	<1	<1	<1	<50	<1	<100	<1
Xylenes (total)	1330-20-7	2.00E+02	1.00E+04	µg/L	<2	<2	<400	<2	<2	<2	<100	<2	<200	<2
Semivolatile Organics-EPA 8270C														
1,1'-Biphenyl	92-52-4	8.30E-01	3.04E+02	µg/L	NA	NA	<1,000	NA	**770**	NA	NA	NA	<97	NA
1,2,4,5-Tetrachlorobenzene	95-94-3	1.10E+01	1.10E+01	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
1,2,4-Trichlorobenzene	120-82-1	2.30E+00	7.00E+01	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
1,2-Dichlorobenzene	95-50-1	3.70E+02	6.00E+02	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
1,3,5-Trinitrobenzene	99-35-4	1.10E+03	1.10E+03	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
1,3-Dichlorobenzene	541-73-1	- -	5.48E+00	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
1,3-Dinitrobenzene	99-65-0	3.70E+00	3.65E+00	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
1,4-Dichlorobenzene	106-46-7	4.30E-01	7.50E+01	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
1,4-Dioxane	123-91-1	6.70E-01	6.09E+00	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	**890**	NA
1,4-Naphthoquinone	130-15-4	- -	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
1-Naphthylamine	134-32-7	- -	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
2,2'-Oxybis(1-Chloropropane)	108-60-1	3.20E-01	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
2,3,4,6-Tetrachlorophenol	58-90-2	1.10E+03	1.10E+03	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
2,4,5-Trichlorophenol	95-95-4	3.70E+03	3.65E+03	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
2,4,6-Trichlorophenol	88-06-2	6.10E+00	6.09E+00	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
2,4-Dichlorophenol	120-83-2	1.10E+02	1.10E+02	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
2,4-Dimethylphenol	105-67-9	7.30E+02	7.30E+02	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
2,4-Dinitrophenol	51-28-5	7.30E+01	7.30E+01	µg/L	NA	NA	<5,000	NA	<500	NA	NA	NA	<480	NA
2,4-Dinitrotoluene	121-14-2	2.20E-01	7.30E+01	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
2,6-Dichlorophenol	87-65-0	- -	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
2,6-Dinitrotoluene	606-20-2	3.70E+01	3.65E+01	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
2-Acetylaminofluorene	53-96-3	1.80E-02	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
2-Chloronaphthalene	91-58-7	2.90E+03	4.87E+02	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
2-Chlorophenol	95-57-8	1.80E+02	3.04E+01	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
2-Methylnaphthalene	91-57-6	1.50E+02	1.22E+02	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
2-Methylphenol	95-48-7	1.80E+03	1.83E+03	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
2-Naphthylamine	91-59-8	3.70E-02	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
2-Nitroaniline	88-74-4	3.70E+02	4.17E-01	µg/L	NA	NA	<5,000	NA	<500	NA	NA	NA	<480	NA
2-Nitrophenol	88-75-5	- -	4.16E-01	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
2-Picoline	109-06-8	- -	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
3 & 4 Methylphenol	15831-10-4	- -	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	660	NA
3,3'-Dichlorobenzidine	91-94-1	1.50E-01	1.49E-01	µg/L	NA	NA	<6,000	NA	<600	NA	NA	NA	<580	NA
3,3'-Dimethylbenzidine	119-93-7	6.10E-03	7.28E-03	µg/L	NA	NA	<2,000	NA	<200	NA	NA	NA	<190	NA
3-Methylcholanthrene	56-49-5	9.80E-04	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
3-Nitroaniline	99-09-2	- -	- -	µg/L	NA	NA	<5,000	NA	<500	NA	NA	NA	<480	NA
4,6-Dinitro-2-methylphenol	534-52-1	2.90E+00	3.65E+00	µg/L	NA	NA	<5,000	NA	<500	NA	NA	NA	<480	NA
4-Aminobiphenyl	92-67-1	3.20E-03	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
4-Bromophenyl-phenylether	101-55-3	- -	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
4-Chloro-3-Methylphenol	59-50-7	3.70E+03	7.30E+04	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
4-Chloroaniline	106-47-8	3.40E-01	1.46E+02	µg/L	NA	NA	<2,000	NA	<200	NA	NA	NA	<190	NA

Table 1. Summary of July 2011 Groundwater Analytical Results, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

Location ID: Date Collected:	CAS #	EPA RSL TAP WATER	MDEQ_GW	UNITS	MW-15 07/28/11	MW-16 07/28/11	MW-17 07/26/11	MW-18 07/27/11	MW-19 07/26/11	MW-20 07/27/11	MW-21 07/26/11	MW-22 07/27/11	MW-23 07/26/11	MW-24 07/27/11
4-Chlorophenyl-phenylether	7005-72-3	- -	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
4-Nitroaniline	100-01-6	3.40E+00	- -	µg/L	NA	NA	<5,000	NA	<500	NA	NA	NA	<480	NA
4-Nitrophenol	100-02-7	- -	2.92E+02	µg/L	NA	NA	<5,000	NA	<500	NA	NA	NA	<480	NA
4-Nitroquinoline-1-oxide	56-57-5	- -	- -	µg/L	NA	NA	<2,000	NA	<200	NA	NA	NA	<190	NA
4-Phenylenediamine	106-50-3	6.90E+03	6.94E+03	µg/L	NA	NA	<200,000	NA	<20,000	NA	NA	NA	<19,000	NA
5-Nitro-o-toluidine	99-55-8	7.50E+00	2.03E+00	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
7,12-Dimethylbenz(a)anthracene	57-97-6	8.60E-05	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
a,a'-Dimethylphenethylamine	122-09-8	- -	- -	µg/L	NA	NA	<200,000	NA	<20,000	NA	NA	NA	<19,000	NA
Acenaphthene	83-32-9	2.20E+03	3.65E+02	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Acenaphthylene	208-96-8	- -	2.19E+03	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Acetophenone	98-86-2	3.70E+03	4.16E-02	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Aniline	62-53-3	1.20E+01	1.17E+01	µg/L	NA	NA	<2,000	NA	<200	NA	NA	NA	<190	NA
Anthracene	120-12-7	1.10E+04	4.34E+01	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Aramite	140-57-8	2.70E+00	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Benzo(a)anthracene	56-55-3	2.90E-02	9.17E-02	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Benzo(a)pyrene	50-32-8	2.90E-03	2.00E-01	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Benzo(b)fluoranthene	205-99-2	2.90E-02	9.17E-02	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Benzo(g,h,i)perylene	191-24-2	- -	1.10E+03	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Benzo(k)fluoranthene	207-08-9	2.90E-01	9.17E-01	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Benzyl Alcohol	100-51-6	3.70E+03	1.10E+04	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
bis(2-Chloroethoxy)methane	111-91-1	1.10E+02	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
bis(2-Chloroethyl)ether	111-44-4	1.20E-02	9.20E-03	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
bis(2-Ethylhexyl)phthalate	117-81-7	4.80E+00	6.00E+00	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Butylbenzylphthalate	85-68-7	3.50E+01	2.69E+03	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Chrysene	218-01-9	2.90E+00	9.17E+00	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Diallate	2303-16-4	1.10E+00	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Dibenzo(a,h)anthracene	53-70-3	2.90E-03	9.17E-03	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Dibenzofuran	132-64-9	3.70E+01	2.43E+01	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Diethylphthalate	84-66-2	2.90E+04	2.92E+04	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Dimethoate	60-51-5	7.30E+00	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Dimethylphthalate	131-11-3	- -	3.65E+05	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Di-n-Butylphthalate	84-74-2	3.70E+03	3.65E+03	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Di-n-Octylphthalate	117-84-0	- -	2.00E+01	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Dinoseb	88-85-7	3.70E+01	7.00E+00	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Disulfoton	298-04-4	1.50E+00	1.46E+00	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Ethyl Methanesulfonate	62-50-0	- -	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Ethyl Parathion	56-38-2	2.20E+02	2.19E+02	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Famphur	52-85-7	- -	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Fluoranthene	206-44-0	1.50E+03	1.46E+03	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Fluorene	86-73-7	1.50E+03	2.43E+02	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Hexachlorobenzene	118-74-1	4.20E-02	1.00E+00	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Hexachlorobutadiene	87-68-3	8.60E-01	8.59E-01	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Hexachlorocyclopentadiene	77-47-4	2.20E+02	5.00E+01	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Hexachloroethane	67-72-1	4.80E+00	4.78E+00	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Hexachlorophene	70-30-4	1.10E+01	1.10E+01	µg/L	NA	NA	<500,000	NA	<50,000	NA	NA	NA	<48,000	NA
Hexachloropropene	1888-71-7	- -	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Indeno(1,2,3-cd)pyrene	193-39-5	2.90E-02	9.17E-02	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Isophorone	78-59-1	7.10E+01	7.05E+01	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Isosafrole	120-58-1	- -	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Methapyrilene	91-80-5	- -	- -	µg/L	NA	NA	<200,000	NA	<20,000	NA	NA	NA	<19,000	NA
Methyl Methanesulfonate	66-27-3	6.80E-01	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Methyl Parathion	298-00-0	9.10E+00	9.13E+00	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Naphthalene	91-20-3	1.40E-01	6.20E+00	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Nitrobenzene	98-95-3	1.20E-01	3.53E+00	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
N-Nitrosodiethylamine	55-18-5	1.40E-04	4.46E-04	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
N-Nitrosodimethylamine	62-75-9	4.20E-04	1.31E-03	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
N-Nitroso-di-n-butylamine	924-16-3	2.40E-03	1.89E-03	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
N-Nitroso-di-n-propylamine	621-64-7	9.60E-03	9.57E-03	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
N-Nitrosodiphenylamine	86-30-6	1.40E+01	1.37E+01	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
N-Nitrosomethylethylamine	10595-95-6	3.10E-03	3.04E-03	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
N-Nitrosomorpholine	59-89-2	1.00E-02	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
N-Nitrosopiperidine	100-75-4	7.20E-03	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
N-Nitrosopyrrolidine	930-55-2	3.20E-02	3.19E-02	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
o,o,o-Triethylphosphorothioate	126-68-1	- -	- -	µg/L	NA	NA	12,000	NA	<99	NA	NA	NA	<97	NA
o-Toluidine	95-53-4	- -	2.79E-01	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
p-Dimethylaminoazobenzene	60-11-7	1.50E-02	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA

Table 1. Summary of July 2011 Groundwater Analytical Results, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

Location ID: Date Collected:	CAS #	EPA RSL TAP WATER	MDEQ_GW	UNITS	MW-15 07/28/11	MW-16 07/28/11	MW-17 07/26/11	MW-18 07/27/11	MW-19 07/26/11	MW-20 07/27/11	MW-21 07/26/11	MW-22 07/27/11	MW-23 07/26/11	MW-24 07/27/11
Pentachlorobenzene	608-93-5	2.90E+01	2.92E+01	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Pentachloronitrobenzene	82-68-8	2.60E-01	2.58E-01	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Pentachlorophenol	87-86-5	1.70E-01	1.00E+00	µg/L	NA	NA	<5,000	NA	<500	NA	NA	NA	<480	NA
Phenacetin	62-44-2	3.10E+01	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Phenanthrene	85-01-8	- -	1.10E+03	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Phenol	108-95-2	1.10E+04	2.19E+04	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	140	NA
Phorate	298-02-2	7.30E+00	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Pronamide	23950-58-5	2.70E+03	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Pyrene	129-00-0	1.10E+03	1.83E+02	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Pyridine	110-86-1	3.70E+01	3.65E+01	µg/L	NA	NA	<5,000	NA	<500	NA	NA	NA	<480	NA
Safrole	94-59-7	9.80E-02	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Sulfotep	3689-24-5	1.80E+01	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Thionazin	297-97-2	- -	- -	µg/L	NA	NA	<1,000	NA	<99	NA	NA	NA	<97	NA
Dioxins-EPA 8290														
2,3,7,8-TCDD	1746-01-6	5.20E-01	3.00E+01	pg/L	NA	NA	<10	NA	<10	NA	NA	NA	<10	NA
Total TEQ	- -	- -	- -	pg/L	NA	NA	0.00	NA	0.00	NA	NA	NA	0.00	NA
Inorganics-EPA 6020														
Antimony	7440-36-0	1.50E+01	6.00E+00	µg/L	NA	NA	<5	NA	<5	NA	NA	NA	<5	NA
Arsenic	7440-38-2	4.50E-02	5.00E+01	µg/L	NA	NA	**28**	NA	**14**	NA	NA	NA	**19**	NA
Barium	7440-39-3	7.30E+03	2.00E+03	µg/L	NA	NA	120	NA	51	NA	NA	NA	240	NA
Beryllium	7440-41-7	7.30E+01	4.00E+00	µg/L	NA	NA	<0.5	NA	<0.5	NA	NA	NA	3.3	NA
Cadmium	7440-43-9	- -	5.00E+00	µg/L	NA	NA	<0.5	NA	<0.5	NA	NA	NA	<0.5	NA
Chromium	7440-47-3	- -	- -	µg/L	NA	NA	<5	NA	<5	NA	NA	NA	5	NA
Cobalt	7440-48-4	1.10E+01	2.19E+03	µg/L	NA	NA	0.69	NA	<0.5	NA	NA	NA	0.71	NA
Copper	7440-50-8	1.50E+03	1.30E+03	µg/L	NA	NA	<5	NA	<5	NA	NA	NA	<5	NA
Lead	7439-92-1	- -	1.50E+01	µg/L	NA	NA	<1.5	NA	<1.5	NA	NA	NA	<1.5	NA
Nickel	7440-02-0	7.30E+02	7.30E+02	µg/L	NA	NA	<5	NA	<5	NA	NA	NA	<5	NA
Selenium	7782-49-2	1.80E+02	5.00E+01	µg/L	NA	NA	<2.5	NA	<2.5	NA	NA	NA	<2.5	NA
Silver	7440-22-4	1.80E+02	1.83E+02	µg/L	NA	NA	<1	NA	<1	NA	NA	NA	<1	NA
Thallium	7440-28-0	3.70E-01	2.00E+00	µg/L	NA	NA	<1	NA	<1	NA	NA	NA	<1	NA
Tin	7440-31-5	2.20E+04	2.19E+04	µg/L	NA	NA	<5	NA	<5	NA	NA	NA	<5	NA
Vanadium	7440-62-2	- -	2.56E+02	µg/L	NA	NA	<10	NA	<10	NA	NA	NA	16	NA
Zinc	7440-66-6	1.10E+04	1.10E+04	µg/L	NA	NA	<20	NA	57	NA	NA	NA	<20	NA
Inorganics-EPA 7470A														
Mercury	7439-97-6	6.30E-01	2.00E+00	µg/L	NA	NA	<0.2	NA	<0.2	NA	NA	NA	<0.2	NA
Miscellaneous-9034														
Sulfide	18496-25-8	- -	- -	mg/L	NA	NA	4.2	NA	<1	NA	NA	NA	7.9	NA
Miscellaneous9012A														
Cyanide	57-12-5	7.30E-01	2.00E-01	mg/L	NA	NA	<0.01	NA	<0.01	NA	NA	NA	<0.01	NA

Notes:

Boldface type	Compound detected.
*	Laboratory duplicate analysis was outside control limits.
<	Less than.
- -	Standard not promulgated.
▨	Shaded cells indicate that the reported result exceeds the E
EPA	U.S. Environmental Protection Agency.
MDEQ	Mississippi Department of Environmentl Quality.
MDEQ_GW	MDEQ Tier 1 Target Remediation Goal.
mg/L	Milligrams per liter.
µg/L	Micrograms per liter.
NA	Not analyzed.
RSL	Regional Screening Level.
TEQ	Toxic equivalent.

Table 2. Summary of VOC Analytical Results, 2002 through 2011, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Mississippi.

Location	Date	Concentrations in µg/L																																					
		Acetone	Benzene	Bromodichloromethane	Bromoform	Bromomethane	Carbon Tetrachloride	Chlorobenzene	Chloroethane	Chloromethane	Chloroform	cis-1,2-dichloroethene	1,2-Dichloroethane	1,2-Dichloropropane	1,1-Dichloroethene	Ethylbenzene	methylene chloride	methyl ethyl ketone	methyl isobutyl ketone	Styrene	Tetrachloroethene	Toluene	Trichloroethene	Vinyl Chloride	Total Xylenes	Bromobenzene	2-Chlorotoluene	4-Chlorotoluene	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,3-Trichlorobenzene	1,2,4-Trichlorobenzene	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	p-Isopropyltoluene	Dibromochloromethane	Isopropylbenzene
MDEQ_GW		6.08E+02	5.00E+00	1.68E-01	8.48E+00	8.52E+00	5.00E+00	1.00E+02	3.64E+00	1.43E+00	1.55E-01	7.00E+01	5.00E+00	5.00E+00	7.00E+00	7.00E+02	5.00E+00	1.91E+03	1.39E+02	1.00E+02	5.00E+00	1.00E+02	5.00E+00	2.00E+00	1.00E+04	--	--	--	6.00E+02	5.48E+00	7.50E+01	6.20E+00	--	7.00E+00	1.23E+01	1.23E+01	--	1.26E-01	6.79E+02
MDEQ_GW		608	5	0.168	8.48	8.52	5	100	3.64	1.43	0.155	70	5	5	7	700	5	1910	139	100	5	100	5	2	10000	--	--	--	600	5.48	75	6.2	--	7	12.3	12.3	--	0.13	679
CM-00	Sep-03	NA	< 1.0	< 1.0	< 1.0	< 5.0	< 1.0	< 1.0	< 5.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**5.0**	**4.1**	< 5.0	NA	NA	**3.16**	< 1.0	< 1.0	< 1.0	< 1.0	**8.31**	**4.18**	**3.40**	**4.61**	**3.44**	**3.66**	**7.54**	< 5.0	< 5.0	< 5.0	< 1.0	**1.04**	< 1.0	< 1.0	< 1.0
	Aug-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Aug-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-07	**42**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**1.10**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CM-01	Feb-03	NA	**2.82**	< 10.0	< 10.0	< 10.0	**3.03**	< 10.0	**20.5**	< 10.0	**2.34**	< 10.0	< 10.0	< 10.0	< 10.0	< 10.00	< 13.0	NA	NA	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 15.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	**25.7**	**32.2**	**3.36**	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
	Sep-03	NA	< 1.0	< 1.0	< 1.0	< 5.0	< 1.0	**6.58**	< 5.0	< 1.0	< 1.0	< 1.0	**1.71**	< 1.0	< 5.0	**1.55**	< 5.0	NA	NA	**2.36**	< 1.00	**4.66**	< 1.00	< 1.00	**7.41**	**13**	**2.53**	**4.17**	**3.76**	**3.42**	**6.35**	**14.7**	**6.64**	**1.8**	**1.3**	**1.57**	< 1.0	< 1.0	< 1.0
	Aug-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Aug-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-06	**62**	**8.40**	< 1.0	< 1.0	< 1.0	< 1.0	**24**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**57**	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	**2.70**	< 1.0	< 1.0	**86**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-07	**49**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CM-02	Feb-03	NA	**1.17**	< 10.0	< 10.0	< 10.0	**1.48**	< 10.0	**15.6**	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 13.0	NA	NA	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 15.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	**20.3**	**24.8**	**2.37**	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
	Aug-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Aug-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	**21**	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-07	**92**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-09	**34**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CM-03	Feb-03	NA	**3.66**	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	**8.42**	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 13.0	NA	NA	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 15.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	**20.1**	**23**	**2.13**	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
	Aug-05	< 25	**1.10**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-05	< 25	**1.40**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-06	< 25	**1.10**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-06	< 25	**1.60**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Aug-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-07	**63**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-07	< 25	**4.80**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-08	< 25	**1.90**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CM-04	Feb-03	NA	**2.25**	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	**3.43**	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 13.0	NA	NA	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 15.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	**13**	**12.2**	**1.26**	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
	Aug-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.00	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Aug-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.00	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-06	**31**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**1.40**	**17**	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	**160**	< 10.0	< 1.0	**90**	< 1.0	**26**	**2.6**	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-07	**160**	**1.30**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-09	< 25	**4.10**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 2. Summary of VOC Analytical Results, 2002 through 2011, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Mississippi.

Location	Date	Concentrations in µg/L																																					
		Acetone	Benzene	Bromodichloromethane	Bromoform	Bromomethane	Carbon Tetrachloride	Chlorobenzene	Chloroethane	Chloromethane	Chloroform	cis-1,2-dichloroethene	1,2-Dichloroethane	1,2-Dichloropropane	1,1-Dichloroethene	Ethylbenzene	methylene chloride	methyl ethyl ketone	methyl isobutyl ketone	Styrene	Tetrachloroethene	Toluene	Trichloroethene	Vinyl Chloride	Total Xylenes	Bromobenzene	2-Chlorotoluene	4-Chlorotoluene	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,3-Trichlorobenzene	1,2,4-Trichlorobenzene	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	p-Isopropyltoluene	Dibromochloromethane	Isopropylbenzene
MDEQ_GW		6.08E+02	5.00E+00	1.68E-01	8.48E+00	8.52E+00	5.00E+00	1.00E+02	3.64E+00	1.43E+00	1.55E-01	7.00E+01	5.00E+00	5.00E+00	7.00E+00	7.00E+02	5.00E+00	1.91E+03	1.39E+02	1.00E+02	5.00E+00	1.00E+02	5.00E+00	2.00E+00	1.00E+04	--	--	--	6.00E+02	5.48E+00	7.50E+01	6.20E+00	--	7.00E+00	1.23E+01	1.23E+01	--	1.26E-01	6.79E+02
MDEQ_GW		608	5	0.168	8.48	8.52	5	100	3.64	1.43	0.155	70	5	5	7	700	5	1910	139	100	5	100	5	2	10000	--	--	--	600	5.48	75	6.2	--	7	12.3	12.3	--	0.13	679
	Nov-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**7.60**	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CM-05	Feb-03	NA	**4.04**	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 12.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 13.0	NA	NA	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 15.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	**7.51**	**5.54**	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
	Aug-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Aug-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-07	< 25	**2.00**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-09	< 25	**4.00**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-09	**47**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-02	Aug-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-05	**32**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Aug-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-03	Aug-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Aug-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**7.5**	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	**54**	< 10.0	< 1.0	**65**	< 1.0	< **39**	**1.2**	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-04	Dec-02	ND	**14**	ND	ND	ND	**10.00**	**1.81**	**63**	**1.72**	ND	ND	ND	ND	ND	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**5.38**	ND	ND	ND	ND	ND	ND	**1.26**
	Feb-03	NA	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 12.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 13.0	NA	NA	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 15.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	B **34.4**	B **45.9**	B **9.79**	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
	Aug-03	NA	< 1.0	< 1.0	< 1.0	< 5.0	< 1.0	< 1.0	< 5.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 1.0	< 5.0	NA	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 5.0	< 5.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
	Aug-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Aug-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**3.6**	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	**68**	< 1.0	**21**	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-05	Aug-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**1.3**	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**1.8**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Aug-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**1.2**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-06	**60**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-07	**52**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**1.6**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-08	**85**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 2. Summary of VOC Analytical Results, 2002 through 2011, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Mississippi.

Location	Date	Concentrations in µg/L																																			
		Acetone	Benzene	Bromodichloromethane	Bromoform	Bromomethane	Carbon Tetrachloride	Chlorobenzene	Chloroethane	Chloromethane	Chloroform	cis-1,2-dichloroethene	1,2-Dichloroethane	1,2-Dichloropropane	1,1-Dichloroethene	Ethylbenzene	methylene chloride	methyl ethyl ketone	methyl isobutyl ketone	Styrene	Tetrachloroethene	Toluene	Trichloroethene	Vinyl Chloride	Total Xylenes	Bromobenzene	2-Chlorotoluene	4-Chlorotoluene	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,3-Trichlorobenzene	1,2,4-Trichlorobenzene	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	p-Isopropyltoluene	Dibromochloromethane	Isopropylbenzene
MDEQ_GW		6.08E+02	5.00E+00	1.68E-01	8.48E+00	8.52E+00	5.00E+00	1.00E+02	3.64E+00	1.43E+00	1.55E-01	7.00E+01	5.00E+00	5.00E+00	7.00E+00	7.00E+02	5.00E+00	1.91E+03	1.39E+02	1.00E+02	5.00E+00	1.00E+02	5.00E+00	2.00E+00	1.00E+04	--	--	--	6.00E+02	5.48E+00	7.50E+01	6.20E+00	--	7.00E+00	1.23E+01	1.23E+01	--	1.26E-01	6.79E+02
MDEQ_GW		608	5	0.168	8.48	8.52	5	100	3.64	1.43	0.155	70	5	5	7	700	5	1910	139	100	5	100	5	2	10000	--	--	--	600	5.48	75	6.2	--	7	12.3	12.3	--	0.13	679
	May-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-10	**27**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-06	Aug-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Aug-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-06	< 25	**56**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**58**	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	**12**	< 1.0	< 1.0	**50**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-08	**490**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-07	Aug-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Aug-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-06	< 25	**93**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**61**	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**110**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-08	Dec-02	ND	**6,900**	**6.84**	ND	**4.07**	**16,000**	**290**	**66**	**39.2**	**1,800**	**19.0**	**20**	ND	**17.0**	**55.6**	**26.1**	NA	NA	ND	**8.51**	**28**	**5.80**	ND	ND	ND	ND	ND	**2.71**	**3.75**	**3.80**	**9.14**	ND	ND	ND	ND	**23.9**	**4.45**	**4.60**
	Feb-03	NA	< 500	**4.72**	< 10.0	< 10.0	**12,000**	**230**	**85.5**	**3.34**	**1,300**	**17.5**	**79.8**	< 10.0	**1.85**	**67.5**	< 13	NA	NA	**1.25**	**48.9**	**35.4**	**3.2**	< 10.0	**62.4**	< 10.0	< 10.0	< 10.0	**2.22**	< 10.0	**3.14**	B **25**	B **25.3**	B **5.73**	**1.92**	**1.80**	**23.8**	< 10.0	**4.35**
	Aug-05	< 6,300	**18,000**	< 1.0	< 250	< 250	**3,500**	< 250	< 250	< 250	**510**	NA	**500**	< 250	< 250	< 250	< 1,300	< 10.0	< 10.0	< 250	< 250	< 250	< 250	< 250	< 500.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-05	< 2,500	**17,000**	< 1.0	< 100	< 100	**1,000**	**160**	< 100	< 100	**260**	NA	< 100	< 100	< 100	**260**	< 500	< 10.0	< 10.0	< 100	< 100	**270**	< 100	< 100	**410**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-06	< 2,500	**11,000**	< 1.0	< 100	< 100	**480**	**160**	< 100	< 100	**130**	NA	< 100	< 100	< 100	**290**	< 500	< 10.0	< 10.0	< 100	< 100	**300**	< 100	< 100	**600**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-06	< 630	**11,000**	< 25	< 25	< 25	**2,200**	**170**	< 25	< 25	**280**	**29.0**	< 25	< 25	< 25	**190**	**380**	< 10.0	< 10.0	< 25	< 25	**240**	< 25	< 25	**340**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Aug-06	**750**	**15,000**	< 1.0	< 1.0	< 1.0	**640**	**220**	**3.80**	< 1.0	**450**	**34.0**	< 1.0	< 1.0	**6.40**	**280**	**510**	< 10.0	< 10.0	< 1.0	**8.40**	**410**	**2.80**	**2.60**	**640**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-06	< 2,500	**13,000**	< 1.0	< 100	< 100	**330**	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	**190**	< 500	< 1,000	< 1,000	< 100	< 100	**270**	< 100	< 100	**430**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-07	< 250	**990**	< 1.0	< 10.0	< 10.0	**840**	**24**	< 10	< 10	**100**	< 10.0	< 10	< 10.0	< 10.0	**12**	< 50	< 100	< 100	< 10	< 10	**11**	< 10.0	< 10.0	**22**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-07	< 2,500	**9,600**	< 1.0	< 50	< 50	**6,100**	**220**	< 50	< 50	**890**	< 50	< 50	< 50	< 50	**100**	< 250	< 500	< 500	< 50	< 50	**79**	< 50	< 50	**160**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-07	< 2,500	**14,000**	< 1.0	< 100	< 100	**370**	< 100	< 100	< 100	< 100	NA	< 100	< 100	< 100	**110**	< 500	< 10.0	< 10.0	< 100	< 100	**110**	< 100	< 100	< 200	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-08	< 2,500	**3,200**	< 1.0	< 100	< 100	**15,000**	**350**	< 100	< 100	**2,200**	NA	< 100	< 100	< 100	**110**	< 500	< 10.0	< 10.0	< 100	< 100	< 100	< 100	< 100	< 200	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-08	< 2,500	**3,400**	< 1.0	< 100	< 100	**1,800**	**150**	< 100	< 100	**460**	NA	< 100	< 100	< 100	**33**	**170**	< 10.0	< 10.0	< 100	< 100	< 100	< 100	< 100	**60**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-09	< 620	**540**	< 25	< 25	< 25	**2,300**	**110**	< 25	< 25	**1,300**	< 25	< 25	< 25	< 25	< 25	< 125	< 250	< 250	< 25	< 25	< 25	< 25	< 25	< 25	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-09	< 620	< 1,000	< 25	< 25	< 25	**2,700**	**180**	< 25	< 25	**610**	< 25	< 25	< 25	< 25	**68**	**380**	< 250	< 250	< 25	< 25	**43.0**	< 25	< 25	**95**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-10	< 250	**2,900**	< 10.0	< 10.0	< 10.0	**8,000**	**180**	< 10.0	< 10.0	**1,400**	< 10.0	**63**	< 10.0	< 10.0	**22**	**230**	< 100	< 100	< 10.0	< 10	**10.0**	< 10	< 10	< 20	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-10	< 1,200	**6,000**	< 50	< 50	< 50	**1,000**	**150**	< 50	< 50	**300**	< 25	< 50	< 50	< 50	**74**	**560**	< 500	< 500	< 50	< 50	< 50	< 50	< 50	< 100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 1,300	**4,600**	< 50	< 50	< 50	**2,600**	**220**	< 50	< 50	**640**	< 50	< 50	< 50	< 50	**55**	**340**	< 500	< 500	< 50	< 50	< 50	< 50	< 50	< 100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-09	Dec-02	ND	**9.15**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**5.92**	ND	**2.48**	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Feb-03	NA	**64**	< 10.0	< 10.0	< 10.0	**20.7**	J **5.85**	**19.7**	< 10.0	J **9.83**	< 10.0	J **1.43**	< 10.0	< 10.0	J **1.53**	< 13.0	NA	NA	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 15.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	B **31.7**	B **36.8**	B **4.98**	< 10.0	< 10.0	J **1.80**	< 10.0	J **1.92**
	Aug-05	< 25	**12**	< 1.0	< 1.0	< 1.0	< 1.0	**1.00**	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	**3.2**	**1.40**	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	**1.2**	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-05	< 25	**16**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	**3.4**	**3.0**	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-06	< 25	**18**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	**4.1**	**3.8**	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-06	< 25	**8.10**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**3.2**	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	**1.1**	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Aug-06	< 25	**10**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**6.0**	1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-06	**34**	**18**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**6.5**	**3.8**	**6.8**	< 10.0	**48**	< 1.0	< 1.0	**4.2**	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-07	< 25	**7.60**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**4.6**	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-07	< 25	**8.40**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**2.6**	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	**1.6**	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-07	< 25	**9.10**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**3.7**	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	**1.5**	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-08	< 25	**3.50**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**1.2**	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-08	**46**	**1.90**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-09	< 25	**1.10**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-09	**210**	**1.60**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-10	< 25	**3.00**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**1.3**	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-10	Aug-03	NA	< 1.0	< 1.0	1.6	< 5.0	< 1.0	< 1.0	< 5.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 1.0	< 5.0	NA	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 5.0	< 5.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
	Aug-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Aug-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 2. Summary of VOC Analytical Results, 2002 through 2011, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Mississippi.

Location	Date	Concentrations in µg/L																																			
		Acetone	Benzene	Bromodichloromethan	Bromoform	Bromomethane	Carbon Tetrachloride	Chlorobenzene	Chloroethane	Chloromethane	Chloroform	cis-1,2-dichloroethene	1,2-Dichloroethane	1,2-Dichloropropane	1,1-Dichloroethene	Ethylbenzene	methylene chloride	methyl ethyl ketone	methyl isobutyl ketone	Styrene	Tetrachloroethene	Toluene	Trichloroethene	Vinyl Chloride	Total Xylenes	Bromobenzene	2-Chlorotoluene	4-Chlorotoluene	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,3-Trichlorobenzene	1,2,4-Trichlorobenzene	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	p-Isopropyltoluene	Dibromochloromethan	Isopropylbenzene
MDEQ_GW		6.08E+02	5.00E+00	1.68E-01	8.48E+00	8.52E+00	5.00E+00	1.00E+02	3.64E+00	1.43E+00	1.55E-01	7.00E+01	5.00E+00	5.00E+00	7.00E+00	7.00E+02	5.00E+00	1.91E+03	1.39E+02	1.00E+02	5.00E+00	1.00E+02	5.00E+00	2.00E+00	1.00E+04	--	--	--	6.00E+02	5.48E+00	7.50E+01	6.20E+00	--	7.00E+00	1.23E+01	1.23E+01	--	1.26E-01	6.79E+02
MDEQ_GW		608	5	0.168	8.48	8.52	5	100	3.64	1.43	0.155	70	5	5	7	700	5	1910	139	100	5	100	5	2	10000	--	--	--	600	5.48	75	6.2	--	7	12.3	12.3	--	0.13	679
	Dec-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-11	Dec-02	ND	**114**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Feb-03	NA	J **6.39**	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 12.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 13.0	NA	NA	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 15.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	B **42.6**	B **53.40**	B **13.55**	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
	Aug-03	NA	< 1.0	< 1.0	< 1.0	< 5.0	< 1.0	< 1.0	< 5.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 1.0	< 5.0	NA	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 5.0	< 5.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
	Aug-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Aug-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	` 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-09	**42**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-12	Aug-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Aug-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-06	**91**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-08	**32**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-09	**28**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-13	Aug-05	< 25	**120**	< 1.0	< 1.0	< 1.0	**260**	**10**	< 1.0	< 1.0	**96**	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	**1.10**	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-05	**29**	**78**	< 1.0	< 1.0	< 1.0	**53**	**9**	< 1.0	< 1.0	**56**	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	**1.70**	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-06	< 25	**110**	< 1.0	< 1.0	**1.6**	**77**	**22**	< 1.0	< 1.0	**63**	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	**2.40**	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-06	< 25	**48**	< 1.0	< 1.0	< 1.0	**110**	**5**	< 1.0	< 1.0	**33**	**1.00**	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Aug-06	< 25	**72**	< 1.0	< 1.0	< 1.0	**45**	**17**	< 1.0	< 1.0	**35**	**3.10**	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	**2.10**	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-06	< 25	**94**	< 1.0	< 1.0	< 1.0	**27**	**19**	< 1.0	< 1.0	**30**	**4.00**	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	**2.50**	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-07	< 25	**160**	< 1.0	< 1.0	< 1.0	**680**	**14**	< 1.0	< 1.0	**120**	**2.50**	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	**1.60**	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-07	< 25	**320**	< 1.0	< 1.0	< 1.0	**1,400**	**13**	< 1.0	< 1.0	**130**	**1.30**	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-07	< 25	**180**	< 1.0	< 1.0	< 1.0	**560**	**9**	< 1.0	< 1.0	**140**	**1.20**	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-08	< 250	**780**	< 1.0	< 20	< 20	**3,200**	**23**	< 20	< 20	**260**	< 20	< 20	< 20	< 20	< 20	< 100	< 200	< 200	< 20	< 20	< 20	< 20	< 20	< 20	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-08	< 250	**250**	**5.60**	< 20	< 20	**880**	**14**	< 20	< 20	**180**	**1.80**	**6.10**	< 20	< 20	< 20	< 100	< 200	< 200	< 20	< 20	< 20	< 20	< 20	< 20	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-09	< 620	**1,200**	< 25	< 25	< 25	**3,500**	< 25	< 25	< 25	**340**	< 25	< 25	< 25	< 25	< 25	< 125	< 250	< 250	< 25	< 25	< 25	< 25	< 25	< 25	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-09	< 620	**790**	< 25	< 25	< 25	**2,000**	**29**	< 25	< 25	**310**	< 25	< 25	< 25	< 25	< 25	< 120	< 250	< 250	< 25	< 25	< 25	< 25	< 25	< 50	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-10	< 500	**2,600**	< 20	< 20	< 20	**4,000**	**110**	< 20	< 20	**1,900**	< 20	< 20	< 20	< 20	< 20	< 100	< 200	< 200	< 20.0	< 20	< 20*	< 20	< 20	< 40	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-10	< 250	**530**	< 10.0	< 10.0	< 10.0	**970**	**25**	< 10.0	< 10.0	**230**	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 50	< 100	< 100	< 200	< 10.0	< 10.0	< 10.0	< 10.0	< 20	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 250	**390**	< 10.0	< 10.0	< 10.0	**620**	**24**	< 10.0	< 10.0	**210**	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 50	< 100	< 100	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 20	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-14	Aug-05	**34**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-05	**35**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-06	**180**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Aug-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-06	**440**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-07	**72**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-08	**650**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-08	**590**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-09	**260**	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 10.0	< 20.0	< 20.0	< 4.0	< 2.0	< 2.0	< 2.0	< 2.0	< 4.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-15	Aug-05	**84**	**1.7**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-05	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-06	**50**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Aug-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-06	**1,500**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-07	**350**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-07	**62**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-08	**2,300**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-09	**1,300**	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 25.0	< 50.0	< 50.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 10.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 2. Summary of VOC Analytical Results, 2002 through 2011, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Mississippi.

Location	Date	Concentrations in µg/L																																					
		Acetone	Benzene	Bromodichloromethan	Bromoform	Bromomethane	Carbon Tetrachloride	Chlorobenzene	Chloroethane	Chloromethane	Chloroform	cis-1,2-dichloroethene	1,2-Dichloroethane	1,2-Dichloropropane	1,1-Dichloroethene	Ethylbenzene	methylene chloride	methyl ethyl ketone	methyl isobutyl ketone	Styrene	Tetrachloroethene	Toluene	Trichloroethene	Vinyl Chloride	Total Xylenes	Bromobenzene	2-Chlorotoluene	4-Chlorotoluene	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,3-Trichlorobenzene	1,2,4-Trichlorobenzene	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	p-Isopropyltoluene	Dibromochloromethan	Isopropylbenzene
MDEQ_GW		6.08E+02	5.00E+00	1.68E-01	8.48E+00	8.52E+00	5.00E+00	1.00E+02	3.64E+00	1.43E+00	1.55E-01	7.00E+01	5.00E+00	5.00E+00	7.00E+00	7.00E+02	5.00E+00	1.91E+03	1.39E+02	1.00E+02	5.00E+00	1.00E+02	5.00E+00	2.00E+00	1.00E+04	--	--	--	6.00E+02	5.48E+00	7.50E+01	6.20E+00	--	7.00E+00	1.23E+01	1.23E+01	--	1.26E-01	6.79E+02
MDEQ_GW		608	5	0.168	8.48	8.52	5	100	3.64	1.43	0.155	70	5	5	7	700	5	1910	139	100	5	100	5	2	10000	--	--	--	600	5.48	75	6.2	--	7	12.3	12.3	--	0.13	679
	May-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-16	Aug-05	< 25	**2.3**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	**5.2**	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-05	< 25	**1.2**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	**2.1**	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Aug-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-06	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-07	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-10	< 25	**1.1**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**1.3**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	**3.5**	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-17	Aug-05	< 6,300	**6,200**	< 1.0	< 250	< 250	**1,500**	**340**	< 250	< 250	**1,200**	NA	< 250	< 250	< 250	< 250	< 1,300	NA	NA	< 250	< 250	**920**	< 250	< 250	**680**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-05	< 13,000	**1,500**	< 1.0	< 500	< 500	**17,000**	< 500	< 500	< 500	**1,600**	NA	< 500	< 500	< 500	< 500	< 2,500	NA	NA	< 500	< 500	< 500	< 500	< 500	< 1,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-06	< 13,000	**1,300**	< 1.0	< 500	< 500	**37,000**	**600**	< 500	< 500	**2,600**	NA	< 500	< 500	< 500	< 500	< 2,500	NA	NA	< 500	< 500	< 500	< 500	< 500	< 1,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-06	< 6,300	**4,200**	< 250	< 250	< 250	**30,000**	**530**	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 250	< 1,300	NA	NA	< 250	< 250	**720**	< 250	< 250	**540**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Aug-06	**570**	**1,000**	< 1.0	< 1.0	< 1.0	**33,000**	**610**	**3**	< 1	**3,000**	**26**	< 1.0	< 1.0	**6.0**	**36**	**10.0**	< 10.0	< 10.0	< 1.0	**8.00**	**69**	< 1.0	< 1.0	**93**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-06	< 5,000	**2,100**	< 1.0	< 200	< 200	**26,000**	**470**	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 1,000	< 2,000	< 2,000	< 200	< 200	< 200	< 200	< 200	< 400	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-07	< 5,000	**3,300**	< 1.0	< 200	< 200	**48,000**	**810**	< 200	< 200	**3,400**	< 200	< 200	< 200	< 200	< 200	< 1,000	< 2,000	< 2,000	< 200	< 200	**270**	< 200	< 200	**420**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-07	**740**	**5,300**	< 1.0	< 20	< 20	**32,000**	**770**	< 20	< 20	**2,800**	< 20	< 20	< 20	< 20	< 20	< 100	< 200	**570**	< 20	**22**	**450**	< 20	< 20	**810**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-07	< 5,000	**3,000**	< 1.0	< 200	< 200	**45,000**	**890**	< 200	< 200	**4,600**	< 200	< 200	< 200	< 200	< 200	< 1,000	< 2,000	< 2,000	< 200	< 200	**210**	< 200	< 200	< 400	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-08	< 5,000	**4,800**	< 1.0	< 200	< 200	**47,000**	**930**	< 200	< 200	**3,600**	< 200	< 200	< 200	< 200	< 200	< 1,000	< 2,000	< 2,000	< 200	< 200	**450**	< 200	< 200	**670**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-08	< 5,000	**1,800**	< 1.0	< 200	< 200	**34,000**	**720**	< 200	< 200	**3,500**	< 200	< 200	< 200	< 200	< 200	< 1,000	< 2,000	< 2,000	< 200	< 200	< 200	< 200	< 200	< 400	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-09	< 5,000	**8,100**	< 1.0	< 200	< 200	**39,000**	**640**	< 200	< 200	**2,900**	< 200	< 200	< 200	< 200	< 200	< 1,000	< 2,000	< 2,000	< 200	< 200	< 200	< 200	< 200	< 400	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-09	< 12,000	**4,500**	< 500	< 500	< 500	**54,000**	**1,200**	< 500	< 500	**7,100**	< 500	< 500	< 500	< 500	< 500	< 2,500	< 5,000	< 5,000	< 10,000	< 500	< 500	< 500	< 500	< 1,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-10	< 2,500	**7,500**	< 100	< 100	< 100	**40,000**	**740**	< 100	< 100	**8,400**	< 100	< 100	< 100	< 100	**230**	**660**	< 1,000	< 1,000	< 100	< 100	**520**	< 100	< 100	**830**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-10	< 12,000	< 500	< 500	< 500	< 500	**32,000**	**760**	< 500	< 500	**5,900**	< 500	< 500	< 500	< 500	< 500	< 2,500	< 5,000	< 5,000	< 500	< 500	< 500	< 500	< 500	< 1,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 5,000	**3,600**	< 200	< 200	< 200	**25,000**	**770**	< 200	< 200	**3,000**	< 400	< 200	< 200	< 200	< 200	< 200	< 2,000	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 400	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-18	Aug-05	< 25	**10.00**	< 1.0	< 1.0	< 1.0	< 1.0	**45**	< 1.0	< 1.0	< 1.0	NA	< 1.0	**2.30**	**2.60**	**1.60**	< 5.0	< 10.0	< 10.0	< 1.0	**1.10**	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-05	< 25	**3.90**	< 1.0	< 1.0	< 1.0	< 1.0	**26**	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	**1.60**	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-06	< 25	**4.20**	< 1.0	< 1.0	< 1.0	< 1.0	**31**	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	**1.50**	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-06	< 25	**6.50**	< 1.0	< 1.0	< 1.0	< 1.0	**35**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**2.30**	**1.10**	< 5.0	< 10.0	< 10.0	< 1.0	**1.00**	**1.20**	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Aug-06	< 25	**4.80**	< 1.0	< 1.0	< 1.0	< 1.0	**34**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**20**	**3.10**	**1.20**	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-06	**61**	**2.90**	< 1.0	< 1.0	< 1.0	< 1.0	**23**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**1.10**	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-07	< 25	**4.10**	< 1.0	< 1.0	< 1.0	< 1.0	**28**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**1.40**	**1.70**	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-07	< 25	**4.00**	< 1.0	< 1.0	< 1.0	< 1.0	**33**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**1.30**	**1.60**	**1.00**	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-07	< 25	**1.20**	< 1.0	< 1.0	< 1.0	< 1.0	**26**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**1.20**	**1.40**	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-08	< 25	**1.70**	< 1.0	< 1.0	< 1.0	< 1.0	**31**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**2.00**	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-08	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**23**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**1.00**	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**24**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**21**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-10	< 25	**1.1**	< 1.0	< 1.0	< 1.0	< 1.0	**20**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**1.00**	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**18**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**21**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-19	Aug-05	< 25	**20**	< 1.0	< 1.0	< 1.0	< 1.0	**7.50**	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	**1.90**	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-05	< 25	**19**	< 1.0	< 1.0	< 1.0	< 1.0	**6.40**	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	**1.30**	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-06	< 25	**22**	< 1.0	< 1.0	< 1.0	< 1.0	**9.80**	< 1.0	< 1.0	< 1.0	NA	< 1.0	< 1.0	< 1.0	**2.10**	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-06	**28**	**21**	< 1.0	< 1.0	< 1.0	< 1.0	**7.20**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**1.70**	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	**1.00**	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Aug-06	< 25	**18**	< 1.0	< 1.0	< 1.0	< 1.0	**6.30**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**2.10**	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-06	< 25	**20**	< 1.0	< 1.0	< 1.0	< 1.0	**6.20**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**2.00**	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Feb-07	< 25	**32**	< 1.0	< 1.0	< 1.0	< 1.0	**8.50**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**2.40**	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-07	< 25	**36**	< 1.0	< 1.0	< 1.0	< 1.0	**9.50**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**2.50**	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.00	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-07	< 25	**44**	< 1.0	< 1.0	< 1.0	< 1.0	**10**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**1.10**	**2.60**	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	**1.40**	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-08	< 25	**66**	< 1.0	< 1.0	< 1.0	**6.70**	**13**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**1.50**	**2.30**	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	**2.70**	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nov-08	< 25	**58**	< 1.0	< 1.0	< 1.0	< 1.0	**9.70**	< 1.0	< 1.0	**1.10**	< 1.0	< 1.0	< 1.0	< 1.0	**2.40**	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	**1.90**	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-09	< 25	**65**	< 1.0	< 1.0	< 1.0	**11.0**	**14**	< 1.0	< 1.0	**4.70**	< 1.0	< 1.0	< 1.0	**1.30**	**2.00**	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	**2.70**	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-09	< 25	**64**	< 1.0	< 1.0	< 1.0	**4.50**	**12**	< 1.0	< 1.0	**2.90**	< 1.0	< 1.0	< 1.0	< 1.0	**2.40**	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	**2.40**	< 1.0	< 1.0	**2.2**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-10	< 25	**52**	< 1.0	< 1.0	< 1.0	**3.20**	**10**	< 1.0	< 1.0	**3.60**	< 1.0	< 1.0	< 1.0	**1.40**	**1.90**	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	**3.00**	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-10	< 25	**61**	< 1.0	< 1.0	< 1.0	< 1.0	**9.1**	< 1.0	< 1.0	**2.70**	< 1.0	< 1.0	< 1.0	< 1.0	**2.20**	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	**2.50**	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 25	**54**	< 1.0	< 1.0*	< 1.0	**3.5**	**9.9**	< 1.0	< 1.0	**3.30**	< 1.0	< 1.0	< 1.0	< 1.0	**1.30**	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	**2.40**	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-20	Sep-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-21	Sep-09	< 1,200	**4,400**	< 50	< 50	< 50	< 50	**170**	< 50	< 50	**6,800**	< 50	< 50	< 50	< 50	< 50	< 250	< 500	**640**	< 50	< 50	**4,800**	< 50	< 50	< 100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-10	< 1,200	**3,500**	< 50	< 50	< 50	**280**	**150**	< 50	< 50	**7,800**	< 50	< 50	< 50	< 50	< 50	< 250	< 500	< 500	< 50	< 50	**4,500**	< 50	< 50	< 100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-10	< 1,200	**4,400**	< 50	< 50	< 50	< 50	**180**	< 50	< 50	**7,300**	< 50	**84**	< 50	< 50	< 50	< 250	< 500	**510**	< 50	< 50	**4,500**	< 50	< 50	< 100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 1,300	**3,200**	< 50	< 50	< 50	< 50	**150**	< 50	< 50	**4,300**	< 100	< 50	< 50	< 50	< 50	< 50	< 500	< 500	< 50	< 50	**2,600**	< 50	< 50	< 100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-22	Sep-09	**86**	**9.80**	< 1.0	< 1.0	< 1.0	< 1.0	**7.70**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-10	< 25	**6.60**	< 1.0	< 1.0	< 1.0	< 1.0	**4.90**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-10	< 25	**6.30**	< 1.0	< 1.0	< 1.0	< 1.0	**2.30**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 25	**10.0**	< 1.0	< 1.0	< 1.0	< 1.0	**8.70**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	**21**	< 1.0	< 1.0	**1.1**	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-23	Sep-09	**1,600**	**9,200**	< 100	< 50	< 100	< 50	**190**	< 100	< 100	**1,400**	< 100	< 50	< 50	< 50	< 50	**290**	< 500	**1,300**	< 100	< 100	**3,300**	< 500	< 50	< 100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	May-10	< 2,500	**10,000**	< 100	< 50	< 100	< 100	**180**	< 100	< 100	**2,000**	< 100	< 100	< 100	< 100	< 100	< 500	< 1,000	**1,000**	< 100	< 100	**3,300**	< 100	< 100	< 200	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-10	< 2,500	**7,600**	< 100	< 50	< 100	< 100	< 100	< 100	< 100	**2,900**	< 100	< 100	< 100	< 100	< 100	< 500	< 1,000	< 1,000	< 100	< 100	**1,400**	< 100	< 100	< 200	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 2,500	**8,800**	< 100	< 100	< 100	< 100	**140**	< 100	< 100	**3,200**	< 100	< 100	< 100	< 100	< 100	< 500	< 1,000	< **1,100**	< 100	< 100	**1,300**	< 100	< 100	< 200	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-24	Sep-09	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 2. Summary of VOC Analytical Results, 2002 through 2011, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Mississippi.

Location	Date	Concentrations in µg/L																																					
		Acetone	Benzene	Bromodichloromethan	Bromoform	Bromomethane	Carbon Tetrachloride	Chlorobenzene	Chloroethane	Chloromethane	Chloroform	cis-1,2-dichloroethene	1,2-Dichloroethane	1,2-Dichloropropane	1,1-Dichloroethene	Ethylbenzene	methylene chloride	methyl ethyl ketone	methyl isobutyl ketone	Styrene	Tetrachloroethene	Toluene	Trichloroethene	Vinyl Chloride	Total Xylenes	Bromobenzene	2-Chlorotoluene	4-Chlorotoluene	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,3-Trichlorobenzene	1,2,4-Trichlorobenzene	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	p-Isopropyltoluene	Dibromochloromethan	Isopropylbenzene
MDEQ_GW		6.08E+02	5.00E+00	1.68E-01	8.48E+00	8.52E+00	5.00E+00	1.00E+02	3.64E+00	1.43E+00	1.55E-01	7.00E+01	5.00E+00	5.00E+00	7.00E+00	7.00E+02	5.00E+00	1.91E+03	1.39E+02	1.00E+02	5.00E+00	1.00E+02	5.00E+00	2.00E+00	1.00E+04	--	--	--	6.00E+02	5.48E+00	7.50E+01	6.20E+00	--	7.00E+00	1.23E+01	1.23E+01	--	1.26E-01	6.79E+02
MDEQ_GW		608	5	0.168	8.48	8.52	5	100	3.64	1.43	0.155	70	5	5	7	700	5	1910	139	100	5	100	5	2	10000	--	--	--	600	5.48	75	6.2	--	7	12.3	12.3	--	0.13	679
	May-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dec-10	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-11	< 25	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 10.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

Boldface type Compound detected.

▨	Shaded cells indicate that the reported result exceeds the EPA RSL or MDEQ_GW.

Some Appendix IX parameters not shown due to no detections for that parameter

- -	Standard not promulgated.
<	Less than.
B	Compound detected in the associated method blank.
J	Estimated value.
MDEQ	Mississippi Department of Environmentl Quality.
MDEQ_GW	MDEQ Tier 1 Target Remediation Goal.
µg/L	Micrograms per liter.
NA	Not analyzed.

Table 3. Combined Groundwater Screening Evaluation, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

		2011 Data				Historic Data				Combined												
Constituent [a]		**Max Detect**	**Location of Maximum Detection**	**Detection Limit Max**	**Detection Limit Min**	**Max Detect**	**Location of Maximum Detection**	**Detection Limit Max**	**Detection Limit Min**	**Max Detect**	**Location of Maximum Detection**	**Detection Limit Max**	**Detection Limit Min**	**MDEQ TRG [b]**	**Does max detect exceed MDEQ TRG?**	**Does max DL exceed MDEQ TRG?**	**Does min DL exceed MDEQ?**	**USEPA RSL [c]**	**Surrogate Value**	**Does max detect exceed RSL?**	**Does max DL exceed RSL?**	**Does min DL exceed RSL?**
Pesticides/PCBs (µg/L)																						
4,4'-DDD		–	--	0.99	0.10	NA	--	NA	NA	--	--	0.99	0.10	0.28	ND	**YES**	No	0.28		ND	**YES**	No
4,4'-DDE		–	--	0.99	0.10	NA	--	NA	NA	--	--	0.99	0.10	0.20	ND	**YES**	No	0.20		ND	**YES**	No
4,4'-DDT		–	--	0.99	0.10	NA	--	NA	NA	--	--	0.99	0.10	0.20	ND	**YES**	No	0.20		ND	**YES**	No
4-Chlorobenzilate		–	--	4.9	0.49	NA	--	NA	NA	--	--	4.9	0.49	0.25	ND	**YES**	**YES**	0.61		ND	**YES**	No
Aldrin		–	--	0.49	0.05	NA	--	NA	NA	--	--	0.49	0.05	0.004	ND	**YES**	**YES**	0.004		ND	**YES**	**YES**
Alpha-BHC		1.5	MW-17(7/26/2011)	0.05	0.05	NA	--	NA	NA	1.5	MW-17(7/26/2011)	0.05	0.05	0.01	**YES**	**YES**	**YES**	0.01		**YES**	**YES**	**YES**
Aroclor 1016		–	--	9.9	0.99	NA	--	NA	NA	--	--	9.9	0.99	0.96	ND	**YES**	**YES**	0.96		ND	**YES**	**YES**
Aroclor 1221		–	--	20	2.0	NA	--	NA	NA	--	--	20	2.0	0.03	ND	**YES**	**YES**	0.01		ND	**YES**	**YES**
Aroclor 1232		–	--	9.9	0.99	NA	--	NA	NA	--	--	9.9	0.99	0.03	ND	**YES**	**YES**	0.01		ND	**YES**	**YES**
Aroclor 1242		–	--	9.9	0.99	NA	--	NA	NA	--	--	9.9	0.99	0.03	ND	**YES**	**YES**	0.03		ND	**YES**	**YES**
Aroclor 1248		–	--	9.9	0.99	NA	--	NA	NA	--	--	9.9	0.99	0.03	ND	**YES**	**YES**	0.03		ND	**YES**	**YES**
Aroclor 1254		–	--	9.9	0.99	NA	--	NA	NA	--	--	9.9	0.99	0.03	ND	**YES**	**YES**	0.03		ND	**YES**	**YES**
Aroclor 1260		–	--	9.9	0.99	NA	--	NA	NA	--	--	9.9	0.99	0.03	ND	**YES**	**YES**	0.03		ND	**YES**	**YES**
Beta-BHC		–	--	0.49	0.05	NA	--	NA	NA	--	--	0.49	0.05	0.04	ND	**YES**	**YES**	0.04		ND	**YES**	**YES**
Delta-BHC	[d]	–	--	0.49	0.05	NA	--	NA	NA	--	--	0.49	0.05	0.04	ND	**YES**	**YES**	0.04	[d]	ND	**YES**	**YES**
Dieldrin		–	--	0.99	0.10	NA	--	NA	NA	--	--	0.99	0.10	0.004	ND	**YES**	**YES**	0.00		ND	**YES**	**YES**
Endosulfan I	[e]	–	--	0.49	0.05	NA	--	NA	NA	--	--	0.49	0.05	219	ND	No	No	220		ND	No	No
Endosulfan II	[e]	–	--	0.99	0.10	NA	--	NA	NA	--	--	0.99	0.10	219	ND	No	No	220		ND	No	No
Endosulfan Sulfate	[e]	–	--	0.99	0.10	NA	--	NA	NA	--	--	0.99	0.10	219	ND	No	No	220		ND	No	No
Endrin		–	--	0.99	0.10	NA	--	NA	NA	--	--	0.99	0.10	2.0	ND	No	No	11		ND	No	No
Endrin Aldehyde	[f]	–	--	0.99	0.10	NA	--	NA	NA	--	--	0.99	0.10	2.0	ND	No	No	11		ND	No	No
Endrin Ketone	[f]	–	--	0.99	0.10	NA	--	NA	NA	--	--	0.99	0.10	2.0	ND	No	No	11		ND	No	No
Gamma-BHC (Lindane)		0.3	MW-08(7/26/2011)	0.49	0.05	NA	--	NA	NA	0.3	MW-08(7/26/2011)	0.49	0.05	0.20	**YES**	**YES**	No	0.06		**YES**	**YES**	No
Heptachlor		–	--	0.49	0.05	NA	--	NA	NA	--	--	0.49	0.05	0.40	ND	**YES**	No	0.02		ND	**YES**	**YES**
Heptachlor Epoxide		–	--	0.49	0.05	NA	--	NA	NA	--	--	0.49	0.05	0.20	ND	**YES**	No	0.01		ND	**YES**	**YES**
Isodrin	[g]	–	--	0.49	0.05	NA	--	NA	NA	--	--	0.49	0.05	0.004	ND	**YES**	**YES**	0.004	[g]	ND	**YES**	**YES**
Kepone		–	--	9.9	0.99	NA	--	NA	NA	--	--	9.9	0.99	NA	ND	NA	NA	0.007		ND	**YES**	**YES**
Methoxychlor		–	--	0.99	0.10	NA	--	NA	NA	--	--	0.99	0.10	40	ND	No	No	180		ND	No	No
Technical Chlordane		–	--	4.9	0.49	NA	--	NA	NA	--	--	4.9	0.49	2.0	ND	**YES**	No	0.19		ND	**YES**	**YES**
Toxaphene		–	--	49	4.9	NA	--	NA	NA	--	--	49	4.9	3.0	ND	**YES**	**YES**	0.06		ND	**YES**	**YES**
Herbicides (µg/L)																						
2,4,5-T		–	--	0.51	0.5	NA	--	NA	NA	--	--	0.51	0.50	365	ND	No	No	370		ND	No	No
2,4,5-TP		–	--	0.51	0.5	NA	--	NA	NA	--	--	0.51	0.50	50	ND	No	No	290		ND	No	No
2,4-D		10	MW-23(7/26/2011)	0.51	0.5	NA	--	NA	NA	10	MW-23(7/26/2011)	0.51	0.50	70	No	No	No	370		No	No	No
Volatile Organic Compounds (µg/L)																						
1,1,1,2-Tetrachloroethane		–	--	200	1.0	NA	--	NA	NA	--	--	200	1.0	0.41	ND	**YES**	**YES**	0.52		ND	**YES**	**YES**
1,1,1-Trichloroethane		–	--	200	1.0	NA	--	NA	NA	--	--	200	1.0	200	ND	No	No	9,100		ND	No	No
1,1,2,2-Tetrachloroethane		–	--	200	1.0	NA	--	NA	NA	--	--	200	1.0	0.05	ND	**YES**	**YES**	0.07		ND	**YES**	**YES**
1,1,2-Trichloroethane		–	--	200	1.0	NA	--	NA	NA	--	--	200	1.0	5.0	ND	**YES**	No	0.24		ND	**YES**	**YES**
1,1-Dichloroethane		–	--	200	1.0	NA	--	NA	NA	--	--	200	1.0	798	ND	No	No	2.4		ND	**YES**	No
1,1-Dichloroethene		–	--	200	1.0	17	MW-08(12/1/2002)	500	1	17	MW-08(12/1/2002)	500	1.0	7.0	**YES**	**YES**	No	340		No	**YES**	No
1,2,3-Trichloropropane		–	--	200	1.0	NA	--	NA	NA	--	--	200	1.0	0.01	ND	**YES**	**YES**	0.0007		ND	**YES**	**YES**
1,2-Dibromo-3-chloropropane		–	--	200	1.0	NA	--	NA	NA	--	--	200	1.0	0.20	ND	**YES**	**YES**	0.0003		ND	**YES**	**YES**
1,2-Dibromoethane		–	--	200	1.0	NA	--	NA	NA	--	--	200	1.0	0.05	ND	**YES**	**YES**	0.01		ND	**YES**	**YES**
1,2-Dichloroethane		–	--	200	1.0	500	MW-08(8/1/2005)	500	1	500	MW-08(8/1/2005)	500	1.0	5.0	**YES**	**YES**	No	0.15		**YES**	**YES**	**YES**
1,2-Dichloropropane		–	--	200	1.0	20	MW-18(8/6/2006)	500	1	20	MW-18(8/6/2006)	500	1.0	5.0	**YES**	**YES**	No	0.39		**YES**	**YES**	**YES**
2-Butanone		–	--	2,000	10	NA	--	NA	NA	--	--	2,000	10	1,906	ND	**YES**	No	7,100		ND	No	No
2-Chloro-1,3-butadiene		–	--	200	1.0	NA	--	NA	NA	--	--	200	1.0	14	ND	**YES**	No	0.02		ND	**YES**	**YES**
2-Hexanone		–	--	2,000	10	NA	--	NA	NA	--	--	2,000	10	1,460	ND	**YES**	No	47		ND	**YES**	No
3-Chloropropene		–	--	200	1.0	NA	--	NA	NA	--	--	200	1.0	NA	ND	NA	NA	0.65		ND	**YES**	**YES**
4-Methyl-2-pentanone		1,100	MW-23(7/26/2011)	2,000	10	NA	--	NA	NA	1,100	MW-23(7/26/2011)	2,000	10	139	**YES**	**YES**	No	2,000		No	No	No
Acetone		–	--	5,000	25	2300	MW-15(11/18/2008)	13,000	25	2,300	MW-15(11/18/2008)	13,000	25	608	**YES**	**YES**	No	22,000		No	No	No
Acetonitrile		–	--	8,000	40	NA	--	NA	NA	--	--	8,000	40	125	ND	**YES**	No	130		ND	**YES**	No
Acrolein		–	--	4,000	20	NA	--	NA	NA	--	--	4,000	20	0.04	ND	**YES**	**YES**	0.04		ND	**YES**	**YES**
Acrylonitrile		–	--	4,000	20	NA	--	NA	NA	--	--	4,000	20	0.04	ND	**YES**	**YES**	0.05		ND	**YES**	**YES**
Benzene		8,800	MW-23(7/26/2011)	1.0	1.0	18000	MW-08(8/1/2005)	1000	1	18,000	MW-08(8/1/2005)	1,000	1.0	5.0	**YES**	**YES**	No	0.41		**YES**	**YES**	**YES**
Bromodichloromethane		–	--	200	1.0	6.84	MW-08(12/1/2002)	500	1	6.8	MW-08(12/1/2002)	500	1.0	0.17	**YES**	**YES**	**YES**	0.12		**YES**	**YES**	**YES**
Bromoform		–	--	200	1.0	1.55	MW-10(8/1/2003)	500	1	1.6	MW-10(8/1/2003)	500	1.0	8.5	No	**YES**	No	8.5		No	**YES**	No

Table 3. Combined Groundwater Screening Evaluation, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

		2011 Data				Historic Data				Combined												
Constituent [a]		**Max Detect**	**Location of Maximum Detection**	**Detection Limit Max**	**Detection Limit Min**	**Max Detect**	**Location of Maximum Detection**	**Detection Limit Max**	**Detection Limit Min**	**Max Detect**	**Location of Maximum Detection**	**Detection Limit Max**	**Detection Limit Min**	**MDEQ TRG [b]**	**Does max detect exceed MDEQ TRG?**	**Does max DL exceed MDEQ TRG?**	**Does min DL exceed MDEQ?**	**USEPA RSL [c]**	**Surrogate Value**	**Does max detect exceed RSL?**	**Does max DL exceed RSL?**	**Does min DL exceed RSL?**
Bromomethane		–	--	200	1.0	4.07	MW-08(12/1/2002)	500	1	4.1	MW-08(12/1/2002)	500	1.0	8.5	No	**YES**	No	8.7		No	**YES**	No
Carbon Disulfide		390	MW-23(7/26/2011)	400	2.0	NA	--	NA	NA	390	MW-23(7/26/2011)	400	2.0	1,043	No	No	No	1,000		No	No	No
Carbon Tetrachloride		25,000	MW-17(7/26/2011)	100	1.0	54000	MW-17(12/10/2009)	100	1	54,000	MW-17(12/10/2009)	100	1.0	5.0	**YES**	**YES**	No	0.44		**YES**	**YES**	**YES**
Chlorobenzene		770	MW-17(7/26/2011)	1.0	1.0	1200	MW-17(12/10/2009)	500	1	1,200	MW-17(12/10/2009)	500	1.0	100	**YES**	**YES**	No	91		**YES**	**YES**	No
Chloroethane		–	--	200	1.0	200	MW-17(11/6/2006)	500	1	200	MW-17(11/6/2006)	500	1.0	3.6	**YES**	**YES**	No	21,000		No	No	No
Chloroform		4,300	MW-21(7/26/2011)	1.0	1.0	8400	MW-17(5/13/2010)	250	1	8,400	MW-17(5/13/2010)	250	1.0	0.15	**YES**	**YES**	**YES**	0.19		**YES**	**YES**	**YES**
Chloromethane		–	--	200	1.0	39.2	MW-08(12/1/2002)	500	1	39	MW-08(12/1/2002)	500	1.0	1.4	**YES**	**YES**	No	190		No	**YES**	No
cis-1,2-Dichloroethene		–	--	200	1.0	34	MW-08(8/6/2006)	500	1	34	MW-08(8/6/2006)	500	1.0	70	No	**YES**	No	73		No	**YES**	No
cis-1,3-Dichloropropene	[h]	–	--	200	1.0	NA	--	NA	NA	--	--	200	1.0	0.08	ND	**YES**	**YES**	0.43		ND	**YES**	**YES**
Dibromochloromethane		–	--	200	1.0	4.45	MW-08(12/1/2002)	10	1	4.5	MW-08(12/1/2002)	200	1.0	0.13	**YES**	**YES**	**YES**	0.15		**YES**	**YES**	**YES**
Dibromomethane		–	--	200	1.0	NA	--	NA	NA	--	--	200	1.0	61	ND	**YES**	No	8.2		ND	**YES**	No
Dichlorodifluoromethane		–	--	200	1.0	NA	--	NA	NA	--	--	200	1.0	348	ND	No	No	200		ND	No	No
Ethyl Methacrylate		–	--	200	1.0	NA	--	NA	NA	--	--	200	1.0	548	ND	No	No	530		ND	No	No
Ethylbenzene		55	MW-08(7/26/2011)	200	1.0	290	MW-08(2/6/2006)	500	1	290	MW-08(2/6/2006)	500	1.0	700	No	No	No	1.5		**YES**	**YES**	No
Iodomethane	[i]	–	--	1,000	5.0	NA	--	NA	NA	--	--	1,000	5.0	8.5	ND	**YES**	No	8.7		ND	**YES**	No
Isobutanol		–	--	8,000	40	NA	--	NA	NA	--	--	8,000	40	1,825	ND	**YES**	No	11,000		ND	No	No
Isopropylbenzene		–	–	–	–	4.6	MW-08(12/1/2002)	10	1	4.6	MW-08(12/1/2002)	10	1.0	679	No	No	No	680		No	No	No
Methacrylonitrile		–	--	4,000	20	NA	--	NA	NA	--	--	4,000	20	1.04	ND	**YES**	**YES**	1.0		ND	**YES**	**YES**
Methyl Methacrylate		–	--	200	1.0	NA	--	NA	NA	--	--	200	1.0	1,419	ND	No	No	1400		ND	No	No
Methylene Chloride		340	MW-08(7/26/2011)	1,000	5.0	660	MW-17(5/13/2010)	2,500	5	660	MW-17(5/13/2010)	2,500	5.0	5.0	**YES**	**YES**	No	4.8		**YES**	**YES**	**YES**
Pentachloroethane		–	--	1,000	5.0	NA	--	NA	NA	--	--	1,000	5.0	NA	ND	NA	NA	0.75		ND	**YES**	**YES**
Propionitrile		–	--	4,000	20	NA	--	NA	NA	--	--	4,000	20	NA	ND	NA	NA	NA		ND	NA	NA
Styrene		–	--	200	1.0	1.25	MW-08(2/1/2003)	10,000	1	1.3	MW-08(2/1/2003)	10,000	1.0	100	No	**YES**	No	1,600		No	**YES**	No
Tetrachloroethene		–	--	200	1.0	68	MW-04(11/6/2006)	500	1	68	MW-04(11/6/2006)	500	1.0	5.0	**YES**	**YES**	No	0.11		**YES**	**YES**	**YES**
Toluene		2,600	MW-21(7/26/2011)	200	1.0	4800	MW-21(9/29/2009)	500	1	4,800	MW-21(9/29/2009)	500	1.0	1,000	**YES**	No	No	2,300		**YES**	No	No
trans-1,2-Dichloroethene		–	--	200	1.0	NA	--	NA	NA	--	--	200	1.0	100	ND	**YES**	No	110		ND	**YES**	No
trans-1,3-Dichloropropene	[h]	–	--	200	1.0	NA	--	NA	NA	--	--	200	1.0	0.08	ND	**YES**	**YES**	0.43		ND	**YES**	**YES**
trans-1,4-Dichloro-2-butene	[j]	–	--	400	2.0	NA	--	NA	NA	--	--	400	2.0	0.004	ND	**YES**	**YES**	0.001		ND	**YES**	**YES**
Trichloroethene		–	--	200	1.0	21	MW-04(11/6/2006)	500	1	21	MW-04(11/6/2006)	500	1.0	5.0	**YES**	**YES**	No	2.0		**YES**	**YES**	No
Trichlorofluoromethane		–	--	200	1.0	NA	--	NA	NA	--	--	200	1.0	1,288	ND	No	No	1,300		ND	No	No
Vinyl Acetate		–	--	400	2.0	NA	--	NA	NA	--	--	400	2.0	412	ND	No	No	410		ND	No	No
Vinyl Chloride		–	--	200	1.0	2.6	MW-08(8/6/2006)	500	1	2.6	MW-08(8/6/2006)	500	1.0	2.0	**YES**	**YES**	No	0.02		**YES**	**YES**	**YES**
Xylenes (total)		–	--	400	2.0	NA	--	NA	NA	--	--	400	2.0	10,000	ND	No	No	200		ND	**YES**	No
Semivolatile Organic Compounds (µg/L)																						
1,1'-Biphenyl		770	MW-19(7/26/2011)	1,000	9.9	NA	--	NA	NA	770	MW-19(7/26/2011)	1,000	9.9	304	**YES**	**YES**	No	0.83		**YES**	**YES**	**YES**
1,2,4,5-Tetrachlorobenzene		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	11.0	ND	**YES**	No	11		ND	**YES**	No
1,2,4-Trichlorobenzene		–	--	1,000	9.9	13.55	MW-11(2/1/2003)	5	5	14	MW-11(2/1/2003)	1,000	9.9	70	No	**YES**	No	2.30		**YES**	**YES**	**YES**
1,2-Dichlorobenzene		–	--	1,000	9.9	2.71	MW-08(12/1/2002)	10	1	2.7	MW-08(12/1/2002)	1,000	9.9	600	No	**YES**	No	370		No	**YES**	No
1,3,5-Trinitrobenzene		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	1,095	ND	No	No	1,100		ND	No	No
1,3-Dichlorobenzene		–	--	1,000	9.9	3.75	MW-08(12/1/2002)	10	1	3.8	MW-08(12/1/2002)	1,000	9.9	5.5	No	**YES**	**YES**	370		No	**YES**	No
1,3-Dinitrobenzene		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	3.7	ND	**YES**	**YES**	3.7		ND	**YES**	**YES**
1,4-Dichlorobenzene		–	--	1,000	9.9	3.8	MW-08(12/1/2002)	10	1	3.8	MW-08(12/1/2002)	1,000	9.9	75	No	**YES**	No	0.43		**YES**	**YES**	**YES**
1,4-Dioxane		13,000	MW-08(7/26/2011)	1,000	9.9	NA	--	NA	NA	13,000	MW-08(7/26/2011)	1,000	9.9	6.1	**YES**	**YES**	**YES**	0.67		**YES**	**YES**	**YES**
1,4-Naphthoquinone		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	NA		ND	NA	NA
1-Naphthylamine		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	NA		ND	NA	NA
2,2'-Oxybis(1-Chloropropane)		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	NA		ND	NA	NA
2,3,4,6-Tetrachlorophenol		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	1,095	ND	No	No	1,100		ND	No	No
2,4,5-Trichlorophenol		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	3,650	ND	No	No	3,700		ND	No	No
2,4,6-Trichlorophenol		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	6.1	ND	**YES**	**YES**	6.1		ND	**YES**	**YES**
2,4-Dichlorophenol		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	110	ND	**YES**	No	110		ND	**YES**	No
2,4-Dimethylphenol		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	730	ND	**YES**	No	730		ND	**YES**	No
2,4-Dinitrophenol		–	--	5,200	49	NA	--	NA	NA	--	--	5,200	49	73	ND	**YES**	No	73		ND	**YES**	No
2,4-Dinitrotoluene		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	73	ND	**YES**	No	0.22		ND	**YES**	**YES**
2,6-Dichlorophenol	[k]	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	73	ND	**YES**	No	73	[k]	ND	**YES**	No
2,6-Dinitrotoluene		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	37	ND	**YES**	No	37		ND	**YES**	No
2-Acetylaminofluorene		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	0.02		ND	**YES**	**YES**
2-Chloronaphthalene		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	487	ND	**YES**	No	2,900		ND	No	No
2-Chlorophenol		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	30	ND	**YES**	No	180		ND	**YES**	No
2-Methylnaphthalene		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	122	ND	**YES**	No	150		ND	**YES**	No

Table 3. Combined Groundwater Screening Evaluation, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

	2011 Data				Historic Data				Combined												
Constituent [a]	**Max Detect**	**Location of Maximum Detection**	**Detection Limit Max**	**Detection Limit Min**	**Max Detect**	**Location of Maximum Detection**	**Detection Limit Max**	**Detection Limit Min**	**Max Detect**	**Location of Maximum Detection**	**Detection Limit Max**	**Detection Limit Min**	**MDEQ TRG [b]**	**Does max detect exceed MDEQ TRG?**	**Does max DL exceed MDEQ TRG?**	**Does min DL exceed MDEQ?**	**USEPA RSL [c]**	**Surrogate Value**	**Does max detect exceed RSL?**	**Does max DL exceed RSL?**	**Does min DL exceed RSL?**
2-Methylphenol	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	1,825	ND	No	No	1,800		ND	No	No
2-Naphthylamine	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	0.04		ND	**YES**	**YES**
2-Nitroaniline	–	--	5,200	49	NA	--	NA	NA	--	--	5,200	49	0.42	ND	**YES**	**YES**	370		ND	**YES**	No
2-Nitrophenol	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	0.42	ND	**YES**	**YES**	1,800		ND	No	No
2-Picoline	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	NA		ND	NA	NA
3 & 4 Methylphenol	660	MW-23(7/26/2011)	1,000	9.9	NA	--	NA	NA	660	MW-23(7/26/2011)	1,000	9.9	NA	NA	NA	NA	NA		NA	NA	NA
3,3'-Dichlorobenzidine	–	--	6,200	59	NA	--	NA	NA	--	--	6,200	59	0.15	ND	**YES**	**YES**	0.15		ND	**YES**	**YES**
3,3'-Dimethylbenzidine	–	--	2,100	20	NA	--	NA	NA	--	--	2,100	20	0.01	ND	**YES**	**YES**	0.01		ND	**YES**	**YES**
3-Methylcholanthrene	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	0.003		ND	**YES**	**YES**
3-Nitroaniline	–	--	5,200	49	NA	--	NA	NA	--	--	5,200	49	NA	ND	NA	NA	3.4		ND	**YES**	**YES**
4,6-Dinitro-2-methylphenol	–	--	5,200	49	NA	--	NA	NA	--	--	5,200	49	3.7	ND	**YES**	**YES**	2.90		ND	**YES**	**YES**
4-Aminobiphenyl	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	0.003		ND	**YES**	**YES**
4-Bromophenyl-phenylether	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	3.7		ND	**YES**	**YES**
4-Chloro-3-Methylphenol	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	73,000	ND	No	No	3,700		ND	No	No
4-Chloroaniline	–	--	2,100	20	NA	--	NA	NA	--	--	2,100	20	146	ND	**YES**	No	0.34		ND	**YES**	**YES**
4-Chlorophenyl-phenylether	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	3.7		ND	**YES**	**YES**
4-Nitroaniline	–	--	5,200	49	NA	--	NA	NA	--	--	5,200	49	NA	ND	NA	NA	3.4		ND	**YES**	**YES**
4-Nitrophenol	–	--	5,200	49	NA	--	NA	NA	--	--	5,200	49	292	ND	**YES**	No	180		ND	**YES**	No
4-Nitroquinoline-1-oxide	–	--	2,100	20	NA	--	NA	NA	--	--	2,100	20	NA	ND	NA	NA	NA		ND	NA	NA
4-Phenylenediamine	–	--	210,000	2,000	NA	--	NA	NA	--	--	210,000	2,000	6,935	ND	**YES**	No	6,900		ND	**YES**	No
5-Nitro-o-toluidine	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	2.0	ND	**YES**	**YES**	7.5		ND	**YES**	**YES**
7,12-Dimethylbenz(a)anthracene	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	0.0003		ND	**YES**	**YES**
a,a'-Dimethylphenethylamine	–	--	210,000	2,000	NA	--	NA	NA	--	--	210,000	2,000	NA	ND	NA	NA	NA		ND	NA	NA
Acenaphthene	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	365	ND	**YES**	No	2,200		ND	No	No
Acenaphthylene	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	2,190	ND	No	No	2,200		ND	No	No
Acetophenone	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	0.04	ND	**YES**	**YES**	3,700		ND	No	No
Aniline	–	--	2,100	20	NA	--	NA	NA	--	--	2,100	20	12	ND	**YES**	**YES**	12		ND	**YES**	**YES**
Anthracene	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	43	ND	**YES**	No	11,000		ND	No	No
Aramite	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	2.7		ND	**YES**	**YES**
Benzo(a)anthracene	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	0.09	ND	**YES**	**YES**	0.03		ND	**YES**	**YES**
Benzo(a)pyrene	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	0.20	ND	**YES**	**YES**	0.003		ND	**YES**	**YES**
Benzo(b)fluoranthene	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	0.09	ND	**YES**	**YES**	0.03		ND	**YES**	**YES**
Benzo(g,h,i)perylene	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	1,095	ND	No	No	1,100		ND	No	No
Benzo(k)fluoranthene	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	0.92	ND	**YES**	**YES**	0.29		ND	**YES**	**YES**
Benzyl Alcohol	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	10,950	ND	No	No	3,700		ND	No	No
bis(2-Chloroethoxy)methane	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	110		ND	**YES**	No
bis(2-Chloroethyl)ether	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	0.01	ND	**YES**	**YES**	0.01		ND	**YES**	**YES**
bis(2-Ethylhexyl)phthalate	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	6.0	ND	**YES**	**YES**	4.8		ND	**YES**	**YES**
Butylbenzylphthalate	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	2,690	ND	No	No	35		ND	**YES**	No
Chrysene	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	9.2	ND	**YES**	**YES**	2.9		ND	**YES**	**YES**
Diallate	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	1.1		ND	**YES**	**YES**
Dibenzo(a,h)anthracene	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	0.01	ND	**YES**	**YES**	0.0029		ND	**YES**	**YES**
Dibenzofuran	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	24	ND	**YES**	No	37		ND	**YES**	No
Diethylphthalate	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	29,200	ND	No	No	29,000		ND	No	No
Dimethoate	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	7.3		ND	**YES**	**YES**
Dimethylphthalate	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	365,000	ND	No	No	29,000		ND	No	No
Di-n-Butylphthalate	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	3,650	ND	No	No	3,700		ND	No	No
Di-n-Octylphthalate	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	20	ND	**YES**	No	3,700		ND	No	No
Dinoseb	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	7.0	ND	**YES**	**YES**	37		ND	**YES**	No
Disulfoton	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	1.5	ND	**YES**	**YES**	1.5		ND	**YES**	**YES**
Ethyl Methanesulfonate	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	NA		ND	NA	NA
Ethyl Parathion	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	219	ND	**YES**	No	220		ND	**YES**	No
Famphur	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	NA		ND	NA	NA
Fluoranthene	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	1,460	ND	No	No	1,500		ND	No	No
Fluorene	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	243	ND	**YES**	No	1,500		ND	No	No
Hexachlorobenzene	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	1.00	ND	**YES**	**YES**	0.04		ND	**YES**	**YES**
Hexachlorobutadiene	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	0.86	ND	**YES**	**YES**	0.86		ND	**YES**	**YES**
Hexachlorocyclopentadiene	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	50	ND	**YES**	No	220		ND	**YES**	No
Hexachloroethane	–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	4.8	ND	**YES**	**YES**	4.8		ND	**YES**	**YES**

Table 3. Combined Groundwater Screening Evaluation, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

		2011 Data				Historic Data				Combined												
Constituent [a]		**Max Detect**	**Location of Maximum Detection**	**Detection Limit Max**	**Detection Limit Min**	**Max Detect**	**Location of Maximum Detection**	**Detection Limit Max**	**Detection Limit Min**	**Max Detect**	**Location of Maximum Detection**	**Detection Limit Max**	**Detection Limit Min**	**MDEQ TRG [b]**	**Does max detect exceed MDEQ TRG?**	**Does max DL exceed MDEQ TRG?**	**Does min DL exceed MDEQ?**	**USEPA RSL [c]**	**Surrogate Value**	**Does max detect exceed RSL?**	**Does max DL exceed RSL?**	**Does min DL exceed RSL?**
Hexachlorophene		–	--	520,000	4,900	NA	--	NA	NA	--	--	520,000	4,900	10.95	ND	**YES**	**YES**	11		ND	**YES**	**YES**
Hexachloropropene		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	NA		ND	NA	NA
Indeno(1,2,3-cd)pyrene		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	0.09	ND	**YES**	**YES**	0.03		ND	**YES**	**YES**
Isophorone		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	70	ND	**YES**	No	71		ND	**YES**	No
Isosafrole		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	NA		ND	NA	NA
Methapyrilene		–	--	210,000	2,000	NA	--	NA	NA	--	--	210,000	2,000	NA	ND	NA	NA	NA		ND	NA	NA
Methyl Methanesulfonate		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	0.68		ND	**YES**	**YES**
Methyl Parathion		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	9.1	ND	**YES**	**YES**	9.1		ND	**YES**	**YES**
Naphthalene		–	--	1,000	9.9	42.6	MW-11(2/1/2003)	5	5	43	MW-11(2/1/2003)	1,000	9.9	6.2	**YES**	**YES**	**YES**	0.14		**YES**	**YES**	**YES**
Nitrobenzene		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	3.5	ND	**YES**	**YES**	0.12		ND	**YES**	**YES**
N-Nitrosodiethylamine		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	0.0004	ND	**YES**	**YES**	0.0001		ND	**YES**	**YES**
N-Nitrosodimethylamine		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	0.001	ND	**YES**	**YES**	0.0004		ND	**YES**	**YES**
N-Nitroso-di-n-butylamine		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	0.002	ND	**YES**	**YES**	0.002		ND	**YES**	**YES**
N-Nitroso-di-n-propylamine		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	0.010	ND	**YES**	**YES**	0.01		ND	**YES**	**YES**
N-Nitrosodiphenylamine		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	13.7	ND	**YES**	No	14		ND	**YES**	No
N-Nitrosomethylethylamine		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	0.003	ND	**YES**	**YES**	0.003		ND	**YES**	**YES**
N-Nitrosomorpholine		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	0.01		ND	**YES**	**YES**
N-Nitrosopiperidine		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	0.007		ND	**YES**	**YES**
N-Nitrosopyrrolidine		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	0.03	ND	**YES**	**YES**	0.03		ND	**YES**	**YES**
o,o,o-Triethylphosphorothioate		12,000	MW-17(7/26/2011)	99	9.9	NA	--	NA	NA	12,000	MW-17(7/26/2011)	99	9.9	NA	NA	NA	NA	NA		NA	NA	NA
o-Toluidine		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	0.28	ND	**YES**	**YES**	NA		ND	NA	NA
p-Dimethylaminoazobenzene		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	0.02		ND	**YES**	**YES**
Pentachlorobenzene		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	29	ND	**YES**	No	29		ND	**YES**	No
Pentachloronitrobenzene		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	0.26	ND	**YES**	**YES**	0.26		ND	**YES**	**YES**
Pentachlorophenol		–	--	5,200	49	NA	--	NA	NA	--	--	5,200	49	1.0	ND	**YES**	**YES**	0.17		ND	**YES**	**YES**
Phenacetin		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	31		ND	**YES**	No
Phenanthrene		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	1,095	ND	No	No	11,000		ND	No	No
Phenol		140	MW-23(7/26/2011)	1,000	9.9	NA	--	NA	NA	140	MW-23(7/26/2011)	1,000	9.9	21,900	No	No	No	11,000		No	No	No
Phorate		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	7.3		ND	**YES**	**YES**
Pronamide		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	2,700		ND	No	No
Pyrene		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	183	ND	**YES**	No	1,100		ND	No	No
Pyridine		–	--	5,200	49	NA	--	NA	NA	--	--	5,200	49	37	ND	**YES**	**YES**	37		ND	**YES**	**YES**
Safrole		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	0.31		ND	**YES**	**YES**
Sulfotep		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	18		ND	**YES**	No
Thionazin		–	--	1,000	9.9	NA	--	NA	NA	--	--	1,000	9.9	NA	ND	NA	NA	NA		ND	NA	NA
Dioxins (pg/L)																						
2,3,7,8-TCDD		–	--	11	9.8	NA	--	NA	NA	--	--	11	9.8	4.5	ND	**YES**	**YES**	0.52		ND	**YES**	**YES**
Total TEQ		–	--	0.00	0.00	NA	--	NA	NA	--	--	0.00	0.00	4.5	ND	No	No	0.52		ND	No	No
Inorganics (µg/L)																						
Antimony		–	--	5.0	5.0	NA	--	NA	NA	--	--	5.0	5.0	6.0	ND	No	No	15		ND	No	No
Arsenic		42	MW-08(7/26/2011)	2.5	2.5	NA	--	NA	NA	42	MW-08(7/26/2011)	2.5	2.5	50	No	No	No	0.05		**YES**	**YES**	**YES**
Barium		260	MW-08(7/26/2011)	–	–	NA	--	NA	NA	260	MW-08(7/26/2011)	--	--	2,000	No	ND	ND	7,300		No	ND	ND
Beryllium		3.3	MW-23(7/26/2011)	0.5	0.5	NA	--	NA	NA	3.3	MW-23(7/26/2011)	0.50	0.50	4.0	No	No	No	73		No	No	No
Cadmium		–	--	0.5	0.5	NA	--	NA	NA	--	--	0.50	0.50	5.0	ND	No	No	18		ND	No	No
Chromium	[l]	5.0	MW-23(7/26/2011)	5.0	5.0	NA	--	NA	NA	5.0	MW-23(7/26/2011)	5.0	5.0	100	No	No	No	0.04	[l]	**YES**	**YES**	**YES**
Cobalt		4.2	MW-02(7/27/2011)	0.5	0.5	NA	--	NA	NA	4.2	MW-02(7/27/2011)	0.50	0.50	2,190	No	No	No	11		No	No	No
Copper		–	--	5.0	5.0	NA	--	NA	NA	--	--	5.0	5.0	1,300	ND	No	No	1,500		ND	No	No
Lead		–	--	1.5	1.5	NA	--	NA	NA	--	--	1.5	1.5	15	ND	No	No	0.24		ND	**YES**	**YES**
Nickel		9.7	MW-12(7/27/2011)	5.0	5.0	NA	--	NA	NA	9.7	MW-12(7/27/2011)	5.0	5.0	730	No	No	No	730		No	No	No
Selenium		–	--	2.5	2.5	NA	--	NA	NA	--	--	2.5	2.5	50	ND	No	No	180		ND	No	No
Silver		–	--	1.0	1.0	NA	--	NA	NA	--	--	1.0	1.0	183	ND	No	No	180		ND	No	No
Thallium		–	--	1.0	1.0	NA	--	NA	NA	--	--	1.0	1.0	2.0	ND	No	No	0.37		ND	**YES**	**YES**
Tin		–	--	5.0	5.0	NA	--	NA	NA	--	--	5.0	5.0	21,900	ND	No	No	22,000		ND	No	No
Vanadium		16	MW-23(7/26/2011)	10	10	NA	--	NA	NA	16	MW-23(7/26/2011)	10	10	256	No	No	No	NA		NA	NA	NA
Zinc		57	MW-19(7/26/2011)	20	20	NA	--	NA	NA	57	MW-19(7/26/2011)	20	20	10,950	No	No	No	11,000		No	No	No
Inorganics (µg/L)																						
Mercury		–	--	0.2	0.2	NA	--	NA	NA	--	--	0.2	0.2	2.0	ND	No	No	0.63		ND	No	No
Miscellaneous (mg/L)																						
Sulfide		7.9	MW-23(7/26/2011)	1.0	1.0	NA	--	NA	NA	7.9	MW-23(7/26/2011)	1.0	1.0	NA	NA	NA	NA	NA		NA	NA	NA

Table 3. Combined Groundwater Screening Evaluation, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

	2011 Data				Historic Data				Combined												
	Max	Location of Maximum Detection	Detection Limit		Max	Location of Maximum Detection	Detection Limit		Max	Location of Maximum Detection	Detection Limit		MDEQ	Does max detect exceed MDEQ TRG?	Does max DL exceed MDEQ TRG?	Does min DL exceed MDEQ?	USEPA	Surrogate	Does max detect exceed RSL?	Does max DL exceed RSL?	Does min DL exceed RSL?
Constituent [a]	**Detect**		**Max**	**Min**	**Detect**		**Max**	**Min**	**Detect**		**Max**	**Min**	**TRG [b]**				**RSL [c]**	**Value**			
Miscellaneous (mg/L)																					
Cyanide	–	--	0.01	0.01	NA	--	NA	NA	--	--	0.01	0.01	0.20	ND	No	No	0.73		ND	No	No

–	Not detected/ not analyzed/ not applicable.
µg/L	Micrograms per Liter.
ND	Non-detects.
NA	Not analyzed/not applicable.
MDEQ	Mississippi Department of Environmental Quality.
TRG	Target Remediation Goal.
USEPA	U.S. Environmental Protection Agency.
RSL	Regional Screening Levels.
DL	Detection limit.
TEQ	Toxic equivalent.

[a] Only constituents detected at least once are presented.
For duplicate samples, the highest detected value or the lowest detection limit were used.

[b] TRG groundwater values source: *Subpart II, Mississippi Department of Environmental Quality Risk Evaluation Procedures for Voluntary Cleanup and Redevelopment of Brownfield Sites* , Appendix A Tier 1 Target Remediation Goals (February, 2002).

[c] USEPA RSLs (June, 2011).

[d] Technical BHC used as a surrogate.

[e] Endosufan used as a surrogate.

[f] Endrin used as a surrogate.

[g] Aldrin used as a surrogate.

[h] 1,3-Dichloropropene used as a surrogate.

[i] Bromomethane is used as a surrogate.

[j] 1,4-Dichloro-2-butene used as a surrogate.

[k] 2,4-Dinitrophenol used as a surrogate.

[l] RSL for chromium (VI) used as a surrogate for total chromium.

Table 4. Combined Surface Water Screening Evaluation, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

		2011 Data					Historic Data				Combined											
Constituent [a]		**New Units**	**Max Detect**	**Location of Maximum Detection**	**Detection Limit Max**	**Detection Limit Min**	**Max Detect**	**Location of Maximum Detection**	**Detection Limit Max**	**Detection Limit Min**	**Max Detect**	**Location of Maximum Detection**	**Detection Limit Max**	**Detection Limit Min**	**MDEQ TRG [b]**	**Does max detect exceed MDEQ TRG?**	**Does max DL exceed MDEQ TRG?**	**Does min DL exceed MDEQ TRG?**	**USEPA RSL [c]**	**Does max detect exceed RSL?**	**Does max DL exceed RSL?**	**Does min DL exceed RSL?**
Volatile Organic Compounds (µg/L)																						
1,1,1,2-Tetrachloroethane		µg/L	–	-	1.0	1.0	NA	--	NA	NA	--	--	1.0	1.0	0.41	ND	**YES**	**YES**	0.52	ND	**YES**	**YES**
1,1,1-Trichloroethane		µg/L	–	-	1.0	1.0	NA	--	NA	NA	--	--	1.0	1.0	200	ND	No	No	9,100	ND	No	No
1,1,2,2-Tetrachloroethane		µg/L	–	-	1.0	1.0	NA	--	NA	NA	--	--	1.0	1.0	0.05	ND	**YES**	**YES**	0.067	ND	**YES**	**YES**
1,1,2-Trichloroethane		µg/L	–	-	1.0	1.0	NA	--	NA	NA	--	--	1.0	1.0	5.0	ND	No	No	0.24	ND	**YES**	**YES**
1,1-Dichloroethane		µg/L	–	-	1.0	1.0	NA	--	NA	NA	--	--	1.0	1.0	798	ND	No	No	2.4	ND	No	No
1,1-Dichloroethene		µg/L	–	-	1.0	1.0	5.0	CM-00(9/1/2003)	10	1.0	5.0	CM-00(9/1/2003)	10	1.0	7.0	No	**YES**	No	340	No	No	No
1,2,3-Trichlorobenzene	[d]	µg/L	NA	--	NA	NA	32	CM-01(2/1/2003)	5.0	5.0	32	CM-01(2/1/2003)	5.0	5.0	70	No	No	No	29	**YES**	No	No
1,2,4-Trichlorobenzene		µg/L	NA	--	NA	NA	3.4	CM-01(2/1/2003)	10	5.0	3.4	CM-01(2/1/2003)	10	5.0	70	No	No	No	2.3	**YES**	**YES**	**YES**
1,2,4-Trimethylbenzene		µg/L	NA	--	NA	NA	1.3	CM-01(9/1/2003)	10	1.0	1.3	CM-01(9/1/2003)	10	1.0	12	No	No	No	15	No	No	No
1,3,5-Trimethylbenzene		µg/L	NA	--	NA	NA	1.6	CM-01(9/1/2003)	10	10	1.6	CM-01(9/1/2003)	10	10	12	No	No	No	370	No	No	No
1,2,3-Trichloropropane		µg/L	–	-	1.0	1.0	NA	--	NA	NA	--	--	1.0	1.0	0.006	ND	**YES**	**YES**	0.0007	ND	**YES**	**YES**
1,2-Dibromo-3-Chloropropane		µg/L	–	-	1.0	1.0	NA	--	NA	NA	--	--	1.0	1.0	0.20	ND	**YES**	**YES**	0.0003	ND	**YES**	**YES**
1,2-Dichlorobenzene		µg/L	NA	--	NA	NA	3.8	CM-01(9/1/2003)	10	10	3.8	CM-01(9/1/2003)	10	10	600	No	No	No	370	No	No	No
1,3-Dichlorobenzene		µg/L	NA	--	NA	NA	3.7	CM-00(9/1/2003)	10	10	3.7	CM-00(9/1/2003)	10	10	5.5	No	**YES**	**YES**	370	No	No	No
1,4-Dichlorobenzene		µg/L	NA	--	NA	NA	7.5	CM-00(9/1/2003)	10	10	7.5	CM-00(9/1/2003)	10	10	75	No	No	No	0.43	**YES**	**YES**	**YES**
1,2-Dichloroethane		µg/L	–	-	1.0	1.0	1.7	CM-01(9/1/2003)	10	1.0	1.7	CM-01(9/1/2003)	10	1.0	5.0	No	**YES**	No	0.15	**YES**	**YES**	**YES**
1,2-Dichloropropane		µg/L	–	-	1.0	1.0	–	-	10	1.0	--	--	10	1.0	5.0	ND	**YES**	No	0.39	ND	**YES**	**YES**
2-Butanone (MEK)		µg/L	–	-	10	10	NA	--	NA	NA	--	--	10	10	1,906	ND	No	No	7,100	ND	No	No
2-Chloro-1,3-butadiene		µg/L	–	-	1.0	1.0	NA	--	NA	NA	--	--	1.0	1.0	14	ND	No	No	0.02	ND	**YES**	**YES**
2-Chlorotoluene		µg/L	NA	--	NA	NA	3.4	CM-00(9/1/2003)	10	10	3.4	CM-00(9/1/2003)	10	10	122	No	No	No	730	No	No	No
4-Chlorotoluene	[e]	µg/L	NA	--	NA	NA	4.6	CM-00(9/1/2003)	10	10	4.6	CM-00(9/1/2003)	10	10	122	No	No	No	730	No	No	No
2-Hexanone		µg/L	–	-	10	10	NA	--	NA	NA	--	--	10	10	1,460	ND	No	No	47	ND	No	No
3-Chloro-1-propene		µg/L	–	-	1.0	1.0	NA	--	NA	NA	--	--	1.0	1.0	NA	ND	NA	NA	0.65	ND	**YES**	**YES**
4-Methyl-2-pentanone (MIBK)		µg/L	–	-	10	10	NA	--	NA	NA	--	--	10	10	139	ND	No	No	2,000	ND	No	No
Acetone		µg/L	–	-	25	25	160	CM-04(2/7/2007)	25	25	160	CM-04(2/7/2007)	25	25	608	No	No	No	22,000	No	No	No
Acetonitrile		µg/L	–	-	40	40	NA	--	NA	NA	--	--	40	40	125	ND	No	No	130	ND	No	No
Acrolein		µg/L	–	-	20	20	NA	--	NA	NA	--	--	20	20	0.04	ND	**YES**	**YES**	0.04	ND	**YES**	**YES**
Acrylonitrile		µg/L	–	-	20	20	NA	--	NA	NA	--	--	20	20	0.04	ND	**YES**	**YES**	0.05	ND	**YES**	**YES**
Benzene		µg/L	–	-	1.0	1.0	8.4	CM-01(11/6/2006)	1.0	1.0	8.4	CM-01(11/6/2006)	1.0	1.0	5.0	**YES**	No	No	0.41	**YES**	**YES**	**YES**
Bromoform		µg/L	–	-	1.0	1.0	–	-	10	1.0	--	--	10	1.0	8.5	ND	**YES**	No	8.5	ND	**YES**	No
Bromobenzene	[f]	µg/L	NA	--	NA	NA	13	CM-01(9/1/2003)	10	10	13	CM-01(9/1/2003)	10	10	100	No	No	No	88	No	No	No
Bromodichloromethane		µg/L	NA	--	NA	NA	–	-	10	1.0	--	--	10	1.0	0.17	ND	**YES**	**YES**	0.12	ND	**YES**	**YES**
Bromomethane		µg/L	–	-	1.0	1.0	–	-	10	1.0	--	--	10	1.0	8.5	ND	**YES**	No	8.7	ND	**YES**	No
Carbon disulfide		µg/L	–	-	2.0	2.0	NA	--	NA	NA	--	--	2.0	2.0	1,043	ND	No	No	1,000	ND	No	No
Carbon tetrachloride		µg/L	–	-	1.0	1.0	3.0	CM-01(2/1/2003)	10	1.0	3.0	CM-01(2/1/2003)	10	1.0	5.0	No	**YES**	No	0.44	**YES**	**YES**	**YES**
Chlorobenzene		µg/L	–	-	1.0	1.0	24	CM-01(11/6/2006)	10	1.0	24	CM-01(11/6/2006)	10	1.0	100	No	No	No	91	No	No	No
Chlorodibromomethane		µg/L	–	-	1.0	1.0	NA	--	NA	NA	--	--	1.0	1.0	0.13	ND	**YES**	**YES**	0.15	ND	**YES**	**YES**
Chloroethane		µg/L	–	-	1.0	1.0	21	CM-01(2/1/2003)	12	1.0	21	CM-01(2/1/2003)	12	1.0	3.6	**YES**	**YES**	No	21,000	No	No	No
Chloroform		µg/L	–	-	1.0	1.0	2.3	CM-01(2/1/2003)	10	1.0	2.3	CM-01(2/1/2003)	10	1.0	0.15	**YES**	**YES**	**YES**	0.19	**YES**	**YES**	**YES**
Chloromethane		µg/L	–	-	1.0	1.0	–	-	10	1.0	--	--	10	1.0	1.4	ND	**YES**	No	190	ND	No	No
cis-1,2-Dichloroethene		µg/L	7.6	CM-04(7/29/2011)	1.0	1.0	17	CM-04(11/6/2006)	10	1.0	17	CM-04(11/6/2006)	10	1.0	70	No	No	No	73	No	No	No
cis-1,3-Dichloropropene	[g]	µg/L	–	-	1.0	1.0	NA	--	NA	NA	--	--	1.0	1.0	0.08	ND	**YES**	**YES**	0.43	ND	**YES**	**YES**
Dibromochloromethane		µg/L	NA	--	NA	NA	–	-	10	1.0	--	--	10	1.0	0.13	ND	**YES**	**YES**	0.15	ND	**YES**	**YES**
Dibromomethane		µg/L	–	-	1.0	1.0	NA	--	NA	NA	--	--	1.0	1.0	61	ND	No	No	8	ND	No	No
Dichlorobromomethane		µg/L	–	-	1.0	1.0	NA	--	NA	NA	--	--	1.0	1.0	0.17	ND	**YES**	**YES**	0.12	ND	**YES**	**YES**
Dichlorodifluoromethane		µg/L	–	-	1.0	1.0	NA	--	NA	NA	--	--	1.0	1.0	348	ND	No	No	200	ND	No	No
Ethyl methacrylate		µg/L	–	-	1.0	1.0	NA	--	NA	NA	--	--	1.0	1.0	548	ND	No	No	530	ND	No	No
Ethylbenzene		µg/L	–	-	1.0	1.0	57	CM-01(11/6/2006)	10	1.0	57	CM-01(11/6/2006)	10	1.0	700	No	No	No	1.5	**YES**	**YES**	No
Ethylene Dibromide		µg/L	–	-	1.0	1.0	NA	--	NA	NA	--	--	1.0	1.0	0.05	ND	**YES**	**YES**	0.007	ND	**YES**	**YES**
Iodomethane	[h]	µg/L	–	-	5.0	5.0	NA	--	NA	NA	--	--	5.0	5.0	8.5	ND	No	No	8.7	ND	No	No
Isobutyl alcohol		µg/L	–	-	40	40	NA	--	NA	NA	--	--	40	40	1,825	ND	No	No	11,000	ND	No	No
Isopropylbenzene		µg/L	NA	--	NA	NA	–	-	10	1.0	--	--	10	1.0	679	ND	No	No	680	ND	No	No

Table 4. Combined Surface Water Screening Evaluation, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

			2011 Data				Historic Data				Combined											
Constituent [a]		**New Units**	**Max Detect**	**Location of Maximum Detection**	**Detection Limit Max**	**Detection Limit Min**	**Max Detect**	**Location of Maximum Detection**	**Detection Limit Max**	**Detection Limit Min**	**Max Detect**	**Location of Maximum Detection**	**Detection Limit Max**	**Detection Limit Min**	**MDEQ TRG [b]**	**Does max detect exceed MDEQ TRG?**	**Does max DL exceed MDEQ TRG?**	**Does min DL exceed MDEQ TRG?**	**USEPA RSL [c]**	**Does max detect exceed RSL?**	**Does max DL exceed RSL?**	**Does min DL exceed RSL?**
p-Isopropyltoluene		µg/L	NA	--	NA	NA	–	-	10	1.0	--	--	10	1.0	NA	ND	NA	NA	680	ND	No	No
Methacrylonitrile		µg/L	–	-	20	20	NA	--	NA	NA	--	--	20	20	1.0	ND	**YES**	**YES**	1.0	ND	**YES**	**YES**
Methyl ethyl ketone		µg/L	NA	--	NA	NA	160	CM-04(11/6/2006)	10	10	160	CM-04(11/6/2006)	10	10	1,906	No	No	No	7,100	No	No	No
Methyl isobutyl ketone		µg/L	NA	--	NA	NA	–	-	10	10	--	--	10	10	139	ND	No	No	2,000	ND	No	No
Methyl methacrylate		µg/L	–	-	1.0	1.0	NA	--	NA	NA	--	--	1.0	1.0	1,419	ND	No	No	1,400	ND	No	No
Methylene Chloride		µg/L	–	-	5.0	5.0	–	-	13	5.0	--	--	13	5.0	5.0	ND	**YES**	No	4.8	ND	**YES**	**YES**
Naphthalene		µg/L	NA	--	NA	NA	–	–	–	–	--	--	--	--	6.2	ND	ND	ND	0.14	ND	ND	ND
Pentachloroethane		µg/L	–	-	5.0	5.0	NA	--	NA	NA	--	--	5.0	5.0	NA	ND	NA	NA	0.75	ND	**YES**	**YES**
Propionitrile		µg/L	–	-	20	20	NA	--	NA	NA	--	--	20	20	NA	ND	NA	NA	NA	ND	NA	NA
Styrene		µg/L	–	-	1.0	1.0	3.2	CM-00(9/1/2003)	10	1.0	3.2	CM-00(9/1/2003)	10	1.0	100	No	No	No	1,600	No	No	No
Tetrachloroethene		µg/L	–	-	1.0	1.0	90	CM-04(11/6/2006)	10	1.0	90	CM-04(11/6/2006)	10	1.0	5.0	**YES**	**YES**	No	0.11	**YES**	**YES**	**YES**
Toluene		µg/L	–	-	1.0	1.0	21	CM-02(11/6/2006)	10	1.0	21	CM-02(11/6/2006)	10	1.0	1,000	No	No	No	2,300	No	No	No
trans-1,2-Dichloroethene		µg/L	–	-	1.0	1.0	NA	--	NA	NA	--	--	1.0	1.0	100	ND	No	No	110	ND	No	No
trans-1,3-Dichloropropene	[g]	µg/L	–	-	1.0	1.0	NA	--	NA	NA	--	--	1.0	1.0	0.08	ND	**YES**	**YES**	0.43	ND	**YES**	**YES**
trans-1,4-Dichloro-2-butene	[i]	µg/L	–	-	2.0	2.0	NA	--	NA	NA	--	--	2.0	2.0	0.004	ND	**YES**	**YES**	0.001	ND	**YES**	**YES**
Trichloroethene		µg/L	–	-	1.0	1.0	26	CM-04(11/6/2006)	10	1.0	26	CM-04(11/6/2006)	10	1.0	5.0	**YES**	**YES**	No	2.0	**YES**	**YES**	No
Trichlorofluoromethane		µg/L	–	-	1.0	1.0	NA	--	NA	NA	--	--	1.0	1.0	1,288	ND	No	No	1,300	ND	No	No
Vinyl acetate		µg/L	–	-	2.0	2.0	NA	--	NA	NA	--	--	2.0	2.0	412	ND	No	No	410	ND	No	No
Vinyl chloride		µg/L	3.2	CM-04(7/29/2011)	1.0	1.0	2.6	CM-04(11/6/2006)	10	1.0	3.2	CM-04(7/29/2011)	10	1.0	2.0	**YES**	**YES**	No	0.02	**YES**	**YES**	**YES**
Xylenes, Total		µg/L	–	-	2.0	2.0	NA	--	NA	NA	--	--	2.0	2.0	10,000	ND	No	No	200	ND	No	No

–	Not detected/ not analyzed/ not applicable.
µg/L	Micrograms per Liter.
ND	Non-detects.
NA	Not analyzed/not applicable.
MDEQ	Mississippi Department of Environmental Quality.
TRG	Target Remediation Goal.
USEPA	U.S. Environmental Protection Agency.
RSL	Regional Screening Levels.
DL	Detection limit.

[a] Only constituents detected at least once are presented.
For duplicate samples, the highest detected value or the lowest detection limit were used.

[b] TRG groundwater values source: *Subpart II, Mississippi Department of Environmental Quality Risk Evaluation Procedures for Voluntary Cleanup and Redevelopment of Brownfield Sites*, Appendix A Tier 1 Target Remediation Goals (February, 2002).

[c] USEPA RSLs (June, 2011).

[d] TRG for 1,2,4-trichlorobenzene used as a surrogate.

[e] 2-Chlorotoluene used as a surrogate.

[f] TRG for chlorobenzene used as a surrogate.

[g] 1,3-Dichloropropene used as a surrogate.

[h] Bromomethane is used as a surrogate.

[i] 1,4-Dichloro-2-butene used as a surrogate.

Table 5. Wells Listed in EDR Database Within Half-Mile of the Site, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi.

SITE ID	STATE	LOCATION	MAP ID	WELL DEPTH	TYPE	DIAMETER	SCREEN LENGTH	AQUIFER	DATE CONSTRUCTED
USGS2404627	NA	On-Site	160	654	NA	NA	NA	Catahoula Formation, Middle	32939
MSC100000048799	MS	On-Site	161	668	IN	16	NA	Catahoula Aquifer	35236
USGS2404617	NA	On-Site	161	668	NA	NA	NA	Catahoula Aquifer	35236
MSC100000048752	MS	Half-Mile	164	650	IN	8	30	Middle Catahoula	NA
USGS2404604	NA	On-Site	164	641	NA	NA	NA	Catahoula Formation, Middle	32157
MSP300000000964	MS	On-Site	166	640	IN	NA	NA	Miocene Aquifer System	NA
MSC100000048730	MS	On-Site	166	640	IN	16	NA	Miocene Aquifer System	35256
MSC100000048729	MS	On-Site	166	671	AB	18	NA	Miocene Aquifer System	24532
MSP300000000963	MS	On-Site	166	671	AB	NA	NA	Miocene Aquifer System	NA
MSC100000048700	MS	On-Site	168	466	IN	18	NA	Miocene Aquifer System	29343
MSP300000000962	MS	On-Site	168	466	IN	NA	NA	Miocene Aquifer System	NA
MSP300000000957	MS	On-Site	184	687	IN	NA	NA	Miocene Aquifer System	NA
MSC100000048469	MS	On-Site	184	687	Not Renewe	10	NA	Miocene Aquifer System	23986
MSPR30000014908	MS	Half-Mile	136	94	NA	NA	NA	NA	NA
USGS2404573		Half-Mile	136	94	NA	NA	NA	Hattiesburg Formation	1971
MSC100000049200	MS	Half-Mile	136	94	Domestic	2	NA	Hattiesburg Formation	1971
MSP300000000987	MS	Half-Mile	139	NA	IN	NA	NA	NA	NA
MSC100000049139	MS	Half-Mile	142	91	IN	4	NA	Hattiesburg Formation	38670
MSC100000049137	MS	Half-Mile	142	91	IN	4	20	Hattiesburg Formation	38670
MSC100000049138	MS	Half-Mile	142	92	IN	4	20	NA	38668
USGS2404666		Half-Mile	153	422	NA	NA	NA	Catahoula Formation, Upper	NA
MSP300000000970	MS	Half-Mile	153	422	IN	NA	NA	Miocene Aquifer System	NA
MSC100000049015	MS	Half-Mile	153	422	NA	6	NA	Miocene Aquifer System	25030
MSC100000049003	MS	Half-Mile	155	265	IN	4	NA	Hattiesburg Formation	34073
USGS2404656	NA	Half-Mile	155	265	NA	NA	NA	NA	34073
MSC100000048829	MS	Half-Mile	158	138	Domestic	2	NA	Hattiesburg Formation	20821
USGS2404628	NA	Half-Mile	158	138	NA	NA	NA	Hattiesburg Formation	20821
MSPR30000014728	MS	Half-Mile	158	138	NA	NA	NA	122HBRG	NA

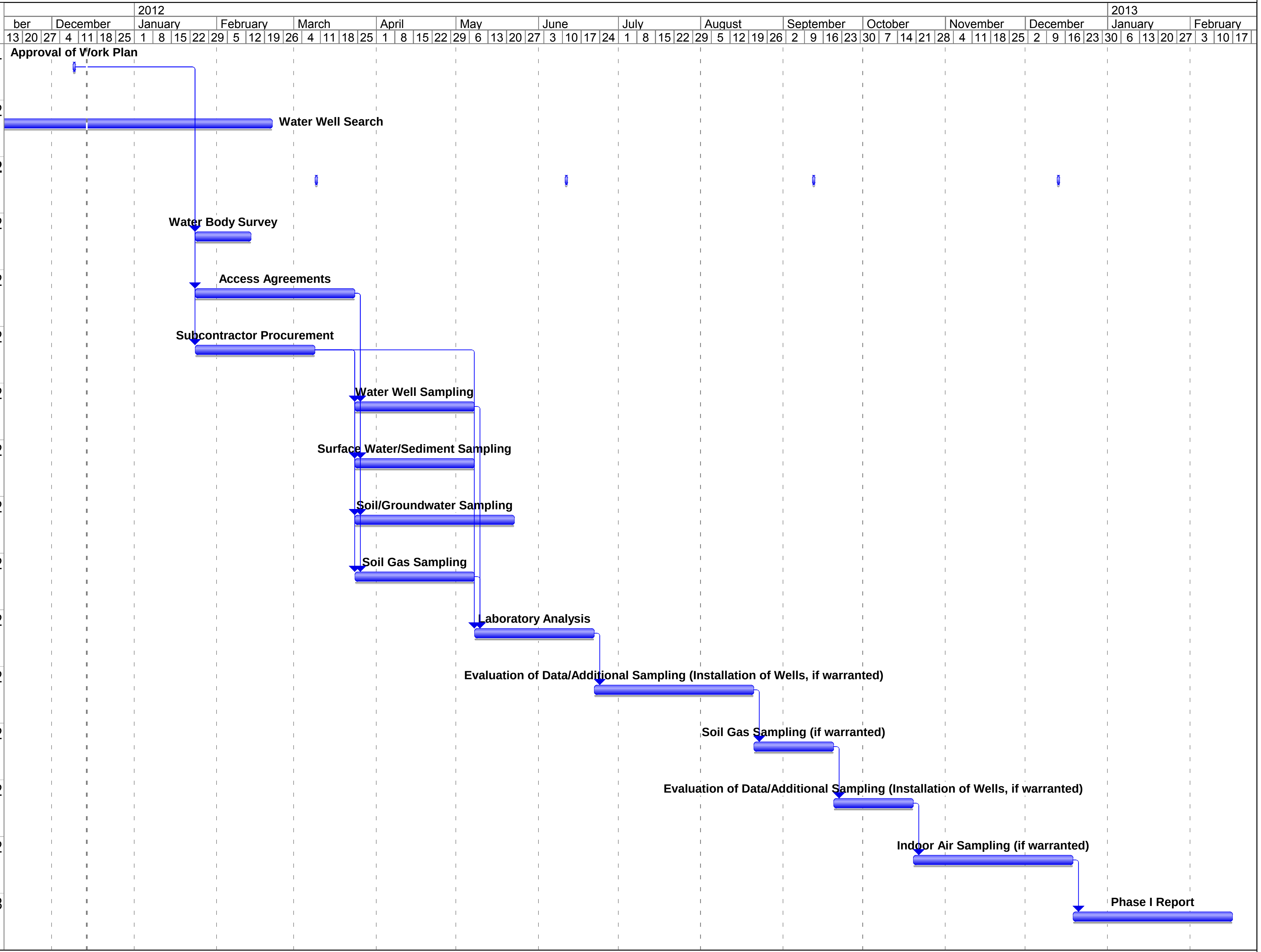
Table 5. Wells Listed in EDR Database Within Half-Mile of the Site, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi.

SITE ID	STATE	LOCATION	MAP ID	WELL DEPTH	TYPE	DIAMETER	SCREEN LENGTH	AQUIFER	DATE CONSTRUCTED
MSC100000048830	MS	Half-Mile	159	105	IN	4	NA	Alluvial Deposits	24473
USGS2404626	NA	Half-Mile	159	105	NA	NA	NA	Alluvial Deposits	24473
USGS2404625	NA	Half-Mile	159	671	NA	NA	NA	Catahoula Formation, Middle	24473
MSP300000000961	MS	Half-Mile	169	650	IN	NA	NA	Miocene Aquifer System	NA
MSC100000048682	MS	Half-Mile	169	654	IN	20	NA	Middle Catahoula	33402
MSC100000048621	MS	Half-Mile	174	350	Domestic	2	20	NA	29018
MSC100000048622	MS	Half-Mile	175	325	Unused	8	NA	Upper Catahoula	17168
USGS2404579	NA	Half-Mile	175	325	NA	NA	NA	Catahoula Formation, Upper	17168
MSP300000000960	MS	Half-Mile	178	353	AB	NA	NA	Miocene Aquifer System	NA
MSC100000048596	MS	Half-Mile	178	353	AB	8	NA	Miocene Aquifer System	23833
MSC100000048483	MS	Half-Mile	181	501	Unused	8	NA	Upper Catahoula	15707
USGS2404744	NA	Half-Mile	181	501	NA	NA	NA	Catahoula Formation, Upper	15707
USGS2404743	NA	Half-Mile	183	687	NA	NA	NA	Catahoula Formation, Middle	23743
MSC100000048345	MS	Half-Mile	207	576	Domestic	5	NA	Middle Catahoula	19725
MSPR30000014563	MS	Half-Mile	207	576	NA	NA	NA	122CTHLM	NA
USGS2404688	NA	Half-Mile	207	576	NA	NA	NA	Catahoula Formation, Middle	19725

Note:	This table was created by compiling data provided in the June 2, 2011, EDR DataMap^{TM} Well Search Report (Inquiry No. 3078218.1w).
AB	Abandoned.
IN	Industrial.
MS	Mississippi.
NA	Data not available in public database.

Table 6. Preliminary Project Schedule, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi.

ID	Task Name	Duration	Start	Finish
1	Approval of Work Plan	1 day	12/9/2011	12/10/2011
2	Water Well Search	180 days	8/26/2011	2/22/2012
3	**Quarterly Progress Report Period ***	**280 days**	**3/9/2012**	**12/14/2012**
8	Water Body Survey	21 days	1/24/2012	2/14/2012
9	Access Agreements	60 days	1/24/2012	3/24/2012
10	Subcontractor Procurement	45 days	1/24/2012	3/9/2012
11	Water Well Sampling	45 days	3/24/2012	5/8/2012
12	Surface Water/Sediment Sampling	45 days	3/24/2012	5/8/2012
13	Soil/Groundwater Sampling	60 days	3/24/2012	5/23/2012
14	Soil Gas Sampling	45 days	3/24/2012	5/8/2012
15	Laboratory Analysis	45 days	5/8/2012	6/22/2012
16	Evaluation of Data/Additional Sampling (Installation of Wells, if	60 days	6/22/2012	8/21/2012
17	Soil Gas Sampling (if warranted)	30 days	8/21/2012	9/20/2012
18	Evaluation of Data/Additional Sampling (Installation of Wells, if	30 days	9/20/2012	10/20/2012
19	Indoor Air Sampling (if warranted)	60 days	10/20/2012	12/19/2012
20	Phase I Report	60 days	12/19/2012	2/17/2013



* Monthly reports will be submitted during periods of increased activity.

Date: 12/13/11

Task	▬	Progress	▬	Summary	▬	External Tasks	▬	Deadline	⇩
Split	⋯	Milestone	◆	Project Summary	▬	External Milestone	◆		

Note: Additional time may be warranted if additional delineation is necessary. Sampling offsite will be completed once an access agreement is obtained, which may increase the duration of individual tasks.

Table 7. Proposed Surface Water and Sediment Sample Location Rationale, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

Sample Location	Area	Relationship of Flow Direction to Hercules	Rationale
AO-SW-01	Drainage A	Upgradient	Water flowing onto Hercules from Greens Creek.
AO-SD-01			
AO-SW-02	Drainage A	Upgradient	Water flowing onto Hercules from Greens Creek.
AO-SD-02			
AO-SW-03	Drainage A	Upgradient	Water flowing onto Hercules from Greens Creek.
AO-SD-03			
AO-SW-04	Drainage A	Upgradient	Water flowing onto Hercules from Greens Creek.
AO-SD-04			
AO-SW-05	Drainage A	Upgradient	Water flowing onto Hercules from Greens Creek.
AO-SD-05			
AO-SW-06	Drainage A	Downgradient	Greens Creek water flowing to Bouie River from Hercules.
AO-SD-06			
AO-SW-07	Drainage A	Downgradient	Greens Creek water flowing to Bouie River from Hercules.
AO-SD-07			
AO-SW-08	Drainage A	Downgradient	Greens Creek water flowing to Bouie River from Hercules.
AO-SD-08			
AO-SW-09	Drainage A	Downgradient	Greens Creek water flowing to Bouie River from Hercules.
AO-SD-09			

Table 7. Proposed Surface Water and Sediment Sample Location Rationale, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

Sample Location	Area	Relationship of Flow Direction to Hercules	Rationale
AO-SW-10	Drainage A	Downgradient	Greens Creek water flowing to Bouie River from Hercules.
AO-SD-10			
AO-SW-11	Drainage B	Downgradient	Water flowing offsite from Hercules toward Bouie River.
AO-SD-11			
AO-SW-12	Drainage B	Downgradient	Water flowing offsite from Hercules toward Bouie River.
AO-SD-12			
AO-SW-13	Drainage B	Downgradient	Water flowing offsite from Hercules toward Bouie River.
AO-SD-13			
AO-SW-14	Drainage B	Downgradient	Water flowing offsite from Hercules toward Bouie River.
AO-SD-14			
AO-SW-15	Drainage C	Downgradient	Water flowing from Drainage C to Bouie River.
AO-SD-15			
AO-SW-16	Drainage C	Downgradient	Water flowing from Drainage C to Bouie River.
AO-SD-16			
AO-SS-01	Drainage C	Downgradient	Surface soil sample over culverted storm water drain.
AO-SS-02	Drainage C	Downgradient	Surface soil sample over culverted storm water drain.
AO-SS-03	Drainage C	Downgradient	Surface soil sample over culverted storm water drain.
AO-SS-04	Drainage C	Downgradient	Surface soil sample over culverted storm water drain.

Table 7. Proposed Surface Water and Sediment Sample Location Rationale, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

Sample Location	Area	Relationship of Flow Direction to Hercules	Rationale
AO-SS-05	Drainage C	Downgradient	Surface soil sample over culverted storm water drain.
AO-SS-06	Drainage C	Downgradient	Surface soil sample over culverted storm water drain.
AO-SS-07	Drainage C	Downgradient	Surface soil sample over culverted storm water drain.
AO-SS-08	Drainage C	Downgradient	Surface soil sample over culverted storm water drain.

Table 8. Proposed Groundwater and Soil Sample Location Rationale, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

Sample Location	Area	Rationale
AO-GP-01	Northwestern Property Boundary near the Sludge Pits	Establish conditions near the property boundary adjacent to off-site residences.
AO-GP-03	Southwestern Property Boundary near Zeon Chemicals and the Cemetery.	Establish conditions near the property boundary adjacent to Zeon Chemicals.
AO-GP-04	Southwestern Property Boundary near Zeon Chemicals and the Cemetery.	Establish conditions near the property boundary adjacent to cemetery.
AO-GP-19	Southeast Corner of Hercules near Providence Street and 9th Street.	Establish conditions near Providence Street property boundary in an area downgradient of groundwater flow.
AO-GP-20	Southern Property Boundary near 7th Street.	Establish conditions near 7th Street property boundary in an area downgradient of groundwater flow.
AO-GP-21	Southeast Corner of Hercules near Providence Street.	Establish conditions south of 7th Street property boundary in an area downgradient of groundwater flow.
AO-GP-22	Southeast Corner of Hercules near Providence Street.	Establish conditions near 7th Street property boundary in an area downgradient of groundwater flow.
AO-GP-23	Southeast Corner of Hercules near Providence Street and 7th Street.	Establish conditions near 7th Street property boundary in an area downgradient of groundwater flow.
AO-GP-24	Southeast Corner of Hercules near Providence Street and 7th Street.	Establish conditions near the corner of 7th Street and Providence Street property boundaries in an area downgradient of groundwater flow.
AO-GP-25	Southeast Corner of Hercules near Providence Street and 7th Street.	Establish conditions near Providence Street property boundary in an area downgradient of groundwater flow.
AO-GP-26	Southeast Corner of Hercules near Providence Street and 7th Street.	Establish conditions near Providence Street property boundary in an area downgradient of groundwater flow.
AO-GP-27	Western Property Boundary near Greens Creek Entrance onto Hercules.	Establish conditions near western property boundary.
AO-GP-28	Offsite near Southeastern Property Boundary near Providence Street.	Establish off-site conditions near Providence Street property boundary in an area downgradient of groundwater flow.

Table 8. Proposed Groundwater and Soil Sample Location Rationale, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

Sample Location	Area	Rationale
AO-GP-29	Offsite near Southeastern Property Boundary near Providence Street.	Establish off-site conditions near Providence Street property boundary in an area downgradient of groundwater flow.
AO-GP-30	Southeast Corner of Hercules near Providence Street	Establish conditions near Providence Street property boundary in an area downgradient of groundwater flow.
AO-GP-31	Northeast Corner of Hercules near Providence Street	Establish conditions near Providence Street property boundary in an area downgradient of groundwater flow.
AO-GP-32	Northern Property Boundary near North Main Street	Establish conditions near North Main Street property boundary near Greens Creek.
AO-GP-33	Northern Property Boundary near North Main Street	Establish conditions near North Main Street property boundary in an area upgradient of groundwater flow.

Table 9. Calculation of Groundwater to Indoor Air Screening Levels, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

Constituent	Parameter	Indoor Air Concentration[a]	Conversion Factor	Henry's Law Constant	Attenuation Factor	Groundwater to Indoor Air Screening Level	Maximum Contaminant Level
	Symbol	(Cia)	(CF)	(HLC)	(AF)	--	(MCL)
	Units	μg/m^3	m^3/L	unitless	unitless	μg/L	μg/L
	Source	USEPA RSL table	By definition	USEPA RSL table	Default value (USEPA 2002)	Calculation	USEPA RSL table
Benzene		0.31	0.001	0.23	0.001	1.37	5
Chloroform		0.11	0.001	0.15	0.001	0.73	80
Carbon Tetrachloride		0.41	0.001	1.13	0.001	0.36	5
Chlorobenzene		52	0.001	0.13	0.001	409	100
1,2-DCA		0.094	0.001	0.05	0.001	1.9	5
Toluene		5,200	0.001	0.27	0.001	19,155	1,000
Acetone		32,000	0.001	0.0014	0.001	22,857,143	NA
1,1-Dichloroethene		210	0.001	0.23	0.001	913	NA
Ethylbenzene		0.97	0.001	0.32	0.001	3.0	700
Xylenes		100	0.001	0.21	0.001	476	10,000
Methylene Chloride		5.2	0.001	0.13	0.001	40	5
Methyl Isobutyl Ketone		3,100	0.001	0.0056	0.001	553,571	NA

Notes:

(a) Residential indoor air Regional Screening Level at 1 x 10-6 risk or noncancer hazard = 1.0.

Groundwater screening levels protective of indoor air.

Groundwater to Indoor Air Screening Level = Cia x CF x 1/HLC * 1/AF.

RSL	Regional Screening Level.
USEPA	U.S. Environmental Protection Agency
m^3/L	Cubic meters per liter.
ug/L	Micrograms per liter.
μg/m^3	Micrograms per cubic meter.

Table 10. Results of Initial Groundwater Screening, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

Location	**Groundwater to Indoor Air Screening Level(a)**	MW-02	MW-02	MW-02	MW-02	MW-03	MW-03	MW-03	MW-03	MW-04	MW-04
Date		May-09	Dec-09	May-10	Nov-10	May-09	Dec-09	May-10	Nov-10	May-09	Dec-09
DTW Nov 2010		7.89	7.89	7.89	7.89	9.19	9.19	9.19	9.19	12.04	12.04
Acetone	22,857,143	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
Benzene	1.4	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chlorobenzene	409	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbon Tetrachloride	0.36	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chloroform	0.73	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,2-Dichloroethane	1.9	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,1-Dichloroethene	913	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ethylbenzene	3.0	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	19,155	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total Xylenes	476	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Methylene Chloride	40	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Methyl Isobutyl Ketone	553,571	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

Notes:

(a) Groundwater (GW) to Indoor air (IA) Screening Levels (Cgw) = Residential RSL x CF x 1/HLC x 1/AF.

RSL = Regional Screening Level (residential indoor air at 1 x 10-6 risk or noncancer hazard = 1.0).

CF = conversion factor (0.001 m^3/L).

HLC = Henry's Law Constant (unitless and constituent-specific).

AF = attenuation factor (0.001).

DTW = Depth to groundwater.

ug/L = micrograms per liter.

m^3/L = cubic meters per liter.

µg/m^3 = micrograms per cubic meter

< indicates that the concentration of the analyte is less than the value shown.

▨ Shaded cells exceed the screening value for the 1x10-6 risk level or hazard of 1.

Table 10. Results of Initial Groundwater Screening, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

Location **Date** **DTW Nov 2010**	**Groundwater to Indoor Air Screening Level**[(a)]	MW-04 May-10 12.04	MW-04 Dec-10 12.04	MW-05 May-09 11.79	MW-05 Dec-09 11.79	MW-05 May-10 11.79	MW-05 Dec-10 11.79	MW-06 May-09 10.72	MW-06 Dec-09 10.72	MW-06 May-10 10.72	MW-06 Dec-10 10.72
Acetone	22,857,143	<25	<25	<25	<25	<25	27	<25	<25	<25	<25
Benzene	1.4	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chlorobenzene	409	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbon Tetrachloride	0.36	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chloroform	0.73	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,2-Dichloroethane	1.9	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,1-Dichloroethene	913	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ethylbenzene	3.0	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	19,155	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total Xylenes	476	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Methylene Chloride	40	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Methyl Isobutyl Ketone	553,571	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

Notes:

(a) Groundwater (GW) to Indoor air (IA) Screening Levels (Cgw) = Residential RSL x CF x 1/HLC x 1/AF.

RSL = Regional Screening Level (residential indoor air at 1 x 10-6 risk or noncancer hazard = 1.0).

CF = conversion factor (0.001 m^3/L).

HLC = Henry's Law Constant (unitless and constituent-specific).

AF = attenuation factor (0.001).

DTW = Depth to groundwater.

ug/L = micrograms per liter.

m^3/L = cubic meters per liter.

$\mu g/m^3$ = micrograms per cubic meter

< indicates that the concentration of the analyte is less than the value shown.

▨ Shaded cells exceed the screening value for the 1x10-6 risk level or hazard of 1.

Table 10. Results of Initial Groundwater Screening, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

Location	**Groundwater to Indoor Air Screening Level(a)**	MW-07	MW-07	MW-07	MW-07	MW-08	MW-08	MW-08	MW-08	MW-09	MW-09
Date		May-09	Dec-09	May-10	Dec-10	May-09	Dec-09	May-10	Dec-10	May-09	Dec-09
DTW Nov 2010		15.95	15.95	15.95	15.95	16.10	16.10	16.10	16.10	13.81	13.81
Acetone	22,857,143	<25	<25	<25	<25	<620	<620	<250	<1,200	<25	210
Benzene	1.4	<1	<1	<1	<1	**540**	<1000	**2,900**	**6,000**	1.1	1.6
Chlorobenzene	409	<1	<1	<1	<1	110	180	180	150	<1	<1
Carbon Tetrachloride	0.36	<1	<1	<1	<1	**2,300**	**2,700**	**8,000**	**1,000**	<1	<1
Chloroform	0.73	<1	<1	<1	<1	**1,300**	**610**	**1,400**	**300**	<1	<1
1,2-Dichloroethane	1.9	<1	<1	<1	<1	<25	<25	63	<50	<1	<1
1,1-Dichloroethene	913	<1	<1	<1	<1	<25	<25	<10	<50	<1	<1
Ethylbenzene	3.0	<1	<1	<1	<1	<25	68	22	74	<1	<1
Toluene	19,155	<1	<1	<1	<1	<25	43	10	<50	<1	<1
Total Xylenes	476	<2	<2	<2	<2	<25	95	<20	<100	<2	<2
Methylene Chloride	40	<5	<5	<5	<5	<125	380	230	560	<5	<5
Methyl Isobutyl Ketone	553,571	<10	<10	<10	<10	<250	<250	<100	<500	<10	<10

Notes:

(a) Groundwater (GW) to Indoor air (IA) Screening Levels (Cgw) = Residential RSL x CF x 1/HLC x 1/AF.

RSL = Regional Screening Level (residential indoor air at 1 x 10-6 risk or noncancer hazard = 1.0).

CF = conversion factor (0.001 m^3/L).

HLC = Henry's Law Constant (unitless and constituent-specific).

AF = attenuation factor (0.001).

DTW = Depth to groundwater.

ug/L = micrograms per liter.

m^3/L = cubic meters per liter.

$\mu g/m^3$ = micrograms per cubic meter

< indicates that the concentration of the analyte is less than the value shown.

■ Shaded cells exceed the screening value for the 1x10-6 risk level or hazard of 1.

Table 10. Results of Initial Groundwater Screening, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

Location	**Groundwater to Indoor Air Screening Level(a)**	MW-09	MW-09	MW-10	MW-10	MW-10	MW-10	MW-11	MW-11	MW-11	MW-11
Date		May-10	Dec-10	May-09	Dec-09	May-10	Dec-10	May-09	Dec-09	May-10	Dec-10
DTW Nov 2010		13.81	13.81	12.63	12.63	12.63	12.63	9.33	9.33	9.33	9.33
Acetone	22,857,143	<25	<25	<25	<25	<25	<25	42	<25	<25	<25
Benzene	1.4	<1	3	<1	<1	<1	<1	<1	<1	<1	<1
Chlorobenzene	409	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbon Tetrachloride	0.36	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chloroform	0.73	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,2-Dichloroethane	1.9	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,1-Dichloroethene	913	<1	1.3	<1	<1	<1	<1	<1	<1	<1	<1
Ethylbenzene	3.0	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	19,155	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total Xylenes	476	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Methylene Chloride	40	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Methyl Isobutyl Ketone	553,571	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

Notes:

(a) Groundwater (GW) to Indoor air (IA) Screening Levels (Cgw) = Residential RSL x CF x 1/HLC x 1/AF.

RSL = Regional Screening Level (residential indoor air at 1 x 10-6 risk or noncancer hazard = 1.0).

CF = conversion factor (0.001 m^3/L).

HLC = Henry's Law Constant (unitless and constituent-specific).

AF = attenuation factor (0.001).

DTW = Depth to groundwater.

ug/L = micrograms per liter.

m^3/L = cubic meters per liter.

μg/m^3 = micrograms per cubic meter

< indicates that the concentration of the analyte is less than the value shown.

▨ Shaded cells exceed the screening value for the 1x10-6 risk level or hazard of 1.

Table 10. Results of Initial Groundwater Screening, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

Location	**Groundwater to Indoor Air Screening Level(a)**	MW-12	MW-12	MW-12	MW-12	MW-13	MW-13	MW-13	MW-13	MW-14	MW-14
Date		May-09	Dec-09	May-10	Dec-10	May-09	Dec-09	May-10	Dec-10	May-09	Dec-09
DTW Nov 2010		9.99	9.99	9.99	9.99	10.86	10.86	10.86	10.86	14.94	14.94
Acetone	22,857,143	28	<25	<25	<25	<620	<620	<500	<250	260	<25
Benzene	1.4	<1	<1	<1	<1	**1,200**	**790**	**2,600**	**530**	<2	<1
Chlorobenzene	409	<1	<1	<1	<1	<25	29	110	25	<2	<1
Carbon Tetrachloride	0.36	<1	<1	<1	<1	**3,500**	**2,000**	**4,000**	**970**	<2	<1
Chloroform	0.73	<1	<1	<1	<1	**340**	**310**	**1,900**	**230**	<2	<1
1,2-Dichloroethane	1.9	<1	<1	<1	<1	<25	<25	<20	<10	<2	<1
1,1-Dichloroethene	913	<1	<1	<1	<1	<25	<25	<20	<10	<2	<1
Ethylbenzene	3.0	<1	<1	<1	<1	<25	<25	<20	<10	<2	<1
Toluene	19,155	<1	<1	<1	<1	<25	<25	<20	<10	<2	<1
Total Xylenes	476	<2	<2	<2	<2	<25	<50	<40	<20	<4	<2
Methylene Chloride	40	<5	<5	<5	<5	<125	<120	<100	<50	<10	<5
Methyl Isobutyl Ketone	553,571	<10	<10	<10	<10	<250	<250	<200	<100	<20	<10

Notes:

(a) Groundwater (GW) to Indoor air (IA) Screening Levels (Cgw) = Residential RSL x CF x 1/HLC x 1/AF.

RSL = Regional Screening Level (residential indoor air at 1 x 10-6 risk or noncancer hazard = 1.0).

CF = conversion factor (0.001 m^3/L).

HLC = Henry's Law Constant (unitless and constituent-specific).

AF = attenuation factor (0.001).

DTW = Depth to groundwater.

ug/L = micrograms per liter.

m^3/L = cubic meters per liter.

µg/m^3 = micrograms per cubic meter

< indicates that the concentration of the analyte is less than the value shown.

▨ Shaded cells exceed the screening value for the 1x10-6 risk level or hazard of 1.

Table 10. Results of Initial Groundwater Screening, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

Location **Date** **DTW Nov 2010**	**Groundwater to Indoor Air Screening Level**[(a)]	MW-14 May-10 14.94	MW-14 Dec-10 14.94	MW-15 May-09 17.41	MW-15 Dec-09 17.41	MW-15 May-10 17.41	MW-15 Dec-10 17.41	MW-16 May-09 17.99	MW-16 Dec-09 17.99	MW-16 May-10 17.99	MW-16 Dec-10 17.99
Acetone	22,857,143	<25	<25	1,300	<25	<25	<25	<25	<25	<25	<25
Benzene	1.4	<1	<1	<5	<1	<1	<1	<1	<1	1.1	<1
Chlorobenzene	409	<1	<1	<5	<1	<1	<1	<1	<1	<1	<1
Carbon Tetrachloride	0.36	<1	<1	<5	<1	<1	<1	<1	<1	<1	<1
Chloroform	0.73	<1	<1	<5	<1	<1	<1	<1	<1	1.3	<1
1,2-Dichloroethane	1.9	<1	<1	<5	<1	<1	<1	<1	<1	<1	<1
1,1-Dichloroethene	913	<1	<1	<5	<1	<1	<1	<1	<1	<1	<1
Ethylbenzene	3.0	<1	<1	<5	<1	<1	<1	<1	<1	<1	<1
Toluene	19,155	<1	<1	<5	<1	<1	<1	<1	<1	3.5	<1
Total Xylenes	476	<2	<2	<10	<2	<2	<2	<2	<2	<2	<2
Methylene Chloride	40	<5	<5	<25	<5	<5	<5	<5	<5	<5	<5
Methyl Isobutyl Ketone	553,571	<10	<10	<50	<10	<10	<10	<10	<10	<10	<10

Notes:

(a) Groundwater (GW) to Indoor air (IA) Screening Levels (Cgw) = Residential RSL x CF x 1/HLC x 1/AF.

RSL = Regional Screening Level (residential indoor air at 1 x 10-6 risk or noncancer hazard = 1.0).

CF = conversion factor (0.001 m^3/L).

HLC = Henry's Law Constant (unitless and constituent-specific).

AF = attenuation factor (0.001).

DTW = Depth to groundwater.

ug/L = micrograms per liter.

m^3/L = cubic meters per liter.

µg/m^3 = micrograms per cubic meter

< indicates that the concentration of the analyte is less than the value shown.

▨ Shaded cells exceed the screening value for the 1x10-6 risk level or hazard of 1.

Table 10. Results of Initial Groundwater Screening, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

Location	**Groundwater to Indoor Air Screening Level$^{(a)}$**	MW-17	MW-17	MW-17	MW-17	MW-18	MW-18	MW-18	MW-18	MW-19	MW-19
Date		May-09	Dec-09	May-10	Dec-10	May-09	Dec-09	May-10	Dec-10	May-09	Dec-09
DTW Nov 2010		19.21	19.21	19.21	19.21	7.11	7.11	7.11	7.11	12.17	12.17
Acetone	22,857,143	<5,000	<12,000	<2,500	<12,000	<25	<25	<25	<25	<25	<25
Benzene	1.4	**8,100**	**4,500**	**7,500**	<500	<1	<1	1.1	<1	65	64
Chlorobenzene	409	**640**	**1,200**	**740**	**760**	24	21	20	18	14	12
Carbon Tetrachloride	0.36	**39,000**	**54,000**	**40,000**	**32,000**	<1	<1	<1	<1	11	4.5
Chloroform	0.73	**2,900**	**7,100**	**8,400**	**5,900**	<1	<1	<1	<1	4.7	2.9
1,2-Dichloroethane	1.9	<200	<500	<100	<500	<1	<1	<1	<1	<1	<1
1,1-Dichloroethene	913	<200	<500	<100	<500	<1	<1	1	<1	1.3	<1
Ethylbenzene	3.0	<200	<500	230	<500	<1	<1	<1	<1	2	2.4
Toluene	19,155	<200	<500	520	<500	<1	<1	<1	<1	2.7	2.4
Total Xylenes	476	<400	<1,000	**830**	<1,000	<2	<2	<2	<2	<2	2.2
Methylene Chloride	40	<1,000	<2,500	660	<2,500	<5	<5	<5	<5	<5	<5
Methyl Isobutyl Ketone	553,571	<2,000	<5,000	<1,000	<5,000	<10	<10	<10	<10	<10	<10

Notes:

(a) Groundwater (GW) to Indoor air (IA) Screening Levels (Cgw) = Residential RSL x CF x 1/HLC x 1/AF.

RSL = Regional Screening Level (residential indoor air at 1 x 10-6 risk or noncancer hazard = 1.0).

CF = conversion factor (0.001 m^3/L).

HLC = Henry's Law Constant (unitless and constituent-specific).

AF = attenuation factor (0.001).

DTW = Depth to groundwater.

ug/L = micrograms per liter.

m^3/L = cubic meters per liter.

µg/m^3 = micrograms per cubic meter

< indicates that the concentration of the analyte is less than the value shown.

▨ Shaded cells exceed the screening value for the 1x10-6 risk level or hazard of 1.

Table 10. Results of Initial Groundwater Screening, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

Location	**Groundwater to**	MW-19	MW-19	MW-20	MW-20	MW-20	MW-21	MW-21	MW-21	MW-22	MW-22
Date	**Indoor Air**	May-10	Dec-10	Sep-09	May-10	Dec-10	Sep-09	May-10	Dec-10	Sep-09	May-10
DTW Nov 2010	**Screening Level(a)**	12.17	12.17	7.71	7.71	7.71	4.05	4.05	4.05	7.37	7.37
Acetone	22,857,143	<25	<25	<25	<25	<25	<1,200	<1,200	<1,200	86	<25
Benzene	1.4	52	61	<1	<1	<1	**4,400**	**3,500**	**4,400**	9.8	6.6
Chlorobenzene	409	10	9.1	<1	<1	<1	170	150	180	7.7	4.9
Carbon Tetrachloride	0.36	3.2	<1	<1	<1	<1	<50	**280**	<50	<1	<1
Chloroform	0.73	3.6	2.7	<1	<1	<1	**6,800**	**7,800**	**7,300**	<1	<1
1,2-Dichloroethane	1.9	<1	<1	<1	<1	<1	<50	<50	84	<1	<1
1,1-Dichloroethene	913	1.4	<1	<1	<1	<1	<50	<50	<50	<1	<1
Ethylbenzene	3.0	1.9	2.2	<1	<1	<1	<50	<50	<50	<1	<1
Toluene	19,155	3	2.5	<1	<1	<1	4,800	4,500	4,500	<1	<1
Total Xylenes	476	<2	<2	<2	<2	<2	<100	<100	<100	<2	<2
Methylene Chloride	40	<5	<5	<5	<5	<5	<250	<250	<250	<5	<5
Methyl Isobutyl Ketone	553,571	<10	<10	<10	<10	<10	640	<500	510	<10	<10

Notes:

(a) Groundwater (GW) to Indoor air (IA) Screening Levels (Cgw) = Residential RSL x CF x 1/HLC x 1/AF.

RSL = Regional Screening Level (residential indoor air at 1 x 10-6 risk or noncancer hazard = 1.0).

CF = conversion factor (0.001 m^3/L).

HLC = Henry's Law Constant (unitless and constituent-specific).

AF = attenuation factor (0.001).

DTW = Depth to groundwater.

ug/L = micrograms per liter.

m^3/L = cubic meters per liter.

µg/m^3 = micrograms per cubic meter

< indicates that the concentration of the analyte is less than the value shown.

▨ Shaded cells exceed the screening value for the 1x10-6 risk level or hazard of 1.

Table 10. Results of Initial Groundwater Screening, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

Location	**Groundwater to Indoor Air Screening Level[(a)]**	MW-22	MW-23	MW-23	MW-23	MW-24	MW-24	MW-24
Date		Dec-10	Sep-09	May-10	Dec-10	Sep-09	May-10	Dec-10
DTW Nov 2010		7.37	4.85	4.85	4.85	8.64	8.64	8.64
Acetone	22,857,143	<25	1,600	<2,500	<2,500	<25	<25	<25
Benzene	1.4	6.3	**9,200**	**10,000**	**7,600**	<1	<1	<1
Chlorobenzene	409	2.3	190	180	<100	<1	<1	<1
Carbon Tetrachloride	0.36	<1	<50	<100	<100	<1	<1	<1
Chloroform	0.73	<1	**1,400**	**2,000**	**2,900**	<1	<1	<1
1,2-Dichloroethane	1.9	<1	<50	<100	<100	<1	<1	<1
1,1-Dichloroethene	913	<1	<50	<100	<100	<1	<1	<1
Ethylbenzene	3.0	<1	<50	<100	<100	<1	<1	<1
Toluene	19,155	<1	3,300	3,300	1,400	<1	<1	<1
Total Xylenes	476	<2	<100	<200	<200	<2	<2	<2
Methylene Chloride	40	<5	290	<500	<500	<5	<5	<5
Methyl Isobutyl Ketone	553,571	<10	1,300	1,000	<1,000	<10	<10	<10

Notes:

(a) Groundwater (GW) to Indoor air (IA) Screening Levels (Cgw) = Residential RSL x CF x 1/HLC x 1/AF.

RSL = Regional Screening Level (residential indoor air at 1 x 10-6 risk or noncancer hazard = 1.0).

CF = conversion factor (0.001 m^3/L).

HLC = Henry's Law Constant (unitless and constituent-specific).

AF = attenuation factor (0.001).

DTW = Depth to groundwater.

ug/L = micrograms per liter.

m^3/L = cubic meters per liter.

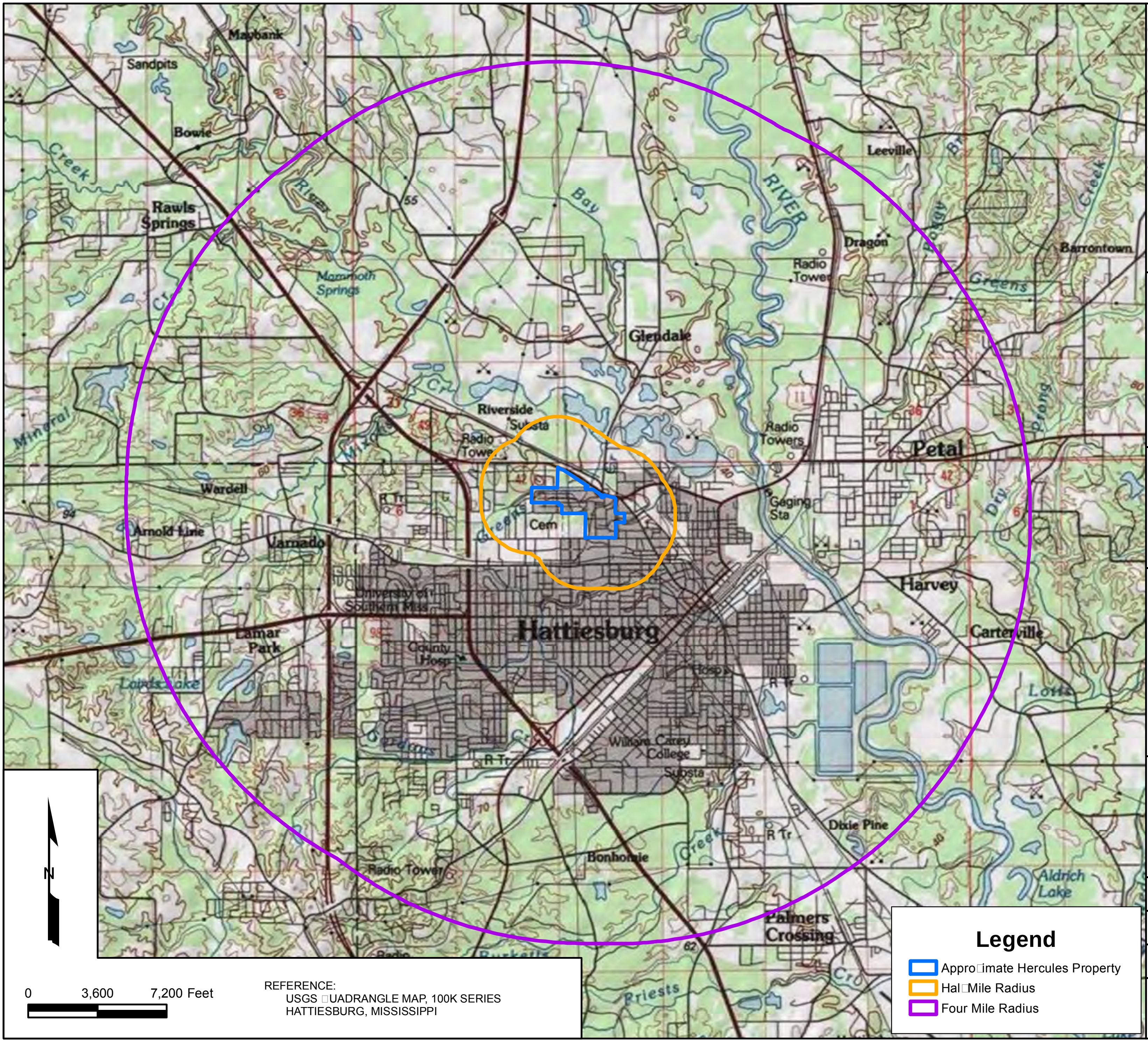
µg/m^3 = micrograms per cubic meter

< indicates that the concentration of the analyte is less than the value shown.

▨ Shaded cells exceed the screening value for the 1x10-6 risk level or hazard of 1.

Table 11. Proposed Soil Gas Sample Location Rationale, Revised Phase I Sampling and Analysis Work Plan, Hercules Incorporated, Hattiesburg, Forrest County, Mississippi.

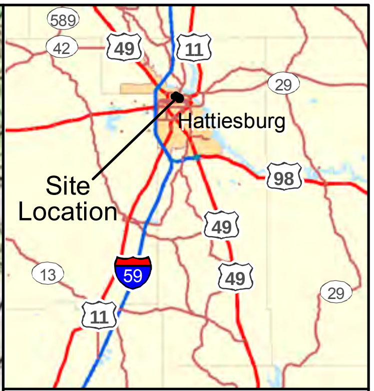
Sample Location	Area	Rationale
AO-SG-01	Southeast Corner of Hercules near Providence Street.	Establish offsite soil gas conditions near eastern boundary of Hercules property near Providence Street.
AO-SG-02	Southeast Corner of Hercules near Providence Street.	Establish offsite soil gas conditions near eastern boundary of Hercules property near Providence Street.
AO-SG-03	Southeast Corner of Hercules near Providence Street.	Establish soil gas conditions near eastern boundary of Hercules property near Providence Street.
AO-SG-04	Southeast Corner of Hercules near Providence Street.	Establish soil gas conditions near eastern boundary of Hercules property near Providence Street.
AO-SG-05	Southeast Corner of Hercules near Providence Street.	Establish soil gas conditions near eastern boundary of Hercules property near Providence Street.



REFERENCE:
USGS QUADRANGLE MAP, 100K SERIES
HATTIESBURG, MISSISSIPPI

Legend

- 🟦 Approximate Hercules Property
- 🟧 Half Mile Radius
- 🟪 Four Mile Radius



SITE LOCATION MAP

Revised Phase I Sampling and Analysis Work Plan

HERCULES INCORPORATED
Hattiesburg, Mississippi

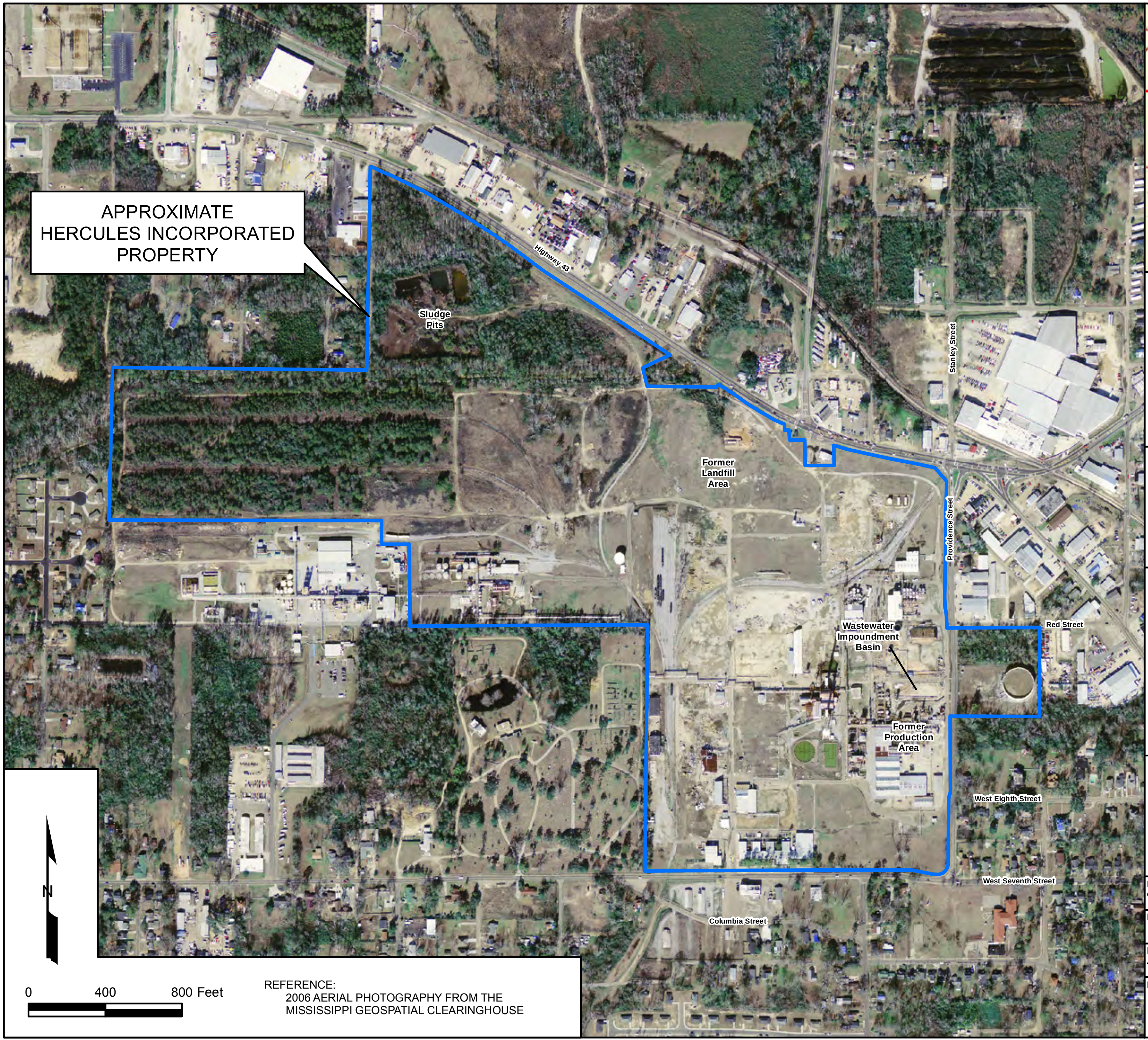
ARCADIS
10352 PLAZA AMERICANA DRIVE
BATON ROUGE, LA 70816
TEL: 225-292-1004
FAX: 225-218-9677
WWW.ARCADIS-US.COM

PROJECT MANAGER: JE	CHECKED BY: CD
DRAWING FILE:	GIS FILE:
DRAWING BY: JEC	DATE: 06/28/2011
PROJECT NUMBER: LA002999.0006	FIGURE NUMBER: 1

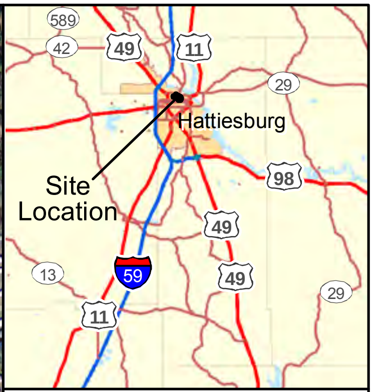
Date Saved: 12/13/2011 2:32:32 PM

Path: U:\projects\ashland\LA002999\ArcMap\LA002999-06\LA002999-0006-0301-01.mxd

U:\projects\ashland\LA002999\output\LA002999-06\LA002999-06-0301-01.pdf



REFERENCE:
2006 AERIAL PHOTOGRAPHY FROM THE MISSISSIPPI GEOSPATIAL CLEARINGHOUSE



SITE LAYOUT MAP

AERIAL

Revised Phase I Sampling and Analysis Work Plan

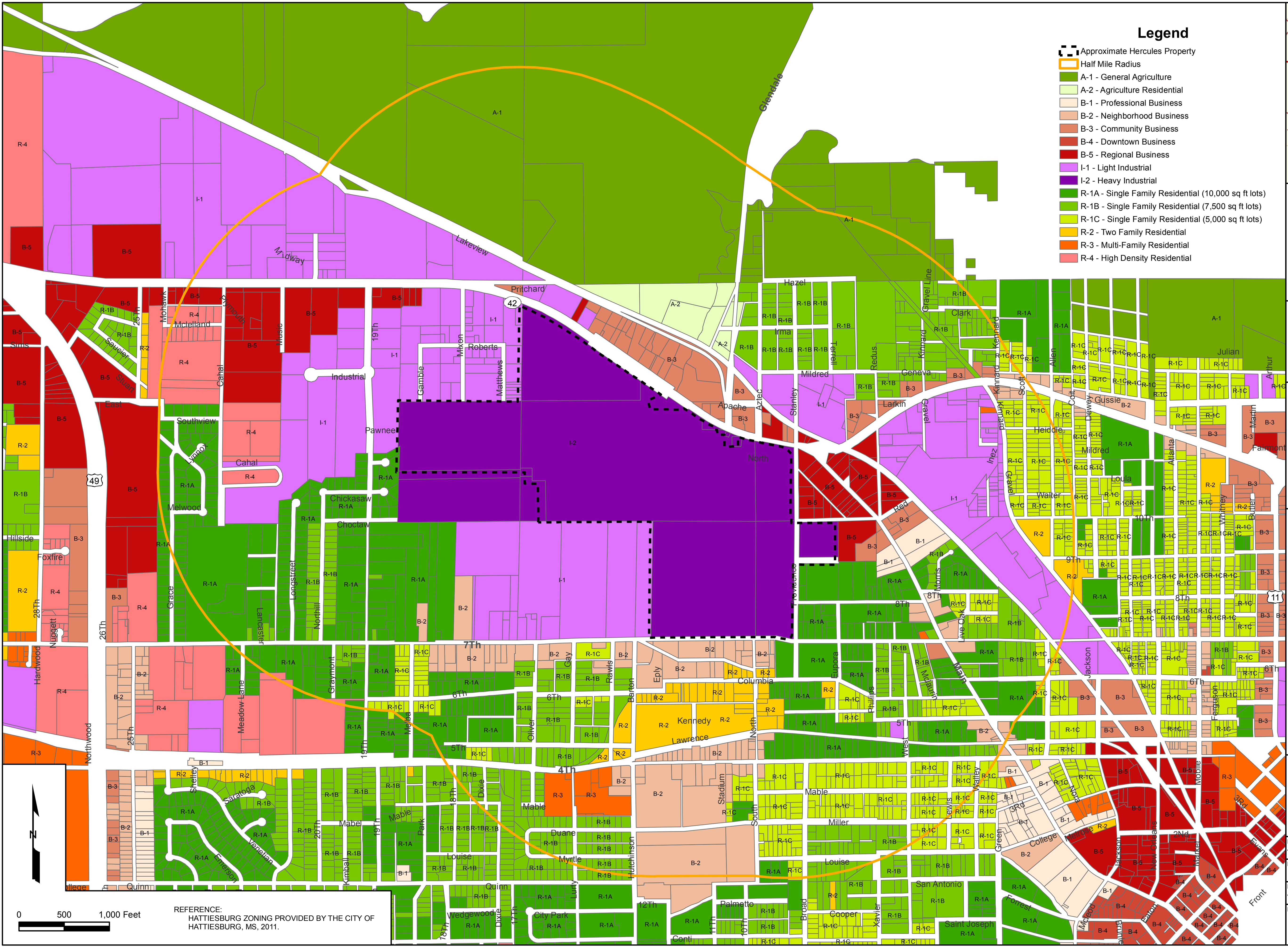
HERCULES INCORPORATED
613 W. 7th Street
Hattiesburg, Mississippi

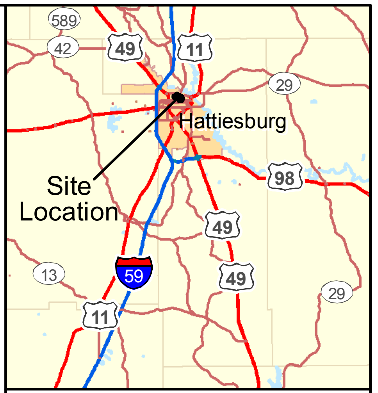
ARCADIS
10352 PLAZA AMERICANA DRIVE
BATON ROUGE, LA 70816
TEL: 225-292-1004
FAX: 225-218-9677
WWW.ARCADIS-US.COM

PROJECT MANAGER: GHC	CHECKED BY: CD
DRAWING FILE:	GIS FILE:
DRAWING BY: JEC	DATE: 07/07/2011
PROJECT NUMBER: LA002999.0006	FIGURE NUMBER: 2

Path: U:\projects\ashland\LA002999\ArcMap\LA002999-06\LA002999-0006-0301-02.mxd Date Saved: 12/13/2011 2:36:49 PM

U:\projects\ashland\LA002999\Output\LA002999-06\LA002999-06-0301-02.pdf





REFERENCE:
HATTIESBURG ZONING PROVIDED BY THE CITY OF HATTIESBURG, MS, 2011.

CITY ZONING MAP

Revised Phase I Sampling and Analysis Work Plan

HERCULES INCORPORATED
613 W. 7th Street
Hattiesburg, Mississippi

ARCADIS
10352 PLAZA AMERICANA DRIVE
BATON ROUGE, LA 70816
TEL: 225-292-1004
FAX: 225-218-9677
WWW.ARCADIS-US.COM

PROJECT MANAGER: JE	CHECKED BY: CD
DRAWING FILE:	GIS FILE:
DRAWING BY: JEC	DATE: 06/28/2011
PROJECT NUMBER: LA002999.0006	FIGURE NUMBER: 3

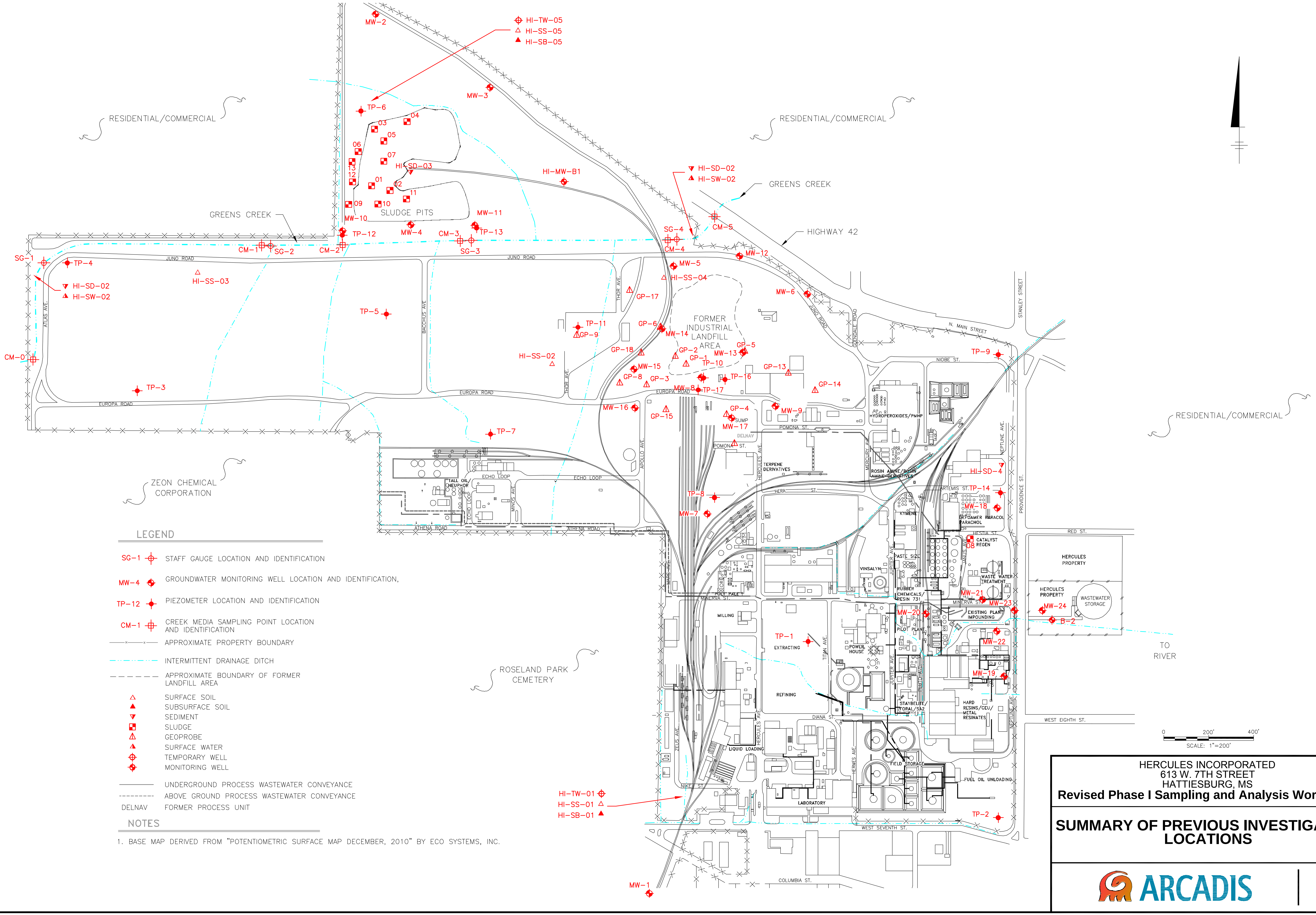
Date Saved: 12/13/2011 2:39:26 PM

Path: U:\projects\ashland\LA002999\ArcMap\LA002999-06\LA002999-0006-0301-03.mxd

U:\projects\ashland\LA002999\output\LA002999-06\LA002999-06-0301-03.pdf

DB: R. PETRIE S. BELL LD: SOTHON MEN PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
G:\APROJECT\Ashland\LA002999.0006\Figures\Final\2999-06-04.dwg LAYOUT: 10SAVED: 11/11/2011 11:10 AM ACADVER: 17.0S (LMS TECH) PAGESETUP: ----PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 12/13/2011 9:35 AM BY: MEN, SOTHON

XREFS: IMAGES: PROJECTNAME: ----
AshlandTitle2
02999X01



NOTES

1. BASE MAP DERIVED FROM "POTENTIOMETRIC SURFACE MAP DECEMBER, 2010" BY ECO SYSTEMS, INC.

HERCULES INCORPORATED
613 W. 7TH STREET
HATTIESBURG, MS
Revised Phase I Sampling and Analysis Work Plan

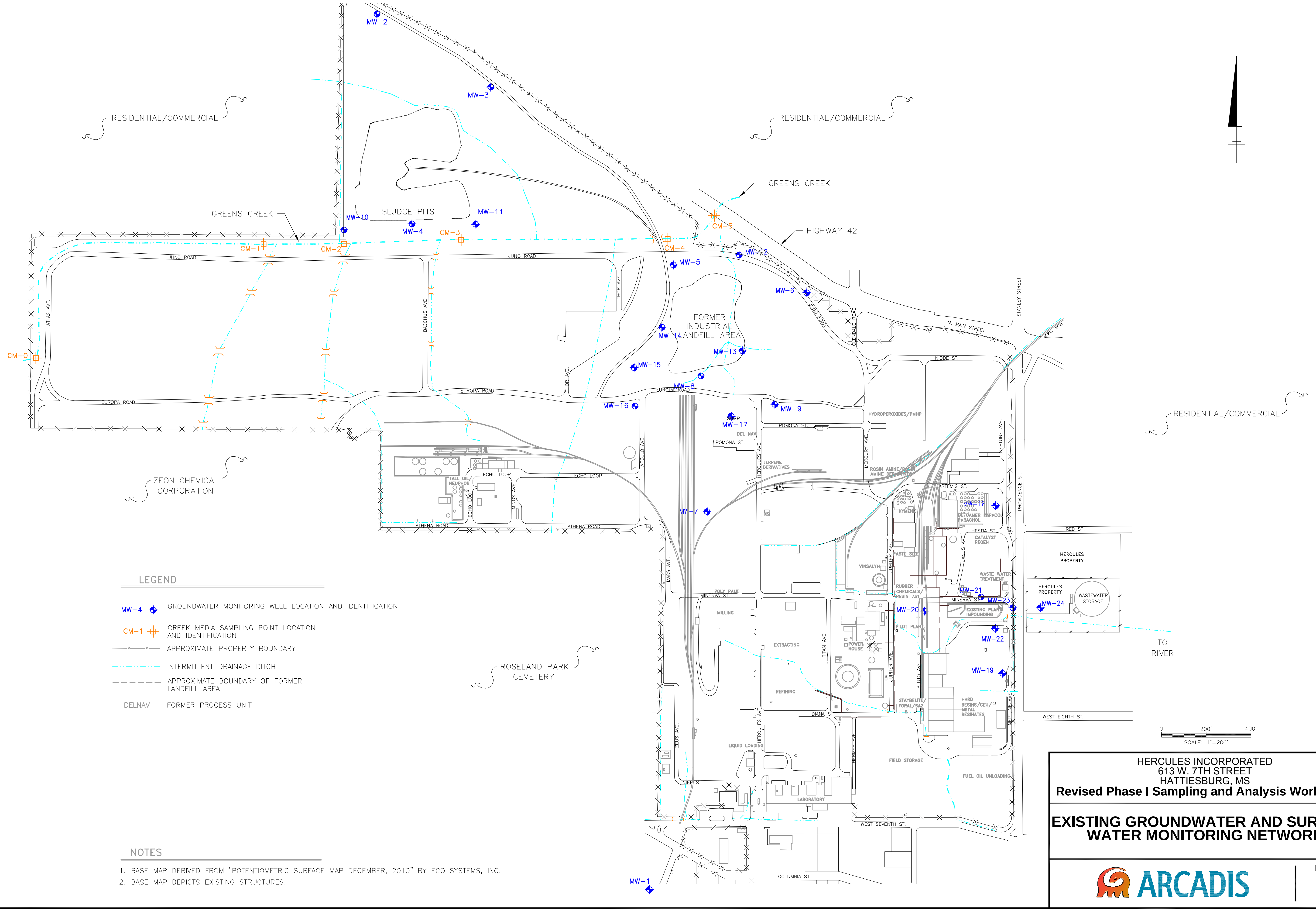
SUMMARY OF PREVIOUS INVESTIGATION LOCATIONS

ARCADIS

FIGURE
4

DB: R. PETRIE S. BELL LD: SOTHON MEN PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
G:\APROJECT\Ashland\LA002999.0006\Figures\Final\2999-06-05.dwg LAYOUT: 5SAVED: 11/11/2011 10:21 AM ACADVER: 17.0S (LMS TECH) PAGESETUP: ----PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 12/13/2011 9:36 AM BY: MEN, SOTHON

XREFS: IMAGES: PROJECTNAME: ----
02999X02
AshlandTitle2



LEGEND

- MW-4 ⯁ GROUNDWATER MONITORING WELL LOCATION AND IDENTIFICATION.
- CM-1 ⌖ CREEK MEDIA SAMPLING POINT LOCATION AND IDENTIFICATION
- —×—×— APPROXIMATE PROPERTY BOUNDARY
- -·-·-·- INTERMITTENT DRAINAGE DITCH
- — — — APPROXIMATE BOUNDARY OF FORMER LANDFILL AREA
- DELNAV FORMER PROCESS UNIT

NOTES

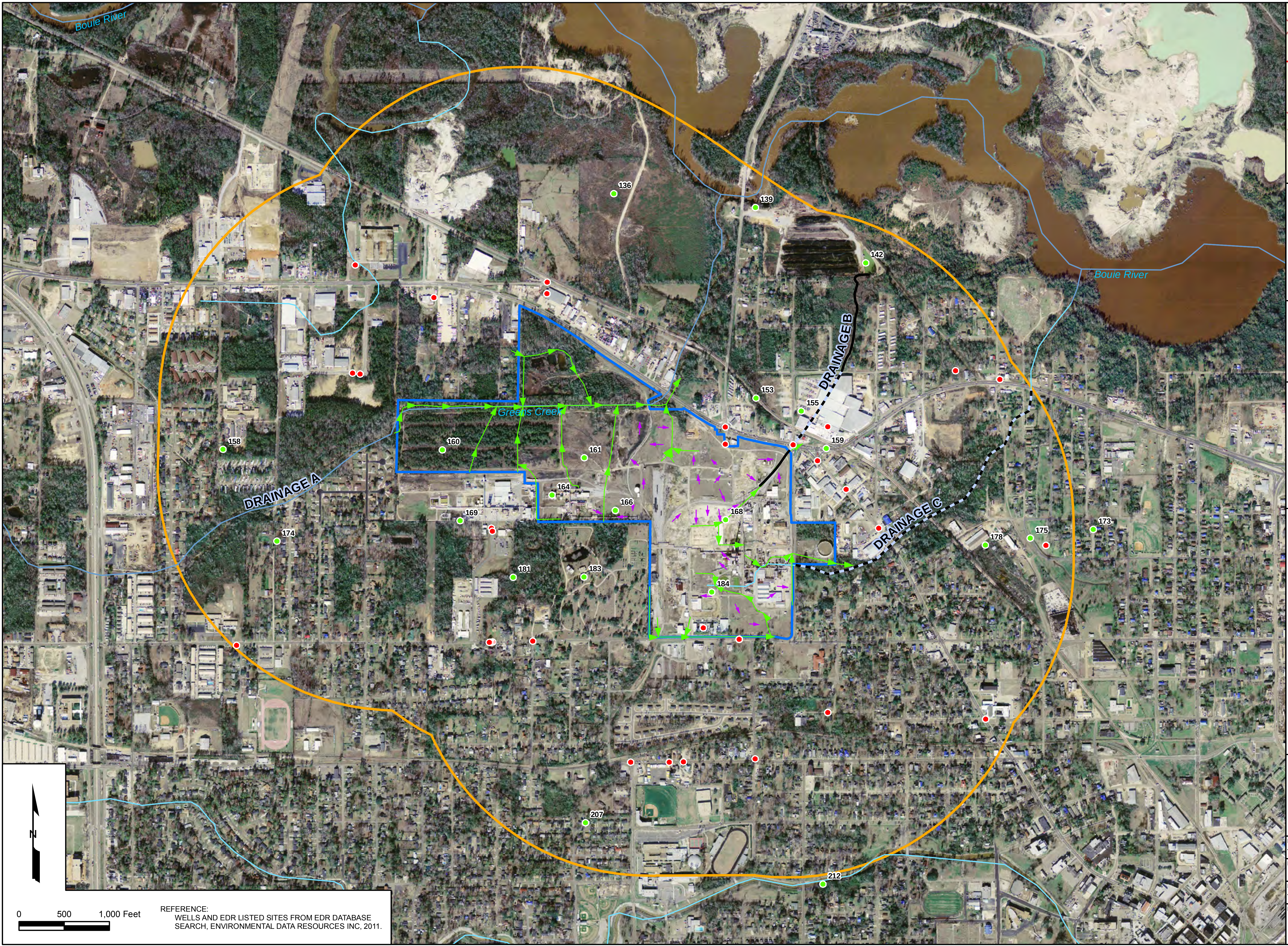
1. BASE MAP DERIVED FROM "POTENTIOMETRIC SURFACE MAP DECEMBER, 2010" BY ECO SYSTEMS, INC.
2. BASE MAP DEPICTS EXISTING STRUCTURES.

HERCULES INCORPORATED
613 W. 7TH STREET
HATTIESBURG, MS
Revised Phase I Sampling and Analysis Work Plan

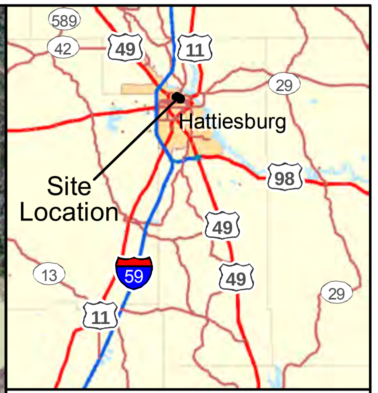
EXISTING GROUNDWATER AND SURFACE WATER MONITORING NETWORK

ARCADIS

FIGURE
5



REFERENCE:
WELLS AND EDR LISTED SITES FROM EDR DATABASE SEARCH, ENVIRONMENTAL DATA RESOURCES INC, 2011.



SURFICIAL DRAINAGE AND WELL LOCATION MAP

Revised Phase I Sampling and Analysis Work Plan

HERCULES INCORPORATED
613 W. 7th Street
Hattiesburg, Mississippi

ARCADIS
10352 PLAZA AMERICANA DRIVE
BATON ROUGE, LA 70816
TEL: 225-292-1004
FAX: 225-218-9677
WWW.ARCADIS-US.COM

Legend

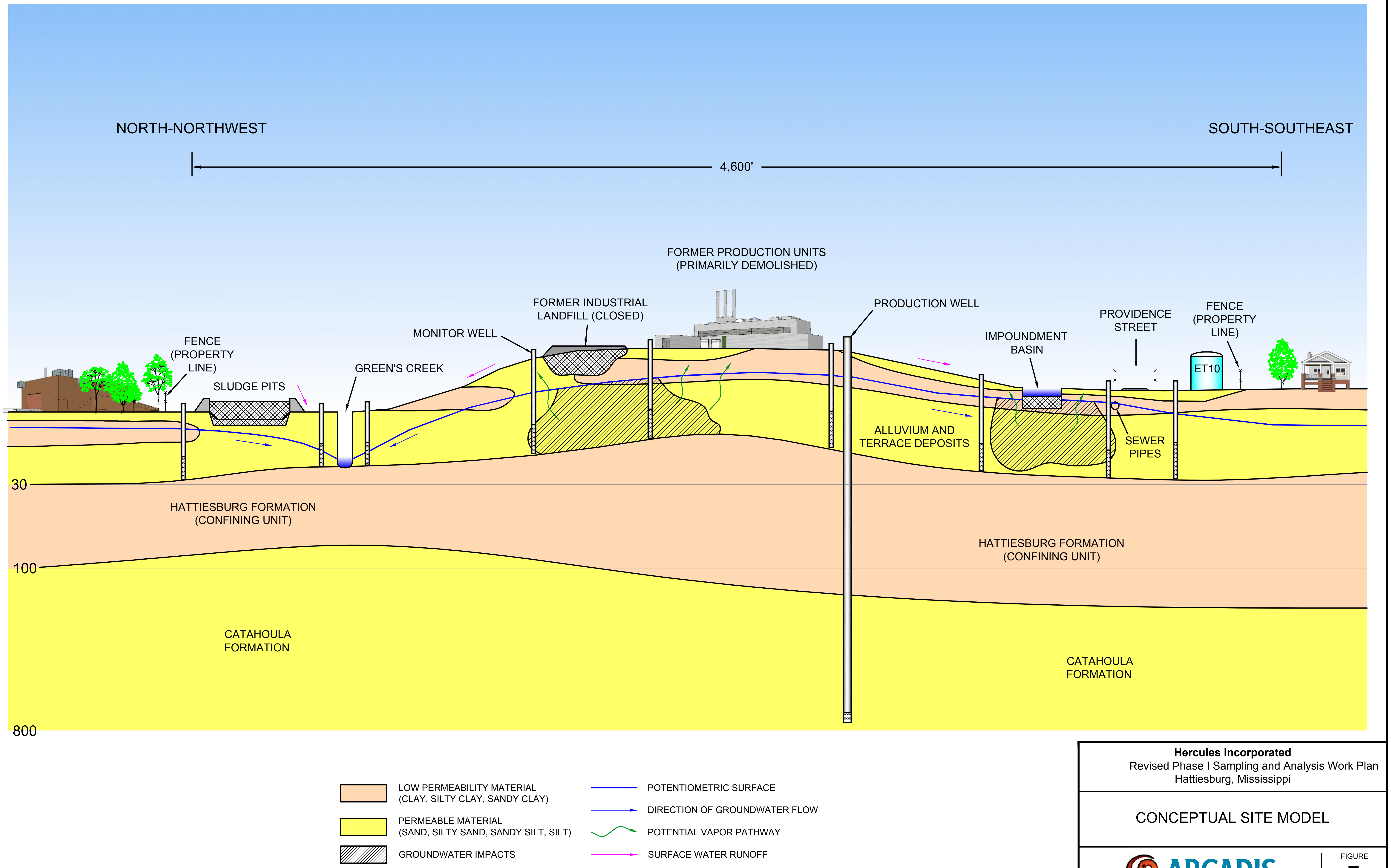
- ● EDR Identified Potential Environmental Site
- ● Wells
- ▬ ▬ Culverted Ditch
- ▬▬ Open Ditch
- → Sheet Flow Direction
- → Water Flow Direction
- ▭ Approximate Hercules Property
- ▭ Half Mile Radius

PROJECT MANAGER: JE	CHECKED BY: CD
DRAWING FILE:	GIS FILE:
DRAWING BY: JEC	DATE: 11/09/2011
PROJECT NUMBER: LA002999.0006	FIGURE NUMBER: 6

Date Saved: 12/13/2011 2:42:08 PM

Path: U:\projects\ashland\LA002999\ArcMap\LA002999-06\LA002999-0006-0301-06.mxd

U:\projects\ashland\LA002999\output\LA002999-06\LA002999-06-0301-06.pdf



Hercules Incorporated
Revised Phase I Sampling and Analysis Work Plan
Hattiesburg, Mississippi

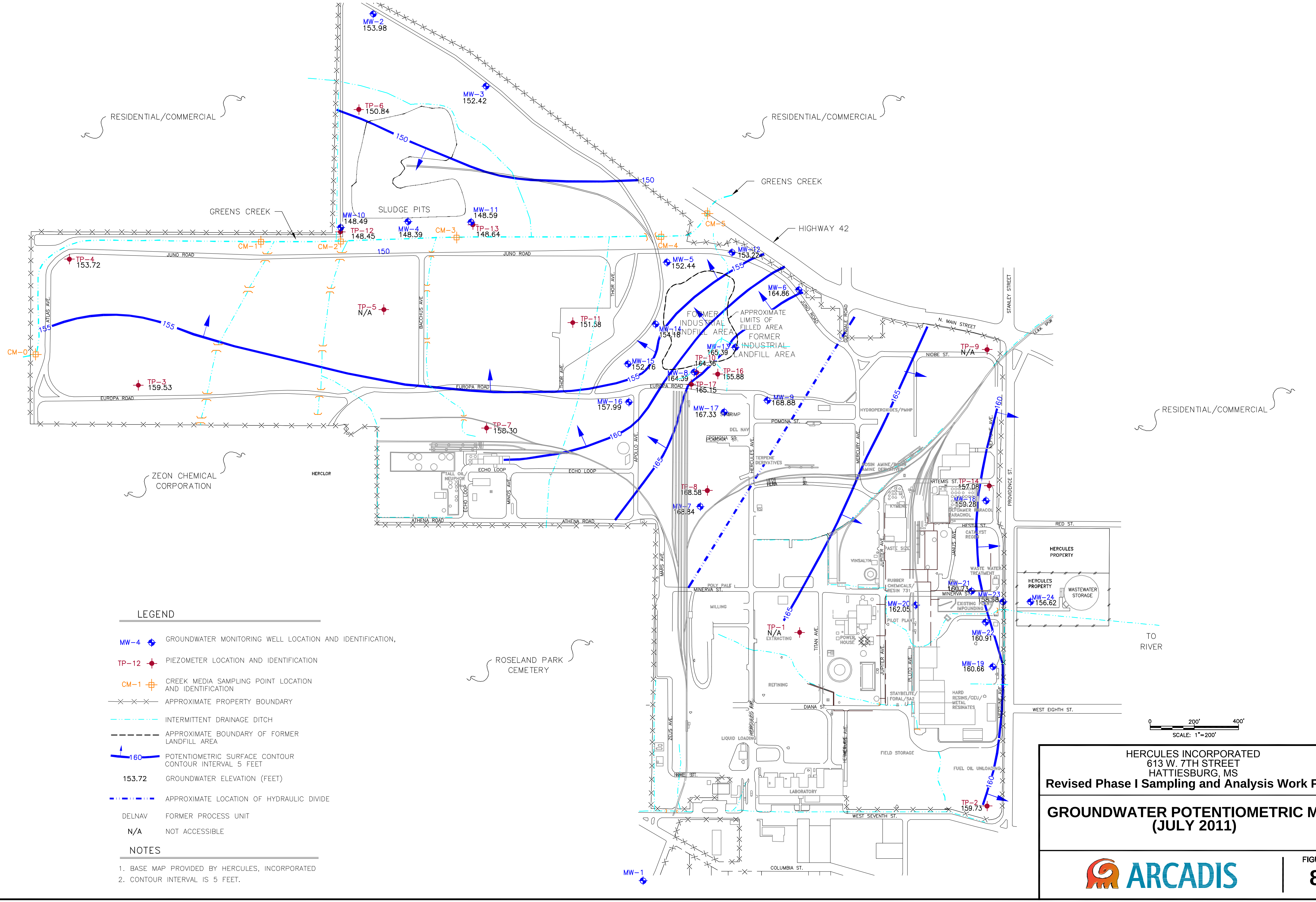
CONCEPTUAL SITE MODEL

ARCADIS

FIGURE
7

CITY:NOVI DIV/GROUP:ENV DB: PIC: PM: TM: TR: PROJECT NUMBER:
C:\Users\tyarbrough\Desktop\GIS\Hercules\Hercules.dwg LAYOUT: MODEL SAVED: 7/13/2011 11:15 PM ACADVER: 18.0S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ARCADIS NOVI.CTB PLOTTED: 9/14/2011 4:24 PM BY: YARBROUGH, TOBI

CITY: SYRACUSE, NY DIV/GROUP: ENVCAD DB: R. PETRIE S. BELL LD: S. MEN PIC: J. REID PM: J. ELLIS TM: H. ENGLISH LYR:(Opt)ON=*;OFF=*REF*
G:\APROJECT\Ashland\LA002999.0006\Figures\Final\2999-06-08.dwg LAYOUT: 3SAVED: 11/11/2011 11:10 AM ACADVER: 17.0S (LMS TECH) PAGESETUP: ----PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 12/13/2011 9:36 AM BY: MEN, SOTHON
XREFS: IMAGES: PROJECTNAME: ----
AshlandTitle2
02999X02



LEGEND

MW-4 ⌖	GROUNDWATER MONITORING WELL LOCATION AND IDENTIFICATION.
TP-12 ⌖	PIEZOMETER LOCATION AND IDENTIFICATION
CM-1 ⌖	CREEK MEDIA SAMPLING POINT LOCATION AND IDENTIFICATION
—X—X—	APPROXIMATE PROPERTY BOUNDARY
-·-·-·-	INTERMITTENT DRAINAGE DITCH
— — —	APPROXIMATE BOUNDARY OF FORMER LANDFILL AREA
—160—	POTENTIOMETRIC SURFACE CONTOUR CONTOUR INTERVAL 5 FEET
153.72	GROUNDWATER ELEVATION (FEET)
-··-··-	APPROXIMATE LOCATION OF HYDRAULIC DIVIDE
DELNAV	FORMER PROCESS UNIT
N/A	NOT ACCESSIBLE

NOTES

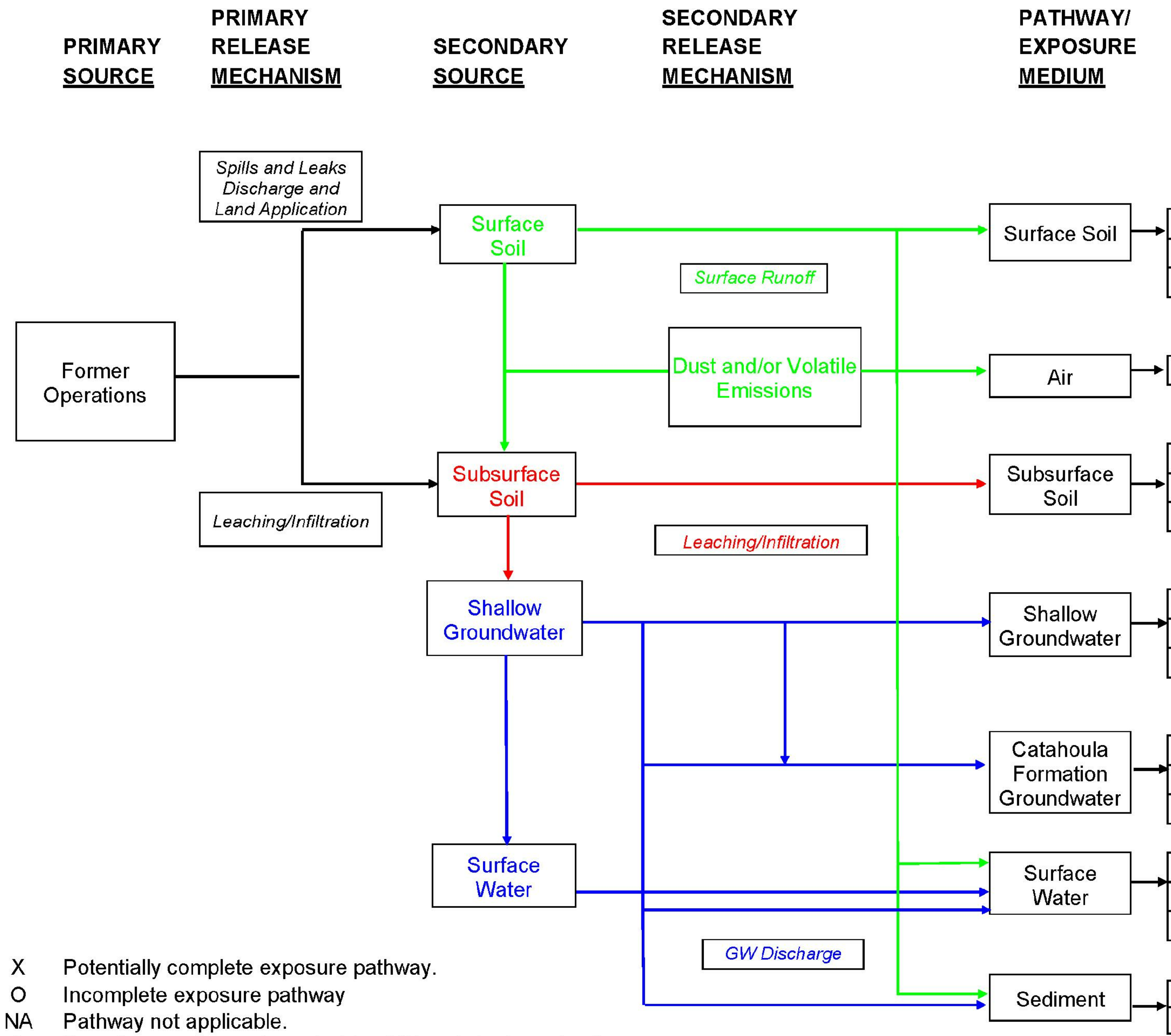
1. BASE MAP PROVIDED BY HERCULES, INCORPORATED
2. CONTOUR INTERVAL IS 5 FEET.

HERCULES INCORPORATED
613 W. 7TH STREET
HATTIESBURG, MS
Revised Phase I Sampling and Analysis Work Plan

GROUNDWATER POTENTIOMETRIC MAP (JULY 2011)

ARCADIS

FIGURE
8



Exposure Medium	EXPOSURE ROUTE	Current: Site Worker	Current: Tresspasser	Current: Off-site Resident	Current: Utility Worker	Hypothetical Future: Site Worker	Hypothetical Future: Utility Worker	Hypothetical Future: Construction Worker	Hypothetical Future: Off-site Resident	Biota: Terrestrial	Biota: Aquatic
Surface Soil	Ingestion	X	X	NA	NA	X	NA	NA	NA	X	NA
	Dermal	X	X	NA	NA	X	NA	NA	NA	X	NA
	Inhalation	X	X	NA	NA	X	NA	NA	NA	X	NA
Air	Inhalation	X	X	?	?	X	?	?	?	NA	NA
Subsurface Soil	Ingestion	NA	NA	NA	X	NA	X	X	NA	NA	NA
	Dermal	NA	NA	NA	X	NA	X	X	NA	NA	NA
	Inhalation	NA	NA	NA	X	NA	X	X	NA	NA	NA
Shallow Groundwater	Ingestion	NA	NA	?	NA	NA	NA	NA	?	NA	NA
	Dermal	NA	NA	?	?	NA	?	NA	?	NA	NA
	Inhalation*	NA	NA	?	?	NA	?	NA	?	NA	NA
Catahoula Formation Groundwater	Ingestion	NA	NA	?	NA	NA	NA	NA	?	NA	NA
	Dermal	NA	NA	?	NA	NA	NA	NA	?	NA	NA
	Inhalation	NA	NA	?	NA	NA	NA	NA	?	NA	NA
Surface Water	Ingestion	NA	X	X	NA	X	NA	NA	X	X	X
	Dermal	NA	X	X	NA	X	NA	NA	X	X	X
	Inhalation	NA	X	X	NA	X	NA	NA	X	X	X
Sediment	Ingestion	NA	X	X	NA	X	NA	NA	X	X	X
	Dermal	NA	X	X	NA	X	NA	NA	X	X	X

X	Potentially complete exposure pathway.
O	Incomplete exposure pathway
NA	Pathway not applicable.
?	Data Gap - to be evaluated with additional site investigation.
*	Inhalation of vapors during domestic use and/or via vapor migration

HERCULES INCORPORATED
613 W. 7TH STREET
HATTIESBURG, MS
Revised Phase I Sampling and Analysis Work Plan

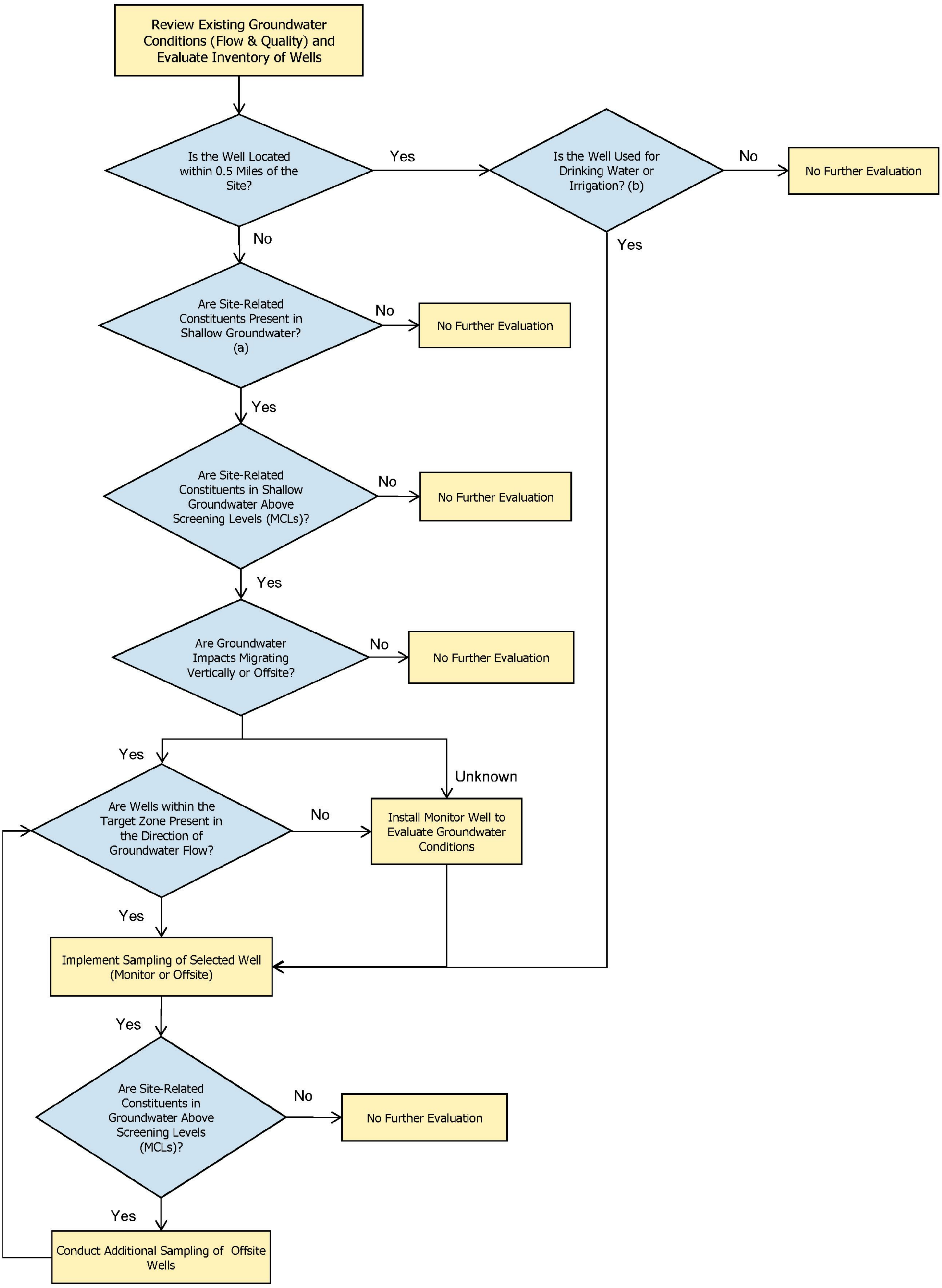
PRELIMINARY CONCEPTUAL SITE MODEL FOR POTENTIAL EXPOSURE PATHWAYS

ARCADIS

FIGURE
9

DB: R. PETRIE S. BELL LD: SOTHON MEN PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
G:\APROJECT\Ashland\LA002999.0006\Figures\Final\2999-06-09.dwg LAYOUT: 5 SAVED: 12/13/2011 11:15 AM ACADVER: 17.0S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 12/13/2011 12:43 PM BY: MEN, SOTHON
XREFS: IMAGES: PROJECTNAME: ----
AshlandTitle2 1-Figure 9 - Conceptual Site Model.jpg

Decision Flow Chart for Drinking Water and Groundwater (Offsite)



Notes:

(a) Constituent list should be focused to site-related chemicals.

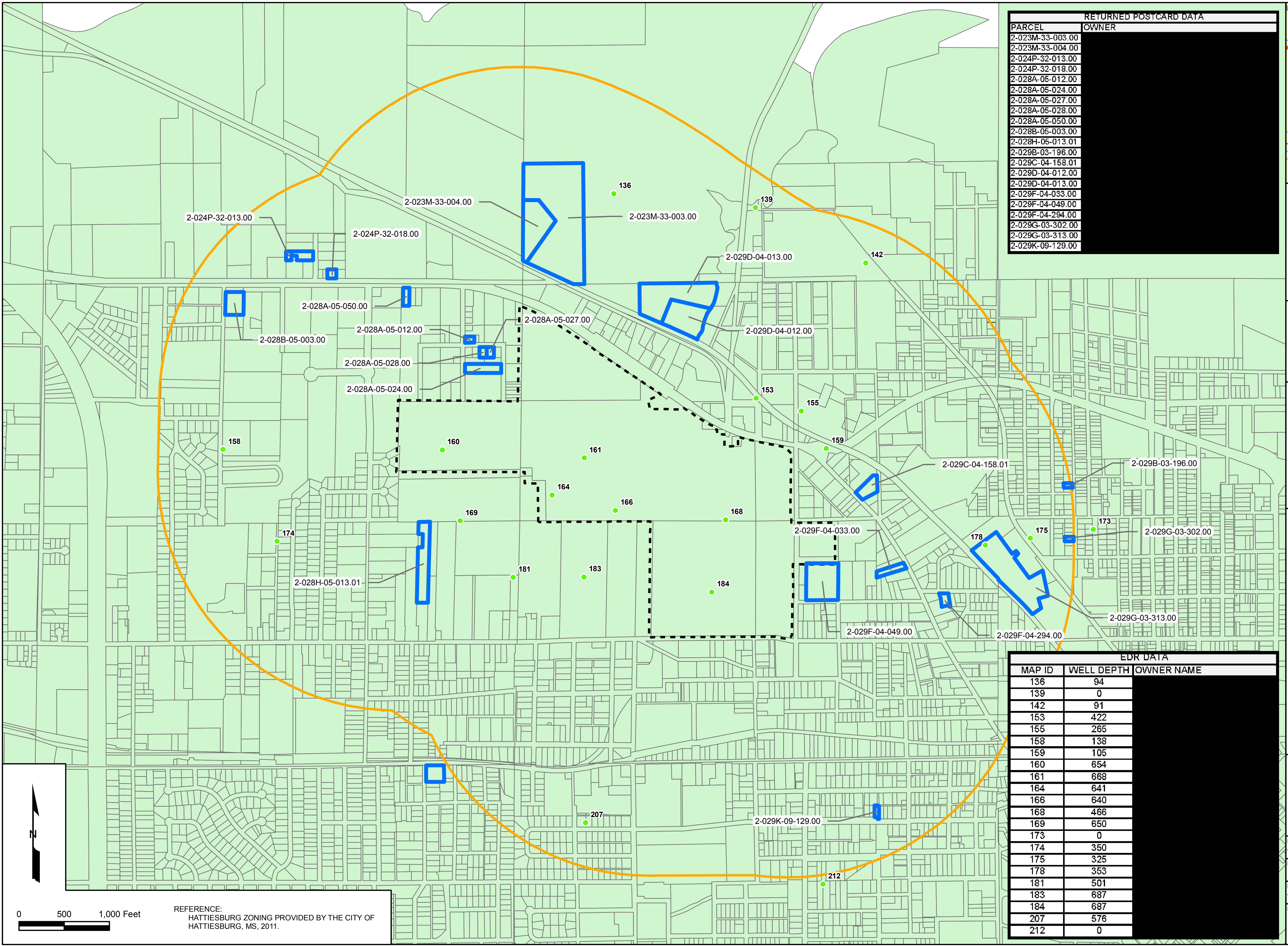
(b) Any monitor well or recovery well identified within the 0.5 mile radius will not be sampled.

HERCULES INCORPORATED
613 W. 7TH STREET
HATTIESBURG, MS
Revised Phase I Sampling and Analysis Work Plan

DECISION FLOW CHART FOR DRINKING WATER AND GROUNDWATER

ARCADIS

FIGURE
10



REFERENCE:
HATTIESBURG ZONING PROVIDED BY THE CITY OF
HATTIESBURG, MS, 2011.

RETURNED POSTCARD DATA

PARCEL	OWNER
2-023M-33-003.00	[redacted]
2-023M-33-004.00	[redacted]
2-024P-32-013.00	[redacted]
2-024P-32-018.00	[redacted]
2-028A-05-012.00	[redacted]
2-028A-05-024.00	[redacted]
2-028A-05-027.00	[redacted]
2-028A-05-028.00	[redacted]
2-028A-05-050.00	[redacted]
2-028B-05-003.00	[redacted]
2-028H-05-013.01	[redacted]
2-029B-03-196.00	[redacted]
2-029C-04-158.01	[redacted]
2-029D-04-012.00	[redacted]
2-029D-04-013.00	[redacted]
2-029F-04-033.00	[redacted]
2-029F-04-049.00	[redacted]
2-029F-04-294.00	[redacted]
2-029G-03-302.00	[redacted]
2-029G-03-313.00	[redacted]
2-029K-09-129.00	[redacted]

EDR DATA

MAP ID	WELL DEPTH	OWNER NAME
136	94	[redacted]
139	0	[redacted]
142	91	[redacted]
153	422	[redacted]
155	265	[redacted]
158	138	[redacted]
159	105	[redacted]
160	654	[redacted]
161	668	[redacted]
164	641	[redacted]
166	640	[redacted]
168	466	[redacted]
169	650	[redacted]
173	0	[redacted]
174	350	[redacted]
175	325	[redacted]
178	353	[redacted]
181	501	[redacted]
183	687	[redacted]
184	687	[redacted]
207	576	[redacted]
212	0	[redacted]

WELLS IDENTIFIED BY QUESTIONNAIRE RESPONSE

Revised Phase I Sampling and
Analysis Work Plan

HERCULES INCORPORATED
613 W. 7th Street
Hattiesburg, Mississippi

ARCADIS

10352 PLAZA AMERICANA DRIVE
BATON ROUGE, LA 70816
TEL: 225-292-1004
FAX: 225-218-9677
WWW.ARCADIS-US.COM

Legend

- 178 ● EDR Database Well Location
- ▭ Landowner Identified Parcel with Well(s) as of 09/12/2011
- ┅ Approximate Hercules Property
- ▭ Half Mile Radius

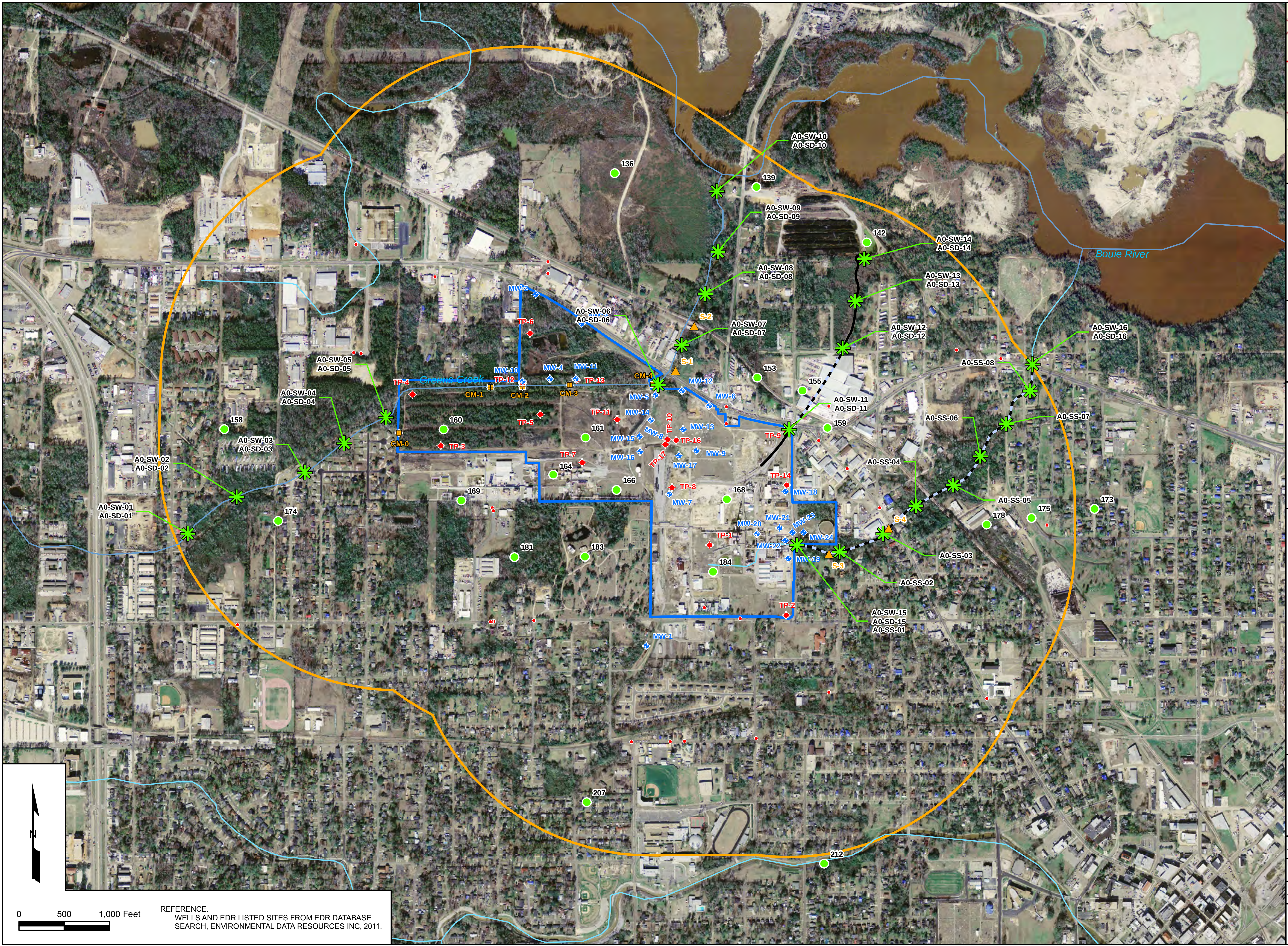
Note:
Positive identification through field verification has not been completed.

PROJECT MANAGER: JE	CHECKED BY: CD
DRAWING FILE:	GIS FILE:
DRAWING BY: JEC	DATE: 11/09/2011
PROJECT NUMBER: LA002999.0006	FIGURE NUMBER: 11

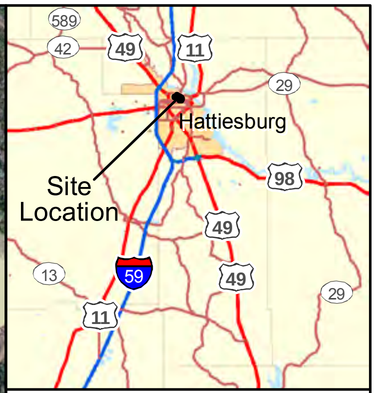
Date Saved: 12/13/2011 2:44:46 PM

Path: U:\projects\ashland\LA002999\ArcMap\LA002999-06\LA002999-0006-0301-11.mxd

U:\projects\ashland\LA002999\output\LA002999\LA002999-06-0301-11.pdf



REFERENCE:
WELLS AND EDR LISTED SITES FROM EDR DATABASE SEARCH, ENVIRONMENTAL DATA RESOURCES INC, 2011.



PROPOSED SAMPLE LOCATION MAP

Revised Phase I Sampling and Analysis Work Plan

HERCULES INCORPORATED
613 W. 7th Street
Hattiesburg, Mississippi

ARCADIS
10352 PLAZA AMERICANA DRIVE
BATON ROUGE, LA 70816
TEL: 225-292-1004
FAX: 225-218-9677
WWW.ARCADIS-US.COM

Legend

▲	MDEQ 2004 Surface Water/ Soil Sample Location
✳	Proposed Surface Water/Sediment/ Soil Sample Location
•	EDR Identified Potential Environmental Site
●	Wells
⊞	Creek Media Sample Location
⊕	Monitor Well Location
⊕	Piezometer Location
╌	Culverted Ditch
─	Open Ditch
▭	Approximate Hercules Property
▭	Half Mile Radius

A0-SW-01 = Surface Water Sample Location
A0-SD-01 = Sediment Sample Location
A0-SS-01 = Surface Soil Sample Location

PROJECT MANAGER: JE	CHECKED BY: CD
DRAWING FILE:	GIS FILE:
DRAWING BY: JEC	DATE: 06/28/2011
PROJECT NUMBER: LA002999.0006	FIGURE NUMBER: 12

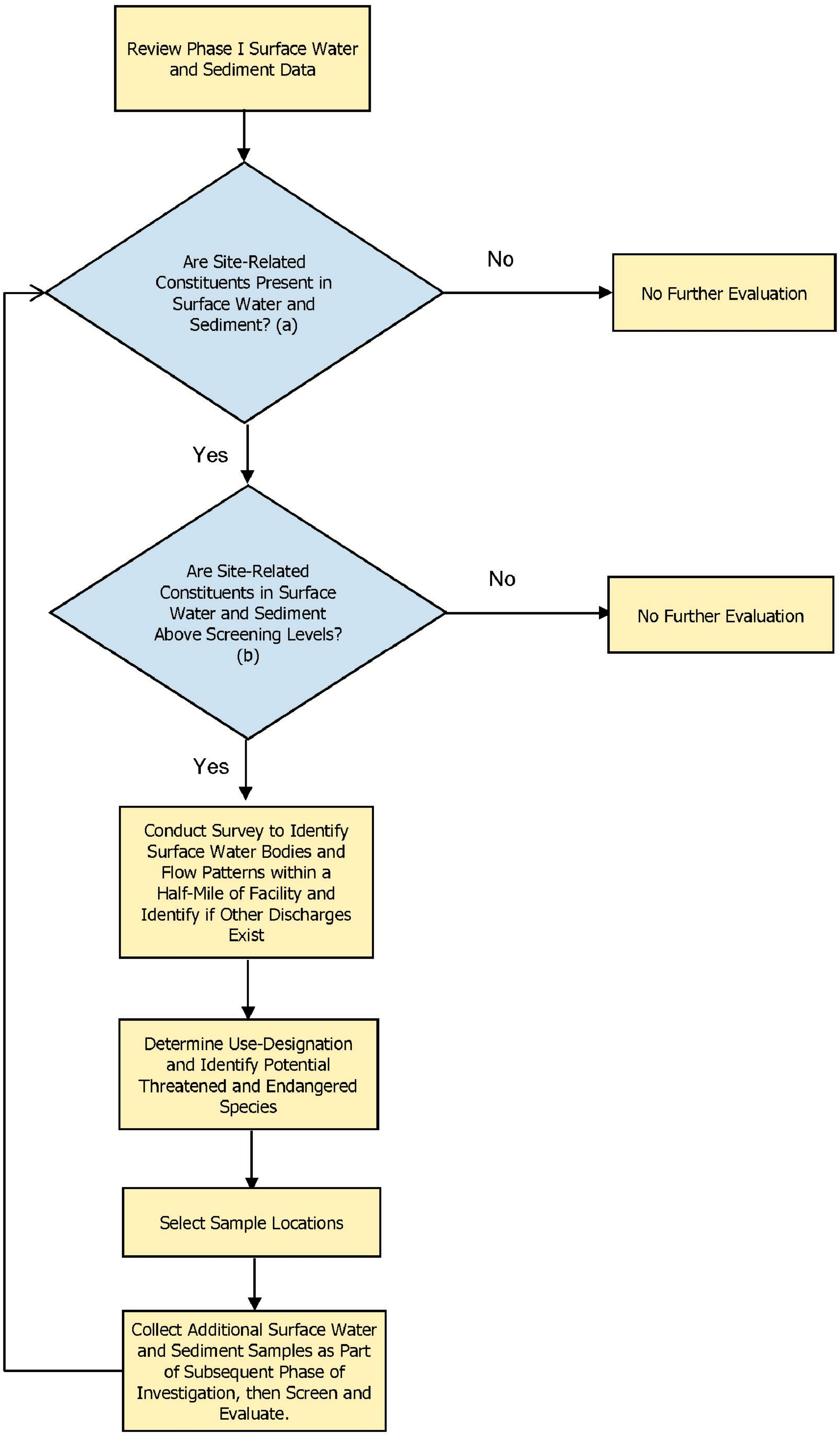
Date Saved: 12/13/2011 2:46:31 PM

Path: U:\projects\ashland\LA002999\ArcMap\LA002999-06\LA002999-06-0301-12.mxd

U:\projects\ashland\LA002999\output\LA002999-06\LA002999-06-0301-12.pdf

CITY: BATON ROUGE DRAWN BY: SMEN CHECKED BY: C. LILLBACK PROJECT MANAGER: D. ESCUDE'
G:\APROJECT\Ashland\LA002999.0006\Figures\Final\2999-06-13New.dwg BY: MEN, SOTHON

Decision Flow Chart for Surface Water and Sediment for Areas Outside the Half-Mile Radius



Notes:

(a) Constituent list will be approved by EPA and MDEQ prior to sampling and will be focused to site-related chemicals.

(b) Human health and ecological screening levels.

HERCULES INCORPORATED
613 W. 7TH STREET
HATTIESBURG, MS
Revised Phase I Sampling and Analysis Work Plan

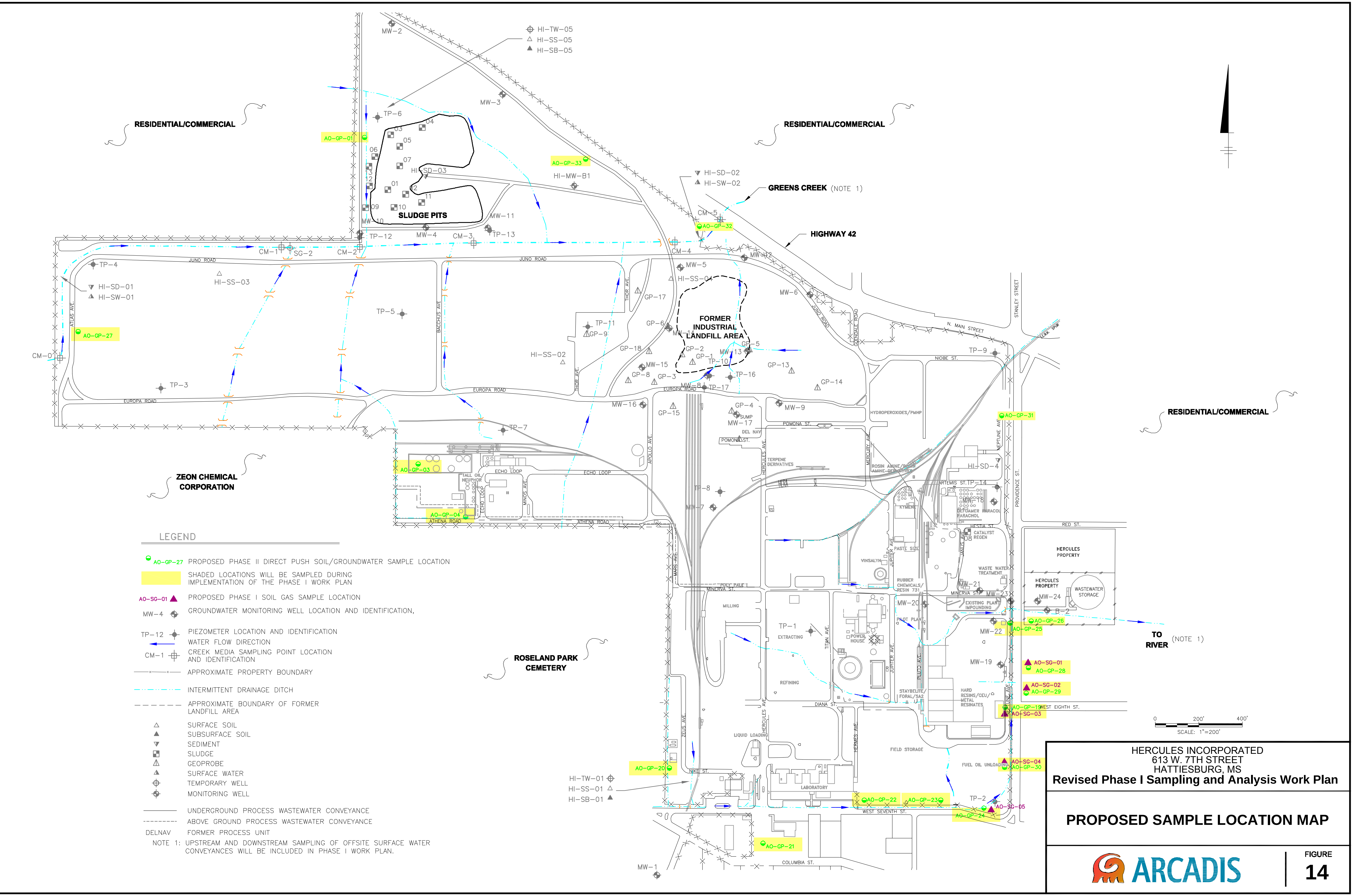
DECISION FLOW CHART FOR SURFACE WATER AND SEDIMENT

ARCADIS

FIGURE
13

DB: R. PETRIE S. BELL LD: SOTHON MEN PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
G:\APROJECT\Ashland\LA002999.0006\Figures\Final\2999-06-14B.dwg LAYOUT: 10SAVED: 12/12/2011 2:19 PM ACADVER: 17.0S (LMS TECH) PAGESETUP: ----PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 12/13/2011 9:37 AM BY: MEN, SOTHON

XREFS: IMAGES: PROJECTNAME: ----
02999X02-B
02999X03
AshlandTitle2



NOTE 1: UPSTREAM AND DOWNSTREAM SAMPLING OF OFFSITE SURFACE WATER CONVEYANCES WILL BE INCLUDED IN PHASE I WORK PLAN.

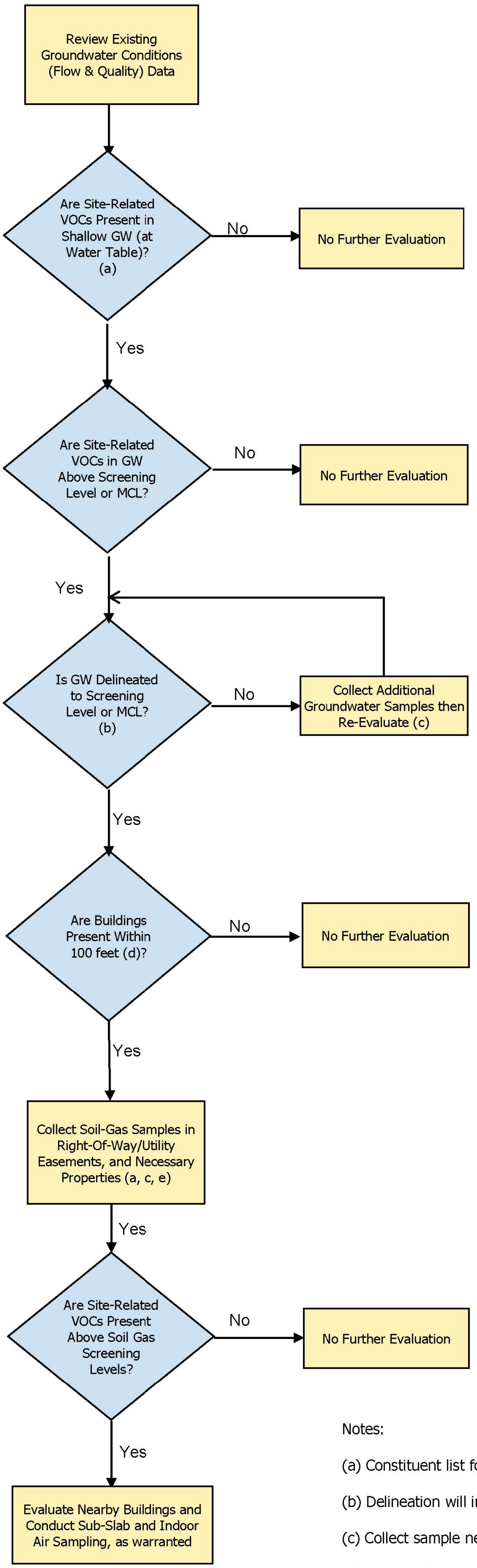
HERCULES INCORPORATED
613 W. 7TH STREET
HATTIESBURG, MS
Revised Phase I Sampling and Analysis Work Plan

PROPOSED SAMPLE LOCATION MAP

ARCADIS

FIGURE
14

Decision Flow Chart for Soil Gas and Vapor Intrusion Within and Beyond Half-Mile Radius of Site



Notes:

(a) Constituent list focused on site-related chemicals as approved by USEPA and MEDQ.

(b) Delineation will include evaluation of utility corridors as they may effect COC migration.

(c) Collect sample near the water table.

(d) Within 100 feet of delineated screening level line.

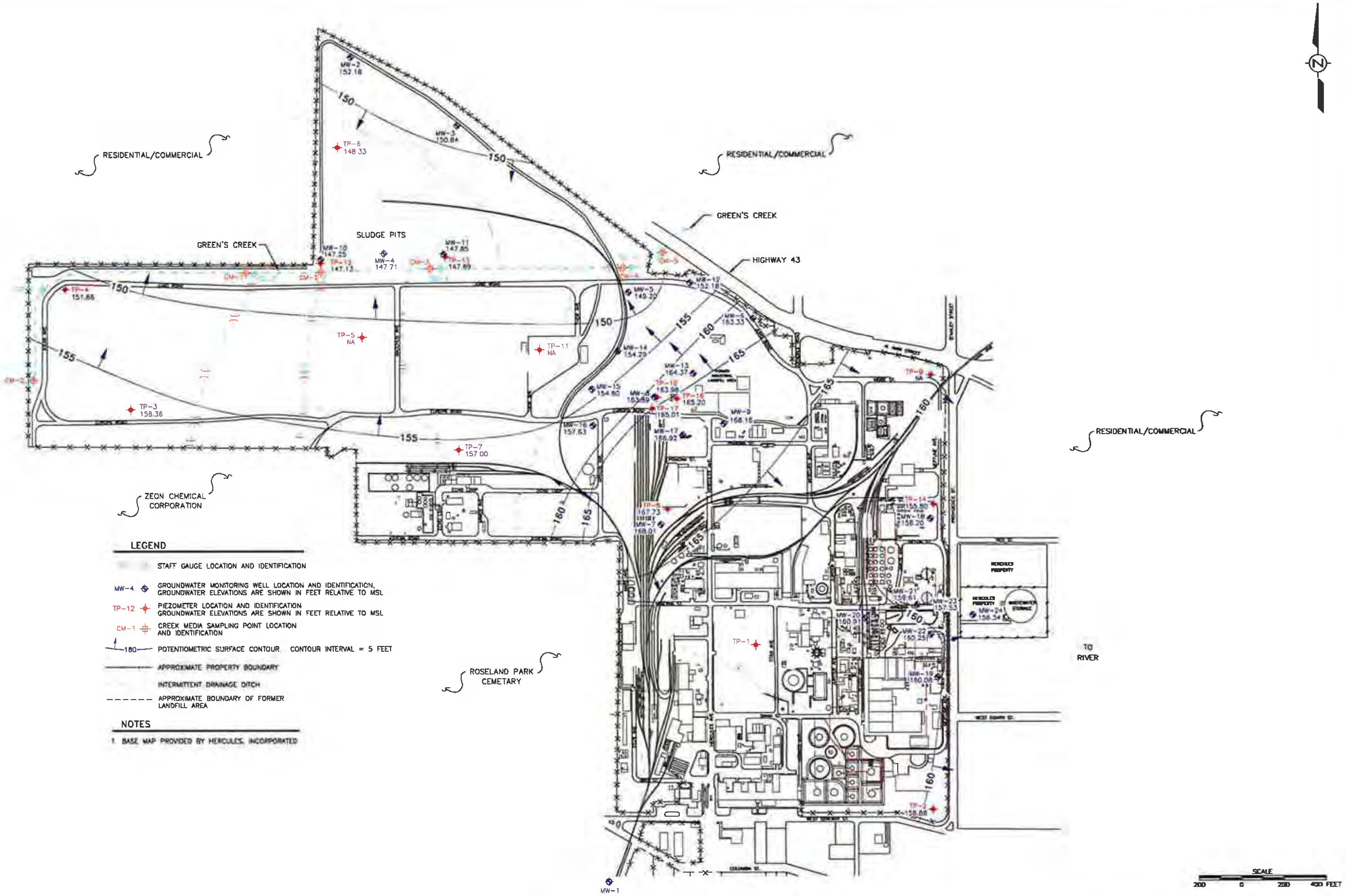
(e) Collect samples within half-mile radius of Site in areas of potential concern (right of ways, easements, other properties, etc.).

HERCULES INCORPORATED
613 W. 7TH STREET
HATTIESBURG, MS
Revised Phase I Sampling and Analysis Work Plan

DECISION FLOW CHART FOR SOIL GAS AND VAPOR INTRUSION

ARCADIS

FIGURE
15



LEGEND

STAFF GAUGE LOCATION AND IDENTIFICATION

MW-4 GROUNDWATER MONITORING WELL LOCATION AND IDENTIFICATION, GROUNDWATER ELEVATIONS ARE SHOWN IN FEET RELATIVE TO MSL

TP-12 PIEZOMETER LOCATION AND IDENTIFICATION GROUNDWATER ELEVATIONS ARE SHOWN IN FEET RELATIVE TO MSL

CM-1 CREEK MEDIA SAMPLING POINT LOCATION AND IDENTIFICATION

180 POTENTIOMETRIC SURFACE CONTOUR CONTOUR INTERVAL = 5 FEET

APPROXIMATE PROPERTY BOUNDARY

INTERMITTENT DRAINAGE DITCH

APPROXIMATE BOUNDARY OF FORMER LANDFILL AREA

NOTES

1. BASE MAP PROVIDED BY HERCULES, INCORPORATED

REV.	DESCRIPTION OF REVISION	BY	CURRENT DATE
0	ISSUED FOR REVIEW	CC	1/14/11

HERCULES
CHEMICAL SPECIALTIES

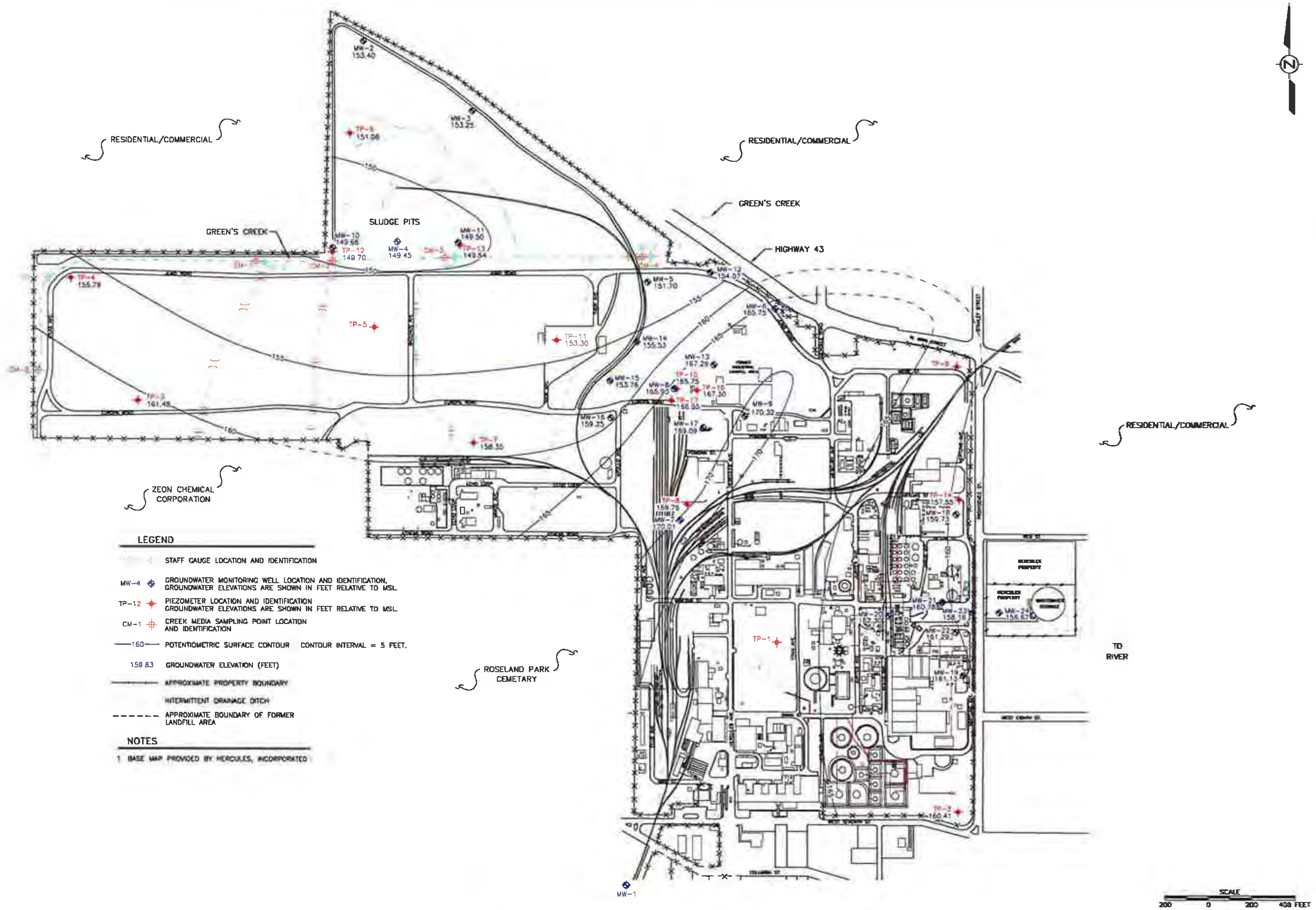
SCALE: 1"=200'
DRAWN: K. SISSON
CHECKED:
REVIEWED:
PROJECT MANAGER: C. WATERS
DATE: 1/14/11

Eco-Systems, Inc.
Consultants, Engineers and Scientists
Jackson, MS • Meridian, MS • Mobile, AL
Houston, TX • Nashville, TN • Atlanta, GA
Hattiesburg, MS • Gulfport, MS

HERCULES INCORPORATED
HATTIESBURG, MISSISSIPPI

POTENTIOMETRIC
SURFACE MAP
DECEMBER, 2010

PROJECT No. [illegible]
CAD FILE NAME [illegible]
FIGURE 3
REVISION 0



LEGEND

	STAFF GAUGE LOCATION AND IDENTIFICATION
MW-4 ◆	GROUNDWATER MONITORING WELL LOCATION AND IDENTIFICATION. GROUNDWATER ELEVATIONS ARE SHOWN IN FEET RELATIVE TO MSL.
TP-12 ✦	PIEZOMETER LOCATION AND IDENTIFICATION GROUNDWATER ELEVATIONS ARE SHOWN IN FEET RELATIVE TO MSL.
CM-1 ⌖	CREEK MEDIA SAMPLING POINT LOCATION AND IDENTIFICATION
—160—	POTENTIOMETRIC SURFACE CONTOUR CONTOUR INTERVAL = 5 FEET.
159.83	GROUNDWATER ELEVATION (FEET)
——·——	APPROXIMATE PROPERTY BOUNDARY
	INTERMITTENT DRAINAGE DITCH
------	APPROXIMATE BOUNDARY OF FORMER LANDFILL AREA

NOTES

1 BASE MAP PROVIDED BY HERCULES, INCORPORATED

0	ISSUED FOR REVIEW	CC	5/27/10
REV.	DESCRIPTION OF REVISION	BY	CURRENT DATE

HERCULES
CHEMICAL SPECIALTIES

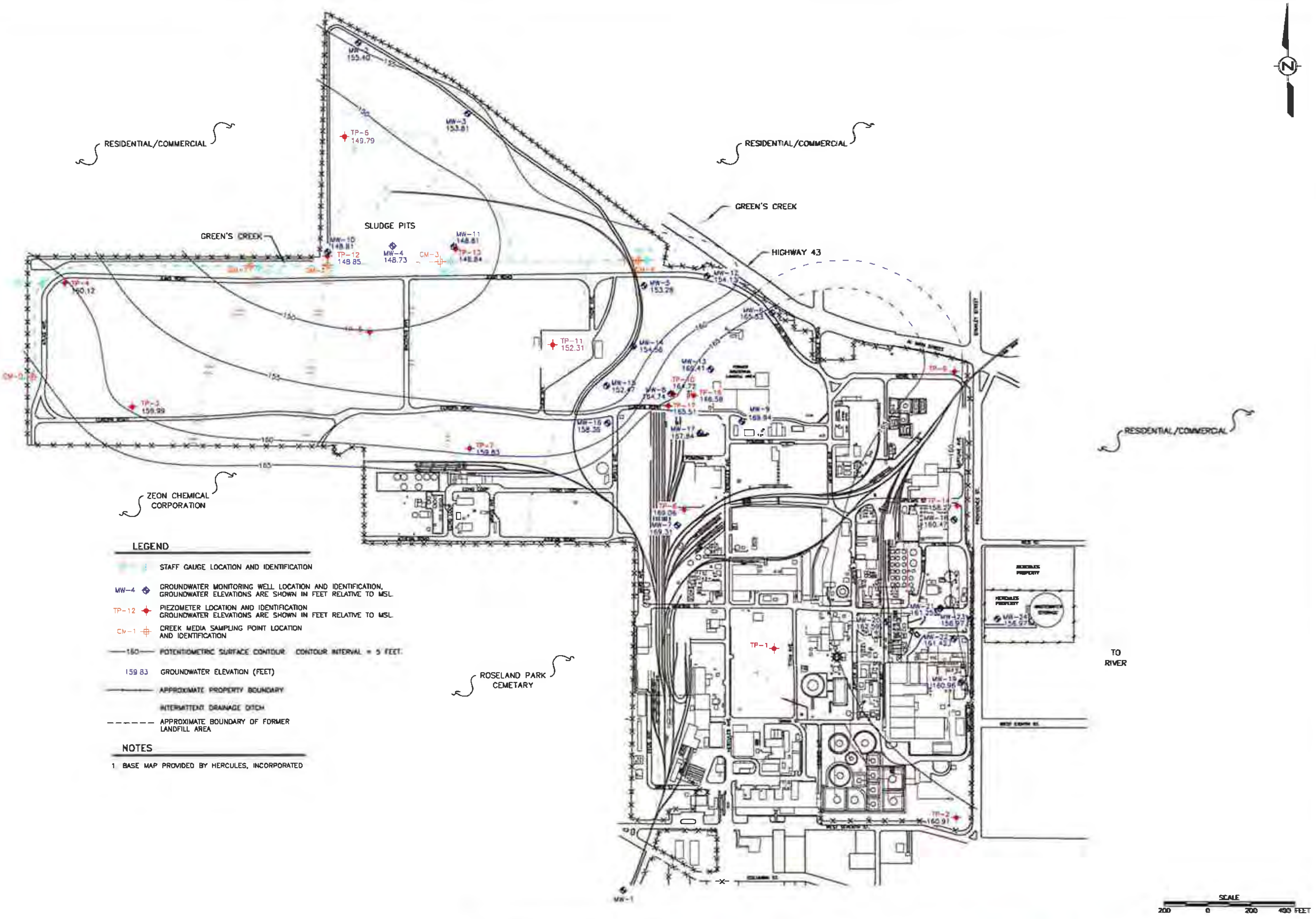
SCALE: 1"=200'
DRAWN: R. SISSON
CHECKED:
REVIEWED: 5/27/10
PROJECT MANAGER: C. WATERS
DATE: 5/27/10

Eco-Systems, Inc.
Consultants, Engineers and Scientists
Jackson, MS • Meridian, MS • Mobile, AL
Houston, TX • Nashville, TN • Atlanta, GA
Hattiesburg, MS • Gulfport, MS

HERCULES INCORPORATED
HATTIESBURG, MISSISSIPPI

POTENTIOMETRIC SURFACE MAP
(MAY 10, 2010)

PROJECT No.
CAD FILE NAME
FIGURE: 3
REVISION: 0



REV.	DESCRIPTION OF REVISION	BY	CURRENT DATE
0	ISSUED FOR REVIEW	CC	12/22/09

HERCULES
CHEMICAL SPECIALTIES

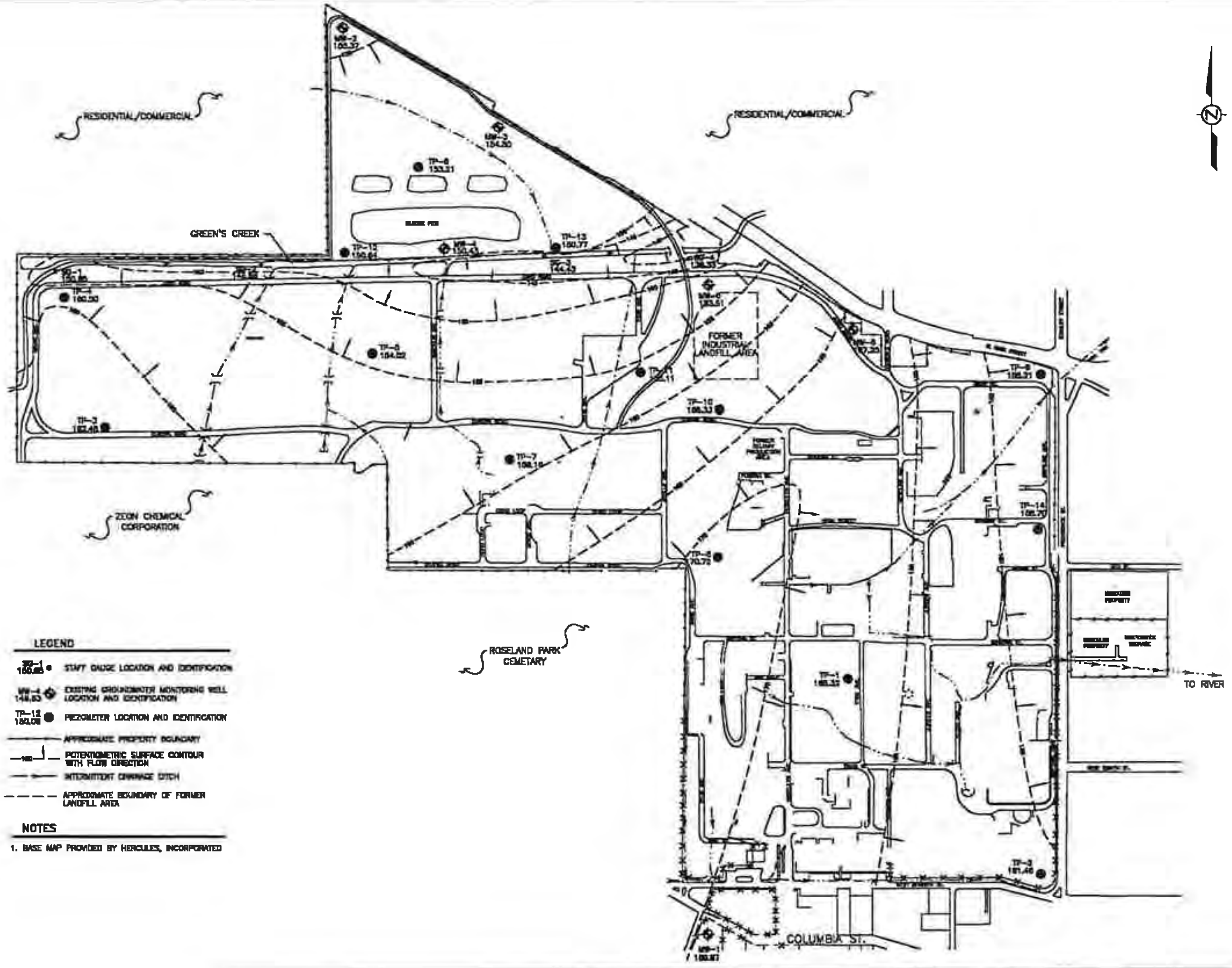
SCALE: 1"=200'
DRAWN: [illegible]
CHECKED:
REVIEWED: 12/22/09
PROJECT MANAGER: C. WATERS
DATE: 12/22/09

Eco-Systems, Inc.
Consultants, Engineers and Scientists
Jackson, MS • Meridian, MS • Mobile, AL
Houston, TX • Nashville, TN • Atlanta, GA
Hattiesburg, MS • Gulfport, MS

HERCULES INCORPORATED
HATTIESBURG, MISSISSIPPI

POTENTIOMETRIC SURFACE MAP
(DECEMBER 7, 2009)

PROJECT No. [illegible]
CAD FILE NAME: [illegible]
FIGURE 3
REVISION 0



LEGEND

SG-1 160.85 ● STAFF GAUGE LOCATION AND IDENTIFICATION
MW-4 148.83 EXISTING GROUNDWATER MONITORING WELL LOCATION AND IDENTIFICATION
TP-12 160.06 ● PIEZOMETER LOCATION AND IDENTIFICATION
APPROXIMATE PROPERTY BOUNDARY
POTENTIOMETRIC SURFACE CONTOUR WITH FLOW DIRECTION
INTERMITTENT DRAINAGE DITCH
APPROXIMATE BOUNDARY OF FORMER LANDFILL AREA

NOTES

1. BASE MAP PROVIDED BY HERCULES, INCORPORATED

J.N.S. 03/17/03 S:\PROJECTS\HER22173\DWGS\HER22173-PSMap.dwg

HERCULES
CHEMICAL SPECIALTIES

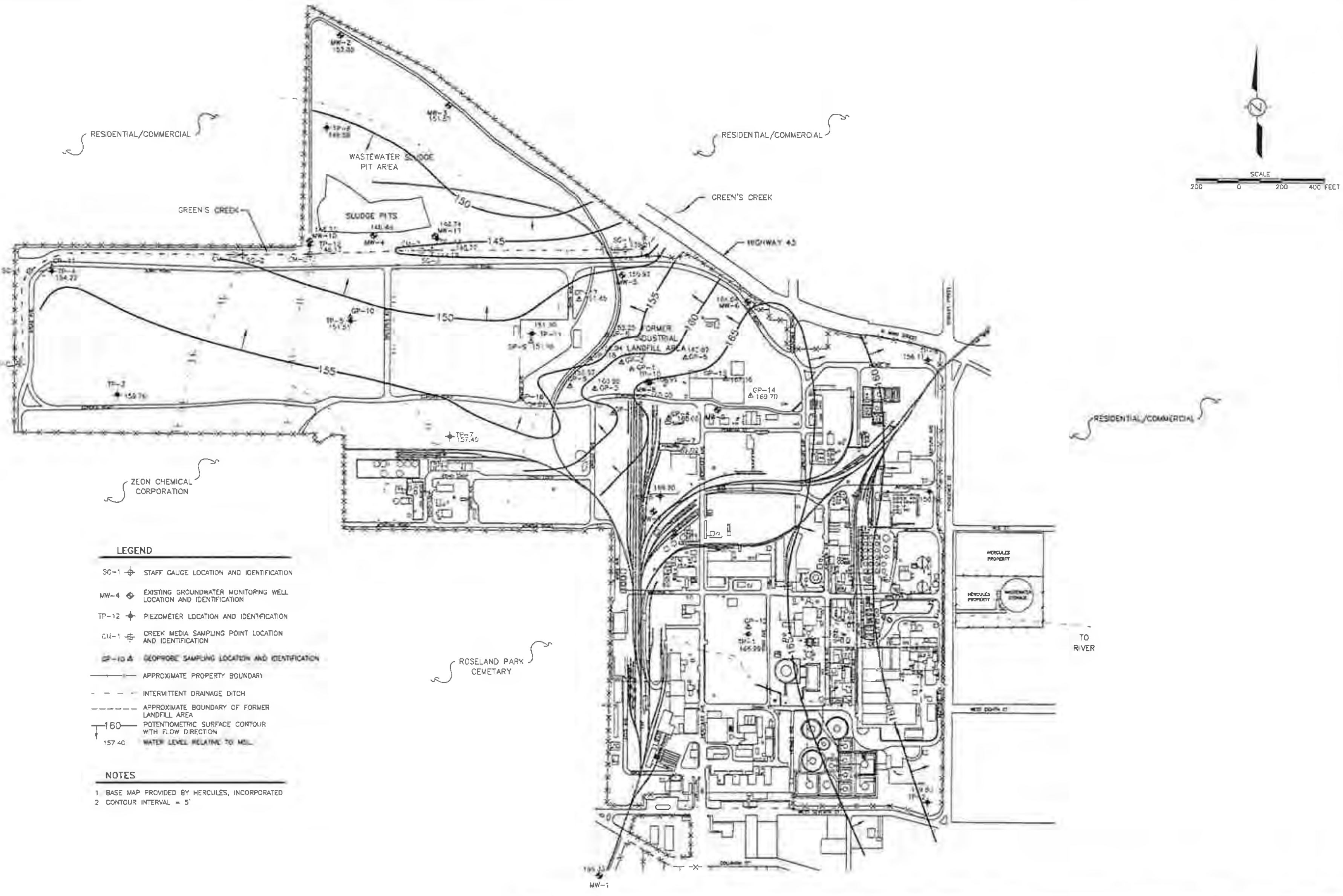
DATE: 3/18/03
SCALE: 1"=450'
DRAWN: N. SISSON
CHECKED:
REVIEWED: 4-4-03
PROJECT MANAGER: CAD

Eco·Systems, Inc.
Consultants, Engineers and Scientists

POTENTIOMETRIC
SURFACE MAP
MARCH 5, 2003

HERCULES CHEMICAL CO.
HATTIESBERG, MISSISSIPPI

PROJECT NO.
HER22173
CAD FILE
HER22173-PSMap.dwg
FIGURE
5



LEGEND

SC-1 ⌖	STAFF GAUGE LOCATION AND IDENTIFICATION
MW-4 ◈	EXISTING GROUNDWATER MONITORING WELL LOCATION AND IDENTIFICATION
TP-12 ✦	PIEZOMETER LOCATION AND IDENTIFICATION
CM-1 ⌖	CREEK MEDIA SAMPLING POINT LOCATION AND IDENTIFICATION
GP-10 ▲	GEOPROBE SAMPLING LOCATION AND IDENTIFICATION
—+—	APPROXIMATE PROPERTY BOUNDARY
- - -	INTERMITTENT DRAINAGE DITCH
— — —	APPROXIMATE BOUNDARY OF FORMER LANDFILL AREA
—160—	POTENTIOMETRIC SURFACE CONTOUR WITH FLOW DIRECTION
157.40	WATER LEVEL RELATIVE TO MSL

NOTES

1. BASE MAP PROVIDED BY HERCULES, INCORPORATED
2. CONTOUR INTERVAL = 5'

0	ISSUED FOR REVIEW	CC	10/14/03
REV.	DESCRIPTION OF REVISION	BY	CURRENT DATE

HERCULES
CHEMICAL SPECIALTIES

SCALE: 1"=200'
DRAWN: PHILLIPS
CHECKED: Cab 11-2-03
REVIEWED: 10/14/03
PROJECT MANAGER: C. COWEY
DATE: 10/14/03

Eco·Systems, Inc.
Consultants, Engineers and Scientists
Jackson, MS • Mobile, AL • Houston, TX

POTENTIOMETRIC
SURFACE MAP
OCTOBER 01, 2003

HERCULES INCORPORATED
HATTIESBURG, MISSISSIPPI

PROJECT No. [illegible]
CAD FILE NAME P-METRIC.dwg
FIGURE 4
REVISION 0

6

STATE OF MISSISSIPPI

COUNTY OF FORREST

Prepared By:
Mississippi Department of Environmental Quality
P.O. Box 20305
Jackson, MS 39289 (601)961-5171

Mississippi Department of Environmental Quality

NOTICE OF LAND USE RESTRICTIONS

COPY

A Restrictive Use Agreed Order has been developed with regard to property located at 613 West 7th Street, Hattiesburg, MS as shown as Parcel 1in the attached survey plat, Exhibit "A". This property, hereafter referred to as the "Site," is situated in Sections 4 and 5, Township 4, Range 13 West, Forrest County, Mississippi, and being more particularly described by metes and bounds as follows, to-wit:

> "A description for a parcel situated in Sections 4 and 5, Township 4 North, Range 13 West Forrest County, Mississippi; said parcel being illustrated as parcel 1 on survey plat for Hercules Incorporated by Land Management Services & Mapping, LLC and being more particularly described by metes and bounds as follows:
>
> Commencing at a Railroad Spike Found at the NW Corner of Said Section 4 said point having a Mississippi NAD 83 State Plane Coordinate of North: 671932.60' East: 834200.91' and thence run S01°48'08"W 243.97', to a metal pipe found on the south right-of way line of Mississippi Highway 42 for the Point of Beginning; thence leaving said south right of way line run S01°32'45"W 1,065.16', to a wood fence post found; thence run N88°48'08"W 1,318.98', to a wood fence post found; thence run S01°48'01"W 796.25', to a concrete monument found; thence run S89°40'54"E 1,422.86', to a concrete monument found; thence run S00°21'17"W 129.67', to a concrete monument found; thence run S89°39'18"E 144.76', to a concrete monument found; thence run S00°14'56"W 429.44', to a concrete monument found; thence run S89°52'14"E 1,237.65', to a metal fence post found; thence run S00°54'06"W 1,298.93', to an X-Cut set in concrete on the north right-of-way line of West 7th Street, said street having a 40' right-of-way as per the City of Hattiesburg; thence run along said north right-of-way N89°54'34"E 267.43', to a PK nail set, thence leaving said north right-of-way run; N00°03'00"E 190.92', to a PK nail set; thence run S89°02'44"E 189.42', to a PK nail set; N00°03'00"E 51.37', to a PK nail set; thence run S89°02'44"E 469.81', to an iron pin set; thence run S00°01'08"W 230.27', to an X-Cut set in concrete on the north right-of-way of said 7th street; thence run along said north right-of-way N89°54'34"E 654.88', to a PK nail set at the intersection of the said north right-of-way line and the west right-of-way line of Providence Street, said Providence Street having a 60' right-of-way as per the City of Hattiesburg; thence leaving said north right-of-way line run along said west right-of-way line N00°03'42"W 1,290.00', to an iron pin set; thence continue along said west right-of-way line N89°54'34"E 10.00', to an iron pin set; thence continue along said west right-of-way N00°04'39"W 817.15', to a PK nail set at the intersection of the west right-of-way of said Providence street and the south right-of-way line of Mississippi Highway 42 as per FAP U-008-2(1); thence leaving said west right-of-way line run along said south right-of-way N78°17'33"W 366.13', to an iron pin set; thence continue along said south right-of-way as per PWS Docket # 1043R-71A-EXT S11°42'03"W 10.00' to a concrete right-of-way marker marking the point of curve of a non tangent curve to the right, having a chord bearing of N74°51'58"W, 233.23', and a radius of 1947.42'; thence continue along said south right-of-way westerly along the arc, through a central angle of 06°51'58", a distance of 233.38, to an iron pin set; thence leaving said south right-of-way run S00°00'01"W 103.94', to a fence corner found; thence run West 100.00', to an iron pin set; thence run N00°31'30"W 113.09', to a metal pipe found; thence run East 74.46' to a PK nail set on the aforementioned south right-of way of Highway 42, said point marking the point of curve of a non tangent curve to the right, having a chord bearing of N68°09'32"W, 166.32', and a radius 1,947.42'; thence run along said south right-of-way westerly along the arc, through a central angle of 04°53'41", a distance of 166.37', to an iron pin set; thence leaving said south right-of-way run South 42.85', to an iron pin set; thence run West 50.00', to an iron pin set; thence run North 50.00', to an iron pin set; thence run West 75.00', to a concrete monument found; thence run North 54.74', to an iron pin set on the south right-of-way line of said Highway 42, said point marking the point of curve of a non tangent curve to the right having a chord bearing of N58°38'21"W, 201.65', and a radius of 1,947.42'; thence run along said south right-of-way northwesterly along the arc, through a central angle of 05°56'08", a distance of 201.74', to a right-of-way marker found; thence continue along said south right-of-way N55°42'47"W 145.58', to an iron pin set; thence continue along said south right-of-way S34°06'38"W 20.11', to an iron pin set; thence continue along said south right-of-way thence run N55°40'42"W 230.37'; thence continue along said south right-of-way S34°19'18"W 20.00', to an iron pin set; thence continue along said south right-of-way N55°40'37"W 570.29', to a right-of-way marker found; thence continue along said right-of-way N55°41'30"W 500.40', to a right-of-way marker found; thence continue along said north right-of-way N33°58'28"E 29.85', to a right-of-way marker found; thence continue along said north right-of-way N55°46'04"W 245.07', to a right-of-way marker found marking the point of curve of a non tangent curve to the left, having a chord bearing of N61°50'00"W, 603.00', and a radius of 2,808.94'; thence continue along said south right-of-way northwesterly along the arc, through a central angle of 12°19'25", a distance of 604.16' back to the Point of Beginning; containing 168.81 acres, more or less; all bearings, coordinates, and distances herein described are grid and are referenced to the west property line and are based on the Mississippi NAD 83 East Zone state plane coordinate system and are referenced to the national spatial reference system through the national geodetic survey's online positioning user service (opus) and are derived from a global positioning system observation. (combined grid factor: 0.99997116; convergence: -0°14'45")."

BOOK 1031 PAGE 0240

Indexing Instructions: NE, NW, SE, SW of Section 4 & NE of Section 5, Township 4 North, Range 13 West

STATE OF MISSISSIPPI

COUNTY OF FORREST

Soil and groundwater on the Site contains Benzene (CAS #71432), Chlorobenzene (CAS #108907), Carbon Tetrachloride (CAS #56235), Chloroform (CAS #67663), 1,2-Dichloroethane (CAS #107062) and Toluene (CAS #105553) at levels in excess of the Target Remediation Goals (TRGs) as established by the Mississippi Department of Environmental Quality (MDEQ). Other substances are present in the soil and groundwater that do not exceed TRGs have also been identified. In order to protect public health and the environment, certain restrictions are hereby placed on the Site.

The following is a listing of all restrictions for the Site:

1. There shall be no excavating, drilling or other activities to depths that could create exposure to contaminated media without approval from MDEQ;
2. The groundwater at the Site shall not be used, unless otherwise approved by MDEQ;
3. Monitoring wells shall be protected and maintained. In the event that a monitoring well is destroyed or damaged or is no longer needed, a plan for repair, reinstallation or abandonment of the well(s) must be submitted to MDEQ for approval; and
4. No wells shall be installed without prior approval from MDEQ.

Prior to executing any deed or other instrument conveying an interest in the Site, the following conditions must be met:

1. Any conveyance of the property, or any portion thereof, must contain as covenants the restrictions listed above with a statement that the covenants run with the land and continue into perpetuity unless otherwise ordered by the Mississippi Commission on Environmental Quality;
2. Notice must be provided to MDEQ at least 30 days prior to any property transaction involving the Site; and
3. Prior to any change in use of the Site or any portion thereof, notice shall be given to the MDEQ.

This Notice may be executed in counterparts.

The parties that have a legal or equitable surface interest in the Site follow:

1. Hercules Incorporated

STATE OF MISSISSIPPI
FORREST COUNTY
I CERTIFY THE INSTRUMENT
WAS FILED AND RECORDED
129454
2008 FEB 25 AM 10:24

WITNESS MY HAND AND SEAL
JIMMY C. HAVARD
CHANCERY CLERK

Executed, this the 10th day of December, 2007.

BY: Thomas H. Strang JM 11/15/07 fw

TITLE: VP SHERA

PERSONALLY appeared before me, the undersigned authority in and for the jurisdiction aforesaid, on this the 10th day of December, 2007 within my jurisdiction, the within named Thomas H. Strang acknowledged that (he)(she) is VP SHERA of Hercules Incorporated, a Delaware corporation, and that for and on behalf of the said corporation, and as its act and deed (he)(she) executed the above and foregoing instrument, after first having been duly authorized by said corporation so to do.

SWORN TO AND SUBSCRIBED BEFORE ME, this the 10th day of December 2007.

NOTARY PUBLIC

BOOK 1031 PAGE 0241

MY COMMISSION EXPIRES: No Expiration Date

RICHMOND L. WILLIAMS
Attorney at Law
Notary Public, State of Delaware
My Commission Has No Expiration Date
29 Del.C. § 4323(a)(3)

ARCADIS

Appendix D

Quality Assurance Project Plan

ARCADIS
Infrastructure · Water · Environment · Buildings

Imagine the result

HERCULES

Revised Quality Assurance Project Plan

USEPA RCRA 3013(a)
Administrative Order
EPA ID No. MSD 008 182 081
Docket No. RCRA-04-2011-4251
MDEQ AI No. 2022

Hattiesburg, Mississippi

30 November 2011

ARCADIS

Revised Quality Assurance Project Plan

USEPA RCRA 3013(a)
Administrative Order
Hattiesburg, Mississippi

Project Coordinator (Timothy D. Hassett)
Hercules Incorporated.
Execution Manager (Bruce J. Hough)

Project Manager (John Ellis)
ARCADIS

Quality Assurance Coordinator (Dennis Capria)
ARCADIS

Quality Assurance Manager (Andrea Teal)
Analytical Laboratory

Project Coordinator (Meredith C. Anderson)
United States Environmental Protection Agency

Prepared for:
Hercules Incorporated

Prepared by:
ARCADIS U.S., Inc.
465 New Karner Road
Albany
New York 12205
Tel 518.452.7826
Fax 518.452.7086

Our Ref.:
LA002999.0006.00701

Date:
30 November 2011

Table of Contents

Tables

Appendices

Distribution List

Company/ Organization	Name	Address	Email	Phone Number
USEPA	Chief, South Section	RCRA and OPA Enforcement and Compliance Branch RCRA Division 61 Forsyth Street, S.W. Atlanta, GA 30303-3104		404.562.8590
USEPA	Chief, Corrective Action Section	Restoration and Underground Storage Tank Branch RCRA Division 61 Forsyth Street, S.W. Atlanta, GA 30303-3104		404.562.8885
MDEQ	Chris Sanders, Chief	Environmental Compliance and Enforcement Division Mississippi Department of Environmental Quality P.O. Box 2261 Jackson, Mississippi 39225	chris_sanders@deq.state.ms.us	601.961.5682
Hercules	Timothy D. Hassett Bruce J. Hough	500 Hercules Road Wilmington, Delaware 19808-1599	tdhassett@ashland.com bjhough@ashland.com	302.995.3456 302-995-3404
ARCADIS	John Ellis	10532 Plaza Americana Drive Baton Rouge, LA 70816	john.ellis@arcadis-us.com	225.292.1004
	Dennis Capria	6723 Towpath Road Syracuse, NY 13214-0066	dennis.capria@arcadis-us.com	315.671.9299
Analytical Laboratory – TestAmerica Savannah	Andrea Teal	5102 LaRoche Avenue Savannah, GA 31404	Andrea.Teal@testamericainc.com	912.354.7858
Bonner Analytical Testing Company (BATCO)	Dr. Micheal Bonner	2703 Oak Grove Road Hattiesburg, MS 39402	msbonner@batco.com	601.264.2854

Acronyms and Abbreviations

AO	Administrative Order
BATCO	Bonner Analytical Testing Company
COC	Chain-of-Custody
CLP	Contract Laboratory Program
CWA	Clean Water Act
DAF	Dissolved Air Floatation
DQO	Data Quality Objective
EDD	Electronic Data Deliverable
EPA	Environmental Protection Agency
ft	feet
GC/MS	Gas Chromatography/Mass Spectrometry
GIS	Geographic Information System
IB	Impoundment Basin
IDW	Investigation-derived Waste
LCS	Laboratory Control Samples
MCL	Maximum Containment Level
MBPC	Mississippi Bureau of Pollution Control
MCLG	Maximum Containment Level Goals
MDEQ	Mississippi Department of Environmental Quality
MS	Matrix Spike
MSD	Matrix Spike Duplicate
msl	mean sea level
NCP	National Contingency Plan
NEIC	National Enforcement Investigations Center
OSHA	Occupational Safety and Health Administration
PAR	Preliminary Assessment Reassessment
PCB	Polychlorinated biphenyls
QA	Quality Assurance
QAC	QA Coordinator
QAPP	QA Project Plan

QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RPD	Relative percent difference
SDG	Sample Delivery Group
SOP	Standard Operating Procedure
SQL	Sample Quantitation Limit
SVOC	Semivolatile organic compound
TRG	Target Remediation Goals
USEPA	United States Environmental Protection Agency
VOC	Volatile organic compound

Introduction

This Quality Assurance Project Plan (QAPP) was prepared for the Hercules Incorporated (Hercules) site located at 613 West 7th Street, Hattiesburg, Mississippi (the Site). It supplements the Phase I Sampling and Analysis Work Plan (Work Plan) developed to evaluate the Site and surrounding area within a 4-mile radius of the Site pursuant to Paragraph 74 of the May 9, 2011, Administrative Order (the AO) issued by Region 4 of the U.S. Environmental Protection Agency (USEPA). The AO was issued pursuant to Section 3013(a) of the Resource Conservation and Recovery Act (RCRA), 42 United States Code (USC) §6934(a), and is specific to Hercules', Hattiesburg, Mississippi, facility. Together, this QAPP and the Work Plan constitute the Sampling and Analysis Plan for the Site.

This QAPP was prepared in a manner consistent with the following reference and guidance documents:

U.S. Environmental Protection Agency (USEPA) guidance document entitled *EPA Requirements for QA Project Plans*, EPA-QA/R-5 (USEPA 2001a), which replaces QAMS-005/80, *Interim Guidance and Specifications for Preparing QA Project Plans* (USEPA 1980);

USEPA *Guidance for QA Project Plans,* EPA-QA/G-5 (USEPA 2002b);

USEPA Field Branches Quality System and Technical Procedures; Field Branches Quality Management Plan; May 8, 2009. http://www.epa.gov/region4/sesd/fbqstp/; and

The National Enforcement Investigations Center (NEIC) *Policies and Procedures Manual* (USEPA 1991).

Information contained in this QAPP has been organized into the following sections:

Section	Content
Project Management	
1	Project Organization
2	Project Background
3	Project Description
4	Quality Objectives and Criteria for Measurement Data
5	Special Training Requirements/Certification

Section	Content
6	Documentation and Records
Measurement/Data Acquisition	
7	Sampling Process Design
8	Sampling Method Requirements
9	Sample Handling and Custody Requirements
10	Analytical Method Requirements
11	Quality Control Requirements
12	Instrument/Equipment Testing, Inspection, and Maintenance Requirements
13	Instrument Calibration and Frequency
14	Inspection/Acceptance Requirements for Supplies and Consumables
15	Data Acquisition Requirements for Non-Direct Measurements
16	Data Management
Assessment/Oversight	
17	Assessment and Response Actions
18	Reports to Management
Data Validation and Usability	
19	Data Reduction and Review
20	Data Validation and Verification
21	Reconciliation with User Requirements
22	References

Details on each of the subjects listed above are provided in the subsequent sections.

1. Project Organization

1.1 Project Organization

The activities to be completed under the Work Plan will require integration of personnel from the organizations identified below, collectively referred to as the “project team.” A detailed description of the responsibilities of each member of the project team is presented below.

1.1.1 Overall Project Management

ARCADIS personnel will perform related sampling activities and will evaluate data and prepare the deliverables as specified in the Work Plans. Project direction will be provided with lead regulatory oversight by the USEPA. A list of key project management personnel is provided below.

Company/Organization	Title	Name	Phone Number
USEPA	Project Coordinator	Meredith C. Anderson	404.562.8608
MDEQ	Project Manager	Willie McKercher	601.961.5731
Hercules	Project Manager	Timothy D. Hassett	302.995.3456
ARCADIS	Project Manager	John Ellis	225.292.1004
	Task Manager	Craig Derouen	225.292.1004
	Technical Manager	TBD	
	QA Coordinator (QAC)	Dennis Capria	315.671.9299

Company/Organization	Title	Name	Phone Number
Analytical Laboratory – TestAmerica Savannah	Project Manager	Lidya Gulizia	912.354.7858
	QA Manager	Andrea Teal	912.354.7858
Bonner Analytical Testing Company (BATCO)	Lab Director	Dr. Micheal Bonner	601.264.2854

1.1.2 Task Managers

The staff performing the site activities will be directed by representatives of the project team. The personnel responsible for each of the site activities are listed below.

Company/Organization	Title	Name	Phone Number
Environmental Consultant	Field Coordinator/Field Operations Manager	TBD	TBD
	Task Manager	TBD	TBD
	Health and Safety Officer	TBD	TBD

1.2 Team Member Responsibilities

The responsibilities of the various team members are summarized below by organization.

1.2.1 Hercules

Project Manager

Responsibilities and duties include:

- Provide overall direction of site actions.
- Direct Consultant(s) and Contractors/Subcontractors.

- Review work products, including data, memoranda, letters, reports, and all other documents transmitted to the USEPA.

1.2.2 Environmental Consultant (ARCADIS US, Inc.)

Project Manager/Assistant Project Manager

Responsibilities and duties include:

- Manage and coordinate the project as defined in the Work Plans with an emphasis on adhering to the objectives of the site activities.
- Review documents prepared by environmental consultant and their subcontractors.
- Verify that corrective actions are taken for deficiencies cited during any audits of site activities.

Task Managers

The sampling components will be managed by various Task Managers, as set forth in Section 1.1.2. Duties of each Task Manager include, as appropriate:

- Manage relevant day-to-day activities.
- Develop, establish, and maintain files on relevant site activities.
- Review data reductions from the relevant site activities.
- Perform final data review of field data reductions and reports on relevant site activities.
- Verify that corrective actions are taken for deficiencies cited during audits of relevant site activities.
- Perform overall QA/QC of the relevant portions of the site activities.
- Review relevant field records and logs.
- Instruct personnel working on relevant site activities.

- Coordinate field and laboratory schedules pertaining to relevant site activities.
- Request sample canisters from laboratory.
- Review field instrumentation, maintenance, and calibration to meet quality objectives.
- Prepare reports pertaining to relevant site activities.
- Maintain field and laboratory files of notebooks/logs, data reductions, and calculations. Transmit originals to the Project Manager.

Field Personnel

Responsibilities and duties include:

- Perform field procedures associated with the investigations as set forth in the Work Plans.
- Perform field analyses and collect QA samples.
- Calibrate, operate, and maintain field equipment.
- Reduce field data.
- Maintain sample custody.
- Prepare field records and logs.

Quality Assurance Coordinator

Responsibilities and duties include:

- Review laboratory data packages.
- Oversee and interface with the analytical laboratory.
- Coordinate field QA/QC procedures with Task Managers, concentrating on field analytical measurements and practices to meet data quality objectives (DQOs).

- Perform and review audit reports.

- Prepare interim QA/QC compliance reports.

- Prepare a QA/QC report in accordance with USEPA guidelines, including an evaluation of laboratory data and data usability reports.

1.2.3 Analytical Laboratories

General responsibilities and duties of the analytical laboratories include:

- Perform sample analyses and associated laboratory QA/QC procedures.

- Supply sample bottles, summa air canisters and shipping cartons.

- Maintain laboratory custody of sample.

- Strictly adhere to all protocols in the QAPP.

<u>Laboratory Project Manager</u>

Responsibilities and duties include:

- Serve as primary communication link between environmental consultant and laboratory technical staff.

- Monitor workloads and maintain availability of resources.

- Oversee preparation of analytical reports.

- Supervise in-house chain-of-custody (COC).

<u>Quality Assurance Manager</u>

Responsibilities and duties include:

- Supervise personnel reviewing and inspecting all project-related laboratory activities.

- Conduct audits of all laboratory activities.

1.2.4 Regulatory Agencies

Project Manager (PM)

Responsibilities and duties include:

- Provide USEPA/MDEQ review and approval of the QAPP, Work Plans, supporting documents, and future deliverables.

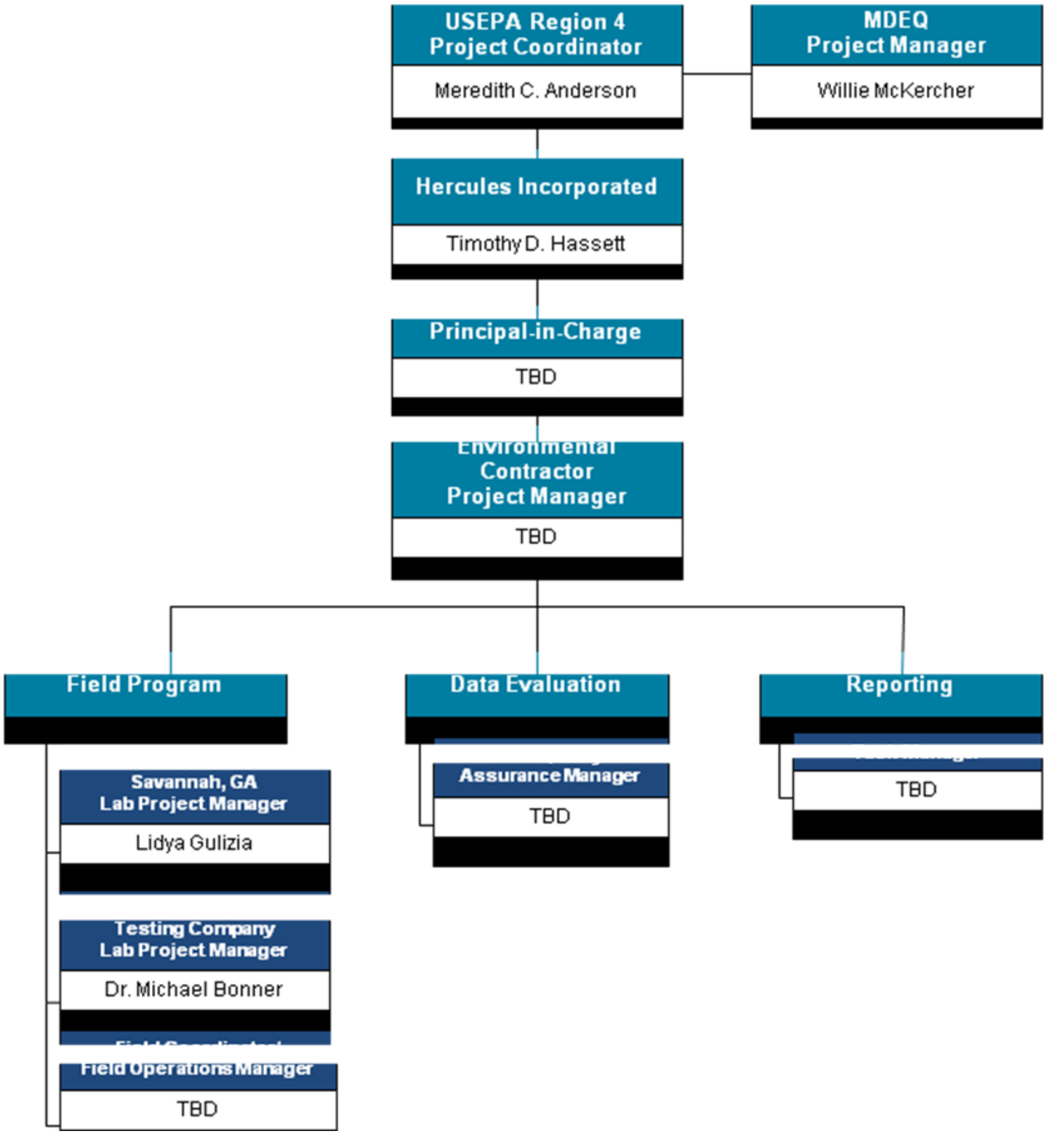
- Monitor progress of site activities.

1.2.5 Project Organization Chart

The project organization chart is presented below. The end data users for the project who will be provided copies of this QAPP, as indicated in the organization chart, include USEPA, MDEQ, Hercules and its Consultants, Contractors and Subcontractors, and the analytical laboratories.

Organizational Chart

Phase I Sampling and Analysis Work Plan



2. Project Background

The following summarizes background information for the Site which is located in Hattiesburg, Mississippi.

2.1 Site Location and Description

The Hercules site is located on approximately 200 acres of land north of West Seventh Street in Hattiesburg, Forrest County, Mississippi (Figure 1). The Site is located in Township 4 North, Range 13 West, within Sections 4 and 5 just north of Hattiesburg, Mississippi. The geographic coordinates of the Site are 31° 20' 20" North latitude and 89° 18' 25" West longitude. The physical address of the Site is 613 West Seventh Street, Hattiesburg, Mississippi. Figure 2 presents a plan view of the Site depicting the physical layout of the Site prior to recent demolition activities.

The Site is bordered to the north by Highway 42 and beyond which is Illinois-Central & Gulf Railroad, along with various residential and commercial properties. The southern property boundary is bordered by 7th Avenue and by Roseland Park cemetery and Zeon Chemical Corporation to the south-southwest. Across from these locations are residential areas. The eastern and western boundaries are bordered by residential and commercial areas.

The Site is zoned for industrial use and this zoning category is unlikely to change in the future due to the size of the property and available infrastructure. Figure 3 shows the zoning categories for the parcels located in the vicinity of the Hercules site.

2.2 Site History/Summary of Activities and Current Status

The facility began operations in 1923 and has produced over 250 products during its decades of operation. By 2009, the facility had ceased all manufacturing operations. Some of the products produced at the facility were modified resins, polyamides, ketene dimmer, crude tall oil wax emulsions, synthetic rubber, and Delnav, an agricultural pesticide. Processes included wood grinding, shredding extraction, fractionation, refining, distillation, and processing of rosin from pine tree stumps.

3. Project Description

This section presents the objectives of the monitoring and describes the associated activities to be conducted at the site.

3.1 Objectives

The objectives of the Phase I Work Plan are to:

- Determine the presence of Site-related Constituents; and
- Evaluate the nature and extent of Site-related Constituents.

Execution of the activities set forth in this Work Plan will obtain data that can be used to determine if impacts exist offsite. Media that will be evaluated may include surface water, groundwater, sediment, soil gas, and/or indoor air.

3.2 Approach

Samples collected during the assessment will be measured for concentrations of specific analytes, as described in the Work Plan. The specific analytes for measurement are dependent upon the collection location of the sample(s).

3.3 Project Schedule

The schedule for the sampling events will vary by area sampled. The sampling schedule is specified in the Work Plan.

4. Quality Objectives and Criteria for Measurement Data

The DQO process, as described in Guidance for QA Project Plans (USEPA 2002b), is intended to provide a “logical framework” for planning field investigations. The following section addresses, in turn, each of the seven sequential steps in the USEPA’s QAPP DQO process.

Step 1: Problem Statement

The Site-specific constituent list can be found in the Work Plan. The Work Plan approach includes incorporating and utilizing existing sampling data previously collected as part of Site-related assessments conducted in the area by Hercules, USEPA, or the state that relate to the purposes of the AO, including assessments to characterize the source(s) of any Site-related constituents, characterize the potential pathways of migration of these constituents, define the degree and extent of the presence of these Constituents, and identify actual or potential human and/or ecological receptors. Detected Site-related constituents will be investigated to determine the extent of any impacts.

Step 2: Decision Identification

If maximum detected concentrations of the constituents are below the USEPA and MDEQ standards for any medium, then the constituent is dropped from further consideration. There will be no excess risk to human health and adverse effects would not be expected to occur.

If maximum detected concentrations of the constituents exceed the limiting USEPA or MDEQ standards for any medium, then acceptable constituent concentrations may be recalculated using alternative acceptable risk standards ($1x10^{-6}$) as defined by precedent in USEPA Region 4.

Step 3: Identifying Decision Inputs

Decision inputs incorporate both the concentration and distribution of constituents in Site media. A fundamental basis for decision making is that a sufficient number of data points of acceptable quality must be available from the investigation to support the decision. Thus, the necessary inputs for the decision are: 1) the proportion of non-rejected (usable) data points; and 2) the quantity of data needed to evaluate whether there is unacceptable risk to human health and the environment at and surrounding the Site.

The data will be evaluated for completeness, general conformance with requirements of this QAPP, and consistency among data sets and with historical data, as appropriate.

Step 4: Defining the Study Boundaries

The facility is located within the City of Hattiesburg, Forrest County, Mississippi. The facility encompasses approximately 170 acres and is irregular in shape. Per the requirements of the AO, the surrounding area must be evaluated on a 4-mile radius and some media sampled within a one half mile radius from the Site. The Work Plan contains decision matrices per each media to be sampled that will be used to define the study boundaries.

Step 5: Developing a Decision Rule

The decision on whether data can be used will be based on the validation results. Following validation, the data will be flagged, as appropriate, and any use restrictions will be noted. The media-specific sampling plans have been devised so that the loss of any single data point will not hinder description of the distribution of constituents or the development of a risk assessment. Given this, a reasonable decision rule would be that 90 percent of the data points not be rejected or deemed unusable.

The usable data will be evaluated versus the appropriate Mississippi and USEPA standards as set force in the AO**.** The required reporting limits are documented in Table 3a, 3b, 3c-1 and -2, 3d and 3e with the intent that the lowest achievable detection limit will be reported by the laboratory and where possible at or below the screening criteria. Applicable actions would be evaluated, if needed, based on the results of the exposure evaluation.

Step 6: Limits on Decision Errors

Specifications for this step call for: 1) giving forethought to corrective actions to improve data usability; and 2) understanding the representative nature of the sampling design. This QAPP has been designed to meet both specifications for this step. The sampling and analysis program has been developed based on a review of previous site data and knowledge of present Site conditions. The representative nature of the sampling design has been facilitated by discussions among professionals familiar with the Site and the appropriate government agencies.

Step 7: Design Optimization

The overall QA objective is to develop and implement procedures for field sampling; COC, laboratory analysis, and reporting that will provide results to support the evaluation of the Site data consistent with AO requirements. Specific procedures for sampling, COC, laboratory instrument calibration, laboratory analysis, data reporting, internal QC, audits, preventive maintenance of field equipment, and corrective action are described in other sections of this QAPP.

A DQO summary for the sampling efforts is presented in the following subsection. The summary consists of stated DQOs relative to data uses, data types, data quantity, sampling and analytical methods, and data measurement performance criteria.

4.1 Data Categories

Three data categories have been defined to address various analytical data uses and the associated QA/QC effort and methods required to achieve the desired levels of quality. These categories are:

Screening Data: Screening data afford a quick assessment of site characteristics or conditions. This DQO is applicable to data collection activities that involve rapid, non-rigorous methods of analysis and QA. This objective is generally applied to physical and/or chemical properties of samples, the degree of contamination relative to concentration differences, and preliminary health and safety assessment.

Screening Data with Definitive Confirmation: Screening data allow rapid identification and quantitation. This DQO is available for data collection activities that require qualitative and/or quantitative verification of a select portion of sample findings (10 percent or more). This objective can also be used to verify less rigorous laboratory-based methods.

Definitive Data: Definitive data are generated using analytical methods such as approved USEPA reference methods. Data are analyte-specific, with confirmation of analyte identity and concentration. Methods produce raw data (*e.g.,* chromatograms, spectra, digital values) in the form of paper printouts or computer-generated electronic files.

It is anticipated that only screening data and definitive data will be used during the field investigation. For this project the level of data reporting for definitive data has been defined as follows:

- Level 2 - Modified Reporting: Modified reporting is used for analyses that are performed following standard USEPA-approved methods and QA/QC protocols. Based on the intended data use, modified reporting may require some supporting documentation, but not full Contract Laboratory Program-(CLP-) type reporting. Examples of supporting documentation include, but may not be limited to, method blank results, laboratory control sample (LCS) recoveries, matrix spike recoveries and relative percent difference (RPD), surrogate recoveries, and serial dilution results. Raw data is not required for Level 2 modified reporting.

The analytical analysis will be performed by TestAmerica located at Savannah, Georgia, and Knoxville, Tennessee, and BATCO of Hattiesburg, Mississippi. The analytical results will be reported by the laboratory in the electronic data deliverable format outlined in EQuIS Lab Standard Operating Procedure (SOP) FSMP Rev. 5 (Appendix A) and of the Form Is (results sheets) in a PDF or electronic spreadsheet format within 15 working days from date of receipt. The Level 2 data packages from the laboratory will be due within 15 working days from date of receipt.

4.2 Field Investigations

As part of the USEPA AO, field sampling will be conducted to support the DQOs. Further details of field sampling are described in the Work Plan.

4.2.1 Drinking Water Wells

Drinking water well samples will be analyzed for the following below. Please note that drinking water samples will be analyzed for the Appendix IX compound list using Drinking water methods were applicable and SW-846 methods for compounds which are not covered by the drinking water methods

- Appendix IX Volatile Organic Compounds (VOCs) by USEPA Methods 524.2 and 504.1 and SW-846 Method 8260

- Appendix IX Semivolatile Organic Compounds (SVOCs) by USEPA Method 525.2 and SW-846 Method 8270

- Appendix IX Organochlorine Pesticides by USEPA Methods 525.2 and 508 and SW-846 Method 8081A
- Appendix IX Polychlorinated Biphenyls (PCBs) by USEPA Method 508.1
- Appendix IX Herbicides by USEPA Method 515.1
- Dioxins and Furans by USEPA Method 1613
- Appendix IX Metals by USEPA Methods 200.8, 200.7, and 245.2 and SW-846 Method 6020
- Cyanide by Standard Method 4500-CN-E
- Sulfide by Standard Method 4500-S-F
- Delnav – (Dioxenethion, *cis* and *trans* Dioxathion)(BATCO 088.1)

Modification to the constituent list may occur after initial data collection and screening.

4.2.2 Surface Water and Groundwater

Surface water and groundwater samples will be analyzed for the following:

- Appendix IX VOCs by SW-846 Methods 8260B and 8011
- Appendix IX SVOCs by SW-846 Method 8270C
- Appendix IX Organochlorine Pesticides by SW-846 Method 8081A
- Appendix IX PCBs by SW-846 Method 8082
- Appendix IX Herbicides by SW-846 Method 8151A
- Dioxins and Furans by USEPA Method1613
- Appendix IX Metals by SW-846 Methods 6020/7470
- Cyanide by SW-846 Method 9012A

- Sulfide by SW-846 Method 9034
- Delnav – (Dioxenethion, *cis* and *trans* Dioxathion)(BATCO 088.1)

Modification to the constituent list may occur after initial data collection and screening.

4.2.3 Sediment and Soil Sampling

Sediment and soil samples will be analyzed for the following:

- Appendix IX VOCs by SW-846 Methods 8260B and 8011
- Appendix IX SVOCs by SW-846 Method 8270C
- Appendix IX Organochlorine Pesticides by SW-846 Method 8081A
- Appendix IX PCBs by SW-846 Method 8082
- Appendix IX Herbicides by SW-846 Method 8151A
- Dioxins and Furans by USEPA Method 1613
- Appendix IX Metals by SW-846 Methods 6020/7470
- Cyanide by SW-846 Method 9012A
- Sulfide by SW-846 Method 9034
- Delnav – (Dioxenethion, *cis* and *trans* Dioxathion)(BATCO 088.1)

Modification to the constituent list may occur after initial data collection and screening.

4.2.4 Soil Gas

Soil gas samples will be analyzed for the following:

- VOCs by USEPA Method TO-15

Modification to the constituent list may occur after initial data collection and screening.

4.2.5 Sub-Slab Soil Gas and Indoor Air

Sub-slab soil gas and indoor air samples will be analyzed for the following:

- VOCs by USEPA Method TO-15

Data Use

The data generated as part of the field sampling will be used for the monitoring program as specified in the Work Plan.

Data Quantity

The sample quantities and quality control requirements are summarized in Table 1. Additional information regarding the choice of specific sample collection locations can be found in the Work Plan.

Sampling and Analytical Methods

Sampling methods will be described in the Work Plan. The analytical methods are as specified in Table 1. Level 2 will be used for definitive data reporting (as defined previously).

Measurement Performance Criteria

Precision and accuracy QC limits for chemical constituents used during data review to assess analytical performance are included in Table 2. Reporting limits are presented in Table 3a through 3e. Data representativeness is addressed by the sample quantities and locations identified in the Work Plan. Data comparability is intended to be achieved through the use of standard USEPA-approved methods. Data completeness will be assessed at the conclusion of the analytical activities.

5. Special Training Requirements/Certification

In compliance with the Occupational Safety and Health Administration's (OSHA) final rule, "Hazardous Waste: Operations and Emergency Response," 29 Code of Federal Regulations 1910.120(e)", all personnel performing sampling activities at the site, except as noted below, will have completed the requirements for OSHA 40-Hour Hazardous Waste Operations and Emergency Response initial training and current 8-hour refresher training. Persons in field supervisory positions will have also completed the additional OSHA 8-Hour Supervisory Training.

Prior to the commencement of field activities, copies of applicable training certificates for consultant, contractor and subcontractor personnel will be provided to Hercules, or their consultant, for verification of training requirements. Copies of training certificates and records will be kept in the project file.

6. Documentation and Records

6.1 General

Samples will be collected as described in the Work Plan. Detailed descriptions of the documentation and reporting requirements are presented below.

6.2 Sample Designation System

6.2.1 Sample Codes

Samples will be identified with a unique designation system that will facilitate sample tracking. The sample designation system to be employed during the sampling activities will be consistent, yet flexible enough to accommodate unforeseen sampling events and conditions. An alpha-numeric system is considered appropriate and will be used by field personnel to assign each sample with a unique sample identification number. The sample identification number will begin with a two-letter prefix indicating the sample type and two digits indicating the sequential sample number collected from the location.

The samples types (if applicable) will be designated using the following codes:

- Soil Sample – “SS”
- Surface Water Sample – “SW”
- Sediment Sample – “SD”
- Private Well Sample – “PW”
- Groundwater Sample – “GW” or “MW”
- Soil Gas Sample – “SG”
- Indoor Air Sample – “IA”
- Trip Blank Sample – “TB”
- Field Duplicate Sample – “DUP”

- Equipment Blank Sample – “EB”

- Matrix Spike and Matrix Spike Duplicate – “MS” and MSD”

The location code, consisting of a two to five digit designation, will follow the sample type code. For subsurface soil samples, the designation will also consist of the sample depth in feet (ft). For example, a subsurface soil sample collected from a depth of 2 to 4 ft from SB-02 would be designated SS-SB-02 (2-4). For groundwater and surface water samples, the sample code will also be a six-digit number indicating the month, day and year the sample was obtained. For example a groundwater sample collected from NS-2 on July 30, 2011 will be designated MW-NS-2(073011).

QA/QC samples will be designated by a three-letter code followed by the six-digit sample collection date. For field and equipment blanks, a two-letter sample type code will precede the blank designation to indicate which medium the blank was intended to represent. For example, a field blank collected on July 30, 2011 during surface soil samples collection would be designated SS-FB1-073011. The sampling point associations for field duplicates must be recorded in the field log.

6.3 Field Documentation

Field personnel will provide comprehensive documentation covering various aspects of field sampling, field analysis, and sample COC. This documentation consists of a record that allows reconstruction of field events to aid in the data review and interpretation process. Documents, records, and information relating to the performance of the field work will be retained in the project file.

The various forms of documentation to be maintained throughout the investigation include:

- Daily Production Documentation – A field notebook(s) consisting of a waterproof, bound notebook(s) that will contain a record of all activities performed at the Site.

- Sampling Information – Detailed notes will be made as to the exact sampling location, physical observations, and weather conditions (as appropriate).

- Sample COC – COC forms will provide the record of responsibility for sample collection, transport, and submittal to the laboratory. COC forms will be filled out at each sampling site, at a group of sampling sites, or at the end of each day of sampling by field personnel responsible for sample custody. In the event that samples are relinquished by the designated sampling person to other sampling or field personnel, the COC form will be signed and dated by the appropriate personnel to document the sample transfer. The original COC form will accompany the samples to the laboratory, and copies will be forwarded to the project files. A sample COC form is included as Appendix B of this QAPP.

Persons will have custody of samples when the samples are in their physical possession, in their view after being in their possession, or in their physical possession and secured so they cannot be tampered with. In addition, when samples are secured in a restricted area accessible only to authorized personnel, they will be deemed to be in the custody of such authorized personnel.

- Field Equipment, Calibration, and Maintenance Logs – To document the calibration and maintenance of field instrumentation, calibration and maintenance logs will be maintained for each piece of field equipment that is not factory calibrated.

6.4 Laboratory Documentation Files

6.4.1 Laboratory Project Files

The laboratory will establish a file for pertinent data. The file will include correspondence, faxed information, phone logs, and COC forms. The laboratory will retain project files and data packages for a period not less than five years.

6.4.2 Laboratory Logbooks

Workbooks, bench sheets, instrument logbooks, and instrument printouts will be used to trace the history of samples through the analytical process and to document important aspects of the work, including the associated QCs. As such, logbooks, bench sheets, instrument logs, and instrument printouts will be part of the permanent record of the laboratory.

Each page or entry will be dated and initialed by the analyst at the time of entry. Errors in entry will be crossed out in indelible ink with a single stroke, corrected without the use of white-out or by obliterating or writing directly over the erroneous entry, and initialed and dated by the individual making the correction. Pages of logbooks that are not used will be completed by lining out unused portions.

Information regarding the sample, analytical procedures performed, and the results of the testing will be recorded on laboratory forms or personal notebook pages by the analyst. These notes will be dated and will also identify the analyst, the instrument used, and the instrument conditions.

Laboratory notebooks will be periodically reviewed by the laboratory group leaders for accuracy, completeness, and compliance with this QAPP. All entries and calculations will be verified by the laboratory group leader. If all entries on the pages are correct, the laboratory group leader will initial and date the pages. Corrective action will be taken for incorrect entries before the laboratory group leader signs.

6.4.3 Computer Tape and Hard Copy Storage

All electronic files and deliverables will be retained by the laboratory for not less than five years; hard copy data packages (or electronic copies) will also be retained for not less than five years.

6.5 Data Reporting Requirements

Data will be reported both in the field and by the analytical laboratory, as described below.

6.5.1 Field Data Reporting

Information collected in the field through visual observation, manual measurement, and/or field instrumentation will be recorded in field notebooks or data sheets and/or on forms. Such data will be reviewed by the appropriate Task Manager for adherence to the Work Plan and for consistency. Concerns identified as a result of this review will be discussed with the field personnel, corrected if possible, and (as necessary) incorporated into the data evaluation process.

If applicable, field data forms and calculations will be processed and included in appendices to the appropriate reports (when generated). The original field logs, documents, and data reductions will be kept in the project file.

6.5.2 Laboratory Data Reporting

The laboratory is responsible for preparing Level 2 data packages for all samples.

Data reports for all parameters will include, at a minimum, the following items:

Narrative: Summary of activities that took place during the course of sample analysis, including the following information:

- Laboratory name and address.
- Date of sample receipt.
- Cross reference of laboratory identification number to sample identification.
- Analytical methods used.
- Deviations from specified protocol.
- Corrective actions taken.

Included with the narrative will be any sample handling documents, including field and internal COC forms, air bills, and shipping tags.

Analytical Results: These will be reported according to analysis type and include the following information, as applicable:

- Sample ID
- Laboratory ID
- Date of collection
- Date of receipt
- Date of extraction
- Date of analysis
- Dilution factor
- Detection limits

Sample results on the report forms will be corrected for dilutions. Unless otherwise specified, all results will be reported uncorrected for blank contamination.

The analytical results will be reported by the laboratory in the electronic data deliverable format outlined in EQuIS SOP in Appendix A and of the Form Is (results sheets) in a PDF or electronic spreadsheet format within 15 working days from date of receipt. The Level 2 data packages from the laboratory will be due within 15 working days from date of receipt.

6.6 Project File

Project documentation will be placed in project files according to the environmental consultant's requirements. Generally, field data and laboratory reports are filed by calendar year and task.

Documents and records are retained on Site or in the environmental consultant's offices, and off site at project sites, and storage facilities (*e.g.*, Document Systems, Inc.). All corporate records and documents, regardless of where they are retained, are filed utilizing a standard filing system. The most current and frequently used records are kept on site in filing cabinets or other record storage areas. Records accessed less frequently than once per month may be sent to storage and retrieved, as needed. When boxed for off-site storage, these records must be segregated by category and record retention dates. Duplicate copies are to be discarded. Records must be stored in facilities that provide a suitable environment to prevent loss and minimize deterioration, tampering, or damage. Such facilities may have controlled access. Electronic documents, data, databases, and electronic communication are stored within files and folders located on computerized hard disk servers.

7. Sampling Process Design

The sampling process design is based on the AO required monitoring, testing, analysis and reporting for the Site. The Work Plans present the sampling location selection rationale for the sampling program.

Surface water, groundwater, drinking water, sediment, soil, soil gas and indoor air samples will be collected, as described in the Work Plan. The approximate sample quantities and field QC samples are shown in Table 1. Field investigation activities will be conducted according to the appropriate USEPA Region 4 Field Branch Quality System and Technical Procedures.

8. Sample Handling and Custody Requirements

8.1 Sample Containers and Preservation

Appropriate sample containers, preservation methods, and laboratory holding times for the samples are shown in Table 4.

The analytical laboratory will supply appropriate sample containers and preservatives, as necessary. The bottles will be purchased pre-cleaned to USEPA Office of Solid Waste and Emergency Response Directive 9240.05A requirements. The field personnel will be responsible for properly labeling containers and preserving samples (as appropriate). The field personnel will be responsible for properly labeling containers. Sample labeling procedures are discussed in Section 8.2.2.

8.2 Field Custody Procedures

The objective of field sample custody is to protect samples from tampering from the time of sample collection through time of transport to the analytical laboratory. Persons will have custody of samples when the samples are in their physical possession, in their view after being in their possession, or in their physical possession and secured so they cannot be tampered with. In addition, when samples are secured in a restricted area accessible only to authorized personnel, they will be deemed to be in the custody of such authorized personnel.

Field custody documentation consists of both field logbooks and field COC forms.

8.2.1 Field Logbooks

Field logbooks will provide the means of recording the data collecting activities that are performed. As such, entries will be described in as much detail as possible so that persons going to the site could reconstruct a particular situation without reliance on memory.

Field logbooks will be bound field survey books or notebooks. Logbooks will be assigned to field personnel, but will be stored in a secure location when not in use. Each logbook will be identified by the project specific document number. The title page of each logbook will contain the following:

- Person to whom the logbook is assigned.

- Logbook number.
- Project name.
- Project start date.
- End date.

Entries into the logbook will contain a variety of information. At the beginning of each entry, the date, start time, weather conditions, names of all sampling team members present, level of personal protection being used, and signature of the person making the entry will be provided. The names of visitors to the site and field sampling or investigation team personnel, as well as the purpose of their visit, will also be recorded in the field logbook.

Measurements made and samples collected will be recorded. Entries will be made in ink, with no erasures. If an incorrect entry is made, the information will be crossed out with a single strike mark. Whenever a sample is collected or a measurement is made, a detailed description of the location of the station will be recorded. The number of the photographs taken, if any, will also be noted. All equipment used to make measurements will be identified, along with the date of calibration.

Samples will be collected following the sampling procedures documented in the Work Plan. The equipment used to collect samples will be noted, along with the time of sampling, sample description, depth at which the sample was collected, volume, and number of containers. Sample identification numbers will be assigned prior to sample collection. Field duplicate samples, which will receive an entirely separate sample identification number, will be noted under sample description.

8.2.2 Sample Labeling

Preprinted sample labels will be affixed to sample bottles prior to delivery at the sampling site. The following information is required on each sample label:

- Project name.
- Date collected.
- Time collected.

- Location.
- Sampler.
- Analysis to be performed.
- Preservative.
- Sample number.

8.2.3 Field COC Forms

Completed COC forms will be required for all samples to be analyzed. COC forms will be initiated by the sampling crew in the field. The COC forms will contain the unique sample identification number, sample date and time, sample description, sample type, preservation (if any), and analyses required. The original COC form will accompany the samples to the laboratory. Copies of the COC will be made prior to shipment (or multiple copy forms will be used) for field documentation. The COC forms will remain with the samples at all times. The samples and signed COC forms will remain in the possession of the sampling crew until the samples are delivered to the express carrier (*e.g.*, Federal Express), hand delivered to a mobile or permanent laboratory, or placed in secure storage.

Sample labels will be completed for each sample using waterproof ink. The labels will include the information listed in Section 8.2.2, above. The completed sample labels will be affixed to each sample bottle and covered with clear tape.

Whenever samples are split with a government agency or other party, a separate COC will be prepared for those samples and marked to identify the party with whom the samples are being split. The person relinquishing the samples to the facility or agency should request the representative’s signature acknowledging sample receipt. If the representative is unavailable or refuses, this is noted in the “Received By” space.

8.3 Management of Investigation-Derived Materials and Wastes

Investigation-derived wastes (IDW) include soils, groundwater, sampling supplies, and personal protective equipment. These wastes are generated during drilling, sampling, and other sampling activities. The intent of managing IDW is to insure that impacted materials and media are not allowed to contaminate non-impacted materials and media. An example of an impacting event would be the purging of impacted groundwater and discharging that water onto non-impacted soil and shallow groundwater. Those kinds of activities will not be allowed. Where necessary to insure the safe, efficient, and environmentally protective performance of work, management of investigation-derived materials and wastes will be performed consistent with the Management of IDW, SESDPROC-202-R2 (USEPA 2010). Disposable equipment (including personal protective equipment) and debris will be containerized, appropriately labeled during the sampling events, and disposed of accordingly. All purged groundwater and water generated during equipment decontamination will be containerized, temporarily staged onsite in 55-gallon drums or portable tanks, and disposed of appropriately based on analytical results. Equipment will be decontaminated, as appropriate.

8.4 Packing, Handling, and Shipping Requirements

Sample packaging and shipment procedures are designed so that the samples will arrive at the laboratory, with the COC, intact.

Samples will be packaged for shipment as outlined below:

- Securely affix the sample label to the container with clear packing tape.
- Check the cap on the sample container to confirm that it is properly sealed.
- Wrap the sample container cap with clear packing tape to prevent the label from becoming loose.
- Complete the COC form with the required sampling information and confirm that the recorded information matches the sample labels. NOTE: If the designated sampler relinquishes the samples to other sampling or field personnel for packing or other purposes, the sampler will complete the COC prior to this transfer. The appropriate personnel will sign and date the COC form to document the sample custody transfer.
- Wrap glass sample containers in bubble wrap or other cushioning material.
- Place 1 to 2 inches of cushioning material at the bottom of the cooler.
- Place the sealed sample containers into the cooler.

- Place ice in plastic bags, seal the bags, and place the bags loosely in the cooler.
- Fill the remaining space in the cooler with cushioning material.
- Place COC forms in a plastic bag and seal. Tape the forms to the inside of the cooler lid.
- Close the lid of the cooler, lock, and secure with duct tape.
- Wrap strapping tape around both ends of the cooler at least twice.
- Mark the cooler on the outside with the shipping address and return address, affix “Fragile” labels, and draw (or affix) arrows indicating “this side up.” Cover the labels with clear plastic tape.
- Place a signed custody seal over the sample cooler lid.

Samples will be packaged by the field personnel and transported as low-concentration environmental samples. The samples will be hand delivered or delivered by an express carrier within 48 hours of the time of collection. In some cases, the analytical method may require analysis within a shorter holding time, and arrangements will need to be made to accommodate the laboratory requirements. Shipments will be accompanied by the COC form identifying the contents. The original form will accompany the shipment; copies will be retained by the sampler for the sampling office records. If the samples are sent by common carrier, a bill of lading will be used. Receipts or bills of lading will be retained as part of the permanent project documentation. Commercial carriers are not required to sign off on the COC form as long as the forms are sealed inside the sample cooler, and the custody seals remain intact.

Sample custody seals and packing materials for filled sample containers will be provided by the analytical laboratory. The filled, labeled, and sealed containers will be placed in a cooler on ice and carefully packed to eliminate the possibility of container breakage.

8.5 Laboratory Custody Procedures

8.5.1 General

Upon sample receipt, laboratory personnel will be responsible for sample custody. The original field COC form will accompany all samples requiring laboratory analysis. The laboratory will use COC guidelines described in the USEPA guidance documents. Samples will be kept secured in the laboratory until all stages of analysis are complete. All laboratory personnel having samples in their custody will be responsible for documenting and maintaining sample integrity.

8.5.2 Sample Receipt and Storage

Immediately upon sample receipt, the laboratory sample custodian will verify the integrity of the cooler seal, open the cooler, and compare the contents against the field COC. If a sample container is missing, a sample container is received broken, the sample is in an inappropriate container, or the sample has not been preserved by appropriate means, the PM will be notified. The laboratory sample custodian will be responsible for logging the samples in, assigning a unique laboratory identification number to each sample, labeling the sample bottle with the laboratory identification number, and moving the sample to an appropriate storage location to await analysis. The project name, field sample code, date sampled, date received, analysis required, storage location and date, and action for final disposition will be recorded in the laboratory tracking system. Relevant custody documentation will be placed in the project file.

8.5.3 Sample Analysis

Analysis of an acceptable sample will be initiated by worksheets that contain all pertinent information for analysis. The analyst will sign and date the laboratory COC form when removing the samples from storage.

Samples will be organized into sample delivery groups (SDGs) by the laboratory. An SDG may contain up to 20 field samples (field duplicates, trip blanks, and rinse blanks are considered field samples for the purposes of SDG assignment). All field samples assigned to a single SDG will be received by the laboratory over a maximum of seven calendar days and must be processed through the laboratory (preparation, analysis, and reporting) as a group.

8.5.4 Sample Storage Following Analysis

Samples will be maintained by the laboratory for at least 1 month after the final report is delivered. The laboratory will be responsible for the eventual and appropriate disposal of the samples. The analytical laboratory will inform the environmental consultant before any samples are disposed. Unused portions of the samples, sample extracts, and associated wastes will be disposed of by the laboratory in accordance with applicable rules and regulations, as specified in the SOP for waste disposal.

9. Analytical Method Requirements

9.1 Laboratory Parameters and Methods

The methods listed below include the range of analyses expected to be performed. The associated laboratory SOPs can be found in Appendix C. TestAmerica in Savannah, Georgia and Knoxville, Tennessee and BATCO in Hattiesburg, Mississippi will be subcontracted to perform analytical work. The QA officers at each laboratory will be responsible for conducting and reporting corrective actions if problems arise during the course of laboratory analytical procedures.

Laboratory analytical requirements presented in the sub-sections below include a general summary of requirements, specifics related to each sample medium to be analyzed, and details of the methods to be used for this project. USEPA SW-846 methods with QA/QC and reporting deliverables requirements will be used for all analytes.

9.1.1 General

The following tables summarize general analytical requirements:

Table	Title
1	Sample Quantities and Quality Control Frequencies
2	Analytical Quality Control Limits
3a	Parameters, Methods, and Target Reporting Limits – Surface Water/ Groundwater
3b	Parameters, Methods, and Target Reporting Limits – Drinking Water
3c-1 and c-2	Parameters, Methods, and Target Reporting Limits – Soil/Sediment
3d	Parameters, Methods, and Target Reporting Limits – Indoor Air
3e	Parameters, Methods, and Target Reporting Limits – Soil Gas
4	Sample Containers, Preservation, Methods, and Holding Times

9.1.2 Sample Matrices

9.1.2.1 Groundwater, Surface Water and Drinking Water

Analyses in this category will relate to groundwater, surface water, and private water well samples. Analyses will be performed following the methods and quality control frequencies listed in Table 1 and quality control limits listed in Table 2. Results will be reported in units presented in Table 3a and 3b.

The primary sources to describe the analytical methods to be used during the investigation for water matrices are provided in the USEPA SW-846 Test Methods for Evaluating Solid Waste, Third Edition, Update IV, and QA/QC, and Clean Water Act (CWA) USEPA Method 500s and 1613 and QA/QC.

9.1.2.2 Sediments/Soil

Analyses in this category will relate to sediment and soil samples. Analyses will be performed following the methods and quality control frequencies listed in Table 1 and quality control limits listed in Table 2. Results will be reported in units presented in Table 3c as dry weight. Moisture content will be reported separately.

The primary sources to describe the analytical methods to be used during the investigation for solid matrices are provided in USEPA SW-846 Test Methods for Evaluating Solid Waste, Third Edition, Update IV, and QA/QC.

9.1.2.3 Soil Gas and Indoor Air

Analyses will be performed following the methods listed in Table 1. Results will be reported in units presented in Table 3d and 3e.

The primary sources to describe the analytical methods to be used during the investigation for air matrices are provided in USEPA TO Compendium of Methods, Second Edition, and QA/QC.

10. Quality Control Requirements

10.1 Quality Assurance Indictors

The overall QA objective for this QAPP is to develop and implement procedures for sampling, COC, laboratory analysis, instrument calibration, data reduction and reporting, internal QC, audits, preventive maintenance, and corrective action, such that valid data will be generated. These procedures are presented or referenced in the following sections. Specific QC checks are discussed in Section 10.2.

QA indicators are generally defined in terms of five parameters:

1. Representativeness.
2. Comparability.
3. Completeness.
4. Precision.
5. Accuracy.

Each parameter is defined below. Specific objectives for the Site actions are set forth in other sections of this QAPP, as referenced below.

10.1.1 Representativeness

Representativeness is the degree to which sampling data accurately and precisely represent site conditions and is dependent on sampling and analytical variability and the variability of environmental media at the site. The actions have been designed to assess the presence of the chemical constituents at the time of sampling. The Work Plan presents the rationale for sample quantities and location. This QAPP presents field sampling and laboratory analytical methodologies. The use of the prescribed field and laboratory analytical methods with associated holding times and preservation requirements, is intended to provide representative data.

10.1.2 Comparability

Comparability is the degree of confidence with which one data set can be compared to another. Comparability between phases of the actions (if additional phases are required) will be maintained through consistent use of the sampling and analytical methodologies set forth in this QAPP, established QA/QC procedures, and the utilization of appropriately trained personnel.

10.1.3 Completeness

Completeness is defined as a measure of the amount of valid data obtained from an event and/or investigation compared to the total amount that was obtained. This will be determined upon final assessment of the analytical results, as discussed in Section 10.6.

10.1.4 Precision

Precision is a measure of the reproducibility of sample results. The goal is to maintain a level of analytical precision consistent with the objectives of the action. To maximize precision, sampling and analytical procedures will be followed. All work for the Site investigations will adhere to established protocols presented in the QAPP. Checks for analytical precision will include the analysis of laboratory duplicates, and field duplicates. Checks for field measurement precision will include duplicate field measurements. Further discussion of precision QC checks is provided in Section 10.4.

10.1.5 Accuracy

Accuracy is a measure of how close a measured result is to the true value. Both field and analytical accuracy will be monitored through initial and continuing calibration of instruments. In addition, reference standards, matrix spikes (MSs), blank spikes, and surrogate standards will be used to assess the accuracy of the analytical data.

10.2 Field Quality Control Checks

10.2.1 Field Measurements

To verify the quality of data using field instrumentation, duplicate measurements will be obtained and reported for all field measurements. A duplicate measurement will involve obtaining measurements a second time at the same sampling location.

10.2.2 Sample Containers

The bottles will be purchased pre-cleaned to USEPA Office of Solid Waste and Emergency Response Directive 9240.05A requirements.

10.2.3 Field Duplicates

Field duplicates will be collected to verify the reproducibility of the sampling methods. Field duplicate air samples for VOC analysis will constitute co-located samples. In general, field duplicates will be analyzed at a 5 percent frequency (every 20 samples) for the chemical constituents. Table 1 provides an estimated number of field duplicates to be prepared for each applicable parameter and matrix.

10.2.4 Rinse Blanks

Rinse blanks are used to monitor the cleanliness of the sampling equipment and the effectiveness of the cleaning procedures. Rinse blanks will be prepared and submitted for analysis at a frequency of 1 per day (when re-useable sample equipment cleaning occurs) or once for every 20 samples collected, whichever is less. Rinse blanks will be prepared by filling sample containers with analyte-free water (supplied by the laboratory), which has been routed through a cleaned sampling device. When dedicated sampling devices are used or sample containers are used to collect the samples, rinse blanks will not be necessary. Table 1 provides an estimated number of rinse blanks collected during the investigation activities.

10.2.5 Trip Blanks

Trip blanks will be used to assess whether samples have been exposed to non Site-related volatile constituents during storage and transport. Trip blanks will be analyzed at a frequency of once per day, per cooler containing samples to be analyzed for VOCs. A trip blank will consist of a container filled with analyte-free water (supplied by the laboratory), which remains unopened with field samples throughout the sampling event. Table 1 provides an estimated number of trip blanks collected for each matrix and parameter during the investigation activities.

10.3 Analytical Laboratory Quality Control Checks

10.3.1 General

Internal laboratory QC checks will be used to monitor data integrity. These checks will include method blanks, laboratory control samples, internal standards, surrogate samples and calibration standards. Project quality control limits are identified in Table 2. Laboratory control charts will be used to determine long-term instrument trends.

10.3.2 Method Blanks

Sources of contamination in the analytical process, whether specific analyses or interferences, must be identified, isolated, and corrected. The method blank is useful in identifying possible sources of contamination within the analytical process. For this reason, it is necessary that the method blank be initiated at the beginning of the analytical process and encompasses all aspects of the analytical work. As such, the method blank would assist in accounting for any potential contamination attributable to glassware, reagents, instrumentation, or other sources that could affect sample analysis. One method blank will be analyzed with each analytical series associated with no more than 20 samples.

10.3.3 Matrix Spike/Matrix Spike Duplicates (MS/MSDs)

MS/MSDs will be used to measure the accuracy of analyte recovery from the sample matrices and will be Site-specific. MS/MSD pairs will be analyzed at a 5 percent frequency (every 20 samples or once every week, whichever comes first).

When MS recoveries are outside quality control limits, associated control sample and surrogate spike recoveries will be evaluated, as applicable, to attempt to verify the reason for the deviation and determine the effect on the reported sample results. Table 1 presents an estimated number of MS and MSD analyses for each applicable parameter.

10.3.4 Laboratory Control Samples

LCS are standards of known concentration and are independent in origin from the calibration standards. The intent of LCS analysis is to provide insight into the analytical proficiency within an analytical series. This includes preparation of calibration standards, validity of calibration, sample preparation, instrument set-up, and the premises inherent in quantitation. Reference standards will be analyzed at the frequencies specified within the analytical methods.

10.3.5 Surrogate Spikes

Surrogates are compounds that are unlikely to occur under natural conditions but that have properties similar to the analytes of interest. This type of control is primarily used for organic samples analyzed by gas chromatography/mass spectrometry (GC/MS) and GC methods and is added to the samples prior to purging or extraction. The surrogate spike is utilized to provide broader insight into the proficiency and efficiency of an analytical method on a sample-specific basis. This control reflects analytical conditions that may not be attributable to sample matrix.

If surrogate spike recoveries exceed specified QC limits, the analytical results must be evaluated thoroughly in conjunction with other control measures. In the absence of other control measures, the integrity of the data may not be verifiable, and reanalysis of the samples with additional control may be necessary.

Surrogate spike compounds will be selected utilizing the guidance provided in the analytical methods.

10.3.6 Laboratory Duplicates

Laboratory duplicates will be analyzed to assess laboratory precision. Laboratory duplicates are defined as a separate aliquot of an individual sample that is analyzed as a separate sample. Table 1 presents an estimated number of laboratory duplicates for each applicable parameter.

10.3.7 Calibration Standards

Calibration check standards analyzed within a particular analytical series provide insight regarding instrument stability. A calibration check standard will be analyzed at the beginning and end of an analytical series, or periodically throughout a series containing a large number of samples.

In general, calibration check standards will be analyzed after every 12 hours or more frequently, as specified in the applicable analytical method. If results of the calibration check standard exceed specified tolerances, samples analyzed since the last acceptable calibration check standard will be re-analyzed.

Laboratory instrument calibration standards will be selected utilizing the guidance provided in the analytical methods as summarized in Section 12.

10.3.8 Internal Standards

Internal standard areas and retention times will be monitored for organic analyses performed by GC/MS methods. Method-specified internal standard compounds will be spiked into all field samples, calibration standards, and quality control samples after preparation and prior to analysis. If internal standard areas in one or more samples exceed the specified tolerances, the cause will be investigated, the instrument will be recalibrated if necessary, and all affected samples may be re-analyzed.

The acceptability of internal standard performance will be determined using the guidance provided within the analytical methods

10.4 Data Precision Assessment Procedures

Field precision is difficult to measure because of temporal variations in field parameters; however, precision will be controlled through the use of experienced field personnel, properly calibrated meters, and duplicate field measurements. Field duplicates will be used to assess precision for the entire measurement system, including sampling, handling, shipping, storage, preparation, and analysis.

Laboratory data precision for analyses will be monitored through the use of MSDs, laboratory duplicate, and field duplicates as identified in Table 1.

The precision of data will be measured by calculation of the RPD by the following equation:

$$\text{RPD} = \frac{(A-B)}{(A+B)/2} \times 100$$

Where:

A = Analytical result from one of two duplicate measurements
B = Analytical result from the second measurement

Precision objectives for duplicate analyses are identified in Table 2.

10.5 Data Accuracy Assessment Procedures

The accuracy of field measurements will be controlled by experienced field personnel, properly calibrated field meters, and adherence to established protocols. The accuracy of field meters will be assessed by review of calibration and maintenance logs.

Laboratory accuracy will be assessed via the use of matrix spikes, surrogate spikes, internal standards, and reference standards. Where available and appropriate, QA performance standards will be analyzed periodically to assess laboratory accuracy. Accuracy will be calculated in terms of percent recovery as follows:

$$\% \text{ Recovery} = \frac{A-X}{B} \times 100$$

Where:

A = Value measured in spiked sample or standard
X = Value measured in original sample
B = True value of amount added to sample or true value of standard

This formula is derived under the assumption of constant accuracy between the original and spiked measurements. Accuracy objectives for MS recoveries are identified in Table 2.

10.6 Data Completeness Assessment Procedures

Completeness of a field or laboratory data set will be calculated by comparing the number of valid sample results generated to the total number of results generated.

$$\text{Completeness} = \frac{\text{Number valid results}}{\text{Total number of results generated}} \times 100$$

As a general guideline, overall project completeness is expected to be at least 90 percent. The assessment of completeness will require professional judgment to determine data usability for intended purposes.

11. Instrument/Equipment Testing, Inspection, and Maintenance Requirements

11.1 General

Testing and maintenance schedules have been developed for both field and laboratory instruments. A summary of the testing and maintenance activities to be performed is presented below.

11.2 Field Instruments and Equipment

Prior to field sampling, each piece of field equipment will be calibrated (if necessary) and inspected to confirm that it is operational. If the equipment is not operational, it will be serviced prior to its use. All meters that require charging or batteries will be fully charged or have fresh batteries. If instrument servicing is required, it is the responsibility of the appropriate Task Manager or field personnel to follow the maintenance schedule and arrange for timely service. Field instruments will be maintained according to the manufacturers' instructions.

Logbooks will be kept for each field instrument. Logbooks will contain records of operation, maintenance, calibration, and any problems and repairs. Logbooks for each piece of equipment will be maintained in project records. The Task Managers will review calibration and maintenance logs.

11.2.1 Equipment Maintenance

All measuring and test equipment to be used in support of the Work Plan activities that directly affect the quality of the analytical data shall be subject to preventative maintenance measures that minimize equipment downtime. Equipment will be examined to certify that it is in operating condition. This includes checking the manufacturer's operating manual to confirm that all maintenance requirements are being observed. Field notes from previous sampling events will be reviewed to verify that any prior equipment problems are not overlooked and that any necessary repairs to equipment have been carried out. In most cases, the environmental consultant will be using field meters maintained and calibrated by national, reputable environmental rental equipment companies; calibration and maintenance records are provided with these pieces of rental equipment and will be maintained as part of the project file.

Field equipment returned from a site will be inspected to confirm that it is in working order. The inspection will be recorded in the logbook or field notebooks, as appropriate. It will also be the obligation of the last user to record any equipment problems in the logbook. Non-operational field equipment will either be repaired or replaced. Appropriate spare parts for field equipment/meters will be available from the rental companies or manufacturers. Consultant-/subcontractor-owned or leased equipment will be maintained in accordance with the manufacturer's instructions.

11.3 Laboratory Instruments and Equipment

11.3.1 General

Laboratory instrument and equipment documentation procedures include details of any observed problems, corrective measure(s), routine maintenance, and instrument repair (including information regarding the repair and the individual who performed the repair).

Preventive maintenance of laboratory equipment generally will follow the guidelines recommended by the manufacturer. A malfunctioning instrument will be repaired immediately by in-house staff or through a service call from the manufacturer.

11.3.2 Instrument Maintenance

Maintenance schedules for laboratory equipment adhere to each manufacturer's recommendations. Records reflect the complete history of each instrument and specify the time frame for future maintenance. Major repairs or maintenance procedures are performed through service contracts with the manufacturer or qualified contractors. Paperwork associated with service calls and preventative maintenance calls will be kept on file by the laboratory.

Laboratory Systems Managers are responsible for the routine maintenance of instruments used in the particular laboratory. Any routine preventative maintenance carried out is logged into the appropriate logbooks. The frequency of routine maintenance is dictated by the nature of samples being analyzed, the requirements of the method used, and/or the judgment of the Laboratory Systems Manager.

All major instruments are backed up by comparable (if not equivalent) instrument systems in the event of unscheduled downtime. An inventory of spare parts is also available to minimize equipment/instrument downtime.

12. Instrument Calibration and Frequency

12.1 Field Instruments and Equipment

The calibration of field instruments is governed by specific SOPs documented in the *Field Measurement Procedures* (USEPA Region 4) for the applicable field analysis method, and such procedures take precedence over the following discussion. Manufacturer instructions will be consulted by field staff regarding specific calibration instructions for field instruments. The measurement-specific procedures outlined in the *Field Measurement Procedures* (USEPA Region 4) will be followed for calibration of field instruments used on site. If any revisions to this QAPP, the Work Plan, or to the *Field Measurement Procedures* are made, then the revised versions shall be distributed to the field personnel by the PM or Task Manager as soon as they are available.

Field calibration solutions, standards, and gases shall be used within specified expiration dates and will be obtained from manufacturers or authorized suppliers. Calibration solutions, standards, and gases will be discarded or returned to the supplier if expiration dates have been exceeded.

Field personnel are responsible for confirming that a master calibration/maintenance log is maintained following the procedures specified for each measuring device. A calibration log for each specific field instrument (as identified by serial/instrument number) will be used to link daily calibrations to that specific field instrument. Where applicable, each log will include, at a minimum, the following information in order to link daily calibrations to specific field instruments:

- Name of device and/or instrument calibrated.
- Device/instrument serial/identification numbers.
- Calibration method.
- Tolerance.
- Calibration standard used.
- Frequency of calibration.

- Date(s) of calibration(s).

- Name of person(s) performing calibration(s).

Instruments and equipment used to gather, generate, or measure environmental data will be calibrated at the intervals specified by the manufacturer or more frequently, and in such a manner that accuracy and reproducibility of results are consistent with the manufacturer's specifications. In the event that an internally calibrated field instrument fails to meet calibration/checkout procedures, it will be returned to the manufacturer for service. Equipment found to be out of tolerance during the period of use will be removed from the field, and measuring and testing activities performed using the equipment will be addressed via the corrective action system described in Section 16.4 of this QAPP.

12.2 Laboratory Instrument and Equipment

When analyses are conducted according to USEPA methods, the calibration procedures and frequencies specified in the applicable method will be followed, as noted in the attached SOPs (Attachment C). For analyses governed by SOPs, see the appropriate SOP for the required calibration procedures and frequencies. Records of calibrations will be filed and maintained by the laboratory. These records will be subject to QA audit. For all instruments, the laboratory will maintain trained repair staff with in-house spare parts or will maintain service contracts with vendors.

All standards used in the calibration of equipment are traceable, directly or indirectly, to National Institute of Standards and Technology. All standards received shall be logged into standard receipt logs maintained by the individual analytical groups. Each group will maintain a standards log that tracks the preparation of standards used for calibration and QC purposes.

13. Inspection/Acceptance Requirements for Supplies and Consumables

All supplies to be used in the field and laboratory will be available when needed. They will be free of target chemicals and interferences.

All laboratory reagents will be tested for acceptability, prior to use in the analyses of samples. All standards will be verified against a second source standard. The laboratory will follow a “first in/first out” procedure for the storage and use of all consumables to minimize the risk of contamination and degradation. The various supplies and consumables required are noted in the laboratory SOPs, which is included as an attachment to this document.

14. Data Acquisition Requirements for Non-Direct Measurements

The historical data sets have been used in preparing the Work Plan.

Historical data that have been generated consistent with appropriate laboratory requirements will be used in decision making. The criteria for usable analytical data are that the data must be generated through procedures consistent with the CLP, must contain backup to facilitate validation, and must be deemed acceptable for use following validation of the supporting laboratory documentation.

15. Data Management

The purpose of the data management is to provide for the accuracy and ready accessibility of all of the necessary data to meet the analytical and reporting objectives of the project.

The data management program established for the project includes field documentation and sample QA/QC procedures, methods for tracking and managing the data, and a system for filing all site-related information. More specifically, data management procedures will be employed to efficiently process the information collected such that the data are readily accessible and accurate. These procedures are described in detail in the following section.

The data management plan has four elements: 1) sample designation system; 2) field activities; 3) sample tracking and management; and 4) data management system.

15.1 Sample Designation System

A concise and easily understandable sample designation system is an important part of the project sampling activities. It provides a unique sample number that will facilitate both sample tracking and easy re-sampling of select locations to evaluate data gaps, if necessary. The sample designation system to be employed during the sampling activities will be consistent, yet flexible enough to accommodate unforeseen sampling events or conditions. A combination of letters and numbers will be used to yield a unique sample number for each field sampled collected, as outlined in Section 6.2.1.

15.2 Field Activities

Field activities designed to gather the information during the field investigation process require consistent documentation and accurate record keeping. During site activities, standardized procedures will be used for documenting field activities, data security, and QA. These procedures are described in further detail in the following subsections.

15.2.1 Field Documentation

Complete and accurate record keeping is a critical component of the field investigation activities. When interpreting analytical results and identifying data trends, investigators realize that field notes are an important part of the review and validation process. To provide for the thorough documentation of the field investigation, several different information records, each with its own specific reporting requirements, will be maintained, including:

- Field logs
- COC forms

A description of each of these types of field documentation is provided below.

Field Logs

The personnel performing the field activities will keep field logs that detail all observations and measurements made during sampling. Data will be recorded directly into site-dedicated, bound notebooks, with each entry dated and signed. So that it can be confirmed at any future date that notebook pages are not missing, each page will be sequentially numbered. Erroneous entries will be corrected by crossing out the original entry, initialing it, and then documenting the proper information. In addition, certain media sampling locations will be surveyed to accurately record their locations. The survey crew will use their own field logs and will supply the sampling location coordinates to the Database Administrator.

COC Forms

COC forms are used as a means of documenting and tracking sample possession from time of collection to the time of disposal. A COC form will accompany each field sample collected, and one copy of the form will be filed in the field office. All field personnel will be briefed on the proper use of the COC procedure.

15.2.2 Data Security

Measures will be taken during the field investigation to prevent samples and records from being lost, damaged, or altered. When not in use, all field notebooks will be stored at the field office or locked in the field vehicle. Access to these files will be limited to the field personnel who utilize them. An electronic copy (*e.g.,* scan to pdf) of all field data and laboratory data are available to all project team members.

15.3 Sample Tracking and Management

A record of all field documentation will be maintained to provide verification of the validity of data used in the site analysis. To effectively execute such documentation, specific sample tracking and data management procedures will be used throughout the sampling program.

Sample tracking will begin with the completion of COC forms, as summarized in Section 8.2.3. The completed COC forms associated with samples collected will be faxed and/or scan and emailed to the Database Administrator. Copies of all completed COC forms will be maintained in the field office. The laboratory will verify receipt of the samples electronically (via email) on the following day.

When analytical data are received from the laboratory, the QAC or his designee will review the incoming analytical data packages against the information on the COCs to confirm that the correct analyses were performed for each sample and that results for all samples submitted for analysis were received. Any discrepancies noted will be promptly followed up by the QAC.

15.4 Data Management System

In addition to the sample tracking system, a data management system will be implemented. The central focus of the data management system will be the development of a personal computer-based project database. Additionally, the data management system will allow submission of data to USEPA and MDEQ in a format specified in the USEPA Region 4 April 23, 2010, “Data Management and Electronic Data Deliverables” memorandum. The project database, to be maintained by the Database Administrator, will combine pertinent geographical, field, and analytical data. Information that will be used to populate the database will be derived from three primary sources: surveying of sampling locations, field observations, and analytical results. Each of these sources is discussed in the following sections.

15.4.1 Computer Hardware

The database will be constructed on personal computer work stations connected through a network server. The network will provide access to various hardware peripherals, such as laser printers, backup storage devices, image scanners, and modems. Computer hardware will be upgraded to industrial and corporate standards, as necessary, in the future.

15.4.2 Computer Software

The data will be warehoused in EQUIS 5 Enterprise system that uses a SQL Server database. Geographic information system (GIS) applications will be developed in ESRI ArcGIS, with additional customization performed with Visual Basic. Tables and other database reports will be generated through Microsoft Access in conjunction with Microsoft Excel and/or Microsoft Word. These software products will be upgraded to current industrial standards, as necessary.

15.4.3 Survey Information

In general, each location sampled will be surveyed or located using a global positioning system with sub-meter accuracy to confirm that accurate documentation of sample locations for mapping and geographic information system purposes (if appropriate) to facilitate the re-sampling of select sample locations during future monitoring programs, if needed, and for any potential remediation activities. The surveying activities that will occur in the field will consist of the collection of information that will be used to compute a northing and easting in state plane coordinates for each sample location and the collection of information to compute elevations relative to the National Geodetic Vertical Datum of 1988 for select sample locations, as appropriate. All field books associated with the surveying activities will be stored as a record of the project activities.

15.4.4 Field Observations

An important part of the information that will ultimately reside in the data management system for use during the project will originate in the observations that are recorded in the field.

During each sampling event, appropriate field documentation will be prepared by the field personnel who performed the sampling activities. The purpose of the documentation is to create a summary and a record of the sampling event. Items to be included are the locations sampled, the sampling methodologies used, blind duplicate and sample identification numbers, equipment decontamination procedures, personnel involved in the activity, and any noteworthy events that occurred.

15.4.5 Analytical Results

Analytical results will be provided by the laboratory in both digital and a hard copy format. The data packages will be examined to confirm that the correct analyses were performed for each sample submitted and that all of the analyses requested on the COC form were performed. If discrepancies are noted, the QAC will be notified and will promptly follow up with the laboratory to resolve any issues.

Each data package will be validated in accordance with the procedures presented in Section 19. Any data that do not meet the specified standards will be flagged pending resolution of the issue. The flag will not be removed from the data until the issue associated with the sample results is resolved. Although flags may remain for certain data, the use of those data may not necessarily be restricted.

Following completion of the data validation, the digital files will be used to populate the appropriate database tables. An example of the format of electronic data deliverable (EDD) format is included in EQuIS SOP in Appendix A. As stated above in section 15.4 once the data validation is complete the data management system will allow submission of data to USEPA and MDEQ in a EDD format specified in the USEPA Region 4 April 23, 2010, “Data Management and Electronic Data Deliverables” memorandum. The EQuIS SOP in Appendix A format specifies one data record for each constituent for each sample analyzed. Specific fields include:

- Sample identification number.
- Date sampled.
- Date analyzed.
- Parameter name.
- Analytical result.
- Units.
- Detection limit.
- Qualifier(s).

The individual EDDs, supplied by the laboratory in Equis 5 file format, will be loaded into the appropriate database. Any analytical data that cannot be provided by the laboratory in electronic format will be entered manually. After entry into the database, the EDD data will be compared to the field information previously entered into the database to confirm that all requested analytical data have been received.

15.4.6 Data Analysis and Reporting

The database management system will have several functions to facilitate the review and analysis of the data. Routines have been developed to permit the user to scan analytical data from a given site for a given media. Several output functions are also available that can be modified, as necessary, for use in the data management system.

A valuable function of the data management system will be the generation of tables of analytical results from the project databases. The capability of the data management system to directly produce tables reduces the redundant manual entry of analytical results during report preparation and precludes transcription errors that may occur otherwise. This data management system function creates a digital file of analytical results and qualifiers for a given media. The file can then processed into a table of rows and columns that can be transferred to word processing software (*e.g.,* Microsoft® Excel) for final formatting and addition of titles and notes. Tables of analytical data will be produced as part of data interpretation tasks and the reporting of data to the USEPA.

The data management system also has the capability of producing a digital file of select parameters that exists in one or more of the databases. This type of custom function is accomplished on an interactive basis and is best used for transferring select information into a number of analysis tools, such as statistical or graphing programs.

16. Assessment and Response Actions

16.1 General

Performance and systems audits may be completed in the field and laboratory during the sampling, as described below.

16.2 Field Audits

The following field performance and systems audits may be completed during this project.

The appropriate Task Manager will monitor field performance. Field performance audit summaries will contain an evaluation of field activities to verify that the activities are performed according to established protocols. Field performance audits may be performed by the USEPA Project Manager (or his designee), and the environmental consultant Project Manager. The auditor(s) will review field reports and communicate concerns to the environmental consultant's Project Manager and/or Task Managers, and/or USEPA/MDEQ Project Manager, as appropriate.

The number and frequency of field performance audits conducted by the USEPA PM will be determined independently by the USEPA/MDEQ PMs. The environmental consultant Project Manager, or their designee, will conduct field performance audits at a minimum frequency of one per month during the duration of the field activities. The observations made during field performance audits and any recommended changes/deviations to the field procedures will be recorded and documented. The observations and any recommendations will be distributed to the USEPA/MDEQ PMs and the Hercules Project Team, as appropriate.

In addition, systems audits comparing scheduled QA/QC activities from this QAPP with actual QA/QC activities completed will be performed. The appropriate Task Manager and QAC will periodically confirm that work is being performed consistent with this QAPP and the Work Plan.

16.3 Laboratory Audits

Internal laboratory audits are conducted by the Laboratory QA Manager. As part of the audit, the overall performance of the laboratory staff is evaluated and compared to the performance criteria outlined in the laboratory QA manual and SOPs. The results of the audits are summarized and issued to each department supervisor, the Laboratory Manager, and the Laboratory Director. A systems audit of each laboratory may be performed by the QA Manager to determine whether the procedures implemented by each laboratory are in compliance with the QA manual and SOPs.

As a participant in state and federal certification programs, the laboratory is audited by representatives of the regulatory agency issuing certification in addition to the laboratory's internal audits. Audits are usually conducted on an annual basis and focus on laboratory conformance to the specific program protocols for which the laboratory is seeking certification. The auditor reviews sample handling and tracking documentation, analytical methodologies, analytical supportive documentation, and final reports. The audit findings are formally documented and submitted to the laboratory for corrective action, if necessary.

16.4 Corrective Action

Corrective actions are required when field or analytical data are not within the objectives specified in this QAPP or the Work Plan. Corrective actions include procedures to promptly investigate, document, evaluate, and correct data collection and/or analytical procedures. Field and laboratory corrective action procedures for the actions are described below.

16.4.1 Field Procedures

If, during field work, a condition is noted by the field crew that would have an adverse effect on data quality, corrective action will be taken so as not to repeat this condition. Condition identification, cause, and corrective action implemented by the Field Manager or a designee will be documented on a Corrective Action Form and reported to the appropriate Task Manager, QAC, and PM.

Examples of situations that would require corrective actions are provided below:

- Protocols as defined by the QAPP and Work Plan have not been followed.
- Equipment is not in proper working order or is not properly calibrated.
- QC requirements have not been met.
- Issues resulting from performance or systems audits have not been resolved.

Project personnel will continuously monitor ongoing work performance in the normal course of daily responsibilities.

16.4.2 Laboratory Procedures

In the laboratory, when a condition is noted to have an adverse effect on data quality, corrective action will be taken so as not to repeat this condition. Condition identification, cause, and corrective action taken will be documented and reported to the appropriate PM and QAC.

Corrective action may be initiated, at a minimum, under the following conditions:

- Protocols as defined by this QAPP have not been followed.
- Predetermined data acceptance standards are not obtained.
- Equipment is not in proper working order or calibrated.
- Sample and test results are not completely traceable.
- QC requirements have not been met.
- Issues resulting from performance or systems audits have not been resolved.

Laboratory personnel will continuously monitor ongoing work performance in the normal course of daily responsibilities. Corrective action is initiated at the point where the problem has been identified. At whatever level this occurs (analyst, supervisor, data review, or quality control), it is brought to the attention of the Laboratory QA Manager and, ultimately, the Laboratory Director. Final approval of any action deemed necessary is subject to the approval of the Laboratory Director.

Any corrective action deemed necessary based on system or performance audits, the analytical results of split samples, or the results of data review will be implemented. The corrective action may include sample re-extraction, re-preparation, re-analysis, cleanup, dilution, matrix modification, or other activities.

17. Reports to Management

The QAC will audit the implementation of the QAPP. Each project component will result in some type of QA report or, by its absence, will indicate that no significant QA or QC deviations occurred. Items that may result in a QA report include:

- Changes or updates to the QAPP.
- Deviations from QAPP or Work Plan specification.
- Results of system and performance audits.
- Significant QA/QC problems, recommended solutions, and the results of corrective actions.
- Limitations on the use of measurement data.

17.1 Field Reports

Reporting of the quality of field sample collection and field measurements will be the responsibility of the Field Supervisor or designee. Information from the field logbooks will be compiled, and a summary report on field activity QA will be prepared for the project file.

17.2 Laboratory Reports

The laboratory will maintain QA records related to analyses, QC, and corrective action. This information will be made available to the Project Manager upon request. Routine reporting will include documenting all internal QC checks performed for this project.

18. Data Reduction and Review

18.1 General

After field and laboratory data are obtained, the data will be subject to the following:

- Reduction, or manipulation mathematically or otherwise into meaningful and useful forms.
- Data validation.
- Review.
- Organization, interpretation, and reporting.

18.2 Field Data Reduction and Review

18.2.1 Field Data Reduction

Information collected in the field through visual observation, manual measurement, and/or field instrumentation will be recorded in field notebooks or data sheets, and/or on forms. Such data will be reviewed by the appropriate Task Manager for adherence to the Work Plan and this QAPP and for consistency. Concerns identified as a result of this review will be discussed with the field personnel; corrected if possible; and, as necessary, incorporated into the data evaluation process.

18.2.2 Field Data Review

Field data calculations, transfers, and interpretations will be conducted by the field personnel and reviewed for accuracy by the appropriate Task Manager and the QAC. Logs and documents will be checked for:

- General completeness.
- Readability.
- Usage of appropriate procedures.
- Appropriate instrument calibration and maintenance.

- Reasonableness in comparison to present and past data collected.
- Correct sample locations.
- Correct calculations and interpretations.

18.3 Laboratory Data Reduction and Review

18.3.1 Laboratory Data Reduction

The calculations used for data reduction will be specified in each of the analytical methods referenced previously. Whenever possible, analytical data will be transferred directly from the instrument to a computerized data system. Raw data will be entered into permanently bound laboratory notebooks. The data entered must be sufficient to document all factors used to arrive at the reported value.

Concentration calculations for chromatographic analyses will be based on response factors. Quantitation will be performed using internal standards.

Unless otherwise specified, all values will be reported uncorrected for blank contamination.

18.3.2 Laboratory Data Review

Data will be subject to multi-level review by the laboratory. The group leader will review all data reports prior to release for final data report generation. The QAC will review the final data reports, and the Laboratory Director will review a cross section of the final data reports prior to shipment to the environmental consultant.

If discrepancies or deficiencies are present in the analytical results, corrective action will be taken, as discussed in Section 17. Deficiencies discovered as a result of internal data review, as well as the corrective actions to be used to rectify the situation, will be documented on a Corrective Action Form. This form will be submitted to the environmental consultant Project Manager.

18.4 Data Validation and Verification

All data generated will be subjected to the data validation and verification procedures outlined in Section 19. Data generated for screening or disposal purposes will not be reviewed.

19. Data Validation and Verification

Data validation entails a review of the QC data and the raw data to verify that the laboratory was operating within required limits; the analytical results were correctly transcribed from the instrument read-outs; and which, if any, environmental samples were related to out-of-control QC samples. The objective of data validation is to identify any questionable or invalid laboratory measurements.

All data generated will be validated using the most recent versions of the USEPA’s Function Guidelines (USEPA 1999; 2004) and USEPA Region 4 Data Validation SOPs (USEPA Region 4, 1999; 2008) for data validation available at the time of project initiation, where appropriate. These procedures and criteria may be modified, as necessary, to address project-specific and method-specific criteria, control limits, and procedures. Data validation will consist of data screening, checking, reviewing, and editing to document analytical data quality and to determine whether the quality is sufficient to meet the DQOs.

Approximately 10 percent of the samples of each matrix will be validated. Samples chosen for validation will be selected from a single SDG per matrix. Should data within the SDG require qualification as estimated, other sample results in the same SDG will be evaluated and qualified, as appropriate. If any data are qualified as rejected during the validation, other SDGs and data for the parameters rejected will be further evaluated.

The data validator will verify that reduction of laboratory measurements and laboratory reporting of analytical parameters is in accordance with the procedures specified for each analytical method and/or as specified in this QAPP. Any deviations from the analytical method or any special reporting requirements apart from those specified in this QAPP will be detailed on COC forms.

Upon receipt of laboratory data, the following procedures will be executed by the data validator:

- Evaluate completeness of data package;
- Verify that field COC forms were completed and that samples were handled properly;

- Verify that holding times were met for each parameter. Holding time exceedances, should they occur, will be documented. Data for all samples exceeding holding time requirements will be flagged as either estimated or rejected. The decision as to which qualifier is more appropriate will be made on a case-by-case basis;

- Verify that parameters were analyzed according to the methods specified;

- Review QA/QC data (*i.e.,* confirm that duplicates, blanks, and LCS were analyzed on the required number of samples, as specified in the method and verify that duplicate RPD are acceptable); and

- Investigate anomalies identified during review. When anomalies are identified, they will be discussed with the PM and/or Laboratory Manager, as appropriate.

Deficiencies discovered as a result of the data review, as well as the corrective actions implemented in response, will be documented and submitted in the form of a written report addressing the following topics, as applicable to each method:

- Assessment of the data package;

- Description of any protocol deviations;

- Failures to reconcile reported and/or raw data;

- Assessment of any compromised data;

- Overall appraisal of the analytical data; and

- Table of site name, sample quantities, matrix, and fractions analyzed.

It should be noted that qualified results do not necessarily invalidate data. The goal to produce the best possible data does not necessarily mean that data must be produced without QC qualifiers. Qualified data can provide useful information.

During the review process, laboratory qualified and unqualified data are verified against the supporting documentation. Based on this evaluation, qualifier codes may be added, deleted, or modified by the data reviewer. Results will be qualified with the following codes in accordance with National Functional Guidelines:

Concentration (C) qualifiers

U	The analyte/compound was analyzed for but not detected. The associated value is the compound quantitation limit.
J	The compound was positively identified; however, the associated numerical value is an estimated concentration only.

Quantitation (Q) qualifiers

Inorganics:

B	The compound has been found in the sample as well as its associated blank, its presence in the sample may be suspect.
E	The reported value is estimated due to the presence of interference.
N	Spiked sample recovery not within control limits.
*	Duplicate analysis not within control limits.

Organics:

B	The compound has been found in the sample as well as its associated blank, its presence in the sample may be suspect.
N	The analysis indicates the presence of a compound for which there is presumptive evidence to make a tentative identification.
JN	The analysis indicates the presence of a compound for which there is presumptive evidence to make a tentative identification. The associated numerical value is an estimated concentration only.
E	The compound was quantitated above the calibration range.
D	Concentration is based on a diluted sample analysis.
C	Identification confirmed by GC/MS.

Validation qualifiers

UJ	The compound was not detected above the reported sample quantitation limit. However, the reported limit is approximate and may or may not represent the actual limit of quantitation.
UB	Compound considered non-detect at the listed value due to associated blank contamination.
R	The sample results are rejected.

Two facts will be noted to all data users. First, the "R" flag means that the associated value is unusable. In other words, due to significant QC problems, the analysis is invalid and provides no information as to whether the compound is present or not. "R" values should not appear on data tables because they cannot be relied upon, even as a last resort. The second fact is that no compound concentration, even if it has passed all QC tests, is guaranteed to be accurate. Strict QC serves to increase confidence in data but any value potentially contains error.

Resolution of any issues regarding laboratory performance or deliverables will be handled between the laboratory and the data validator. Suggestions for reanalysis may be made by the QAC at this point.

Data validation reports will be kept in electronic format (PDF) at the environmental consultant’s office.

20. Reconciliation with User Requirements

The data results will be examined to determine the performance that was achieved for each data usability criterion. The performance will then be compared with the project objectives and DQOs. Deviations from objectives will be noted. Additional action may be warranted when performance does not meet performance objectives for critical data. Options for corrective action relating to incomplete information, questionable results, or inconsistent data may include any or all of the following:

- Retrieval of missing information;
- Request for additional explanation or clarification;
- Reanalysis of sample from extract (when appropriate); and
- Recalculation or reinterpretation of results by the laboratory.

These actions may improve the data quality, reduce uncertainty, and eliminate the need to qualify or reject data.

If these actions do not improve the data quality to an acceptable level, the following additional actions may be taken:

- Extrapolation of missing data from existing data points;
- Use of historical data; and
- Evaluation of the critical/non-critical nature of the sample.

  If the data gap cannot be resolved by these actions, an evaluation of the data bias and potential for false negatives and positives can be performed. If the resultant uncertainty level is unacceptable, additional sample collection and analysis may be required.

21. References

USEPA. 1980. *Interim Guidance and Specifications for Preparing QA Project Plans*. QAMS-005/80. Office of Research and Development. December.

USEPA. 1999a. *Data Validation Standard Operating Procedures for Contract Laboratory Program Routine Analytical Services*. July.

USEPA. 1999b. *Contract Laboratory Program National Functional Guidelines for Organic Data Review*. EPA-540/R-99-008. October.

USEPA. 2001a. *EPA Requirements for QA Project Plans for Environmental Operations*. EPA-QA/R-5. Office of Environmental Information. March.

USEPA. 2002b. *Guidance for QA Project Plans*. EPA-QA/G-5. Office of Environmental Information. December.

USEPA. 2004. *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*. EPA-540/R-04-004. October.

USEPA Region 4, 2007. *Field Equipment Cleaning and Decontamination*. USEPA. November 1, 2007.

USEPA Region 4, 2010. *Management of Investigation Derived Waste*. USEPA, October 15, 2010.

USEPA Region 4. *Field Branches Quality System and Technical Procedures*; SESD Field Branches Quality Management Plan; May 8, 2009. http://www.epa.gov/region4/sesd/fbqstp/.

Tables

Table 1. Sample Quantities and Quality Control Frequencies, Quality Assurance Project Plan, Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi.

Parameter	Estimated Environmental Sample Quantity	Field QC Analyses						Laboratory QC Sample						Total
		Trip Blank		Rinse Blank		Field Duplicate		Matrix Spike		Matrix Spike Duplicate		Lab Duplicate		
		Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	
Surface Water														
Volatile Organic Compounds (SW846-8260B)	15	1/cooler	1	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	20
Semivolatile Organic Compounds (SW846-8270C)	15	NA	--	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	19
Organochlorine Pesticides (USEPA 8081A)	15	NA	--	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	19
PCBs (USEPA 8082)	15	NA	--	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	19
Herbicides (USEPA 8151A)	15	NA	--	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	19
PCDD/PCDFs SW-846(8290)	15	NA	--	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	19
Total Metals (including Mercury) (SW846-6020, 7470A)	15	NA	--	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	19
Cyanide, Total (USEPA 9012A)	15	NA	--	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	19
Sulfide, Total (USEPA 9034)	15	NA	--	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	19
Dioxathion/Dioxenethion (BATCO 088.1)	15	NA	--	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	19
Groundwater														
Volatile Organic Compounds (SW846-8260B)	10	1/cooler	1	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	15
Semivolatile Organic Compounds (SW846-8270C)	10	NA	--	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	14
Organochlorine Pesticides (USEPA 8081A)	10	NA	--	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	14
PCBs (USEPA 8082)	10	NA	--	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	14
Herbicides (USEPA 8151A)	10	NA	--	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	14
PCDD/PCDFs SW-846(8290)	10	NA	--	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	14
Total Metals (including Mercury) (SW846-6020, 7470A)	10	NA	--	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	14
Cyanide, Total (USEPA 9012A)	10	NA	--	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	14
Sulfide, Total (USEPA 9034)	10	NA	--	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	14
Dioxathion/Dioxenethion (BATCO 088.1)	10	NA	--	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	14
Drinking Water														
Volatile Organic Compounds (USEPA 524.2, 504.1 and SW-846 8260)	40	1/cooler	1	1/day	2	1/20	2	1/20	2	1/20	2	NA	--	49
Semivolatile Organic Compounds (EPA 525.2 and SW846-8270C)	40	NA	--	1/day	2	1/20	2	1/20	2	1/20	2	NA	--	48
Organochlorine Pesticides (USEPA 508 and SW-846 8081A)	40	NA	--	1/day	2	1/20	2	1/20	2	1/20	2	NA	--	48
PCBs (USEPA 508)	40	NA	--	1/day	2	1/20	2	1/20	2	1/20	2	NA	--	48
Herbicides (USEPA 515.1)	40	NA	--	1/day	2	1/20	2	1/20	2	1/20	2	NA	--	48
PCDD/PCDFs (USEPA 1613)	40	NA	--	1/day	2	1/20	2	1/20	2	1/20	2	NA	--	48
Total Metals (including Mercury) (EPA 200.8, 200.7, 245, and SW846-6020)	40	NA	--	1/day	2	1/20	2	1/20	2	1/20	2	NA	--	48
Cyanide, Total (USEPA 4500)	40	NA	--	1/day	2	1/20	2	1/20	2	1/20	2	NA	--	48
Sulfide, Total (USEPA 4500)	40	NA	--	1/day	2	1/20	2	1/20	2	1/20	2	NA	--	48
Dioxathion/Dioxenethion (BATCO 088.1)	40	NA	--	1/day	2	1/20	2	1/20	2	1/20	2	NA	--	48

Table 1. Sample Quantities and Quality Control Frequencies, Quality Assurance Project Plan, Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi.

Parameter	Estimated Environmental Sample Quantity	Field QC Analyses						Laboratory QC Sample						Total
		Trip Blank		Rinse Blank		Field Duplicate		Matrix Spike		Matrix Spike Duplicate		Lab Duplicate		
		Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	
Sediment														
Volatile Organic Compounds (SW846-8260B)	15	1/cooler	1	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	20
Semivolatile Organic Compounds (SW846-8270C)	15	NA	--	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	19
Organochlorine Pesticides (USEPA 8081A)	15	NA	--	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	19
PCBs (USEPA 8082)	15	NA	--	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	19
Herbicides (USEPA 8151A)	15	NA	--	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	19
PCDD/PCDFs SW-846 (8290)	15	NA	--	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	19
Total Metals (including Mercury) (SW846-6020, 7470A)	15	NA	--	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	19
Cyanide, Total (USEPA 9012A)	15	NA	--	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	19
Sulfide, Total (USEPA 9034)	15	NA	--	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	19
Dioxathion/Dioxenethion (BATCO 088.1)	15	NA	--	1/day	1	1/20	1	1/20	1	1/20	1	NA	--	19
Soil Gas/Indoor Air														
Volatile Organic Compounds (USEPA TO-15)	30	NA	--	NA	--	1/20	1	NA	--	NA	--	1/20	2	33

Note: Sample Counts are an approximation.
BATCO Bonner Analytical Testing Company
Freq Frequency.
N/A Not Applicable.
No. Number.
PCDD Polychlorinated dibenzodioxins.

1/day One rinse blank per day or one per 20 samples, whichever is more frequent. Rinse blanks not required when dedicated sampling equipment is used.
PCDF Polychlorinated dibenzofurans.
PCBs Polychlorinated biphenyls.
QC Quality Control.
TBD To Be Determined.
USEPA U.S. Environmental Protection Agency.

Note : Where applicable the drinking water methods are being used to analyze compounds associated with the APP IX compound list. If the APP IX compound is not part of the Drinking water method being utilized the appropriate SW-846 method will be utilized to complete the analysis of that compound. Compounds that are bolded are part of the EPA's 500 series drinking water method but are not part of the APP IX compound list.

Table 2. Analytical Quality Control Limits[1], Quality Assurance Project Plan, Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi.

Parameter	Accuracy - % Recovery			Precision - RPD		
	Surrogate	MS/MSD	LCS	MS/MSD	Lab Duplicate	Field Duplicate
Surface Water/Groundwater						
Volatile Organic Compounds	70-130	60-135	70-140	30	--	50
Semivolatile Organic Compounds	25-135	50-130	60-130	50	--	50
Organochlorine Pesticides	38-130	40-150	30-150	50	--	50
PCBs	38-130	40-150	30-150	50	--	50
Herbicides	52-151	60-130	60-130	50	--	50
PCDD/PCDFs	40-135	65-147	65-147	20	--	50
Total Metals (including Mercury)	--	75-125	80-120	20	--	50
Cyanide, Total	--	75-125	85-115	20	--	50
Sulfide, Total	--	75-125	75-125	30	--	50
Dioxathion	40-97	69-104	69-104	25	--	50
Dioxenethion	40-97	63-100	63-100	25	--	50
Drinking Water						
Volatile Organic Compounds	70-130	60-135	70-140	30	--	50
Semivolatile Organic Compounds	25-135	50-130	60-130	50	--	50
Organochlorine Pesticides	38-130	40-150	30-150	50	--	50
PCBs	38-130	40-150	30-150	50	--	50
Herbicides	52-151	60-130	60-130	50	--	50
PCDD/PCDFs	40-135	65-147	65-147	20	--	50
Total Metals (including Mercury)	--	75-125	80-120	20	--	50
Cyanide, Total	--	75-125	85-115	20	--	50
Sulfide, Total	--	75-125	75-125	30	--	50
Dioxathion	40-97	69-104	69-104	25	--	50
Dioxenethion	40-97	63-100	63-100	25	--	50
Sediment						
Volatile Organic Compounds	65-130	60-140	60-135	50	--	100
Semivolatile Organic Compounds	45-130	30-130	20-130	50	--	100
Organochlorine Pesticides	45-130	30-130	20-130	50	--	100
PCBs	45-130	30-130	20-130	50	--	100
Herbicides	35-137	30-130	30-130	50	--	100
PCDD/PCDFs	40-135	58-143	58-143	50	--	100
Total Metals (including Mercury)	--	75-125	75-125	35	--	100
Cyanide, Total	--	75-125	75-125	35	--	100
Sulfide, Total	--	50-150	50-150	50	--	100
Dioxathion	40-97	69-104	69-104	35	--	100
Dioxenethion	40-97	63-100	63-100	35	--	100
Soil Gas/Indoor Air						
Volatile Organics	60-140	--	70-130	--	--	50

Note:

[1] The listed QC limits are based on SW-846 guidance and are advisory. The actual limits are determined based on laboratory performance. Frequent failure to meet the QC limits; however, warrant investigation of the laboratory.

LCS	Laboratory Control Sample.
MS	Matrix Spike.
MSD	Matrix Spike Duplicate.
PCBs	Polychlorinated biphenyls.
PCDD	Polychlorinated dibenzodioxins.
PCDF	Polychlorinated dibenzofurans.

Table 3a. Parameters, Methods, and Target Reporting Limits, Quality Assurance Project Plan,
Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi.

Analyte[1]	CAS Number	Groundwater/Surface Water					
		Tier 1 TRG (ug/L)	RSL Tapwater (ug/L)	Laboratory MDL (ug/L)	Laboratory RL (ug/L)	Low Level Laboratory MDL ug/L	Low Level Laboratory RL ug/L
Volatile Organic Compounds (Method 8260)							
Ethylbenzene	100-41-4	700	1.5	0.11	1	--	--
Styrene	100-42-5	100	1600	0.11	1	--	--
cis-1,3-Dichloropropene	10061-01-5	0.084	NE	0.11	1	--	--
trans-1,3-Dichloropropene	10061-02-6	0.084	NE	0.21	1	--	--
1,2-Dibromoethane	106-93-4	0.05	0.0065	0.25	1	--	--
Acrolein	107-02-8	0.042	0.042	7.4	20	--	--
3-Chloro-1-propene	107-05-1	NE	0.65	0.2	1	--	--
1,2-Dichloroethane	107-06-2	5	0.15	0.1	1	--	--
Propionitrile	107-12-0	NE	NE	4.6	20	--	--
Acrylonitrile	107-13-1	0.037	0.045	7.2	20	--	--
Vinyl acetate	108-05-4	412	410	0.28	2	--	--
4-Methyl-2-pentanone (MIBK)	108-10-1	139	2000	1	10	--	--
Toluene	108-88-3	1000	2300	0.33	1	--	--
Chlorobenzene	108-90-7	100	91	0.25	1	--	--
trans-1,4-Dichloro-2-butene	110-57-6	NE	0.0012	0.5	2	--	--
Chlorodibromomethane	124-48-1	0.126	0.15	0.1	1	--	--
Methacrylonitrile	126-98-7	1.04	1	3.3	20	--	--
2-Chloro-1,3-butadiene	126-99-8	14.3	0.016	0.3	1	--	--
Tetrachloroethene	127-18-4	5.0	0.11	0.15	1	--	--
Xylenes, Total	1330-20-7	10000	200	0.2	2	--	--
cis-1,2-Dichloroethene	156-59-2	70	73	0.15	1	--	--
trans-1,2-Dichloroethene	156-60-5	100	110	0.2	1	--	--
Carbon tetrachloride	56-23-5	5.0	0.44	0.5	1	--	--
2-Hexanone	591-78-6	1460	47	1	10	--	--
1,1,1,2-Tetrachloroethane	630-20-6	0.406	0.52	0.33	1	--	--
Acetone	67-64-1	608	22000	5	25	--	--
Chloroform	67-66-3	0.155	0.19	0.14	1	--	--
Benzene	71-43-2	5.0	0.41	0.25	1	--	--
1,1,1-Trichloroethane	71-55-6	200	9100	0.5	1	--	--
Bromomethane	74-83-9	8.52	8.7	0.8	1	--	--
Chloromethane	74-87-3	1.43	190	0.33	1	--	--
Iodomethane	74-88-4	NE	NE	1	5	--	--
Dibromomethane	74-95-3	60.8	8.2	0.2	1	--	--
Chloroethane	75-00-3	3.64	21000	1	1	--	--
Vinyl chloride	75-01-4	2.0	0.016	0.18	1	--	--
Acetonitrile	75-05-8	125	130	10	40	--	--
Methylene Chloride	75-09-2	5.0	4.8	1	5	--	--
Carbon disulfide	75-15-0	1043	1000	0.6	2	--	--
Bromoform	75-25-2	8.48	8.5	0.5	1	--	--
Dichlorobromomethane	75-27-4	0.168	0.12	0.25	1	--	--
1,1-Dichloroethane	75-34-3	798	2.4	0.25	1	--	--
1,1-Dichloroethene	75-35-4	7	340	0.11	1	--	--
Trichlorofluoromethane	75-69-4	1288	1300	0.25	1	--	--
Dichlorodifluoromethane	75-71-8	348	200	0.25	1	--	--
Pentachloroethane	76-01-7	NE	0.75	1.2	5	--	--
Isobutyl alcohol	78-83-1	1825	11000	11	40	--	--
1,2-Dichloropropane	78-87-5	5	0.39	0.13	1	--	--
2-Butanone (MEK)	78-93-3	1906	7100	1	10	--	--
1,1,2-Trichloroethane	79-00-5	5.0	0.24	0.13	1	--	--
Trichloroethene	79-01-6	5.0	2	0.13	1	--	--
1,1,2,2-Tetrachloroethane	79-34-5	0.053	0.067	0.18	1	--	--
Methyl methacrylate	80-62-6	1419	1400	0.48	1	--	--
1,2-Dibromo-3-Chloropropane	96-12-8	0.20	0.00032	0.44	1	--	--
1,2,3-Trichloropropane	96-18-4	0.0062	0.00072	0.41	1	--	--
Ethyl methacrylate	97-63-2	548	530	0.25	1	--	--

Table 3a. Parameters, Methods, and Target Reporting Limits, Quality Assurance Project Plan,
Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi.

Analyte[1]	CAS Number	Groundwater/Surface Water					
		Tier 1 TRG (ug/L)	RSL Tapwater (ug/L)	Laboratory MDL (ug/L)	Laboratory RL (ug/L)	Low Level Laboratory MDL ug/L	Low Level Laboratory RL ug/L
Semivolatile Organic Compounds (Method 8270)							
4-Nitroaniline	100-01-6	NE	3.4	5	50	0.5	5
4-Nitrophenol	100-02-7	292	NE	1.9	50	0.5	5
Benzyl alcohol	100-51-6	10950	3700	1.1	10	0.14	1
N-Nitrosopiperidine	100-75-4	NE	0.0072	0.88	10	0.1	1
4-Bromophenyl phenyl ether	101-55-3	NE	NE	0.77	10	0.12	1
2,4-Dimethylphenol	105-67-9	730	NE	4	10	0.69	2
N-Nitrosomethylethylamine	10595-95-6	0.003	0.0031	3.3	10	0.1	2
1,4-Dichlorobenzene	106-46-7	75	0.43	0.54	10	0.10	1.0
4-Chloroaniline	106-47-8	146	0.34	2.2	20	0.36	2
p-Phenylene diamine	106-50-3	6935	6900	10	2000	16	200
bis(chloroisopropyl) ether	108-60-1	0.26	0.32	0.78	10	0.1	1
Phenol	108-95-2	21900	11000	0.83	10	0.13	1
2-Picoline	109-06-8	NE	NE	1.4	10	0.15	2
Pyridine	110-86-1	36.5	37	2.3	50	0.73	5
Bis(2-chloroethyl)ether	111-44-4	0.009	0.012	1.1	10	0.1	1
Bis(2-chloroethoxy)methane	111-91-1	NE	110	0.94	10	0.1	1
Bis(2-ethylhexyl) phthalate	117-81-7	6	4.8	1.6	10	0.64	2
Di-n-octyl phthalate	117-84-0	20	NE	1.4	10	0.17	1
Hexachlorobenzene	118-74-1	1.0	0.042	0.79	10	0.1	1
3,3'-Dimethylbenzidine	119-93-7	0.007	0.0061	10	20	5	20
Anthracene	120-12-7	43.4	11000	0.69	10	0.1	0.2
Isosafrole	120-58-1	NE	NE	0.5	10	0.1	1
1,2,4-Trichlorobenzene	120-82-1	70	2.3	0.56	10	0.10	1.0
2,4-Dichlorophenol	120-83-2	110	110	1.1	10	0.1	1
2,4-Dinitrotoluene	121-14-2	73	0.22	1.2	10	0.12	1
alpha,alpha-Dimethyl phenethylamine	122-09-8	NE	NE	35	2000	3.4	10
1,4-Dioxane	123-91-1	6.09	0.67	3.4	10	0.31	2.0
o,o',o'-Triethylphosphorothioate	126-68-1	NE	NE	1	10	0.13	1
Pyrene	129-00-0	183	1100	0.63	10	0.1	0.2
1,4-Naphthoquinone	130-15-4	NE	NE	0.62	10	0.5	1
Dimethyl phthalate	131-11-3	365000	NE	0.99	10	0.1	1
Dibenzofuran	132-64-9	24.3	37	0.79	10	0.1	1
1-Naphthylamine	134-32-7	NE	NE	1.1	10	1.3	5
Aramite, Total	140-57-8	NE	2.7	0.91	10	0.11	1.5
3 & 4 Methylphenol	15831-10-4	1825	NE	1.3	10	0.66	2
Hexachloropropene	1888-71-7	11.0	NE	1.4	10	0.1	1
Benzo[g,h,i]perylene	191-24-2	1095	NE	0.87	10	0.1	0.2
Indeno[1,2,3-cd]pyrene	193-39-5	0.092	0.029	1	10	0.1	0.2
Benzo[b]fluoranthene	205-99-2	0.092	0.029	2.6	10	0.1	0.2
Fluoranthene	206-44-0	1460	1500	0.74	10	0.1	0.2
Benzo[k]fluoranthene	207-08-9	0.92	0.29	1.2	10	0.1	0.2
Acenaphthylene	208-96-8	2190	NE	0.85	10	0.1	0.2
Chrysene	218-01-9	9.17	2.9	0.51	10	0.045	0.2
Diallate	2303-16-4	NE	1.1	0.78	10	0.1	1
Pronamide	23950-58-5	NE	2700	0.89	10	0.12	1
Thionazin	297-97-2	NE	NE	0.91	10	0.20	1.0
Methyl parathion	298-00-0	9.13	9.1	0.88	10	0.13	1.0
Phorate	298-02-2	NE	7.3	0.87	10	0.20	1.0
Disulfoton	298-04-4	1.46	1.5	0.79	10	0.10	1.0
Sulfotepp	3689-24-5	NE	18	0.53	10	0.14	1
Benzo[a]pyrene	50-32-8	0.20	0.0029	0.71	10	0.1	0.2
2,4-Dinitrophenol	51-28-5	73	73	10	50	1.1	10
Famphur	52-85-7	NE	NE	1.1	10	0.16	1.0
4,6-Dinitro-2-methylphenol	534-52-1	3.65	2.9	10	50	0.13	5
Dibenz(a,h)anthracene	53-70-3	0.009	0.0029	1	10	0.1	0.2
2-Acetylaminofluorene	53-96-3	NE	0.018	1.6	10	0.1	1
1,3-Dichlorobenzene	541-73-1	5.48	NE	0.59	10	0.10	1.0
N-Nitrosodiethylamine	55-18-5	0.0004	0.00014	0.93	10	0.1	1
Ethyl Parathion	56-38-2	219	220	1.3	10	0.10	2.0
3-Methylcholanthrene	56-49-5	NE	0.00098	1.4	10	0.5	1
Benzo[a]anthracene	56-55-3	0.092	0.029	0.55	10	0.1	0.2
4-Nitroquinoline-1-oxide	56-57-5	NE	NE	10	20	1.1	2

Table 3a. Parameters, Methods, and Target Reporting Limits, Quality Assurance Project Plan,
Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi.

Analyte[1]	CAS Number	Groundwater/Surface Water					
		Tier 1 TRG (ug/L)	RSL Tapwater (ug/L)	Laboratory MDL (ug/L)	Laboratory RL (ug/L)	Low Level Laboratory MDL ug/L	Low Level Laboratory RL ug/L
Semivolatile Organic Compounds (Method 8270)							
7,12-Dimethylbenz(a)anthracene	57-97-6	NE	0.000086	1.2	10	0.2	1
2,3,4,6-Tetrachlorophenol	58-90-2	1095	1100	0.72	10	0.1	1
4-Chloro-3-methylphenol	59-50-7	73000	3700	1	10	0.12	1
N-Nitrosomorpholine	59-89-2	NE	0.01	0.84	10	0.1	1
p-Dimethylamino azobenzene	60-11-7	NE	0.015	0.79	10	0.15	5
Dimethoate	60-51-5	NE	7.3	0.75	10	0.12	2.0
2,6-Dinitrotoluene	606-20-2	36.5	37	1.1	10	0.13	1
Pentachlorobenzene	608-93-5	29.2	29	0.52	10	0.1	1
N-Nitrosodi-n-propylamine	621-64-7	0.0096	0.0096	0.72	10	0.13	1
Phenacetin	62-44-2	NE	31	1.4	10	0.1	1
Ethyl methanesulfonate	62-50-0	NE	NE	0.96	10	0.1	2
Aniline	62-53-3	11.7	12	2.1	20	0.97	2
N-Nitrosodimethylamine	62-75-9	0.0013	0.00042	2.8	10	0.25	1
Methyl methanesulfonate	66-27-3	NE	0.68	0.6	10	0.1	2
Hexachloroethane	67-72-1	4.8	4.8	0.76	10	0.5	1
4-Chlorophenyl phenyl ether	7005-72-3	NE	NE	0.84	10	0.1	1
Hexachlorophene	70-30-4	11.0	11	27	5000	25	500
Hexachlorocyclopentadiene	77-47-4	50	220	2.5	10	0.5	2
Isophorone	78-59-1	70.5	71	0.9	10	0.1	1
Pentachloronitrobenzene	82-68-8	0.258	0.26	0.78	10	0.5	1
Acenaphthene	83-32-9	365	2200	0.76	10	0.1	0.2
Diethyl phthalate	84-66-2	29200	29000	0.88	10	0.11	1
Di-n-butyl phthalate	84-74-2	3650	3700	0.83	10	0.39	1
Phenanthrene	85-01-8	1095	NE	0.77	10	0.1	0.2
Butyl benzyl phthalate	85-68-7	2690	35	1.2	10	0.12	1
N-Nitrosodiphenylamine	86-30-6	13.7	14	0.92	10	0.37	1
Fluorene	86-73-7	243	1500	0.96	10	0.1	0.2
2,6-Dichlorophenol	87-65-0	NE	NE	0.73	10	0.1	1
Hexachlorobutadiene	87-68-3	0.859	0.86	0.62	10	0.10	1.0
Pentachlorophenol	87-86-5	1.0	0.17	2	50	0.40	5.0
2,4,6-Trichlorophenol	88-06-2	6.09	6.1	0.85	10	0.17	1
2-Nitroaniline	88-74-4	0.417	370	1.3	50	0.16	1
2-Nitrophenol	88-75-5	0.416	NE	0.76	10	0.1	1
Dinoseb	88-85-7	7.0	37	5	10	0.15	2.0
Naphthalene	91-20-3	6.20	0.14	0.7	10	0.10	0.20
2-Methylnaphthalene	91-57-6	122	150	0.78	10	0.10	0.20
2-Chloronaphthalene	91-58-7	487	2900	0.8	10	0.1	1
2-Naphthylamine	91-59-8	NE	0.037	1.5	10	1.3	5
Methapyrilene	91-80-5	NE	NE	2.7	2000	1.3	200
3,3'-Dichlorobenzidine	91-94-1	0.15	0.15	30	60	2	20
N-Nitrosodi-n-butylamine	924-16-3	0.0019	0.0024	0.96	10	0.1	1
1,1'-Biphenyl	92-52-4	304	0.83	0.58	10	--	--
4-Aminobiphenyl	92-67-1	NE	0.0032	1.2	10	0.31	5
N-Nitrosopyrrolidine	930-55-2	0.032	0.032	1	10	0.1	1
Safrole, Total	94-59-7	NE	0.098	0.8	10	0.1	1
2-Methylphenol	95-48-7	1825	1800	0.89	10	0.74	2
1,2-Dichlorobenzene	95-50-1	600	370	0.53	10	0.10	1.0
2-Toluidine	95-53-4	0.28	NE	1.4	10	0.13	1
2-Chlorophenol	95-57-8	30.4	180	0.87	10	0.12	1
1,2,4,5-Tetrachlorobenzene	95-94-3	11.0	11	0.76	10	0.1	1
2,4,5-Trichlorophenol	95-95-4	3650	3700	1.2	10	0.12	1
Acetophenone	98-86-2	0.0416	3700	0.57	10	0.1	1
Nitrobenzene	98-95-3	3.53	0.12	0.73	10	0.1	1
3-Nitroaniline	99-09-2	NE	NE	5	50	0.16	5
1,3,5-Trinitrobenzene	99-35-4	1095	1100	2	10	0.5	1
N-Nitro-o-toluidine	99-55-8	2.03	7.5	1.5	10	0.1	1
1,3-Dinitrobenzene	99-65-0	3.65	3.7	0.6	10	0.1	1

Table 3a. Parameters, Methods, and Target Reporting Limits, Quality Assurance Project Plan,
Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi.

Analyte[1]	CAS Number	Groundwater/Surface Water					
		Tier 1 TRG (ug/L)	RSL Tapwater (ug/L)	Laboratory MDL (ug/L)	Laboratory RL (ug/L)	Low Level Laboratory MDL ug/L	Low Level Laboratory RL ug/L
Organochlorine Pesticides (USEPA 8081A)							
Aldrin	309-00-2	0.004	0.004	0.007	0.05	--	--
alpha-BHC	319-84-6	0.011	0.011	0.0057	0.05	--	--
beta-BHC	319-85-7	0.037	0.037	0.0067	0.05	--	--
Chlordane	57-74-9	2	0.19	0.1	0.5	--	--
Chlorobenzilate	510-15-6	0.248	0.61	0.5	0.5	--	--
4,4'-DDD	72-54-8	0.279	0.28	0.0065	0.1	--	--
4,4'-DDE	72-55-9	0.197	0.2	0.0077	0.1	--	--
4,4'-DDT	50-29-3	0.197	0.2	0.0097	0.1	--	--
delta-BHC	319-86-8	NE	NE	0.0048	0.05	--	--
Dieldrin	60-57-1	0.004	0.0042	0.0091	0.1	--	--
Endosulfan I	959-98-8	219	NE	0.0042	0.05	--	--
Endosulfan II	33213-65-9	219	NE	0.0098	0.1	--	--
Endosulfan sulfate	1031-07-8	NE	NE	0.0068	0.1	--	--
Endrin	72-20-8	2.0	11	0.0097	0.1	--	--
Endrin aldehyde	7421-93-4	NE	NE	0.016	0.1	--	--
Endrin ketone	53494-70-5	NE	NE	0.0084	0.1	--	--
gamma-BHC (Lindane)	58-89-9	0.20	0.061	0.0059	0.05	--	--
Heptachlor	76-44-8	0.40	0.015	0.007	0.05	--	--
Heptachlor epoxide	1024-57-3	0.20	0.0074	0.006	0.05	--	--
Isodrin	465-73-6	NE	NE	0.05	0.05	--	--
Kepone	143-50-0	NE	0.0067	1	1	--	--
Methoxychlor	72-43-5	40	180	0.013	0.1	--	--
Toxaphene	8001-35-2	3.0	0.061	0.5	5	--	--
PCBs (USEPA 8082)							
PCB-1016	12674-11-2	0.96	0.96	0.071	1	--	--
PCB-1221	11104-28-2	0.033	0.0068	0.28	2	--	--
PCB-1232	11141-16-5	0.033	0.0068	0.11	1	--	--
PCB-1242	53469-21-9	0.033	0.034	0.18	1	--	--
PCB-1248	12672-29-6	0.033	0.034	0.36	1	--	--
PCB-1254	11097-69-1	0.033	0.034	0.26	1	--	--
PCB-1260	11096-82-5	0.033	0.034	0.2	1	--	--
PCBs, Total	1336-36-3	0.500	0.17	0.36	1	--	--
Herbicides (USEPA 8151A)							
2,4-D	94-75-7	70	370	0.037	0.5	--	--
Silvex (2,4,5-TP)	93-72-1	50	290	0.062	0.5	--	--
2,4,5-T	93-76-5	365	370	0.062	0.5	--	--
Dioxathion/Dioxenethion (BATCO 088.1)							
cis-Dioxathion	78-34-2	54.8	NE	NA	0.48	--	--
trans-Dioxathion	78-34-2	54.8	NE	NA	0.31	--	--
Dioxenethion	--	NE	NE	NA	0.22	--	--

Analyte[1]	CAS Number	Groundwater/Surface Water					
		Tier 1 TRG (pg/L)	RSL Tapwater (pg/L)	Laboratory MDL (pg/L)	Laboratory RL (pg/L)	Low Level Laboratory MDL (pg/L)	Low Level Laboratory RL(pg/L)
Dioxins and Furans (8290) (pg/L)							
2,3,7,8-TCDD	51207-31-9	4.5	NE	2.1	10	--	--
1,2,3,7,8-PeCDD	40321-76-4	0.89	NE	2.6	50	--	--
1,2,3,4,7,8-HxCDD	39227-28-6	4.5	NE	1.3	50	--	--
1,2,3,6,7,8-HxCDD	57653-85-7	10.8	NE	1.8	50	--	--
1,2,3,7,8,9-HxCDD	19408-74-3	10.8	NE	1.6	50	--	--
1,2,3,4,6,7,8-HpCDD	35822-46-9	44.6	NE	1.5	50	--	--
OCDD	3268-87-9	446	NE	3.1	100	--	--
2,3,7,8-TCDF	51207-31-9	4.5	NE	3.4	10	--	--
1,2,3,7,8-PeCDF	57117-41-6	8.9	NE	1.3	50	--	--
2,3,4,7,8-PeCDF	57117-31-4	0.89	NE	1.2	50	--	--
1,2,3,4,7,8-HxCDF	70648-26-9	4.5	NE	1.4	50	--	--
1,2,3,6,7,8-HxCDF	57117-44-9	4.5	NE	1.2	50	--	--
2,3,4,6,7,8-HxCDF	60851-34-5	4.5	NE	1.1	50	--	--
1,2,3,7,8,9-HxCDF	72918-21-9	4.5	NE	1.9	50	--	--
1,2,3,4,6,7,8-HpCDF	55673-89-7	NE	NE	1.7	50	--	--
1,2,3,4,7,8,9-HpCDF	67562-39-4	NE	NE	2.1	50	--	--
OCDF	39001-02-0	446	NE	1.3	100	--	--

Table 3a. Parameters, Methods, and Target Reporting Limits, Quality Assurance Project Plan,
Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi.

Analyte[1]	CAS Number	Groundwater/Surface Water					
		Tier 1 TRG (ug/L)	RSL Tapwater (ug/L)	Laboratory MDL (ug/L)	Laboratory RL (ug/L)	Low Level Laboratory MDL ug/L	Low Level Laboratory RL ug/L
Total Metals (including Mercury) (SW846-6020, 7470A)							
Antimony	7440-36-0	6.0	15	2	5	--	--
Arsenic	7440-38-2	50	0.045	1.3	2.5	--	--
Barium	7440-39-3	2000	7300	1.4	5	--	--
Beryllium	7440-41-7	4.0	73	0.15	0.5	--	--
Cadmium	7440-43-9	5.0	18	0.13	0.5	--	--
Chromium	7440-47-3	100	?	2.5	5	--	--
Cobalt	7440-48-4	2190.0	11	0.12	0.5	--	--
Copper	7440-50-8	1300	1500	1.1	5	--	--
Lead	7439-92-1	15	?	0.5	1.5	--	--
Mercury	7439-97-6	2	0.63	0.091	0.2	--	--
Nickel	7440-02-0	730	730	2	5	--	--
Selenium	7782-49-2	50	180	1.1	2.5	--	--
Silver	7440-22-4	183	180	0.18	1	--	--
Thallium	7440-28-0	2.0	0.37	0.25	1	--	--
Tin	7440-31-5	21900	22000	1.4	5	--	--
Vanadium	7440-62-2	256	180	3.2	10	--	--
Zinc	7440-66-6	10950	11000	8.4	20	--	--
Cyanide, Total (USEPA 9012A)							
Cyanide, Total	57-12-5	200	730	0.005	0.01	--	--
Sulfide, Total (USEPA 9034)							
Sulfide, Total	18496-25-8	NE	NE	NA	1	--	--

Notes:

[1] USEPA. Office of Solid Waste and Emergency Response. *Test Methods for Evaluating Solid Waste. SW-846 3rd ed. Washington, D.C. 1996.*

**TRG=MDEQ Tier 1 Target Remedial Goals per the Final Regulations Governing Brownfields Voluntary Cleanup and Redevelopment in Mississippi (MDBQ, March 2002)

BATCO	Bonner Analytical Testing Company.
HpCDF	Heptachlorodibenzofuran.
HxCDF	Hexachlorodibenzofuran.
MDL	Method detection limit.
MEK	Methyl ethyl ketone.
MIBK	Methyl isobutyl ketone.
NA	Not applicable.
NE	RSL or TRG not yet established for the compound.
OCDD	Octachlorodibenzodioxin.
OCDF	Octachlorodibenzofuran.
PeCDD	Pentachlorodibenzo-p-dioxin.
PeCDF	Pentachlorodibenzofuran .
pg/L	picograms per liter.
TCDD	Tetrachlorodibenzodioxin.
TCDF	Tetrafuran.
ug/L	Micrograms per liter.
USEPA	U.S. Environmental Protection Agency.

Table 3b. Parameters, Methods, and Target Reporting Limits, Quality Assurance Project Plan,
Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi.

Analyte[1]	CAS Number	Drinking Water			
		Tier 1 TRG (µg/L)	RSL Tap (µg/L)	Laboratory MDL (µg/L)	Laboratory RL (µg/L)
Volatile Organic Compounds (Method 524.2)					
1,1,1,2-Tetrachloroethane	630-20-6	0.406	0.52	0.16	0.5
1,1,1-Trichloroethane	71-55-6	200	9,100	0.27	0.5
1,1,2,2-Tetrachloroethane	79-34-5	0.053	0.067	0.18	0.5
1,1,2-Trichloroethane	79-00-5	5.0	0.24	0.22	0.5
1,1-Dichloroethane	75-34-3	798	2.4	0.39	0.5
1,1-Dichloroethene	75-35-4	7.0	340	0.32	0.5
1,2,3-Trichloropropane	96-18-4	0.0062	0.00072	0.18	0.5
1,2-Dichloroethane	107-06-2	5.0	0.15	0.17	0.5
1,2-Dichloropropane	78-87-5	5.0	0.39	0.45	0.5
Benzene	71-43-2	5.0	0.41	0.18	0.5
Bromoform	75-25-2	8.48	8.5	0.39	0.5
Bromomethane	74-83-9	8.52	8.7	0.45	1
Carbon tetrachloride	56-23-5	5.0	0.44	0.22	0.5
Chlorobenzene	108-90-7	100	91	0.27	0.5
Chlorodibromomethane	124-48-1	0.126	0.15	0.43	0.5
Chloroethane	75-00-3	3.64	21000	0.33	1
Chloroform	67-66-3	0.155	0.19	0.29	0.5
Chloromethane	74-87-3	1.43	190	0.32	0.5
cis-1,2-Dichloroethene	156-59-2	70	73	0.37	0.5
cis-1,3-Dichloropropene	10061-01-5	0.084	NA	0.32	0.5
Dibromomethane	74-95-3	60.8	8.2	0.38	0.5
Dichlorobromomethane	75-27-4	0.168	0.12	0.54	1
Ethylbenzene	100-41-4	700	1.5	0.12	0.5
Methylene Chloride	75-09-2	5.0	4.8	0.36	0.5
Styrene	100-42-5	100	1,600	0.28	0.5
Tetrachloroethene	127-18-4	5.0	0.11	0.3	0.5
Toluene	108-88-3	1,000	2,300	0.23	0.5
trans-1,2-Dichloroethene	156-60-5	100	110	0.24	0.5
trans-1,3-Dichloropropene	10061-02-6	0.084	NA	0.48	0.5
Trichloroethene	79-01-6	5.0	2.0	0.37	0.5
Vinyl chloride	75-01-4	2.0	0.016	0.33	0.5
Xylenes, Total	1330-20-7	10,000	200	0.33	0.5
1,1-Dichloropropene	**563-58-6**	NE	11	0.19	0.5
1,2,4-Trichlorobenzene	**120-82-1**	70	2.3	0.18	0.5
1,2-Dichlorobenzene	**95-50-1**	600	370	0.17	0.5
1,3-Dichlorobenzene	**541-73-1**	5.48	NA	0.14	0.5
1,3-Dichloropropane	**142-28-9**	NE	730	0.43	0.5
1,4-Dichlorobenzene	**106-46-7**	75	0.43	0.18	0.5
2,2-Dichloropropane	**594-20-7**	NE	NA	0.31	0.5
2-Chlorotoluene	**95-49-8**	122	730	0.17	0.5
4-Chlorotoluene	**106-43-4**	NE	730	0.16	0.5
Bromobenzene	**108-86-1**	NE	88	0.42	0.5
Ethylene Dibromide	**106-93-4**	0.050	0.0065	0.0077	0.02
Methyl tert-butyl ether	**1634-04-4**	40	12	0.26	0.5
m-Xylene & p-Xylene	**179601-23-1**	10,000	200	0.42	0.5
o-Xylene	**95-47-6**	10,000	200	0.27	0.5
Volatile Organic Compounds (Method 8260)					
1,2-Dibromoethane	106-93-4	0.050	0.0065	0.25	1
Acrolein	107-02-8	0.042	0.042	7.4	20
3-Chloro-1-propene	107-05-1	NE	0.65	0.2	1
Propionitrile	107-12-0	NE	NA	4.6	20
Acrylonitrile	107-13-1	0.037	0.045	7.2	20
Vinyl acetate	108-05-4	412	410	0.28	2
4-Methyl-2-pentanone (MIBK)	108-10-1	139	2,000	1	10
trans-1,4-Dichloro-2-butene	110-57-6	NE	0.0012	0.5	2
Methacrylonitrile	126-98-7	1.04	1	3.3	20
2-Chloro-1,3-butadiene	126-99-8	14.3	0.016	0.3	1
2-Hexanone	591-78-6	1,460	47	1	10
Acetone	67-64-1	608	22,000	5	25
Iodomethane	74-88-4	NE	NA	1	5
Acetonitrile	75-05-8	125	130	10	40
Carbon disulfide	75-15-0	1,043	1,000	0.6	2

Table 3b. Parameters, Methods, and Target Reporting Limits, Quality Assurance Project Plan,
Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi.

Analyte[1]	CAS Number	Drinking Water			
		Tier 1 TRG (µg/L)	RSL Tap (µg/L)	Laboratory MDL (µg/L)	Laboratory RL (µg/L)
Volatile Organic Compounds (Method 8260)					
Trichlorofluoromethane	75-69-4	1,288	1,300	0.25	1
Dichlorodifluoromethane	75-71-8	348	200	0.25	1
Pentachloroethane	76-01-7	NE	0.75	1.2	5
Isobutyl alcohol	78-83-1	1,825	11,000	11	40
2-Butanone (MEK)	78-93-3	1,906	7,100	1	10
Methyl methacrylate	80-62-6	1,419	1,400	0.48	1
Ethyl methacrylate	97-63-2	548	530	0.25	1
Volatile Organic Compounds (Method 504.1)					
1,2-Dibromo-3-Chloropropane	96-12-8	0.2	0.00032	0.0032	0.02
Ethylene Dibromide	**106-93-4**	0.050	0.0065	0.0077	0.02
Semivolatile Organic Compounds (Method 525.2)					
Benzo[a]pyrene	50-32-8	0.20	0.0029	0.029	0.2
Bis(2-ethylhexyl) phthalate	117-81-7	6.0	4.8	0.6	2
Hexachlorobenzene	118-74-1	1.0	0.042	0.041	0.2
Hexachlorocyclopentadiene	77-47-4	50	220	0.042	2
Alachlor	**15972-60-8**	2.0	1.2	0.033	0.2
Atrazine	**1912-24-9**	3.0	0.29	0.022	0.2
Di(2-ethylhexyl)adipate	**103-23-1**	400	56	0.6	1.5
Methoxychlor	**72-43-5**	40	180	0.043	0.5
Simazine	**122-34-9**	4.0	0.56	0.035	0.5
Semivolatile Organic Compounds (Method 8270)					
4-Nitroaniline	100-01-6	NE	3.4	5	50
4-Nitrophenol	100-02-7	292	NA	1.9	50
Benzyl alcohol	100-51-6	10,950	3,700	1.1	10
N-Nitrosopiperidine	100-75-4	NE	0.0072	0.88	10
4-Bromophenyl phenyl ether	101-55-3	NE	NA	0.77	10
2,4-Dimethylphenol	105-67-9	730	730	4	10
N-Nitrosomethylethylamine	10595-95-6	0.003	0.0031	3.3	10
1,4-Dichlorobenzene	106-46-7	75	0.43	0.54	10
4-Chloroaniline	106-47-8	146	0.34	2.2	20
p-Phenylene diamine	106-50-3	6,935	6,900	10	2000
bis(chloroisopropyl) ether	108-60-1	0.26	0.32	0.78	10
Phenol	108-95-2	21,900	11,000	0.83	10
2-Picoline	109-06-8	NE	NA	1.4	10
Pyridine	110-86-1	36.5	37	2.3	50
Bis(2-chloroethyl)ether	111-44-4	0.009	0.012	1.1	10
Bis(2-chloroethoxy)methane	111-91-1	NE	110	0.94	10
Di-n-octyl phthalate	117-84-0	20	0.042	1.4	10
3,3'-Dimethylbenzidine	119-93-7	0.007	0.0061	10	20
Anthracene	120-12-7	43.4	11,000	0.69	10
Isosafrole	120-58-1	NE	NA	0.5	10
1,2,4-Trichlorobenzene	120-82-1	70	2.3	0.56	10
2,4-Dichlorophenol	120-83-2	110	110	1.1	10
2,4-Dinitrotoluene	121-14-2	73	0.22	1.2	10
alpha,alpha-Dimethyl phenethylamine	122-09-8	NE	NA	35	2000
1,4-Dioxane	123-91-1	6.09	0.67	3.4	10
o,o',o'-Triethylphosphorothioate	126-68-1	NE	NA	1	10
Pyrene	129-00-0	183	1,100	0.63	10
1,4-Naphthoquinone	130-15-4	NE	NA	0.62	10
Dimethyl phthalate	131-11-3	365,000	NA	0.99	10
Dibenzofuran	132-64-9	24.3	37	0.79	10
1-Naphthylamine	134-32-7	NE	NA	1.1	10
Aramite, Total	140-57-8	NE	2.7	0.91	10
3 & 4 Methylphenol	15831-10-4	1,825	NA	1.3	10

Table 3b. Parameters, Methods, and Target Reporting Limits, Quality Assurance Project Plan,
Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi.

Analyte[1]	CAS Number	Drinking Water			
		Tier 1 TRG (µg/L)	RSL Tap (µg/L)	Laboratory MDL (µg/L)	Laboratory RL (µg/L)
Semivolatile Organic Compounds (Method 8270) continued					
Hexachloropropene	1888-71-7	11.0	NA	1.4	10
Benzo[g,h,i]perylene	191-24-2	1,095	NA	0.87	10
Indeno[1,2,3-cd]pyrene	193-39-5	0.092	0.029	1	10
Benzo[b]fluoranthene	205-99-2	0.092	0.029	2.6	10
Fluoranthene	206-44-0	1,460	1,500	0.74	10
Benzo[k]fluoranthene	207-08-9	0.92	0.29	1.2	10
Acenaphthylene	208-96-8	2,190	NA	0.85	10
Chrysene	218-01-9	9.17	2.9	0.51	10
Diallate	2303-16-4	NE	1.1	0.78	10
Pronamide	23950-58-5	NE	2,700	0.89	10
Thionazin	297-97-2	NE	NA	0.91	10
Methyl parathion	298-00-0	9.13	9.1	0.88	10
Phorate	298-02-2	NE	7.3	0.87	10
Disulfoton	298-04-4	1.46	1.5	0.79	10
Sulfotepp	3689-24-5	NE	18	0.53	10
2,4-Dinitrophenol	51-28-5	73	73	10	50
Famphur	52-85-7	NE	NA	1.1	10
4,6-Dinitro-2-methylphenol	534-52-1	3.65	2.9	10	50
Dibenz(a,h)anthracene	53-70-3	0.009	0.0029	1	10
2-Acetylaminofluorene	53-96-3	NE	0.018	1.6	10
1,3-Dichlorobenzene	541-73-1	5.48	0.43	0.59	10
N-Nitrosodiethylamine	55-18-5	0.0004	0.00014	0.93	10
Ethyl Parathion	56-38-2	219	220	1.3	10
3-Methylcholanthrene	56-49-5	NE	0.00098	1.4	10
Benzo[a]anthracene	56-55-3	0.092	0.029	0.55	10
4-Nitroquinoline-1-oxide	56-57-5	NE	NA	10	20
7,12-Dimethylbenz(a)anthracene	57-97-6	NE	0.000086	1.2	10
2,3,4,6-Tetrachlorophenol	58-90-2	1,095	1,100	0.72	10
4-Chloro-3-methylphenol	59-50-7	73,000	3,700	1	10
N-Nitrosomorpholine	59-89-2	NE	0.01	0.84	10
p-Dimethylamino azobenzene	60-11-7	NE	0.015	0.79	10
Dimethoate	60-51-5	NE	7.3	0.75	10
2,6-Dinitrotoluene	606-20-2	36.5	37	1.1	10
Pentachlorobenzene	608-93-5	29.2	29	0.52	10
N-Nitrosodi-n-propylamine	621-64-7	0.0096	0.0096	0.72	10
Phenacetin	62-44-2	NE	31	1.4	10
Ethyl methanesulfonate	62-50-0	NE	NA	0.96	10
Aniline	62-53-3	11.7	12	2.1	20
N-Nitrosodimethylamine	62-75-9	0.0013	0.00042	2.8	10
Methyl methanesulfonate	66-27-3	NE	0.68	0.6	10
Hexachloroethane	67-72-1	4.8	9.8	0.76	10
4-Chlorophenyl phenyl ether	7005-72-3	NE	NA	0.84	10
Hexachlorophene	70-30-4	11.0	11	27	5000
Isophorone	78-59-1	70.5	71	0.9	10
Pentachloronitrobenzene	82-68-8	0.258	0.26	0.78	10
Acenaphthene	83-32-9	365	2,200	0.76	10
Diethyl phthalate	84-66-2	29,200	29,000	0.88	10
Di-n-butyl phthalate	84-74-2	3,650	3,700	0.83	10
Phenanthrene	85-01-8	1,095	NA	0.77	10
Butyl benzyl phthalate	85-68-7	2,690	35	1.2	10
N-Nitrosodiphenylamine	86-30-6	13.7	14	0.92	10
Fluorene	86-73-7	243	1,500	0.96	10
2,6-Dichlorophenol	87-65-0	NE	NA	0.73	10
Hexachlorobutadiene	87-68-3	0.859	0.86	0.62	10
2,4,6-Trichlorophenol	88-06-2	6.09	6.1	0.85	10
2-Nitroaniline	88-74-4	0.417	370	1.3	50
2-Nitrophenol	88-75-5	0.416	NA	0.76	10
Dinoseb	88-85-7	7.0	37	5	10
Naphthalene	91-20-3	6.20	0.14	0.7	10
2-Methylnaphthalene	91-57-6	122	150	0.78	10
2-Chloronaphthalene	91-58-7	487	2,900	0.8	10
2-Naphthylamine	91-59-8	NE	0.037	1.5	10

Table 3b. Parameters, Methods, and Target Reporting Limits, Quality Assurance Project Plan,
Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi.

Analyte[1]	CAS Number	Drinking Water			
		Tier 1 TRG (µg/L)	RSL Tap (µg/L)	Laboratory MDL (µg/L)	Laboratory RL (µg/L)
Semivolatile Organic Compounds (Method 8270) continued					
Methapyrilene	91-80-5	NE	NA	2.7	2000
3,3'-Dichlorobenzidine	91-94-1	0.15	0.15	30	60
N-Nitrosodi-n-butylamine	924-16-3	0.0019	0.0024	0.96	10
1,1'-Biphenyl	92-52-4	304	0.83	0.58	10
4-Aminobiphenyl	92-67-1	NE	0.0032	1.2	10
N-Nitrosopyrrolidine	930-55-2	0.032	0.032	1.0	10
Safrole, Total	94-59-7	NE	0.098	0.8	10
2-Methylphenol	95-48-7	1,825	1,800	0.89	10
1,2-Dichlorobenzene	95-50-1	600	370	0.53	10
2-Toluidine	95-53-4	0.28	NA	1.4	10
2-Chlorophenol	95-57-8	30.4	180	0.87	10
1,2,4,5-Tetrachlorobenzene	95-94-3	11.0	11	0.76	10
2,4,5-Trichlorophenol	95-95-4	3,650	3,700	1.2	10
Acetophenone	98-86-2	0.0416	3,700	0.57	10
Nitrobenzene	98-95-3	3.53	0.12	0.73	10
3-Nitroaniline	99-09-2	NE	NA	5.0	50
1,3,5-Trinitrobenzene	99-35-4	1,095	1,100	2.0	10
N-Nitro-o-toluidine	99-55-8	2.03	7.5	1.5	10
1,3-Dinitrobenzene	99-65-0	3.65	3.7	0.60	10
Organochlorine Pesticides (USEPA 8081A)					
Aldrin	309-00-2	0.004	0.004	0.007	0.05
alpha-BHC	319-84-6	0.011	0.011	0.0057	0.05
beta-BHC	319-85-7	0.037	0.037	0.0067	0.05
Chlorobenzilate	510-15-6	0.248	0.61	0.5	0.5
4,4'-DDD	72-54-8	0.279	0.28	0.0065	0.1
4,4'-DDE	72-55-9	0.197	0.2	0.0077	0.1
4,4'-DDT	50-29-3	0.197	0.2	0.0097	0.1
delta-BHC	319-86-8	NE	NA	0.0048	0.05
Dieldrin	60-57-1	0.004	0.0042	0.0091	0.1
Endosulfan I [a]	959-98-8	219	NA	0.0042	0.05
Endosulfan II [a]	33213-65-9	219	NA	0.0098	0.1
Endosulfan sulfate [a]	1031-07-8	219	NA	0.0068	0.1
Endrin aldehyde [b]	7421-93-4	2.0	NA	0.016	0.1
Endrin ketone [b]	53494-70-5	2.0	NA	0.0084	0.1
Isodrin	465-73-6	NE	NA	0.05	0.05
Kepone	143-50-0	NE	0.0067	1	1
PCBs (USEPA 508)					
Endrin	72-20-8	2.0	11	0.0022	0.05
gamma-BHC (Lindane)	58-89-9	0.20	0.061	0.0024	0.025
Heptachlor	76-44-8	0.40	0.015	0.0063	0.025
Heptachlor epoxide	1024-57-3	0.20	0.0074	0.0017	0.025
Methoxychlor	72-43-5	40	180	0.0078	0.1
Chlordane (technical)	57-74-9	2.0	NA	0.12	0.25
Toxaphene	8001-35-2	3.0	0.061	0.058	2.5
PCB-1016	12674-11-2	0.96	0.96	0.068	0.5
PCB-1221	11104-28-2	0.033	0.0068	0.051	0.5
PCB-1232	11141-16-5	0.033	0.0068	0.098	0.5
PCB-1242	53469-21-9	0.033	0.034	0.14	0.5
PCB-1248	12672-29-6	0.033	0.034	0.049	0.5
PCB-1254	11097-69-1	0.033	0.034	0.051	0.5
PCB-1260	11096-82-5	0.033	0.034	0.05	0.5
PCBs, Total	1336-36-3	0.50	0.17	0.045	0.5
Herbicides (USEPA 515.1)					
2,4-D	94-75-7	70	370	0.037	0.5
Silvex (2,4,5-TP)	93-72-1	50	290	0.06	0.5
Dalapon	**75-99-0**	200	1,100	1.0	10
Dinoseb	**88-85-7**	7.0	37	0.15	3
Pentachlorophenol	**87-86-5**	1.0	0.17	0.038	1
Picloram	**2/1/1918**	NE	2,600	0.077	0.5
Herbicides (USEPA 8151A)					
2,4,5-T	93-76-5	365	370	0.062	0.5
Dioxathion/Dioxenethion (BATCO 088.1)					
cis-Dioxathion	78-34-2	54.8	NA	NA	0.48
trans-Dioxathion	78-34-2	54.8	NA	NA	0.31
Dioxenethion	--	NE	NA	NA	0.22

Table 3b. Parameters, Methods, and Target Reporting Limits, Quality Assurance Project Plan, Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi.

Analyte[1]	CAS Number	Drinking Water			
		Tier 1 TRG (pg/L)	**RSL Tap (pg/L)**	**Laboratory MDL (pg/L)**	**Laboratory RL (pg/L)**
Dioxins and Furans (1613) (pg/L)					
2,3,7,8-TCDD	51207-31-9	4.5	0.52	2.1	10
1,2,3,7,8-PeCDD	40321-76-4	0.89	NA	2.6	50
1,2,3,4,7,8-HxCDD	39227-28-6	4.5	NA	1.3	50
1,2,3,6,7,8-HxCDD	57653-85-7	10.8	NA	1.8	50
1,2,3,7,8,9-HxCDD	19408-74-3	10.8	NA	1.6	50
1,2,3,4,6,7,8-HpCDD	35822-46-9	44.6	NA	1.5	50
OCDD	3268-87-9	446	NA	3.1	100
2,3,7,8-TCDF	51207-31-9	4.5	NA	3.4	10
1,2,3,7,8-PeCDF	57117-41-6	8.9	NA	1.3	50
2,3,4,7,8-PeCDF	57117-31-4	0.89	NA	1.2	50
1,2,3,4,7,8-HxCDF	70648-26-9	4.5	NA	1.4	50
1,2,3,6,7,8-HxCDF	57117-44-9	4.5	NA	1.2	50
2,3,4,6,7,8-HxCDF	60851-34-5	4.5	NA	1.1	50
1,2,3,7,8,9-HxCDF	72918-21-9	4.5	NA	1.9	50
1,2,3,4,6,7,8-HpCDF	55673-89-7	45	NA	1.7	50
1,2,3,4,7,8,9-HpCDF	67562-39-4	45	NA	2.1	50
OCDF	39001-02-0	446	NA	1.3	100

Analyte[1]	CAS Number	Drinking Water			
		Tier 1 TRG (µg/L)	**RSL Tap (µg/L)**	**Laboratory MDL (µg/L)**	**Laboratory RL (µg/L)**
Total Metals (including Mercury) (200.8, 245)					
Antimony	7440-36-0	6.0	15	0.4	1
Arsenic	7440-38-2	50	0.045	0.37	1
Barium	7440-39-3	2,000	7,300	0.14	2
Beryllium	7440-41-7	4.0	73	0.15	0.4
Cadmium	7440-43-9	5.0	18	0.043	0.1
Chromium	7440-47-3	100	NA	1	2
Copper	7440-50-8	1,300	1,500	0.5	1
Lead	7439-92-1	15	NA	0.06	0.3
Selenium	7782-49-2	50	180	0.58	2
Thallium	7440-28-0	2.0	0.37	0.1	0.2
Mercury	7439-97-6	2.0	0.63	0.091	0.2
Total Metals (including Mercury) (EPA 200.7)					
Zinc	7440-66-6	10,950	11,000	6.3	20
Aluminum	**7429-90-5**	36,500	37,000	100	200
Iron	**7439-89-6**	10,950	26,000	24	50
Manganese	**7439-96-5**	730	880	3	10
Silver	**7440-22-4**	183	180	0.97	10
Cobalt	7440-48-4	2,190	11	0.12	0.5
Nickel	7440-02-0	730	730	2	5
Tin	7440-31-5	21,900	22,000	1.4	5
Vanadium	7440-62-2	256	180	3.2	10
Cyanide, Total (USEPA 4500)					
Cyanide, Total	57-12-5	200	730	0.005	0.01
Sulfide, Total (USEPA 4500)					
Sulfide, Total	18496-25-8	NE	NA	NA	1

Notes:

[1] USEPA. Office of Solid Waste and Emergency Response. *Test Methods for Evaluating Solid Waste. SW-846 3rd ed. Washington, D.C. 1996.*

**TRG=MDEQ Tier 1 Target Remedial Goals per the Final Regulations Governing Brownfields Voluntary Cleanup and Redevelopment in Mississippi (MDBQ, March 2002)

Note : Where applicable the drinking water methods are being used to analyze compounds associated with the APP IX compound list. If the APP IX compound is not part of the Drinking water method being utilized the appropriate SW-846 method will be utilized to complete the analysis of that compound. Compounds that are bolded are part of the EPA's 500 series drinking water method but are not part of the APP IX compound list.

BATCO	Bonner Analytical Testing Company.
HpCDF	Heptachlorodibenzofuran.
HxCDF	Hexachlorodibenzofuran.
MDL	Method detection limit.
MEK	Methyl ethyl ketone.
MIBK	Methyl isobutyl ketone.
NA	Not available.
NE	TRG not yet established for the compound.

Table 3b. Parameters, Methods, and Target Reporting Limits, Quality Assurance Project Plan,
Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi.

OCDD	Octachlorodibenzodioxin.
OCDF	Octachlorodibenzofuran.
PeCDD	Pentachlorodibenzo-p-dioxin.
PeCDF	Pentachlorodibenzofuran .
pg/L	picograms per liter.
TCDD	Tetrachlorodibenzodioxin.
TCDF	Tetrafuran.
ug/L	Mcrograms per liter.
USEPA	U.S. Environmental Protection Agency.

[a] Endosulfan used as a surrogate.
[b] Endrin used as a surrogate.

Table 3c-1. Parameters, Methods, and Target Reporting Limits, Quality Assurance Project Plan, Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi

Analyte[1]	CAS Number	Soil / Sediment						
		Tier 1 TRG Restricted mg/Kg	Tier 1 TRG Unrestricted mg/Kg	RSL Resident Soil mg/Kg	Laboratory MDL mg/Kg	Laboratory RL mg/Kg	Low Level Laboratory MDL mg/Kg	Low Level Laboratory RL mg/Kg
Volatile Organic Compounds (Method 8260)								
Ethylbenzene	100-41-4	395	395	5.4	0.0018	0.005	--	--
Styrene	100-42-5	384	384	6300	0.0019	0.005	--	--
trans-1,3-Dichloropropene	10061-02-6	NE	NE	NE	0.0033	0.025	--	--
Ethylene Dibromide	106-93-4	0.067	0.008	0.034	0.0017	0.005	--	--
Acrolein	107-02-8	40880	1564	0.15	0.024	0.1	--	--
3-Chloro-1-propene	107-05-1	NE	NE	0.68	0.0022	0.005	--	--
Propionitrile	107-12-0	NE	NE	NE	0.0016	0.005	--	--
Acrylonitrile	107-13-1	10.6	1.18	0.24	0.034	0.1	--	--
Vinyl acetate	108-05-4	9.13	9.13	970	0.0025	0.01	--	--
4-Methyl-2-pentanone (MIBK)	108-10-1	163333	6257	NE	0.00093	0.005	--	--
Toluene	108-88-3	38.0	38.0	5000	0.00087	0.005	--	--
Chlorobenzene	108-90-7	1.19	1.19	290	0.00096	0.005	--	--
trans-1,4-Dichloro-2-butene	110-57-6	NE	NE	0.0069	0.0015	0.005	--	--
Chlorodibromomethane	124-48-1	68.1	7.60	0.68	0.0014	0.005	--	--
Methacrylonitrile	126-98-7	204	7.82	3.2	0.0042	0.025	--	--
2-Chloro-1,3-butadiene	126-99-8	NE	NE	0.0094	0.0027	0.005	--	--
Tetrachloroethene	127-18-4	18.2	11.9	0.55	0.00063	0.005	--	--
Xylenes, Total	1330-20-7	318	318	630	0.0011	0.01	--	--
Carbon tetrachloride	56-23-5	0.569	0.371	0.61	0.00083	0.005	--	--
2-Hexanone	591-78-6	81760	3129	210	0.023	0.1	--	--
1,1,1,2-Tetrachloroethane	630-20-6	220	24.6	1.9	0.00084	0.005	--	--
Acetone	67-64-1	103751	7821	61000	0.011	0.05	--	--
Chloroform	67-66-3	0.478	0.312	0.29	0.001	0.005	--	--
Benzene	71-43-2	1.36	0.887	1.1	0.00073	0.005	--	--
1,1,1-Trichloroethane	71-55-6	1188	1188	8700	0.00059	0.005	--	--
Bromomethane	74-83-9	2.97	2.97	7.3	0.0015	0.005	--	--
Chloromethane	74-87-3	440	49.1	120	0.0021	0.005	--	--
Dibromomethane	74-95-3	20417	782	25	0.0044	0.01	--	--
Chloroethane	75-00-3	1974	220	15000	0.0011	0.005	--	--
Vinyl chloride	75-01-4	0.939	0.426	0.06	0.0015	0.005	--	--
Acetonitrile	75-05-8	111	111	870	0.041	0.2	--	--
Methylene Chloride	75-09-2	440	49.1	11	0.0063	0.025	--	--
Carbon disulfide	75-15-0	7.97	7.97	820	0.0011	0.005	--	--
Bromoform	75-25-2	90.1	58.8	62	0.0015	0.005	--	--
Dichlorobromomethane	75-27-4	1.89	1.24	0.27	0.00097	0.005	--	--
Trichlorofluoromethane	75-69-4	142917	23464	790	0.0012	0.005	--	--
Pentachloroethane	76-01-7	NE	NE	5.4	0.0024	0.005	--	--
Isobutyl alcohol	78-83-1	612500	23464	23000	0.0045	0.01	--	--
2-Butanone (MEK)	78-93-3	84.5	84.5	28000	0.0024	0.025	--	--
1,1,2-Trichloroethane	79-00-5	1.7	1.1	1.1	0.0013	0.005	--	--
Trichloroethene	79-01-6	7.92	5.17	2.8	0.0013	0.005	--	--
1,1,2,2-Tetrachloroethane	79-34-5	1.00	0.656	0.56	0.0029	0.01	--	--
Methyl methacrylate	80-62-6	16333	16333	4800	0.026	0.1	--	--
1,2-Dibromo-3-Chloropropane	96-12-8	0.100	0.100	0.0054	0.00083	0.005	--	--
1,2,3-Trichloropropane	96-18-4	0.818	0.091	0.005	0.0024	0.005	--	--
Ethyl methacrylate	97-63-2	18375	7039	1500	0.052	0.2	--	--

Table 3c-1. Parameters, Methods, and Target Reporting Limits, Quality Assurance Project Plan, Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi

Analyte[1]	CAS Number	Soil / Sediment						
		Tier 1 TRG Restricted mg/Kg	Tier 1 TRG Unrestricted mg/Kg	RSL Resident Soil mg/Kg	Laboratory MDL mg/Kg	Laboratory RL mg/Kg	Low Level Laboratory MDL mg/Kg	Low Level Laboratory RL mg/Kg
Semivolatile Organic Compounds (Method 8270)								
4-Nitroaniline	100-01-6	NE	NE	24	0.049	1.7	0.0083	0.17
4-Nitrophenol	100-02-7	16352	626	NE	0.33	1.7	0.073	0.17
Benzyl alcohol	100-51-6	204167	23464	6100	0.033	0.33	0.0061	0.033
N-Nitrosopiperidine	100-75-4	NE	NE	0.052	0.021	0.33	0.0034	0.033
4-Bromophenyl phenyl ether	101-55-3	NE	NE	NE	0.036	0.33	0.0069	0.033
2,4-Dimethylphenol	105-67-9	40833	1564	1200	0.044	0.33	0.0076	0.066
N-Nitrosomethylethylamine	10595-95-6	0.260	0.029	0.022	0.025	0.33	0.0033	0.033
1,4-Dichlorobenzene	106-46-7	238	26.6	2.4	0.035	0.33	0.0052	0.033
4-Chloroaniline	106-47-8	817	313	2.4	0.052	0.66	0.0052	0.066
p-Phenylene diamine	106-50-3	388360	14861	12000	0.83	1.7	0.36	0.83
bis(chloroisopropyl) ether	108-60-1	9.1	5.9	4.6	0.03	0.33	0.0072	0.033
Phenol	108-95-2	122500	46929	18000	0.034	0.33	0.0065	0.033
2-Picoline	109-06-8	NE	NE	NE	0.017	0.33	0.0033	0.066
Pyridine	110-86-1	2042	78.2	78	0.029	0.33	0.02	0.033
Bis(2-chloroethyl)ether	111-44-4	0.419	0.273	0.21	0.045	0.33	0.0065	0.033
Bis(2-chloroethoxy)methane	111-91-1	NE	NE	180	0.039	0.33	0.0065	0.033
Bis(2-ethylhexyl) phthalate	117-81-7	409	45.6	35	0.029	0.33	0.006	0.066
Di-n-octyl phthalate	117-84-0	4083	1564	NE	0.029	0.33	0.0036	0.033
Hexachlorobenzene	118-74-1	1.65	0.399	0.3	0.039	0.33	0.0076	0.033
3,3'-Dimethylbenzidine	119-93-7	0.622	0.069	0.044	0.83	1.7	0.066	0.066
Anthracene	120-12-7	612500	23464	17000	0.025	0.33	0.0033	0.0067
Isosafrole	120-58-1	NE	NE	NE	0.024	0.33	0.0033	0.033
1,2,4-Trichlorobenzene	120-82-1	824	782	22	0.031	0.33	0.0046	0.033
2,4-Dichlorophenol	120-83-2	613	235	180	0.035	0.33	0.0072	0.033
2,4-Dinitrotoluene	121-14-2	408	156	1.6	0.049	0.33	0.0075	0.033
alpha,alpha-Dimethyl phenethylamine	122-09-8	NE	NE	NE	2.7	67	0.33	6.7
1,4-Dioxane	123-91-1	520	58.1	4.9	0.12	0.33	0.0034	0.033
o,o,o-Triethylphosphorothioate	126-68-1	NE	NE	NE	0.04	0.33	0.0044	0.066
Pyrene	129-00-0	61250	2346	1700	0.027	0.33	0.0033	0.0067
1,4-Naphthoquinone	130-15-4	NE	NE	NE	0.017	0.33	0.0033	0.033
Dimethyl phthalate	131-11-3	20440000	782143	NE	0.034	0.33	0.0075	0.033
Dibenzofuran	132-64-9	8176	313	78	0.033	0.33	0.0067	0.033
1-Naphthylamine	134-32-7	NE	NE	NE	0.066	0.33	0.017	0.066
Aramite, Total	140-57-8	NE	NE	19	0.057	0.33	0.0048	0.066
3 & 4 Methylphenol	15831-10-4	102200	3911	NE	0.043	0.33	0.0073	0.033
Hexachloropropene	1888-71-7	NE	NE	NE	0.029	0.33	0.0053	0.033
Benzo[g,h,i]perylene	191-24-2	61320	2346	NE	0.022	0.33	0.0033	0.0067
Indeno[1,2,3-cd]pyrene	193-39-5	7.84	0.875	0.15	0.028	0.33	0.0033	0.0067
Benzo[b]fluoranthene	205-99-2	7.84	0.875	0.15	0.038	0.33	0.0033	0.0067
Fluoranthene	206-44-0	81667	3129	2300	0.032	0.33	0.0033	0.0067
Benzo[k]fluoranthene	207-08-9	78.4	8.75	1.5	0.065	0.33	0.002	0.0067
Acenaphthylene	208-96-8	122640	4693	NE	0.036	0.33	0.0033	0.0067
Chrysene	218-01-9	784	87.5	15	0.021	0.33	0.0033	0.0067
Diallate	2303-16-4	NE	NE	8	0.17	0.33	0.0056	0.033
Pronamide	23950-58-5	NE	NE	4600	0.024	0.33	0.0042	0.033
Thionazin	297-97-2	NE	NE	NE	0.023	0.33	0.017	0.033
Methyl parathion	298-00-0	408	19.6	15	0.026	0.33	0.017	0.033
Phorate	298-02-2	NE	NE	12	0.022	0.33	0.0059	0.033
Disulfoton	298-04-4	8.17	3.13	2.4	0.017	0.33	0.017	0.033
Sulfotepp	3689-24-5	NE	NE	31	0.02	0.33	0.0065	0.033
Benzo[a]pyrene	50-32-8	0.784	0.087	0.015	0.052	0.33	0.0012	0.0067
2,4-Dinitrophenol	51-28-5	408	156	120	0.83	1.7	0.017	0.33
Famphur	52-85-7	NE	NE	NE	0.029	0.33	0.017	0.033
4,6-Dinitro-2-methylphenol	534-52-1	204	7.82	4.9	0.17	1.7	0.017	0.17
Dibenz(a,h)anthracene	53-70-3	0.784	0.087	0.015	0.039	0.33	0.0033	0.0067
2-Acetylaminofluorene	53-96-3	2042	78.2	0.13	0.028	0.33	0.042	0.033
1,3-Dichlorobenzene	541-73-1	1840	70.4	NE	0.034	0.33	0.0056	0.033
N-Nitrosodiethylamine	55-18-5	0.038	0.004	0.00077	0.028	0.33	0.0033	0.066
Ethyl Parathion	56-38-2	1225	469	370	0.022	0.33	0.042	0.033
3-Methylcholanthrene	56-49-5	NE	NE	0.0052	0.041	0.33	0.042	0.033
Benzo[a]anthracene	56-55-3	7.8	0.87	0.15	0.027	0.33	0.0033	0.0067
4-Nitroquinoline-1-oxide	56-57-5	NE	NE	NE	0.83	3.3	0.042	0.33
7,12-Dimethylbenz(a)anthracene	57-97-6	NE	NE	0.00043	0.017	0.33	0.017	0.033
2,3,4,6-Tetrachlorophenol	58-90-2	61250	2346	1800	0.022	0.33	0.0033	0.033

Table 3c-1. Parameters, Methods, and Target Reporting Limits, Quality Assurance Project Plan, Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi

Analyte[1]	CAS Number	Soil / Sediment						
		Tier 1 TRG Restricted mg/Kg	Tier 1 TRG Unrestricted mg/Kg	RSL Resident Soil mg/Kg	Laboratory MDL mg/Kg	Laboratory RL mg/Kg	Low Level Laboratory MDL mg/Kg	Low Level Laboratory RL mg/Kg
Semivolatile Organic Compounds (Method 8270) (Continued)								
4-Chloro-3-methylphenol	59-50-7	408333	156429	6100	0.035	0.33	0.007	0.033
N-Nitrosomorpholine	59-89-2	NE	NE	0.073	0.027	0.33	0.0045	0.033
p-Dimethylamino azobenzene	60-11-7	NE	NE	0.11	0.019	0.33	0.017	0.033
Dimethoate	60-51-5	NE	NE	12	0.025	0.33	0.017	0.033
2,6-Dinitrotoluene	606-20-2	2042	78	61	0.042	0.33	0.0079	0.033
Pentachlorobenzene	608-93-5	1633	62.6	49	0.025	0.33	0.0033	0.033
N-Nitrosodi-n-propylamine	621-64-7	0.818	0.091	0.069	0.032	0.33	0.0075	0.033
Phenacetin	62-44-2	NE	NE	220	0.033	0.33	0.017	0.033
Ethyl methanesulfonate	62-50-0	NE	NE	NE	0.031	0.33	0.0078	0.066
Aniline	62-53-3	1004	112	85	0.034	0.66	0.0082	0.066
N-Nitrosodimethylamine	62-75-9	0.112	0.013	0.0023	0.12	0.33	0.019	0.033
Methyl methanesulfonate	66-27-3	NE	NE	4.9	0.017	0.33	0.0038	0.033
Hexachloroethane	67-72-1	93.3	45.6	35	0.028	0.33	0.0058	0.033
4-Chlorophenyl phenyl ether	7005-72-3	NE	NE	NE	0.044	0.33	0.0064	0.033
Hexachlorophene	70-30-4	613	23.5	18	13	170	2.4	17
Hexachlorocyclopentadiene	77-47-4	0.951	0.951	370	0.041	0.33	0.0037	0.066
Isophorone	78-59-1	4570	672	510	0.033	0.33	0.007	0.033
Pentachloronitrobenzene	82-68-8	22.0	2.46	1.9	0.021	0.33	0.017	0.033
Acenaphthene	83-32-9	122500	4693	3400	0.041	0.33	0.0033	0.0067
Diethyl phthalate	84-66-2	1974	1974	49000	0.037	0.33	0.0074	0.033
Di-n-butyl phthalate	84-74-2	2279	2279	6100	0.03	0.33	0.017	0.17
Phenanthrene	85-01-8	61320	2346	NE	0.027	0.33	0.0024	0.0067
Butyl benzyl phthalate	85-68-7	928	928	260	0.026	0.33	0.0055	0.033
N-Nitrosodiphenylamine	86-30-6	1168	130	99	0.033	0.33	0.0061	0.033
Fluorene	86-73-7	81667	3129	2300	0.036	0.33	0.0033	0.0067
2,6-Dichlorophenol	87-65-0	NE	NE	NE	0.027	0.33	0.0033	0.033
Hexachlorobutadiene	87-68-3	0.135	0.088	6.2	0.036	0.33	0.0068	0.033
Pentachlorophenol	87-86-5	23.8	2.66	0.89	0.33	1.7	0.017	0.17
2,4,6-Trichlorophenol	88-06-2	314	58.1	44	0.029	0.33	0.0079	0.033
2-Nitroaniline	88-74-4	0.492	0.492	610	0.045	1.7	0.007	0.17
2-Nitrophenol	88-75-5	NE	NE	NE	0.041	0.33	0.0058	0.033
Dinoseb	88-85-7	204	78.2	61	0.16	0.33	0.0062	0.066
Naphthalene	91-20-3	247	194	3.6	0.03	0.33	0.0033	0.0067
2-Methylnaphthalene	91-57-6	40880	1564	310	0.038	0.33	0.0033	0.0067
2-Chloronaphthalene	91-58-7	163520	6257	6300	0.035	0.33	0.006	0.033
2-Naphthylamine	91-59-8	NE	NE	0.27	0.034	0.33	0.017	0.066
Methapyrilene	91-80-5	NE	NE	NE	0.83	67	0.033	6.7
3,3'-Dichlorobenzidine	91-94-1	12.7	1.42	1.1	0.028	0.66	0.017	0.066
N-Nitrosodi-n-butylamine	924-16-3	1.060	0.118	0.087	0.024	0.33	0.017	0.033
1,1'-Biphenyl	92-52-4	10208	3911	51	0.74	0.33	--	--
4-Aminobiphenyl	92-67-1	NE	NE	0.023	0.037	0.33	0.017	0.066
N-Nitrosopyrrolidine	930-55-2	2.73	0.304	0.23	0.018	0.33	0.0036	0.033
Safrole, Total	94-59-7	NE	NE	0.52	0.024	0.33	0.0033	0.033
2-Methylphenol	95-48-7	102200	3911	3100	0.027	0.33	0.0063	0.033
1,2-Dichlorobenzene	95-50-1	279	279	1900	0.037	0.33	0.0086	0.033
2-Toluidine	95-53-4	30.1	3.36	NE	0.035	0.33	0.0033	0.033
2-Chlorophenol	95-57-8	10208	391	390	0.04	0.33	0.0053	0.033
1,2,4,5-Tetrachlorobenzene	95-94-3	613	23	18	0.031	0.33	0.0033	0.033
2,4,5-Trichlorophenol	95-95-4	204400	7821	6100	0.035	0.33	0.0076	0.033
Acetophenone	98-86-2	2633	2633	7800	0.028	0.33	0.0068	0.033
Nitrobenzene	98-95-3	8.41	8.41	4.8	0.026	0.33	0.0066	0.033
3-Nitroaniline	99-09-2	NE	NE	NE	0.046	1.7	0.0067	0.17
1,3,5-Trinitrobenzene	99-35-4	102	102	2200	0.17	0.33	0.017	0.066
N-Nitro-o-toluidine	99-55-8	173	19	54	0.026	0.33	0.017	0.033
1,3-Dinitrobenzene	99-65-0	204	7.82	6.1	0.024	0.33	0.017	0.033
Organochlorine Pesticides (EPA 8081A)								
Aldrin	309-00-2	0.337	0.038	0.029	0.00045	0.0017	--	--
alpha-BHC	319-84-6	0.9	0.1	0.077	0.00011	0.0017	--	--
beta-BHC	319-85-7	3.2	0.4	0.27	0.00011	0.0017	--	--
Chlordane (technical)	57-74-9	12.3	1.82	NE	0.0029	0.017	--	--
Chlorobenzilate	510-15-6	21.2	2.37	4.4	0.017	0.017	--	--
4,4'-DDD	72-54-8	23.8	2.66	2	0.00024	0.0033	--	--
4,4'-DDE	72-55-9	16.8	1.88	1.4	0.00019	0.0033	--	--
4,4'-DDT	50-29-3	16.8	1.88	1.7	0.00023	0.0033	--	--

Table 3c-1. Parameters, Methods, and Target Reporting Limits, Quality Assurance Project Plan, Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi

Analyte[1]	CAS Number	Soil / Sediment						
		Tier 1 TRG Restricted mg/Kg	Tier 1 TRG Unrestricted mg/Kg	RSL Resident Soil mg/Kg	Laboratory MDL mg/Kg	Laboratory RL mg/Kg	Low Level Laboratory MDL mg/Kg	Low Level Laboratory RL mg/Kg
Organochlorine Pesticides (EPA 8081A) (Continued)								
delta-BHC	319-86-8	NE	NE	NE	0.00013	0.0017	--	--
Dieldrin	60-57-1	0.358	0.040	0.03	0.00028	0.0033	--	--
Endosulfan I	959-98-8	1225	469	NE	0.00015	0.0017	--	--
Endosulfan II	33213-65-9	1225	469	NE	0.00023	0.0033	--	--
Endosulfan sulfate	1031-07-8	NE	NE	NE	0.00024	0.0033	--	--
Endrin	72-20-8	61.3	23.5	18	0.00073	0.0033	--	--
Endrin aldehyde	7421-93-4	NE	NE	NE	0.0003	0.0033	--	--
Endrin ketone	53494-70-5	NE	NE	NE	0.00027	0.0033	--	--
gamma-BHC (Lindane)	58-89-9	4.40	0.491	0.52	0.00011	0.0017	--	--
Heptachlor	76-44-8	0.195	0.127	0.11	0.000083	0.0017	--	--
Heptachlor epoxide	1024-57-3	0.629	0.070	0.053	0.00014	0.0017	--	--
Isodrin	465-73-6	NE	NE	NE	0.0033	0.0033	--	--
Kepone	143-50-0	NE	NE	0.049	0.17	0.17	--	--
Methoxychlor	72-43-5	1021	391	310	0.00035	0.0033	--	--
Toxaphene	8001-35-2	5.20	0.581	0.44	0.06	0.17	--	--
PCBs (EPA 8082)								
PCB-1016	12674-11-2	10.0	1.0	3.9	0.0029	0.033	--	--
PCB-1221	11104-28-2	10.0	1.0	0.14	0.0048	0.067	--	--
PCB-1232	11141-16-5	10.0	1.0	0.14	0.0033	0.033	--	--
PCB-1242	53469-21-9	10.0	1.0	0.22	0.0028	0.033	--	--
PCB-1248	12672-29-6	10.0	1.0	0.22	0.0072	0.033	--	--
PCB-1254	11097-69-1	10.0	1.0	0.22	0.0023	0.033	--	--
PCB-1260	11096-82-5	10.0	1.0	0.22	0.0067	0.033	--	--
Total PCBs	1336-36-3	10.0	1.0	0.22	0.0072	0.033	--	--
Herbicides (EPA 8151A)								
2,4-D	94-75-7	2042	782	690	0.005	0.0083	--	--
Silvex (2,4,5-TP)	93-72-1	1633	626	490	0.0016	0.0083	--	--
2,4,5-T	93-76-5	20417	782	610	0.0023	0.0083	--	--
Dioxathion/Dioxenethion (BATCO 088.1)								
cis-Dioxathion	78-34-2	3066	117	NE	NA	14	--	--
trans-Dioxathion	78-34-2	3066	117	NE	NA	15	--	--
Dioxenethion	--	NE	NE	NE	NA	17	--	--
Analyte[1]	**CAS Number**	**Soil / Sediment**						
		Tier 1 TRG Restricted pg/g	**Tier 1 TRG Unrestricted pg/g**	**RSL Resident Soil pg/g**	**Laboratory MDL pg/g**	**Laboratory RL pg/g**	**Low Level Laboratory MDL pg/g**	**Low Level Laboratory RL pg/g**
Dioxins and Furans (8290) (pg/g)								
2,3,7,8-TCDD	51207-31-9	38.2	42.6	NE	1.0	1	--	--
1,2,3,7,8-PeCDD	40321-76-4	76.3	8.5	NE	0.4	5	--	--
1,2,3,4,7,8-HxCDD	39227-28-6	382	42.6	NE	0.6	5	--	--
1,2,3,6,7,8-HxCDD	57653-85-7	923	103	NE	0.4	5	--	--
1,2,3,7,8,9-HxCDD	19408-74-3	923	103	NE	0.4	5	--	--
1,2,3,4,6,7,8-HpCDD	35822-46-9	3815	426	NE	0.4	5	--	--
OCDD	3268-87-9	38155	4258	NE	1.1	10	--	--
2,3,7,8-TCDF	51207-31-9	382	42.6	NE	0.7	1	--	--
1,2,3,7,8-PeCDF	57117-41-6	763	85.2	NE	0.7	5	--	--
2,3,4,7,8-PeCDF	57117-31-4	76.3	8.5	NE	0.4	5	--	--
1,2,3,4,7,8-HxCDF	70648-26-9	382	43	NE	0.5	5	--	--
1,2,3,6,7,8-HxCDF	57117-44-9	382	43	NE	0.6	5	--	--
2,3,4,6,7,8-HxCDF	60851-34-5	382	43	NE	0.2	5	--	--
1,2,3,7,8,9-HxCDF	72918-21-9	382	43	NE	0.4	5	--	--
1,2,3,4,6,7,8-HpCDF	55673-89-7	NE	NE	NE	0.4	5	--	--
1,2,3,4,7,8,9-HpCDF	67562-39-4	NE	NE	NE	0.6	5	--	--
OCDF	39001-02-0	38155	4258	NE	1.3	10	--	--

Table 3c-1. Parameters, Methods, and Target Reporting Limits, Quality Assurance Project Plan, Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi

Analyte[1]	CAS Number	Soil / Sediment						
		Tier 1 TRG Restricted mg/Kg	Tier 1 TRG Unrestricted mg/Kg	RSL Resident Soil mg/Kg	Laboratory MDL mg/Kg	Laboratory RL mg/Kg	Low Level Laboratory MDL mg/Kg	Low Level Laboratory RL mg/Kg
Total Metals (including Mercury) (SW846-6020, 7471A)								
Antimony	7440-36-0	81.7	31.3	31	1	2	--	--
Arsenic	7440-38-2	3.82	0.426	0.39	0.2	0.5	--	--
Barium	7440-39-3	14292	5475	15000	0.25	1	--	--
Beryllium	7440-41-7	1021	156	160	0.05	0.1	--	--
Cadmium	7440-43-9	1022	39.1	70	0.024	0.1	--	--
Chromium	7440-47-3	NE	NE	NE	0.5	1	--	--
Cobalt	7440-48-4	12250	4693	23	0.03	0.1	--	--
Copper	7440-50-8	8167	3129	3100	0.4	1	--	--
Lead	7439-92-1	1700	400	400	0.2	0.4	--	--
Mercury	7439-97-6	61.3	10.0	10	0.0082	0.02	--	--
Nickel	7440-02-0	4083	1564	1500	0.5	1	--	--
Selenium	7782-49-2	1021	391	390	0.5	1	--	--
Silver	7440-22-4	1021	391	390	0.1	0.2	--	--
Thallium	7440-28-0	143	5.48	0.78	0.05	0.2	--	--
Tin	7440-31-5	122500	46929	47000	5.1	20	--	--
Vanadium	7440-62-2	1429	548	NE	0.55	1	--	--
Zinc	7440-66-6	61250	23464	23000	1.1	4	--	--
Cyanide, Total (EPA 9012A)								
Cyanide, Total	57-12-5	4083	1564	1600	0.21	0.5	--	--
Sulfide, Total (EPA 9034)								
Sulfide, Total	18496-25-8	NE	NE	NE	NA	60	--	--

Notes:

[1] USEPA. Office of Solid Waste and Emergency Response. *Test Methods for Evaluating Solid Waste. SW-846 3rd ed. Washington, D.C. 1996.*

**TRG=MDEQ Tier 1 Target Remedial Goals per the Final Regulations Governing Brownfields Voluntary Cleanup and Redevelopment in Mississippi (MDBQ, March 2002)

All results to be reported in dry weight

BATCO	Bonner Analytical Testing Company.
HpCDF	Heptachlorodibenzofuran.
HxCDF	Hexachlorodibenzofuran.
MDL	Method detection limit.
MEK	Methyl ethyl ketone.
mg/Kg	milligrams per kilogram.
MIBK	Methyl isobutyl ketone.
NA	Not applicable.
NE	RSL or TRG not yet established for the compound.
OCDD	Octachlorodibenzodioxin.
OCDF	Octachlorodibenzofuran.
PeCDD	Pentachlorodibenzo-p-dioxin.
PeCDF	Pentachlorodibenzofuran .
pg/g	picograms per gram.
TCDD	Tetrachlorodibenzodioxin.
TCDF	Tetrafuran.
ug/L	Micrograms per liter.
USEPA	U.S. Environmental Protection Agency.

Table 3c-2. Parameters, Methods, and Target Reporting Limits, Quality Assurance Project Plan, Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi

Analyte[1]	CAS Number	Soil / Sediment						
		Tier 1 TRG Restricted mg/Kg	Tier 1 TRG Unrestricted mg/Kg	RSL Resident Soil mg/Kg	Laboratory MDL mg/Kg	Laboratory RL mg/Kg	Low Level Laboratory MDL mg/Kg	Low Level Laboratory RL mg/Kg
Volatile Organic Compounds (Method 8260)								
Ethylbenzene	100-41-4	395	395	27	0.0018	0.005	--	--
Styrene	100-42-5	384	384	36000	0.0019	0.005	--	--
trans-1,3-Dichloropropene	10061-02-6	NE	NE	NE	0.0033	0.025	--	--
Ethylene Dibromide	106-93-4	0.067	0.008	0.17	0.0017	0.005	--	--
Acrolein	107-02-8	40880	1564	0.65	0.024	0.1	--	--
3-Chloro-1-propene	107-05-1	NE	NE	3.4	0.0022	0.005	--	--
Propionitrile	107-12-0	NE	NE	NE	0.0016	0.005	--	--
Acrylonitrile	107-13-1	10.6	1.18	1.2	0.034	0.1	--	--
Vinyl acetate	108-05-4	9.13	9.13	4100	0.0025	0.01	--	--
4-Methyl-2-pentanone (MIBK)	108-10-1	163333	6257	NE	0.00093	0.005	--	--
Toluene	108-88-3	38.0	38.0	45000	0.00087	0.005	--	--
Chlorobenzene	108-90-7	1.19	1.19	1400	0.00096	0.005	--	--
trans-1,4-Dichloro-2-butene	110-57-6	NE	NE	0.035	0.0015	0.005	--	--
Chlorodibromomethane	124-48-1	68.1	7.60	3.3	0.0014	0.005	--	--
Methacrylonitrile	126-98-7	204	7.82	18	0.0042	0.025	--	--
2-Chloro-1,3-butadiene	126-99-8	NE	NE	0.047	0.0027	0.005	--	--
Tetrachloroethene	127-18-4	18.2	11.9	2.6	0.00063	0.005	--	--
Xylenes, Total	1330-20-7	318	318	2700	0.0011	0.01	--	--
Carbon tetrachloride	56-23-5	0.569	0.371	3	0.00083	0.005	--	--
2-Hexanone	591-78-6	81760	3129	1400	0.023	0.1	--	--
1,1,1,2-Tetrachloroethane	630-20-6	220	24.6	9.3	0.00084	0.005	--	--
Acetone	67-64-1	103751	7821	630000	0.011	0.05	--	--
Chloroform	67-66-3	0.478	0.312	1.5	0.001	0.005	--	--
Benzene	71-43-2	1.36	0.887	5.4	0.00073	0.005	--	--
1,1,1-Trichloroethane	71-55-6	1188	1188	38000	0.00059	0.005	--	--
Bromomethane	74-83-9	2.97	2.97	32	0.0015	0.005	--	--
Chloromethane	74-87-3	440	49.1	500	0.0021	0.005	--	--
Dibromomethane	74-95-3	20417	782	110	0.0044	0.01	--	--
Chloroethane	75-00-3	1974	220	61000	0.0011	0.005	--	--
Vinyl chloride	75-01-4	0.939	0.426	1.7	0.0015	0.005	--	--
Acetonitrile	75-05-8	111	111	3700	0.041	0.2	--	--
Methylene Chloride	75-09-2	440	49.1	53	0.0063	0.025	--	--
Carbon disulfide	75-15-0	7.97	7.97	3700	0.0011	0.005	--	--
Bromoform	75-25-2	90.1	58.8	220	0.0015	0.005	--	--
Dichlorobromomethane	75-27-4	1.89	1.24	1.4	0.00097	0.005	--	--
Trichlorofluoromethane	75-69-4	142917	23464	3400	0.0012	0.005	--	--
Pentachloroethane	76-01-7	NE	NE	19	0.0024	0.005	--	--
Isobutyl alcohol	78-83-1	612500	23464	310000	0.0045	0.01	--	--
2-Butanone (MEK)	78-93-3	84.5	84.5	200000	0.0024	0.025	--	--
1,1,2-Trichloroethane	79-00-5	1.7	1.1	5.3	0.0013	0.005	--	--
Trichloroethene	79-01-6	7.92	5.17	14	0.0013	0.005	--	--
1,1,2,2-Tetrachloroethane	79-34-5	1.00	0.656	2.8	0.0029	0.01	--	--
Methyl methacrylate	80-62-6	16333	16333	21000	0.026	0.1	--	--
1,2-Dibromo-3-Chloropropane	96-12-8	0.100	0.100	0.069	0.00083	0.005	--	--
1,2,3-Trichloropropane	96-18-4	0.818	0.091	0.095	0.0024	0.005	--	--
Ethyl methacrylate	97-63-2	18375	7039	7500	0.052	0.2	--	--

Table 3c-2. Parameters, Methods, and Target Reporting Limits, Quality Assurance Project Plan, Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi

Analyte[1]	CAS Number	Soil / Sediment						
		Tier 1 TRG Restricted mg/Kg	Tier 1 TRG Unrestricted mg/Kg	RSL Resident Soil mg/Kg	Laboratory MDL mg/Kg	Laboratory RL mg/Kg	Low Level Laboratory MDL mg/Kg	Low Level Laboratory RL mg/Kg
Semivolatile Organic Compounds (Method 8270)								
4-Nitroaniline	100-01-6	NE	NE	86	0.049	1.7	0.0083	0.17
4-Nitrophenol	100-02-7	16352	626	NE	0.33	1.7	0.073	0.17
Benzyl alcohol	100-51-6	204167	23464	62000	0.033	0.33	0.0061	0.033
N-Nitrosopiperidine	100-75-4	NE	NE	0.18	0.021	0.33	0.0034	0.033
4-Bromophenyl phenyl ether	101-55-3	NE	NE	NE	0.036	0.33	0.0069	0.033
2,4-Dimethylphenol	105-67-9	40833	1564	12000	0.044	0.33	0.0076	0.066
N-Nitrosomethylethylamine	10595-95-6	0.260	0.029	0.078	0.025	0.33	0.0033	0.033
1,4-Dichlorobenzene	106-46-7	238	26.6	12	0.035	0.33	0.0052	0.033
4-Chloroaniline	106-47-8	817	313	8.6	0.052	0.66	0.0052	0.066
p-Phenylene diamine	106-50-3	388360	14861	120000	0.83	1.7	0.36	0.83
bis(chloroisopropyl) ether	108-60-1	9.1	5.9	22	0.03	0.33	0.0072	0.033
Phenol	108-95-2	122500	46929	180000	0.034	0.33	0.0065	0.033
2-Picoline	109-06-8	NE	NE	NE	0.017	0.33	0.0033	0.066
Pyridine	110-86-1	2042	78.2	1000	0.029	0.33	0.02	0.033
Bis(2-chloroethyl)ether	111-44-4	0.419	0.273	1	0.045	0.33	0.0065	0.033
Bis(2-chloroethoxy)methane	111-91-1	NE	NE	1800	0.039	0.33	0.0065	0.033
Bis(2-ethylhexyl) phthalate	117-81-7	409	45.6	120	0.029	0.33	0.006	0.066
Di-n-octyl phthalate	117-84-0	4083	1564	NE	0.029	0.33	0.0036	0.033
Hexachlorobenzene	118-74-1	1.65	0.399	1.1	0.039	0.33	0.0076	0.033
3,3'-Dimethylbenzidine	119-93-7	0.622	0.069	0.16	0.83	1.7	0.066	0.066
Anthracene	120-12-7	612500	23464	170000	0.025	0.33	0.0033	0.0067
Isosafrole	120-58-1	NE	NE	NE	0.024	0.33	0.0033	0.033
1,2,4-Trichlorobenzene	120-82-1	824	782	99	0.031	0.33	0.0046	0.033
2,4-Dichlorophenol	120-83-2	613	235	1800	0.035	0.33	0.0072	0.033
2,4-Dinitrotoluene	121-14-2	408	156	5.5	0.049	0.33	0.0075	0.033
alpha,alpha-Dimethyl phenethylamine	122-09-8	NE	NE	NE	2.7	67	0.33	6.7
1,4-Dioxane	123-91-1	520	58.1	17	0.12	0.33	0.0034	0.033
o,o,o-Triethylphosphorothioate	126-68-1	NE	NE	NE	0.04	0.33	0.0044	0.066
Pyrene	129-00-0	61250	2346	17000	0.027	0.33	0.0033	0.0067
1,4-Naphthoquinone	130-15-4	NE	NE	NE	0.017	0.33	0.0033	0.033
Dimethyl phthalate	131-11-3	20440000	782143	NE	0.034	0.33	0.0075	0.033
Dibenzofuran	132-64-9	8176	313	1000	0.033	0.33	0.0067	0.033
1-Naphthylamine	134-32-7	NE	NE	NE	0.066	0.33	0.017	0.066
Aramite, Total	140-57-8	NE	NE	69	0.057	0.33	0.0048	0.066
3 & 4 Methylphenol	15831-10-4	102200	3911	NE	0.043	0.33	0.0073	0.033
Hexachloropropene	1888-71-7	NE	NE	NE	0.029	0.33	0.0053	0.033
Benzo[g,h,i]perylene	191-24-2	61320	2346	NE	0.022	0.33	0.0033	0.0067
Indeno[1,2,3-cd]pyrene	193-39-5	7.84	0.875	2.1	0.028	0.33	0.0033	0.0067
Benzo[b]fluoranthene	205-99-2	7.84	0.875	2.1	0.038	0.33	0.0033	0.0067
Fluoranthene	206-44-0	81667	3129	22000	0.032	0.33	0.0033	0.0067
Benzo[k]fluoranthene	207-08-9	78.4	8.75	21	0.065	0.33	0.002	0.0067
Acenaphthylene	208-96-8	122640	4693	NE	0.036	0.33	0.0033	0.0067
Chrysene	218-01-9	784	87.5	210	0.021	0.33	0.0033	0.0067
Diallate	2303-16-4	NE	NE	28	0.17	0.33	0.0056	0.033
Pronamide	23950-58-5	NE	NE	46000	0.024	0.33	0.0042	0.033
Thionazin	297-97-2	NE	NE	NE	0.023	0.33	0.017	0.033
Methyl parathion	298-00-0	408	19.6	150	0.026	0.33	0.017	0.033
Phorate	298-02-2	NE	NE	120	0.022	0.33	0.0059	0.033
Disulfoton	298-04-4	8.17	3.13	25	0.017	0.33	0.017	0.033
Sulfotepp	3689-24-5	NE	NE	310	0.02	0.33	0.0065	0.033
Benzo[a]pyrene	50-32-8	0.784	0.087	0.21	0.052	0.33	0.0012	0.0067
2,4-Dinitrophenol	51-28-5	408	156	1200	0.83	1.7	0.017	0.33
Famphur	52-85-7	NE	NE	NE	0.029	0.33	0.017	0.033
4,6-Dinitro-2-methylphenol	534-52-1	204	7.82	49	0.17	1.7	0.017	0.17
Dibenz(a,h)anthracene	53-70-3	0.784	0.087	0.21	0.039	0.33	0.0033	0.0067
2-Acetylaminofluorene	53-96-3	2042	78.2	0.45	0.028	0.33	0.042	0.033
1,3-Dichlorobenzene	541-73-1	1840	70.4	NE	0.034	0.33	0.0056	0.033
N-Nitrosodiethylamine	55-18-5	0.038	0.004	0.011	0.028	0.33	0.0033	0.066
Ethyl Parathion	56-38-2	1225	469	3700	0.022	0.33	0.042	0.033
3-Methylcholanthrene	56-49-5	NE	NE	0.078	0.041	0.33	0.042	0.033
Benzo[a]anthracene	56-55-3	7.8	0.87	2.1	0.027	0.33	0.0033	0.0067
4-Nitroquinoline-1-oxide	56-57-5	NE	NE	NE	0.83	3.3	0.042	0.33
7,12-Dimethylbenz(a)anthracene	57-97-6	NE	NE	0.0062	0.017	0.33	0.017	0.033
2,3,4,6-Tetrachlorophenol	58-90-2	61250	2346	18000	0.022	0.33	0.0033	0.033

Table 3c-2. Parameters, Methods, and Target Reporting Limits, Quality Assurance Project Plan, Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi

Analyte[1]	CAS Number	Soil / Sediment						
		Tier 1 TRG Restricted mg/Kg	Tier 1 TRG Unrestricted mg/Kg	RSL Resident Soil mg/Kg	Laboratory MDL mg/Kg	Laboratory RL mg/Kg	Low Level Laboratory MDL mg/Kg	Low Level Laboratory RL mg/Kg
Semivolatile Organic Compounds (Method 8270) (Continued)								
4-Chloro-3-methylphenol	59-50-7	408333	156429	62000	0.035	0.33	0.007	0.033
N-Nitrosomorpholine	59-89-2	NE	NE	0.26	0.027	0.33	0.0045	0.033
p-Dimethylamino azobenzene	60-11-7	NE	NE	0.37	0.019	0.33	0.017	0.033
Dimethoate	60-51-5	NE	NE	120	0.025	0.33	0.017	0.033
2,6-Dinitrotoluene	606-20-2	2042	78	620	0.042	0.33	0.0079	0.033
Pentachlorobenzene	608-93-5	1633	62.6	490	0.025	0.33	0.0033	0.033
N-Nitrosodi-n-propylamine	621-64-7	0.818	0.091	0.25	0.032	0.33	0.0075	0.033
Phenacetin	62-44-2	NE	NE	780	0.033	0.33	0.017	0.033
Ethyl methanesulfonate	62-50-0	NE	NE	NE	0.031	0.33	0.0078	0.066
Aniline	62-53-3	1004	112	300	0.034	0.66	0.0082	0.066
N-Nitrosodimethylamine	62-75-9	0.112	0.013	0.034	0.12	0.33	0.019	0.033
Methyl methanesulfonate	66-27-3	NE	NE	17	0.017	0.33	0.0038	0.033
Hexachloroethane	67-72-1	93.3	45.6	120	0.028	0.33	0.0058	0.033
4-Chlorophenyl phenyl ether	7005-72-3	NE	NE	NE	0.044	0.33	0.0064	0.033
Hexachlorophene	70-30-4	613	23.5	180	13	170	2.4	17
Hexachlorocyclopentadiene	77-47-4	0.951	0.951	3700	0.041	0.33	0.0037	0.066
Isophorone	78-59-1	4570	672	1800	0.033	0.33	0.007	0.033
Pentachloronitrobenzene	82-68-8	22.0	2.46	6.6	0.021	0.33	0.017	0.033
Acenaphthene	83-32-9	122500	4693	33000	0.041	0.33	0.0033	0.0067
Diethyl phthalate	84-66-2	1974	1974	490000	0.037	0.33	0.0074	0.033
Di-n-butyl phthalate	84-74-2	2279	2279	62000	0.03	0.33	0.017	0.17
Phenanthrene	85-01-8	61320	2346	NE	0.027	0.33	0.0024	0.0067
Butyl benzyl phthalate	85-68-7	928	928	910	0.026	0.33	0.0055	0.033
N-Nitrosodiphenylamine	86-30-6	1168	130	350	0.033	0.33	0.0061	0.033
Fluorene	86-73-7	81667	3129	22000	0.036	0.33	0.0033	0.0067
2,6-Dichlorophenol	87-65-0	NE	NE	NE	0.027	0.33	0.0033	0.033
Hexachlorobutadiene	87-68-3	0.135	0.088	22	0.036	0.33	0.0068	0.033
Pentachlorophenol	87-86-5	23.8	2.66	2.7	0.33	1.7	0.017	0.17
2,4,6-Trichlorophenol	88-06-2	314	58.1	160	0.029	0.33	0.0079	0.033
2-Nitroaniline	88-74-4	0.492	0.492	6000	0.045	1.7	0.007	0.17
2-Nitrophenol	88-75-5	NE	NE	NE	0.041	0.33	0.0058	0.033
Dinoseb	88-85-7	204	78.2	620	0.16	0.33	0.0062	0.066
Naphthalene	91-20-3	247	194	18	0.03	0.33	0.0033	0.0067
2-Methylnaphthalene	91-57-6	40880	1564	4100	0.038	0.33	0.0033	0.0067
2-Chloronaphthalene	91-58-7	163520	6257	82000	0.035	0.33	0.006	0.033
2-Naphthylamine	91-59-8	NE	NE	0.96	0.034	0.33	0.017	0.066
Methapyrilene	91-80-5	NE	NE	NE	0.83	67	0.033	6.7
3,3'-Dichlorobenzidine	91-94-1	12.7	1.42	3.8	0.028	0.66	0.017	0.066
N-Nitrosodi-n-butylamine	924-16-3	1.060	0.118	0.4	0.024	0.33	0.017	0.033
1,1'-Biphenyl	92-52-4	10208	3911	210	0.74	0.33	--	--
4-Aminobiphenyl	92-67-1	NE	NE	0.082	0.037	0.33	0.017	0.066
N-Nitrosopyrrolidine	930-55-2	2.73	0.304	0.82	0.018	0.33	0.0036	0.033
Safrole, Total	94-59-7	NE	NE	7.8	0.024	0.33	0.0033	0.033
2-Methylphenol	95-48-7	102200	3911	31000	0.027	0.33	0.0063	0.033
1,2-Dichlorobenzene	95-50-1	279	279	9800	0.037	0.33	0.0086	0.033
2-Toluidine	95-53-4	30.1	3.36	NE	0.035	0.33	0.0033	0.033
2-Chlorophenol	95-57-8	10208	391	5100	0.04	0.33	0.0053	0.033
1,2,4,5-Tetrachlorobenzene	95-94-3	613	23	180	0.031	0.33	0.0033	0.033
2,4,5-Trichlorophenol	95-95-4	204400	7821	62000	0.035	0.33	0.0076	0.033
Acetophenone	98-86-2	2633	2633	100000	0.028	0.33	0.0068	0.033
Nitrobenzene	98-95-3	8.41	8.41	24	0.026	0.33	0.0066	0.033
3-Nitroaniline	99-09-2	NE	NE	NE	0.046	1.7	0.0067	0.17
1,3,5-Trinitrobenzene	99-35-4	102	102	27000	0.17	0.33	0.017	0.066
N-Nitro-o-toluidine	99-55-8	173	19	190	0.026	0.33	0.017	0.033
1,3-Dinitrobenzene	99-65-0	204	7.82	62	0.024	0.33	0.017	0.033
Organochlorine Pesticides (EPA 8081A)								
Aldrin	309-00-2	0.337	0.038	0.1	0.00045	0.0017	--	--
alpha-BHC	319-84-6	0.9	0.1	0.27	0.00011	0.0017	--	--
beta-BHC	319-85-7	3.2	0.4	0.96	0.00011	0.0017	--	--
Chlordane (technical)	57-74-9	12.3	1.82	NE	0.0029	0.017	--	--
Chlorobenzilate	510-15-6	21.2	2.37	16	0.017	0.017	--	--
4,4'-DDD	72-54-8	23.8	2.66	7.2	0.00024	0.0033	--	--
4,4'-DDE	72-55-9	16.8	1.88	5.1	0.00019	0.0033	--	--
4,4'-DDT	50-29-3	16.8	1.88	7	0.00023	0.0033	--	--

Table 3c-2. Parameters, Methods, and Target Reporting Limits, Quality Assurance Project Plan, Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi

Analyte[1]	CAS Number	Soil / Sediment						
		Tier 1 TRG Restricted mg/Kg	Tier 1 TRG Unrestricted mg/Kg	RSL Resident Soil mg/Kg	Laboratory MDL mg/Kg	Laboratory RL mg/Kg	Low Level Laboratory MDL mg/Kg	Low Level Laboratory RL mg/Kg
Organochlorine Pesticides (EPA 8081A) (Continued)								
delta-BHC	319-86-8	NE	NE	NE	0.00013	0.0017	--	--
Dieldrin	60-57-1	0.358	0.040	0.11	0.00028	0.0033	--	--
Endosulfan I	959-98-8	1225	469	NE	0.00015	0.0017	--	--
Endosulfan II	33213-65-9	1225	469	NE	0.00023	0.0033	--	--
Endosulfan sulfate	1031-07-8	NE	NE	NE	0.00024	0.0033	--	--
Endrin	72-20-8	61.3	23.5	180	0.00073	0.0033	--	--
Endrin aldehyde	7421-93-4	NE	NE	NE	0.0003	0.0033	--	--
Endrin ketone	53494-70-5	NE	NE	NE	0.00027	0.0033	--	--
gamma-BHC (Lindane)	58-89-9	4.40	0.491	2.1	0.00011	0.0017	--	--
Heptachlor	76-44-8	0.195	0.127	0.38	0.000083	0.0017	--	--
Heptachlor epoxide	1024-57-3	0.629	0.070	0.19	0.00014	0.0017	--	--
Isodrin	465-73-6	NE	NE	NE	0.0033	0.0033	--	--
Kepone	143-50-0	NE	NE	0.17	0.17	0.17	--	--
Methoxychlor	72-43-5	1021	391	3100	0.00035	0.0033	--	--
Toxaphene	8001-35-2	5.20	0.581	1.6	0.06	0.17	--	--
PCBs (EPA 8082)								
PCB-1016	12674-11-2	10.0	1.0	21	0.0029	0.033	--	--
PCB-1221	11104-28-2	10.0	1.0	0.54	0.0048	0.067	--	--
PCB-1232	11141-16-5	10.0	1.0	0.54	0.0033	0.033	--	--
PCB-1242	53469-21-9	10.0	1.0	0.74	0.0028	0.033	--	--
PCB-1248	12672-29-6	10.0	1.0	0.74	0.0072	0.033	--	--
PCB-1254	11097-69-1	10.0	1.0	0.74	0.0023	0.033	--	--
PCB-1260	11096-82-5	10.0	1.0	0.74	0.0067	0.033	--	--
Total PCBs	1336-36-3	10.0	1.0	0.74	0.0072	0.033	--	--
Herbicides (EPA 8151A)								
2,4-D	94-75-7	2042	782	7700	0.005	0.0083	--	--
Silvex (2,4,5-TP)	93-72-1	1633	626	4900	0.0016	0.0083	--	--
2,4,5-T	93-76-5	20417	782	6200	0.0023	0.0083	--	--
Dioxathion/Dioxenethion (BATCO 088.1)								
cis-Dioxathion	78-34-2	3066	117	NE	NA	14	--	--
trans-Dioxathion	78-34-2	3066	117	NE	NA	15	--	--
Dioxenethion	--	NE	NE	NE	NA	17	--	--
Analyte[1]	**CAS Number**	**Soil / Sediment**						
		Tier 1 TRG Restricted pg/g	**Tier 1 TRG Unrestricted pg/g**	**RSL Resident Soil pg/g**	**Laboratory MDL pg/g**	**Laboratory RL pg/g**	**Low Level Laboratory MDL pg/g**	**Low Level Laboratory RL pg/g**
Dioxins and Furans (8290) (pg/g)								
2,3,7,8-TCDD	51207-31-9	38.2	42.6	NE	1.0	1	--	--
1,2,3,7,8-PeCDD	40321-76-4	76.3	8.5	NE	0.4	5	--	--
1,2,3,4,7,8-HxCDD	39227-28-6	382	42.6	NE	0.6	5	--	--
1,2,3,6,7,8-HxCDD	57653-85-7	923	103	NE	0.4	5	--	--
1,2,3,7,8,9-HxCDD	19408-74-3	923	103	NE	0.4	5	--	--
1,2,3,4,6,7,8-HpCDD	35822-46-9	3815	426	NE	0.4	5	--	--
OCDD	3268-87-9	38155	4258	NE	1.1	10	--	--
2,3,7,8-TCDF	51207-31-9	382	42.6	NE	0.7	1	--	--
1,2,3,7,8-PeCDF	57117-41-6	763	85.2	NE	0.7	5	--	--
2,3,4,7,8-PeCDF	57117-31-4	76.3	8.5	NE	0.4	5	--	--
1,2,3,4,7,8-HxCDF	70648-26-9	382	43	NE	0.5	5	--	--
1,2,3,6,7,8-HxCDF	57117-44-9	382	43	NE	0.6	5	--	--
2,3,4,6,7,8-HxCDF	60851-34-5	382	43	NE	0.2	5	--	--
1,2,3,7,8,9-HxCDF	72918-21-9	382	43	NE	0.4	5	--	--
1,2,3,4,6,7,8-HpCDF	55673-89-7	NE	NE	NE	0.4	5	--	--
1,2,3,4,7,8,9-HpCDF	67562-39-4	NE	NE	NE	0.6	5	--	--
OCDF	39001-02-0	38155	4258	NE	1.3	10	--	--

Table 3c-2. Parameters, Methods, and Target Reporting Limits, Quality Assurance Project Plan, Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi

Analyte[1]	CAS Number	Soil / Sediment						
		Tier 1 TRG Restricted mg/Kg	Tier 1 TRG Unrestricted mg/Kg	RSL Resident Soil mg/Kg	Laboratory MDL mg/Kg	Laboratory RL mg/Kg	Low Level Laboratory MDL mg/Kg	Low Level Laboratory RL mg/Kg
Total Metals (including Mercury) (SW846-6020, 7471A)								
Antimony	7440-36-0	81.7	31.3	410	1	2	--	--
Arsenic	7440-38-2	3.82	0.426	1.6	0.2	0.5	--	--
Barium	7440-39-3	14292	5475	190000	0.25	1	--	--
Beryllium	7440-41-7	1021	156	2000	0.05	0.1	--	--
Cadmium	7440-43-9	1022	39.1	800	0.024	0.1	--	--
Chromium	7440-47-3	NE	NE	NE	0.5	1	--	--
Cobalt	7440-48-4	12250	4693	300	0.03	0.1	--	--
Copper	7440-50-8	8167	3129	41000	0.4	1	--	--
Lead	7439-92-1	1700	400	800	0.2	0.4	--	--
Mercury	7439-97-6	61.3	10.0	43	0.0082	0.02	--	--
Nickel	7440-02-0	4083	1564	20000	0.5	1	--	--
Selenium	7782-49-2	1021	391	5100	0.5	1	--	--
Silver	7440-22-4	1021	391	5100	0.1	0.2	--	--
Thallium	7440-28-0	143	5.48	10	0.05	0.2	--	--
Tin	7440-31-5	122500	46929	610000	5.1	20	--	--
Vanadium	7440-62-2	1429	548	NE	0.55	1	--	--
Zinc	7440-66-6	61250	23464	310000	1.1	4	--	--
Cyanide, Total (EPA 9012A)								
Cyanide, Total	57-12-5	4083	1564	20000	0.21	0.5	--	--
Sulfide, Total (EPA 9034)								
Sulfide, Total	18496-25-8	NE	NE	NE	NA	60	--	--

Notes:

[1] USEPA. Office of Solid Waste and Emergency Response. *Test Methods for Evaluating Solid Waste. SW-846 3rd ed. Washington, D.C. 1996.*

**TRG=MDEQ Tier 1 Target Remedial Goals per the Final Regulations Governing Brownfields Voluntary Cleanup and Redevelopment in Mississippi (MDBQ, March 2002)

All results to be reported in dry weight

BATCO	Bonner Analytical Testing Company.
HpCDF	Heptachlorodibenzofuran.
HxCDF	Hexachlorodibenzofuran.
MDL	Method detection limit.
MEK	Methyl ethyl ketone.
mg/Kg	milligrams per kilogram.
MIBK	Methyl isobutyl ketone.
NA	Not applicable.
NE	RSL or TRG not yet established for the compound.
OCDD	Octachlorodibenzodioxin.
OCDF	Octachlorodibenzofuran.
PeCDD	Pentachlorodibenzo-p-dioxin.
PeCDF	Pentachlorodibenzofuran .
pg/g	picograms per gram.
TCDD	Tetrachlorodibenzodioxin.
TCDF	Tetrafuran.
ug/L	Micrograms per liter.
USEPA	U.S. Environmental Protection Agency.

Table 3d. Parameters, Methods, and Target Reporting Limits, Quality Assurance Project Plan, Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi

Analyte[1]	CAS Number	Indoor Air Residential Air Screening Level ug/m3	Indoor Air Industrial Air Screening Level ug/m3	Indoor Air Laboratory MDL ug/m3	Indoor Air Laboratory RL ug/m3	Indoor Air Laboratory RL(ppbv)
Volatile Organic Compounds (Method TO 15)						
Benzene	71-43-2	0.31	1.6	0.18	0.64	0.20
Benzyl Chloride	100-44-7	0.05	0.25	0.40	2.07	0.40
Bromomethane	74-83-9	5.2	22	0.12	0.78	0.20
Carbon tetrachloride	56-23-5	0.41	2	0.24	1.26	0.20
Chlorobenzene	108-90-7	52	220	0.23	0.92	0.20
Chloroethane	75-00-3	10000	44000	0.09	0.53	0.20
Chloroform	67-66-3	0.11	0.53	0.19	0.98	0.20
Chloromethane	74-87-3	94	390	0.33	1.03	0.50
1,2-Dibromoethane	106-93-4	0.0041	0.02	0.34	1.54	0.20
1,2-Dichlorobenzene	95-50-1	210	880	0.42	1.20	0.20
1,3-Dichlorobenzene	541-73-1	NE	NE	0.39	1.20	0.20
1,4-Dichlorobenzene	106-46-7	0.22	1.1	0.38	1.20	0.20
Dichlorodifluoromethane	75-71-8	100	440	0.33	0.98	0.20
1,1,Dichloroethane	75-34-3	1.5	7.7	0.11	0.81	0.20
1,2-Dichloroethane	107-06-2	0.094	0.47	0.19	0.81	0.20
1,1-Dichloroethene	75-35-4	1.5	7.7	0.13	0.79	0.20
cis-1,2-Dichloroethene	156-59-2	NE	NE	0.24	0.79	0.20
1,2-Dichloropropane	78-87-5	0.24	1.2	0.24	0.92	0.20
cis-1,3-Dichloropropene	10061-01-5	NE	NE	0.34	0.91	0.20
trans-1,3-Dichloropropene	10061-02-6	NE	NE	0.22	0.91	0.20
Ethylbenzene	100-41-4	0.97	4.9	0.29	0.87	0.20
1,2-Dichloro-1,1,2,2-tetrafluoroethane	76-14-2	NE	NE	0.22	1.40	0.20
Hexachlorobutadiene	87-68-3	0.11	0.56	0.83	11	1.0
Methylene Chloride	75-09-2	5.2	26	0.16	1.7	0.50
1,2,4-Trichlorobenzene	120-82-1	2.1	8.8	0.73	7.4	1.0
Styrene	100-42-5	1000	4400	0.25	0.9	0.20
1,1,2,2-Tetrachloroethane	79-34-5	0.042	0.21	0.42	1.4	0.20
Tetrachloroethene	127-18-4	0.41	2.1	0.27	1.4	0.20
Toluene	108-88-3	5200	22000	0.20	0.75	0.20
1,1,1-Trichloroethane	71-55-6	5200	22000	0.16	1.1	0.20
1,1,2-Trichloroethane	79-00-5	0.15	0.77	0.29	1.1	0.20
Trichloroethene	79-01-6	1.2	6.1	0.19	1.1	0.20
Trichlorofluoromethane	75-69-4	730	3100	0.13	1.1	0.20
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	31000	130000	0.24	1.5	0.20
1,2,4-Trimethylbenzene	95-63-6	7.3	31	0.31	1.0	0.20
1,3,5-Trimethylbenzene	108-67-8	NE	NE	0.32	1.0	0.20
Vinyl chloride	75-01-4	0.16	2.8	0.18	0.51	0.20
m-Xylene & p-Xylene	136777-61-	100	440	0.52	0.87	0.20
o-Xylene	95-47-6	100	440	0.26	0.87	0.20

Notes:

1 USEPA Compendium Method TO-15, *Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography/ Mass Spectrometry (GC/MS).* January 1999

2 USEPA Regional Screening Levels

Table 3e. Parameters, Methods, and Target Reporting Limits, Quality Assurance Project Plan, Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi

Analyte[1]	CAS Number	Soil Gas				
		Residential Air Screening Level ug/m3	Industrial Air Screening Level ug/m3	Laboratory MDL ug/m3	Laboratory RL ug/m3	Laboratory RL(ppbv)
Volatile Organic Compounds (Method TO 15)						
Benzene	71-43-2	0.31	1.6	1.8	6.4	2.0
Benzyl Chloride	100-44-7	0.05	0.25	4	20.7	4.0
Bromomethane	74-83-9	5.2	22	1.2	7.8	2.0
Carbon tetrachloride	56-23-5	0.41	2	2.4	12.6	2.0
Chlorobenzene	108-90-7	52	220	2.3	9.2	2.0
Chloroethane	75-00-3	10000	44000	0.9	5.3	2.0
Chloroform	67-66-3	0.11	0.53	1.85	9.8	2.0
Chloromethane	74-87-3	94	390	3.3	10.3	5.0
1,2-Dibromomethane	106-93-4	0.0041	0.02	3.4	15.4	2.0
1,2-Dichlorobenzene	95-50-1	210	880	4.2	12.0	2.0
1,3-Dichlorobenzene	541-73-1	NE	NE	3.9	12.0	2.0
1,4-Dichlorobenzene	106-46-7	0.22	1.1	3.8	12.0	2.0
Dichlorodifluoromethane	75-71-8	100	440	3.3	9.8	2.0
1,1,Dichloroethane	75-34-3	1.5	7.7	1.1	8.1	2.0
1,2-Dichloroethane	107-06-2	0.094	0.47	1.9	8.1	2.0
1,1-Dichloroethene	75-35-4	1.5	7.7	1.3	7.9	2.0
cis-1,2-Dichloroethene	156-59-2	NE	NE	2.4	7.9	2.0
1,2-Dichloropropane	78-87-5	0.24	1.2	2.4	9.2	2.0
cis-1,3-Dichloropropene	10061-01-5	NE	NE	3.4	9.1	2.0
trans-1,3-Dichloropropene	10061-02-6	NE	NE	2.2	9.1	2.0
Ethylbenzene	100-41-4	0.97	4.9	2.9	8.7	2.0
1,2-Dichloro-1,1,2,2-tetrafluoroethane	76-14-2	NE	NE	2.2	14.0	2.0
Hexachlorobutadiene	87-68-3	0.11	0.56	8.3	110	10
Methylene Chloride	75-09-2	5.2	26	1.6	17.0	5.0
1,2,4-Trichlorobenzene	120-82-1	2.1	8.8	7.3	14.8	2.0
Styrene	100-42-5	1000	4400	2.5	8.5	2.0
1,1,2,2-Tetrachloroethane	79-34-5	0.042	0.21	4.2	14.0	2.0
Tetrachloroethene	127-18-4	0.41	2.1	2.7	14.0	2.0
Toluene	108-88-3	5200	22000	2	7.5	2
1,1,1-Trichloroethane	71-55-6	5200	22000	1.6	11.0	2.0
1,1,2-Trichloroethane	79-00-5	0.15	0.77	2.9	11.0	2.0
Trichloroethene	79-01-6	1.2	6.1	1.9	11.0	2.0
Trichlorofluoromethane	75-69-4	730	3100	1.3	11.0	2.0
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	31000	130000	2.4	15.0	2.0
1,2,4-Trimethylbenzene	95-63-6	7.3	31	3.1	9.8	2.0
1,3,5-Trimethylbenzene	108-67-8	NE	NE	3.2	9.8	2.0
Vinyl chloride	75-01-4	0.16	2.8	1.8	5.1	2.0
m-Xylene & p-Xylene	136777-61-	100	440	5.2	8.7	2.0
o-Xylene	95-47-6	100	440	2.6	8.7	2.0

Notes:

1 USEPA Compendium Method TO-15, *Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography/ Mass Spectrometry (GC/MS).* January 1999

2 USEPA Regional Screening Levels

Table 4. Sample Containers, Preservation, and Holding Times, Quality Assurance Project Plan, Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi.

Parameter	Method	Bottle Type	Preservation	Holding Time
Surface Water/Groundwater				
Volatile Organic Compounds	8260 [1]	3 - 40 ml glass vials with Teflon®-lined lid w/ septum	Cool <6°C; pH <2 w/HCl	14 days to analysis
Acid Sensitive VOCs		2-40 ml glass vials with Teflon®-lined lid w/ septum	Cool <6°C	7 days to analysis
Semivolatile Organic Compounds	8270 [1]	2 - 1 liter amber glass bottle with Teflon®-lined lid	Cool <6°C	7 days to extraction 40 days to analysis
Organochlorine Pesticides	8081A	2 - 1 liter amber glass bottle with Teflon®-lined lid	Cool <6°C	7 days to extraction 40 days to analysis
Polychlorinated biphenyls (PCBs)	8082	2 - 1 liter amber glass bottle with Teflon®-lined lid	Cool <6°C	7 days to extraction 40 days to analysis
Herbicides	8151A	2 - 1 liter amber glass bottle with Teflon®-lined lid	Cool <6°C	7 days to extraction 40 days to analysis
PCDDs/PCDFs	8290	2 - 1 liter amber glass bottle with Teflon®-lined lid	Cool <6°C	30 days to extraction 45 days to analysis
Total Metals (including Mercury)	6020, 7470A [1]	1-250 ml plastic	pH < 2 w/ HNO3	6 months Metals 28 days Mercury
Cyanide, Total	9012A	1-250 ml plastic	Cool <6°C; pH > 10 w/ NaOH	14 days to analysis
Sulfide, Total	9034	2-250 ml plastic	Cool <6°C; Zinc Acetate & NaOH (pH > 9)	7 days to analysis
Dioxathion	BATCO 088.1	1 liter amber glass bottle with Teflon®-lined lid	Cool <6°C Protect from Light	7 days to extraction 6 months to analysis
Drinking (Potable) Water				
Volatile Organic Compounds	524.2, 504.1, and 8260 [1]	6 - 40 ml glass vials with Teflon®-lined lid w/ septum 1-250 clear glass bottle (for dechlorination)	Dechlorinate w/ ascorbic acid; preserve to pH < 2 w/ HCl	14 days to analysis
Acid Sensitive VOCs		4-40 ml glass vials with Teflon®-lined lid w/ septum	Cool <6°C	7 days to analysis
Semivolatile Organic Compounds	525.2 and 8270 [1]	4 - 1 liter amber glass bottle with Teflon®-lined lid	Cool <6°C	7 days to extraction 40 days to analysis
Organochlorine Pesticides	508 and 8081A	4 - 1 liter amber glass bottle with Teflon®-lined lid	Cool <6°C	7 days to extraction 40 days to analysis
Polychlorinated biphenyls (PCBs)	508	2 - 1 liter amber glass bottle with Teflon®-lined lid	Cool <6°C	7 days to extraction 40 days to analysis
Herbicides	515.1	2 - 1 liter amber glass bottle with Teflon®-lined lid	Cool <6°C	7 days to extraction 40 days to analysis
PCDDs/PCDFs	1613	2 - 1 liter amber glass bottle with Teflon®-lined lid	Cool <6°C	1 year to extraction 1 year to analysis
Total Metals (including Mercury)	200.8, 200.7, 245 and 6020 [1]	2-250 ml plastic	pH < 2 w/ HNO3	6 months Metals 28 days Mercury
Cyanide, Total	4500A	1-250 ml plastic	Cool <6°C; pH > 10 w/ NaOH	14 days to analysis
Sulfide, Total	4500	2-250 ml plastic	Cool <6°C; Zinc Acetate & NaOH (pH > 9)	7 days to analysis
Dioxathion	BATCO 088.1	1 liter amber glass bottle with Teflon®-lined lid	Cool <6°C Protectfrom Light	7 days to extraction 6 months to analysis

Table 4. Sample Containers, Preservation, and Holding Times, Quality Assurance Project Plan, Hercules Incorporated, Hattiesburg Facility, Hattiesburg, Forrest County, Mississippi.

Parameter	Method	Bottle Type	Preservation	Holding Time
Sediment				
Volatile Organic Compounds	8260 [1]	**Bulk**: 1 - 4 oz. wide-mouth glass jar	Cool <6°C	14 days to analysis
		Encore: 3 - 5 g samplers	Cool <6°C; lab preserve w/in 48 hours	
		Terracore: 2-DI & 1-MeOH 40 ml glass vials w/ septum	Cool <6°C; lab preserve w/in 48 hours	
Semivolatile Organic Compounds	8270 [1]	1 - 8 oz. wide-mouth glass jar	Cool <6°C	14 days to extraction 40 days to analysis
Organochlorine Pesticides	8081A	1 - 8 oz. wide-mouth glass jar	Cool <6°C	14 days to extraction 40 days to analysis
Polychlorinated biphenyls (PCBs)	8082	1 - 8 oz. wide-mouth glass jar	Cool <6°C	14 days to extraction 40 days to analysis
Herbicides	8151A	1 - 8 oz. wide-mouth glass jar	Cool <6°C	14 days to extraction 40 days to analysis
PCDDs/PCDFs	8290	1 - 8 oz. wide-mouth glass jar	Cool <6°C	30 days to extraction 45 days to analysis
Total Metals (including Mercury)	6020, 7471A [1]	1 - 8 oz. wide-mouth plastic jar	Cool <6°C	6 months Metals
				28 days Mercury
Cyanide, Total	9012A	1 - 8 oz. wide-mouth plastic jar	Cool <6°C	14 days to analysis
Sulfide, Total	9030B/9034 [1]	1 - 8 oz. wide-mouth plastic jar	Cool <6°C	7 days to analysis
Dioxathion	BATCO 088.1	1 - 8 oz. wide-mouth glass bottle with Teflon®-lined lid	Cool <6°C Protect from Light	14 days to extraction 6 months to analysis
Indoor Air/Soil Gas				
Volatile Organic Compounds	TO-15 [3]	600 L Canister	NA	30 days to analysis

Notes:

1 USEPA. Office of Solid Waste and Emergency Response. *Test Methods for Evaluating Solid Waste. SW-846 3rd ed. Washington, D.C. 1996.*

2 USEPA Compendium Method TO-15, *Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography/Mas Spectrometry (GC/MS).* January 1999

3 All holding times are measured from date of collection.

Appendix A

EQuIS Lab SOP

INTRODUCTION

ARCADIS manages and verifies/validates analytical data generated by commercial analytical laboratories in the EQuIS database (product of Earthsoft, Inc.). All laboratories contracted by ARCADIS or their clients, on a site-by-site basis, may be required to submit electronic data deliverables (EDDs) in addition to the hard copy report. This Standard Operating Procedure (SOP) describes the structure, format, and submission requirements for electronic data deliverables (EDDs) in the EQuIS EFWEDD (Sample, Test, Result, Batch) format.

This document is a general guidance for preparation of the required electronic data and associated quality control information. The structure of the EDD as defined in this document will remain constant unless Earthsoft modifies the database structure. Reference values and requirements for population of additional fields with specific information will not change from project to project.

Modification to reference value lists may NOT be made by the laboratory without authorization from ARCADIS.

Section I provides ARCADIS contact information and the procedure to submit electronic deliverables directly via e-mail. However, all EDDs will be required to be submitted in a final CD compilation for each specific sampling event or as directed by the ARCADIS Project Manager (PM).

Section II outlines the table structures and general requirements of the EDDs. The EDD structure is based on EarthSoft's EFWEDD EDD format. EarthSoft's EDD format has not been changed; however, some 'optional' fields identified in the EarthSoft EDD have been modified to be 'required' in this EDD format. Additional information regarding the EarthSoft products can be found at http://www.earthsoft.com/.

Section III presents some additional explanation and requirements for populating the table structure and population set forth in Section II.

Section IV summarizes the use of the EDP. Each laboratory **MUST** use EDP to check each EDD file set prior to submission to ARCADIS. The EDP Error Report must be submitted with the EDD. ***All errors identified by the EDP routine must be corrected prior to forwarding the files for entry into the EQuIS database. Or approval for submittal with errors must be authorized by ARCADIS.***

I. CONTACT INFORMATION

Laboratories should contact the ARCADIS National Program Lab Managers with questions regarding this document. The contact info is as follows:

Richard J. Murphy, Ph.D.
Principal Scientist
ARCADIS U.S., Inc.
630 Plaza Drive, Suite 100
Highlands Ranch, CO, 80129
Phone: 720.344.3804
Cell: 303.475.5210
Fax: 720.344.3535
Richard.murphy@arcadis-us.com

OR

Dennis K. Capria
Principal Scientist/Associate
ARCADIS
6723 Towpath Road
Syracuse, NY 13214
Phone: 315.446.9120
Direct: 315.671.9299
Fax: 315.449.0025
Cell: 315.751.1672
Dennis.capria@arcadis-us.com

ELECTRONIC LABORATORY DATA CHECKER EDP

Prior to submitting an EDD to ARCADIS, the EarthSoft EDP must be run to check and verify the EDD structure, format and reference value compliance. The EDP report must be submitted for each file with each EDD set. The Data Checker error report, which demonstrates that the EDD files were successfully checked, must be electronically submitted with the four EDD files to ARCADIS.

REFERENCE VALUES

A specific set of values is required to be utilized in populating certain key fields of the EDD. The Reference Value Lists for the EDP will be provided for each ARCADIS subcontracted laboratory. The Reference Value Lists must be utilized as provided. Alterations or additions to the Reference Values are **NOT** allowed **without prior** written authorization by the ARCADIS Data Manager. Electronic mail may be considered written authorization.

ELECTRONIC DATA DELIVERABLE (EDD) SUBMISSION

Prior to submission to ARCADIS, each data file must also be reviewed by the laboratory to ensure that the sample IDs, dates, times and other inter-related information is consistent between all four (4) files and the EDD is complete. All parameters that are subcontracted to other laboratories must be included in the EDD for a specific SDG or Laboratory Project Number. It is not acceptable to submit separate EDDs for subcontract parameters. Manual review of the files may be necessary to complete this review.

It is **IMPERATIVE** that the EDD results match the hard copy results. If the results do not match the lab will correct the error ASAP at no additional charge. This includes issues involving various rounding routines for different electronic data management programs within the laboratory (i.e. LIMS vs. EPA CLP). Significant figures must also match hard copy and be consistent from one sampling event to the next. Reporting limits must be consistent between events as well and must be in compliance with the Laboratory Task Order or Project Statement of Work. There may be instances where diluted surrogates and unrecovered spike compounds will require population of the EDD with numeric values in lieu of data flags in the hard copy report. The ARCADIS Data Manager will provide project specific guidance for these conditions. Adherence to the SOP requirements for population of spike/surrogate recovery and RPD fields is required to allow electronic validation of the data.

The EDP Reports for each file must be submitted with the 4 files of the actual EDD.

Laboratories must submit EDDs via e-mail for verification of compatibility and completeness to the assigned ARCADIS Data Manager for the project.

The subject line of this e-mail must include the following text:

[Facility-Code] [Laboratory Project/Log/SDG Number] - EDD Submission

The e-mail should also include the laboratory contact name and phone number.

EDDs must be submitted via e-mail prior to or at the same time the final hard copy document is delivered. ARCADIS may review the EDDs prior to requesting final submittal on CD. EDDs will be returned to the laboratory for modifications until the files can be successfully imported into the EQuIS Project Database and Electronic Data Validation can be performed without field population errors. Any revisions to the EDD will be required within 24 hours of notification to the laboratory regarding observed problems with the EDD. When the EDD is acceptable to the ARCADIS Data Manager and Project Manager, a CD containing all final versions of the EDD should be submitted to ARCADIS for archiving.

Invoices for analytical work will not be approved for payment until the final EDD revisions are acceptable.

II. ELECTRONIC DELIVERABLE DATA FORMAT

This section identifies the structure and format requirements for EQuIS EFWEDD EDDs submitted by all laboratories to ARCADIS. Specific field definitions are presented for each of the four files. Laboratories should review the unique requirements for these fields. The format population and adherence to the criteria are mandatory. Data are electronically validated and errors are quickly identifiable if the EDD is incorrect.

GENERAL FORMAT REQUIREMENTS

All laboratory data must be saved as an ASCII file format using the following standard format. Each subcontracting laboratory's data must be incorporated into the primary laboratory's EDD.

Each data field must be either separated by tabs or enclosed in double quotes (") and separated by commas. Data fields that do not contain information may be represented by two commas. Maximum length of text fields is indicated in the parentheses. If the input information is less than the maximum field length, **DO NOT ADD** spaces to account for the difference.

Each record must be terminated with a carriage return/line feed (i.e., standard DOS text file). The file can be produced using any software with the capability to create ASCII files.

THE LABORATORY SHALL LEAVE THE HEADERS IN EACH ASCII FILE TO ASSIST IN REVIEW AND RESOLUTION OF ERRORS.

Four files are required for each SDG or Laboratory Project Number: one each for samples, tests, results, and batches. Each file must be saved as a Tab Delimited or Comma Separated file.

Enterprise EDD File Naming Conventions

EDD packages must be named using a specific naming convention. An EDD Package consists of a .zip file containing the text (.txt) EDDs and a User Certificate. The zip file and text file names must contain the specific elements listed below under file naming conventions, separated by a period. A User Certificate file will be supplied to the lab by Arcadis for inclusion in the zip file. Please include in the subject line of emailed EDD submissions the facility code and Sample Delivery Group (SDG) number.

File Naming Conventions:

ZIP File Name = Unique ID.Facility Code.Format Name.zip
Text File EDDs Name = Unique ID.EDD Section Name.txt

Unique ID = SDG number.
Facility Code = The facility code (i.e., Site Name from ENFOS)
Format Name = The EQuIS EDD format name (e.g., ESBasic, EFWEDD, etc.).
EDD Section Name = The name of the section within the EDD (e.g. EFW2FSample, EFW2LabTST, etc.).

For example, ZIP File Name = "2009001.BP-99999.EFWEDD.zip" will contain the following files: "2009001.EFW2FSample.txt", "2009001.EFW2LabTST.txt", “2009001.EFW2LabRES.txt", '2009001.EFW2LabBCH.txt' and "pfoos.usr".

Package re-submittal

In order to re-submit corrected EDDs, the .zip file and text (.txt) EDDs must each be renamed. If the example EDD package above were to be re-submitted it would have ZIP File Name = "2009001B.BP-99999.EFWEDD.zip" containing "2009001B.EFW2FSample.txt", "2009001B.EFW2LabTST.txt", “2009001B.EFW2LabRES.txt", '2009001B.EFW2LabBCH.txt' and "pfoos.usr". Note that a “B” has been appended to the SDG name in both the zip file name and each of the text file names. A subsequent re-submittal of the same SDG would require that a C be appended and so on.

Referential integrity is enforced between tables (e.g. sys_sample_code present in the result, batch, and test tables must also be present in the sample table). For example, a data record with a specific sys_sample_code found in the result table, but not in the sample table, will cause and error in the Data Import Module and the file will not be allowed to be entered into the database. Dates and times associated with each test must match in the “Test” and “Result” files or the database will not allow entry of the entire file.

Reference values must be adhered to for a variety of fields as identified in the Reference Value list and described in the following table format requirements.

FORMAT DETAILS

The following four sections provide a detailed summary and the specific layout for each field required in each of the four (4) tables of the EDD. The ARCADIS EDD has been derived from the EarthSoft EFWEDD EDD.

Date is reported as MM/DD/YY (month/day/year) and time as HH:MM (hour:minute). Time must be reported in 24-hour (military) format (3:30 p.m. = 15:30 and 8:30 AM = 08:30 not 8:30). **NOTE:** Make certain that the LIMS systems format the date and time the same way for all files.

The columns in the following 4 tables relate to:

“Number” Column in Tables = Column of EDD table

“Attribute Name” = Column Name
PK after attribute indicates this is a primary key within Access for the table.

"Column Data" Type = Text or Numeric values required. Parenthetical number indicates total allowable number of characters in the field.

"Required" Column:

The column titled 'Required' will contain the text 'Yes' if the field is required to be populated by the laboratory. In addition, a "condition" is added to indicate additional information applying to population of the associated field. The first number of the condition relates to the table in which the condition applies, i.e. 1 is the Sample File, 2 is the Test File, 3 is the Result File, and 4 is the Batch File. Conditions apply as follows:

Condition	Table	Description
0	ALL	Field always required
1-1	SAMPLE	Field required for field samples only not required for laboratory samples
1-2	SAMPLE	Field required (parent_sample_code) for **laboratory** QC samples that have 'parents'
1-3	SAMPLE	Field not required for field samples
2-1	TEST	Field required if applicable for specific test
3-1	RESULT	Field required (result_value) for detected analytes only (TRG or TICs). Must be NULL if non-detect or surrogates, internal standards or spiked compounds
3-2	RESULT	Field required if available or appropriate for result
3-3	RESULT	Field required for matrix spikes or matrix spike duplicates (NOT required for surrogate compounds or LCS samples where the original concentration is assumed to be zero).
3-4	RESULT	Field required for surrogate compounds, LCS, Blank Spikes, Matrix Spikes, and Internal Standards.
3-5	RESULT	Field required for LCS duplicates, Blank Spike Duplicates, Matrix Spike Duplicates, Lab Replicates
3-6	RESULT	Field required for LCSD, BSD, MSD, and Lab duplicate samples
3-7	RESULT	Field required for surrogates and spike compounds
4-1	BATCH	Field required if available or appropriate for result

"REQUIRED":

"YES" = Required data if applicable

"NO" = Optional information unless otherwise directed by ARCADIS Data Manager or preferred for insertion by lab except where lab is specifically directed to leave the field Null.

Parent Sample Definition

Parent Samples are base samples for duplicates or spikes. i.e. original field samples used for matrix spikes or field sample used for Lab Duplicate/Replicate. A Matrix Spike is not the Parent Sample of the Matrix Spike Duplicate.

POPULATING SPIKE FIELDS

SURROGATES: surrogate recoveries are to be populated in qc_spike_added, qc_spike_measure, and qc_spike_recovery fields. Surrogates are analyte type = SUR. Control limits for surrogate recoveries must also be populated.

INTERNAL STANDARDS: internal standard values are to be populated in qc_spike_added, qc_spike_measure, and qc_spike_recovery fields. Internal Standards are analyte type = IS.

LCS, BS, and MS COMPOUNDS: recoveries are to be populated in qc_spike_added, qc_spike_measured, and qc_spike_recovery fields. Compounds spiked to evaluate method accuracy are analyte type = SC. Control limits for spike recoveries must also be populated.

LCSD, BD, AND MSD COMPOUNDS: recoveries are to be populated in qc_dup_spike_added, qc_dup_spike_measured, and qc_dup_spike_recovery fields. The Compounds spiked to evaluate method accuracy are analyte type = SC. Control limits for spike recoveries must also be populated. Additionally, the qc_rpd and qc_rpd_cl fields must be populated for these samples.

LAB REPLICATE SAMPLE DATA: values for lab duplicates/replicates are to be populated in qc_dup_spike_measured field. The qc_rpd and qc_rpd_cl fields must be populated for these samples.

III. ADDITIONAL REQUIREMENTS

SAMPLE TABLE

Num	Attribute Name	Column Data Type	Required	Attribute Definition
1	sys_sample_code	Text(40)	Yes (0)	Unique sample identifier (COC Sample ID). Each sample must have a unique value, including spikes and duplicates. Unique sample identifiers **throughout** the database are an **ABSOLUTE** restriction enforced by EQuIS Chemistry. This unique identifier also carries through to each subsequent sampling event where the samples IDs must be unique for EVERY event of the project (continuing years). Laboratory QC samples must also have unique identifiers between sampling event and from 1 year to the next and between laboratories in the event subcontractors are used. For Matrix Spike, Matrix Spike Duplicate, and Laboratory Duplicates of Field Samples, add the suffix **MS, MSD, and LR**, respectively to create unique identifiers for these types of Lab QC samples.
2	sample_name	Text(30)	No	Additional sample identification information as necessary. Is not required to be unique (i.e., duplicates are OK).

SAMPLE TABLE				
Num	**Attribute Name**	**Column Data Type**	**Required**	**Attribute Definition**
3	sample_matrix_code	Text(10)	Yes (0)	Code, which distinguishes between different types of sample matrix. **Examples**: Soil samples ="SO" , groundwater samples = "WG". Field Blanks, Trip Blanks, and Rinsate Blanks = "WQ". Water Method Blanks and liquid matrix spikes = "WQ" Soil Method Blanks and soil/sludge/sediment matrix spikes = "SQ' This field refers to the sample matrix not the matrix after preparation or extraction. See rt_matrix for the list of valid values.
4	sample_type_code	Text(10)	Yes (0)	Code that distinguishes between different types of samples. **For example**, normal field samples = "N" and laboratory method blank ="LB". Field QC sample types are Field Duplicates = "FD", Field Blanks = "FB", Trip Blanks = "TB". Lab QC sample types are LCS or Blank Spikes = "BS", LCSD or BS Duplicates = "BD" and Matrix Spikes = "MS" and Matrix Spike Duplicates = "SD". See rt_sample_type in Reference Values list of valid values.
5	sample_source	Text(10)	Yes (0)	Must be either "Field" for field samples **or** "Lab" for laboratory QC samples. No other values are allowed. Matrix spikes and lab duplicate/replicate are "Lab" samples, even though the parent is a "Field" and the base sample came from the field. The spiking or splitting for duplication is done in the lab. Field duplicates as submitted to the lab by field sampling teams are "Field"
6	parent_sample_code	Text(40)	Yes (1-2)	The value in the "sys_sample_code" that identifies the sample that was the source of this sample. *For example*, the Matrix Spike and the Matrix Spike Duplicate or Lab Replicates parent_sample_code is the sys_sample_code for the originating field sample that is spiked to generate the MS/MSD or split by the lab for use as the laboratory duplicate. This field is only required in the EDD for laboratory "clone" samples (e.g., matrix spikes and duplicates). Field duplicates are submitted blind to the laboratory, so this field cannot be completed by the laboratory. This field must be blank for samples that have no parent (e.g., normal field samples, method blanks, etc.).
7	sample_delivery_group	Text(10)	Yes (0)	Sample delivery group or laboratory Project/Log Number. All deliverables must reference the SDG or Lab Log-in Number. **This field MUST BE POPULATED**
8	sample_date	Date	Yes (1-1)	Date of sample collection in **MM/DD/YY** format including trip blanks. Must be blank for laboratory samples.
9	sample_time	Time	Yes (1-1)	Time of sample collection in 24-hour (military) **HH:MM** format. 8:45 AM = 08:45 and 3:30 PM = 15:30. Must be blank for laboratory samples.

SAMPLE TABLE				
Num	**Attribute Name**	**Column Data Type**	**Required**	**Attribute Definition**
10	sys_loc_code	Text(20)	No	Sample collection location. To be populated by ARCADIS unless otherwise directed at project initiation.
11	start_depth	Double	No	Beginning depth (top) of soil sample. To be populated by ARCADIS unless otherwise directed at project initiation.
12	end_depth	Double	No	Ending depth (bottom) of soil sample. To be populated by ARCADIS unless otherwise directed at project initiation.
13	depth_unit	Text(15)	No	Unit of measurement for the sample begin and end depths. IRPIMS-style unit of measurement codes (see table X03) are recognized by Chem; other codes may be allowed by the Chem project manager. To be populated by ARCADIS unless otherwise directed at project initiation.
14	chain_of_custody	Text(15)	Yes (1-1)	Chain of custody identifier or number. A single sample may be assigned to only one chain of custody. The COC identifier will be provided by the field sampling team based on conventions established for a specific project.
15	sent_to_lab_date	Date	No	Date sample was sent to lab (in MM/DD/YY format for EDD).
16	sample_receipt_date	Date	Yes (1-1)	Date that sample was received at laboratory in **MM/DD/YY** format. Must be blank for laboratory samples.
17	sampler	Text(30)	No	Name or initials of sampler.
18	sampling_company_code	Text(10)	Yes (1-1)	Name or initials of sampling company (no controlled vocabulary). “ARCADIS” should be entered into this field unless otherwise directed at project initiation.
19	sampling_reason	Text(30)	No	Optional reason for sampling. No controlled vocabulary is enforced.
20	sampling_technique	Text(40)	No (1-1)	To be populated by ARCADIS unless otherwise directed at project initiation. Sampling technique. **For example**, low flow, bailing, MIP, etc… Must be blank for laboratory samples.
21	task_code	Text(10)	No	Code used to identify the task under which the field sample was retrieved.
22	collection_quarter	Text(5)	No	Quarter of the year sample was collected (e.g., "1Q96")
23	composite_yn	Text(1)	No	Boolean field used to indicate whether a sample is a composite sample.
24	composite_desc	Text(255)	No	Description of composite sample (if composite_yn is YES).

SAMPLE TABLE

Num	Attribute Name	Column Data Type	Required	Attribute Definition
25	sample_class	Text(10)	No	Navy sample class code.
26	custom_field_1	Text(255)	No	Custom sample field
27	custom_field_2	Text(255)	No	Custom sample field
28	custom_field_3	Text(255)	No	Custom sample field
29	comment	Text(255)	Yes (0)	Field required to contain the full sample ID code.
30	sample_receipt_time	Text(5)	Yes (1-1)	Time of sample receipt by laboratory in 24-hour (military) **HH:MM** format. 8:45 AM = 08:45 and 3:30 PM = 15:30

TEST TABLE

Num	Attribute Name	Column Data Type	Required	Attribute Definition
1	sys_sample_code (PK)	Text (40)	Yes (0)	SAME AS #1 IN SAMPLE TABLE. This value is used in enforcing referential integrity between tables. Must match sys_sample_code in Sample Table.
2	lab_anl_method_name (PK)	Text (35)	Yes (0)	Laboratory analytic method name or description. See rt_analytic_method in reference value tables for list of valid values.
3	analysis_date (PK)	Date/ Time	Yes (0)	Date of sample analysis in MM/DD/YY format. Refers to initiation of the analysis not prep method date.
4	analysis_time (PK)	Text (5)	Yes (0)	Time of sample analysis in 24-hour (military) HH:MM format. Note that this field, combined with the "analysis_date" field is used to distinguish between reextractions, reanalyses, and dilutions. Please ensure that retests have "analysis_date" and/or analysis_time" different from the original test event (and complete test_type field as appropriate).
5	total_or_dissolved (PK)	Text (1)	Yes (0)	"T" for total metal organic carbon concentration, "D" for dissolved or filtered metal or organic carbon concentration ONLY. USE "N" for organic (or other) constituents for which neither "total" nor "dissolved" is applicable including TDS.
6	column_number (PK)	Text (2)	Yes (2-1)	Applicable for GC or HPLC methods. "1C" for first column analyses, "2C" for second column analyses, or "NA" for analyses where not applicable. If any "2C" tests are listed, then there must be corresponding "1C" tests present also. Laboratories must indicate which of the two columns is to be considered "primary" by entering “Y” in the "reportable_result" field of the result table for the result presented in hard copy reports. It is NOT acceptable to identify both “1C” and “2C” reportable_result as “Y:; one must be “N” if” “1C” and “2C” are provided in the EDD.

TEST TABLE				
Num	**Attribute Name**	**Column Data Type**	**Required**	**Attribute Definition**
7	test_type (PK)	Text (10)	Yes (0)	Type of test. Valid values include "initial", "reextract", and "reanalysis", “dilution” are acceptable. See rt_test_type for al valid values.
8	lab_matrix_code	Text (10)	Yes (0)	Code that distinguishes between different types of matrix analyzed. Soil = “SO”; groundwater = “GW” and TCLP = TCLP as a lab matrix. See rt_matrix for valid values
9	analysis_location	Text (2)	Yes (0)	"LB" for fixed-based laboratory analysis, "FI" for field instrument, "FL" for mobile field laboratory analysis, or.
10	basis	Text (10)	Yes (0)	"Wet" for wet-weight basis; or "Dry" for dry-weight basis. For tests for which this distinction is not applicable use Wet
11	container_id	Text (30)	No	Sample container identifier.
12	dilution_factor	Single	Yes (0)	Test or analytical run dilution factor. **Must** be “1’” if no dilution.
13	Prep_method	Text (35)	Yes (2-1)	Laboratory sample preparation method name. See rt_std_prep_method for valid values.
14	prep_date	Date/ Time	Yes (2-1)	Date of sample preparation in MM/DD/YY format.
15	prep_time	Text (5)	Yes (2-1)	Time of sample preparation in 24-hour (military) HH:MM format
16	leachate_method	Text (15)	Yes (2-1)	Method name, e.g., SW1311 or SW1312. See rt_analytic_method for valid values.
17	leachate_date	Date/ Time	Yes (2-1)	Date of leachate preparation in MM/DD/YY format.
18	leachate_time	Text (5)	Yes (2-1)	Time of leachate preparation in 24-hour (military) HH:MM format.
19	lab_name_code	Text (10)	Yes (0)	Unique identifier of the laboratory reporting results. See rt_subcontractor for valid values.
20	qc_level	Text (10)	NO	Not populated by Lab.
21	lab_sample_ id	Text (20)	Yes (0)	Laboratory sample identifier. A field sample may have more than one laboratory lab_sample_id; however it is limited to only ONE lab_sample_id per method).
22	percent_moisture	Text (5)	Yes (2-1)	Percent moisture of the sample portion used in the specific lab_anl_methd_name test; this value may vary from test to test for any sample. The value must be NUMERIC as "NN.MM", e.g., 70.1% could be reported as "70.1" but not as 70.1%". The database assumes that the number is a “%” and units of measure are not necessary. **NOTE: This field MUST be populated for all soil, sludge, and sediment samples whether or not the value is reported in the hard copy. Use “0” for lab soil QC samples.**
23	subsample_amount	Text (14)	Yes 0)	Amount of sample used for the test. THIS FIELD MUST BE POPULATED
24	subsample_amount_unit	Text (15)	Yes (0)	Unit of measurement for subsample amount. See rt_unit for valid values.

TEST TABLE				
Num	**Attribute Name**	**Column Data Type**	**Required**	**Attribute Definition**
25	analyst_name	Text (30)	Yes (0)	Name or initials of laboratory analyst.
26	instrument_lab	Text (50)	Yes (0)	Instrument identifier.
27	comment	Text (255)	NO	Comments about the test as necessary (Optional).
28	preservative	Text (50)	Yes (2-1)	Indicate preservative or leave blank, if none. **THIS FIELD MUST BE POPULATED IF A PRESERVATIVE WAS IN THE SAMPLE AS RECEIVED FROM THE FIELD OR IF THE SAMPLE WAS PRESERVED BY THE LABORATORY BEFORE PREPARATION AND ANALYSIS.**
29	final_volume	Text (15)	Yes (2-1)	Final amount of extract or digestate.
30	final_volume_unit	Text (15)	Yes (2-1)	Unit of measure for final_volume. See rt_unit for valid values.

RESULT TABLE				
Num	**Attribute Name**	**Column Data Type**	**Required**	**Attribute Definition**
1	sys_sample_code (PK)	Text (40)	Yes (0)	SAME AS #1 IN SAMPLE & TEST TABLES. This value is used in enforcing referential integrity between tables.
2	lab_anl_method_name (PK)	Text (35)	Yes (0)	Laboratory analytic method name. Must be same as lab_anl_method_name in Test File. See rt _analytic_method for valid values.
3	analysis_date (PK)	Date/Time	Yes (0)	Must be the SAME AS #3 IN THE TEST TABLE. This value is used in enforcing referential integrity between tables. Date of sample analysis in MM/DD/YY format.
4	analysis_time (PK)	Text (5)	Yes (0)	Must be the SAME AS #4 IN THE TEST TABLE. This value is used in enforcing referential integrity between tables.
5	total_or_dissolved_ (PK)	Text (1)	Yes (0)	Must be the SAME AS #5 IN THE TEST FILE.
6	column_number (PK)	Text (2)	Yes (3-2)	Must be the SAME AS #6 IN THE TEST FILE
7	test_type (PK)	Text (10)	Yes (0)	Must be the SAME AS #7 IN THE TEST FILE
8	cas_rn (PK)	Text (15)	Yes (0)	Chemical Abstracts Number for the parameter if available. This must be the true CAS # and "not made up". Where CAS #s are not available, i.e. wet chem. Parameters, identifiers will be provided by ARCADIS project requirements. See notes at end of section for TIC management. See rt_analyte for valid values. The lab is not authorized to add internally developed "CAS #s" for general chemistry parameters, surrogates, internal standards, TICs. CAS#s used for TICs must be available through an outside source such as "Chemfinder".
9	chemical_name	Text (60)	Yes (0)	Chemical name associated with CAS # in #8. The cas_rn field is the only chemical identifier information actually imported in EQuIS Chemistry.

RESULT TABLE				
Num	**Attribute Name**	**Column Data Type**	**Required**	**Attribute Definition**
10	result_value	Text (20)	Yes (3-1)	Analytical result reported for **"TRG" or "TIC"** result_type **ONLY**. Appropriate and consistent number of significant digits must be entered. **MUST BE BLANK FOR NON-DETECTS.** "SUR", "IS", and "SC" results do **NOT** populate this field (populate the QC fields).
11	result_error_delta	Text (20)	Yes (3-2) [Radiochem)	Error range applicable to the result value for radiochemistry results.
12	result_type_code	Text (10)	Yes (0)	Must be either "TRG" for a target or regular results, "TIC" for tentatively identified compounds, "SUR" for surrogates, "IS" for internal standards, or "SC" for spiked compounds.**[LCS, LCSD, MS, MSD, BS, BSD]**
13	reportable_result	Text (10)	Yes (0)	Must be either "**Yes**" for results, which are considered to be reportable, **or** "**No**" for other results. Used to distinguish between multiple results where a sample is retested after dilution or to indicate which of the first or second column result should be considered primary. For re-analyses and dilutions all results must be entered into the database if hard copy data is provided **BUT ONLY ONE RESULT FOR EACH COMPOUND/ANALYTE MAY BE FLAGGED AS REPORTABLE**.
14	detect_flag	Text (2)	Yes (0)	Either "Y" for detected analytes or "N" for non-detects. **MUST be "N" for NON-DETECTS**.
15	lab_qualifiers	Text (7)	Yes (3-2)	Qualifier flags assigned by the laboratory. See rt_qualifier for valid qualifiers that may be used.
16	Organic_ yn	Yes/No	Yes (0)	Must be either "Y" for organic constituents or "N" for inorganic constituents.
17	method_detection_ limit	Text (20)	Yes (0)	Laboratory determined MDL per 40 CFR Part 136, adjusted for dilutions and percent moisture (if it applies).
18	reporting_detection_ limit	Text (20)	Yes (0)	Detection limit that reflects sample analysis conditions including analysis volumes and dilution factors. This should be the laboratory PQL or standard reporting limits
19	quantitation_limit	Text (20)	No	NOT Currently used unless specifically defined for the project.
20	Result_unit	Text (15)	Yes (0)	Units of measure relates to **ALL** results including result_value, qc_original_concentration, qc_spike added, qc_spike_measured, qc_dup_orginal_conc, qc_dup_spike_added, qc_dup_spike_measured. See rt_unit for valid values.
21	detection_limit_unit	Text (15)	Yes (0)	Units of measure for detection limit(s). See rt_unit for valid values.
22	tic_retention_time	Text (8)	Yes (3-2)	Retention time in minutes for tentatively identified compounds (TICs). Populated only for TIC result_type
23	result_comment	Text (255)	NO	MUST BE LEFT BLANK BY THE LAB

RESULT TABLE				
Num	**Attribute Name**	**Column Data Type**	**Required**	**Attribute Definition**
24	qc_original_conc	Text (14)	Yes (3-3)	The concentration of the analyte in the original (unspiked) sample. Populated for matrix spike samples. Not populated where original concentration is assumed to be zero, i.e. LCS or BS samples.
25	qc_spike_added	Text (14)	Yes (3-4)	The concentration of the analyte added to the original sample. Populated for **ALL** Surrogates, and LCS, BS, and MS samples
26	qc_spike_measured	Text (14)	Yes (3-4)	The measured concentration of the analyte. Use zero for spiked compounds that were not detected in the sample. **MUST BE NUMBERIC** even if diluted out or not recovered (use "0" if diluted, matrix interference, elevated concentrations of target compounds, etc.) Populated for **ALL** Surrogates, and LCS, BS, and MS samples
27	qc_spike_recovery	Text (14)	Yes (3-4)	The percent recovery for "SUR" and "SC" results. **MUST BE NUMERIC** even if diluted out or not recovered (use "0" if diluted, matrix interference, elevated concentrations of target compounds, etc.) Report as percentage (e.g., report "120%" as "120"); DO NOT include "%" sign in field. Populated for **ALL** Surrogates, and LCS, BS, and MS samples
28	qc_dup_original conc	Text (14)	Yes (3-5)	The concentration of the analyte in the original (unspiked) sample. Populated for matrix spike duplicate samples. Not populated where original concentration is assumed to be zero, i.e. LCSD or BSD samples.
29	qc_dup_spike_added	Text (14)	Yes (3-5)	The concentration of the analyte added to the original sample. Populated for **ALL** LCSD, BSD, and MSD samples.
30	qc_dup_spike_measured	Text (14)	Yes (3-5)	The measured concentration of the analyte in the duplicate. Populated for **ALL** LCSD, BSD, and MSD samples. MUST be NUMERIC. Use zero for spiked compounds that were not recovered due to dilution, matrix interference, elevated concentrations of target compounds, etc..
31	qc_dup_spike_recovery	Text (14)	Yes (3-5)	The duplicate percent recovery. Populated for **ALL** LCSD, BSD, and MSD samples. **MUST be NUMERIC.** Use zero for spiked compounds that were not recovered due to dilution, matrix interference, elevated concentrations of target compounds, etc Report as percentage (e.g., report "120%" as "120").
32	qc_rpd	Text (8)	Yes (3-6)	The relative percent difference between MS and MSD, LCS and LCSD, BS and BSD, & primary field sample result and Lab Replicate. Populated for **ALL** LCSD, BSD, MSD, and LR samples. **MUST be NUMERIC**. Use zero for RPDs that were not calculated due to elevated concentrations of target compounds, dilution, matrix interference, etc Report as percentage (e.g., report "120%" as 120").
33	qc_spike_lcl	Text (8)	Yes (3-7)	Lower control limit for spike recovery. Required for spikes, spike duplicates, surrogate compounds, LCS and any spiked sample. Report as

RESULT TABLE				
Num	**Attribute Name**	**Column Data Type**	**Required**	**Attribute Definition**
				percentage (e.g., report "120%" as "120").
34	qc_spike_ucl	Text (8)	Yes (3-7)	Upper control limit for spike recovery. Required for spikes, spike duplicates, surrogate compounds, LCS and any spiked sample. Report as percentage (e.g., report "120%" as "120").
35	qc_rpd_cl	Text (8)	Yes (3-6)	Relative percent difference control limit. Required for any duplicated sample. Report as percentage (e.g., report "120%" as "120").
36	qc_spike_status	Text (10)	Yes (3-4)	Used to indicate whether the spike recovery was within control limits. Use the "+" character to indicate failure, otherwise leave blank.
37	qc_dup_spike_status	Text (10)	Yes (3-5)	Used to indicate whether the duplicate spike recovery was within control limits. Use the "+" character to indicate failure, otherwise leave blank.
38	qc_rpd_status	Text (10)	Yes (3-6)	Used to indicate whether the relative percent difference was within control limits. Use the "+" character to indicate failure, otherwise leave blank. Required for any duplicated sample.

BATCH TABLE				
Num	**Attribute Name**	**Column Datatype**	**Required**	**Attribute Definition**
1	sys_sample_code (PK)	Text (40)	Yes (0)	SAME AS #1 IN SAMPLE , TEST TABLE. This value is used in enforcing referential integrity between tables.
2	lab_anl_method_name (PK)	Text (35)	Yes (0)	SAME AS #2 IN TEST TABLE. See rt _analytic_method for valid values.
3	analysis_date (PK)	Date	Yes (0)	SAME AS #3 IN TEST TABLE. This value is used in enforcing referential integrity between tables. Date of sample analysis in MM/DD/YY format. May refer to either beginning or end of the analysis as required by EQuIS Chemistry project manager.
4	analysis_time (PK)	Text (5)	Yes (0)	SAME AS #4 IN TEST, AND RESULT TABLES. This value is used in enforcing referential integrity between tables.
5	total_or_dissolved (PK)	Text (1)	Yes (0)	SAME AS #5 IN TEST TABLE. This value is used in enforcing referential integrity between tables.
6	column_number (PK)	Text (2)	Yes (4-1)	SAME AS #6 IN TEST TABLE. This value is used in enforcing referential integrity between tables.
7	test_type (PK)	Text (10)	Yes (0)	SAME AS #7 IN TEST TABLE. This value is used in enforcing referential integrity between tables.
8	test_batch_type (PK)	Text (10)	Yes (0)	Lab batch type. Valid values include "Prep", "Analysis", and "Leach". Additional valid values may optionally be provided by the EQuIS Chemistry project manager. This is a required field for all batches.
9	test_batch_id	Text (20)	Yes (0)	Unique identifier for all and each lab batches. Must be unique within EQuIS Chemistry database. For example, the same identifier cannot be used for a prep batch and an analysis batch and the values must be different from one sampling event to another. THIS IDENTIFIER CANNOT BE USED FROM ONE YEAR TO THE NEXT.

ADDITIONAL INFORMATION FOR PREPARING THE 4-FILE EDD

SAMPLE FILE AND SYS_SAMPLE_CODE

1. The sys_sample_code is the unique sample ID as supplied on the Chain of Custody form with the same spacing as identified on the COC or on a supplemental Sample ID list submitted to the laboratory with the Laboratory Task Order or prior to submission of samples.

2. In order to uniquely identify MS/MSD, laboratory duplicates, TCLP, and SPLP samples, the laboratory shall add a suffix to the original sample ID listed on the chain of custody:

   Matrix Spike Sample = xxxxx MS
   Matrix Spike Duplicate Sample = xxxxx MSD
   Lab Duplicate/Replicate = xxxxx LR
   TCLP Extract Sample = xxxxx TCLP
   SPLP Extract Sample = xxxxx SPLP

   These are the only characters that are allowed to be amended to ANY sample ID as listed on the COC or the sample ID list referred to above.
   The parent_sample_code shall be entered into the parent_sample_code field of the Sample File.

3. If the sample_name field is provided it must contain the full sample ID from the chain of custody.

4. Sample_Type_Code must be appropriately applied as follows:
   "N" = normal field samples
   "FD" = field duplicates samples submitted blind to the laboratory
   "TB" = trip blanks
   "FB" = field blanks
   "EB" = rinsate or equipment blanks
   "BS" = laboratory control samples or blank spikes
   "BD" = laboratory control sample duplicates or blank spike duplicates
   "MS" = matrix spikes
   "SD" = matrix spike duplicates
   "LR" = laboratory duplicates or laboratory replicates

5. The following "**matrix_type**" codes must be used ("**SQ**" = soil QC sample and "**WQ"** = water QC sample):
   Method Blank = "SQ" or "WQ"
   MS/MSDs = "SQ" or "WQ"
   LCS/LCSDs = "SQ" or "WQ"
   BS/BSDs = "SQ" or "WQ"

6. SDG Numbers or laboratory Log Numbers (per ARCADIS PM direction) **MUST** be populated in "**sample_delivery_group**" field of the **Sample File.**

QUALITY CONTROL SAMPLES AND DATA

7. The source of Lab Duplicates, Lab Replicates, Matrix Spikes, and Matrix Spike Duplicates is the Lab not the Field even if the MS/MSD are identified on the COC by the field sampling team. The samples are spiked in the laboratory not in the field.

8. Laboratory QC data, which span more than one SDG may be submitted with each appropriate SDG.

9. Laboratory LCS and LCSD should be reported as two separate samples.

10. **Matrix Spike and Matrix Spike Duplicate recoveries must be reported as "0" if the value is not calculated due to concentrations of the spiked analyte in the sample at concentrations above the 4X factor.**

11. **All laboratory method performance site-specific and batch Quality Control sample results (i.e. Method Blanks, LCS/LCSDs, Blank Spikes, Leachate Blanks as method appropriate) must be included in the EDD.** For most projects, this does **NOT** include **non-site-specific** matrix spikes and laboratory duplicates/replicates.

12. Laboratory batch sample duplicate/replicate and MS/MSD results from **non-project specific** samples (i.e. batch QC samples) shall **NOT** be included in the EDD.

13. Surrogates populate the qc_spike fields not qc_dup_spike fields or the result_value field even if the surrogates are reported for MSD, BSD, or LCSD samples.

14. QC_Spike_Added values for Spike, IS and Surrogate compounds are REQUIRED.

15. QC_Spike_Measured values for Spike, IS and Surrogate compounds are REQUIRED.

16. RPDs for LCSDs, BSDs, MSDs, and Laboratory Duplicates must be populated in the "**qc_rpd"** field. A value of "0" or "100" must be reported, as appropriate, if the RPD is not calculated due to excessive concentrations or interference present in the sample. The "**qc_rpd**" must be a numeric entry.

17. The RPD control limit must be listed in the "**rpd_cl"** field for all parameters where an RPD is reported. This includes lab duplicate/replicate samples.

SAMPLE FILE

18. The following "**matrix_type**" codes must be used for QC samples ("**SQ**" = soil QC sample and "**WQ"** = water QC sample):

    Method Blank = "SQ" of "WQ"
    MS/MSDs = "SQ" or "WQ"
    LCS/LCSDs = "SQ" or "WQ"
    BS/BSDs = "SQ" or "WQ"

19. SDG or Laboratory Project numbers must be populated in "sample_delivery_group" field.

TEST FILE

20. Percent moisture must be reported in the "**percent_moisture**" field in the **Test File** for all solid samples (i.e., soil, sediment, and sludge).

21. Subsample weights and final volumes must be listed for all parameters as appropriate.

RESULTS FILE

22. Result_value is only populated with data for "TRG" and "TIC" detections. All other data is entered in the "qc_" fields. The field must be "NULL" for non-detects and other analyte_types. The Reporting Limit must not be entered in this field.

23. Non-detected data shall have a lab_qualifier of "U" in addition to other qualifiers deemed applicable. The Detect_Flag shall be "N" and the Result_value field shall be blank.

24. The Reporting Limit must be provided for all parameters. The RL MUST be adjusted for dilutions made during analysis.

25. Surrogate recoveries MUST BE REPORTED in the qc_spike_measured and qc_spike_recovery fields, even if the surrogate had been diluted out. List “0” as the measured and recovered amount. Control Limits must also be entered for surrogates. Surrogates are “SUR” analyte_type not “TRG”.

26. Surrogate, LCS, LCSD, BS, BSD, MS, and MSD detected concentrations, and percent recoveries must be populated with a numeric value. A value of “0” **must** be entered if the Spiked Compound is diluted out or not recovered. An “+” is unacceptable as this is a numeric field.

27. “**QC_original_concentration**” must be populated for matrix spikes and matrix spike duplicates

28. Valid entries for the reportable_result field are "Yes" or "No” only.

29. ONLY report compounds of interest for any method blank, sample, and sample duplicate, trip blank.

30. Laboratory Qualifier designation must be consistent. For an estimated concentration with blank contamination “BJ” must be used. Note that “JB”, “B J” or “J B” cannot be used.

31. Explanation of Duplicate Qualifiers:

B	Analyte found in associated blank	Organic Analysis
B	<CRDL but >= Instrument Detection Limit	Inorganic Analysis
N	Presumptive evidence of a compound	Organic Analysis
N	Sample recovery not within control limits	Inorganic Analysis

It is preferred by ARCADIS that the laboratory not qualifiers with multiple explanations. **Any qualifiers utilized in the hard copy report or the electronic report must be defined in the hard copy report. There is no exception to this requirement for explanation of qualifiers applied to electronic data.**

32. Nomenclature for tentatively identified compounds (TIC):

Use the CAS # if it is available and **REAL (outside verifiable source)** for TICs and enter the chemical name in the chemical_name field.

For UNKNOWN TICs follow the following protocol:

cas_rn for unkown VOA TIC = VTIC 1 through VTIC 10
cas_rn for unkown SVOA TIC = SVTIC 1 through SVTIC 20

Enter “UNKNOWN”, “UNKNOWN Hydrocarbon”, “UNKNOWN Aliphatic”, or other identifier as appropriate or applicable in “chemical_name” field.

TICs will produce errors in the ELDC/EDDP that cannot be corrected by the laboratory. These are the only acceptable errors in the data checker report unless otherwise authorized by ARCADIS.

33. TCLP or SPLP results must be submitted in units of mg/L or appropriate liquid units. **(Make sure that moisture correction is not automatically enforced).**

BATCH FILE

34. **The laboratory must use unique Batch File Names for each analytical department/method and for continuing years. Electronic validation utilizes Batch IDs to link field samples with quality control data. Overlapping Batch IDs are not acceptable.**

GENERAL ISSUES

35. Incomplete chain-of-custody (C-O-C) forms must be immediately communicated to the project manager. Some of the C-O-C information is used for completion of the Sample_Matrix_Code and Sample_Delivery_Group. These discrepancies must be rectified upon receipt of samples at the laboratory prior to log in.

36. **Duplicate sample IDs are not acceptable within the EQuIS database. It is imperative that samples including field blanks, trip blanks, equipment blanks, field duplicates have unique sample IDs for projects including ongoing sampling events such as quarterly groundwater monitoring.**

SUBCONTRACTED PARAMETERS

37. The EDD must be populated with **ALL** appropriate and applicable fields, including **ALL** QC data for any subcontracted parameters.

PLEASE CONTACT THE ARCADIS PROJECT CHEMIST, DATA MANAGER or PROJECT MANAGER IF THERE ARE ANY QUESTIONS REGARDING PREPARATION OR GENERATION OF THE EDD.

EXAMPLE EDD REPORTS

The following subsections provide examples of how the EQuIS EDD should be populated for QC data.

RESULT FILE FIELDS FOR A NORMAL FIELD SAMPLE, TRG AND TIC RESULTS

The table below shows some of the fields in the Result File for a normal field sample (i.e., Sample_type_code = N, TB, FD, etc.) and "TRG" or "TIC" analyte_type_code. NOTE: all QC fields are blank.

cas_rn	result value	qc original conc	qc spike added	qc spike measured	qc spike recovery	qc dup. original conc	qc dupl. spike added	qc dup. spike measured	qc dup. spike recovery
93-76-5	3.17								
94-75-7	1.56								
94-82-6	2.31								

RESULT FILE FIELDS FOR A NORMAL FIELD SAMPLE WITH SURROGATES

The following table shows some of the fields in the result file for a normal field sample (i.e., Sample_type_code = N, TB, etc.). Note that QC fields are blank except on surrogate Rows.

cas_rn	result value	result unit	result type code	qc original conc	qc spike added	qc spike measured	qc spike recovery
93-76-5	1.56	mg/L	TRG				
94-75-7	3.17	mg/L	TRG				
PHEN2F		mg/L	SUR		12.5	12.9	103

RESULT FILE FIELDS FOR A MATRIX SPIKE

The following table shows some of the fields in the result file for a matrix spike sample (i.e., Sample_type_code = MS). Note that all "dup" QC fields are blank, and that the result_value field is NULL. Also, the qc_rpd field would be blank for these rows. The parent_sample_code must contain the contents of the sys_sample_code of the original (parent) sample.

cas_rn	result value	qc original conc	qc spike added	qc spike measured	qc spike recovery	qc dup. original conc	qc dupl. Spike added	qc dup. spike measured	qc dup. spike recovery
93-76-5		1.56	4.18	5.36	90.9				
94-75-7		3.17	4.18	7.15	95.2				
94-82-6		2.31	4.22	5.66	79.3				

RESULT FILE FIELDS FOR A MATRIX SPIKE DUPLICATE

The following table shows some of the fields in the result file for a matrix spike/matrix spike duplicate considered as a single sample (i.e., Sample_type_code = MSD). Note that all QC fields are completed, and that the result_value field is not needed. Also, the qc_rpd field would be completed for these rows. The parent_sample_code must contain the contents of the sys_sample_code of the original (parent) sample.

cas_rn	result value	qc original conc	qc spike added	qc spike measured	qc spike recovery	qc dup original conc	qc dup. spike added	qc dup spike measured	qc dup spike recovery
93-76-5						1.56	4.23	5.70	97.8
94-75-7						3.17	4.23	7.62	105
94-82-6						2.31	4.13	5.33	73.1

RESULT FILE FIELDS FOR A LCS or BS \

The following table shows some of the fields in the result file for an LCS sample (i.e., laboratory control sample, blank spike, Sample_type_code = BS). The qc_rpd field is left blank for these rows.

cas_rn	result value	qc original conc	qc spike added	qc spike measured	qc spike recovery	qc dup original conc	qc dup spike added	qc dup spike measured	qc dup spike recovery
93-76-5		1.5	5.00	5.26	105				
94-75-7		10.2	1.00	1.02	102				
94-82-6		3.4	12.5	12.9	103				

RESULT FILE FIELDS FOR A LCS DUPLICATE OR BS DUPLICATE

The following table shows some of the fields in the result file for a laboratory control sample duplicate (i.e., Sample_type_code = BD). Note that the result_value field is not required. Also, the qc_rpd field must be completed for these rows.

cas_rn	result value	qc original conc	qc spike added	qc spike measured	qc spike recovery	qc dup original conc	qc dup spike added	qc dup spike measured	qc dup spike recovery	qc_rpd
93-76-5							5.00	4.92	98	2.0
94-75-7							1.00	0.95	95	6.6
94-82-6							12.5	11.8	94	12.3

REANALYSES, REEXTRACTIONS, DILUTIONS

The following table shows how to report retests for three different circumstances. The first example, the sample was retested (for 75-25-2) because the initial result required reanalysis due to QC failure. For the second example, the initial sample result (for 95-95-4) required dilution. The third example (for 67-66-3) required both reanalysis and dilution (reanalysis supercedes dilution). The fourth example (87-86-5) shows an initial result that require re-extraction due to QC failure or elevated concentrations that could not be diluted based on the original extraction. The other results are "turned off" by setting the reportable_result field to "No".

test_type	cas_rn	result_value	reportable_result
initial	75-25-2	1.2	No
reanalysis	75-25-2	1.1	Yes
initial	95-95-4	250E	No
dilution	95-95-4	328	Yes
initial	67-66-3	3.4	No
reanalysis	67-66-3	3.3	Yes
initial	87-86-5	980E	No
reextraction	87-86-5	1500	Yes

ANALYSES REQUIRING SECOND COLUMN CONFIRMATION

Analyte identification requiring confirmation by a second analytical technique is required by certain gas chromatography (GC) methods. A common technique used to confirm the identity of an analyte is to analyze the sample using a second GC column that is dissimilar from the GC column used for the first analysis. This confirmation technique is used routinely when analyzing samples for pesticides, herbicides, and certain volatile organic compounds (e.g., BTEX), and the two analyses often are performed simultaneously using an instrument equipped with dual GC columns connected to common injection port.

The method for reporting data from dual column GC analyses is not standard throughout the environmental laboratory industry. ARCADIS recommends that laboratories use the method described in SW-846 Method 8000B, unless project-specific requirements or the method used for analysis dictate otherwise. The following table illustrates the proper format to be used to report first and second column results. The results for the first and third constituents (75-25-2 and 95-95-4) are being reported from column 1, and the result for the second constituent (67-66-3) is being reported from column 2. The other results are "turned off" by setting the reportable_result field to "No".

column_number	cas_rn	result_value	reportable_result
1C	75-25-2	6.2	Yes
1C	67-66-3	3.4	No
1C	95-95-4	5.6	Yes
2C	75-25-2	1.3	No
2C	67-66-3	33.7	Yes
2C	95-95-4	5.4	No

REFERENCE TABLES

A number of fields in each of the EDD files must be entered to correspond exactly with reference values standardized by ARCADIS. These reference values will be updated from time to time. Each laboratory will be supplied a copy of the updated document. It is the laboratory's responsibility to submit EDDs using the most current reference tables as defined by a specific project.

The following table summarizes the EDD fields where standard reference values must be used:

EDD File	EDD Field	Reference Table
Sample	sample_type_code	rt_sample_type
	sample_matrix_code	rt_matrix
Test	lab_anl_method_name	rt_anl_mthd
	lab_matrix_code	rt_matrix
	prep_method	rt_std_prep_mthd
	subsample_amount_unit	rt_unit
	final_volume_unit	rt_unit
Result	lab_anl_method_name	rt_anl_mthd
	cas_rn	rt_analyte
	chemical_name	rt_analyte
	result_type_code	rt_result_type
	lab_qualifier	rt_qualifier
	result_unit	rt_unit
	detection_limit_unit	rt_unit
Batch	lab_anl_method_name	rt_anl_mthd

IV. EDP

The EDP data checker assists the **LABORATORY** in checking EDD files to ensure that they are error-free prior to submission to ARCADIS. All laboratories providing data to ARCADIS **must use** the EDP program to verify that EDDs are without error. The EDP error reports for each file **must be** submitted with each EDD.

The use of the EDDP helps to solve common data population problems including duplicate data, incorrectly populated fields, and incorrect methods, CAS #s, and other acceptable reference values. If an EDD is received by ARCADIS containing errors it will be rejected until the EDD report is acceptable for import into the EQuIS database. Invoice payment will not be made until the EDD is acceptable.

ARCADIS will provide laboratories with the most recent version of the EDP.

Appendix B

COC Form

ARCADIS
Infrastructure, environment, facilities

ID #:

CHAIN OF CUSTODY & LABORATORY ANALYSIS REQUEST FORM

Page ___ of ___

Lab Work Order #

Send Results to:	Contact & Company Name:	Telephone:
	Address:	Fax:
	City State Zip	E-mail Address:
	Project Name/Location (City, State):	Project #:
	Sampler's Printed Name:	Sampler's Signature:

Preservative							
Filtered (✓)							
# of Containers							
Container Information							

PARAMETER ANALYSIS & METHOD

Keys

Preservation Key:
A. H_2SO_4
B. HCL
C. HNO_3
D. NaOH
E. None
F. Other: ________
G. Other: ________
H. Other: ________

Container Information Key:
1. 40 ml Vial
2. 1 L Amber
3. 250 ml Plastic
4. 500 ml Plastic
5. Encore
6. 2 oz. Glass
7. 4 oz. Glass
8. 8 oz. Glass
9. Other: ________
10. Other: ________

Matrix Key:

SO - Soil	SE - Sediment	NL - NAPL/Oil
W - Water	SL - Sludge	SW - Sample Wipe
T - Tissue	A - Air	Other: ________

Sample ID	**Collection**		**Type (✓)**		**Matrix**								**REMARKS**
	Date	Time	Comp	Grab									

Special Instructions/Comments:

☐ **Special QA/QC Instructions(✓):**

Laboratory Information and Receipt		**Relinquished By**	**Received By**	**Relinquished By**	**Laboratory Received By**
Lab Name:	Cooler Custody Seal (✓)	Printed Name:	Printed Name:	Printed Name:	Printed Name:
☐ Cooler packed with ice (✓)	☐ Intact ☐ Not Intact	Signature:	Signature:	Signature:	Signature:
Specify Turnaround Requirements:	Sample Receipt:	Firm:	Firm/Courier:	Firm/Courier:	Firm:
Shipping Tracking #:	Condition/Cooler Temp: ________	Date/Time:	Date/Time:	Date/Time:	Date/Time:

20730826 CofC AR Form 01.12.2007

Distribution: **WHITE – Laboratory returns with results** **YELLOW – Lab copy** **PINK – Retained by ARCADIS**

Appendix C

Laboratory Standard Operating Procedures

Controlled Copy
Copy No. uncontrolled copy
Implementation Date: 4/14/11

TESTAMERICA KNOXVILLE

STANDARD OPERATING PROCEDURE

TITLE: Analysis of Polychlorinated Dioxins/Furans by High Resolution Gas Chromatography/High Resolution Mass Spectrometry (HRGC/HRMS) Based on Methods 8290, 8290A, 1613B, 23, 0023A, and TO-9A

(SUPERSEDES: KNOX-ID-0004, Rev. 9)

Prepared By: David C

Reviewed By: Brent Wagner 3.10.11
Technical Specialist

Approved By: 3/10/11
Quality Assurance Manager

Approved By: 3-11-11
Environmental, Health and Safety Coordinator

Approved By: 3-11-11
Laboratory Director

Copyright Information:

This documentation has been prepared by TestAmerica Laboratories, Inc. and its affiliates ("TestAmerica"), solely for their own use and the use of their customers in evaluating their qualifications and capabilities in connection with a particular project. The user of this document agrees by its acceptance to return it to TestAmerica upon request and not to reproduce, copy, lend, or otherwise disclose its contents, directly or indirectly, and not to use it for any other purpose other than that for which it was specifically provided. The user also agrees that where consultants or other outside parties are involved in the evaluation process, access to these documents shall not be given to said parties unless those parties also specifically agree to these conditions.

THIS DOCUMENT CONTAINS VALUABLE CONFIDENTIAL AND PROPRIETARY INFORMATION. DISCLOSURE, USE OR REPRODUCTION OF THESE MATERIALS WITHOUT THE WRITTEN AUTHORIZATION OF TESTAMERICA IS STRICTLY PROHIBITED. THIS UNPUBLISHED WORK BY TESTAMERICA IS PROTECTED BY STATE AND FEDERAL LAW OF THE UNITED STATES. IF PUBLICATION OF THIS WORK SHOULD OCCUR THE FOLLOWING NOTICE SHALL APPLY: @COPYRIGHT 2011 TESTAMERICA LABORATORIES, INC. ALL RIGHTS RESERVED.

1. Scope and Application

1.1 This procedure is used for the determination of tetra- through octa- chlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) in water, soils, solids, sediments, wipes, biological samples, fly ash, XAD resin, filters, still bottoms, waste oils, and other sample matrices by high resolution gas chromatography/high resolution mass spectrometry (HRGC/HRMS). This procedure is designed to meet analytical program requirements where US EPA Method 8290, 8290A, 1613B, 23, 0023A, or TO-9A is specified.

1.2 The seventeen 2,3,7,8-substituted and total Tetra-Hepta PCDDs/PCDFs listed in Table 1 can be determined by this procedure. Specifications are also provided for separate determination of 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) and 2,3,7,8-tetrachlorodibenzofuran (2,3,7,8-TCDF). In addition, total homologs (i.e., Total TCDD, Total TCDF, etc.) can be identified by this method.

1.3 The detection limits and quantitation levels in this method are usually dependent on the level of interferences rather than instrumental limitations. The minimum levels (MLs) in Table 2 are the levels at which the PCDDs/PCDFs can be quantitated with no interferences present.

1.4 This procedure is designed for use by analysts who are experienced with residue analysis and skilled in HRGC/HRMS. Each analyst must demonstrate the ability to generate acceptable results with this method.

1.5 Because of the extreme toxicity of many of these compounds, the analyst must take the necessary precautions to prevent exposure to materials known or believed to contain PCDDs or PCDFs. It is the responsibility of the laboratory personnel to ensure that safe handling procedures are employed. Section 5 of this procedure discusses safety procedures.

2. Summary of Method

2.1 This procedure uses high resolution capillary column gas chromatography/high resolution mass spectrometry (HRGC/HRMS) techniques.

2.2 Samples are spiked with a solution of known amounts of the isotopically labeled internal standards listed in Table 13 and Table 15. The samples are then extracted using matrix specific extraction procedures.

2.2.1 Water samples are extracted using separatory funnel techniques with methylene chloride as the extraction solvent.

2.2.2 Solid samples are extracted by Soxhlet extraction with the appropriate solvent.

2.2.3 Organic liquid waste samples are diluted in solvent.

2.3 After extraction, the sample is concentrated and solvent exchanged to hexane. The extract is then subjected to one or more optional cleanup steps to remove the sample of interferences. The final extract is prepared by adding a known amount of the labeled recovery standards ($^{13}C_{12}$-1,2,3,4-TCDD and $^{13}C_{12}$-1,2,3,7,8,9-HxCDD) and concentrating to the final volume.

2.4 The acid-base cleanup of the sample is used before column chromatography for samples that contain large amounts of basic and acidic coextractable compounds. If such interferences are not removed before column chromatography, they can cause a shift in the predicted elution pattern. Conditions which can indicate the need for this procedure are as follows: Samples which are highly colored, samples which contain lipids or other oxidizable compounds or samples which contain known large amounts of polar organics.

2.5 Dual Column Cleanup: Silica gel is effective in removing chlorophenoxy herbicide residues, while alumina partitions PCBs, 2,4,5-trichlorophenol and hexachlorophene.

2.6 When the above cleanup techniques do not completely remove interferences, an activated carbon cleanup is used to remove interferences.

2.7 An aliquot of the extract is injected into the gas chromatograph. The analytes are separated by the GC and detected by a high resolution ($\geq$10,000 resolution) mass spectrometer (HRMS). Two exact m/z's are monitored for each analyte.

2.8 The identification of the target 2,3,7,8 substituted isomers is based on their retention time relative to the labeled internal standards as established during routine calibration and the simultaneous detection of the two most abundant ions in the molecular ion region. All other PCDD/PCDF congeners are identified by their retention times falling within retention time windows as established during routine calibration, and the simultaneous detection of the two most abundant ions in the molecular ion region. Confirmation of identification is based on comparing the calculated ion ratios with the theoretical ion abundances. The identification of 2,3,7,8-TCDF is confirmed on an isomer specific (DB-225) GC column.

2.9 Quantitation of the 2,3,7,8-substituted PCDD/PCDF isomers, total PCDDs, and total PCDFs is based on their relative response to the internal standards. A multipoint calibration is performed to establish mean response factors for the target analytes. The instrument performance is routinely checked by the analysis of continuing calibration standards. Method performance is demonstrated by the analysis of method blanks, initial precision and recovery samples, and ongoing precision and recovery samples.

3. Definitions

3.1 Analyte: A PCDD or PCDF tested for by this method. The analytes are listed in Table 1.

3.2 Calibration Standard: A solution prepared from a secondary standard and/or stock solution and used to calibrate the response of the instrument with respect to analyte concentration.

3.3 Calibration Verification Standard (VER): The mid-point calibration standard (CS3) that is used to verify calibration. See Table 5 and Table 6.

3.4 Cleanup Standard: Solution containing $^{37}Cl_4$-2,3,7,8-TCDD that is added to the calibration solutions and to every 1613B and 8290A sample, blank, and quality control spike sample. It is added after extraction but prior to extract cleanup, and the analysis results are used to judge the efficiency of the cleanup procedures.

3.5 Column Performance Solution Mixture (CPSM): A mixture of TCDD or TCDF isomers (including the 2,3,7,8-TCDD or 2,3,7,8-TCDF isomer) known to elute close to the retention time of 2,3,7,8-TCDD or 2,3,7,8-TCDF on the analytical column being used. It is used to demonstrate acceptable resolution between the 2,3,7,8-TCDD or 2,3,7,8-TCDF isomer and all other TCDD or TCDF isomers on analytical column (percent valley $\leq$ 25).

3.6 Congener: Any member of a particular homologous series, for example, 1,2,3,7,8-pentachlorodibenzofuran.

3.7 CS1, CS2, CS3, CS4, CS5: See Calibration Standard and Table 5 and Table 6.

3.8 Estimated Detection Limit (EDL): The sample specific estimated detection limit (EDL) is the concentration of a given analyte required to produce a signal with a peak height of at least 2.5 times the background signal level.

3.9 Estimated Maximum Possible Concentration (EMPC): The calculated concentration of a signal in the same retention time region as a target analyte but which does not meet the other qualitative identification criteria defined in the procedure.

3.10 GC: Gas chromatograph or gas chromatography

3.11 Homologous Series: A series of compounds in which each member differs from the next member by a constant amount. The members of the series are called homologs.

3.12 HRGC: High resolution GC

3.13 HRMS: High resolution MS

3.14 ICV: Initial Calibration Verification Standard. A calibration standard from a second source, traceable to a national standard if possible. The ICV is analyzed after the initial calibration to verify the concentration of the Initial Calibration Standards.

3.15 Internal Standards: Isotopically labeled analogs of the target analytes that are added to every sample, blank, quality control spike sample, and calibration solution. They are added to the sample before extraction and are used to calculate the concentration of the target analytes or detection limits.

3.16 Initial Precision and Recovery (IPR): See Initial Demonstration of Capability in Sections 9.1 and 13.2.

3.17 Isomer: Chemical compounds that contain the same number of atoms of the same elements, but differ in structural arrangement and properties. For example, 1,2,3,4-TCDD and 2,3,7,8-TCDD are structural isomers.

3.18 Laboratory Blank: See Method Blank.

3.19 Laboratory Control Sample (LCS): A laboratory blank spiked with known quantities of analytes. The LCS is analyzed exactly like a sample. Its purpose is to assure that the results produced by the laboratory remain within the limits specified in this method for precision and recovery..

3.20 Maximum Level (MaxL): The concentration or mass of analyte in the sample that corresponds to the highest calibration level in the initial calibration. Also referred to as the upper method calibration limit (UMCL). It is equivalent to the concentration of the highest calibration standard, assuming that all method-specified sample weights, volumes, and cleanup procedures have been employed.

3.21 Method Blank: An aliquot of reagent water, sand, sodium sulfate, or other representative matrix, free of the targets of interest and interferences, that is extracted and analyzed along with the samples to monitor for laboratory contamination.

3.22 Minimum Level (MinL): The level at which the entire analytical system must give a recognizable signal and acceptable calibration point for the analyte. Also referred to as the lower method calibration limit (LMCL). It is equivalent to the concentration of the lowest calibration standard assuming that all method-specified sample weights, volumes, and cleanup procedures have been employed.

3.23 MS: Mass spectrometer or mass spectrometry.

3.24 Multiple Ion Detection (MID): A MS operational mode in which only selected ions are monitored rather than scanning the instrument to obtain a complete mass spectrum.

3.25 Ongoing precision and recovery standard (OPR): See Laboratory Control Sample.

3.26 PCDD: Polychlorinated dibenzo-p-dioxins.

3.27 PCDF: Polychlorinated dibenzofurans.

3.28 PFK: Perfluorokerosene; the mixture of compounds used to calibrate the exact m/z scale in the HRMS.

3.29 FC-43 (PFTBA): Perfluorotributylamine

3.30 Recovery Standard: Solution containing $^{13}C_{12}$-1,2,3,4-TCDD and $^{13}C_{12}$-1,2,3,7,8,9-HxCDD that is added to every sample, blank, and quality control spike sample extract just prior to analysis. The results are used to measure the recovery of the internal standards and the cleanup standard.

3.31 Percent Difference (%D): A measure of the difference between two values normalized to one of the values. It is used to determine the accuracy of the concentration measurements of second source verification standards.

3.32 Relative Response Factor (RRF): The ratio of the response of the mass spectrometer to a known amount of a compound relative to that of a known amount of a reference standard as measured in the initial and continuing calibrations. It is used to determine instrument performance and it is used to calculate the concentration of target analytes, internal standard recoveries, or detection limits in samples, blanks, and quality control samples.

3.33 Signal to Noise Ratio: The ratio of the mass spectrometer response of a GC peak to the background noise signal.

3.34 Split Ratio (S): The decimal expression of the proportion of extract used from splits taken after the addition of internal standards and before the addition of recovery standards.

3.35 Window Defining Mix: A solution which contains the first and last eluting isomers of each homologue group and is used to verify that the switching times between the MID descriptors have been appropriately set.

3.36 Additional definitions can be found in the Test America Knoxville QAM.

4. Interferences

4.1 Solvents, reagents, glassware and other sample processing hardware can yield discrete artifacts or elevated baselines that can cause misinterpretation of the chromatographic data. All of these materials must be demonstrated to be free from interferences under the conditions of analysis by performing laboratory method blanks. Analysts must not use PVC gloves, powdered gloves, or gloves with levels of phthalates which cause interference.

4.2 The use of high purity reagents and solvents (pesticide grade) helps minimize interference problems. Where necessary, reagents are cleaned by extraction or solvent rinse.

4.3 Interferences coextracted from the samples can vary considerably from matrix to matrix. PCDDs and PCDFs are often associated with other interfering chlorinated substances such as polychlorinated biphenyls (PCBs), polychlorinated diphenyl ethers (PCDPEs), polychlorinated naphthalenes, and polychlorinated alkyldibenzofurans that can be found at concentrations several orders of magnitude higher than the analytes of interest. Retention times of target analytes must be verified using reference standards. While certain cleanup techniques are provided as part of this method, unique samples can require additional cleanup steps to achieve lower detection limits.

5. Safety

5.1 Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual and this document.

5.2 Eye protection that satisfies ANSI Z87.1 (as per the Corporate Safety Manual), laboratory coat and appropriate gloves must be worn while samples, standards, solvents and reagents are being handled. Disposable gloves that have become contaminated must be removed and discarded, other gloves must be cleaned immediately.

5.2.1 Latex and vinyl gloves provide no protection against most of the organic solvents used in this method. For the operations described herein, Nitrile gloves are to be worn. For operations using solvents that may splash, SilverShield® gloves are recommended. SilverShield® gloves protect against breakthrough for most of the solvents used in this procedure.

5.3 The effluents of sample splitters for the gas chromatograph and roughing pumps on the mass spectrometer must be vented to the laboratory hood exhaust system or must pass through an activated charcoal filter.

5.4 The gas chromatograph and mass spectrometer contain zones that have elevated temperatures. The analyst needs to be aware of the locations of those zones, and must cool them to room temperature prior to working on them or use thermal protection when working on them while they are above room temperature.

5.5 The mass spectrometer is under high vacuum. The mass spectrometer must be brought to atmospheric pressure prior to working on the source. Alternatively, the source can be removed from the vacuum manifold through a vacuum interlock.

5.6 There are areas of high voltage in both the gas chromatograph and the mass spectrometer. Depending on the type of work involved, either turn the power to the instrument off, or disconnect it from its source of power. If the work involved requires measurement of voltage supplies, the instrument can be left on.

5.7 Primary Materials Used: The following is a list of the materials used in this method, which have a serious or significant hazard rating. **NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material	**Hazards**	**Exposure Limit (2)**	**Signs and symptoms of exposure**
Methylene chloride	Carcinogen, Irritant	25 ppm-TWA, 125 ppm-STEL	Causes irritation to respiratory tract. Has a strong narcotic effect with symptoms of mental confusion, light-headedness, fatigue, nausea, vomiting and headache. Causes irritation, redness and pain to the skin and eyes. Prolonged contact can cause burns. Liquid degreases the skin. Can be absorbed through skin.

Material	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Hexane	Flammable, Irritant	500 ppm-TWA	Inhalation of vapors irritates the respiratory tract. Overexposure can cause lightheadedness, nausea, headache, and blurred vision. Vapors can cause irritation to the skin and eyes.
Methanol	Flammable, Poison, Irritant	200 ppm-TWA	A slight irritant to the mucous membranes. Toxic effects exerted upon nervous system, particularly the optic nerve. Symptoms of overexposure can include headache, drowsiness and dizziness. Methyl alcohol is a defatting agent and can cause skin to become dry and cracked. Skin absorption can occur; symptoms can parallel inhalation exposure. Irritant to the eyes.
Toluene	Flammable, Poison, Irritant	200 ppm-TWA 300 ppm-Ceiling	Inhalation can cause irritation of the upper respiratory tract. Symptoms of overexposure can include fatigue, confusion, headache, dizziness and drowsiness. Peculiar skin sensations (e. g. pins and needles) or numbness can be produced. Causes severe eye and skin irritation with redness and pain. Can be absorbed through the skin.
Acetone	Flammable	1000 ppm-TWA	Inhalation of vapors irritates the respiratory tract. Can cause coughing, dizziness, dullness, and headache.
Cyclohexane	Flammable, Irritant	300 ppm TWA	Inhalation of vapors causes irritation to the respiratory tract. Symptoms can include coughing, shortness of breath. High concentrations have a narcotic effect.
Tetradecane	Irritant	None established	Inhalation of vapors can cause difficulty breathing, headache, intoxication and central nervous system damage.
Benzene	Flammable, Toxic, Carcinogen	PEL: 1 ppm TWA ; 5 ppm, 15 min. STEL	Causes skin irritation. Toxic if absorbed through skin. Causes severe eye irritation. Toxic if inhaled. Vapor or mist causes irritation to mucous membranes and upper respiratory tract. Exposure can cause narcotic effect. Inhalation at high concentrations can have an initial stimulatory effect on the central nervous system characterized by exhilaration, nervous excitation and/or giddiness, depression, drowsiness or fatigue. Victim can experience tightness in the chest, breathlessness, and loss of consciousness.
Nonane	Flammable	None established	Harmful if inhaled/swallowed. Vapor/mist is irritating to eyes, mucous membranes and upper respiratory tract. Causes skin irritation.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

5.7.1 Chemicals that have been classified as carcinogens, or potential carcinogens, under OSHA regulations include benzene and methylene chloride, 2,3,7,8-TCDD and all other 2,3,7,8- substituted PCDD or PCDF isomers.

NOTE: The 2,3,7,8-TCDD isomer has been found to be acnegenic, carcinogenic, and teratogenic in laboratory animal studies. Other PCDDs and PCDFs containing chlorine atoms in positions 2,3,7,8 are known to have toxicities comparable to that of 2,3,7,8-TCDD. The toxicity or carcinogenicity of each reagent used in this method is not precisely defined; however, each chemical compound must be treated as a potential health hazard. From this viewpoint, exposure to these chemicals must be kept to a minimum.

5.8 Exposure to chemicals must be maintained as low as reasonably achievable; therefore, unless they are known to be non-hazardous, all samples must be opened, transferred and prepared in a fume hood, or under other means of mechanical ventilation. Solvent and waste containers must be kept closed unless transfers are being made.

5.9 All procedures that involve solvents such as acetone, toluene, methylene chloride, and hexane (e.g., glassware cleaning and the preparation of standards and reagents) must be conducted in a fume hood with the sash closed as far as the operations permit.

5.10 Personal Hygiene: Thorough washing of hands and forearms is recommended after each manipulation and before breaks (coffee, lunch, and shifts).

5.11 All work must be stopped in the event of a known or potential compromise to the health or safety of an associate. The situation must be reported immediately to a laboratory supervisor.

6. Equipment and Supplies

6.1 Sample Analysis Equipment.

6.1.1 Gas Chromatograph – Must have splitless or on-column injection port for capillary column, temperature program with isothermal hold, and must meet all of the performance specification in Section 10.

6.1.1.1 GC column for PCDDs/PCDFs and for isomer specificity for 2,3,7,8-TCDD – 60m x 0.32mm ID x 0.25µm film thickness DB-5 or RTX-5 fused silica capillary column (J&W No. 123-5062, Restek No.10227 or 10227-125 IntegraGuard) or equivalent is required.

6.1.1.2 GC column for isomer specificity for 2,3,7,8-TCDF – 30m x 0.32mm ID x 0.25µm film thickness DB-225 or RTX-225 fused silica capillary column (J&W No. 123-2232 or Restek No.14024) or equivalent is required.

6.1.2 Mass Spectrometer – Electron impact ionization with the filament electron volts (eV) optimized for best instrument sensitivity, stability and signal to noise ratio. Must be capable of repetitively selectively monitoring 12 exact m/z's minimum at high resolution (≥10,000) during a period of approximately 1 second and must meet all of the performance specifications in Section 10.

6.1.3 GC/MS Interface – The mass spectrometer (MS) must be interfaced to the GC such that the end of the capillary column terminates within 1 cm of the ion source but does not intercept the electron or ion beam.

6.1.4 Data System – Capable of collecting, recording, and storing MS data.

7. Reagents and Standards

7.1 Standards and Calibration Solutions: Certified Reference Standards purchased from Cambridge Isotope Laboratories (CIL, Andover Massachusetts), and Wellington Laboratories (Guelph, Ontario, Canada). If the chemical purity is 98% or greater, the weight can be used without correction to compute the concentration of the standard. When not being used, standards are stored in the dark at room temperature in screw-capped vials with PTFE-lined caps. Standards are used as received after being sonicated and transferred to 2.0 mL amber glass vials with PTFE lined caps.

7.1.1 Stability of Solutions: Standards have an expiration of ten (10) years from date of receipt unless otherwise specified by the manufacturer. Standard solutions used for quantitative purposes must be analyzed periodically, and must be assayed against reference standards before use.

7.2 Initial Calibration Standards:

7.2.1 1613B/8290/8290A: CS1-CS5. CIL Catalog No. EDF-9999. (See Table 5).

7.2.2 23/0023A/TO-9A: CS1-CS5. Wellington Catalog No. EPA-23 CS1-5. (See Table 6).

7.3 Initial Calibration Verification Standards:

7.3.1 1613B/8290/8290A: Wellington Catalog No. EPA-1613-CS3.

7.3.2 23/0023A/TO-9A: CS3. CIL Catalog No. EDF-4052-3.

7.4 Daily Calibration Verification Standards

7.4.1 1613B/8290/8290A: CS3. CIL Catalog No. EDF-9999-3. (See Table 7).

7.4.2 1613B/8290/8290A: CS3. CIL Catalog No. EDF-4141. (See Table 7).

NOTE: This standard can be used as both the Continuing Calibration Standard and the DB/Rtx-5 GC Window Defining Mix/Column Performance Check Solution.

7.4.3 23/0023A/TO-9A: CS3. Wellington Catalog No. EPA-23-CS3. (See Table 8).

7.5 Native Standards

7.5.1 Native Standard Stock Solution: CIL Catalog No. EDF-7999-10x, 400-4000 ng/mL in nonane, 1.2 mL.

7.5.2 Native Standard Working Stock Solution: Dilute 0.300 mL of the native standard stock solution to 3.0 mL in a volumetric flask with nonane for a final concentration of 40-400 ng/mL.

7.5.3 Native LCS Spiking Solution: Dilute 500 µL of the native standard working stock solution to 100 mL in a 125 mL amber bottle with a PTFE lined cap with iso-octane to a final concentration of 0.2-2.0 ng/mL. 1.0 mL of this solution is added to each LCS, LCSD or MS/MSD sample. See Table 11 for a complete list of compounds and their concentrations.

7.6 1613B/8290/8290A Internal Standards

7.6.1 1613B/8290/8290A Internal Standard Stock Solution: CIL Catalog No. EDF-8999, 100 ng/mL ($^{13}C_{12}$-OCDD 200 ng/mL) in nonane, 500 µL.

7.6.2 1613B/8290/8290A Internal Standard Spiking Solution: Dilute 2000 µL of the internal standard stock solution to 200 mL in a 250 mL amber bottle with a PTFE lined cap with iso-octane to a final concentration of 1.0 ng/mL ($^{13}C_{12}$-OCDD 2.0 ng/mL). 1.0 mL of this solution is added to each sample, method blank and QC sample. See Table 12 for a complete list of compounds and their concentrations.

7.7 2,3,7,8-TCDD/2,3,7,8-TCDF Internal Standards

7.7.1 $^{13}C_{12}$-2,3,7,8-TCDD Internal Standard Stock Solution: CIL Catalog No. ED-900, 50 µg/mL in nonane, 1.2 mL

7.7.2 $^{13}C_{12}$-2,3,7,8-TCDF Internal Standard Stock Solution: CIL Catalog No. EF-904, 50 µg/mL in nonane, 1.2 mL

7.7.3 $^{13}C_{12}$-TCDD/$^{13}C_{12}$-TCDF Internal Standard Secondary Stock Solution: Dilute 0.100 mL of the stock solutions above to 5 mL in a volumetric flask with nonane to a final concentration of 1000 ng/mL.

7.7.4 $^{13}C_{12}$-TCDD/$^{13}C_{12}$-TCDF Internal Standard Spiking Solution: Dilute 200 µL of the internal standard secondary stock solution to 200 mL in a 250 mL amber bottle with a PTFE lined cap with iso-octane to a final concentration of 1.0 ng/mL. 1.0 mL of this solution is added to each sample, method blank and QC sample extract that is extracted for TCDD and/or TCDF analysis only. See Table 2 for a complete list of compounds and their concentrations.

7.8 23/0023A/TO-9A Internal Standards

7.8.1 23/0023A/TO-9A Internal Standard Stock Solution: Wellington Catalog No. EPA-23ISS, 1000 ng/mL ($^{13}C_{12}$-OCDD 2000 ng/mL) in nonane/toluene (80:20 v:v), 1.2 mL.

7.8.2 23/0023A/TO-9A Internal Standard Spiking Solution: Dilute 200 µL of the internal standard stock solution to 200 mL in a 250 mL amber bottle with a PTFE lined cap with iso-octane to a final concentration of 1.0 ng/mL ($^{13}C_{12}$-OCDD 2.0 ng/mL). 1.0 mL of this solution is added to each sample, method blank, and QC sample. See Table 15 for a complete list of compounds and their concentrations.

7.9 Recovery Standards

7.9.1 $^{13}C_{12}$-1,2,3,4-TCDD Recovery Standard Stock Solution: CIL Catalog No. ED-911, 50 µg/mL in nonane, 1.2 mL

7.9.2 $^{13}C_{12}$-1,2,3,7,8,9-HxCDD Recovery Standard Stock Solution: CIL Catalog No. ED-996, 50 µg/mL in nonane, 1.2 mL

7.9.3 Recovery Standard Secondary Stock Solution: Dilute 1.0 mL of the stock solutions above to 10 mL in a volumetric flask with nonane to a final concentration of 5.0 µg/mL.

7.9.4 Recovery Standard Spiking Solution: Add 10 mL of nonane to a 12 mL amber vial with a Class A glass pipette. With a syringe, remove 200 µL of nonane from the vial and add 200 µL of the recovery standard secondary stock solution to a final concentration of 0.1 µg/mL. 20 µL of this solution is added to each sample, method blank and QC sample extract. See Table 2 for a complete list of compounds and their concentrations.

7.10 1613B and 8290A Cleanup Standards

7.10.1 Cleanup Standard Stock Solution: CIL Catalog No. ED-907, 50 µg/mL in nonane, 1.2 mL

7.10.2 Cleanup Standard Secondary Stock Solution: Dilute 0.100 mL of the 50 µg/mL cleanup standard stock solution to 1.0 mL in a volumetric flask with nonane to a final concentration of 5.0 µg/mL.

7.10.3 Cleanup Standard Working Stock Solution: Dilute 0.120 mL of the 5.0 µg/mL cleanup standard secondary stock solution to 3.0 mL in a volumetric flask with nonane to a final concentration of 200 ng/mL.

7.10.4 Cleanup Standard Spiking Solution: Dilute 200 µL of the 200 ng/mL working stock solution to 200 mL in a 250 mL amber bottle with a PTFE lined cap with hexane to a final concentration of 0.20 ng/mL. 1.0 mL of this solution is added to each 1613B or 8290A sample, method blank and QC sample extract prior to cleanup. See Table 17 for a complete list of compounds and their concentrations.

7.11 23/0023A/TO-9A Surrogate Standards

7.11.1 23/0023A/TO-9A Surrogate Standard Stock Solution: Wellington Catalog No. EPA-23SSS, 1000 ng/mL in nonane/toluene (95:5 v:v), 1.2 mL.

7.11.2 23/0023A/TO-9A Surrogate Standard Spiking Solution: Dilute 500 µL of the surrogate standard stock solution to 25 mL in a graduated cylinder with nonane to a final concentration of 20 ng/mL. 100 µL of this solution is added to each sample train components before sampling. See Table 16 for a complete list of compounds and their concentrations.

7.12 PCDD/PCDF Window Defining and Isomer Specificity Standard

7.12.1 PCDD/PCDF Window Defining and Isomer Specificity Mixture: CIL Catalog No. EDF-4141. This standard contains the daily standard, window defining mix and the isomer specificity mix.

7.13 Perfluorokerosene (PFK) is used in neat form to tune and calibrate the mass spectrometer. Fluka (Catalog No. - 77275) has been found to be superior to other sources of PFK.

7.14 FC-43 (PFTBA) is used in neat form to tune and calibrate the mass spectrometer. (Scientific Instrument Services Catalog No. FC-43-35).

8. Sample Collection, Preservation and Storage

8.1 Sampling is not performed for this method by TestAmerica Knoxville. For information regarding sample shipping, refer to SOP KNOX-SC-0003, “Sample Receipt and Log In”, current revision. Sample container and preservation recommendations are listed in the table below.

Method:	**1613B**	**8290/8290A[1]**	**23**	**0023A[1]**	**TO-9A**
Holding Times	Samples – 1 year from collection to extraction Extracts – 1 year from extraction to analysis	Samples – 30 days from collection to extraction Extracts – 45 days from extraction to analysis Tissue Extracts –45 days from collection to analysis	Samples – 30 days from collection to extraction Extracts – 45 days from extraction to analysis	Samples – 30 days from collection to extraction Extracts – 45 days from extraction to analysis	Samples – 7 days from collection to extraction Extracts – 40 days from extraction to analysis
Containers	Amber Glass	Amber Glass	See KNOX-ID-0012	See KNOX-ID-0012	See KNOX-ID-0012

Method:	**1613B**	**8290/8290A**[1]	**23**	**0023A**[1]	**TO-9A**
Preservation:					
Aqueous Samples	≤6 °C in the dark If residual chlorine is present, add 80 mg/L sodium thiosulfate. If pH > 9, adjust to pH 7-9 with sulfuric acid	≤6 °C in the dark If residual chlorine is present, add 80 mg/L sodium thiosulfate.	N/A	N/A	N/A
Solid Samples	<-10 °C in the dark	≤6 °C in the dark	N/A	N/A	N/A
Tissue Samples	<-10 °C in the dark	<-20 °C in the dark[2]	N/A	N/A	N/A
Air Samples	N/A	≤6 °C in the dark	≤6 °C in the dark	≤6 °C in the dark	≤6 °C in the dark

Notes:

1 For method 8290, 8290A and 0023A the holding times listed are recommendations. PCDDs and PCDFs are very stable in a variety of matrices, and holding times under the conditions listed can be as high as a year for certain matrices. The results of samples analyzed after the holding time expiration date must be considered to be minimum concentrations and must be identified as such in the final report. Sample extracts, however, must always be analyzed within 45 days of extraction. (For the State of South Carolina and the New Jersey DEP, the holdings times are as listed in the table and are not considered recommendations.)

2 If the freezer used to store samples is not capable of reaching a temperature of <-20 °C when the temperature control is set to its maximum limit, a storage higher temperature is acceptable as long as it is <-10 °C.

9. Quality Control

9.1 The Initial Demonstration of Capability (IDOC) studies described in Section 13 must be completed with acceptable results before analysis of samples can begin.

9.2 The Method Detection Limit (MDL) study described in Section 13 must be completed with acceptable results before analysis of samples can begin.

9.3 A laboratory method blank must be run along with each analytical batch of 20 (10, including field blank if provided, for TO-9A) or fewer samples. The method blank is normally analyzed immediately after the calibration standards. The method blank must meet the following acceptance criteria:

9.3.1 The concentration of target analytes in the method blank must be less than the minimum level (ML) and “B” qualifiers are added to all associated samples with analytes detected in the method blank above the estimated detection limit (EDL).

9.3.2 If the concentration of target analytes in the method blank is greater than minimum level (ML) but less than 5% of the concentration in the associated samples, corrective action is required but the associated data can be reported. At a minimum, corrective action must include the addition of "B" qualifiers to all associated samples with analytes detected in the method blank above the ML and documentation in the case narrative.

9.3.3 If the method blank sample fails to meet the acceptance criteria, the Project Manager is notified and the entire sample batch is re-extracted. If there is insufficient sample volume remaining for re-extraction, the client is contacted for information about the availability of additional sample volume. If there is no additional sample available, the original sample data is flagged and reported. A nonconformance memo is initiated describing the problem and corrective action. The problem and corrective action is documented in the project narrative.

9.3.4 If there is no target analyte greater than the minimum levels (ML) in the samples associated with an unacceptable method blank, the data can be reported with qualifiers. Such action must be done in consultation with the client.

9.3.5 The method blank internal standard recoveries must be within the established control limits. If internal standard recoveries are not acceptable, the data must be evaluated to determine if the method blank has served the purpose of demonstrating that the analysis is free of contamination.

9.3.5.1 If internal standard recoveries are low in the method blank and there are analytes >ML in the associated samples re-extraction of the blank and affected samples is required if the method blank does not demonstrate that the analysis is free of contamination.

9.3.5.2 If the method blank internal standard recoveries are outside the QC limits and the decision is made to report the sample results, an NCM must be initiated and the reason for accepting the sample results clearly documented. Consultation with the client before acceptance must take place.

9.3.6 Refer to the QC Program document (QA-003) for further details of the corrective actions.

9.4 Instrument Blank

9.4.1 Instruments must be evaluated for contamination during each 12 hour analytical sequence. This is accomplished by analysis of a method blank if available. If a method blank is not available, an instrument blank must be analyzed. An instrument blank consists of solvent with the internal standards and recovery standards added. It is evaluated in the same way as the method blank.

9.5 Laboratory Control Sample

An LCS is analyzed along with each analytical batch of 20 (10, including field blank if provided, for TO-9A) or fewer samples. The LCS consists of reagent water for aqueous samples, and a clean solid matrix (sodium sulfate) for solid samples. The LCS extract must be subject to the same clean up procedures as the associated sample extracts. LCS spike components, concentrations, and control limits are given in Table 11.

9.5.1 If any analyte in the LCS is outside the control limits, corrective action must occur. Corrective action includes:

9.5.1.1 If the LCS fails to meet the acceptance criteria, the Project Manager is notified and the entire sample batch is re-extracted. If there is insufficient sample volume remaining for re-extraction, the client is contacted for information about the availability of additional sample volume. If there is no additional sample available, the original sample data is flagged and reported. A nonconformance memo is initiated describing the problem and corrective action. The problem and corrective action is documented in the project narrative.

9.5.1.2 If the batch is not re-extracted and reanalyzed, an NCM must be initiated and the reasons for accepting the batch must be clearly presented in the project records and the report. (An example of an acceptable reason for not reanalyzing might be that the matrix spike and matrix spike duplicate recoveries are within control limits, the method blank and sample internal standard recoveries are within limits, and the data clearly demonstrates that the problem was confined to the LCS).

9.5.1.3 For method TO-9A calculate the precision (%D) from the LCS/LCSD. The precision must be within ± 30%.

9.5.2 Ongoing monitoring of the LCS provides evidence that the laboratory is performing the method within accepted QC guidelines for accuracy and precision.

9.6 Internal Standards

Internal standards are spiked into all samples, blanks, and laboratory control samples to assess method performance on the sample matrix. The recovery of each labeled internal standard must be within the limits in Table 13 for methods 1613B, 8290 and 8290A or in Table 15 for methods 23, 0023A, and TO-9A.

9.6.1 If the recovery is outside these limits the following corrective action must be taken:

9.6.1.1 Check all calculations for error.

9.6.1.2 Ensure that instrument performance is acceptable.

9.6.1.3 Recalculate the data and/or reanalyze if either of the above checks reveal a problem.

9.6.1.4 If the recovery of any internal standard is less than the lower control limit, calculate the S/N ratio of the internal standard. If the S/N is > 10 and the estimated detection limits (EDLs) are less than the minimum levels (MLs), report the data as is with qualifiers in the report and a discussion in the case narrative. If the S/N is < 10 or the estimated detection limits (EDLs) are greater than the minimum levels (MLs), re-extract and re-analyze the sample. If the poor internal standard recovery is judged to be a result of sample matrix, a reduced portion of the sample can be re-extracted or additional clean-ups can be employed. The decision to reanalyze or flag the data is made in consultation with the client.

9.7 Matrix Spike/Matrix Spike Duplicate (MS/MSD) – Method 8290 only.

When method 8290 is performed a matrix spike/matrix spike duplicate (MS/MSD) is prepared and analyzed with every 20 samples of a given matrix. **Note that a MS/MSD is not required for Method 8290A**. The MS/MSD is spiked with the same subset of analytes as the LCS (See Table 12). Compare the percent recovery and relative percent difference (RPD) to that in the laboratory specific historically generated limits.

9.7.1 If any individual recovery or RPD falls outside the acceptable range, corrective action must occur. The initial corrective action is to check the recovery of that analyte in the Laboratory Control Sample (LCS). Generally, if the recovery of the analyte in the LCS is within limits, then the laboratory operation is in control and analysis can proceed. The reasons for accepting the batch must be documented in the report narrative.

9.7.2 If the recovery for any component is outside QC limits for both the MS/MSD and the LCS, the analysis is out of control and corrective action must be taken. Corrective action normally includes repreparation and reanalysis of the batch.

9.7.3 If a MS/MSD is not possible due to limited sample, then a LCSD must be analyzed. The LCSD is evaluated using the same acceptance criteria as the LCS. The RPD of the LCS and LCSD are compared to the acceptance limits in Table 12.

9.7.4 The MS/MSD must be analyzed at the same dilution as the unspiked sample, even if the matrix spike compounds are diluted out.

9.8 Surrogate Standards – Methods 23, 0023A, TO-9A

Field surrogate standards are added to the collection media prior to sample collection when performing methods 23, 0023A, or TO-9A. The surrogate recoveries are calculated relative to the internal standards and are a measure of sampling efficiency. The recovery of the surrogate standards must be within the limits specified in Table 16. Poor recoveries of the surrogate standards can indicate breakthrough in the sampling train.

9.8.1 If the recovery is outside these limits the following corrective action must be taken:

9.8.1.1 Check all calculations for error.

9.8.1.2 Ensure that instrument performance is acceptable.

9.8.1.3 Recalculate the data and/or reanalyze if either of the above checks reveal a problem.

9.8.1.4 Flag the results that are outside control limits and notify the Project Manager. The client must be notified and consulted for additional corrective action.

10. Calibration and Standardization

10.1 Two types of calibration procedures are required. One type, initial calibration, is required before any samples are analyzed and is required intermittently throughout sample analyses as dictated by the results of continuing calibration procedures described below. The other type, continuing calibration, consists of analyzing the column performance check solution and a calibration solution (CS3). No samples are to be analyzed until acceptable calibration as described in sections 10.2 and 10.2.9.1 is demonstrated and documented. A 2uL injection volume is specified for all extracts, blanks, calibration solutions and performance check samples. A 1uL injection volume can be used; however, the laboratory must keep the injection volume the same throughout calibration and analysis.

10.2 Initial Calibration

10.2.1 Prepare multi-level calibration standards containing the compounds and concentrations as specified in Table 5 for methods 1613B and 8290/8290A or in Table 6 for methods 23, 0023A, or TO-9A. Store calibration standards at room temperature in the dark. Calibration standard solutions have an expiration date of ten (10) years from date of receipt unless otherwise specified by the manufacturer/supplier.

10.2.2 Establish operating parameters for the GC/MS system (suggested operating conditions are displayed in Figure 1 and Figure 2). For method 1613B adjust the GC conditions to meet the relative retention times for the PCDDs/PCDFs listed in Table 3. The cycle time for MID descriptors must be ≤ 1 sec.

10.2.3 By using a PFK or FC-43 molecular leak, tune the instrument to meet the minimum resolving power of 10,000 (10 percent valley) at m/z 304.9824 (PFK) or 313.9838 (FC-43) or any other reference signal close to the m/z 303.9016 (from TCDF).

10.2.4 By using peak matching conditions and the aforementioned either PFK or FC-43 reference peak, verify that the exact mass of m/z 380.9760 (PFK) or m/z 363.9807 (FC-43) is within 5 ppm of the required value. Document that the resolving power at reduced accelerating voltage of m/z 380.9760 (PFK) or m/z 363.9807 (FC-43) is greater than 10,000 (10 percent valley).

10.2.5 Analyze 2µL of the Window Defining Mixture and set the switchpoints for the MID descriptors. The switchpoints must be set to encompass the retention time window of each congener group.

10.2.6 If the initial calibration is being performed on the DB-5 or RTX-5 column, analyze 2µL of the Column Performance solution. The chromatographic peak separation between 2,3,7,8-TCDD and the closest eluting non-2,3,7,8-TCDD isomer must be resolved with a % Valley of ≤ 25, where

$$\% \text{ Valley} = \frac{\text{baseline to valley height of closest eluting isomer}}{\text{peak height of 2,3,7,8-TCDD}} \times 100$$

If the initial calibration is being performed on the DB-225 or RTX-225 column, analyze 2µL of the TCDF Column Performance solution. The chromatographic peak separation between 2,3,7,8-TCDF and the closest eluting non-2,3,7,8-TCDF isomer must be resolved with a % Valley of ≤ 25, where

$$\% \text{ Valley} = \frac{\text{baseline to valley height of closest eluting isomer}}{\text{peak height of 2,3,7,8-TCDF}} \times 100$$

10.2.7 Analyze 2µL of each of the five calibration standards and calculate the RRF of each analyte vs. the appropriate internal standard listed in Table 3 for methods 1613B, 8290/8290A or in Table 4 for methods 23, 0023A, and TO-9A using the following equation;

$$\text{RRF} = \frac{\text{As} \times \text{Cis}}{\text{Ais} \times \text{Cs}}$$

where:

As = sum of the areas of the quantitation ions of the compound of interest
Ais = sum of the areas of the quantitation ions of the appropriate internal standard
Cis = concentration of the appropriate internal standard
Cs = concentration of the compound of interest

10.2.7.1 Calculate the mean relative response factor (mean RRF) and the percent relative standard deviation (RSD) of the relative response factors for each compound of interest in the five calibration standard solutions using the following equations;

$$\overline{\text{RRF}}_{n=5} = \frac{1}{n} \times \sum_{i=1}^{n} \text{RF}_i$$

$$\mathrm{RSD}_{n=5} = \sqrt{\frac{\sum_{i=1}^{n}\left(\mathrm{RF}_i - \overline{\mathrm{RF}}\right)^2}{n-1}} \times \frac{100}{\overline{\mathrm{RRF}}}$$

10.2.8 Criteria for Acceptable Calibration - The criteria listed below for acceptable calibration must be met for each initial calibration standard before sample analyses are performed. If acceptable initial calibration is not achieved, identify the root cause, perform corrective action, and repeat the initial calibration. If the root cause can be traced to problems with an individual analysis within the calibration series, follow the procedure in Test America Policy CA-T-P-002 Selection of Calibration Points, current revision (see reference section 16.10).

10.2.8.1 The percent relative standard deviation (RSD) for the mean relative response factors must be within the acceptance criteria listed in Table 5 for methods 1613B, 8290/8290A or in Table 6 for methods 23, 0023A, and TO-9A.

10.2.8.2 The peaks representing the PCDDs/PCDFs and labeled compounds in the calibration standards must have signal-to-noise ratios (S/N) ≥ 10.

10.2.8.3 The ion abundance ratios must be within the specified control limits in Table 22.

10.2.8.4 For method 1613B the absolute retention time of $^{13}C_{12}$-1234-TCDD must exceed 25.0 minutes on the DB/Rtx-5 column and 15.0 minutes on the DB/Rtx-225 column.

10.2.8.5 Corrective action can include replacing the injector port liner, replacing the injector port septum, removal of a small portion of the front of the analytical column, replacing the autosampler syringes and rinse solvent, adjusting the instrument tuning, cleaning the ion volume or ion source, installing a new analytical column and replacing the calibration standard solutions.

10.2.9 Analyze 2μL of the Initial Calibration Verification (ICV) Standard in section 7.3 after the completion of the initial calibration prior to sample analysis. Calculate the concentration of the ICV using the RRFs from the CS3 standard analyzed in section 10.2.7 and the formula in section 12.3.4. Calculate the percent difference (%D) between the expected and the calculated ICV concentration using the following formula.

$$\%D = \frac{\left(C_{Exp} - C_{Calc}\right)}{C_{Exp}} \times 100$$

Where:
C_{Exp} = The expected concentration of the Standard.

C_{Calc} = The calculated concentration of the Standard.

10.2.9.1 The general criteria for percent difference acceptance limits is ±25% for all native compounds. The warning limits for percent difference is ±25% to ±35%.

10.2.9.2 All data associated with compounds with percent differences in the warning limits must be reviewed before acceptance.

10.2.9.3 All data associated with compounds with percent differences outside the warning limits must be documented as an NCM. Corrective action must be taken and can include the following:

- Reanalyze the ICV Standard
- Replace and reanalyze the ICV Standard
- Evaluate the instrument performance
- Evaluate the Initial Calibration Standards

10.3 Continuing Calibration

10.3.1 Continuing calibration is performed at the beginning of a 12 hour period after successful mass resolution and GC resolution performance checks. A calibration check is also required at the end of a 12 hour period when performing method 8290/8290A or 0023A.

10.3.2 Document the mass resolution performance as specified in sections 10.2.3 and 10.2.4. The mass resolution checks must be performed at the beginning and at the end of each 12-hour shift.

10.3.3 Analyze 2µL of the Window Defining Mixture and/or Column Performance Solution Mixture under the same instrument conditions used to perform the initial calibration. Determine and document acceptable column performance as described in section 10.2.5 and 10.2.6.

10.3.4 Analyze 2µL of the Daily Calibration Standard Solution (CS3). Calculate the concentrations and percent difference of the standard using the formulas in sections 12.3.4 and 10.2.9.

NOTE: The combined Continuing Calibration Standard/Window Defining Mix/Column Performance Solution specified in section 7.4.2 can be used in section 10.3.2, 10.3.4, and 10.3.6.

10.3.5 Criteria for Acceptable Calibration - The criteria listed below for acceptable calibration must be met at the beginning of each 12 hour period that samples are analyzed. If acceptable beginning continuing calibration criteria is not met, identify the root cause, perform corrective action and repeat the continuing calibration. If the second consecutive beginning continuing calibration does not meet acceptance criteria, additional corrective action must be performed. Acceptable performance must be demonstrated after two consecutive failing beginning continuing calibrations by the analysis of two consecutive acceptable beginning continuing calibrations or by analysis of a new initial calibration.

10.3.5.1 The measured concentration or percent difference for each compound must be within the acceptance criteria limits in Table 7 for methods 1613B, 8290/8290A or in Table 8 for methods 23, 0023A and TO-9A.

10.3.5.2 For method 1613B the relative retention times of PCDDs/PCDFs and labeled compounds in the standard must be within the limits in Table 3.

10.3.5.3 The peaks representing the PCDDs/PCDFs and labeled compounds in the calibration standard must have signal-to-noise ratios (S/N) ≥ 10.

10.3.5.4 The ion abundance ratios must be within the specified control limits in Table 22.

10.3.5.5 Corrective action can include all of the items specified in section 10.2.8.5.

10.3.5.6 When performing method 8290/8290A or 0023A, if the continuing calibration fails at the beginning of a 12-hour shift, the instructions in section 10.3.5 must be followed. If the continuing calibration check performed at the end of a 12 hour period fails by no more than ±25 %D for unlabeled native analytes and ±35 %D for labeled standards, the closing standard must not be used as a beginning calibration standard for the next 12-hour shift and the requirements in section 10.3.5 must be met before analysis can continue. Use the mean RRF from the two daily continuing calibration runs to compute the analyte concentrations instead of the RRFs obtained from the initial calibration. If the continuing calibration check performed at the end of a 12 hour period fails by more than ±25 %D for unlabeled native analytes and ±35 %RPD for labeled standards initiate corrective action and reanalyze all sample extracts analyzed during the 12 hour period encompassing the failed end of shift calibration check.

It is realized that it might not always be possible to achieve all RF criteria. For example, the RF criteria for $^{13}C_{12}$-HpCDD and $^{13}C_{12}$-OCDD were not met, however the RF values for the corresponding unlabeled compounds were within the criteria established in this procedure. The data quality for the unlabeled HpCDD and OCDD values were not compromised as a result of the calibration event. In these situations, the analyst must consult with the group manager and the project manager to assess the impact on the data quality objectives on the affected samples. Corrective action must be taken and any decision to report sample data in this situation must be made in conjunction with the client. An NCM must be initiated if the data is to be reported.

10.3.6 Daily calibration must be performed every 12 hours of instrument operation. The 12 hour shift begins with the documentation of the mass resolution followed by the injection of the Window Defining Mixture or Column Performance Solution Mixture and the Daily Calibration Standard.

10.3.6.1 For methods 1613B, 23, TO-9A- The mass resolution documentation must also be performed at the end of the 12 hour shift. If the lab is operating consecutive 12 hour shifts, the mass resolution check from the end of the previous period can be used for the beginning of the next period.

10.3.6.2 For method 8290/8290A or 0023A - The Continuing Calibration Standard check and mass resolution documentation must also be performed at the end of the 12 hour shift. If the lab is operating consecutive 12-hour shifts, the Window Defining Mixture and/or Column Performance Solution Mixture must be analyzed at the beginning of each 12-hour period. The mass resolution and continuing calibration checks from the previous period can be used for the beginning of the next period.

11. Procedure

11.1 One time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variations in sample matrix, radioactivity, chemistry, sample size or other parameters. Any variations in the procedure, except those specified by project specific instructions, must be completely documented using a Nonconformance Memo and approved by a Technical Specialist, Project Manager and QA Manager. If contractually required the client must be notified.

11.2 Any unauthorized deviations from this procedure must also be documented as a nonconformance with a cause and corrective action described.

11.3 Sample Extract Analysis

11.3.1 Analyze the sample extracts under the same instrument operating conditions used to perform the instrument calibrations. Inject 2 µL into the GC/MS and acquire data until OCDF has eluted from the column.

11.3.2 Record analysis information in the instrument logbook. The following information is required:

Date of analysis

Time of analysis
Instrument data system filename
Analyst
Lab sample identification

Additional information can be recorded in the logbook if necessary.

11.3.3 Generate ion chromatograms for the masses listed in Table 21 that encompass the expected retention windows of the PCDD and PCDF homologous series.

11.4 Refer to the TestAmerica Knoxville Quality Assurance Manual, current revision for the GC/MS instrument equipment maintenance table.

11.5 Refer to TestAmerica Knoxville SOP KNOX-IT-0001, current revision for requirements for computer hardware and software.

12. Data Analysis and Calculations

12.1 Refer to Figure 3 for an example data review checklists used to perform and document the review of the data. Using the data review checklist, the analyst also creates a narrative which includes any qualifications of the sample data.

12.2 Qualitative identification criteria for PCDDs and PCDFs. For a gas chromatographic peak to be identified as a PCDD or PCDF, it must meet all of the following criteria:

12.2.1 The ion current response for both ions used for quantitative purposes must reach maximum simultaneously (± 2 seconds).

12.2.2 The signal-to-noise ratio (S/N) for each GC peak at each exact m/z must be ≥ 2.5 for positive identification of a PCDD/PCDF compound.

12.2.3 The ratio of the integrated areas of the two exact m/z's specified in Table 21 must be within the limits specified in Table 22, or alternatively when performing method 1613B, within ±10 percent of the ratio in the midpoint (CS3) calibration or the calibration verification (VER), whichever is most recent.

12.2.4 Method 1613B only - The relative retention time of the peak for a 2,3,7,8-substituted PCDD or PCDF must be within the limits in Table 3.

12.2.5 Method 8290, 8290A and 0023A only - For 2,3,7,8-substituted isomers, which have an isotopically labeled internal standard or recovery standard present in the sample extract, the retention time of the two ions used for quantitation purposes must be within -1 to +3 seconds of the isotopically labeled standard.

12.2.6 Method 23 and TO-9A only - For 2,3,7,8-substituted isomers, which have an isotopically labeled internal standard or recovery standard present in the sample extract, the retention time of the two ions used for quantitation purposes must be within ±3 seconds of the isotopically labeled standard.

12.2.7 Method 8290, 8290A, 23, 0023A, and TO-9A only - For 2,3,7,8-substituted isomers, which do not have an isotopically labeled internal standard present in the sample extract, the retention time must fall within 0.005 retention time units of the relative retention times measured in the routine calibration.

12.2.8 The retention time of peaks representing non-2,3,7,8-substituted PCDDs/PCDFs must be within the retention time windows established in section 10.2.5.

12.2.9 No peaks detected in the polychlorinated diphenyl-ether (PCDPE) mass channel in the same retention time region (± 2 sec for method 8290, 8290A & 0023A) as a PCDF peak.

12.3 Quantitation for PCDDs and PCDFs.

12.3.1 Calculate the Internal Standard and Cleanup Standard Recoveries (Ris) relative to the Recovery Standard according to the following equation:

$$\mathrm{Ris} = \frac{\mathrm{Ais} \times \mathrm{Qrs}}{\mathrm{Ars} \times \mathrm{RRFis} \times \mathrm{Qis}} \times 100\%$$

Where:

Ais = sum of the areas of the quantitation ions of the appropriate internal standard (cleanup standard is single ion)
Ars = sum of the areas of the quantitation ions of the recovery standard
Qrs = ng of recovery standard added to extract
Qis = ng of internal standard or cleanup standard added to sample
RRFis = mean relative response factor of internal standard obtained during initial calibration

NOTE: In some situations, such as high-volume water sampling or air train samples, the extract is split for multiple analyses. In this case, Qrs must be correctly calculated to account for the splitting of extracts before the recovery standard was added.

$$\mathrm{Q}rs = \frac{Crs \times Vrs}{\mathrm{S}}$$

Where:
Qrs = ng of recovery standard added to extract
Crs = concentration of recovery standard added to the split portion of the extract
Vrs = volume of recovery standard added to the split portion of the extract
S = split ratio of the extract (decimal fraction of the extract used)

12.3.2 The split ratio represents the proportion of extract used from splits taken after the addition of internal standards and before the addition of recovery standards.

The split ratio is calculated as the product of all split ratios generated between these steps:

$$S = Spis \times Spcs \times Spfc$$

Where:

Spis = the decimal fraction of extract used from split taken once the internal standard has been added and the extraction is performed.

Spcs = the decimal fraction of extract used from split taken once the cleanup standard (if used) has been added.

Spfc = the decimal fraction of extract used from split taken once the cleanup fractionation column has been run.

12.3.3 When properly applied, isotope dilution techniques produce results that are independent of recovery. The recovery of each internal standard must be within the limits specified in Table 13 for method 1613B, 8290 or 8290A or in Table 15 for method 23, 0023A, or TO-9A. If the recovery of any internal standard is not within the specified limits, calculate the S/N ratio of the internal standard. If the S/N is ≥ 10 and the method minimum levels are met, report the data as is with qualifiers in the report and a discussion in the case narrative. If the S/N is < 10 or the minimum levels are not achieved, re-extract and re-analyze the sample. If the poor internal standard recovery is judged to be a result of sample matrix, a reduced portion of the sample can be re-extracted or additional clean-ups can be employed.

12.3.4 Calculate the concentration of the 2,3,7,8 isomers according to the following equation:

$$C_{2,3,7,8\ \text{isomers}} = \frac{\text{Ata} \times \text{Qis}}{\text{Ais} \times \text{RRF} \times \text{Ws}}$$

Where:
C = Concentration of 2,3,7,8 isomers
Ata = sum of the areas of the quantitation ions of the target analyte
Ais = sum of the areas of the quantitation ions of the appropriate internal standard
Qis = ng of internal standard added to sample
RRF = mean relative response factor from initial calibration.
Ws = amount of sample spiked and extracted (grams or liters)

12.3.5 The concentrations of non-2,3,7,8-isomers are calculated using the RRF for the corresponding 2,3,7,8-isomer. If more than one 2,3,7,8-isomer exist for a particular level of chlorination, the average of the individual 2,3,7,8-isomer RRFs is used in the calculation.

$$C_{\text{non 2,3,7,8 isomer}} = \frac{\text{Ata} \times \text{Qis}}{\text{Ais} \times \text{RRF} \times \text{Ws}}$$

Where:
Ata = sum of the areas of the quantitation ions of the non-2,3,7,8 isomer
Ais = sum of the areas of the quantitation ions of the appropriate internal standard
Qis = ng of internal standard added to sample
RRF = mean relative response factor from initial calibration for the corresponding 2,3,7,8 isomer.
Ws = amount of sample spiked and extracted (grams or liters)

12.3.6 Calculate the total concentration of all isomers within each homologous series of PCDDs and PCDFs by summing the concentrations of the individual PCDD or PCDF 2,3,7,8 and non-2,3,7,8 isomers.

$$C_{\text{Total}} = \sum C_{\text{2,3,7,8 isomers}} + \sum C_{\text{non 2,3,7,8 isomers}}$$

12.3.7 If solid samples are to be reported on a dry weight basis, the laboratory LIMS system performs the following calculation:

$$\text{Concentration (Dry Weight)} = \frac{C}{\text{\%Solids} \div 100}$$

Where:
C = Concentration of the target analyte
%Solids = The sample percent solids determined by moisture analysis

12.3.8 If no peaks are present in the region of the ion chromatogram where the compounds of interest are expected to elute, calculate the estimated detection limit (EDL) for that compound according to the following equation:

$$\text{EDL} = \frac{\text{N} \times 2.5 \times \text{Qis}}{\text{His} \times \text{RRFs} \times \text{Ws} \times \text{Ssl}}$$

Where:
N = average peak to peak noise of quantitation ion signals in the region of the ion chromatogram where the compound of interest is expected to elute
His = peak height of quantitation ions for appropriate internal standard
Qis = ng of internal standard added to sample
RRFs = mean relative response factor of compound from initial calibration
W = amount of sample spiked and extracted (grams or liters)
Ssl = decimal expression of percent solids (optional, if results are requested to be reported on dry weight basis)

NOTE: The percent solids calculation is performed by the laboratory LIMS system prior to final reporting.

12.3.9 If peaks are present in the region of the ion chromatogram which do not meet the qualitative criteria listed in section 12.2, calculate an Estimated Maximum Possible Concentration (EMPC). Two different calculation formulas can be used depending upon specific client requirements.

12.3.9.1 When performing methods 8290, 8290A for EPA regulated analyses where the currently promulgated method is required by law (e.g. Trial Burns) and for all other analyses unless the client has specified otherwise, use the equation in section 12.3.4, except that Ata represents the sum of the area under the one peak and of the other peak area calculated using the theoretical chlorine isotope ratio. The peak selected to calculate the theoretical area is the one which gives the lower of the two possible results (i.e. the EMPC is lower than the result calculated from the uncorrected areas).

12.3.9.2 When the client has specifically requested, use the equation in section 12.3.4 without correcting the areas. This method gives an EMPC which is always higher than the method above and would be considered the worst case.

12.3.10 If peaks are present in the diphenyl ether mass channel at the same retention time as a PCDF peak, the peak cannot be identified as a PCDF. Calculate the concentration of the peak using the equation in section 12.3.4 but report the concentration as an Estimated Maximum Possible Concentration.

12.3.11 If the concentration in the final extract of any 2,3,7,8-substituted PCDD/PCDF isomer (except OCDD or OCDF) exceeds the upper method calibration limits, a dilution of the extract or a re-extraction of a smaller portion of the sample must be performed. For OCDD and OCDF, report the measured concentration and indicate that the value exceeds the calibration limit by flagging the results with "E". Dilutions of up to 1/10 can be performed on the extract. If the compounds that exceed the calibration range cannot be brought within the calibration range by a 1/10 dilution, extraction of a smaller aliquot of sample can be performed or the sample can be analyzed by a more appropriate analytical technique such as HRGC/LRMS. Consultation with the client must occur before any re-extraction is performed.

12.3.12 Evaluate the ion chromatograms of the PFK or FC-43 lock mass and calibration mass for each MID group. The PFK or FC-43 mass intensity must be consistent throughout the retention time of the target compounds. Negative excursions or variations in the PFK or FC-43 mass intensity indicate the elution of interferences from the GC column that are causing suppression in the ion source of the mass spectrometer. This ion suppression can reduce the instrument sensitivity and quantitative result of any peaks that elute at the same retention time. Either additional extract cleanup or dilutions can reduce ion suppression. The quantitative results must be carefully evaluated when there is evidence of ion suppression present in the PFK or FC-43 mass traces.

12.4 The DB-5 (RTX-5) column does not provide for isomer specificity of 2,3,7,8-TCDF using the operating condition required for this method. If a peak is determined to be present at the expected retention time of 2,3,7,8-TCDF and its calculated concentration is above the MinL, the sample extract must be analyzed on the DB-225 (RTX-225) column.

12.5 The Minimum Level (MinL) is defined as the level at which the instrument gives acceptable calibration assuming a sample is extracted at the recommended weight or volume and is carried through all normal extraction and analysis procedures. Deviation from the extraction amounts or final volumes listed Table 2 changes the MinL. The MinL is calculated as shown in the following equation:

$$\mathrm{MinL} = \frac{C\,\mathrm{min} \times Vfe}{W\mathrm{s}}$$

Where:

Cmin = the concentration the analyte in the lowest calibration standard
Ws = amount of sample spiked and extracted (grams or liters)
Vfe = the final volume of the extract, corrected for all splits and dilutions

$$\mathrm{V}fe = \frac{Vdel \times DFpr}{Spr \times S}$$

Where:

Vdel = the volume of extract delivered to the analysis
DFpr = the dilution factor for dilutions performed to the final extract
Spr = the split ratio for any post-recovery standard splits
S = the split ratio for any post-internal standard and post-cleanup standard splits

12.6 The Maximum Level (MaxL) is defined as the concentration or mass of analyte in the sample that corresponds to the highest calibration level in the initial calibration. It is equivalent to the concentration of the highest calibration standard, assuming that all method-specified sample weights, volumes, and cleanup procedures have been employed. The MaxL is calculated as shown in the following equation:

$$\mathrm{M}axL = \frac{C\,\mathrm{max} \times Vfe}{W\mathrm{s}}$$

Where:

Cmax = the concentration the analyte in the highest calibration standard Vfe and Ws are defined in Section 12.5.

12.7 Flag all compound results in the sample that were detected in the method blank with a “B” qualifier.

12.8 Flag all compound results in the sample that are below the minimum level with a “J” qualifier.

12.9 Flag all compound results in the sample that are above the upper calibration limit with an “E” qualifier.

12.10 Flag all compound results in the sample that are “Estimated Maximum Possible Concentrations” with a “Q” qualifier.

12.11 Flag compound results in the sample that exhibit chromatographic evidence of co-eluting compounds with a “C” qualifier.

12.12 Flag compound results in the sample that are affected by ion suppression with a “S” qualifier.

12.13 Data Review

12.13.1 The analyst who performs the initial data calculations must initial and date the front chromatogram of the raw data package to document that they have performed the qualitative and quantitative analysis on the sample data.

12.13.2 A second analyst must verify all qualitative peak identifications. If discrepancies are found, the data must be returned to the analyst who performed the initial peak identification for resolution.

12.13.3 A second analyst must check all hand calculation and data entry into calculation programs, databases, or spreadsheets at a frequency of 100 percent. If discrepancies are found, the data must be returned to the analyst who performed the initial calculation for resolution.

12.13.4 The reviewing analyst must initial and date the front chromatogram of the raw data package to document that they have performed the second level review on the sample data.

12.13.5 All items listed on the data review check list must be checked by both the analyst who performed the initial qualitative and quantitative analysis and the analyst who performed the second level review. Using the data review checklist, the analyst also creates a narrative which includes any qualifications of the sample data. An example data review check list is shown in Figure 3.

13. Method Performance

13.1 Method Detection Limit (MDL): An MDL must be determined for each analyte in each routine matrix prior to the analysis of any samples. The procedure for determination of the method detection limit is given in the SOP CA-Q-S-006, current revision, based on 40

CFR Part 136 Appendix B. The result of the MDL determination must support the reporting limit.

13.2 Initial Demonstration of Capability: Each analyst must perform an initial demonstration of capability (IDOC) for each target analyte prior to performing the analysis independently. The IDOC is determined by analyzing four replicate spikes (e.g., LCSs) as detailed in Test America Knoxville SOP KNOX-QA-0009, current revision. Demonstration for both aqueous and solid matrices is required.

13.2.1 For aqueous samples, extract, concentrate, and analyze four 1-L aliquots of reagent water spiked with labeled internal standards and native analytes according to the procedures in section 11. For non-aqueous samples, extract, concentrate, and analyze four aliquots of sodium sulfate spiked with labeled internal standards and native analytes according to the procedures in section 11. It is recommended that a method blank be prepared with the IDOC samples. Extracts must be stored in the dark at room temperature in amber or clear glass vials prior to analysis.

13.2.2 Using the results of the set of four analyses, compute the average concentration (X) of the extracts in ng/mL and the standard deviation (S) of the concentration in ng/mL for each compound.

13.2.3 For each compound, compare S and X with the corresponding limits for initial precision and recovery in Table 9 for method 1613B and Table 10 for methods 8290, 8290A 23, 0023A, and TO-9A. If S and X for all compounds meet the acceptance criteria, system performance is acceptable and analysis of blanks and samples can begin. If, however, any individual S exceeds the precision limit or any individual X falls outside the range for accuracy, system performance is unacceptable for that compound. Correct the problem and repeat the test.

13.3 Training Qualification: The group/team leader has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required experience. Refer to SOP KNOX-QA-0009, current revision for further requirements for performing and documenting initial and on-going demonstrations of capability.

14. Pollution Prevention

14.1 All attempts will be made to minimize, as far as practical, the use of solvents and standard materials.

15. Waste Management

15.1 All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

15.2 See the current revision of SOP KNOX-HS-0002 for specific waste handling guidelines.

15.3 The following waste streams are produced when this method is carried out.

15.3.1 Waste solvents must be placed in the flammable waste stream, contained in a steel satellite accumulation container or flammable solvent container.

15.3.2 Miscellaneous disposable glassware, chemical resistant gloves, bench paper and similar materials that may or may not be contaminated/hazardous must be placed in the incinerable laboratory waste stream, contained in a HDPE satellite accumulation container.

16. References

16.1 TestAmerica Knoxville Quality Assurance Manual (QAM), current revision.

16.2 EPA Method 1613: Tetra- Through Octa- Chlorinated Dioxins and Furans by Isotope Dilutions HRGC/HRMS, Revision B, October 1994.

16.3 SW-846 Method 8290, Polychlorinated Dibenzodioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs) by High-Resolution Gas Chromatography/High-Resolution Mass Spectrometry (HRGC/HRMS), Revision 0, September 1994.

16.4 SW-846 Method 8290A, Polychlorinated Dibenzodioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs) by High-Resolution Gas Chromatography/High-Resolution Mass Spectrometry (HRGC/HRMS), Revision 1, February 2007.

16.5 SW-846 Method 0023A, Sampling Method for Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofuran Emissions from Stationary Sources, Revision 1, December 1996.

16.6 USEPA Method 23 – Determination of Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzofurans from Municipal Waste Combustors. 40 CFR Part 60 Appendix A.

16.7 Method TO-9A: Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition EPA/625/R-96/010b.

16.8 TestAmerica Knoxville SOP KNOX-ID-0012, "Method 0023A and Method 0010 Sampling Train Pre-Sampling Preparation and Sample Extraction Procedure (Includes TO-9A Sampling Components)", current revision.

16.9 TestAmerica Knoxville SOP KNOX-OP-0001, "Extraction of Polychlorinated Dioxins/Furans for Analysis by HRGC/HRMS Based on Methods 8290, 8290A and 1613B", current revision.

16.10 TestAmerica Policy, CA-T-P-002, Selection of Calibration Points, current revision.

17. Miscellaneous

17.1 Deviations from Reference Methods.

17.1.1 Spiking levels have been reduced to minimize the amount of dioxin contaminated waste generated by this procedure. It has been demonstrated that the performance criteria specified in the method are not affected by this modification.

17.1.2 The absolute retention time requirements in Method 1613 section 15.4.1.1 is not required in this procedure. The routine maintenance required of GC columns when analyzing samples from hazardous waste sites makes this requirement virtually impossible to meet in a commercial laboratory environment. This requirement provides no additional quality assurance purpose beyond those already provided by the use of labeled internal standards and required relative retention time limits.

17.1.3 This procedure provides for additional calculation and reporting of sample specific detection limits and estimated maximum possible concentrations not required by Method 1613. These reporting conventions are similar to those required by EPA SW-846 Method 8290 and expected by data users familiar with EPA Office of Solid Waste program requirements.

17.1.4 Methods 8290/8290A do not require dilution and reanalysis of samples for which OCDD exceeds the calibration range. Although this allowance is not made by method 1613B, this procedure does not require dilution for OCDD on samples analyzed by that method.

17.1.5 The calibration standards specified in method 23 are used for method 0023A and TO-9A.

17.1.6 Extracts are stored at room temperature rather than at <10 °C as specified in method 1613B. Methods 8290 and 8290A allow for the storage of extracts at room temperature in the dark. All of the reference methods require that standards be stored at room temperature. Recovery studies performed by Cambridge Isotopes Laboratories (CIL) indicate freezing or refrigeration of standards causes problems with precipitation and irreversible adsorption to the inside surface of the vial. CIL recommends the storage of standards and extracts at room temperature as long as they are protected from exposure to UV and evaporative losses.

17.1.7 This procedure allows for the use of perfluorotributylamine (FC43) for mass calibration and resolution instead of the method recommended reference compound, Perfluorokerosene (PFK). FC43 is used on the newest HRMS instrument in the laboratory based on the manufacturer’s recommendation. The use of another mass reference substance is noted in both reference methods 1613B and 8290A. FC43 provides for less noise and less ion source contamination than the method recommended PFK.

17.1.8 The percent valley column resolution criteria is ≤ 25% for this SOP. Among the reference methods both ≤ 25% and < 25% are represented.

17.2 List of tables and figures referenced in the body of the SOP.

17.2.1 Table 1 – Polychlorinated Dibenzodioxins and Furans Determined by Isotope Dilution and Internal Standard High Resolution Gas Chromatography /High Resolution Mass Spectrometry (HRGC/HRMS)

17.2.2 Table 2 – Methods – All, Minimum Levels by Matrix

17.2.3 Table 3 – Methods – 1613B and 8290/8290A, Retention Time References, Quantitation References, and Relative Retention Times

17.2.4 Table 4 – Methods – 23, 0023A, and TO-9A, Retention Time References and Quantitation References

17.2.5 Table 5 – Methods – 1613B and 8290/8290A, Initial Calibration Standard Concentrations and Acceptance Criteria

17.2.6 Table 6 – Methods – 23, 0023A, and TO-9A, Initial Calibration Standard Concentrations and Acceptance Criteria

17.2.7 Table 7 – Methods – 1613B and 8290/8290A, Daily Verification Standard (VER) Concentrations and Acceptance Criteria

17.2.8 Table 8 – Methods – 23, 0023A, and TO-9A, Daily Verification Standard (VER) Concentrations and Acceptance Criteria

17.2.9 Table 9 – Method – 1613B, Initial Demonstration of Capability (IDOC) Acceptance Criteria

17.2.10 Table 10 – Methods – 8290/8290A, 23, 0023A, and TO-9A, Initial Demonstration of Capability (IDOC) Acceptance Criteria

17.2.11 Table 11 – Laboratory Control Sample (LCS) Spiking Solution Component Concentrations and Acceptance Limits

17.2.12 Table 12 – Method – 8290/8290A. Matrix Spike and Matrix Spike Duplicate Sample (MS/MSD) Spiking Solution Component Concentrations and Acceptance Limits

17.2.13 Table 13 - Methods – 1613B and 8290/8290A, Internal Standard Spiking Solution Component Concentrations and Acceptance Limits

17.2.14 Table 14 – Method – 1613B, Cleanup Standard Spiking Solution Component Concentrations and Acceptance Limits

17.2.15 Table 15 – Methods – 23, 0023A, and TO-9A, Internal Standard Spiking Solution Component Concentrations and Acceptance Limits

17.2.16 Table 16 – Methods – 23, 0023A, and TO-9A, Surrogate Standard Spiking Solution Component Concentrations and Acceptance Limits

17.2.17 Table 17 – Methods – All, Recovery Standard Spiking Solution Component Concentrations

17.2.18 Table 18 – Rtx-5/DB-5 Column Window Defining Standard Mixture Components. – Rtx-5 (DB-5) Column Performance Standard Mixture Components

17.2.19 Table 19 – Rtx-5/DB-5 Column Performance Standard Mixture Components

17.2.20 Table 20 – Rtx-225/DB-225 Column Performance Standard Mixture Components

17.2.21 Table 21 – DB-225 (Rtx-225) Column Performance Standard Mixture Components

17.2.22 Table 21 – Ions Monitored for HRGC/HRMS Analysis of PCDDs and PCDFs

17.2.23 Table 22 – Theoretical Ion Abundance Ratios and Their Control Limits for PCDDs and PCDFs

17.2.24 Figure 1 – Recommended GC Operating Conditions

17.2.25 Figure 2 – Recommended MID Descriptors

17.2.26 Figure 3 – Example Data Review Checklist

17.2.27 Figure 4 – Analysis of PCDDs and PCDFs by HRGC/HRMS Flowchart

Table 1

Polychlorinated Dibenzo-p-dioxins/Dibenzofurans Determined by Isotope Dilution and Internal Standard High Resolution Gas Chromatography/High Resolution Mass Spectrometry (HRGC/HRMS)

PCDDs/PCDFs [1] Isomer/Congener	CAS Registry	Labeled Analog	CAS Registry
2,3,7,8-TCDD	1746-01-6	$^{13}C_{12}$-2,3,7,8-TCDD $^{37}Cl_4$-2,3,7,8-TCDD	76523-40-5 85508-50-5
Total TCDD	41903-57-5		
2,3,7,8-TCDF	51207-31-9	$^{13}C_{12}$-2,3,7,8-TCDF	89059-46-1
Total TCDF	55722-27-5		
1,2,3,7,8-PeCDD	40321-76-4	$^{13}C_{12}$-1,2,3,7,8-PeCDD	109719-79-1
Total PeCDD	36088-22-9		
1,2,3,7,8-PeCDF	57117-41-6	$^{13}C_{12}$-1,2,3,7,8-PeCDF	109719-77-9
2,3,4,7,8-PeCDF	57117-31-4	$^{13}C_{12}$-2,3,4,7,8-PeCDF	116843-02-8
Total PeCDF	30402-15-4		
1,2,3,4,7,8-HxCDD	39227-28-6	$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	109719-80-4
1,2,3,6,7,8-HxCDD	57653-85-7	$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	109719-81-5
1,2,3,7,8,9-HxCDD	19408-74-3	$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	109719-82-6
Total HxCDD	34465-46-8		
1,2,3,4,7,8-HxCDF	70648-26-9	$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	114423-98-2
1,2,3,6,7,8-HxCDF	57117-44-9	$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	116843-03-9
2,3,4,6,7,8-HxCDF	60851-34-5	$^{13}C_{12}$-2,3,4,6,7,8-HxCDF	116843-05-1
1,2,3,7,8,9-HxCDF	72918-21-9	$^{13}C_{12}$-1,2,3,7,8,9-HxCDF	116843-04-0
Total HxCDF	55684-94-1		
1,2,3,4,6,7,8-HpCDD	35822-46-9	$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	109719-83-7
Total HpCDD	37871-00-4		
1,2,3,4,6,7,8-HpCDF	67562-39-4	$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	109719-84-8
1,2,3,4,7,8,9-HpCDF	55673-89-7	$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	109719-94-0
Total HpCDF	38998-75-3		
OCDD	3268-87-9	$^{13}C_{12}$-OCDD	114423-97-1
OCDF	39001-02-0	none	

Notes:

1. Polychlorinated dioxins and furans

TCDD = Tetrachlorodibenzo-p-dioxin
PeCDD = Pentachlorodibenzo-p-dioxin
HxCDD = Hexachlorodibenzo-p-dioxin
HpCDD = Heptachlorodibenzo-p-dioxin
OCDD = Octachlorodibenzo-p-dioxin
TCDF = Tetrachlorodibenzofuran
PeCDF = Pentachlorodibenzofuran
HxCDF = Hexachlorodibenzofuran
HpCDF = Heptachlorodibenzofuran
OCDF = Octachlorodibenzofuran

Table 2

Methods – All
Minimum Levels by Matrix

Analyte	Extract (ng/mL)[1]	Water (pg/L)[2]	Solids (pg/g)[3]	Biological Tissue (pg/g)[3]	Waste (pg/g)[4]	Air/Wipe (pg)[5]
2,3,7,8-TCDD	0.5	10	1	1	10	10
2,3,7,8-TCDF	0.5	10	1	1	10	10
1,2,3,7,8-PeCDD	2.5	50	5	5	50	50
1,2,3,7,8-PeCDF	2.5	50	5	5	50	50
2,3,4,7,8-PeCDF	2.5	50	5	5	50	50
1,2,3,4,7,8-HxCDD	2.5	50	5	5	50	50
1,2,3,6,7,8-HxCDD	2.5	50	5	5	50	50
1,2,3,7,8,9-HxCDD	2.5	50	5	5	50	50
1,2,3,4,7,8-HxCDF	2.5	50	5	5	50	50
1,2,3,6,7,8-HxCDF	2.5	50	5	5	50	50
2,3,4,6,7,8-HxCDF	2.5	50	5	5	50	50
1,2,3,7,8,9-HxCDF	2.5	50	5	5	50	50
1,2,3,4,6,7,8-HpCDD	2.5	50	5	5	50	50
1,2,3,4,6,7,8-HpCDF	2.5	50	5	5	50	50
1,2,3,4,7,8,9-HpCDF	2.5	50	5	5	50	50
OCDD	5.0	100	10	10	100	100
OCDF	5.0	100	10	10	100	100

Notes:

1 Concentration in the extract assuming a 20 µL volume.
2 Based on a sample volume of 1.0 L.
3 Based on a sample weight of 10.0 g.
4 Based on a sample weight of 1.0 g.
5 Based on extraction of the entire sample.

Table 3

Methods – 1613B and 8290/8290A
Retention Time References, Quantitation References and Relative Retention Times

Analyte	Retention Time and Quantitation Reference	Relative Retention Time
Compounds using $^{13}C_{12}$-1,2,3,4-TCDD as the recovery standard		
2,3,7,8-TCDD	$^{13}C_{12}$-2,3,7,8-TCDD	0.999-1.002
2,3,7,8-TCDF	$^{13}C_{12}$-2,3,7,8-TCDF	0.999-1.003
1,2,3,7,8-PeCDD	$^{13}C_{12}$-1,2,3,7,8-PeCDD	0.999-1.002
1,2,3,7,8-PeCDF	$^{13}C_{12}$-1,2,3,7,8-PeCDF	0.999-1.002
2,3,4,7,8-PeCDF	$^{13}C_{12}$-2,3,4,7,8-PeCDF	0.999-1.002
$^{13}C_{12}$-2,3,7,8-TCDD	$^{13}C_{12}$-1,2,3,4-TCDD	0.976-1.043
$^{37}Cl_4$-2,3,7,8-TCDD	$^{13}C_{12}$-1,2,3,4-TCDD	0.989-1.052
$^{13}C_{12}$-2,3,7,8-TCDF	$^{13}C_{12}$-1,2,3,4-TCDD	0.923-1.103
$^{13}C_{12}$-1,2,3,7,8-PeCDD	$^{13}C_{12}$-1,2,3,4-TCDD	1.000-1.567
$^{13}C_{12}$-1,2,3,7,8-PeCDF	$^{13}C_{12}$-1,2,3,4-TCDD	1.000-1.425
$^{13}C_{12}$-2,3,4,7,8-PeCDF	$^{13}C_{12}$-1,2,3,4-TCDD	1.011-1.526
Compounds using $^{13}C_{12}$-1,2,3,7,8,9-HxCDD as the recovery standard		
1,2,3,4,7,8-HxCDD	$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	0.999-1.001
1,2,3,6,7,8-HxCDD	$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	0.998-1.004
1,2,3,7,8,9-HxCDD	--[1]	1.000-1.019
1,2,3,4,7,8-HxCDF	$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	0.999-1.001
1,2,3,6,7,8-HxCDF	$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	0.997-1.005
2,3,4,6,7,8-HxCDF	$^{13}C_{12}$-2,3,4,6,7,8-HxCDF	0.999-1.001
1,2,3,7,8,9-HxCDF	$^{13}C_{12}$-1,2,3,7,8,9-HxCDF	0.999-1.001
1,2,3,4,6,7,8-HpCDD	$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	0.999-1.001
1,2,3,4,6,7,8-HpCDF	$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	0.999-1.001
1,2,3,4,7,8,9-HpCDF	$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	0.999-1.001
OCDD	$^{13}C_{12}$-OCDD	0.999-1.001
OCDF	$^{13}C_{12}$-OCDD	0.999-1.008
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	0.977-1.000
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	0.981-1.003
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	0.944-0.970
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	0.949-0.975
$^{13}C_{12}$-2,3,4,6,7,8-HxCDF	$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	0.959-1.021
$^{13}C_{12}$-1,2,3,7,8,9-HxCDF	$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	0.977-1.047
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	1.086-1.110
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	1.043-1.085
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	1.057-1.151
$^{13}C_{12}$-OCDD	$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	1.032-1.311

Notes:

1 The retention time reference for 1,2,3,7,8,9-HxCDD is $^{13}C_{12}$-1,2,3,6,7,8-HxCDD. 1,2,3,7,8,9-HxCDD is quantified using the averaged responses for $^{13}C_{12}$-1,2,3,4,7,8-HxCDD and $^{13}C_{12}$-1,2,3,6,7,8-HxCDD.

Table 4

Methods – 23, 0023A and TO-9A
Retention Time References and Quantitation References

Analyte	**Retention Time and Quantitation Reference**
Compounds using $^{13}C_{12}$-1,2,3,4-TCDD as the recovery standard	
2,3,7,8-TCDD	$^{13}C_{12}$-2,3,7,8-TCDD
2,3,7,8-TCDF	$^{13}C_{12}$-2,3,7,8-TCDF
1,2,3,7,8-PeCDD	$^{13}C_{12}$-1,2,3,7,8-PeCDD
1,2,3,7,8-PeCDF	$^{13}C_{12}$-1,2,3,7,8-PeCDF
2,3,4,7,8-PeCDF	$^{13}C_{12}$-1,2,3,7,8-PeCDF
$^{13}C_{12}$-2,3,7,8-TCDD	$^{13}C_{12}$-1,2,3,4-TCDD
$^{37}Cl_{4}$-2,3,7,8-TCDD	$^{13}C_{12}$-2,3,7,8-TCDD
$^{13}C_{12}$-2,3,7,8-TCDF	$^{13}C_{12}$-1,2,3,4-TCDD
$^{13}C_{12}$-1,2,3,7,8-PeCDD	$^{13}C_{12}$-1,2,3,4-TCDD
$^{13}C_{12}$-1,2,3,7,8-PeCDF	$^{13}C_{12}$-1,2,3,4-TCDD
$^{13}C_{12}$-2,3,4,7,8-PeCDF	$^{13}C_{12}$-1,2,3,7,8-PeCDF
Compounds using $^{13}C_{12}$-1,2,3,7,8,9-HxCDD as the recovery standard	
1,2,3,4,7,8-HxCDD	$^{13}C_{12}$-1,2,3,6,7,8-HxCDD
1,2,3,6,7,8-HxCDD	$^{13}C_{12}$-1,2,3,6,7,8-HxCDD
1,2,3,7,8,9-HxCDD	$^{13}C_{12}$-1,2,3,6,7,8-HxCDD
1,2,3,4,7,8-HxCDF	$^{13}C_{12}$-1,2,3,6,7,8-HxCDF
1,2,3,6,7,8-HxCDF	$^{13}C_{12}$-1,2,3,6,7,8-HxCDF
2,3,4,6,7,8-HxCDF	$^{13}C_{12}$-1,2,3,6,7,8-HxCDF
1,2,3,7,8,9-HxCDF	$^{13}C_{12}$-1,2,3,6,7,8-HxCDF
1,2,3,4,6,7,8-HpCDD	$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD
1,2,3,4,6,7,8-HpCDF	$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF
1,2,3,4,7,8,9-HpCDF	$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF
OCDD	$^{13}C_{12}$-OCDD
OCDF	$^{13}C_{12}$-OCDD
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	$^{13}C_{12}$-1,2,3,6,7,8-HxCDD
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	$^{13}C_{12}$-1,2,3,7,8,9-HxCDD
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	$^{13}C_{12}$-1,2,3,6,7,8-HxCDF
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	$^{13}C_{12}$-1,2,3,7,8,9-HxCDD
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	$^{13}C_{12}$-1,2,3,7,8,9-HxCDD
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	$^{13}C_{12}$-1,2,3,7,8,9-HxCDD
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF
$^{13}C_{12}$-OCDD	$^{13}C_{12}$-1,2,3,7,8,9-HxCDD

Table 5

Methods – 1613B and 8290/8290A
Initial Calibration Standard Concentrations and Acceptance Criteria

Analyte	CS1 (ng/mL)	CS2 (ng/mL)	CS3 (ng/mL)	CS4 (ng/mL)	CS5 (ng/mL)	1613B %RSD	8290 %RSD	8290A %RSD
Native PCDD's and PCDF's								
2,3,7,8-TCDD	0.5	2.0	10	40	200	±20	±20	±20
2,3,7,8-TCDF	0.5	2.0	10	40	200	±20	±20	±20
1,2,3,7,8-PeCDD	2.5	10	50	200	1000	±20	±20	±20
1,2,3,7,8-PeCDF	2.5	10	50	200	1000	±20	±20	±20
2,3,4,7,8-PeCDF	2.5	10	50	200	1000	±20	±20	±20
1,2,3,4,7,8-HxCDD	2.5	10	50	200	1000	±20	±20	±20
1,2,3,6,7,8-HxCDD	2.5	10	50	200	1000	±20	±20	±20
1,2,3,7,8,9-HxCDD	2.5	10	50	200	1000	±35	±20	±20
1,2,3,4,7,8-HxCDF	2.5	10	50	200	1000	±20	±20	±20
1,2,3,6,7,8-HxCDF	2.5	10	50	200	1000	±20	±20	±20
2,3,4,6,7,8-HxCDF	2.5	10	50	200	1000	±20	±20	±20
1,2,3,7,8,9-HxCDF	2.5	10	50	200	1000	±20	±20	±20
1,2,3,4,6,7,8-HpCDD	2.5	10	50	200	1000	±20	±20	±20
1,2,3,4,6,7,8-HpCDF	2.5	10	50	200	1000	±20	±20	±20
1,2,3,4,7,8,9-HpCDF	2.5	10	50	200	1000	±20	±20	±20
OCDD	5.0	20	100	400	2000	±20	±20	±20
OCDF	5.0	20	100	400	2000	±35	±20	±20
Labeled Internal Standards								
$^{13}C_{12}$-2,3,7,8-TCDD	100	100	100	100	100	±35	±30	±20
$^{13}C_{12}$-2,3,7,8-TCDF	100	100	100	100	100	±35	±30	±20
$^{13}C_{12}$-1,2,3,7,8-PeCDD	100	100	100	100	100	±35	±30	±20
$^{13}C_{12}$-1,2,3,7,8-PeCDF	100	100	100	100	100	±35	±30	±20
$^{13}C_{12}$-2,3,4,7,8-PeCDF	100	100	100	100	100	±35	±30	±20
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	100	100	100	100	100	±35	±30	±20
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	100	100	100	100	100	±35	±30	±20
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	100	100	100	100	100	±35	±30	±20
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	100	100	100	100	100	±35	±30	±20
$^{13}C_{12}$-2,3,4,6,7,8-HxCDF	100	100	100	100	100	±35	±30	±20
$^{13}C_{12}$-1,2,3,7,8,9-HxCDF	100	100	100	100	100	±35	±30	±20
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	100	100	100	100	100	±35	±30	±20
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	100	100	100	100	100	±35	±30	±20
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	100	100	100	100	100	±35	±30	±20
$^{13}C_{12}$-OCDD	200	200	200	200	200	±35	±30	±20
Labeled Cleanup Standard								
$^{37}Cl_4$-2,3,7,8-TCDD	0.5	2.0	10	40	200	±35	-	-
Labeled Recovery Standard								
$^{13}C_{12}$-1,2,3,4-TCDD	100	100	100	100	100	-	-	-
$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	100	100	100	100	100	-	-	-

Table 6

Methods – 23, 0023A and TO-9A
Initial Calibration Standard Concentrations and Acceptance Criteria

Analyte	CS1 (ng/mL)	CS2 (ng/mL)	CS3 (ng/mL)	CS4 (ng/mL)	CS5 (ng/mL)	23 / TO-9A %RSD	0023A %RSD
Native PCDDs and PCDFs							
2,3,7,8-TCDD	0.5	1.0	5	50	100	±25	±20
2,3,7,8-TCDF	0.5	1.0	5	50	100	±25	±20
1,2,3,7,8-PeCDD	2.5	5	25	250	500	±25	±20
1,2,3,7,8-PeCDF	2.5	5	25	250	500	±25	±20
2,3,4,7,8-PeCDF	2.5	5	25	250	500	±25	±20
1,2,3,4,7,8-HxCDD	2.5	5	25	250	500	±25	±20
1,2,3,6,7,8-HxCDD	2.5	5	25	250	500	±25	±20
1,2,3,7,8,9-HxCDD	2.5	5	25	250	500	±25	±20
1,2,3,4,7,8-HxCDF	2.5	5	25	250	500	±25	±20
1,2,3,6,7,8-HxCDF	2.5	5	25	250	500	±25	±20
2,3,4,6,7,8-HxCDF	2.5	5	25	250	500	±25	±20
1,2,3,7,8,9-HxCDF	2.5	5	25	250	500	±25	±20
1,2,3,4,6,7,8-HpCDD	2.5	5	25	250	500	±25	±20
1,2,3,4,6,7,8-HpCDF	2.5	5	25	250	500	±25	±20
1,2,3,4,7,8,9-HpCDF	2.5	5	25	250	500	±25	±20
OCDD	5.0	10	50	500	1000	±25	±20
OCDF	5.0	10	50	500	1000	±30	±20
Labeled Internal Standards							
$^{13}C_{12}$-2,3,7,8-TCDD	100	100	100	100	100	±25	±30
$^{13}C_{12}$-2,3,7,8-TCDF	100	100	100	100	100	±30	±30
$^{13}C_{12}$-1,2,3,7,8-PeCDD	100	100	100	100	100	±30	±30
$^{13}C_{12}$-1,2,3,7,8-PeCDF	100	100	100	100	100	±30	±30
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	100	100	100	100	100	±25	±30
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	100	100	100	100	100	±30	±30
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	100	100	100	100	100	±30	±30
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	100	100	100	100	100	±30	±30
$^{13}C_{12}$-OCDD	200	200	200	200	200	±30	±30
Surrogate Standards							
$^{37}Cl_4$-2,3,7,8-TCDD	0.5	1.0	5	50	100	±25	±30
$^{13}C_{12}$-2,3,4,7,8-PeCDF	2.5	5	25	250	500	±25	±30
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	2.5	5	25	250	500	±25	±30
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	2.5	5	25	250	500	±25	±30
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	2.5	5	25	250	500	±25	±30
Labeled Recovery Standard							
$^{13}C_{12}$-1,2,3,4-TCDD	100	100	100	100	100	-	-
$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	100	100	100	100	100	-	-

Table 7

Methods – 1613B and 8290/8290A
Daily Verification Standard (VER) Concentrations and Acceptance Criteria

		1613B			8290/8290A	
Analyte	**VER (ng/mL)**	**All Isomers (ng/mL)**	**Tetra only (ng/mL)**		**Shift Open %D**	**Shift Close[1] %D**
Native PCDDs and PCDFs						
2,3,7,8-TCDD	10	7.8-12.9	8.2-12.3		±20	±25
2,3,7,8-TCDF	10	8.4-12.0	8.6-11.6		±20	±25
1,2,3,7,8-PeCDD	50	39-65	-		±20	±25
1,2,3,7,8-PeCDF	50	41-60	-		±20	±25
2,3,4,7,8-PeCDF	50	41-61	-		±20	±25
1,2,3,4,7,8-HxCDD	50	39-64	-		±20	±25
1,2,3,6,7,8-HxCDD	50	39-64	-		±20	±25
1,2,3,7,8,9-HxCDD	50	41-61	-		±20	±25
1,2,3,4,7,8-HxCDF	50	45-56	-		±20	±25
1,2,3,6,7,8-HxCDF	50	44-57	-		±20	±25
2,3,4,6,7,8-HxCDF	50	44-57	-		±20	±25
1,2,3,7,8,9-HxCDF	50	45-56	-		±20	±25
1,2,3,4,6,7,8-HpCDD	50	43-58	-		±20	±25
1,2,3,4,6,7,8-HpCDF	50	45-55	-		±20	±25
1,2,3,4,7,8,9-HpCDF	50	43-58	-		±20	±25
OCDD	100	79-126	-		±20	±25
OCDF	100	63-159	-		±20	±25
Labeled Internal Standards						
$^{13}C_{12}$-2,3,7,8-TCDD	100	82-121	85-117		±30	±35
$^{13}C_{12}$-2,3,7,8-TCDF	100	71-140	76-131		±30	±35
$^{13}C_{12}$-1,2,3,7,8-PeCDD	100	62-160	-		±30	±35
$^{13}C_{12}$-1,2,3,7,8-PeCDF	100	76-130	-		±30	±35
$^{13}C_{12}$-2,3,4,7,8-PeCDF	100	77-130	-		±30	±35
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	100	85-117	-		±30	±35
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	100	85-118	-		±30	±35
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	100	76-131	-		±30	±35
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	100	70-143	-		±30	±35
$^{13}C_{12}$-2,3,4,6,7,8-HxCDF	100	73-137	-		±30	±35
$^{13}C_{12}$-1,2,3,7,8,9-HxCDF	100	74-135	-		±30	±35
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	100	72-138	-		±30	±35
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	100	78-129	-		±30	±35
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	100	77-129	-		±30	±35
$^{13}C_{12}$-OCDD	200	96-415	-		±30	±35
Labeled Cleanup Standard						
$^{37}Cl_4$-2,3,7,8-TCDD	10	7.9-12.7	8.3-12.1		-	-
Labeled Recovery Standard						
$^{13}C_{12}$-1,2,3,4-TCDD	100	-	-		-	-
$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	100	-	-		-	-

Notes:

1 If the closing standard %D exceeds the opening %D criteria, the average of the Opening and Closing RF is used instead of the Initial Calibration RF to calculate sample concentrations.

Table 8

Methods – 23, 0023A and TO-9A
Daily Verification Standard (VER) Concentrations and Acceptance Criteria

			0023A	
	VER	**23 and TO-9A**	**Shift Open**	**Shift Close[1]**
Analyte	**(ng/mL)**	**%D**	**%D**	**%D**
<u>Native PCDDs and PCDFs</u>				
2,3,7,8-TCDD	5	±25	±20	±25
2,3,7,8-TCDF	5	±25	±20	±25
1,2,3,7,8-PeCDD	25	±25	±20	±25
1,2,3,7,8-PeCDF	25	±25	±20	±25
2,3,4,7,8-PeCDF	25	±25	±20	±25
1,2,3,4,7,8-HxCDD	25	±25	±20	±25
1,2,3,6,7,8-HxCDD	25	±25	±20	±25
1,2,3,7,8,9-HxCDD	25	±25	±20	±25
1,2,3,4,7,8-HxCDF	25	±25	±20	±25
1,2,3,6,7,8-HxCDF	25	±25	±20	±25
2,3,4,6,7,8-HxCDF	25	±25	±20	±25
1,2,3,7,8,9-HxCDF	25	±25	±20	±25
1,2,3,4,6,7,8-HpCDD	25	±25	±20	±25
1,2,3,4,6,7,8-HpCDF	25	±25	±20	±25
1,2,3,4,7,8,9-HpCDF	25	±25	±20	±25
OCDD	50	±25	±20	±25
OCDF	50	±30	±20	±25
<u>Labeled Internal Standards</u>				
$^{13}C_{12}$-2,3,7,8-TCDD	100	±25	±30	±35
$^{13}C_{12}$-2,3,7,8-TCDF	100	±30	±30	±35
$^{13}C_{12}$-1,2,3,7,8-PeCDD	100	±30	±30	±35
$^{13}C_{12}$-1,2,3,7,8-PeCDF	100	±30	±30	±35
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	100	±25	±30	±35
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	100	±30	±30	±35
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	100	±30	±30	±35
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	100	±30	±30	±35
$^{13}C_{12}$-OCDD	200	±30	±30	±35
<u>Surrogate Standards</u>				
$^{37}Cl_4$-2,3,7,8-TCDD	5	±25	±30	±35
$^{13}C_{12}$-2,3,4,7,8-PeCDF	25	±25	±30	±35
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	25	±25	±30	±35
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	25	±25	±30	±35
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	25	±25	±30	±35
<u>Labeled Recovery Standard</u>				
$^{13}C_{12}$-1,2,3,4-TCDD	100	-	-	
$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	100	-	-	

<u>Notes:</u>

1 If the closing standard %D exceeds the opening %D criteria, the average of the Opening and Closing RF is used instead of the Initial Calibration RF to calculate sample concentrations.

Table 9

Method – 1613B
Initial Demonstration of Capability (IDOC) Acceptance Criteria

	Test	**1613B**			**1613B Tetra Only**	
Analyte	**Conc. (ng/mL)[1]**	**s[2] (ng/mL)[1]**	**X[3] (ng/ml)[1]**		**s[2] (ng/mL)[1]**	**X[3] (ng/ml)[1]**
Native PCDDs and PCDFs						
2,3,7,8-TCDD	10	2.8	8.3-12.9		2.7	8.7-12.4
2,3,7,8-TCDF	10	2.0	8.7-13.7		2.0	9.1-13.1
1,2,3,7,8-PeCDD	50	7.5	38-66		-	-
1,2,3,7,8-PeCDF	50	7.5	43-62		-	-
2,3,4,7,8-PeCDF	50	8.6	36-75		-	-
1,2,3,4,7,8-HxCDD	50	9.4	39-76		-	-
1,2,3,6,7,8-HxCDD	50	7.7	42-62		-	-
1,2,3,7,8,9-HxCDD	50	11.1	37-71		-	-
1,2,3,4,7,8-HxCDF	50	8.7	41-59		-	-
1,2,3,6,7,8-HxCDF	50	6.7	46-60		-	-
2,3,4,6,7,8-HxCDF	50	7.4	37-74		-	-
1,2,3,7,8,9-HxCDF	50	6.4	42-61		-	-
1,2,3,4,6,7,8-HpCDD	50	7.7	38-65		-	-
1,2,3,4,6,7,8-HpCDF	50	6.3	45-56		-	-
1,2,3,4,7,8,9-HpCDF	50	8.1	43-63		-	-
OCDD	100	19	89-127		-	-
OCDF	100	27	74-146		-	-
Labeled Internal Standards						
$^{13}C_{12}$-2,3,7,8-TCDD	50	18.5	14-67		17.5	16-57.5
$^{13}C_{12}$-2,3,7,8-TCDF	50	17.5	15.5-56.5		17	17.5-49.5
$^{13}C_{12}$-1,2,3,7,8-PeCDD	50	19.5	13.5-92		-	-
$^{13}C_{12}$-1,2,3,7,8-PeCDF	50	17.0	13.5-78		-	-
$^{13}C_{12}$-2,3,4,7,8-PeCDF	50	19.0	8-139.5		-	-
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	50	20.5	14.5-73.5		-	-
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	50	19.0	17-61		-	-
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	50	21.5	13.5-76		-	-
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	50	17.5	15-61		-	-
$^{13}C_{12}$-2,3,4,6,7,8-HxCDF	50	18.5	14.5-68		-	-
$^{13}C_{12}$-1,2,3,7,8,9-HxCDF	50	20.0	12-78.5		-	-
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	50	17.5	17-64.5		-	-
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	50	20.5	16-55		-	-
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	50	20.0	14-70.5		-	-
$^{13}C_{12}$-OCDD	100	47.5	20.5-138		-	-
Labeled Cleanup Standard						
$^{37}Cl_4$-2,3,7,8-TCDD	10	3.6	3.9-15.4		3.4	4.5-13.4

Notes:

1 All specifications are given as concentration in the final extract, assuming a 20-µL volume.

2 s = standard deviation of the concentration

3 X = average concentration. The acceptance range for average recovery can be normalized (shifted to center on 100% recovery) to compensate for the bias in the collaborative study used to develop the acceptance criteria.

Table 10

Methods – 8290/8290A, 23, 0023A and TO-9A
Initial Demonstration of Capability (IDOC) Acceptance Criteria

Analyte	**Test Conc (ng/mL)** [1]	**s**[2] **(%Rec)**	**X**[3] **(%Rec)**
Native PCDDs and PCDFs			
2,3,7,8-TCDD	10	15[4]	70-130[4]
2,3,7,8-TCDF	10	15[4]	70-130[4]
1,2,3,7,8-PeCDD	50	15[4]	70-130[4]
1,2,3,7,8-PeCDF	50	15[4]	70-130[4]
2,3,4,7,8-PeCDF	50	15[4]	70-130[4]
1,2,3,4,7,8-HxCDD	50	15[4]	70-130[4]
1,2,3,6,7,8-HxCDD	50	15[4]	70-130[4]
1,2,3,7,8,9-HxCDD	50	15[4]	70-130[4]
1,2,3,4,7,8-HxCDF	50	15[4]	70-130[4]
1,2,3,6,7,8-HxCDF	50	15[4]	70-130[4]
2,3,4,6,7,8-HxCDF	50	15[4]	70-130[4]
1,2,3,7,8,9-HxCDF	50	15[4]	70-130[4]
1,2,3,4,6,7,8-HpCDD	50	15[4]	70-130[4]
1,2,3,4,6,7,8-HpCDF	50	15[4]	70-130[4]
1,2,3,4,7,8,9-HpCDF	50	15[4]	70-130[4]
OCDD	100	15[4]	70-130[4]
OCDF	100	15[4]	70-130[4]

Notes:

1 All specifications are given as concentration in the final extract, assuming a 20 μL volume.
2 s = standard deviation of the percent recovery
3 X = average percent recovery
4 Inhouse generated historical control limits can be used in place of the specified limit.

Table 11

Laboratory Control Sample (LCS) Spiking Solution Component Concentrations and Acceptance Limits

Analyte	**LCS Solution Conc. (ng/mL)[1]**	**Final Extract Conc (ng/mL)[2]**	**1613B LCS Conc (ng/mL)[2]**	**8290/8290A, 23, 0023A, TO-9A Recovery (%Rec)**
2,3,7,8-TCDD	0.2	10	6.7-15.8	70-130[4]
2,3,7,8-TCDF	0.2	10	7.5-15.8	70-130[4]
1,2,3,7,8-PeCDD	1.0	50	35-71	70-130[4]
1,2,3,7,8-PeCDF	1.0	50	40-67	70-130[4]
2,3,4,7,8-PeCDF	1.0	50	34-80	70-130[4]
1,2,3,4,7,8-HxCDD	1.0	50	35-82	70-130[4]
1,2,3,6,7,8-HxCDD	1.0	50	38-67	70-130[4]
1,2,3,7,8,9-HxCDD	1.0	50	32-81	70-130[4]
1,2,3,4,7,8-HxCDF	1.0	50	36-67	70-130[4]
1,2,3,6,7,8-HxCDF	1.0	50	42-65	70-130[4]
2,3,4,6,7,8-HxCDF	1.0	50	35-78	70-130[4]
1,2,3,7,8,9-HxCDF	1.0	50	39-65	70-130[4]
1,2,3,4,6,7,8-HpCDD	1.0	50	35-70	70-130[4]
1,2,3,4,6,7,8-HpCDF	1.0	50	41-61	70-130[4]
1,2,3,4,7,8,9-HpCDF	1.0	50	39-69	70-130[4]
OCDD	2.0	100	78-144	70-130[4]
OCDF	2.0	100	63-170	70-130[4]
Tetras Only				
2,3,7,8-TCDD	0.2	10	7.3-14.6	70-130[4]
2,3,7,8-TCDF	0.2	10	8.0-14.7	70-130[4]

Notes:

1 1.0 mL of this solution is added to the LCS before extraction (see section 7.11.2).

2 The final extract concentration is based on an extract volume of 20 µL.

3 Spike concentrations are based on a 1.0 L extraction for water, 10.0g extraction for solids, and entire sample extraction for air/wipe samples.

4 Inhouse generated historical control limits can be used in place of the specified limit.

Table 12

Method – 8290/8290A
Matrix Spike and Matrix Spike Duplicate Sample (MS/MSD) Spiking Solution Component Concentrations and Acceptance Limits[1]

Analyte	LCS Solution Conc. (ng/mL)[2]	Final Extract Conc (ng/mL)[3]	8290 Recovery (%Rec)	8290 Precision (RPD)
2,3,7,8-TCDD	0.2	10	70-130[4]	±15[4]
2,3,7,8-TCDF	0.2	10	70-130[4]	±15[4]
1,2,3,7,8-PeCDD	1.0	50	70-130[4]	±15[4]
1,2,3,7,8-PeCDF	1.0	50	70-130[4]	±15[4]
2,3,4,7,8-PeCDF	1.0	50	70-130[4]	±15[4]
1,2,3,4,7,8-HxCDD	1.0	50	70-130[4]	±15[4]
1,2,3,6,7,8-HxCDD	1.0	50	70-130[4]	±15[4]
1,2,3,7,8,9-HxCDD	1.0	50	70-130[4]	±15[4]
1,2,3,4,7,8-HxCDF	1.0	50	70-130[4]	±15[4]
1,2,3,6,7,8-HxCDF	1.0	50	70-130[4]	±15[4]
2,3,4,6,7,8-HxCDF	1.0	50	70-130[4]	±15[4]
1,2,3,7,8,9-HxCDF	1.0	50	70-130[4]	±15[4]
1,2,3,4,6,7,8-HpCDD	1.0	50	70-130[4]	±15[4]
1,2,3,4,6,7,8-HpCDF	1.0	50	70-130[4]	±15[4]
1,2,3,4,7,8,9-HpCDF	1.0	50	70-130[4]	±15[4]
OCDD	2.0	100	70-130[4]	±15[4]
OCDF	2.0	100	70-130[4]	±15[4]

Notes:

1 If insufficient sample exists for MS/MSD analysis, these limits apply to LCS/LCSD samples.
2 1.0 mL of this solution is added to the LCS before extraction (see section 1.1).
3 The final extract concentration is based on an extract volume of 20 µL.
4 Inhouse generated historical control limits can be used in place of the specified limit.

Table 13

Methods – 1613B and 8290/8290A
Internal Standard Spiking Solution Component Concentrations and Acceptance Limits

Labeled Analyte	**Solution Conc (ng/mL)[1]**	**Test Conc. (ng/mL)[2]**	**1613B LCS Conc (ng/mL)[2]**	**1613B Sample Conc (ng/mL)[2]**	**8290 Recovery (%Rec)**
$^{13}C_{12}$-2,3,7,8-TCDD	1.0	50	10.0-87.5	12.5-82.0	40-135
$^{13}C_{12}$-2,3,7,8-TCDF	1.0	50	11.0-76.0	12.0-84.5	40-135
$^{13}C_{12}$-1,2,3,7,8-PeCDD	1.0	50	10.5-113.5	12.5-90.5	40-135
$^{13}C_{12}$-1,2,3,7,8-PeCDF	1.0	50	10.5-96.0	12.0-92.5	40-135
$^{13}C_{12}$-2,3,4,7,8-PeCDF	1.0	50	6.5-164.0	10.5-89.0	40-135
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	1.0	50	10.5-96.5	16.0-70.5	40-135
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	1.0	50	12.5-81.5	14.0-65.0	40-135
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	1.0	50	9.5-101.0	13.0-76.0	40-135
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	1.0	50	10.5-79.5	13.0-61.5	40-135
$^{13}C_{12}$-2,3,4,6,7,8-HxCDF	1.0	50	11.0-88.0	14.0-68.0	40-135
$^{13}C_{12}$-1,2,3,7,8,9-HxCDF	1.0	50	8.5-102.5	14.5-73.5	40-135
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	1.0	50	13.0-83.0	11.5-70.0	40-135
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	1.0	50	10.5-79.0	14.0-71.5	40-135
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	1.0	50	10.0-93.0	13.0-69.0	40-135
$^{13}C_{12}$-OCDD	2.0	100	13.0-198.5	17.0-157	40-135
Tetras Only					
$^{13}C_{12}$-2,3,7,8-TCDD	1.0	50	12.5-70.5	15.5-68.5	40-135
$^{13}C_{12}$-2,3,7,8-TCDF	1.0	50	13.0-63.0	14.5-70.0	40-135

Notes:

1 1.0 mL of the Internal Standard Spiking Solution is added to each sample, method blank and LCS prior to extraction (see section 1.1).

2 Specifications given as concentration in the final extract, assuming a 20 µL volume

Table 14

Method – 1613B
Cleanup Standard Spiking Solution Component Concentrations and Acceptance Limits

Labeled Analyte	**Solution Conc (ng/mL)[1]**	**Test Conc. (ng/mL)[2]**	**1613B LCS Conc (ng/mL)[2]**	**1613B Sample Conc (ng/mL)[2]**	**1613B LCS Tetra Only Conc (ng/mL)[2]**	**1613B Sample Tetra Only Conc (ng/mL)[2]**
$^{37}Cl_4$-2,3,7,8-TCDD	0.2	10	3.1-19.1	3.5-19.7	3.7-15.8	4.2-16.4

Notes:

1 1.0 mL of the Cleanup Standard Spiking Solution is added to each sample, method blank and LCS prior to cleanup (see section 7.11.6).

2 Specifications given as concentration in the final extract, assuming a 20 µL volume

Table 15

Methods – 23, 0023A and TO-9A
Internal Standard Spiking Solution Component Concentrations and Acceptance Limits

Labeled Analyte	Solution Conc (ng/mL)[1]	Test Conc. (ng/mL)[2]	23 Recovery (%Rec)	0023A Recovery (%Rec)	TO-9A Recovery (%Rec)
$^{13}C_{12}$-2,3,7,8-TCDD	1.0	50	40-130	40-135	50-120
$^{13}C_{12}$-2,3,7,8-TCDF	1.0	50	40-130	40-135	50-120
$^{13}C_{12}$-1,2,3,7,8-PeCDD	1.0	50	40-130	40-135	50-120
$^{13}C_{12}$-1,2,3,7,8-PeCDF	1.0	50	40-130	40-135	50-120
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	1.0	50	40-130	40-135	50-120
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	1.0	50	40-130	40-135	50-120
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	1.0	50	25-130	40-135	40-120
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	1.0	50	25-130	40-135	40-120
$^{13}C_{12}$-OCDD	2.0	100	25-130	40-135	40-120

Notes:

1 1.0 mL of the Internal Standard Spiking Solution is added to each sample, method blank and LCS prior to extraction (see section 7.11.4).

2 Specifications given as concentration in the final extract, assuming a 20 µL volume

Table 16

Methods – 23, 0023A, and TO-9A
Surrogate Standard Spiking Solution Component Concentrations and Acceptance Limits

Labeled Analyte	Solution Conc (ng/mL)[1]	Test Conc. (ng/mL)[2]	23 Recovery (%Rec)	0023A Recovery (%Rec)	TO-9A Recovery (%Rec)
$^{37}Cl_4$-2,3,7,8-TCDD	20	100	70-130	70-130	50-120
$^{13}C_{12}$-2,3,4,7,8-PeCDF	20	100	70-130	70-130	50-120
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	20	100	70-130	70-130	50-120
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	20	100	70-130	70-130	50-120
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	20	100	70-130	70-130	40-120

Notes:

1 100 µL of the Surrogate Standard Spiking Solution is added to each sample train prior to sampling (see section 1.1).

2 Specifications given as concentration in the final extract, assuming a 20 µL volume

Table 17

Methods – All
Recovery Standard Spiking Solution Component Concentrations

Labeled Analyte	Solution Conc (µg/mL)[1]	Test Conc. (ng/mL)[2]
$^{13}C_{12}$-1,2,3,4-TCDD	0.1	100
$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	0.1	100

Notes:

1 20 µL of the Recovery Standard Spiking Solution is added to each sample, method blank and LCS prior to analysis (see section 1.1).

2 Specifications given as concentration in the final extract, assuming a 20 µL volume

Table 18

Rtx-5/DB-5 Column Window Defining Standard Mixture Components

Congener	First Eluted	Last Eluted
TCDF	1,3,6,8-	1,2,8,9-
TCDD	1,3,6,8-	1,2,8,9-
PeCDF	1,3,4,6,8-	1,2,3,8,9-
PeCDD	1,2,4,6,8-/1,2,4,7,9-	1,2,3,8,9-
HxCDF	1,2,3,4,6,8-	1,2,3,4,8,9-
HxCDD	1,2,4,6,7,9-/1,2,4,6,8,9-	1,2,3,4,6,7-
HpCDF	1,2,3,4,6,7,8-	1,2,3,4,7,8,9-
HpCDD	1,2,3,4,6,7,9-	1,2,3,4,6,7,8-

Table 19

Rtx-5 (DB-5) Column Performance Standard Mixture Components

Isomer
1,2,3,7/1,2,3,8-TCDD
1,2,3,9-TCDD
2,3,7,8-TCDD

Table 20

DB-225 (Rtx-225) Column Performance Standard Mixture Components

Isomer
2,3,4,7-TCDF
2,3,7,8-TCDF
1,2,3,9-TCDF

Table 21

Ions Monitored for HRGC/HRMS Analysis of PCDDs and PCDFs

Descriptor	Accurate Mass[1]	Ion ID	Elemental Composition	Analyte
1	292.9825 (313.9834)	LOCK	$C_7F_{11}\,(C_6NF_{12}^{+})$	PFK (FC43)
	303.9016	M	$C_{12}H_4{}^{35}Cl_4\,0$	TCDF
	305.8987	M+2	$C_{12}H_4{}^{35}Cl_3{}^{37}Cl\,0$	TCDF
	315.9419	M	$^{13}C_{12}H_4{}^{35}Cl_4\,0$	TCDF (S)
	317.9389	M+2	$^{13}C_{12}H_4{}^{35}Cl_3{}^{37}Cl\,0$	TCDF (S)
	319.8965	M	$C_{12}H_4{}^{35}Cl_4\,0_2$	TCDD
	321.8936	M+2	$C_{12}H_4{}^{35}Cl_3{}^{37}Cl\,0_2$	TCDD
	327.8847	M	$C_{12}H_4{}^{37}Cl_4\,0_2$	TCDD
	331.9368	M	$^{13}C_{12}H_4{}^{35}Cl_4\,0_2$	TCDD (S)
	333.9338	M+2	$^{13}C_{12}H_4{}^{35}Cl_3{}^{37}Cl\,0_2$	TCDD (S)
	342.9792 (363.9802)	QC	$C_8F_{13}\,(C_7NF_{14}^{+})$	PFK (FC43)
	375.8364	M+2	$C_{12}H_4{}^{35}Cl_5{}^{37}Cl\,0$	HxCDPE
2	330.9792 (313.9834)	LOCK	$C_7F_{13}\,(C_6NF_{12}^{+})$	PFK (FC43)
	339.8597	M+2	$C_{12}H_3{}^{35}Cl_4{}^{37}Cl\,0$	PeCDF
	341.8567	M+4	$C_{12}H_3{}^{35}Cl_3{}^{37}Cl_2\,0$	PeCDF
	351.9000	M+2	$^{13}C_{12}H_3{}^{35}Cl_4{}^{37}Cl\,0$	PeCDF (S)
	353.8970	M+4	$^{13}C_{12}H_3{}^{35}Cl_3{}^{37}Cl_2\,0$	PeCDF (S)
	355.8546	M+2	$C_{12}H_3{}^{35}Cl_4{}^{37}Cl\,0_2$	PeCDD
	357.8516	M+4	$C_{12}H_3{}^{35}Cl_3{}^{37}Cl_2\,0_2$	PeCDD
	367.8949	M+2	$^{13}C_{12}H_3{}^{35}Cl_4{}^{37}Cl\,0_2$	PeCDD (S)
	369.8919	M+4	$^{13}C_{12}H_3{}^{35}Cl_3{}^{37}Cl_2\,0_2$	PeCDD (S)
	380.9760 (375.9802)	QC	$C_8F_{15}\,(C_8NF_{14}^{+})$	PFK (FC43)
	409.7974	M+2	$C_{12}H_3{}^{35}Cl_6{}^{37}Cl\,0$	HpCDPE
3	373.8208	M+2	$C_{12}H_2{}^{35}Cl_5{}^{37}Cl\,0$	HxCDF
	375.8178	M+4	$C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2\,0$	HxCDF
	380.9760 (375.9802)	LOCK	$C_8F_{15}\,(C_8NF_{14}^{+})$	PFK (FC43)
	383.8639	M	$^{13}C_{12}H_2{}^{35}Cl_6\,0$	HxCDF (S)
	385.8610	M+2	$^{13}C_{12}H_2{}^{35}Cl_5{}^{37}Cl\,0$	HxCDF (S)
	389.8156	M+2	$C_{12}H_2{}^{35}Cl_5{}^{37}Cl\,0_2$	HxCDD
	391.8127	M+4	$C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2\,0_2$	HxCDD
	401.8559	M+2	$^{13}C_{12}H_2{}^{35}Cl_5{}^{37}Cl\,0_2$	HxCDD (S)
	403.8529	M+4	$^{13}C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2\,0_2$	HxCDD (S)
	404.9760 (413.9770)	QC	$C_{10}F_{15}\,(C_8NF_{16}^{+})$	PFK (FC43)
	445.7555	M+4	$C_{12}H_2{}^{35}Cl_6{}^{37}Cl_2\,0$	OCDPE

Table 21 (Continued)

Ions Monitored for HRGC/HRMS Analysis of PCDDs and PCDFs

Descriptor	Accurate Mass[1]	Ion ID	Elemental Composition	Analyte
4	404.9760 (413.9770)	LOCK	$C_{10}F_{15}(C_8NF_{16}^{+})$	PFK (FC43)
	407.7818	M+2	$C_{12}H\,^{35}Cl_6\,^{37}Cl\,0$	HpCDF
	409.7788	M+4	$C_{12}H\,^{35}Cl_5\,^{37}Cl_2\,0$	HpCDF
	417.8250	M	$^{13}C_{12}H\,^{35}Cl_7\,0$	HpCDF (S)
	419.8220	M+2	$^{13}C_{12}H\,^{35}Cl_6\,^{37}Cl\,0$	HpCDF (S)
	423.7767	M+2	$C_{12}H\,^{35}Cl_6\,^{37}Cl\,0_2$	HpCDD
	425.7737	M+4	$C_{12}H\,^{35}Cl_5\,^{37}Cl_2\,0_2$	HpCDD
	435.8169	M+2	$^{13}C_{12}H\,^{35}Cl_6\,^{37}Cl\,0_2$	HpCDD (S)
	437.8140	M+4	$^{13}C_{12}H\,^{35}Cl_5\,^{37}Cl_2\,0_2$	HpCDD (S)
	442.9728 (463.9738)	QC	$C_{10}F_{17}(C_9NF_{18}^{+})$	PFK (FC43)
	479.7165	M+4	$C_{12}H\,^{35}Cl_7\,^{37}Cl_2\,0$	NCDPE
5	430.9728 (425.9770)	LOCK	$C_9F_{17}(C_9NF_{16}^{+})$	PFK (FC43)
	441.7428	M+2	$C_{12}\,^{35}Cl_7\,^{37}Cl\,0$	OCDF
	443.7399	M+4	$C_{12}\,^{35}Cl_6\,^{37}Cl_2\,0$	OCDF
	457.7377	M+2	$C_{12}\,^{35}Cl_7\,^{37}Cl\,0_2$	OCDD
	459.7348	M+4	$C_{12}\,^{35}Cl_6\,^{37}Cl_2\,0_2$	OCDD
	469.7780	M+2	$^{13}C_{12}\,^{35}Cl_7\,^{37}Cl\,0_2$	OCDD (S)
	471.7750	M+4	$^{13}C_{12}\,^{35}Cl_6\,^{37}Cl_2\,0_2$	OCDD (S)
	480.9696 (501.9706)	QC	$C_{10}F_{19}(C_9NF_{20}^{+})$	PFK (FC43)
	513.6775	M+4	$C_{12}\,^{35}Cl_8\,^{37}Cl_2\,0$	DCDPE

Notes:

1 Nuclidic masses used:

H = 1.007825	C = 12.00000	^{13}C = 13.003355	F = 18.9984
O = 15.994915	^{35}Cl = 34.968853	^{37}Cl = 36.965903	

Table 22

Theoretical Ion Abundance Ratios and Their Control Limits for PCDDs and PCDFs

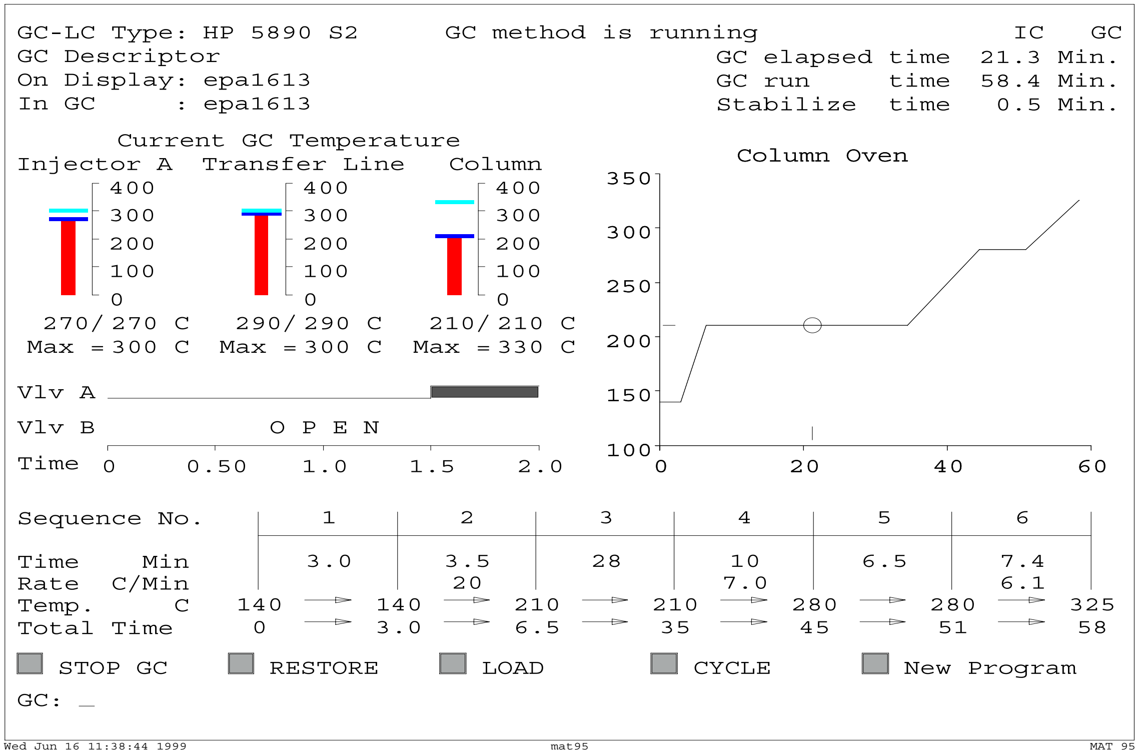
Number of Chlorine Atoms	Ion Type	Theoretical Ratio	Control Limits	
			Lower	Upper
4	M/M+2	0.77	0.65	0.89
5	M+2/M+4	1.55	1.32	1.78
6	M+2/M+4	1.24	1.05	1.43
6 [1]	M/M+2	0.51	0.43	0.59
7	M+2/M+4	1.04/1.05[3]	0.88	1.20
7 [2]	M/M+2	0.44	0.37	0.51
8	M+2/M+4	0.89	0.76	1.02

Notes:

1 Used for ^{13}C-HxCDF (IS).
2 Used for ^{13}C-HpCDF (IS).
3 Method 1613B Theoretical Ratio

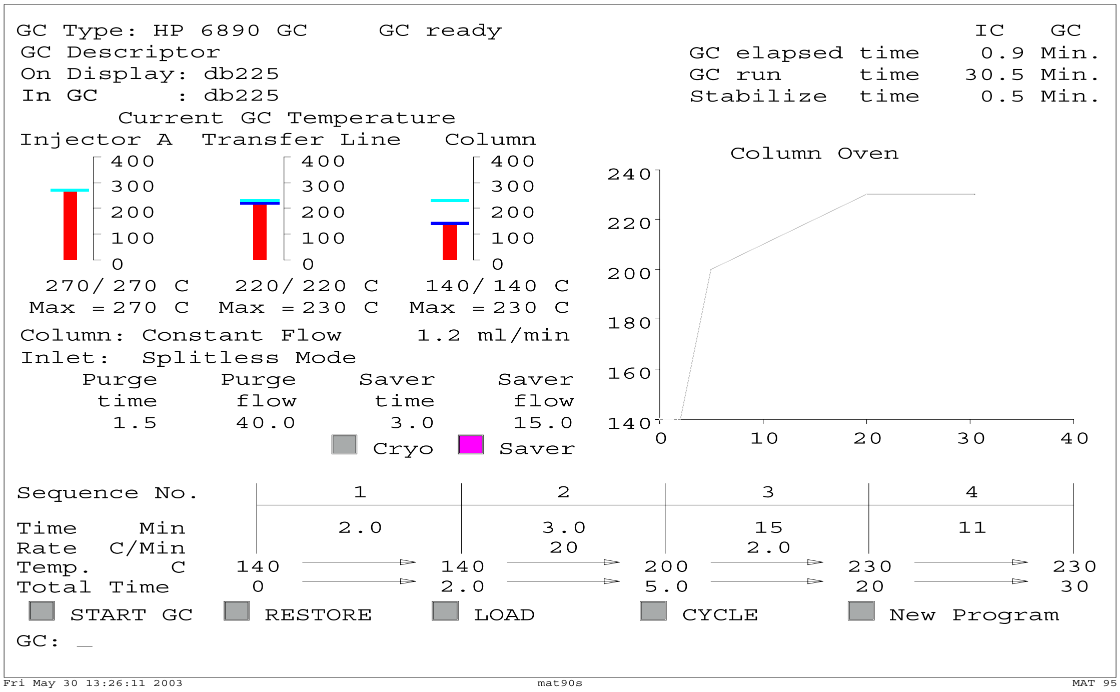
Figure 1

Rtx-5 Recommended GC Operating Conditions



```
GC-LC Type: HP 5890 S2      GC method is running                  IC    GC
GC Descriptor                              GC elapsed time  21.3 Min.
On Display: epa1613                        GC run     time  58.4 Min.
In GC      : epa1613                       Stabilize  time   0.5 Min.

         Current GC Temperature
Injector A   Transfer Line    Column
  270/ 270 C    290/ 290 C    210/ 210 C
 Max  = 300 C  Max  = 300 C  Max  = 330 C

Vlv A
Vlv B                 O P E N
Time  0     0.50     1.0     1.5     2.0

Sequence No.      1       2       3       4       5       6

Time     Min         3.0     3.5     28      10     6.5     7.4
Rate   C/Min                 20             7.0             6.1
Temp.      C   140  -->  140  -->  210 --> 210 --> 280 --> 280 --> 325
Total  Time     0   -->  3.0  -->  6.5 -->  35 -->  45 -->  51 -->  58

☐ STOP GC    ☐ RESTORE    ☐ LOAD    ☐ CYCLE    ☐ New Program
GC: _
Wed Jun 16 11:38:44 1999                mat95                       MAT 95
```

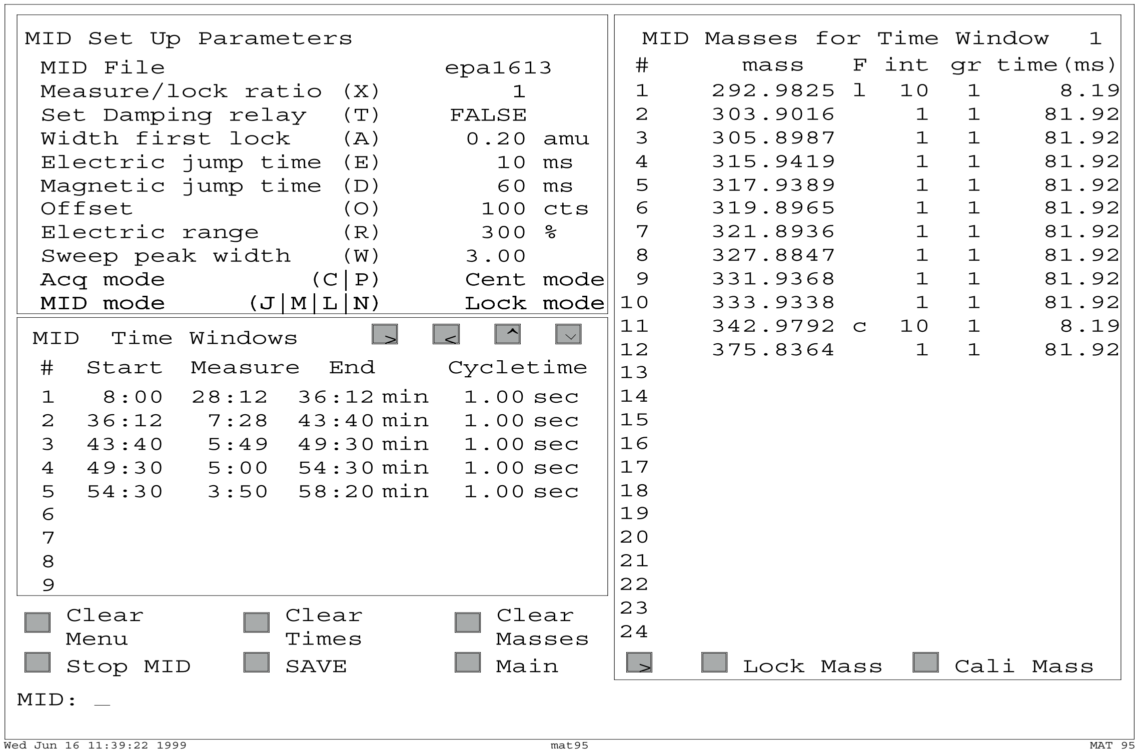
DB-225 Recommended GC Operating Conditions



```
GC Type: HP 6890 GC      GC ready                               IC    GC
GC Descriptor                              GC elapsed time    0.9 Min.
On Display: db225                          GC run     time   30.5 Min.
In GC      : db225                         Stabilize  time    0.5 Min.
         Current GC Temperature
Injector A    Transfer Line    Column
  270/ 270 C    220/ 220 C    140/ 140 C
 Max  = 270 C  Max  = 230 C  Max  = 230 C
Column: Constant Flow            1.2 ml/min
Inlet:  Splitless Mode
     Purge      Purge      Saver      Saver
      time       flow       time       flow
       1.5       40.0        3.0       15.0
                        ☐ Cryo     ■ Saver

Sequence No.        1            2            3            4

Time     Min       2.0          3.0          15           11
Rate   C/Min                    20          2.0
Temp.      C  140  -->   140   -->   200  -->  230  -->   230
Total  Time    0   -->   2.0   -->   5.0  -->   20  -->    30
 ☐ START GC   ☐ RESTORE   ☐ LOAD   ☐ CYCLE   ☐ New Program
GC: _
Fri May 30 13:26:11 2003               mat90s                      MAT 95
```

Figure 2

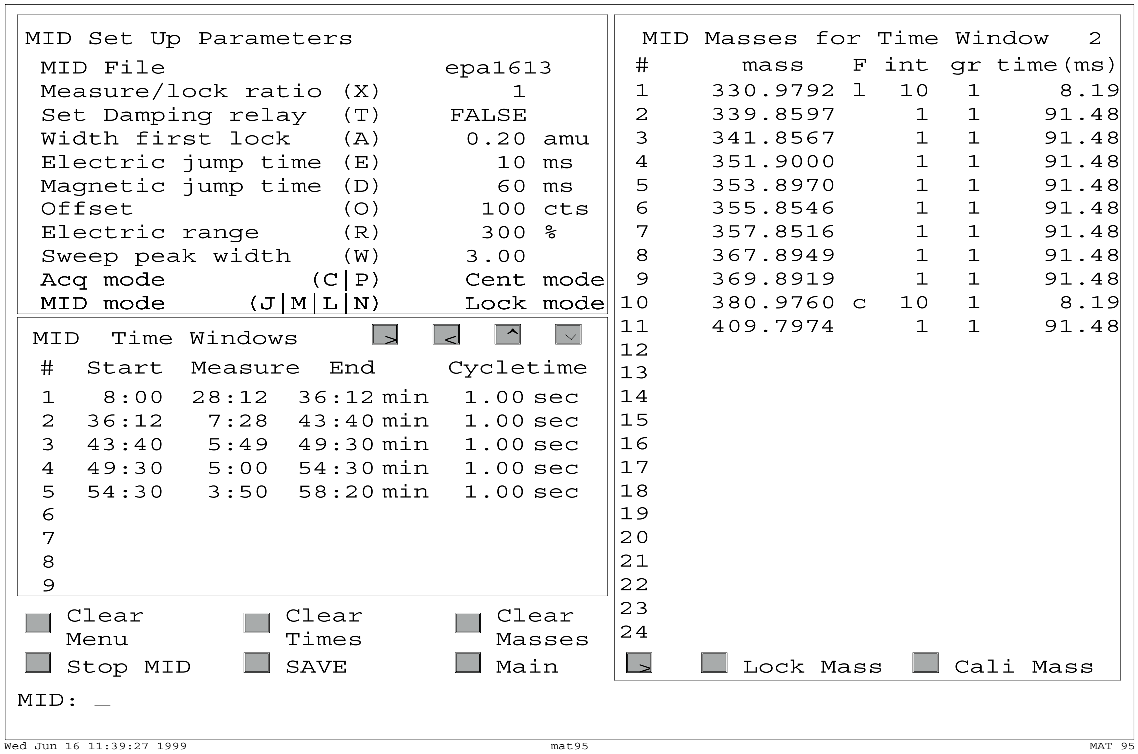
Rtx-5 Recommended MID Descriptors



```
MID Set Up Parameters
 MID File                          epa1613
 Measure/lock ratio (X)               1
 Set Damping relay  (T)           FALSE
 Width first lock   (A)            0.20 amu
 Electric jump time (E)              10 ms
 Magnetic jump time (D)              60 ms
 Offset             (O)             100 cts
 Electric range     (R)             300 %
 Sweep peak width   (W)            3.00
 Acq mode         (C|P)            Cent mode
 MID mode     (J|M|L|N)            Lock mode

 MID  Time Windows
 #  Start  Measure  End       Cycletime
 1   8:00  28:12  36:12 min   1.00 sec
 2  36:12   7:28  43:40 min   1.00 sec
 3  43:40   5:49  49:30 min   1.00 sec
 4  49:30   5:00  54:30 min   1.00 sec
 5  54:30   3:50  58:20 min   1.00 sec
 6
 7
 8
 9

MID: _
```

```
 MID Masses for Time Window   1
 #      mass    F int  gr time(ms)
 1    292.9825  l  10   1     8.19
 2    303.9016      1   1    81.92
 3    305.8987      1   1    81.92
 4    315.9419      1   1    81.92
 5    317.9389      1   1    81.92
 6    319.8965      1   1    81.92
 7    321.8936      1   1    81.92
 8    327.8847      1   1    81.92
 9    331.9368      1   1    81.92
10    333.9338      1   1    81.92
11    342.9792  c  10   1     8.19
12    375.8364      1   1    81.92
13
14
15
16
17
18
19
20
21
22
23
24
```

```
Wed Jun 16 11:39:22 1999            mat95            MAT 95
```



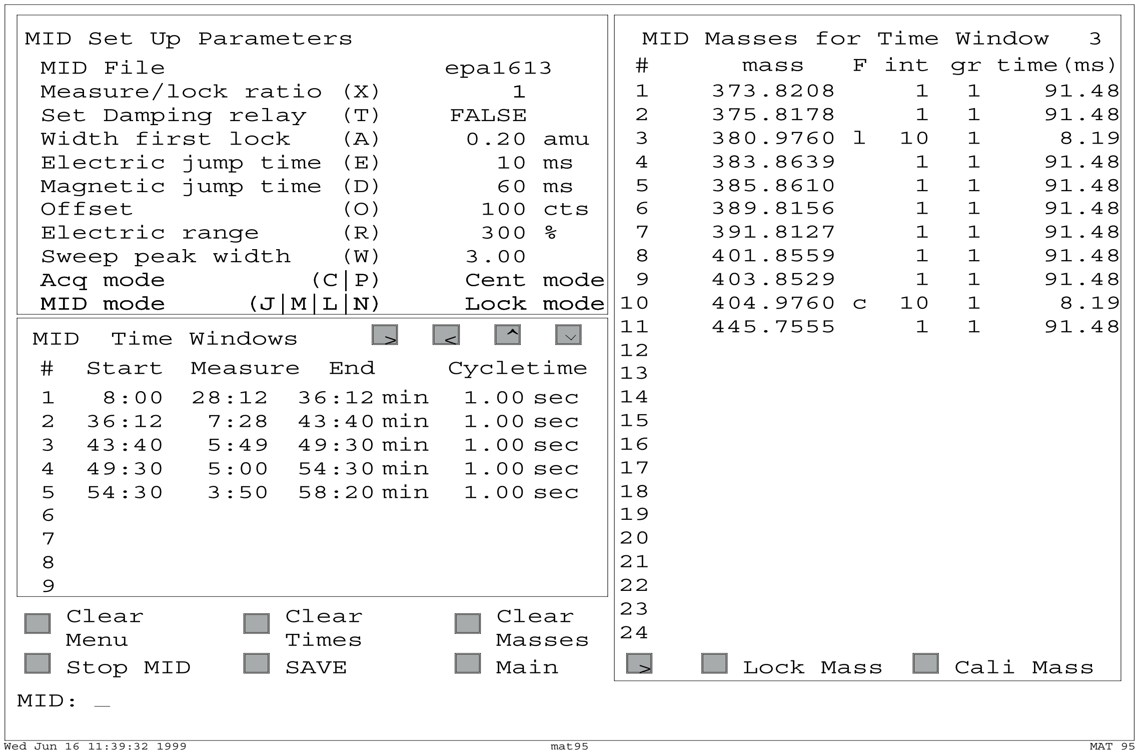
```
MID Set Up Parameters
 MID File                          epa1613
 Measure/lock ratio (X)               1
 Set Damping relay  (T)           FALSE
 Width first lock   (A)            0.20 amu
 Electric jump time (E)              10 ms
 Magnetic jump time (D)              60 ms
 Offset             (O)             100 cts
 Electric range     (R)             300 %
 Sweep peak width   (W)            3.00
 Acq mode         (C|P)            Cent mode
 MID mode     (J|M|L|N)            Lock mode

 MID  Time Windows
 #  Start  Measure  End       Cycletime
 1   8:00  28:12  36:12 min   1.00 sec
 2  36:12   7:28  43:40 min   1.00 sec
 3  43:40   5:49  49:30 min   1.00 sec
 4  49:30   5:00  54:30 min   1.00 sec
 5  54:30   3:50  58:20 min   1.00 sec
 6
 7
 8
 9

MID: _
```

```
 MID Masses for Time Window   2
 #      mass    F int  gr time(ms)
 1    330.9792  l  10   1     8.19
 2    339.8597      1   1    91.48
 3    341.8567      1   1    91.48
 4    351.9000      1   1    91.48
 5    353.8970      1   1    91.48
 6    355.8546      1   1    91.48
 7    357.8516      1   1    91.48
 8    367.8949      1   1    91.48
 9    369.8919      1   1    91.48
10    380.9760  c  10   1     8.19
11    409.7974      1   1    91.48
12
13
14
15
16
17
18
19
20
21
22
23
24
```

```
Wed Jun 16 11:39:27 1999            mat95            MAT 95
```

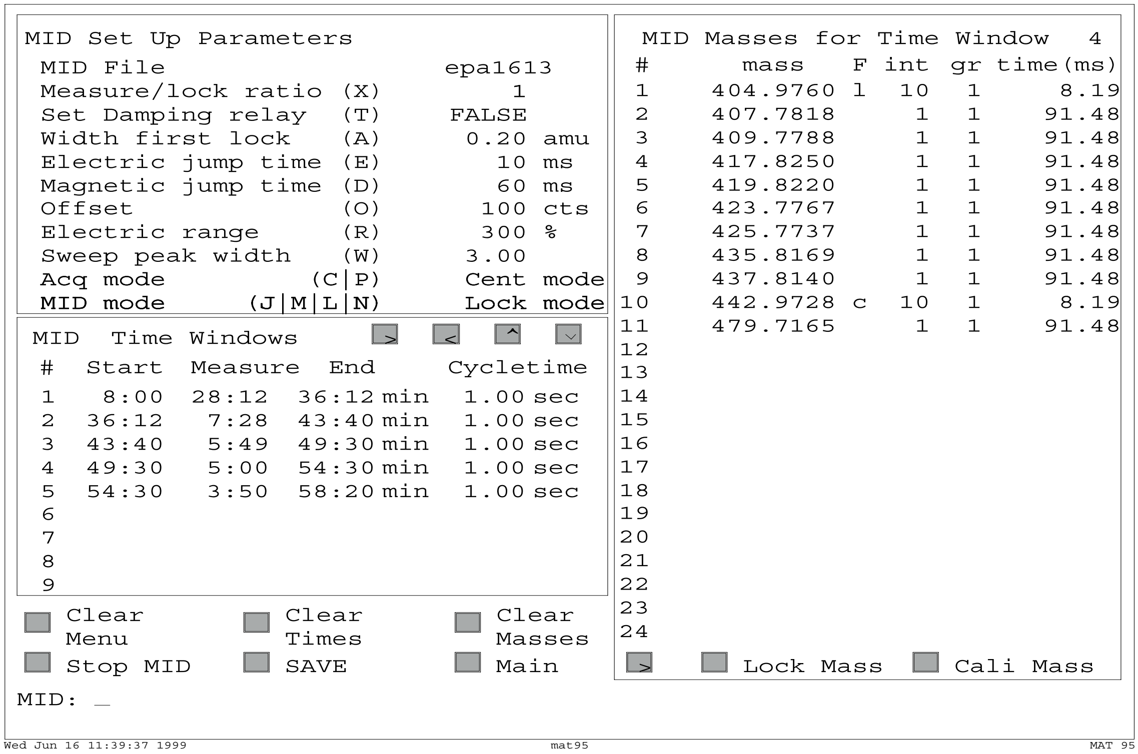
Figure 2 (Continued)

Rtx-5 Recommended MID Descriptors



```
MID Set Up Parameters
 MID File                        epa1613
 Measure/lock ratio (X)             1
 Set Damping relay  (T)          FALSE
 Width first lock   (A)           0.20 amu
 Electric jump time (E)             10 ms
 Magnetic jump time (D)             60 ms
 Offset             (O)            100 cts
 Electric range     (R)            300 %
 Sweep peak width   (W)           3.00
 Acq mode         (C|P)           Cent mode
 MID mode     (J|M|L|N)           Lock mode

 MID  Time Windows
 #  Start  Measure  End      Cycletime
 1   8:00  28:12   36:12 min  1.00 sec
 2  36:12   7:28   43:40 min  1.00 sec
 3  43:40   5:49   49:30 min  1.00 sec
 4  49:30   5:00   54:30 min  1.00 sec
 5  54:30   3:50   58:20 min  1.00 sec
 6
 7
 8
 9

MID: _
```

```
 MID Masses for Time Window  3
 #      mass    F  int  gr time(ms)
 1    373.8208      1   1    91.48
 2    375.8178      1   1    91.48
 3    380.9760  l  10   1     8.19
 4    383.8639      1   1    91.48
 5    385.8610      1   1    91.48
 6    389.8156      1   1    91.48
 7    391.8127      1   1    91.48
 8    401.8559      1   1    91.48
 9    403.8529      1   1    91.48
10    404.9760  c  10   1     8.19
11    445.7555      1   1    91.48
12
13
14
15
16
17
18
19
20
21
22
23
24
```

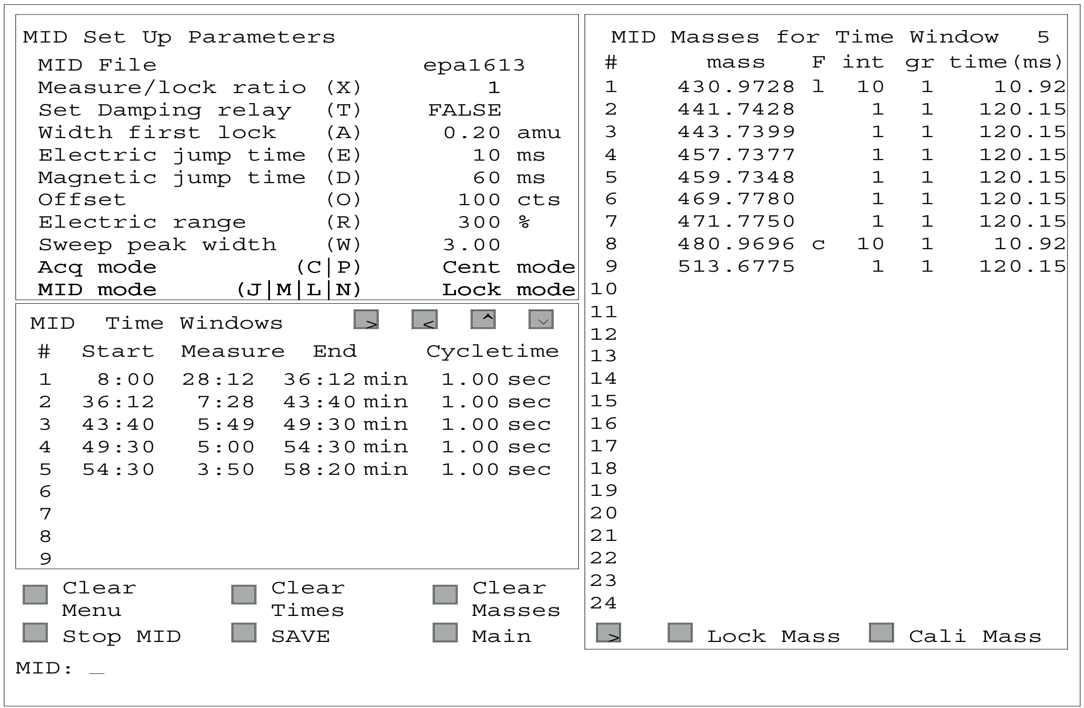


```
MID Set Up Parameters
 MID File                        epa1613
 Measure/lock ratio (X)             1
 Set Damping relay  (T)          FALSE
 Width first lock   (A)           0.20 amu
 Electric jump time (E)             10 ms
 Magnetic jump time (D)             60 ms
 Offset             (O)            100 cts
 Electric range     (R)            300 %
 Sweep peak width   (W)           3.00
 Acq mode         (C|P)           Cent mode
 MID mode     (J|M|L|N)           Lock mode

 MID  Time Windows
 #  Start  Measure  End      Cycletime
 1   8:00  28:12   36:12 min  1.00 sec
 2  36:12   7:28   43:40 min  1.00 sec
 3  43:40   5:49   49:30 min  1.00 sec
 4  49:30   5:00   54:30 min  1.00 sec
 5  54:30   3:50   58:20 min  1.00 sec
 6
 7
 8
 9

MID: _
```

```
 MID Masses for Time Window  4
 #      mass    F  int  gr time(ms)
 1    404.9760  l  10   1     8.19
 2    407.7818      1   1    91.48
 3    409.7788      1   1    91.48
 4    417.8250      1   1    91.48
 5    419.8220      1   1    91.48
 6    423.7767      1   1    91.48
 7    425.7737      1   1    91.48
 8    435.8169      1   1    91.48
 9    437.8140      1   1    91.48
10    442.9728  c  10   1     8.19
11    479.7165      1   1    91.48
12
13
14
15
16
17
18
19
20
21
22
23
24
```

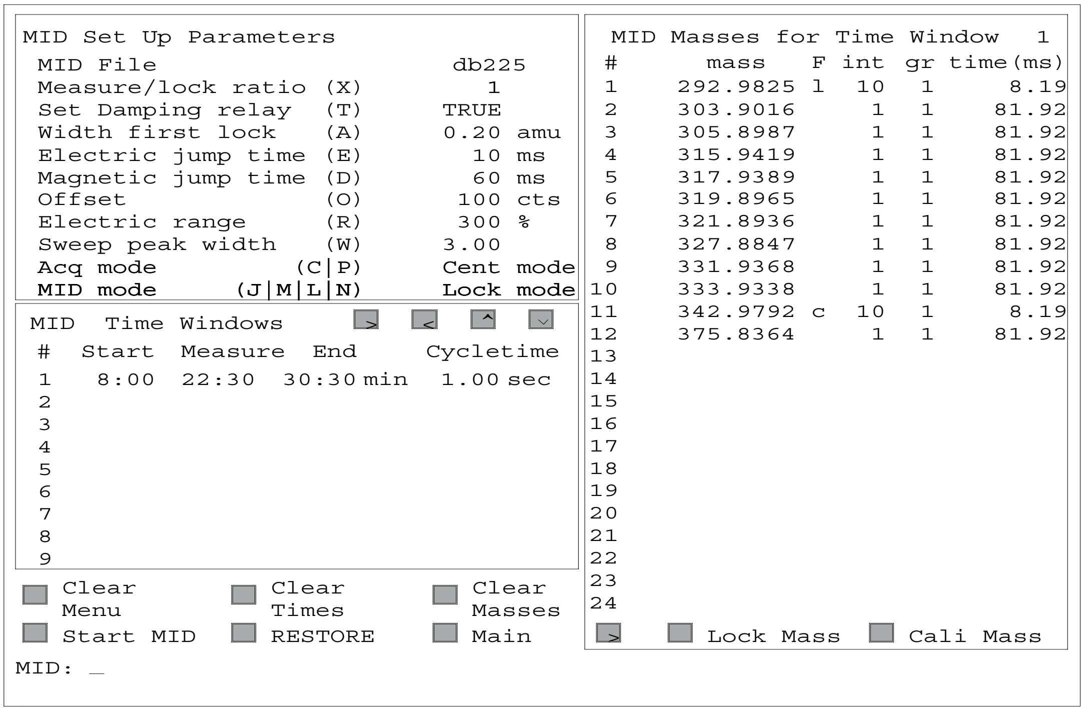
Figure 2 (Continued)

Rtx-5 Recommended MID Descriptors



```
MID Set Up Parameters                          MID Masses for Time Window   5
 MID File                       epa1613        #      mass    F  int  gr time(ms)
 Measure/lock ratio  (X)           1           1    430.9728  l   10   1     10.92
 Set Damping relay   (T)       FALSE           2    441.7428       1   1    120.15
 Width first lock    (A)        0.20 amu       3    443.7399       1   1    120.15
 Electric jump time  (E)          10 ms        4    457.7377       1   1    120.15
 Magnetic jump time  (D)          60 ms        5    459.7348       1   1    120.15
 Offset              (O)         100 cts       6    469.7780       1   1    120.15
 Electric range      (R)         300 %         7    471.7750       1   1    120.15
 Sweep peak width    (W)        3.00           8    480.9696  c   10   1     10.92
 Acq mode                (C|P)   Cent mode     9    513.6775       1   1    120.15
 MID mode        (J|M|L|N)       Lock mode    10
                                              11
 MID  Time Windows                            12
  #  Start  Measure  End      Cycletime       13
  1    8:00  28:12  36:12 min  1.00 sec       14
  2  36:12    7:28  43:40 min  1.00 sec       15
  3  43:40    5:49  49:30 min  1.00 sec       16
  4  49:30    5:00  54:30 min  1.00 sec       17
  5  54:30    3:50  58:20 min  1.00 sec       18
  6                                           19
  7                                           20
  8                                           21
  9                                           22
                                              23
☐ Clear        ☐ Clear        ☐ Clear         24
  Menu           Times          Masses
☐ Stop MID     ☐ SAVE         ☐ Main          ☐ >   ☐ Lock Mass   ☐ Cali Mass
MID: _
```

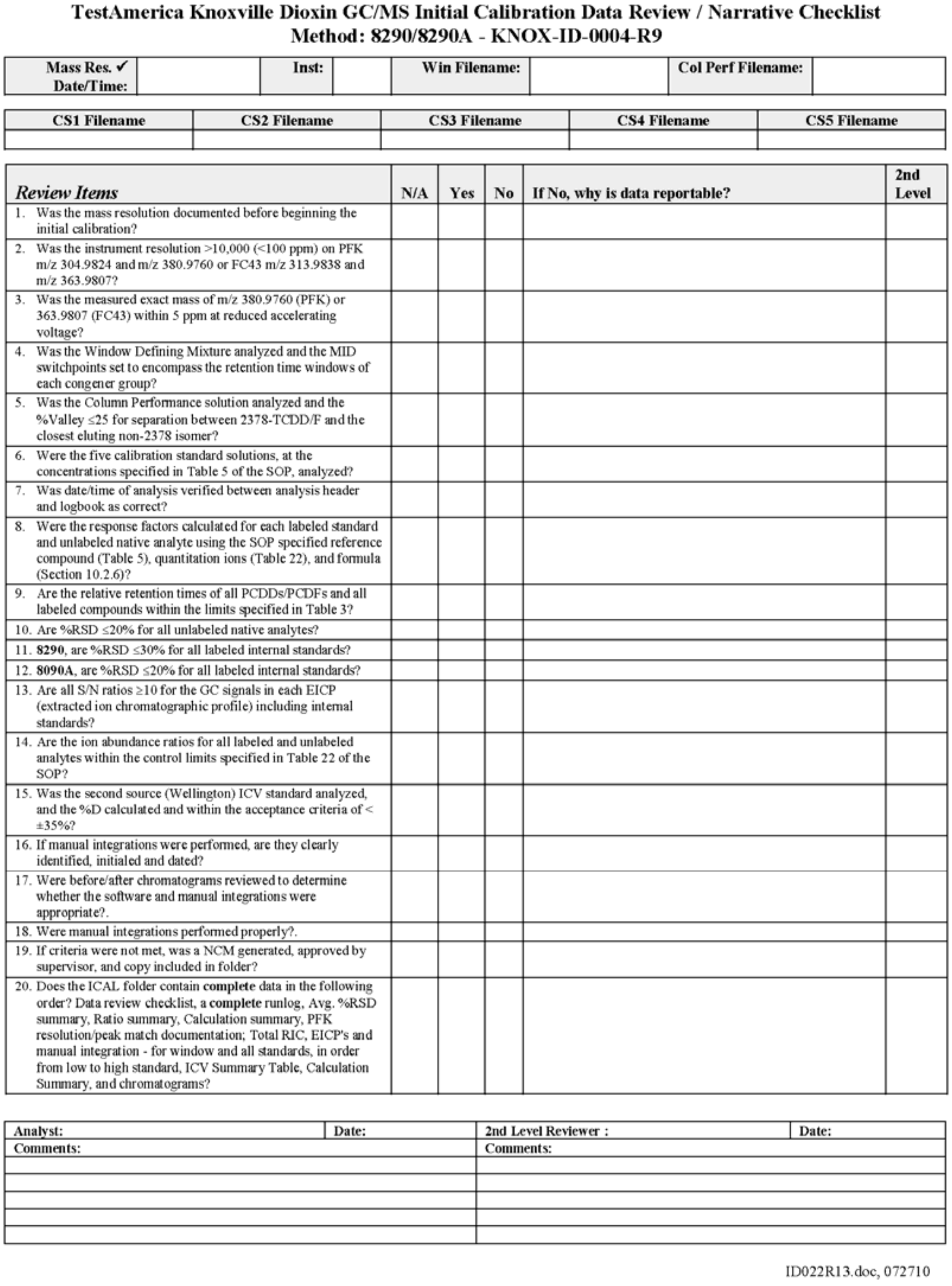
DB-225 Recommended MID Descriptor



```
MID Set Up Parameters                          MID Masses for Time Window   1
 MID File                         db225        #      mass    F  int  gr time(ms)
 Measure/lock ratio  (X)           1           1    292.9825  l   10   1      8.19
 Set Damping relay   (T)        TRUE           2    303.9016       1   1     81.92
 Width first lock    (A)        0.20 amu       3    305.8987       1   1     81.92
 Electric jump time  (E)          10 ms        4    315.9419       1   1     81.92
 Magnetic jump time  (D)          60 ms        5    317.9389       1   1     81.92
 Offset              (O)         100 cts       6    319.8965       1   1     81.92
 Electric range      (R)         300 %         7    321.8936       1   1     81.92
 Sweep peak width    (W)        3.00           8    327.8847       1   1     81.92
 Acq mode                (C|P)   Cent mode     9    331.9368       1   1     81.92
 MID mode        (J|M|L|N)       Lock mode    10    333.9338       1   1     81.92
                                              11    342.9792  c   10   1      8.19
 MID  Time Windows                            12    375.8364       1   1     81.92
  #  Start  Measure  End      Cycletime       13
  1    8:00  22:30  30:30 min  1.00 sec       14
  2                                           15
  3                                           16
  4                                           17
  5                                           18
  6                                           19
  7                                           20
  8                                           21
  9                                           22
                                              23
☐ Clear        ☐ Clear        ☐ Clear         24
  Menu           Times          Masses
☐ Start MID    ☐ RESTORE      ☐ Main          ☐ >   ☐ Lock Mass   ☐ Cali Mass
MID: _
```

Figure 3

Example Sample Data Review Checklist



TestAmerica Knoxville Dioxin GC/MS Initial Calibration Data Review / Narrative Checklist
Method: 8290/8290A - KNOX-ID-0004-R9

Mass Res. ✓ Date/Time:		**Inst:**		**Win Filename:**		**Col Perf Filename:**	

CS1 Filename	CS2 Filename	CS3 Filename	CS4 Filename	CS5 Filename

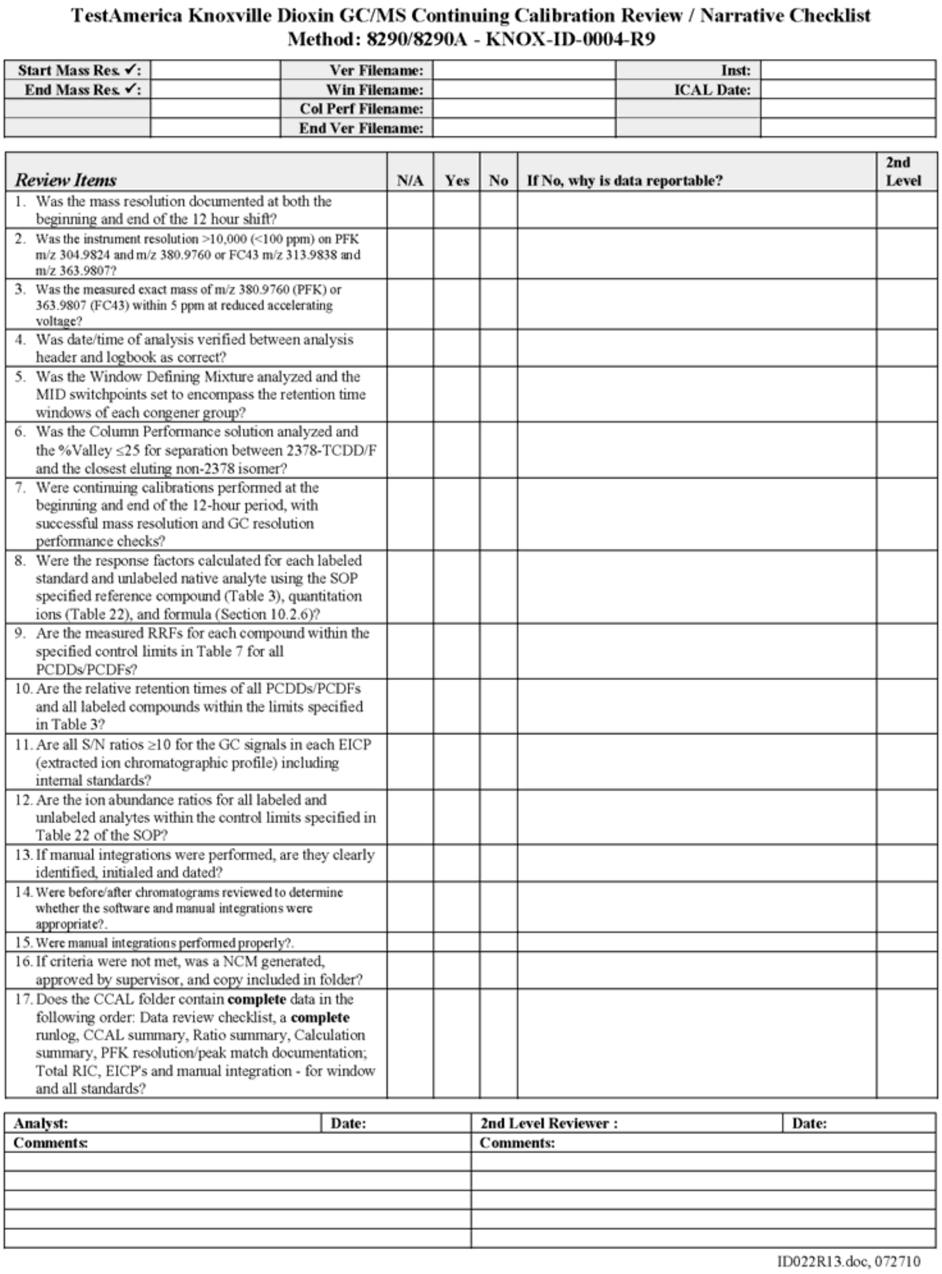
Review Items	N/A	Yes	No	If No, why is data reportable?	2nd Level
1. Was the mass resolution documented before beginning the initial calibration?					
2. Was the instrument resolution >10,000 (<100 ppm) on PFK m/z 304.9824 and m/z 380.9760 or FC43 m/z 313.9838 and m/z 363.9807?					
3. Was the measured exact mass of m/z 380.9760 (PFK) or 363.9807 (FC43) within 5 ppm at reduced accelerating voltage?					
4. Was the Window Defining Mixture analyzed and the MID switchpoints set to encompass the retention time windows of each congener group?					
5. Was the Column Performance solution analyzed and the %Valley ≤ 25 for separation between 2378-TCDD/F and the closest eluting non-2378 isomer?					
6. Were the five calibration standard solutions, at the concentrations specified in Table 5 of the SOP, analyzed?					
7. Was date/time of analysis verified between analysis header and logbook as correct?					
8. Were the response factors calculated for each labeled standard and unlabeled native analyte using the SOP specified reference compound (Table 5), quantitation ions (Table 22), and formula (Section 10.2.6)?					
9. Are the relative retention times of all PCDDs/PCDFs and all labeled compounds within the limits specified in Table 3?					
10. Are %RSD $\leq 20\%$ for all unlabeled native analytes?					
11. **8290**, are %RSD $\leq 30\%$ for all labeled internal standards?					
12. **8090A**, are %RSD $\leq 20\%$ for all labeled internal standards?					
13. Are all S/N ratios ≥ 10 for the GC signals in each EICP (extracted ion chromatographic profile) including internal standards?					
14. Are the ion abundance ratios for all labeled and unlabeled analytes within the control limits specified in Table 22 of the SOP?					
15. Was the second source (Wellington) ICV standard analyzed, and the %D calculated and within the acceptance criteria of < ±35%?					
16. If manual integrations were performed, are they clearly identified, initialed and dated?					
17. Were before/after chromatograms reviewed to determine whether the software and manual integrations were appropriate?.					
18. Were manual integrations performed properly?.					
19. If criteria were not met, was a NCM generated, approved by supervisor, and copy included in folder?					
20. Does the ICAL folder contain **complete** data in the following order? Data review checklist, a **complete** runlog, Avg. %RSD summary, Ratio summary, Calculation summary, PFK resolution/peak match documentation; Total RIC, EICP's and manual integration - for window and all standards, in order from low to high standard, ICV Summary Table, Calculation Summary, and chromatograms?					

Analyst:	**Date:**	**2nd Level Reviewer :**	**Date:**
Comments:		**Comments:**	

ID022R13.doc, 072710

Figure 3 (Continued)

Example Data Review Checklist



TestAmerica Knoxville Dioxin GC/MS Continuing Calibration Review / Narrative Checklist
Method: 8290/8290A - KNOX-ID-0004-R9

Start Mass Res. ✓:		**Ver Filename:**		**Inst:**	
End Mass Res. ✓:		**Win Filename:**		**ICAL Date:**	
		Col Perf Filename:			
		End Ver Filename:			

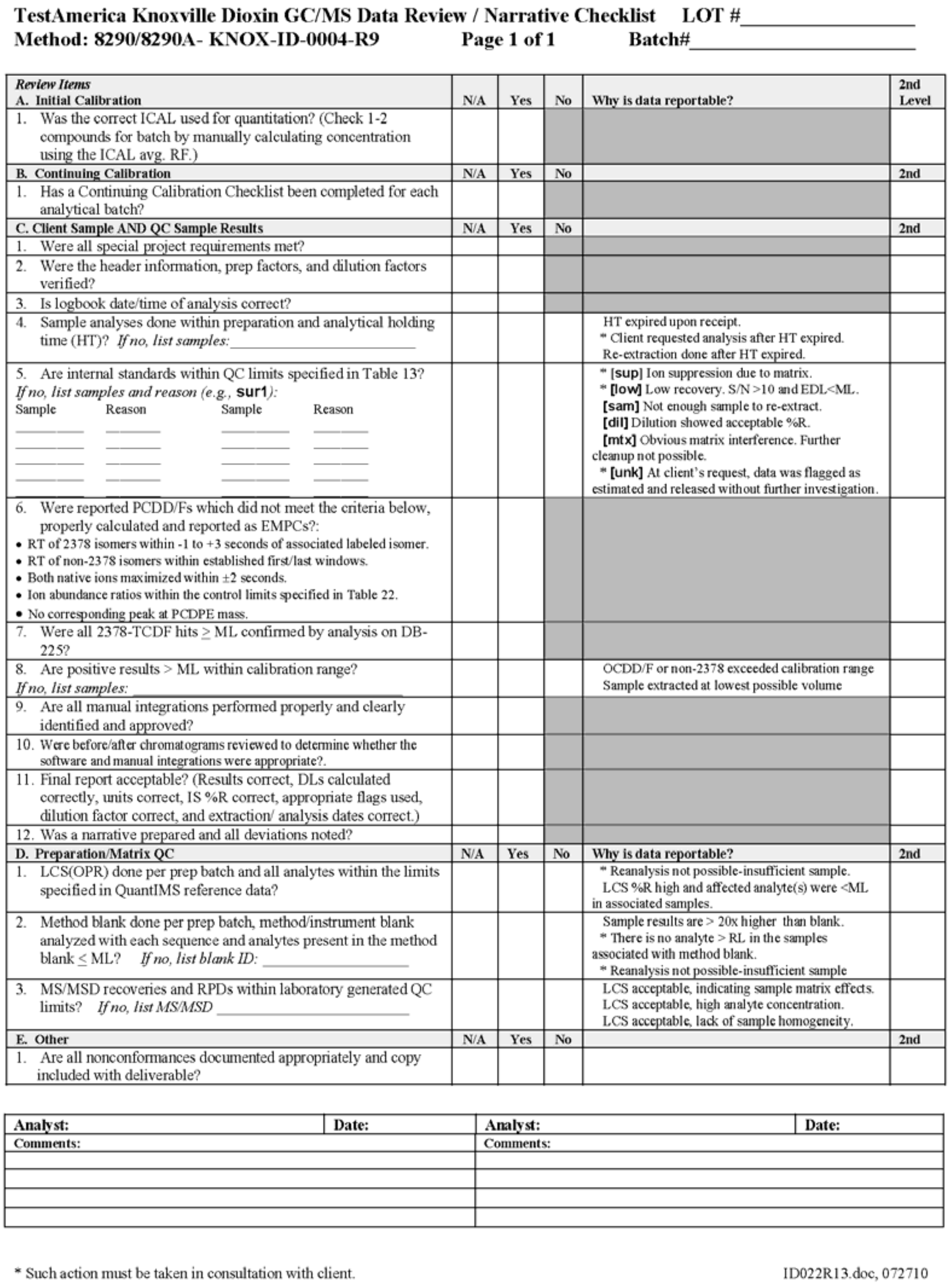
Review Items	**N/A**	**Yes**	**No**	**If No, why is data reportable?**	**2nd Level**
1. Was the mass resolution documented at both the beginning and end of the 12 hour shift?					
2. Was the instrument resolution >10,000 (<100 ppm) on PFK m/z 304.9824 and m/z 380.9760 or FC43 m/z 313.9838 and m/z 363.9807?					
3. Was the measured exact mass of m/z 380.9760 (PFK) or 363.9807 (FC43) within 5 ppm at reduced accelerating voltage?					
4. Was date/time of analysis verified between analysis header and logbook as correct?					
5. Was the Window Defining Mixture analyzed and the MID switchpoints set to encompass the retention time windows of each congener group?					
6. Was the Column Performance solution analyzed and the %Valley ≤25 for separation between 2378-TCDD/F and the closest eluting non-2378 isomer?					
7. Were continuing calibrations performed at the beginning and end of the 12-hour period, with successful mass resolution and GC resolution performance checks?					
8. Were the response factors calculated for each labeled standard and unlabeled native analyte using the SOP specified reference compound (Table 3), quantitation ions (Table 22), and formula (Section 10.2.6)?					
9. Are the measured RRFs for each compound within the specified control limits in Table 7 for all PCDDs/PCDFs?					
10. Are the relative retention times of all PCDDs/PCDFs and all labeled compounds within the limits specified in Table 3?					
11. Are all S/N ratios ≥10 for the GC signals in each EICP (extracted ion chromatographic profile) including internal standards?					
12. Are the ion abundance ratios for all labeled and unlabeled analytes within the control limits specified in Table 22 of the SOP?					
13. If manual integrations were performed, are they clearly identified, initialed and dated?					
14. Were before/after chromatograms reviewed to determine whether the software and manual integrations were appropriate?.					
15. Were manual integrations performed properly?.					
16. If criteria were not met, was a NCM generated, approved by supervisor, and copy included in folder?					
17. Does the CCAL folder contain **complete** data in the following order: Data review checklist, a **complete** runlog, CCAL summary, Ratio summary, Calculation summary, PFK resolution/peak match documentation; Total RIC, EICP's and manual integration - for window and all standards?					

Analyst:	**Date:**	**2nd Level Reviewer :**	**Date:**
Comments:		**Comments:**	

ID022R13.doc, 072710

Figure 3 (Continued)

Example Data Review Checklist



TestAmerica Knoxville Dioxin GC/MS Data Review / Narrative Checklist **LOT #**________________
Method: 8290/8290A- KNOX-ID-0004-R9 **Page 1 of 1** **Batch#**_____________________

Review Items **A. Initial Calibration**	**N/A**	**Yes**	**No**	**Why is data reportable?**	**2nd Level**
1. Was the correct ICAL used for quantitation? (Check 1-2 compounds for batch by manually calculating concentration using the ICAL avg. RF.)					
B. Continuing Calibration	**N/A**	**Yes**	**No**		**2nd**
1. Has a Continuing Calibration Checklist been completed for each analytical batch?					
C. Client Sample AND QC Sample Results	**N/A**	**Yes**	**No**		**2nd**
1. Were all special project requirements met?					
2. Were the header information, prep factors, and dilution factors verified?					
3. Is logbook date/time of analysis correct?					
4. Sample analyses done within preparation and analytical holding time (HT)? *If no, list samples:*________________________				HT expired upon receipt. * Client requested analysis after HT expired. Re-extraction done after HT expired.	
5. Are internal standards within QC limits specified in Table 13? *If no, list samples and reason (e.g.,* **sur1***):* Sample ________ Reason _______ Sample ________ Reason _______				* **[sup]** Ion suppression due to matrix. * **[low]** Low recovery. S/N >10 and EDL<ML. **[sam]** Not enough sample to re-extract. **[dil]** Dilution showed acceptable %R. **[mtx]** Obvious matrix interference. Further cleanup not possible. * **[unk]** At client's request, data was flagged as estimated and released without further investigation.	
6. Were reported PCDD/Fs which did not meet the criteria below, properly calculated and reported as EMPCs?: • RT of 2378 isomers within -1 to +3 seconds of associated labeled isomer. • RT of non-2378 isomers within established first/last windows. • Both native ions maximized within ±2 seconds. • Ion abundance ratios within the control limits specified in Table 22. • No corresponding peak at PCDPE mass.					
7. Were all 2378-TCDF hits ≥ ML confirmed by analysis on DB-225?					
8. Are positive results > ML within calibration range? *If no, list samples:* ________________________________				OCDD/F or non-2378 exceeded calibration range Sample extracted at lowest possible volume	
9. Are all manual integrations performed properly and clearly identified and approved?					
10. Were before/after chromatograms reviewed to determine whether the software and manual integrations were appropriate?.					
11. Final report acceptable? (Results correct, DLs calculated correctly, units correct, IS %R correct, appropriate flags used, dilution factor correct, and extraction/ analysis dates correct.)					
12. Was a narrative prepared and all deviations noted?					
D. Preparation/Matrix QC	**N/A**	**Yes**	**No**	**Why is data reportable?**	**2nd**
1. LCS(OPR) done per prep batch and all analytes within the limits specified in QuantIMS reference data?				* Reanalysis not possible-insufficient sample. LCS %R high and affected analyte(s) were <ML in associated samples.	
2. Method blank done per prep batch, method/instrument blank analyzed with each sequence and analytes present in the method blank ≤ ML? *If no, list blank ID:* ___________________				Sample results are > 20x higher than blank. * There is no analyte > RL in the samples associated with method blank. * Reanalysis not possible-insufficient sample	
3. MS/MSD recoveries and RPDs within laboratory generated QC limits? *If no, list MS/MSD* ________________________				LCS acceptable, indicating sample matrix effects. LCS acceptable, high analyte concentration. LCS acceptable, lack of sample homogeneity.	
E. Other	**N/A**	**Yes**	**No**		**2nd**
1. Are all nonconformances documented appropriately and copy included with deliverable?					

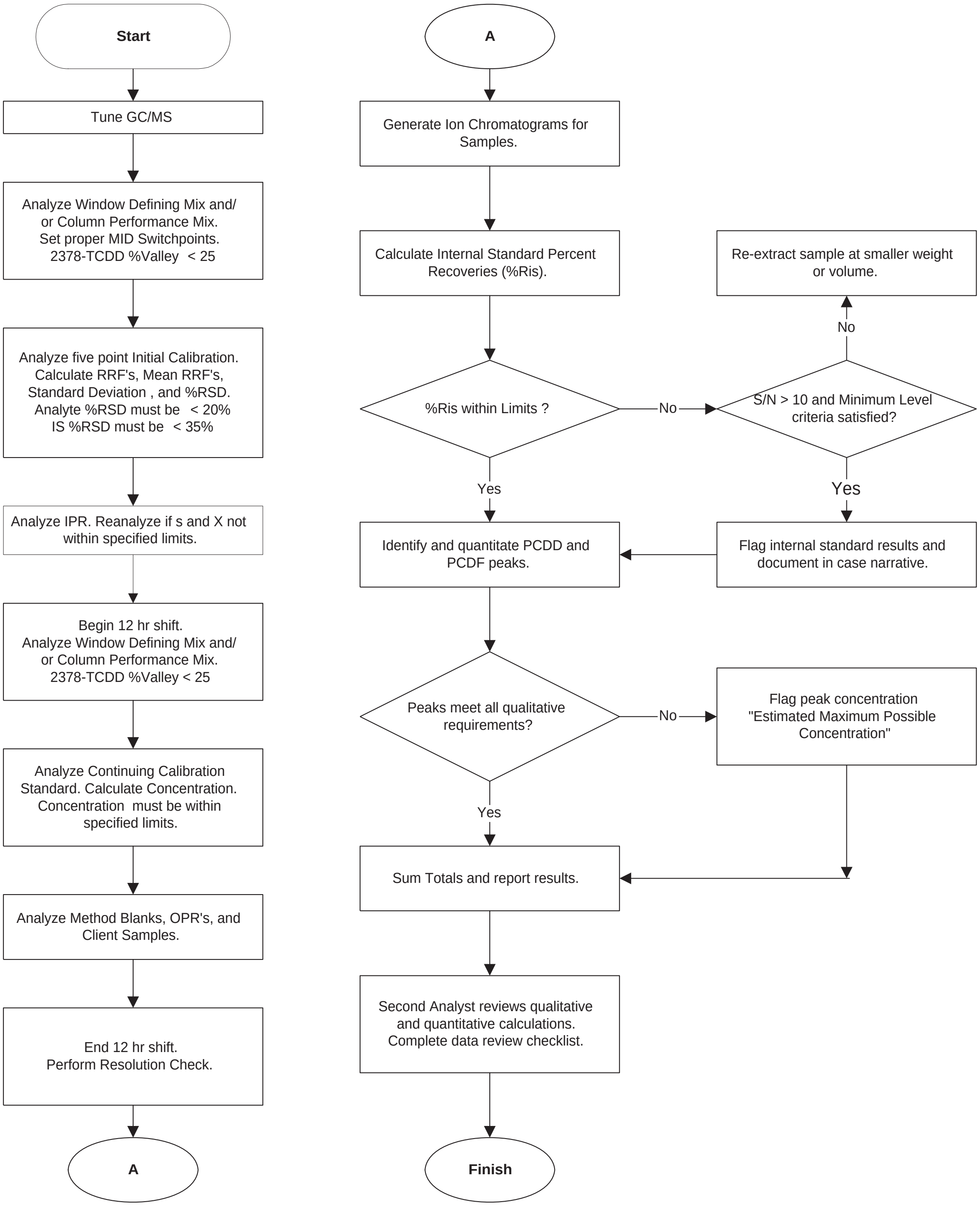
Analyst:	**Date:**	**Analyst:**	**Date:**
Comments:		**Comments:**	

* Such action must be taken in consultation with client.

ID022R13.doc, 072710

Figure 4

Analysis of PCDDs and PCDFs by HRGC/HRMS



Controlled Copy
Copy No. _____________

TESTAMERICA KNOXVILLE
SOP CHANGE FORM

SOP NUMBER: KNOX-OP-0001 Revision 1

SOP TITLE: Extraction of Polychlorinated Dioxins/Furans for Analysis by HRGC/HRMS Based on Methods 8290, 8290A, and 1613B

SOP SECTIONS AFFECTED BY CHANGE: 3.1, 7.13, 7.13.4, 9.2, and 11.11.2

REASON FOR ADDITION OR CHANGE: Method 8290A does not require the use of a Cleanup Standard. Therefore, only Method 1613 will be spiked with the Cleanup Standard.

CHANGE EFFECTIVE FROM: 4/22/11

CHANGE OR ADDITION (SPECIFY SECTION; USE ADDITIONAL SHEETS IF NECESSARY)

3.1 Cleanup Standard: Solution containing $^{37}Cl_4$-2,3,7,8-TCDD that is added to every 1613B ~~and 8290A~~ sample, blank and quality control spike sample after extraction but prior to extract cleanup. The analysis results are used to judge the efficiency of the cleanup procedures.

7.13 1613B ~~and 8290A~~ Cleanup Standards

7.13.4 Cleanup Standard Spiking Solution: Dilute 200 µL of the 200 ng/mL working stock solution to 200 mL in a 250 mL amber bottle with a PTFE lined cap with hexane to a final concentration of 0.20 ng/mL. 1.0 mL of this solution is added to each 1613B ~~or 8290A~~ sample, method blank and QC sample extract prior to cleanup. See Table 2 for a complete list of compounds and their concentrations.

9.2 Cleanup Standards: For methods 1613B ~~and 8290A~~, every sample, blank and QC sample extract is spiked with labeled cleanup standards after extraction but prior to extract cleanup. They are used to assess the efficiency of the cleanup procedures.

11.11.2 For 1613B ~~and 8290A~~ samples that are to be subjected to one or more cleanup steps, add 1.0 mL of the $^{37}Cl_4$-2,3,7,8-TCDD cleanup standard (section 7.13.4) to each sample, method blank and LCS/LCSD extract before any cleanup steps are performed.

SUBMITTED BY/DATE: MSP 4/22/11

Controlled Copy
Copy No. 4/14/11

APPROVED BY:

RMWagner
Technical Reviewer Signature

4/20/11
Date

Environmental Health & Safety Signature

4-25-11
Date

QA Signature

04/25/11
Date

Management Signature

4/25/11
Date

Controlled Copy
Copy No. uncontrolled copy

TESTAMERICA KNOXVILLE

STANDARD OPERATING PROCEDURE

TITLE: Extraction of Polychlorinated Dioxins/Furans for Analysis by HRGC/HRMS Based on Methods 8290, 8290A and 1613B

(SUPERSEDES: KNOX-ID-0004, Rev. 9)

Prepared By: Michael S. Patty

Reviewed By: Robyn M. Wagner 4/12/11
Technical Specialist

Approved By: 04/12/11
Quality Assurance Manager

Approved By: 4-12-11
Environmental, Health and Safety Coordinator

Approved By: 4-12-11
Laboratory Director

Copyright Information:

This documentation has been prepared by TestAmerica Laboratories, Inc. and its affiliates ("TestAmerica"), solely for their own use and the use of their customers in evaluating their qualifications and capabilities in connection with a particular project. The user of this document agrees by its acceptance to return it to TestAmerica upon request and not to reproduce, copy, lend, or otherwise disclose its contents, directly or indirectly, and not to use it for any other purpose other than that for which it was specifically provided. The user also agrees that where consultants or other outside parties are involved in the evaluation process, access to these documents shall not be given to said parties unless those parties also specifically agree to these conditions.

THIS DOCUMENT CONTAINS VALUABLE CONFIDENTIAL AND PROPRIETARY INFORMATION. DISCLOSURE, USE OR REPRODUCTION OF THESE MATERIALS WITHOUT THE WRITTEN AUTHORIZATION OF TESTAMERICA IS STRICTLY PROHIBITED. THIS UNPUBLISHED WORK BY TESTAMERICA IS PROTECTED BY STATE AND FEDERAL LAW OF THE UNITED STATES. IF PUBLICATION OF THIS WORK SHOULD OCCUR THE FOLLOWING NOTICE SHALL APPLY:

@COPYRIGHT 2011 TESTAMERICA LABORATORIES, INC. ALL RIGHTS RESERVED.

1. Scope and Application

1.1 This procedure is used by TestAmerica Knoxville for the extraction of tetra- through octa-chlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) from a variety of environmental matrices (including water, soil, solids, sediments, wipes, biological samples, fly ash, still bottoms and waste oils) for analysis by high resolution gas chromatography/ high resolution mass spectrometry (HRGC/HRMS). This procedure is designed to meet analytical program requirements where EPA Method 8290, 8290A or 1613B is specified.

1.2 Because of the extreme toxicity of many of these compounds, the analyst must take the necessary precautions to prevent exposure to materials known or believed to contain PCDDs or PCDFs. It is the responsibility of the laboratory personnel to ensure that safe handling procedures are employed. Section 5 of this procedure discusses safety procedures.

2. Summary of Method

2.1 Samples are spiked with a solution of known amounts of the isotopically labeled internal standards listed in Table 2. The samples are then extracted using matrix specific extraction procedures.

2.2 Water samples are extracted using separatory funnel techniques with methylene chloride as the extraction solvent. Solid samples are extracted by Soxhlet extraction with the appropriate solvent and organic liquid waste samples are diluted in solvent.

2.3 After extraction, the sample is concentrated and solvent exchanged to hexane. The extract is then subjected to one or more optional cleanup steps to remove interferences. The final extract is prepared by adding a known amount of the labeled recovery standards ($^{13}C_{12}$-1,2,3,4-TCDD and $^{13}C_{12}$-1,2,3,7,8,9-HxCDD) and concentrating to the final volume.

2.4 The acid-base cleanup of the sample is used before column chromatography for samples that contain large amounts of basic and acidic coextractable compounds. If such interferences are not removed before column chromatography, they can cause a shift in the predicted elution pattern. Conditions which can indicate the need for this procedure are as follows: Samples which are highly colored, samples which contain lipids or other oxidizable compounds or samples which contain known large amounts of polar organics.

2.5 Dual Column Cleanup: Silica gel is effective in removing chlorophenoxy herbicide residues, while alumina partitions PCBs, 2,4,5-trichlorophenol and hexachlorophene.

2.6 When the above cleanup techniques do not completely remove interferences, an activated carbon cleanup is used to remove interferences.

3. Definitions

3.1 Cleanup Standard: Solution containing $^{37}Cl_4$-2,3,7,8-TCDD that is added to every 1613B and 8290A sample, blank and quality control spike sample after extraction but prior to extract cleanup. The analysis results are used to judge the efficiency of the cleanup procedures.

3.2 Internal Standards: Solution containing isotopically labeled analogs of the target analytes that is added to every sample, blank and quality control spike sample before extraction. The analysis results are used to calculate the concentration of the target analytes or detection limits.

3.3 Recovery Standard: Solution containing ${}^{13}C_{12}$-1,2,3,4-TCDD and ${}^{13}C_{12}$-1,2,3,7,8,9-HxCDD that is added to every sample, blank and quality control spike sample just prior to analysis. The analysis results are used to measure the recovery of the internal standards and the cleanup standard.

3.4 Additional definitions can be found in the Test America Knoxville Quality Assurance Manual (QAM).

4. Interferences

4.1 Solvents, reagents, glassware and other sample processing hardware can yield discrete artifacts or elevated baselines that can cause misinterpretation of the chromatographic data. All of these materials must be demonstrated to be free from interferences under the conditions of analysis by performing laboratory method blanks. Analysts must not use PVC gloves, powdered gloves, or gloves with levels of phthalates which cause interference.

4.2 The use of high purity reagents and solvents (pesticide grade) helps minimize interference problems. Where necessary, reagents are cleaned by extraction or solvent rinse.

4.3 Proper cleaning of glassware is extremely important, because glassware may not only contaminate the samples but may also remove the analytes of interest by adsorption on the glass surface. For specific glassware cleaning procedures, see SOP KNOX-QA-0002, “Glassware Cleaning”, current revision.

4.4 Interferences coextracted from the samples can vary considerably from matrix to matrix. PCDDs and PCDFs are often associated with other interfering chlorinated substances such as polychlorinated biphenyls (PCBs), polychlorinated diphenyl ethers (PCDPEs), polychlorinated naphthalenes and polychlorinated alkyldibenzofurans that can be found at concentrations several orders of magnitude higher than the analytes of interest. While certain cleanup techniques are provided as part of this method, unique samples can require additional cleanup steps to achieve lower detection limits.

5. Safety

5.1 Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual and this document.

5.2 Eye protection that satisfies ANSI Z87.1 (as per the Corporate Safety Manual), laboratory coat and appropriate gloves must be worn while samples, standards, solvents and reagents are being handled. Disposable gloves that have become contaminated must be removed and discarded; other gloves must be cleaned immediately.

5.3 Latex and vinyl gloves provide no protection against most of the organic solvents used in this method. For the operations described herein, Nitrile gloves are to be worn. For operations using solvents that may splash, SilverShield® gloves are recommended. SilverShield® gloves protect against breakthrough for most of the solvents used in this procedure.

5.4 Finely divided dry soils contaminated with PCDDs and PCDFs can be particularly hazardous because of the potential for inhalation and ingestion. Such samples are to be processed in a hood.

5.5 When using a scalpel, wear cut-resistant gloves and cut away from your hand.

5.6 Primary Materials Used: The following is a list of the materials used in this method which have a serious or significant hazard rating. **NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material	**Hazards**	**Exposure Limit (2)**	**Signs and symptoms of exposure**
Sulfuric Acid (1)	Corrosive, Oxidizer, Dehydradator	1 mg/m^3	This material will cause burns if it comes into contact with the skin or eyes. Inhalation of vapors will cause irritation of the nasal and respiratory system.
Sodium Hydroxide	Corrosive, Poison	2 ppm, 5 mg/m^3	This material will cause burns if it comes into contact with the skin or eyes. Inhalation of sodium hydroxide dust will cause irritation of the nasal and respiratory system.
Hydrochloric Acid	Corrosive, Poison	5 ppm-Ceiling	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure and death. Can cause redness, pain and severe skin burns. Vapors are irritating and can cause damage to the eyes. Contact can cause severe burns and permanent eye damage.
Methylene chloride	Carcinogen, Irritant	25 ppm-TWA, 125 ppm-STEL	Causes irritation to respiratory tract. Has a strong narcotic effect with symptoms of mental confusion, light-headedness, fatigue, nausea, vomiting and headache. Causes irritation, redness and pain to the skin and eyes. Prolonged contact can cause burns. Liquid degreases the skin. Can be absorbed through skin.

Material	**Hazards**	**Exposure Limit (2)**	**Signs and symptoms of exposure**
Hexane	Flammable, Irritant	500 ppm-TWA	Inhalation of vapors irritates the respiratory tract. Overexposure can cause lightheadedness, nausea, headache and blurred vision. Vapors can cause irritation to the skin and eyes.
Methanol	Flammable, Poison, Irritant	200 ppm-TWA	A slight irritant to the mucous membranes. Toxic effects exerted upon nervous system, particularly the optic nerve. Symptoms of overexposure can include headache, drowsiness and dizziness. Methyl alcohol is a defatting agent and can cause skin to become dry and cracked. Skin absorption can occur; symptoms can parallel inhalation exposure. Irritant to the eyes.
Toluene	Flammable, Poison, Irritant	200 ppm-TWA, 300 ppm-Ceiling	Inhalation can cause irritation of the upper respiratory tract. Symptoms of overexposure can include fatigue, confusion, headache, dizziness and drowsiness. Peculiar skin sensations (e.g., pins and needles) or numbness can be produced. Causes severe eye and skin irritation with redness and pain. Can be absorbed through the skin.
Acetone	Flammable	1000 ppm-TWA	Inhalation of vapors irritates the respiratory tract. Can cause coughing, dizziness, dullness and headache.
Cyclohexane	Flammable, Irritant	300 ppm TWA	Inhalation of vapors causes irritation to the respiratory tract. Symptoms can include coughing and shortness of breath. High concentrations have a narcotic effect.
Tetradecane	Irritant	None established	Inhalation of vapors can cause difficulty breathing, headache, intoxication and central nervous system damage.
Benzene	Flammable, Toxic, Carcinogen	PEL: 1 ppm TWA; 5 ppm, 15 min. STEL	Causes skin irritation. Toxic if absorbed through skin. Causes severe eye irritation. Toxic if inhaled. Vapor or mist causes irritation to mucous membranes and upper respiratory tract. Exposure can cause narcotic effect. Inhalation at high concentrations can have an initial stimulatory effect on the central nervous system characterized by exhilaration, nervous excitation and/or giddiness, depression, drowsiness or fatigue. Victim can experience tightness in the chest, breathlessness and loss of consciousness.
Nonane	Flammable	None established	Harmful if inhaled/swallowed. Vapor/mist is irritating to eyes, mucous membranes and upper respiratory tract. Causes skin irritation.
Potassium Hydroxide	Corrosive, Poison	2 mg/m^3 ceiling	Severe irritant. Effects from inhalation of dust or mist vary from mild irritation to serious damage of the upper respiratory tract, depending on the severity of exposure. Symptoms can include coughing, sneezing and damage to the nasal or respiratory tract. High concentrations can cause lung damage. Corrosive! Contact with skin can cause irritation or severe burns and scarring with greater exposures.

Material	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

5.7 Chemicals that have been classified as carcinogens or potential carcinogens under OSHA regulations include benzene and methylene chloride, 2,3,7,8-TCDD and all other 2,3,7,8-substituted PCDD or PCDF isomers.

NOTE: The 2,3,7,8-TCDD isomer has been found to be acnegenic, carcinogenic and teratogenic in laboratory animal studies. Other PCDDs and PCDFs containing chlorine atoms in positions 2,3,7,8 are known to have toxicities comparable to that of 2,3,7,8-TCDD. The toxicity or carcinogenicity of each reagent used in this method is not precisely defined; however, each chemical compound must be treated as a potential health hazard. From this viewpoint, exposure to these chemicals must be kept to a minimum.

5.8 Exposure to chemicals must be maintained as low as reasonably achievable; therefore, unless they are known to be non-hazardous, all samples must be opened, transferred and prepared in a fume hood or under other means of mechanical ventilation. Solvent and waste containers must be kept closed unless transfers are being made.

5.9 All procedures that involve solvents such as acetone, toluene, methylene chloride and hexane (e.g., glassware cleaning and the preparation of standards and reagents) must be conducted in a fume hood with the sash closed as far as the operations permit.

5.10 Safety glasses or a face shield must be used when employees are using solvents to rinse or clean glassware.

5.11 Personal Hygiene: Thorough washing of hands and forearms is recommended after each manipulation and before breaks (coffee, lunch and shifts).

5.12 Accidents: Remove contaminated clothing immediately, taking precautions not to contaminate skin or other articles. Wash exposed skin vigorously and repeatedly until medical attention is obtained.

5.13 All work must be stopped in the event of a known or potential compromise to the health or safety of an associate. The situation must be reported immediately to a laboratory supervisor.

6. Equipment and Supplies

NOTE: All glassware used in extraction and cleanup procedures is precleaned as described in SOP KNOX-QA-0002, “Glassware Cleaning”, current revision.

6.1 Miscellaneous Laboratory Equipment

6.1.1 Laboratory fume hood of sufficient size to contain the equipment used for sample preparation

6.1.2 Oven, capable of maintaining a temperature of 105 ± 5°C and 125 to 135°C

6.1.3 Balance, >100 g capacity, accurate to ± 0.01 g

6.1.4 Syringes, various sizes

6.1.5 Borosilicate 5.75 inch and 9.0 inch disposable pipettes with rubber bulbs

6.1.6 Class A 1 mL pipettes

6.1.7 Graduated cylinders, 25 mL, 100 mL and 1000 mL volume

6.1.8 Vials, 40 mL volume, with PTFE lined caps

6.1.9 Glass wool, precleaned with methylene chloride

6.1.10 Bottle top solvent dispensers

6.1.11 PTFE boiling chips

6.1.12 PTFE squirt bottles, 500 mL

6.2 Tissue Homogenization Equipment

6.2.1 Laboratory blender with glass body and stainless steel blades

6.2.2 Industrial meat grinder, Intedge Industries, Model C2H or equivalent

6.2.3 Laboratory homogenizer, OMNI GLH-01, Model LR060902 or equivalent

6.2.4 Scalpels or knives

6.2.5 Cut-resistant gloves

6.3 Aqueous Sample Extraction

6.3.1 Multi-position separatory funnel rotator

6.3.2 2000 mL separatory funnels with PTFE stopcocks and PTFE stoppers

6.3.3 100 mm glass funnels with short stems

6.3.4 600 mL concentration tubes

6.3.5 Buchner funnels with filter flasks, rubber stopper and GF/D filters

6.3.6 Vacuum source

6.4 Soxhlet Extraction

6.4.1 Soxhlet extractors or Dean-Stark Soxhlet extractors

6.4.2 Heating mantles with temperature controls

6.4.3 500 mL boiling flasks, flat or round bottom

6.4.4 Glass condensers, compatible with the Dean-Stark extractors

6.4.5 High purity glass fiber Soxhlet thimbles

6.4.6 Boiling beads, 6 mm glass

6.4.7 Recirculating chillers

6.4.8 Stainless steel spatulas

6.4.9 Stainless steel tweezers

6.5 Dual Column (Silica Gel/Alumina) Cleanup

6.5.1 Disposable glass columns

6.5.1.1 20mm x 240mm custom glass column with support ring and tapered tip

6.5.1.2 16mm x 240mm custom glass column with support ring and tapered tip

6.5.2 Tornado II portable paint shaker or equivalent (for mixing reagents)

6.5.3 Aluminum support rack for custom columns

6.5.4 Amber-colored glass jars with a PTFE lined screw caps, 250mL and 500 mL

6.5.5 Solvent waste collection jars, 125mL

6.6 Activated Carbon Cleanup

6.6.1 31 cm glass columns (pre-cut), 8 mm ID

6.7 Concentration Equipment

6.7.1 Labconco Rapid-Vap concentrator

6.7.2 600 mL sample concentrator tubes, Labconco or equivalent

6.7.3 Heating mantles with temperature controls

6.7.4 Three-ball macro Snyder columns

6.7.5 Nitrogen evaporator, N-EVAP or equivalent

6.7.6 Mini vials, 1.1 mL capacity with tapered bottom, PTFE faced rubber septa and screw caps

7. Reagents and Standards

7.1 Solvents

7.1.1 Acetone, pesticide quality or equivalent

7.1.2 Benzene, pesticide quality or equivalent

7.1.3 Cyclohexane, pesticide quality or equivalent

7.1.4 Hexane, pesticide quality or equivalent

7.1.5 Iso-octane, pesticide quality or equivalent

7.1.6 Methanol, pesticide quality or equivalent

7.1.7 Methylene chloride, pesticide quality or equivalent

7.1.8 Nonane, pesticide quality or equivalent

7.1.9 Tetradecane, pesticide quality or equivalent

7.1.10 Toluene, pesticide quality or equivalent

7.2 Reagents

7.2.1 Reagent water must be produced by a Millipore DI system or equivalent, that is capable of producing water with ≥18 megohm-cm (MΩ-cm) resistivity. Reagent water must be free of the analytes of interest as demonstrated through the analysis of method blanks.

7.2.2 Sodium sulfate, reagent grade, granular, anhydrous, J.T Baker 3375 or equivalent

7.2.2.1 Sodium sulfate is cleaned by putting approximately 600 g of sodium sulfate in large amber glass jars and completely covering with methylene chloride, stirring the mixture with a stirring rod and letting the sodium sulfate soak for 5 minutes. The methylene chloride is drained and this step is repeated. After the methylene chloride is drained, the sodium sulfate is transferred to a Buchner funnel fitted onto a vacuum flask and rinsed 2 times with methylene chloride while a vacuum is being applied. The sodium sulfate is then placed into shallow borosilicate glass dishes where it is allowed to dry. After the sodium sulfate is air dried, it is placed in an oven at 125 – 135°C for one hour to drive off any residual moisture. After drying in the oven, the sodium sulfate is transferred into precleaned glass jars with PTFE lined screw caps and is placed in a desiccator until needed.

7.3 Fly Ash Sample Pretreatment

7.3.1 Hydrochloric acid (HCl), concentrated, Mallinckrodt AR Select or equivalent

7.3.2 1N HCl - Carefully add 83 mL of concentrated HCl to 917 mL of reagent water in a glass container

7.4 Tissue Sample Pretreatment

7.4.1 Dry ice, purchased from local vendor

7.5 Acid-Base Cleanup

7.5.1 Sulfuric acid, concentrated, ACS grade, specific gravity 1.84

7.5.2 Potassium hydroxide 20% (w/v) - Cautiously dissolve 200 g of potassium hydroxide pellets in reagent water and dilute to 1000 mL final volume. This solution is stored at room temperature in a HDPE bottle.

7.5.3 Sodium chloride, NaCl, analytical reagent, 5 percent (w/v) in reagent grade water

7.6 Silica Gel/Alumina Column Cleanup

7.6.1 Silica gel, F679-212, Fisher Chromatographic Silica Gel, 100-200 mesh or equivalent. Prepare by Soxhlet extraction with methylene chloride for at least 6 hours. Transfer to a shallow, borosilicate glass dish and air dry. After drying, cover with aluminum foil and activate in an oven at 125 - 130°C for a minimum of four (4) hours. Store in labeled glass jars in a desiccator until use.

7.6.2 3.3% Deactivated silica gel – To prepare add 6.6 mL of reagent water to 200 g of silica gel (section 7.6.1) in a 500 mL amber glass jar with a PTFE lined screw cap. Mix thoroughly by shaking until no lumps are visible and the silica gel is free flowing and no longer sticks to the side of the jar. The Tornado II portable paint shaker may be used to aid in mixing these reagents.

7.6.3 Acidic silica gel - To prepare, add 57 mL of concentrated sulfuric acid to 180 g silica gel (section 7.6.1) in a 500 mL amber glass jar with a PTFE lined screw cap. Mix thoroughly by shaking until no lumps are visible and the silica gel is free flowing and no longer sticks to the side of the jar. The Tornado II portable paint shaker may be used to aid in mixing these reagents.

7.6.4 Alumina, Neutral - Super I - Scientific Absorbents. Purchase and use only activated alumina. Store in an oven at 125 - 130°C when not in use.

7.6.4.1 Each new lot of alumina must be tested upon receipt and before use. Elute a solution containing all of the ^{13}C labeled internal standards and native analytes through a column packed with the new lot of alumina. Collect the 65% fraction and analyze by HRMS. The target analytes and internal standard recoveries must be greater than 85% in the final fraction. If the recovery is less than 85% for any compound or internal standard, the ratios and volumes of the elution solvents must be optimized and the test repeated until all compounds meet the recovery criteria.

7.6.5 95:5 Hexane:Methylene Chloride - Add 15 mL methylene chloride to 285 mL hexane. Store in an amber glass bottle at room temperature until use. Other amounts may be prepared based on the dual column set size.

7.6.6 35:65 Hexane:Methylene Chloride - Add 390 mL methylene chloride to 210 mL hexane. Store in an amber glass bottle at room temperature until use. Other amounts may be prepared based on the dual column set size.

7.7 Activated Carbon Cleanup

7.7.1 Silica gel, F679-212, Fisher Chromatographic Silica Gel, 100-200 mesh or equivalent. Prepare by Soxhlet extraction with methylene chloride for at least 6 hours. Transfer to a shallow, borosilicate glass dish and air dry. After drying, cover with aluminum foil and activate in an oven at 125 - 130°C for a minimum of four (4) hours. Store in labeled glass jars in a desiccator until use.

7.7.2 J.T Baker Carbon, Activated Powder, E345-07 or equivalent

7.7.3 Activated Carbon - Thoroughly mix 5% (by weight) activated J.T Baker carbon and 95% (by weight) Fisher Chromatographic silica gel (100-200 mesh). The Tornado II portable paint shaker may be used to aid in mixing these reagents. Activate in an oven at 125 - 130°C for 6 hours. Store in a desiccator in an amber colored bottle with a PTFE lined lid until use. Do not label the bottle until oven activation is completed to avoid heat damage to the label.

7.8 Standard Solutions

7.8.1 Certified reference standards are purchased from Cambridge Isotope Laboratories (CIL, Andover Massachusetts). If the chemical purity is 98% or greater, the weight can be used without correction to compute the concentration of the standard. When not being used, standards are stored in the dark at room temperature in screw-capped vials with PTFE lined caps. Standards are used as received after being sonicated and transferred to 2.0 mL amber glass vials with PTFE lined caps.

7.8.2 Stability of Solutions: Standards have an expiration of ten (10) years from date of receipt unless otherwise specified by the manufacturer. Standard solutions used for quantitative purposes must be analyzed periodically and must be assayed against reference standards before use.

7.9 Native Standards

7.9.1 Native Standard Stock Solution: CIL Catalog No. EDF-7999-10x, 400-4000 ng/mL in nonane, 1.2 mL.

7.9.2 Native Standard Working Stock Solution: Dilute 0.300 mL of the native standard stock solution to 3.0 mL in a volumetric flask with nonane for a final concentration of 40-400 ng/mL.

7.9.3 Native LCS Spiking Solution: Dilute 500 µL of the native standard working stock solution to 100 mL in a 125 mL amber bottle with a PTFE lined cap with iso-octane to a final concentration of 0.2-2.0 ng/mL. 1.0 mL of this solution is added to each LCS, LCSD or MS/MSD sample. See Table 1 for a complete list of compounds and their concentrations.

7.10 1613B/8290/8290A Internal Standards

7.10.1 1613B/8290/8290A Internal Standard Stock Solution: CIL Catalog No. EDF-8999, 100 ng/mL ($^{13}C_{12}$-OCDD 200 ng/mL) in nonane, 500 µL.

7.10.2 1613B/8290/8290A Internal Standard Spiking Solution: Dilute 2000 µL of the internal standard stock solution to 200 mL in a 250 mL amber bottle with a PTFE lined cap with iso-octane to a final concentration of 1.0 ng/mL ($^{13}C_{12}$-OCDD 2.0 ng/mL). 1.0 mL of this solution is added to each sample, method blank and QC sample. See Table 2 for a complete list of compounds and their concentrations.

7.11 2,3,7,8-TCDD/2,3,7,8-TCDF Internal Standards

7.11.1 $^{13}C_{12}$-2,3,7,8-TCDD Internal Standard Stock Solution: CIL Catalog No. ED-900, 50 µg/mL in nonane, 1.2 mL

7.11.2 $^{13}C_{12}$-2,3,7,8-TCDF Internal Standard Stock Solution: CIL Catalog No. EF-904, 50 µg/mL in nonane, 1.2 mL

7.11.3 $^{13}C_{12}$-TCDD/$^{13}C_{12}$-TCDF Internal Standard Secondary Stock Solution: Dilute 0.100 mL of the stock solutions in sections 7.11.1 and 7.11.2 to 5 mL in a volumetric flask with nonane to a final concentration of 1000 ng/mL.

7.11.4 $^{13}C_{12}$-TCDD/$^{13}C_{12}$-TCDF Internal Standard Spiking Solution: Dilute 200 µL of the internal standard secondary stock solution to 200 mL in a 250 mL amber bottle with a PTFE lined cap with iso-octane to a final concentration of 1.0 ng/mL. 1.0 mL of this solution is added to each sample, method blank and

QC sample extract that is extracted for TCDD and/or TCDF analysis only. See Table 2 for a complete list of compounds and their concentrations.

7.12 Recovery Standards

7.12.1 $^{13}C_{12}$-1,2,3,4-TCDD Recovery Standard Stock Solution: CIL Catalog No. ED-911, 50 µg/mL in nonane, 1.2 mL

7.12.2 $^{13}C_{12}$-1,2,3,7,8,9-HxCDD Recovery Standard Stock Solution: CIL Catalog No. ED-996, 50 µg/mL in nonane, 1.2 mL

7.12.3 Recovery Standard Secondary Stock Solution: Dilute 1.0 mL of the stock solutions in sections 7.12.1 and 7.12.2 to 10 mL in a volumetric flask with nonane to a final concentration of 5.0 µg/mL.

7.12.4 Recovery Standard Spiking Solution: Add 10 mL of nonane to a 12 mL amber vial with a Class A glass pipette. With a syringe, remove 200 µL of nonane from the vial and add 200 µL of the recovery standard secondary stock solution to a final concentration of 0.1 µg/mL. 20 µL of this solution is added to each sample, method blank and QC sample extract. See Table 2 for a complete list of compounds and their concentrations.

7.13 1613B and 8290A Cleanup Standards

7.13.1 Cleanup Standard Stock Solution: CIL Catalog No. ED-907, 50 µg/mL in nonane, 1.2 mL

7.13.2 Cleanup Standard Secondary Stock Solution: Dilute 0.100 mL of the 50 µg/mL cleanup standard stock solution to 1.0 mL in a volumetric flask with nonane to a final concentration of 5.0 µg/mL.

7.13.3 Cleanup Standard Working Stock Solution: Dilute 0.120 mL of the 5.0 µg/mL cleanup standard secondary stock solution to 3.0 mL in a volumetric flask with nonane to a final concentration of 200 ng/mL.

7.13.4 Cleanup Standard Spiking Solution: Dilute 200 µL of the 200 ng/mL working stock solution to 200 mL in a 250 mL amber bottle with a PTFE lined cap with hexane to a final concentration of 0.20 ng/mL. 1.0 mL of this solution is added to each 1613B or 8290A sample, method blank and QC sample extract prior to cleanup. See Table 2 for a complete list of compounds and their concentrations.

8. Sample Collection, Preservation and Storage

8.1 Sampling is not performed for this method by TestAmerica Knoxville. For information regarding sample shipping, refer to SOP KNOX-SC-0003, “Sample Receipt and Log In”, current revision. Sample container and preservation recommendations are listed in the table below.

Method:	**1613B**	**8290/8290A[1]**
Holding Times	Samples – 1 year from collection to extraction. Extracts – 1 year from extraction to analysis.	Samples – 30 days from collection to extraction. Extracts – 45 days from extraction to analysis. Tissue Extracts –45 days from collection to analysis.
Containers	Amber Glass	Amber Glass
Preservation:		
Aqueous Samples	≤6 °C in the dark. If residual chlorine is present, add 80 mg/L sodium thiosulfate. If pH > 9, adjust to pH 7-9 with sulfuric acid.	≤6 °C in the dark.
Solid Samples	<-10 °C in the dark.	≤6°C in the dark.
Tissue Samples	<-10 °C in the dark.	<-20 °C in the dark[2].

Notes:

1 For methods 8290 and 8290A, the holding times listed are recommendations. PCDDs and PCDFs are very stable in a variety of matrices, and holding times under the conditions listed can be as high as a year for certain matrices. The results of samples analyzed after the holding time expiration date must be considered to be minimum concentrations and must be identified as such in the final report. Sample extracts, however, must always be analyzed within 45 days of extraction. (For the State of South Carolina and the New Jersey DEP, the holdings times are as listed in the table and are not considered recommendations.)

2 If the freezer used to store samples is not capable of reaching a temperature of <-20 °C when the temperature control is set to its maximum limit, storage at a higher temperature is acceptable as long as it is <-10 °C.

9. Quality Control

9.1 Internal Standards: Every sample, blank and QC sample is spiked with labeled internal standards prior to extraction. Internal standards in samples, blanks and QC samples are used to calculate the concentration of the target analytes or detection limits.

9.2 Cleanup Standards: For methods 1613B and 8290A, every sample, blank and QC sample extract is spiked with labeled cleanup standards after extraction but prior to extract cleanup. They are used to assess the efficiency of the cleanup procedures.

9.3 Recovery Standards: Every sample, blank and QC sample extract is spiked with labeled recovery standards prior to analysis. They are used to measure the recovery of the internal standards and the cleanup standards.

9.4 Method Blank: A laboratory method blank must be run along with each batch of 20 or fewer samples. The method blank is processed in the same manner and at the same time as the associated samples. The method blank is used to identify any background interference or contamination of the analytical system that may lead to the reporting of elevated concentration levels or false positive data. Refer to the table below for a cross-reference between the sample matrix and method blank matrix.

Matrix	Method Blank Matrix
Aqueous	Reagent water
Solid	Sodium sulfate
Tissue	Sodium sulfate
Wipe	Sterile gauze pad
Waste	Hexane

9.5 Laboratory Control Sample: A laboratory control sample (LCS) is prepared and analyzed with every batch of 20 or fewer samples. The LCS extract must be subject to the same cleanup procedures as the associated sample extracts. LCS spike components and concentrations are listed in Table 1. Refer to the table below for a cross-reference between the sample matrix and LCS matrix.

Matrix	LCS Matrix
Aqueous	Reagent water
Solid	Sodium sulfate
Tissue	Sodium sulfate and corn oil
Wipe	Sterile gauze pad
Waste	Hexane

9.6 Matrix Spike/Matrix Spike Duplicate (MS/MSD) – Method 8290 only.

When method 8290 is performed, a matrix spike/matrix spike duplicate (MS/MSD) is prepared and analyzed with every 20 samples of a given matrix. **Note that an MS/MSD is not required for Method 8290A**. The MS/MSD is spiked with the same subset of analytes as the LCS (see Table 1). If an MS/MSD is not possible due to limited sample, then an LCSD must be analyzed.

10. Calibration and Standardization

10.1 Not applicable.

11. Procedure

11.1 One time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variations in sample matrix, radioactivity, chemistry, sample size or other parameters. Any variations in the procedure, except those specified by project specific instructions, must be completely documented using a Nonconformance Memo and approved by a Technical Specialist, Project Manager and QA Manager. If contractually required the client must be notified.

11.2 Any unauthorized deviations from this procedure must also be documented as a nonconformance with a cause and corrective action described.

11.3 Samples are extracted by the following procedures depending upon sample matrix. Water samples are prepared by separatory funnel liquid/liquid extraction. Solid samples, including soils, sediments, tissues and solid waste materials, are prepared by Soxhlet extraction. Non-aqueous liquid wastes and organic solvents are prepared by waste dilution techniques.

11.4 Aqueous Sample Extraction

11.4.1 Remove samples from the refrigerator and allow them to come to room temperature before measuring the volume or performing the extraction. Inspect the samples carefully for biphasic sample characteristics. If this condition exists, document the observation and contact the project manager for instructions before proceeding with the extraction.

11.4.2 For aqueous samples that potentially contain >1% visible solids (as determined visually by an experienced analyst), a percent solid determination must be performed using the following procedure.

11.4.2.1 Add 10 mL of the well shaken sample to a tared aluminum weighing dish. Weigh the dish to three significant figures. Dry the dish overnight in an oven at 105 °C. Reweigh the dish and calculate the percent solids using the following equation.

$$\%\,\text{Solids} = \frac{\text{weight of dish plus sample after drying} - \text{weight of dish}}{\text{weight of dish plus sample before drying} - \text{weight of dish}} \times 100$$

11.4.3 8290/8290A aqueous extraction: For samples with ≤ 1% visible solids (as determined visually by an experienced analyst), follow the normal extraction procedure (i.e., without filtration).

11.4.4 1613B aqueous extraction: For samples with ≤ 1% visible solids (as determined visually by an experienced analyst), samples must be filtered and extracted as solid and aqueous fractions. The extracts from each fraction are then combined into one extract. See section 11.4.11 for filtration procedures.

11.4.5 8290/8290A/1613B aqueous extraction: For samples with > 1% visible solids, consult the project manager for further instructions before proceeding with extraction using one of the options listed below:

11.4.5.1 Samples can be filtered, extracted separately as solid and aqueous fractions, and analyzed separately.

11.4.5.2 Samples can be filtered, extracted separately as solid and aqueous fractions, and the extracts combined for a single analysis.

11.4.5.3 The client may decide to resample if they determine that solids should not have been present.

11.4.6 Refer to Knoxville SOP KNOX-QA-0002, current revision, for information on glassware cleaning procedures for extraction glassware. Visually inspect all glassware prior to use for scratches or cracks. Retire, repair or replace any glassware found to be damaged.

11.4.7 Place separatory funnels (one for each sample, the method blank and the LCS) in the positions in the rotary extractor.

11.4.8 Place a 600 mL concentration tube directly beneath each separatory funnel in the tube holder.

11.4.9 Plug a glass funnel with glass wool and pour in sodium sulfate (about 1 to 2 inches from the top). Rinse the sodium sulfate with methylene chloride over a waste container to catch the solvent waste. When the funnel stops dripping, place the funnel on top of the concentrator tube.

11.4.10 If solids are not observed in the sample, mark the level of the sample on the sample bottle in order to measure the volume later and carefully add the sample to the separatory funnel, taking care not to spill any sample. Using a Class A 1000 mL graduated cylinder, measure out 1000 mL of reagent water and add to the separatory funnels marked for the method blank, LCS and LCSD (if required).

11.4.11 Sample Filtration

11.4.11.1 Assemble a Buchner funnel with a rubber stopper on top of a precleaned vacuum filter flask. Wet a 15 cm diameter, 2.7 µm particle retention glass fiber filter with a few mL of reagent water and carefully fit the filter into the funnel.

11.4.11.2 Apply vacuum to the flask. Mark the level of the sample on the sample bottle in order to measure the volume later. Carefully add the sample to the Buchner funnel, swirling the sample remaining in the bottle to suspend any particles.

11.4.11.3 Rinse the sample bottle twice with approximately 10 mL portions of reagent water to transfer any remaining particles onto the filter. Rinse any particles off the sides of the Buchner funnel with small quantities of reagent water.

11.4.11.4 If the percent solids in a 1613B sample are ≤ 1%, extract the filtrate in a separatory funnel by proceeding to section 11.4.12. Extract the solids on the filter and the filter itself following the procedure in section 11.5. **Do not add internal standards to this portion of the sample; only add internal standards to the**

aqueous portion of the sample! The resulting extract is combined with the extract of the aqueous portion during the concentration step in section 11.9.19.

11.4.12 Using a Class A 1 mL volumetric pipette or syringe, add 1 mL of the appropriate 1.0 ng/mL internal standard spiking solution (see sections 7.10.2 and 7.11.4) to each sample, the method blank, LCS, LCSD (as required) and MS/MSD (as required). Record the amount of spike used and the spike solution number on the extraction benchsheet.

11.4.13 Using a Class A 1 mL volumetric pipette or syringe, add 1 mL of the native LCS spiking solution (see section 7.9.3) to the designated LCS, LCSD (as required) and MS/MSD (as required). Record the amount of spike used and the spike solution number on the extraction benchsheet.

11.4.14 Add 60 mL of methylene chloride to the sample bottle and shake. Then carefully pour the methylene chloride into the separatory funnel. Add 60 mL of methylene chloride to the method blank, LCS and LCSD (if required) as well.

11.4.15 Secure the separatory funnel with the rotator retaining straps and rotate for 2 minutes.

CAUTION: Care must be used while performing this operation. Vent the separatory funnel frequently.

11.4.16 Allow the water and the methylene chloride to separate. If it is not separated after 10 minutes, attempt to break up the emulsion layer by gently swirling the sample or tilting the separatory funnel on its side.

11.4.17 Drain the methylene chloride from the separatory funnel into the glass funnel that is filled with sodium sulfate, allowing the extract to drip into the concentrator tube. Be careful not to allow water to escape the separatory funnel or the sodium sulfate will harden and block the flow of the extract. If at least 10 minutes has elapsed and other ways of breaking up or reducing the size of the emulsion have failed, the following steps can be tried to reduce the impact of the emulsion on the sodium sulfate.

11.4.17.1 Place a large piece of precleaned glass wool in the funnel containing the sodium sulfate.

11.4.17.2 Spread the glass wool out, covering the entire surface of the sodium sulfate to a depth of ~5 to 10 mm. If the emulsion is hard to break up and persistent, a small, additional layer of sodium sulfate is added on top of the glass wool.

11.4.17.3 Drain the solvent and emulsion layer into the funnel being careful to drain no more than 60 mL of volume if a clear phase layer cannot be determined.

11.4.17.4 If this procedure is used, the funnel is rinsed with an extra 30 mL of methylene chloride after the emulsion layer is drained into the funnel to ensure all analytes are rinsed into the concentrator tube.

11.4.18 Repeat steps 11.4.14 through 11.4.17 two more times.

11.4.19 After the third methylene chloride portion has filtered through the sodium sulfate, rinse the funnel with approximately 40 mL of methylene chloride.

11.4.20 Remove the separatory funnel from the hood and pour the extracted water into the extracted water waste container.

11.4.21 Fill the empty sample bottle to the marked level with tap water. Pour the tap water into a Class A 1000 mL graduated cylinder. Record the volume of sample used on the extraction benchsheet.

11.4.22 Proceed to Macro Extract Concentration of Aqueous Extracts by Rapid-Vap in section 11.5.

11.5 Macro Extract Concentration of Aqueous Extracts by Rapid-Vap

11.5.1 Preheat the unit to the appropriate temperature for the solvent used in the extraction.

11.5.2 Set the operating parameters on the programmer. For example, if there is 300 mL of a methylene chloride extract, the following parameters are used and adjusted as needed:

Temperature:	30 °C
Vortex Speed:	30%, initially
Nitrogen:	7-9 psi
Timer Set:	30 minutes

11.5.3 Place 600 mL concentrator tubes containing the extract in the Rapid-Vap. Begin concentrating the extract, adjusting the vortex speed for the proper rate of concentration.

11.5.4 When the extract has been concentrated to less than 20 mL, add approximately 60 mL of hexane. Concentrate the extract to a final volume of approximately 2 mL (that is the volume contained in the reservoir tip of the Rapid-Vap). Shut off the nitrogen flow and turn off the Rapid-Vap or remove the 600 mL concentrator tube to prevent further concentration.

11.5.5 Transfer the extract to a 40 mL vial with a 9” disposable pipette, rinsing the sample tube 3 times with approximately 3 mL of hexane. Reduce the volume in the 40 mL vial using the N-EVAP to approximately 2 mL and proceed to extract cleanup in section 11.11. If no cleanups are to be performed, continue with the following steps to dry the extract. The sample extracts sometimes contain small amounts of water due to condensation forming on the glassware during the concentration steps. Take care to ensure the water is removed.

11.5.6 Prepare a small funnel by placing a small plug of precleaned glass wool at the bottom of the funnel and adding a layer of sodium sulfate on top of the glass wool. Rinse the funnel with approximately 5 mL of hexane to pre-wet the sodium sulfate.

11.5.7 Pipette the extract from the Rapid-Vap concentrator tube and through the funnel containing the sodium sulfate into a 40 mL vial.

11.5.8 Rinse the concentrator tube 3 times with approximately 3 mL of hexane for each rinse. Rinse the sodium sulfate funnel with an additional 2 mL of hexane. Proceed to micro concentration in section 11.12.

11.6 Screening Process for Samples with High Concentration of Dioxins/Furans

11.6.1 Samples received are carefully reviewed before starting the extraction process. Any samples that are received from known dioxin/furan sites and samples that contain keywords such as PCP (pentachlorophenol) site, wood treaters, PCB sites and fire/burn sites can be subjected to the screening process.

11.6.2 Screening is done as a precaution to minimize the chance of having high level samples exposing the preparation and analytical areas to excessive amounts of dioxins/furans, thereby potentially contaminating areas and other samples contained in those areas. See Appendix III for LRMS Dioxin Screen Strategy.

11.6.3 Mix sample well, weigh out 2.5 g (± 0.1 g) and place in a 40 mL vial.

11.6.4 Add 10 mL of toluene and shake on a shaker table for 3 hours.

11.6.5 After the contents have settled, remove the toluene supernatant from the vial and place in a fresh, clean vial containing 100 µL of tetradecane as a keeper. Rinse the vial 3 times with 1 mL of toluene to insure complete transfer of the extract.

11.6.6 Solvent exchange the extract by placing it on the nitrogen concentration device. Concentrate the extract to near dryness. Add 4 mL of hexane and concentrate to near dryness again. Repeat again and then bring the extract to volume with 2 mL of hexane.

11.6.7 Run the extract through a silica gel/alumina column cleanup as detailed in section 11.11.4. After the silica gel/alumina column cleanup is completed, put the extract back on the nitrogen concentration device and concentrate to approximately 0.5 mL.

11.6.8 Transfer the concentrated extract to a 2 mL clear, screw cap vial marked at 1.0 mL. Rinse the 40 mL vial several times with small amounts of hexane to complete the transfer. Adjust volume of the extract to 1.0 mL. Take extract to the GC/MS Semivolatiles group for analysis.

11.7 Pretreatment for Fly Ash Samples

11.7.1 If the sample matrix is fly ash and is to be analyzed by method 8290 or 8290A, pretreat the sample with HCl. Weigh 10 g (± 0.5 g) of the fly ash sample and transfer to a 250 mL glass jar. Record the sample weight on the extraction benchsheet. If a sample is designated for MS/MSD analysis, prepare two additional portions of the sample and label them as the MS and MSD.

11.7.2 Add 150 mL of 1N HCl to the sample. Seal the jar with a PTFE lined screw cap and shake for 3 hours at room temperature.

11.7.3 Rinse a 15 cm diameter, 2.7 µm particle retention glass fiber filter with reagent water. Carefully fit the glass fiber filter into a Buchner funnel and filter the sample through the funnel attached to a 1 L vacuum flask. Rinse the sample bottle twice with small amounts of reagent water, making sure that all particulate matter is transferred onto the glass fiber filter. Wash the fly ash cake with approximately 500 mL reagent water.

11.7.4 Transfer the filter and fly ash filter cake sample to a Dean-Stark Soxhlet. Proceed to section 11.9.

11.8 Sample Pretreatment for Tissues

11.8.1 If the sample matrix is tissue and has not been homogenized prior to receipt, the entire sample is homogenized prior to extraction using an industrial meat grinder, a laboratory blender, or a laboratory homogenizer. Select the equipment that is most appropriate for the size and type of tissue received.

11.9 Solid/Tissue/Wipe Sample Extraction

11.9.1 Prepare and label the required number of Soxhlet or Dean-Stark Soxhlet systems. Refer to Knoxville SOP KNOX-QA-0002, current revision, for information on glassware cleaning procedures for extraction glassware. Visually inspect all glassware prior to use for scratches or cracks. Retire, repair or replace any glassware found to be damaged.

NOTE: A Dean-Stark extractor is used to remove the water from all sample matrices except tissue and wipes. The Dean-Stark apparatus is installed between the Soxhlet body and the condenser when the components are assembled. All method 1613B solid samples and extremely wet 8290/8290A solid samples (e.g., samples with standing water) are extracted using Dean-Stark Soxhlets.

11.9.2 For 8290 and 8290A soil samples, transfer a well-mixed 10 g (± 0.5 g) aliquot of the sample into a glass microfiber extraction thimble. Record the sample weight on the extraction benchsheet.

11.9.3 For method 1613B solids and for all sediment samples, adjust the amount weighed to achieve 10 to 10.5 g dry weight. Determine the amount of sediment sample to extract using the "Sediment Extraction Amounts" spreadsheet (refer to Appendix IV) on the local area network in the MSOffice\template\Knx OrgPrep directory. Transfer a well-mixed aliquot of the sample into a glass microfiber extraction thimble. Record the sample weight on the extraction benchsheet.

11.9.4 For tissue samples, weigh out 10 g (± 0.5 g) of homogenized tissue into a beaker or extraction thimble. Mix thoroughly with ~20 g of sodium sulfate. Record the sample weight on the extraction benchsheet.

NOTE: If gravimetric lipids are to be determined using the tissue extracts, refer to SOP KNOX-OP-0020, "Gravimetric Lipids Determination", current revision.

11.9.5 For wipes samples, place the wipe directly into the Soxhlet extractor. Rinse the sample container with ~30 mL of toluene and transfer the rinsate to the top of the Soxhlet extractor.

11.9.6 Refer to the Section 9.4 for a cross-reference between the sample matrix and method blank matrix and Section 9.5 for the LCS matrix.

11.9.7 Pour approximately 350 mL toluene into a 500 mL boiling flask. For tissue samples, use methylene chloride as the extraction solvent. Place the flask in the heating mantle.

11.9.8 Place the extraction thimble in the glass Soxhlet extractor.

11.9.9 Assemble the Soxhlet system and secure to the lab supports.

11.9.9.1 Place the method blank and QC samples in random positions within the available prep positions in the hood (i.e., do not use the same positions each time for the method blank and QC samples).

11.9.10 Spike each sample and QC samples with 1.0 mL of the appropriate internal standard spiking solution (see sections 7.10.2 and 7.11.4) and add a small amount of glass wool to the top of the thimble, if needed, to secure the sample material. Record the standard solution ID and volume spiked on the extraction benchsheet.

NOTE: Each time the samples are spiked, the spiking process should be witnessed by another analyst. Refer to Appendix II for the steps that must be taken.

11.9.11 Spike the LCS (and LCSD, MS/MSD, if required) with 1.0 mL of the native LCS spiking solution (see section 7.9.3) prior to adding the glass wool. Record the standard solution ID and volume spiked on the extraction benchsheet.

11.9.11.1 If a sample is designated for MS/MSD analysis, prepare two additional portions of the sample and label them as the MS and MSD.

11.9.11.2 The MS and MSD samples must be prepared at the same weight to avoid calculation errors in the RPD values.

11.9.12 Add approximately 10 boiling beads and several PTFE boiling chips to the boiling flask.

CAUTION: When extracting or concentrating a sample with hexane, toluene or any mixture containing these solvents, the analyst **must** add the boiling chips within 5 minutes of placing the flask on the heat source in order to prevent bumping of the solvent.

11.9.13 Adjust the temperature of the heating mantle to bring the solvent in the boiling flask to a rolling boil. There must be a steady drip from the condensers so that the solvent completely cycles at least 5 times an hour. Record the date and time that the Soxhlet extraction was started on the extraction benchsheet and initial and date.

11.9.14 Soxhlet extract the sample in the above manner for a minimum of 16 hours. At the end of the extraction period, turn off the heating mantles. Record the date and time that the Soxhlet extraction was completed on the extraction benchsheet and initial and date.

11.9.15 Remove the condensers. If a Dean Stark condenser is used, drain the water from the Dean Stark (the bottom layer of liquid). Then drain the remaining liquid into the Soxhlet. Empty the Soxhlet extractor chamber into the boiling flask and remove the Soxhlet extractor from the 500 mL boiling flask.

11.9.16 Add several (2-3) fresh boiling chips to the flask. Insert a three-ball macro Snyder column into the top of the 500 mL boiling flask.

CAUTION: When extracting or concentrating a sample with hexane, toluene or any mixture containing these solvents, the analyst **must** add the boiling chips within 5 minutes of placing the flask on the heat source in order to prevent bumping of the solvent.

11.9.17 Apply heat to the 500 mL flask in the heating mantle and reduce the extract volume to approximately 10-15 mL.

11.9.18 For tissue samples, transfer the concentrated methylene chloride extract to a 40 mL vial rinsing the 500 mL flask 3 times with approximately 3 mL of methylene chloride. Place the 40 mL vial into the nitrogen concentration device and reduce the volume to approximately 6 to 8 mL. Follow the instructions in SOP KNOX-OP-0022, current revision, for GPC cleanup.

11.9.19 For samples that were extracted using toluene, follow the steps listed below:

11.9.19.1 Transfer the extract into a 40 mL vial containing 100 µL of tetradecane, rinsing the 500 mL flask 3 times with approximately 3 mL of hexane. Add the rinsings to the 40 mL vial.

11.9.19.2 Place the 40 mL vial into the nitrogen concentration device and reduce the volume to near dryness. Add 4 mL of hexane and swirl the vial. Reduce the volume of hexane to near dryness again to complete the solvent exchange. If the sample exhibits poor solubility in hexane, add approximately 1 mL of benzene with a pipette to the vial to aid in dissolving the residue. Adjust the final volume of the extract with hexane to 12 mL for acid-base cleanup or 2 mL for column cleanup. Proceed to sample cleanup in section 11.11.

11.10 Waste Dilution

11.10.1 Organic wastes, oil and solids that dissolve in solvent and non-aqueous sludge samples can be prepared by the waste dilution technique.

11.10.2 Tare a clean 40 mL vial on a laboratory balance. Add an appropriate amount of sample (e.g., 1.0 ± 0.1 g) to the vial. If a sample is designated for MS/MSD analysis, prepare two additional portions of the sample and label them as the MS and MSD samples. Prepare method blank, LCS and LCSD (if required) samples by adding 12 mL of hexane to a 40 mL vial.

11.10.3 Record the weights and volumes used on the extraction benchsheets and initial and date.

11.10.4 Add 1.0 mL of the appropriate internal standard spiking solution (see sections 7.10.2 and 7.11.4) to the samples, method blank and QC samples. Record the standard solution ID and volume spiked on the extraction benchsheet. Add hexane to bring the volume to 12 mL. If the sample exhibits poor solubility in hexane, add approximately 1 mL of benzene to the vial to aid in dissolving the sample.

11.10.5 Add 1.0 mL of the native LCS spiking solution (see section 7.9.3) to the designated LCS, LCSD (as required) and MS/MSD (as required). Record the amount of spike used and the spike solution number on the extraction benchsheet.

11.10.6 Proceed to sample extract cleanup in section 11.11.

11.11 Sample Extract Cleanup

11.11.1 Any or all sample cleanup techniques may be employed to remove sample interferences as necessary. The same cleanup techniques must also be performed on the associated quality control samples (method blank, LCS/LCSD). MS/MSD samples must undergo the same cleanup procedures as the associated parent sample.

11.11.2 For 1613B and 8290A samples that are to be subjected to one or more cleanup steps, add 1.0 mL of the $^{37}Cl_4$-2,3,7,8-TCDD cleanup standard (section 7.13.4) to each sample, method blank and LCS/LCSD extract before any cleanup steps are performed.

11.11.3 Acid-Base Cleanup

The acid-base cleanup is employed when sample extracts are colored and/or oily in appearance, or if specified by the client or project manager.

11.11.3.1 Bring the extract volume up to ~12 mL with hexane in a 40 mL vial.

NOTE: If the extracts are from fish tissue, omit sections 11.11.3.2 and 11.11.3.3.

11.11.3.2 Wash the extract by adding approximately 10 mL of 20% aqueous potassium hydroxide to the vial and gently shaking for 20 seconds. If an emulsion begins to form, discontinue shaking. Vent the vial frequently to prevent pressure build up. Let the vial stand for 10 minutes or longer until any emulsion present settles out. Carefully remove the aqueous layer (the bottom layer) with a glass pipette, taking care not to remove any of the solvent layer or remaining emulsion. Repeat the base washing until no color is visible in the base layer (perform a maximum of two base washings).

11.11.3.3 Add approximately 10 mL of 5% (w/v) aqueous sodium chloride to the vial and gently shake for 20 seconds. If an emulsion forms, discontinue shaking. Vent the vial frequently to prevent pressure build up. Let the vial stand for 10 minutes or longer until any emulsion present settles out. Carefully remove the aqueous layer (the bottom layer) with a glass pipette, taking care not to remove any of the solvent layer or remaining emulsion.

11.11.3.4 Slowly add approximately 15 mL of concentrated sulfuric acid to the vial. If an emulsion remains from the previous step, slowly add concentrated sulfuric acid (drop by drop) to the vial. **CAUTION: HEAT CAN BE GENERATED DURING THIS STEP**. Shake the vial for 30 seconds. Vent the vial frequently to prevent pressure build up. Let the vial stand for 10 minutes or longer until any emulsion settles out. Carefully remove the bottom layer (i.e., the aqueous, acid or base layer) with a glass pipette, taking care not to remove any of the solvent layer. Repeat the acid washing if the solvent layer is still darkly colored (perform a maximum of four acid washings). An option to employ if the acid layer is large or very dark and thick is to remove the hexane layer (the top layer) and any emulsion to a fresh 40 mL vial. Rinse the vial containing the acid 2 times with 2 mL of hexane and add these rinsings to the sample vial.

NOTE: Centrifuging is an option for extracts with emulsions that will not break up after 10 minutes.

11.11.3.5 Add approximately 10 mL 5% (w/v) aqueous sodium chloride to the vial and gently shake for 20 seconds. Vent the vial frequently to prevent pressure build up. Let the vial stand for 10 minutes or longer until any emulsion present settles out. Carefully remove the aqueous layer (the bottom layer) with a glass pipette, taking care not to remove any of the solvent layer. Dry the hexane extract by adding 1 to 2 grams of sodium sulfate and swirling the vial.

11.11.3.6 Reduce the extract volume to approximately 6 to 8 mL.

11.11.3.7 Proceed to section 11.11.4 for dual column (silica gel/alumina) cleanup.

11.11.4 Dual Column (Silica Gel/Alumina) Cleanup

Dual column cleanup is employed for most sample extracts. If treated drinking water samples are being analyzed, cleanup may not be necessary.

11.11.4.1 Prepare a 20 mm diameter column and a 16mm diameter column for each extract by rinsing, in order, with acetone and hexane. Place a large ball of precleaned glass wool in the bottom of each column before rinsing the columns.

11.11.4.2 Mark the level to which the column packings are to be added with a marking pen starting at the top of the glass wool plug and proceeding from bottom to top. The levels for each type column are as follows;

20 mm diameter silica gel column:
  12 mm – 2g of 3.3% deactivated silica gel
  16 mm – 4g of acidic silica gel
  12 mm – 2g of 3.3% deactivated silica gel
  10 mm – sodium sulfate

16 mm diameter alumina column:
  40 mm – 6 g of neutral alumina
  10 mm – sodium sulfate

11.11.4.3 Place the columns in the lab supports in the hood so that the 20 mm silica gel column is above the 16 mm alumina column. Offset the columns slightly so that the packings can be added and the columns rinsed.

11.11.4.4 Add the column packing materials in the order listed above (while tapping the column with a marking pen) to settle the contents and to prevent channeling. When the columns have been completely packed, remove the ink markings with a paper towel moistened with acetone or rinse the outside of the column with methylene chloride.

11.11.4.5 Place a 125 mL glass jar under the lower alumina column to catch the solvent wastes and eluents as they filter through the column.

11.11.4.6 Add 20 mL of hexane to each column to rinse the packing. Collect the hexane from the columns in the 125 mL glass jar; the columns must be aligned so that the waste from both columns drips directly into the 125 mL jar. When the level of solvent in the silica gel column approaches the top of the packing, move the upper column support so that the tips of the upper columns are inserted into the tops of the lower columns and the solvent drips into the lower columns.

11.11.4.7 Just as the level of hexane reaches the top of the packing in the silica gel column, transfer the sample extract into the top of the column. Rinse the extract vial 3 times with small amounts of hexane and add each of these rinses to the silica gel column.

11.11.4.8 Just as the solvent level reaches the top of the column packing, add 70 mL of hexane (via a solvent bottle top dispenser in 20 to 30 mL increments) into the top of the silica gel column and allow this to drip into and through the alumina column and into the collection jar. When the hexane has completely drained from the silica gel column, remove the column from the support rack and dispose of it in the appropriate waste container.

11.11.4.9 Just as the level of hexane reaches the top of the packing in the alumina column, replace the 125 mL glass jar containing the solvent waste with a 40 mL vial which has been labeled with the sample workorder number. Using a solvent dispenser, add 10 mL of 5% methylene chloride/hexane mixture. Dispose of the solvent waste in the 125 mL glass jar in the appropriate waste container.

11.11.4.10 Just as the level of the 5% mixture reaches the top of the packing in the alumina column, add 30 mL of 65% methylene chloride/hexane using a solvent dispenser and continue to catch the eluents in the 40 mL vial.

11.11.4.11 When the solvent has completely drained from the alumina column, cap the 40 mL vial containing the eluent and dispose of the alumina column in the appropriate waste container.

11.11.4.12 If no further cleanup is to be performed, proceed to final extract concentration detailed in section 11.12. Otherwise, reduce the volume of the extract to approximately 2 mL using the nitrogen concentration apparatus and proceed to the next cleanup.

11.11.5 Activated Carbon Cleanup

Carbon column cleanup is performed to remove diphenyl ether interferences and when site history indicates they are necessary for removal of other interferences. Carbon column cleanup is also performed when sample extracts cause the acid silica layer of the dual column cleanup to become colored along the entire length of the acid silica. Most solid samples meet these criteria.

11.11.5.1 Prepare a 31 cm pre-cut glass column (8mm ID) by rinsing, in order, with acetone and hexane, and then inserting a glass wool plug of about 1 cm in length approximately 10 cm into the column. Pack the column with 5.0 cm of the J.T Baker Carbon/Silica Gel mixture (section 7.7.3). Hold the packing by inserting an additional glass wool plug, again about 1 cm in length, in the other end.

11.11.5.2 Orient the carbon column in the carbon column rack so that the end with approximately 16 cm of space between the column packing and the end of the column is upright.

11.11.5.3 Pre-elute the column with 10 mL of cyclohexane/methylene chloride (50:50 v/v). Turn the column over and pre-elute in the opposite direction with another 5 mL of cyclohexane/methylene chloride (50:50 v:v).

11.11.5.4 When the solvent reaches the glass wool, add the sample extract. Rinse the sample vial 2 times with approximately 2 mL of 50:50

cyclohexane/methylene chloride. Add these rinses to the column. Elute the column with the following sequence of solvents:

11.11.5.4.1 6 mL of cyclohexane/methylene chloride (50:50 v/v).

11.11.5.4.2 5 mL of methylene chloride/methanol/benzene (75:20:5 v/v).

11.11.5.5 Allow the 75:20:5 methylene chloride/methanol/benzene to drain completely. Turn the column over and in the direction of reverse flow, elute the column with 30 mL toluene into a 40 mL vial.

11.11.5.6 Place vials containing the extract in the nitrogen concentration apparatus and reduce the solvent volume to approximately 0.3 mL. Proceed to section 11.12 for final concentration.

11.12 Final Concentration by Nitrogen Evaporation

11.12.1 When all sample cleanup steps have been completed, add 20 µL of the 0.1 µg/mL recovery standard spiking solution (section 7.12.4) using a 25 µL Hamilton syringe to an empty, clean 1.1 mL tapered mini-vial that has been labeled with the sample ID. (Assure that the vial and cap fit together properly before use.) Mark the level of the recovery standard on the mini-vial. Mark half the level, i.e., 10 µL, if the extracts are from treated drinking waters. Record the volume of recovery standard added and the standard ID on the extraction benchsheet.

11.12.2 Transfer the concentrated extract into the mini-vial. Rinse the 40 mL vial at least twice with a small amount of hexane and add the rinses to the mini-vial. Put the mini-vial on the N-EVAP nitrogen concentration apparatus and reduce the volume to the mark on the vial. Put the cap with PTFE-faced septa securely on the vial. Record the final extract volume on the extraction benchsheet.

11.12.3 All items listed on the data review checklist must be checked by both the analyst who performed the extraction and cleanup steps and the analyst who performed the second level review.

11.12.4 Transfer the extracts and paperwork to the HRMS group for analysis.

12. Data Analysis and Calculations

12.1 Not applicable.

13. Method Performance

13.1 Method Detection Limit (MDL): An MDL must be determined for each analyte in each routine matrix prior to the analysis of any samples. The procedure for determination of the method detection limit is given in SOP CA-Q-S-006, current revision, based on 40 CFR Part 136 Appendix B. The result of the MDL determination must support the reporting limit.

13.2 Initial Demonstration of Capability: Each analyst must perform an initial demonstration of capability (IDOC) for each target analyte prior to performing the analysis independently. The IDOC is determined by analyzing four replicate spikes (e.g., LCSs) as detailed in Test America Knoxville SOP KNOX-QA-0009, current revision.

13.3 Training Qualification: The group/team leader has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required experience. Refer to SOP KNOX-QA-0009, current revision, for further requirements for performing and documenting initial and ongoing demonstrations of capability.

14. Pollution Prevention

14.1 All attempts will be made to minimize the use of solvents and standard materials.

15. Waste Management

15.1 All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Safety Manual for “Waste Management and Pollution Prevention.”

15.2 See the current revision of SOP KNOX-HS-0002 for specific waste handling guidelines.

15.3 The following waste streams are produced when this method is carried out.

15.3.1 Waste solvents must be placed in the flammable waste stream, contained in a steel satellite accumulation container or flammable solvent container.

15.3.2 Miscellaneous disposable glassware, chemical resistant gloves, bench paper and similar materials that may or may not be contaminated/hazardous must be placed in the incinerable laboratory waste stream, contained in a HDPE satellite accumulation container.

15.3.3 Extracted solid/tissue samples, paper funnel filters, glass wool, etc., that has been contaminated with solvents shall be placed in the incinerable laboratory waste stream, contained in a steel or HDPE satellite accumulation container.

15.3.4 Contaminated sulfuric acid used during extract cleanup must be placed in the acidic laboratory waste stream, contained in a HDPE satellite accumulation container or 55 gallon HDPE drum.

15.3.5 Extracted aqueous samples contaminated with methylene chloride must be placed in the organic water waste stream, contained in a HDPE satellite accumulation container.

15.3.6 Silica gel, alumina, carbon and sodium sulfate that has been contaminated with various solvents and eluents, must be placed in the incinerable laboratory waste stream, contained in a HDPE satellite accumulation container.

16. References

16.1 TestAmerica Knoxville Quality Assurance Manual (QAM), current revision.

16.2 EPA Method 1613: Tetra- Through Octa- Chlorinated Dioxins and Furans by Isotope Dilutions HRGC/HRMS, Revision B, October 1994.

16.3 SW-846 Method 8290, Polychlorinated Dibenzodioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs) by High-Resolution Gas Chromatography/High-Resolution Mass Spectrometry (HRGC/HRMS), Revision 0, September 1994.

16.4 SW-846 Method 8290A, Polychlorinated Dibenzodioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs) by High-Resolution Gas Chromatography/High-Resolution Mass Spectrometry (HRGC/HRMS), Revision 1, February 2007.

16.5 TestAmerica Knoxville SOP KNOX-ID-0004, “Analysis of Polychlorinated Dioxins/Furans by High Resolution Gas Chromatography/High Resolution Mass Spectrometry (HRGC/HRMS) Based on Methods 8290, 8290A, 1613B, 23, 0023A and TO-9A”, current revision.

16.6 TestAmerica Knoxville SOP KNOX-OP-0020, “Gravimetric Lipids Determination”, current revision.

16.7 TestAmerica Knoxville SOP KNOX-OP-0022, “GPC Cleanup”, current revision.

16.8 TestAmerica Knoxville SOP KNOX-QA-0002, “Glassware Cleaning”, current revision.

17. Miscellaneous

17.1 Deviations from Reference Methods

17.1.1 Spiking levels have been reduced to minimize the amount of dioxin contaminated waste generated by this procedure. It has been demonstrated that the performance criteria specified in the method are not affected by this modification.

17.1.2 Method 1613B employs a gravimetric determination of sample size rather than a volumetric determination. This procedure employs a volumetric determination of sample size to allow reporting of sample concentration in the standard units of pg/L (ppq). This modification has no impact on the performance criteria of this method.

17.1.3 The determination of solids content procedure used for aqueous samples is the same as the 1613B procedure used for solid samples rather than the 1613B procedure for aqueous samples. The aqueous sample procedure in 1613B is subject to error if the sample density is not exactly 1.0 g/mL.

17.1.4 The amount of hexane used in the solvent exchange step has been reduced from that specified in the reference methods. The reduction in solvent used is a pollution prevention measure. It has been demonstrated that the performance criteria specified in the method are not affected by this modification.

17.1.5 Method 1613B specifies that the sample bottle is rinsed twice with 5 mL of reagent water after the sample is transferred to the separatory funnel. This procedure specifies that the sample bottle is rinsed three times with methylene chloride after the sample is transferred to the separatory funnel. This modification improves the removal of target compounds from the sample bottle.

17.1.6 Toluene volumes and cycle rates for Soxhlet extractors have been optimized for the specific size of glassware used and might not be the same as those specified in the referenced method. It has been demonstrated that the performance criteria specified in the method are not affected by this modification.

17.1.7 Soxhlet extracts are not filtered before concentration and solvent exchange. The use of glass wool in the extraction thimbles eliminates the transfer of particles to the extraction solvent. The column cleanup procedures remove any particulate that might not be removed by the glass wool. It has been demonstrated that the performance criteria specified in the methods is not affected by this modification.

17.1.8 Particle size determination and reduction as specified in method 1613B is not performed on a routine basis. Silica and sand is not added to the Soxhlet extraction thimble as specified in method 1613B. These procedures are considered to be outside the scope of the laboratories routine extraction procedures and are only performed on a client specific or project specific basis. These procedures, if required, must be specified and documented in the appropriate QAPPs.

17.1.9 Benzene is used to aid in dissolving the samples and/or extracts in hexane. It has been demonstrated that the performance criteria specified in the methods is not affected by this modification.

17.1.10 The acid-base cleanup procedure is carried out in a 40 mL vial instead of a separatory funnel. Disposable glassware is used to decrease the risk of cross contamination. The volumes of the washes used have been adjusted for use in the 40 mL vial. It has been demonstrated that the performance criteria specified in the methods is not affected by this modification.

17.1.11 The silica gel/alumina column cleanup and carbon column cleanup procedures described in this SOP have been optimized and may vary significantly from the referenced methods. It has been demonstrated that the performance criteria specified in the methods is not affected by these modifications.

17.1.12 Extracts are stored at room temperature rather than at <10 °C as specified in method 1613B. Methods 8290 and 8290A allow for the storage of extracts at room temperature in the dark. All of the reference methods require that standards be stored at room temperature. Recovery studies performed by Cambridge Isotopes Laboratories (CIL) indicate freezing or refrigeration of standards causes problems with precipitation and irreversible adsorption to the inside surface of the vial. CIL recommends the storage of standards and extracts at room temperature as long as they are protected from exposure to UV and evaporative losses.

17.2 List of Tables, Figures and Appendices

17.2.1 Table 1 – Concentration of Native Stock and Spiking Solutions

17.2.2 Table 2 – Concentration of Labeled Stock and Spiking Solutions

17.2.3 Appendix I – Example Extraction Benchsheet

17.2.4 Appendix II – Guidelines for the Spike Witnessing Process

17.2.5 Appendix III –LRMS Dioxin Screen Strategy

17.2.6 Appendix IV – Example Determination of Sediment Sample Extraction Amounts Spreadsheet

Table 1 – Concentration of Native Stock and Spiking Solutions

Native Analyte	Standard Source	Catalog Number	Vendor Conc (ng/mL)	Working Stock Conc. (ng/mL)	LCS Spiking Solution Conc (ng/mL)
2,3,7,8-TCDD	CIL	EDF-7999-10x	400	40	0.2
2,3,7,8-TCDF	CIL	EDF-7999-10x	400	40	0.2
1,2,3,7,8-PeCDD	CIL	EDF-7999-10x	2000	200	1.0
1,2,3,7,8-PeCDF	CIL	EDF-7999-10x	2000	200	1.0
2,3,4,7,8-PeCDF	CIL	EDF-7999-10x	2000	200	1.0
1,2,3,4,7,8-HxCDD	CIL	EDF-7999-10x	2000	200	1.0
1,2,3,6,7,8-HxCDD	CIL	EDF-7999-10x	2000	200	1.0
1,2,3,7,8,9-HxCDD	CIL	EDF-7999-10x	2000	200	1.0
1,2,3,4,7,8-HxCDF	CIL	EDF-7999-10x	2000	200	1.0
1,2,3,6,7,8-HxCDF	CIL	EDF-7999-10x	2000	200	1.0
2,3,4,6,7,8-HxCDF	CIL	EDF-7999-10x	2000	200	1.0
1,2,3,7,8,9-HxCDF	CIL	EDF-7999-10x	2000	200	1.0
1,2,3,4,6,7,8-HpCDD	CIL	EDF-7999-10x	2000	200	1.0
1,2,3,4,6,7,8-HpCDF	CIL	EDF-7999-10x	2000	200	1.0
1,2,3,4,7,8,9-HpCDF	CIL	EDF-7999-10x	2000	200	1.0
OCDD	CIL	EDF-7999-10x	4000	400	2.0
OCDF	CIL	EDF-7999-10x	4000	400	2.0

Table 2 – Concentration of Labeled Stock and Spiking Solutions

Labeled Analyte	Standard Source	Catalog Number	Vendor Conc (ng/mL)	Stock Conc (ng/mL)	Working Stock Conc. (ng/mL)	Spiking Solution Conc (ng/mL)
Internal Standards						
$^{13}C_{12}$-2,3,7,8-TCDD	CIL	EDF-8999	100	N/A	N/A	1.0
$^{13}C_{12}$-2,3,7,8-TCDF	CIL	EDF-8999	100	N/A	N/A	1.0
$^{13}C_{12}$-1,2,3,7,8-PeCDD	CIL	EDF-8999	100	N/A	N/A	1.0
$^{13}C_{12}$-1,2,3,7,8-PeCDF	CIL	EDF-8999	100	N/A	N/A	1.0
$^{13}C_{12}$-2,3,4,7,8-PeCDF	CIL	EDF-8999	100	N/A	N/A	1.0
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	CIL	EDF-8999	100	N/A	N/A	1.0
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	CIL	EDF-8999	100	N/A	N/A	1.0
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	CIL	EDF-8999	100	N/A	N/A	1.0
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	CIL	EDF-8999	100	N/A	N/A	1.0
$^{13}C_{12}$-2,3,4,6,7,8-HxCDF	CIL	EDF-8999	100	N/A	N/A	1.0
$^{13}C_{12}$-1,2,3,7,8,9-HxCDF	CIL	EDF-8999	100	N/A	N/A	1.0
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	CIL	EDF-8999	100	N/A	N/A	1.0
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	CIL	EDF-8999	100	N/A	N/A	1.0
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	CIL	EDF-8999	100	N/A	N/A	1.0
$^{13}C_{12}$-OCDD	CIL	EDF-8999	100	N/A	N/A	2.0
Internal Standards - Tetras Only						
$^{13}C_{12}$-2,3,7,8-TCDD	CIL	ED-900	50000	1000	N/A	1.0
$^{13}C_{12}$-2,3,7,8-TCDF	CIL	EF-904	50000	1000	N/A	1.0
Recovery Standards						
$^{13}C_{12}$-1,2,3,4-TCDD	CIL	ED-911	50000	5000	N/A	100
$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	CIL	ED-996	50000	5000	N/A	100
Cleanup Standard						
$^{37}Cl_4$-2,3,7,8-TCDD	CIL	ED-907	50000	5000	200	0.2

Appendix I – Example Extraction Benchsheet

1613B ☐ 8290 ☐ 8290A ☐

TestAmerica Knoxville Extraction Sheet
1613/8290/8290A Sediment/Soil by Soxhlet - KNOX-ID-0004

Batch Number: ____________ Native Spike (0.20/1.0/2.0 ng/mL) ID: ____________ Spiked by: ________ Witness: ________ Date: ____________ Delivered: ____________
Initials/Date/Time
Soxhlet Start Date/Time: ____________ Internal Std (1.0/2.0 ng/mL) ID: ____________ Spiked by: ________ Witness: ________ Date: ____________
Soxhlet Stop Date/Time: ____________ Cleanup Std (0.20 ng/mL) ID: ____________ Spiked by: ________ Witness: ________ Date: ____________ Received: ____________
Initials/Date/Time
Soil ☐ Sediment ☐ Recovery Std (100 ng/mL) ID: ____________ Spiked by: ________ Witness: ________ Date: ____________

Lot Sample Number	Work Order Number	Suf	Add sample to Soxhlet thimble. Record weight (g).	Water layer decanted? (Y/N/NA)	Add IS to all samples & QC. Record volume (mL).	Add native spike to LCS, LCSD, MS, MSD. Record volume (mL).	Extract for a minimum of 16 hr in toluene.	Concentrate extracts on heating mantles.	Add 100 µL tetradecane to rinsed 40 mL vials. Concentrate extracts on N-EVAP.	Solvent exchange to hexane on N-EVAP. Bring to ~12 mL in hexane.	Add cleanup std to all 1613B and 8290A extracts. Record volume (mL).	Acid/Base wash extracts if needed.	Concentrate extracts on N-EVAP to 2-4 mL in hexane.	Perform silica gel/alumina column cleanup.	Concentrate to ~2 mL on N-EVAP for carbon cleanup.	Perform carbon cleanup.	Concentrate to <1 mL.	Add recovery std to mini-vial. Record volume added (µL). Transfer extract to vial.	Conc to delivery volume in nonane. Record delivery vol (µL).

Extr Toluene Lot #: ____________ 5% NaCl ID: ________ Deact Silica ID: ________ 95/5 Hex/$MeCl_2$ ID: ____________ 75/20/5 $MeCl_2$/MeOH/Benz ID: ________
Tetradecane Lot #: ____________ H_2SO_4 Lot #: ________ Acid Silica ID: ________ 65/35 $MeCl_2$/Hex ID: ____________ Carbon Col Toluene Lot #: ________
Conc Hexane Lot #: ____________ A/B Na_2SO_4 Lot #: ________ SG/A Col Na_2SO_4 Lot #: ________ Carbon Lot #: ____________
20% KOH ID: ____________ Alumina Lot #: ________ SG/A Col Hex Lot #: ________ 50/50 $MeCl_2$/Cyclo ID: ____________
Comments: ____

1613B 8290 Solid.xls **Printed: 2/2/2011 4:23 PM**

Appendix II – Guidelines for the Spike Witnessing Process

- Make sure there are no distractions, for example, phone calls, checking samples on water bath, people coming in to ask questions.
- The person spiking must tell the person who is witnessing what is being spiked and how much. Make sure the paperwork shows the spike amounts and spike IDs.
- The person witnessing should make sure they know and understand what is to be spiked and how much. Check the paperwork to verify.
- Check the syringe for air bubbles and also check the spike volume.
- It is a good idea to also check for cracks in the glassware.
- If client service requires spiking to occur when another analyst is not available, a witness is not required. In this case, the analyst will serve as his/her own witness and must carefully double check the spike solutions and spike amounts added to the client samples and associated quality control samples. The analyst enters his/her initials as both the analyst and witness.

Appendix III – LRMS Dioxin Screen Strategy

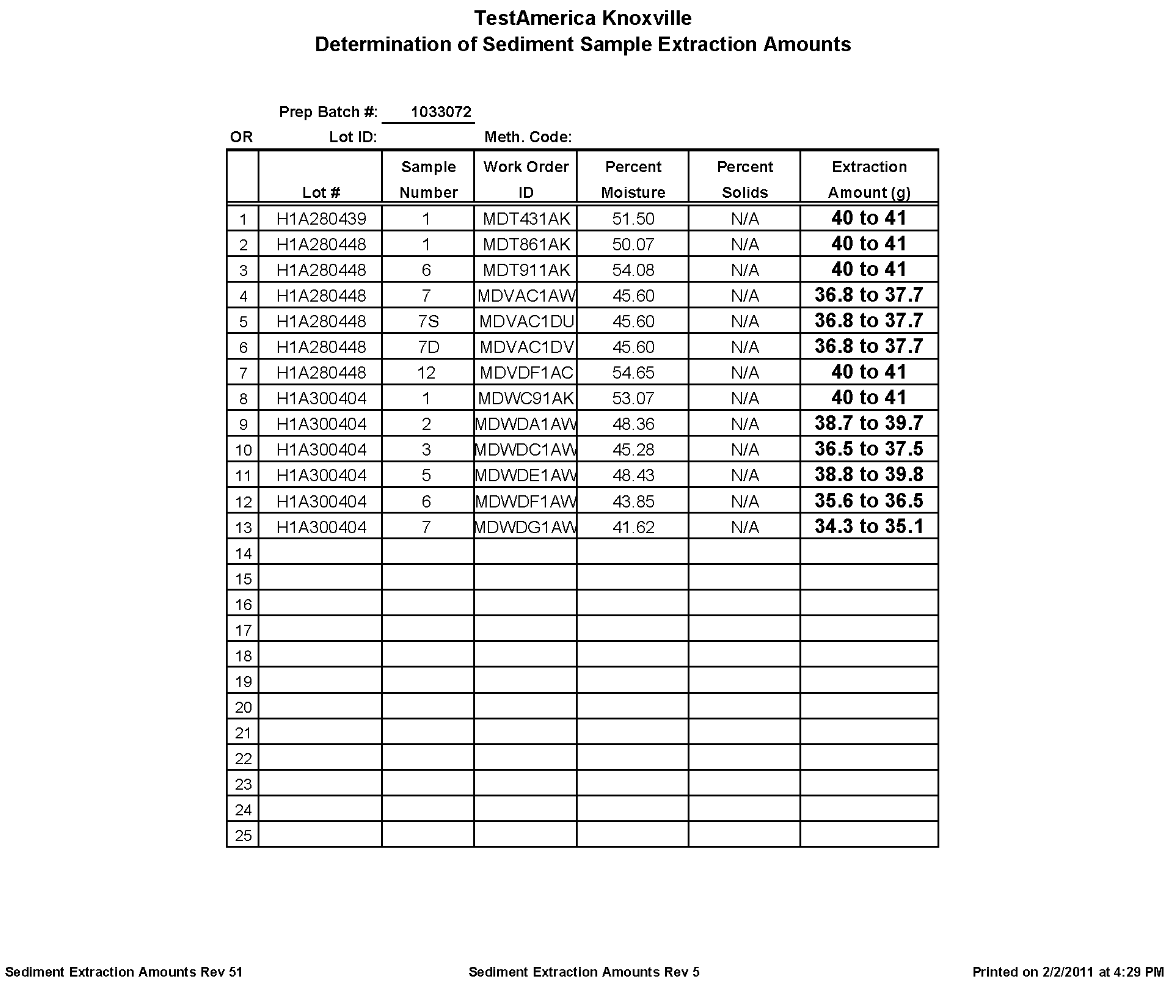
LRMS Dioxin Screen Strategy

Analyte	10g LCL ppt pg/g	10g UCL ppt pg/g	5X UCL 10 g 20 uL	**5X UCL @ 1 g pg/g**	Level 4 Samp Conc pg/g	Level 4 Screen Using 1 g 20uL pg/g	Level 4 Screen Using 1 g 500 uL vs 20uL (pg/g)	Level 4 Screen Using 1.25 g 500 uL vs 20uL (pg/g)	**Level 4 Screen Using 2.5 1000 uL vs 20uL (pg/g)**
2,3,7,8-TCDD	1	400	2000	**20000**	100	1000	25000	20000	**20000**
2,3,7,8-TCDF	1	400	2000	**20000**	100	1000	25000	20000	**20000**
1,2,3,7,8-PeCDD	5	2000	10000	**100000**	500	5000	125000	100000	**100000**
1,2,3,7,8-PeCDF	5	2000	10000	**100000**	500	5000	125000	100000	**100000**
2,3,4,7,8-PeCDF	5	2000	10000	**100000**	500	5000	125000	100000	**100000**
1,2,3,4,7,8-HxCDD	5	2000	10000	**100000**	500	5000	125000	100000	**100000**
1,2,3,6,7,8-HxCDD	5	2000	10000	**100000**	500	5000	125000	100000	**100000**
1,2,3,7,8,9-HxCDD	5	2000	10000	**100000**	500	5000	125000	100000	**100000**
1,2,3,4,7,8-HxCDF	5	2000	10000	**100000**	500	5000	125000	100000	**100000**
1,2,3,6,7,8-HxCDF	5	2000	10000	**100000**	500	5000	125000	100000	**100000**
2,3,4,6,7,8-HxCDF	5	2000	10000	**100000**	500	5000	125000	100000	**100000**
1,2,3,7,8,9-HxCDF	5	2000	10000	**100000**	500	5000	125000	100000	**100000**
1,2,3,4,6,7,8-HpCDD	5	2000	10000	**100000**	500	5000	125000	100000	**100000**
1,2,3,4,6,7,8-HpCDF	5	2000	10000	**100000**	500	5000	125000	100000	**100000**
1,2,3,4,7,8,9-HpCDF	5	2000	10000	**100000**	500	5000	125000	100000	**100000**
OCDD	10	4000	20000	**200000**	1000	10000	250000	200000	**200000**
OCDF	10	4000	20000	**200000**	1000	10000	250000	200000	**200000**

If levels in screen are greater than the level 4 standard, do not prep. Send for 8280 analysis.
If peaks are observed at 1/5 to 1 time(s) the areas of the level 4 standard, prep at 1 g, 1/10 bench dilution.***
If peaks are observed at 1/50 to 1/5 time(s) the areas of the level 4 standard, prep at 1 g.***
If no peaks are observed, prep 10 grams.

*** In these cases, the glassware used is treated as contaminated. Post- Clean with solvent before washing.

Appendix IV – Example Determination of Sediment Sample Extraction Amounts Spreadsheet



TestAmerica Knoxville
Determination of Sediment Sample Extraction Amounts

Prep Batch #: 1033072
OR Lot ID: Meth. Code:

	Lot #	Sample Number	Work Order ID	Percent Moisture	Percent Solids	Extraction Amount (g)
1	H1A280439	1	MDT431AK	51.50	N/A	**40 to 41**
2	H1A280448	1	MDT861AK	50.07	N/A	**40 to 41**
3	H1A280448	6	MDT911AK	54.08	N/A	**40 to 41**
4	H1A280448	7	MDVAC1AW	45.60	N/A	**36.8 to 37.7**
5	H1A280448	7S	MDVAC1DU	45.60	N/A	**36.8 to 37.7**
6	H1A280448	7D	MDVAC1DV	45.60	N/A	**36.8 to 37.7**
7	H1A280448	12	MDVDF1AC	54.65	N/A	**40 to 41**
8	H1A300404	1	MDWC91AK	53.07	N/A	**40 to 41**
9	H1A300404	2	MDWDA1AW	48.36	N/A	**38.7 to 39.7**
10	H1A300404	3	MDWDC1AW	45.28	N/A	**36.5 to 37.5**
11	H1A300404	5	MDWDE1AW	48.43	N/A	**38.8 to 39.8**
12	H1A300404	6	MDWDF1AW	43.85	N/A	**35.6 to 36.5**
13	H1A300404	7	MDWDG1AW	41.62	N/A	**34.3 to 35.1**
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						

Sediment Extraction Amounts Rev 51 Sediment Extraction Amounts Rev 5 Printed on 2/2/2011 at 4:29 PM

ARCADIS

Infrastructure · Water · Environment · Buildings

Imagine the result

HERCULES

Site-Specific Health & Safety Plan

Phase I and II Sampling and Analysis
Hattiesburg, Mississippi

16 September 2011

ARCADIS

Site-Specific Health & Safety Plan

Phase I and II Sampling and Analysis
Hattiesburg, Mississippi

Craig A. Derouen

Craig A Derouen
Designated H&S Plan Writer

Joel A. Riley

Joel A. Riley
Designated H&S Plan Reviewer

Ashly A. Insco
CHMM H&S Plan Reviewer

John Ellis

John Ellis, P.G.
Principal Scientist/Geologist
Project Manager

Prepared for:
Hercules Incorporated

Prepared by:
ARCADIS U.S., Inc.
10352 Plaza Americana Drive
Baton Rouge
Louisiana 70816
Tel 225.292.1004
Fax 225.218.9677

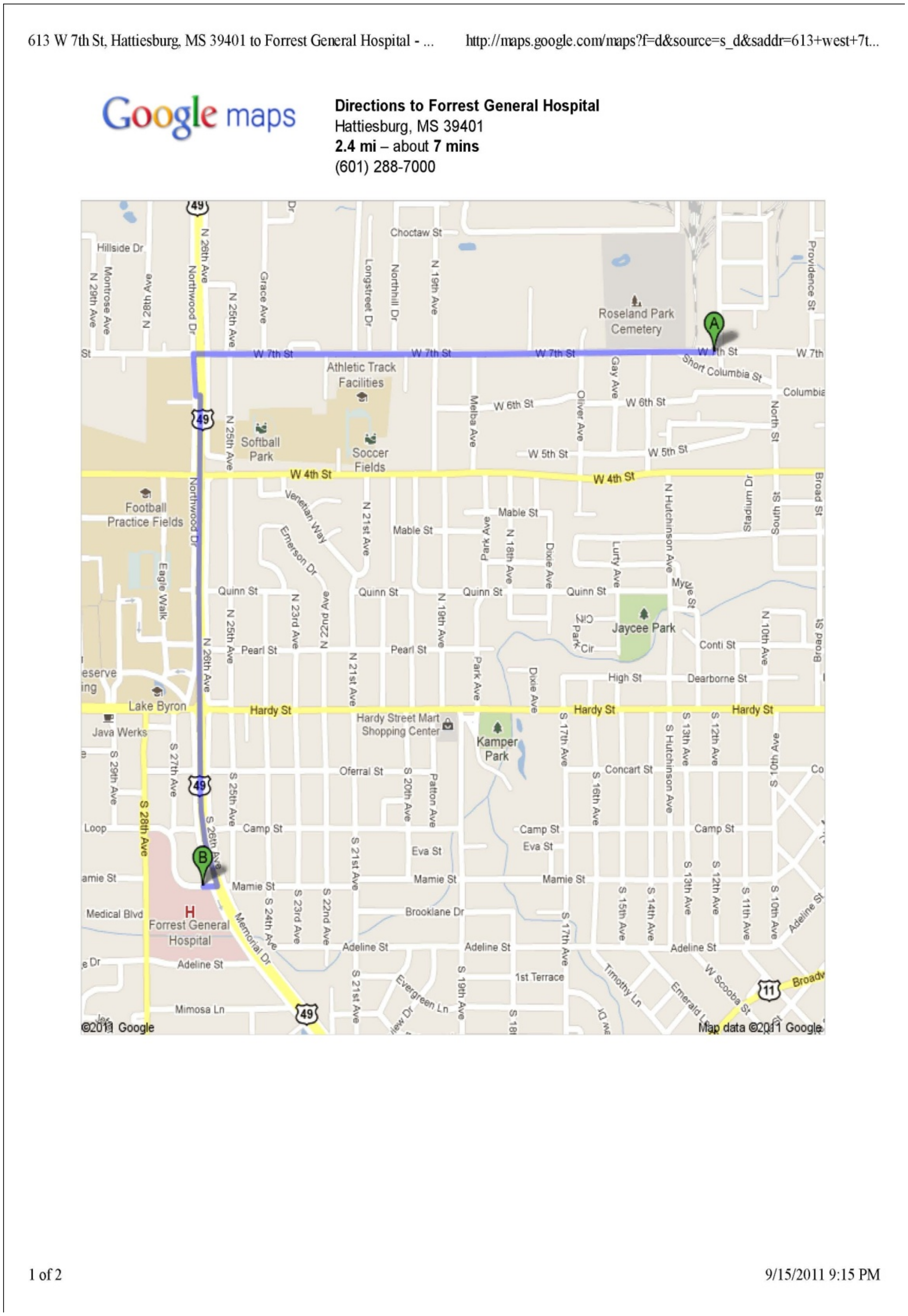
Our Ref.:
LA002999.0004

Date:
16 September 2011

Tables

Appendices

Hospital Route

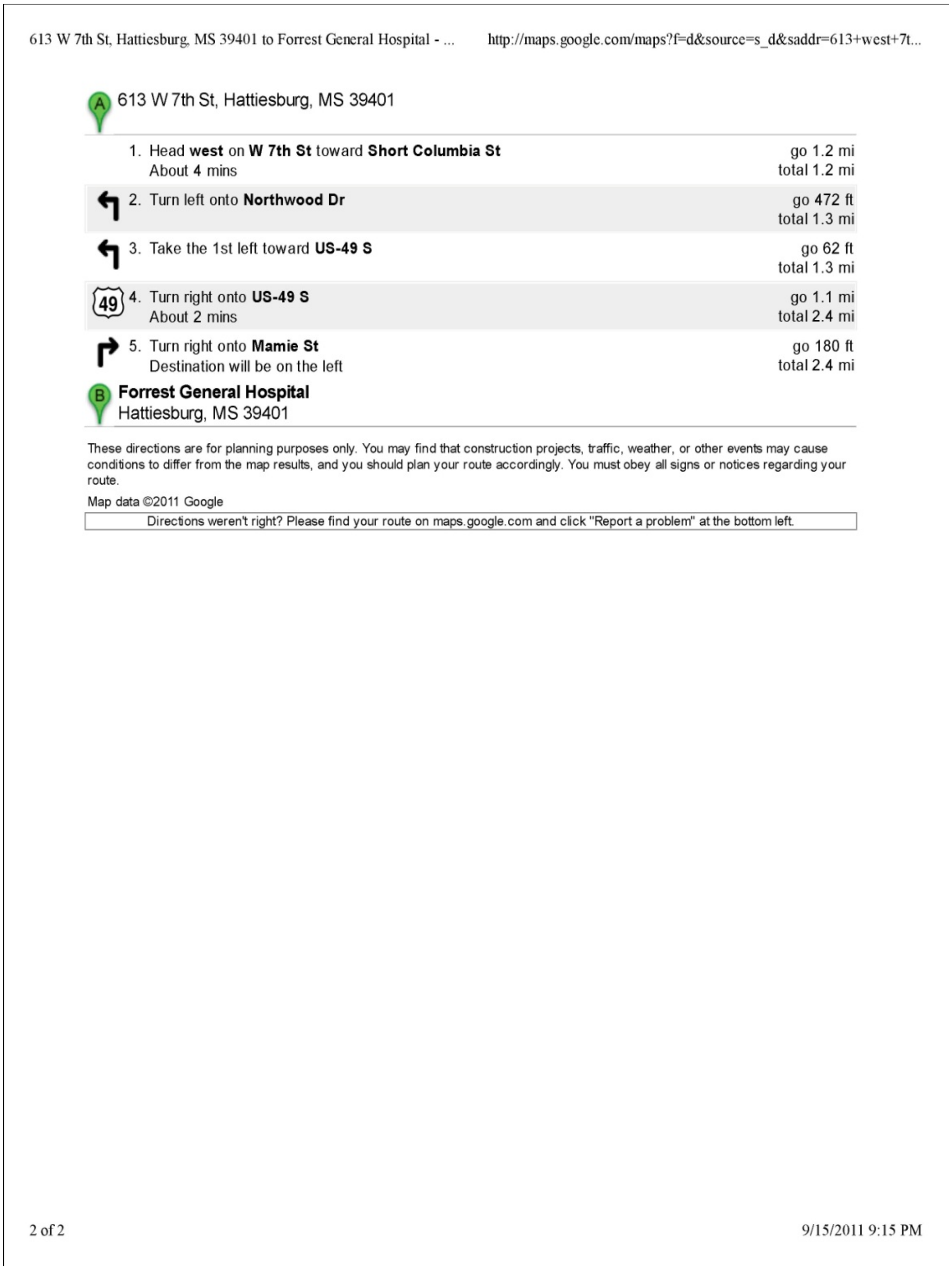


613 W 7th St, Hattiesburg, MS 39401 to Forrest General Hospital - ... http://maps.google.com/maps?f=d&source=s_d&saddr=613+west+7t...

Directions to Forrest General Hospital
Hattiesburg, MS 39401
2.4 mi – about **7 mins**
(601) 288-7000

1 of 2

9/15/2011 9:15 PM



613 W 7th St, Hattiesburg, MS 39401 to Forrest General Hospital - ... http://maps.google.com/maps?f=d&source=s_d&saddr=613+west+7t...

A 613 W 7th St, Hattiesburg, MS 39401

	1. Head **west** on **W 7th St** toward **Short Columbia St** About 4 mins	go 1.2 mi total 1.2 mi
↰	2. Turn left onto **Northwood Dr**	go 472 ft total 1.3 mi
↰	3. Take the 1st left toward **US-49 S**	go 62 ft total 1.3 mi
49	4. Turn right onto **US-49 S** About 2 mins	go 1.1 mi total 2.4 mi
↱	5. Turn right onto **Mamie St** Destination will be on the left	go 180 ft total 2.4 mi

B **Forrest General Hospital**
Hattiesburg, MS 39401

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.

Map data ©2011 Google

Directions weren't right? Please find your route on maps.google.com and click "Report a problem" at the bottom left.

2 of 2 9/15/2011 9:15 PM

1. Emergency Contact Information and Procedures

Local Police – *Hattiesburg Police Department* *701 James Street, Hattiesburg, MS 39401*	911 and (601) 544-7900
Local Ambulance – *AAA Ambulance Services* *6-92 US Highway 49, Hattiesburg, MS 39401*	911 and (601) 545-8996
Local Fire Department – *Hattiesburg Fire Department* *810 North Main Street, Hattiesburg, MS 39401*	911 and (601) 582-3311
Local Hospital – *Forrest General Hospital* *6051 US Highway 49, Hattiesburg, MS 39401*	(601) 288-7000
Local Weather Data	Weather.com
Poison Control	(800) 332-3073
National Response Center (all spills in reportable quantities)	(800) 424-8802
U.S. Coast Guard (spills to water)	(800) 424-8802
ARCADIS Project Manager – John Ellis	Office: (225) 292-1004 Cell: (225) 803-7012
ARCADIS H&S Manager – Craig Derouen	Office: (225) 292-1004 Cell: (225) 802-7005
Client Contact – Tim Hassett	Office: (302) 995-3456 Cell: (302) 379-0512
WorkCare	1-800-455-6155

Directions to Hospital

Medical Facility: Forrest General Hospital
Address: 6051 US Highway 49, Hattiesburg, MS

Phone Number: (601) 288-7000

See map and directions on Page a.

Emergency Notification Procedure for the Project

Step 1:Dial 911 (if necessary) and/or Work Care (800) 455-6155

Step 2:John Ellis – Office: (225) 292-1004; Cell: (225) 803-7012

Step 3:Craig Derouen – Office: (225) 292-1004; Cell: (225) 802-7005

Step 4:Tim Hassett – Office: (302) 995-3456; Cell: (302) 379-0512

Emergency Supplies and Equipment List

Emergency Supplies and Equipment (check all that apply)	Location on Project Site
☒ First Aid Kit (type):	Vehicles and office
☒ Fire Extinguisher	Vehicles and office
☒ Mobile Phone ☐ Satellite Phone	On person
☒ Traffic Cones	When working near roadways
☐ Walkie Talkies	
☒ Water or Other Fluid Replenishment	Vehicles and office
☒ Eye Wash/Quick Drench Station	Office
☒ Eye Wash Bottle	Vehicles
☒ Wash and Dry Towelettes	Office
☒ Sunscreen (SPF 15 or higher)	Vehicles and office
☒ Insect Repellant	Vehicles and office (needs project approval)
☐ Chemical Spill Kit	
☐ *Other (specify):*	

2. Introduction

All work on this project will be carried out in compliance with ARCADIS, U.S., Inc. (ARCADIS') Health and Safety Standards and the Occupational Safety and Health Administration's Hazardous Waste Operations and Emergency Response regulation. The design of this health and safety plan (HASP) conforms to the requirements of the ARC HSFS010-H&S Plan Standard. Specific health and safety information for the project is contained in this HASP. All personnel working on hazardous operations or in the area of hazardous operations shall read and be familiar with this HASP before doing any work. All project personnel shall sign the certification page acknowledging that they have read and understand this HASP.

Changes in the scope of the project or introduction of new hazards to the project shall require revision of the HASP by the HASP writer and reviewer, and approval by the Project Manager. The HASP Addendum Form and log table are included as Appendix A.

Hercules Incorporated (Hercules) in Jackson, MS received an Administrative Order (AO) from the United States Environmental Protection Agency (USEPA) May 9, 2011, to determine, if any, the presence of contamination off-site, originating from the Hercules facility. The USEPA AO directs Hercules to identify potential off-site migration of contaminants and the respective pathways. ARCADIS has been contracted by Hercules to conduct further environmental investigation of the Hercules facility and to conduct an environmental investigation of the surrounding area. The surrounding area for the initial investigations is a 0.5-mile radius, with the potential to extend out to a 4 mile radius, as defined in the USEPA AO. The primary goal of sampling activities will be to assess the presence, magnitude, extent, direction, and rate of movement of any of the constituents to be monitored under the AO. The approach will include incorporating and utilizing existing sampling data previously collected as part of Site-related assessments conducted in the area by Hercules, USEPA, or the state that relate to the purposes of the AO, including assessments to: characterize the source(s) of any Constituents; characterize the potential pathways of migration of any Constituents; define the degree and extent of the presence of any Constituents; and identify actual or potential human and/or ecological receptors. Detected Constituents will be investigated to determine the extent of any impacts. The impacts will then be evaluated to determine the potential impact to any identified human or ecological receptors.

3. Project Site History and Requirements

3.1 Site Background

The Hattiesburg, Mississippi, facility was developed in the 1920s as Hercules Powder Company. In the mid-1960s, the name of the company that owned the plant was changed to Hercules Incorporated. Additional production plants were added in the 1960s and 1970s. Portions of the plant were demolished in the 1980s. In November 2008, Ashland Inc. purchased the stock of Hercules Incorporated, and Hercules became a wholly owned subsidiary of Ashland Inc. During 2008 and 2009, two active plants on the property produced chemicals for the pulp and paper industry: the Kymene Plant and the AKD Plant. Hercules closed the facility in December 2009. Currently, no active plants are on the property, nor are any such facilities planned.

The Hercules facility began operations in 1923. Throughout the facility's history the operations consisted of extracting and/or working with rosins to produce rosin derivatives, paper chemicals, and Delnav, an agricultural insecticide. Structures at the facility included offices, a laboratory, a powerhouse, production buildings, a wastewater treatment plant, settling ponds, a landfill, and central loading and packaging areas. The plant began to downsize in the 1980s (i.e. there was no new chemical expansion) and process operations at the facility were shut down at the end of 2009. Currently, many of the former plant buildings have been demolished. As part of plant demolition and decommissioning activities, Hercules has been working with the Mississippi Department of Environmental Quality to gain approval for decommissioning of the on-site wastewater treatment impoundment basin (IB) and is awaiting a response to the August 2010 Impoundment Basin Decommissioning Work Plan.

Various environmental investigations have been conducted at the Hercules facility since the early 1980's. The work has included geophysical investigations and sampling of soil, groundwater, surface water, and stream sediment for analysis of various constituents, including volatile organic compound (VOCs), semivolatile organic compounds, pesticides, polychlorinated biphenyls, metals, cyanide, Dioxathion (cis- and trans-), and Dioxenethion.

In 2005, a Corrective Action Plan was approved for monitored natural attenuation with institutional controls. A monitoring program was implemented and controls were established to restrict the land use and activities on-site. The monitoring program for groundwater and surface water is currently conducted on a semiannual basis and consists of water level gauging and analysis of select samples for VOCs (semiannually) and Dioxathion/Dioxenethion (annually).

As noted above, the scope of the Order, and the activities to be performed under the Order, including but not limited to the implementation of the AO, is to assess the presence, magnitude, extent, direction, and rate of movement of any Constituents.

3.2 Site Description

Site Type: (Check as many as applicable}

	Active	X	Secure	X	Industrial		Landfill		Service station
X	Inactive		Unsecured		Commercial		Well field		Water work
			Uncontrolled		Residential		Railroad		Undeveloped
Other specify:									

The Hercules Site is located on approximately 200 acres of land north of West Seventh Street in Hattiesburg, Forest County, Mississippi. The Site is located in Township 4 North, Range 13 West, within Sections 4 and 5 just north of Hattiesburg, Mississippi. The geographic coordinates of the Site are 31° 20' 20" north latitude and 89° 18' 25" west longitude. The physical address of the facility is 613 West Seventh Street, Hattiesburg, Mississippi.

The Site is bordered to the north by Highway 42 and beyond which is Illinois-Central & Gulf Railroad, along with various residential and commercial properties. The southern property boundary is bordered by 7th Avenue; and by Roseland Park cemetery and Zeon Chemical Corporation to the south-southwest. Across from these locations are residential areas. The eastern and western boundaries are bordered by sparsely populated residential and commercial areas.

The primary Chemicals of Concern (COCs) on this project are:

Known Compounds	Source (soil/water/drum, etc.)	Known Concentration Range (ppm, mg/kg, mg/L)	
		Lowest	**Highest**
Benzene	Groundwater	0.0063 mg/L	7.6 mg/L
Chloroform	Groundwater	0.0027 mg/L	7.3 mg/L
Carbon Tetrachloride	Groundwater	0.97 mg/L	32 mg/L
Total Dioxathion (Dioxathion & Dioxenethion)	Groundwater	ND	0.0847 mg/L
Chlorobenzene	Groundwater	0.15 mg/L	0.760 mg/L
Methylene Chloride	Groundwater	ND	0.560 mg/L

Known Compounds	Source (soil/water/drum, etc.)	Known Concentration Range (ppm, mg/kg, mg/L)	
		Lowest	**Highest**
1,2 – Dichloroethane	Groundwater	ND	0.084 mg/L
Methyl Isobutyl Ketone	Groundwater	ND	0.51 mg/L
Toluene	Groundwater	ND	4.5 mg/L

ND Nondetect.

3.3 List of Project Tasks and Scope of Work

- *Task 1: Drinking Water Well Survey and Sampling* – A potable water well survey and sampling program will be implemented in the area surrounding the facility. Sampling will be phased within the initial 0.5-mile radius as defined in the AO. ARCADIS will identify and sample all appropriate water wells according to the Sampling and Analysis Work Plan (SAP) developed for the project. An additional assessment will be conducted in appropriate directions; based on initial well survey findings, in 0.5-mile radial increments, until COC are no longer detected. If warranted, additional sampling will be conducted out to a 4 mile radius.

  Sampling activities will utilize low flow techniques (bladder or peristaltic pumps). Modified Level D (hard hat, safety glasses, nitrile gloves, and steel toed boots) personal protective equipment (PPE) will be required during water well sampling activities. The Site Safety Officer (SSO) will conduct periodic air monitoring with an organic vapor analyzer (OVA), during initial sampling activities to monitor the ambient air for VOC concentrations. PPE upgrades (action level) will be based on sustained readings at concentrations equal to the threshold limit value (TLV) of the constituent with the lowest TLV requirement. Benzene is the constituent of concern with the lowest TLV, which is 0.5 parts per million (PPM) The short-term exposure limit for benzene is 5 ppm for 15 minutes. The project personal will base PPE upgrades on Benzene, unless the OVAs utilized on site can distinguish the various constituent concentrations separately. If the OVAs can monitor concentrations of the project constituents separately, project management may base PPE upgrades on the respective TLV values for each constituent deemed present.

  Higher constituent concentrations are expected in the area of the Hercules facility, with lower constituent concentrations in the radius surrounding the Hercules facility. Initial air monitoring for VOCs will be conducted during water well sampling activities on or close to the Hercules facility. If air monitoring determines that ambient air around the water well sampling activities are free or below one half of the threshold limit value throughout the task, air monitoring frequency will be adjusted accordingly by project management. Based on known groundwater concentrations at the Hercules facility, all sampling activities are expected to require level D personal protective equipment (PPE). ARCADIS will conduct all water well sampling procedures according to the SAP. Additional hazards could result from unfriendly or unsafe neighborhoods or people. If ARCADIS personal identifies or observes any dangerous activities, stop work authority (SWA) will be initiated and the proper notifications will be made. Work on the project will be conducted in the daylight hours and staff will periodically check in with project management approximately every 30 minutes. If deemed necessary by project management, police escorts may be required.

- *Task 2: Surface Water and Sediment Sampling* – ARCADIS will conduct a surface water and sediment sampling in the area surrounding the facility. Assessment will be conducted up to 0.5 mile away from the Facility. ARCADIS will identify wetlands, creeks, lakes or other surface water bodies to be sampled, including any ditches located within a 0.5 mile radius of the Facility's property boundaries. ARCADIS will identify any such bodies of water which are used for public recreational purposes or may contain threatened and endangered species. Sampling will be focused on surface water bodies that could potentially be impacted.

  Level D PPE is expected for both the sediment and surface water sampling activities. ARCADIS will utilize the buddy system at all times during these activities. Due to the nature of the areas where surface and sediment sampling activities will be conducted, additional PPE or work protocol may be required. Sediment and surface water sampling activities have increased likelihood of contact with biological hazards such as: snakes, ticks, bees, wild animals, dogs, spiders, and poisonous plants. The SSO will evaluate the conditions and determine if PPE needs upgraded (snake chaps, dog whistle, poison ivy block) based on both physical and chemical conditions. Additionally, Kevlar gloves will be utilized when handling glass sample containers. ARCADIS will conduct all sediment and surface water sampling procedures according to the SAP.

- *Task 3: Groundwater Sampling* – Current shallow (water table) groundwater data will be screened against calculated groundwater screening levels protective of indoor air exposure. These values will be calculated from USEPA Regional Screening Levels. If the groundwater screening level is below a Maximum Contaminant Levels (MCLs), the MCL will be used as the criteria instead. As necessary, additional groundwater samples may be collected to complete the delineation of shallow groundwater. As described in USEPA (2002) VI Guidance, further investigation of the VI pathway is necessary for any building within 100 feet the screening level or MCL.

A Direct Push Technology (DPT) rig will be utilized to install the temporary monitoring wells. Project management may determine to collect soil samples during the installation of the monitoring wells. ARCADIS will ensure the proper utility locates have been completed with a minimum of three lines of evidence. Groundwater sampling activities will utilize low flow techniques (bladder or peristaltic pumps). Level D PPE will be required during the installation of the monitoring wells. If the well location is in or near a residential area, ARCADIS will section off the work zone with caution tape and monitor pedestrian activity. If any unauthorized individuals approaches or enters the work zone, stop work authority will be used until it's safe to continue work activities. The SSO will conduct periodic air monitoring during installation activities to monitor the area for VOC concentrations. Air monitoring for VOCs will also be conducted during initial groundwater sampling activities on or close to the Hercules facility. If air monitoring determines that ambient air around the groundwater sampling activities is free or below the TLV, throughout the tasks, air monitoring frequency will be adjusted accordingly by project management. If established air monitoring readings (data must be logged by calibrated unit and posted at Site) and laboratory analysis indicates that the exposure hazards are below the TLV for an activity, air monitoring may be discontinued on any task proven to be free of or below the TLV for constituents' onsite. At minimum level D PPE will be worn at all times. PPE upgrades will be based on sustained readings of the action level of the constituent with the lowest TLV. Sustained readings are defined as a one minute average ambient air concentration.

Groundwater samples will be obtained from the temporary wells following standard sampling protocol. Upon completion of the groundwater sampling, project management will determine when and if the temporary wells will be removed and the borings will be plugged and abandoned. ARCADIS will conduct all groundwater sampling procedures according to the SAP.

- *Task 4: Soil Gas Sampling* – A soil gas sampling program will be implemented. Sampling will be phased within the initial 0.5-mile radius. Assessment will be conducted up to 0.5-mile away from the Facility, if warranted. Identify residential and commercial properties within a 0.5-mile radius of the Facility's property boundaries.

Soil gas sampling activities will utilize a hand auger to create a boring down to the groundwater interface. If boring hand augering exceeds 5 feet, ARCADIS will rotate staff to ensure muscle strain and fatigue hazards are minimized. A Summa® canister or tubing attach to the canister, will be advanced into the boring to approximately one foot above the groundwater interface. When properly positioned, ARCADIS will collect the soil gas sample with the Summa® canister for the timeframe indicated by the laboratory. Air monitoring for VOCs will be conducted during soil-gas sampling activities. If air monitoring determines that ambient air around the soil-gas sampling activities is free or below one half of the TLV, throughout the task, air monitoring frequency will be adjusted accordingly by project management.

A DPT rig may be utilized to create the boring needed to the collect the soil gas samples if the groundwater interface is to deep to hand auger. Project management will determine where the DPT rig is appropriate, however for Health and Safety purposes anything over 10 feet depth will utilized DPT rig to obtain the sample. If a DPT rig is utilized; ARCADIS will ensure that skilled associates or sub-contractors are operating the DPT rig, that three lines of evidence are obtained for proper utility clearance, and that PPE will be upgraded accordingly. ARCADIS will section off the work zone with caution tape and monitor pedestrian activity. If any unauthorized individuals approaches or enters the work zone, stop work authority will be used until it's safe to continue work activities. ARCADIS will conduct all soil gas sampling procedures according to the SAP.

- *Task 5: Sub-Slab Soil Gas and Indoor Air Sampling* – Based on the soil gas results, a sub-slab soil gas and indoor air sampling program may be implemented. Assessment will be conducted up to 0.5-mile away from the Facility. Identify residential and commercial properties within a 0.5-mile radius of the Facility's property boundaries.

  ARCADIS will obtain the proper access and acknowledgement agreements prior to conducting any sub-slab soil gas sampling. ARCADIS will ensure that three lines of evidence are obtained for proper utility clearance prior to conducting sub-slab soil sampling. To obtain a sub-slab soil sample, ARCADIS personal will use a hammer drill or like equipment to create a small hole in the building slab, down to the soil below the slab. When the hole is created ARCADIS may utilize helium gas to test the hole for integrity. When ready, ARCADIS will use a Summa® canister to collect the sub-slab soil gas sample. Upon completion ARCADIS will fill and seal the hole in the slab and return the property to its previous condition. If ARCADIS encounters unfriendly or unsafe conditions or people, or observes an illegal activity while conducting indoor sub-slab soil sampling activities, ARCADIS will use SWA and make the proper notifications. ARCADIS will conduct all sub-slab soil gas procedures according to the SAP.

4. ARCADIS Organization and Responsibilities

4.1 All Personnel

Each person is responsible for completing tasks safely, and reporting any unsafe acts or conditions to their supervisor. No person may work in a manner that conflict with these procedures. Prior to initiating Site activities, all ARCADIS and subcontractor personnel will receive training in accordance with applicable regulations, and be familiar with the requirements and standards referenced in this HASP. In addition, all personnel will attend daily safety meetings (tailgate meetings) to discuss Site-specific hazards prior to beginning each day's work. Every ARCADIS employee, subcontractor, and client representative at the Site has the responsibility to stop the work of a coworker or subcontractor if the working conditions or behaviors are considered unsafe.

4.2 Project Manager/Task Manager

The Project Manager is responsible for verifying that project activities are completed in accordance with the requirements of this HASP. The Project Manager is responsible for confirming that the project has the equipment, materials, and qualified personnel to fully implement the safety requirements of this HASP, and/or that subcontractors assigned to this project, meet the requirements established by ARCADIS. It is also the responsibility of the Project Manager to:

- Review all applicable H&S Standards, and ensure that project activities conform to all requirements;
- Obtain client-specific health and safety information and communicate with the client on health and safety issues;
- Communicate with the SSO on health and safety issues;
- Allocate resources for correction of identified unsafe work conditions;
- Ensure ARCADIS Site workers have all training necessary for the project; and

- Report all injuries, illnesses and near-misses to the client representative, lead incident investigations, and ensure that any recommendations made are implemented.

4.3 Site Safety Officer

The SSO has overall responsibility for the technical health and safety aspects of the project. Inquiries regarding ARCADIS health and safety standards, project procedures, and other technical or regulatory issues should be addressed to this individual. It is also the responsibility of the SSO to:

- Review and work in accordance with the components of this HASP;
- Ensure that this HASP is available to and reviewed by all Site personnel including subcontractors;
- Ensure that necessary Site-specific training is performed (both initial and “tailgate” safety briefings);
- Ensure Site visitors have been informed of the hazards related to ARCADIS work;
- Ensure that work is performed in a safe manner and has authority to stop work when necessary to protect workers and/or the public;
- Coordinate activities during emergency situations;
- Ensure that all necessary permits and safety information provided by the client is disseminated to other Site personnel and is maintained in an organized manner;
- Communicate with the PM on health and safety issues;
- Reports all injuries, illnesses and near-misses to the PM; and
- Ensures that necessary safety equipment is maintained and used at the Site.

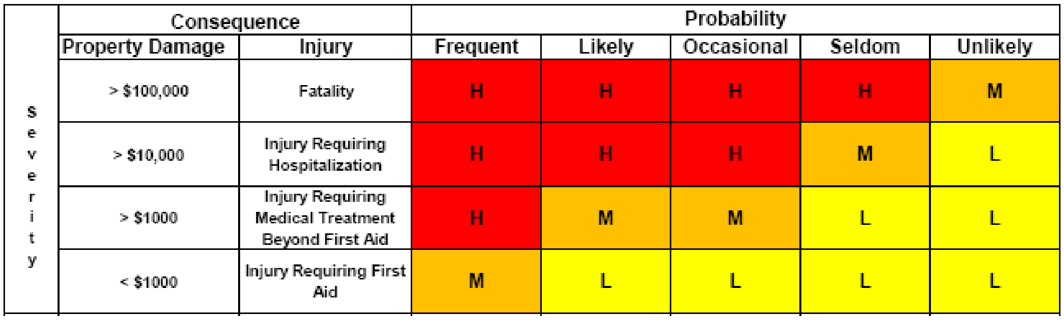
The SSO will contacts a health and safety professional for assistance in establishing the respiratory cartridge change schedule as required.

5. Project Hazards and Control Measures

5.1 Hazard Analysis

Rank the hazards in the table below using HIGH (H), MEDIUM (M) or LOW (L) based on current Site knowledge. For hazards that are not applicable, leave blank. Use results of this analysis to verify controls in Job Loss Analysis (JLA) or other supporting documents are adequate to mitigate task hazards. When in the field, use the Tailgate Safety Meeting Form for task specific evaluation of task hazards.

Table 1. Hazard Ranking Chart



	Consequence		Probability				
	Property Damage	Injury	Frequent	Likely	Occasional	Seldom	Unlikely
Severity	> $100,000	Fatality	H	H	H	H	M
	> $10,000	Injury Requiring Hospitalization	H	H	H	M	L
	> $1000	Injury Requiring Medical Treatment Beyond First Aid	H	M	M	L	L
	< $1000	Injury Requiring First Aid	M	L	L	L	L

☒ Hazards are ranked using the ARCADIS HARC Process: *ARC HSMS002*

Biological		***Mechanical***		***Chemical/Radiation***	
M	Biting/stinging insects	L	Cuts on equipment/tools		Not applicable
L	Biting animals	L	Pinch points on equipment	L	General
H	Poisonous plants	L	Burns from equipment	L	Dusts, toxic
M	Phys. damaging plants	L	Struck by equipment	L	Dusts, nuisance
				L	Chemicals, ARCADIS use
Driving		***Motion***			Chemicals, corrosive
L	Night driving	M	Lifting/awkward body positions		Chemicals, explosive
M	Off-road driving	M	Struck by vehicle/traffic	L	Chemicals, flammable
M	Urban driving				Chemicals, oxidizing
M	All terrain vehicle	***Personal Safety***			Chemicals, toxic
M	Boat	L	Working late/night		Chemicals, reactive
		L	Working alone		Radiation, ionizing
Electrical		M	High crime area		Radiation, non-ionizing
	Wet environments				
	Electrical panels	***Pressure***		***Compound Specific***	
	Electric utilities	H	Utilities (gas, water, etc)		Asbestos
	Electric power tools	L	Compressed gas cylinders	L	Benzene
			Compressed air/aerosols		Cadmium
Environment		L	Hydraulic systems		Hydrogen sulfide
H	Heat				Lead
	Cold	***Sound***			Silica
M	Lightning	M	Equipment noise		
M	Inclement weather	M	Tool noise	***Gravity***	
L	High wind	L	Traffic noise (vehicle/train/etc)	M	Slip, trip, fall
				L	Fall from height
					Ladders or scaffolds
				L	Struck by falling object

5.2 Job Loss Analyses, H&S Standards, and Personal Protective Equipment

A JLA has been completed for each DPT rig soil sampling, along with sediment and surface water sampling. The Site SSO will develop additional JLAs on an as needed basis with project specific information, and are included in Appendix B. The SSO will be responsible for developing additional JLAs for the project on an as needed basis. Hazards identified in the table above are addressed specifically in the JLAs as well as control methods to protect employees and property from hazards. The JLA also lists the type of personal protective equipment (PPE) required for the completion of the project. A detailed list of PPE for the project is located in Appendix D.

ARCADIS H&S Standards applicable to this project are listed below. These standards should be reviewed by the project manager, task manager and Site personnel. The Client H&S Resource should be contacted with any questions concerning the standards.

- ARC HSFS019 – Utility Location.
- ARC HSIH003 – Benzene.

5.3 Field Health & Safety Handbook

The Field H&S Handbook (FHSHB) is an ARCADIS document containing information about topic-specific health and safety requirements for the field. This handbook contains relevant general topics and is used as part of the overall HASP process. To aid in the consistency of the HASP process the handbook will be used as an informational source in conjunction with this HASP.

The following handbook sections are required reading for this project:

- Section III-F. General Housekeeping, Personal Hygiene and Field Sanitation.
- Section III-G. Site Security, Work Zone and Decontamination for HAZWOPER Sites.
- Section III-GG. HAZWOPER and HAZMAT Response.
- Section III-II. Drums and other Material Handling.
- Section III and Title N. Biological Hazards.
- Section III and Title X. Boating Operations Safety.
- Section III and Title Y. Confined Spaces (ARCHSSF003).
- Section III and Title BB. Fall Protection (ARCHSFS007).
- Section III and Title CC. Hand and Power Tools.

6. Hazard Communication (HazCom)

All project required chemicals must be handled in accordance with the ARCADIS-HazCom Standard (ARC HSGE007), and the requirements outlined in the Field H&S Handbook. The table below lists all chemicals that will be brought, used, and/or stored on the Site by ARCADIS or its subcontractors. Material Safety Data Sheets (MSDS) for chemicals brought on site are included in Appendix E.

List the chemicals anticipated to be used by ARCADIS on this project subject to HazCom requirements.

(Modify quantities as needed)

	Acids/Bases	Qty
☐	Not applicable	
☒	Hydrochloric acid	<500 ml
☒	Nitric acid	<500 ml
☐	Sulfuric acid	<500 ml
☐	Sodium hydroxide	<500 ml
☐	Zinc acetate	<500 ml
☐	Ascorbic acid	<500 ml
☐	Acetic acid	<500 ml
☐	Other:	

	Decontamination	Qty
☐	Not applicable	
☐	Alconox	• 5 lbs
☒	Liquinox	• 1 gal
☐	Acetone	• 1 gal
☐	Methanol	• 1 gal
☐	Hexane	• 1 gal
☐	Isopropyl alcohol	• 4 gal
☐	Nitric acid	• 1 L
☐	Other:	

	Calibration	Qty.
☐	Not applicable	
☒	Isobutylene/air	1 cyl
☐	Methane/air	1 cyl
☐	Pentane/air	1 cyl
☐	Hydrogen/air	1 cyl
☐	Propane/air	1 cyl
☐	Hydrogen sulfide/air	1 cyl
☐	Carbon monoxide/air	1 cyl
☒	pH standards (4,7,10)	• 1 gal
☒	Conductivity standards	• 1 gal
☐	Other:	

	Fuels	Qty.
☐	Not applicable	
☒	Gasoline	• 5 gal
☒	Diesel	• 5 gal
☐	Kerosene	• 5 gal
☐	Propane	1 cyl
☐	Other:	

	Kits	Oty.
☐	Not applicable	
☐	Hach (specify):	1 kit
☐	DTECH (specify):	1 kit
☐	EPA 5035 Soil (specify kit):	1 kit
☐	Other:	

	Remediation	Qty.
☒	Not applicable	
☐	Other:	
☐	Other:	
☐	Other:	
☐	Other:	

	Other:	Qty.
☐	Not applicable	
☐	Spray paint	• 6 cans
☐	WD-40	• 1 can
☒	Helium	• 1 cyl
☐	Pipe primer	• 1 can
☐	Mineral spirits	• 1 gal

Material safety data sheets (MSDSs) must be available to field staff. Manufacturer supplied MSDSs are preferred, however, if the manufacturer's MSDS cannot be located, use the source provided below. Indicate below how MSDS information will be provided:

☐ Not applicable
☐ Printed copy in company vehicle
☒ Printed copy in the project trailer/office
☐ Printed copy attached
☐ Electronic copy on field computer

Find an MSDS	
Source:	www.hz.genium.com
Username:	arcadis_library
Password:	library1

Bulk quantities of the following materials will be stored:

Contact the project H&S contact for information in determining code and regulatory requirements associated with bulk storage of materials.

6.1 Chemical Hazards

Air monitoring will be conducted as outlined in this HASP to collect exposure data for COC or for chemicals brought on site for use. Table 2 lists the properties of chemicals that will be encountered at the Site.

Table 2. Chemical Hazard Information

Chemical Name	IP (eV)	Odor Threshold (ppm)	Routes of Entry/ Exposure Symptoms	8-hr TWA[1] (ppm)	IDLH (NIOSH) (ppm)	STEL (ppm)	Source TLV/PEL
Benzene	9.25	4.68	inhalation, skin absorption, ingestion, skin and/or eye contact	0.5	500	2.5	ACGIH
Carbon Tetrachloride	11.28	21.4	inhalation, skin absorption, ingestion, skin and/or eye contact	5 (skin)	200	10 (skin)	ACGIH
Chlorobenzene	9.07	0.741	inhalation, skin absorption, ingestion, skin and/or eye contact	10	1,000	N/A	ACGIH
Chloroform	11.37	250-1,000	inhalation, skin absorption, ingestion, skin and/or eye contact	10	500	2 (NIOSH)	ACGIH
Dioxathion/Dioxenethion	N/A	N/A	inhalation, skin absorption, ingestion, skin and/or eye contact	0.1 (skin)	N/A	N/A	ACGIH

Chemical Name	**IP (eV)**	**Odor Threshold (ppm)**	**Routes of Entry/ Exposure Symptoms**	**8-hr TWA[1] (ppm)**	**IDLH (NIOSH) (ppm)**	**STEL (ppm)**	**Source TLV/PEL**
1,2-Dichloroethane	11.05	24-440	inhalation, skin absorption, ingestion, skin and/or eye contact	10	50	100 (OSHA)	ACGIH
Methylene Chloride	11.32	540-2,160	inhalation, skin absorption, ingestion, skin and/or eye contact	50	2,300	125 (OSHA)	ACGIH
Methyl Isobutyl Ketone	N/A	N/A	inhalation, skin absorption, ingestion, skin and/or eye contact	50	500	75	ACGIH
Toluene	8.82	2.9	inhalation, skin absorption, ingestion, skin and/or eye contact	20	500	300	ACGIH

[1] The TLV (Threshold Limit Value) from the American Conference of Governmental Industrial Hygienists (ACGIH) is listed unless the PEL (Permissible Exposure Limit), designated by OSHA, is lower.

See Section 8 for information on air monitoring requirements.

7. Tailgate Meetings

Tailgate safety briefings must be conducted at least once daily and should be conducted twice daily (at the start of the job and after mid-day meal break), or as tasks/hazards change. Each tailgate safety briefing must be documented on the form included in Appendix C and maintained with the project files. The tailgate safety briefing will serve as a final review for hazard identification and controls to be utilized. JLAs and the ARCADIS FHSHB controls should be reviewed as part of the briefing to ensure hazard controls are adequate for planned work.

8. Personal Exposure Monitoring and Respiratory Protection

Personal and area exposure monitoring will be documented on the Real Time revamped Exposure Monitoring Data Form provided in Appendix C. All monitoring equipment will be maintained and calibrated in accordance with manufacturer's recommendations. All pertinent monitoring data will be logged on the form and maintained on site for the duration of project activities. Calibration of all monitoring equipment will be conducted daily and logged on the same form.

Table 3 lists exposure monitoring requirements and associated action levels for site exposure hazards (e.g. chemical, noise, radiation, etc). Action levels have been developed for exposure monitoring with real-time air monitoring instruments as specified in the table. Air monitoring data will determine the required respiratory protection levels at the Site during scheduled intrusive activities. The action levels are based on sustained readings indicated by the instrument(s). Air monitoring will be performed and recorded at up to 30-minute intervals.

If elevated concentrations are indicated, the monitoring frequency will be increased, as appropriate. If sustained measurements are observed during this time, the following actions will be instituted, and the Project Manager and Project Health and Safety Manager will be notified. For purposes of this HASP, sustained readings are defined as the average airborne concentration maintained for a period of one minute.

Table 3. Exposure Monitoring Requirements

TASK 1 – Water well sampling Is exposure monitoring required for the completion of this task? ☒ YES ☐ NO If yes, complete the following:				
Exposure Hazard	**Monitoring Equipment**	**Monitoring Frequency**	**Action Level (ppm)**	**Required Action**
Benzene	PID / FID / Dräger Tube	Continuous	0.5	Level C (full face)
Chloroform	PID / FID / Dräger Tube	Continuous	5	Level C (full face)
Chlorobenzene	PID / FID / Dräger Tube	Continuous	5	Level C (full face)
1,2-Dichloroethane	PID / FID / Dräger Tube	Continuous	5	Level C (full face)
Methylene Chloride	PID / FID / Dräger Tube	Continuous	25	Level C (full face)
Methyl Isobutyl Ketone	PID / FID / Dräger Tube	Continuous	25	Level C (full face)
Toluene	PID / FID / Dräger Tube	Continuous	10	Level C (full face)
TASK 2 – Surface Water and Sediment Sampling Is exposure monitoring required for the completion of this task? ☐ YES ☒ NO If yes, complete the following:				
TASK 3 – Groundwater well installation and sampling Is exposure monitoring required for the completion of this task? ☒ YES ☐ NO If yes, complete the following:				
Exposure Hazard	**Monitoring Equipment**	**Monitoring Frequency**	**Action Level (ppm)**	**Required Action**
Benzene	PID / FID / Dräger Tube	Continuous	0.5	Level C (full face)
Chloroform	PID / FID / Dräger Tube	Continuous	5	Level C (full face)
Chlorobenzene	PID / FID / Dräger Tube	Continuous	5	Level C (full face)
1,2-Dichloroethane	PID / FID / Dräger Tube	Continuous	5	Level C (full face)
Methylene Chloride	PID / FID / Dräger Tube	Continuous	25	Level C (full face)
Methyl Isobutyl Ketone	PID / FID / Dräger Tube	Continuous	25	Level C (full face)

Toluene	PID / FID / Dräger Tube	Continuous	10	Level C (full face)

TASK 4 – Soil gas sampling

Is exposure monitoring required for the completion of this task?

☒ YES ☐ NO If yes, complete the following:

Exposure Hazard	Monitoring Equipment	Monitoring Frequency	Action Level (ppm)	Required Action
Benzene	PID / FID / Dräger Tube	Continuous	0.5	Level C (full face)
Chloroform	PID / FID / Dräger Tube	Continuous	5	Level C (full face)
Chlorobenzene	PID / FID / Dräger Tube	Continuous	5	Level C (full face)
1,2-Dichloroethane	PID / FID / Dräger Tube	Continuous	5	Level C (full face)
Methylene Chloride	PID / FID / Dräger Tube	Continuous	25	Level C (full face)
Methyl Isobutyl Ketone	PID / FID / Dräger Tube	Continuous	25	Level C (full face)
Toluene	PID / FID / Dräger Tube	Continuous	10	Level C (full face)

TASK 5 – Sub-slab soil gas sampling

Is exposure monitoring required for the completion of this task?

☒ YES ☐ NO If yes, complete the following:

Exposure Hazard	Monitoring Equipment	Monitoring Frequency	Action Level (ppm)	Required Action
Benzene	PID / FID / Dräger	Continuous	0.5	Level C (full face)
Chloroform	PID / FID / Dräger	Continuous	5	Level C (full face)
Chlorobenzene	PID / FID / Dräger	Continuous	5	Level C (full face)
1,2-Dichloroethane	PID / FID / Dräger Tube	Continuous	5	Level C (full face)
Methylene Chloride	PID / FID / Dräger Tube	Continuous	25	Level C (full face)
Methyl Isobutyl Ketone	PID / FID / Dräger Tube	Continuous	25	Level C (full face)
Toluene	PID / FID / Dräger	Continuous	10	Level C (full face)

8.1 Respirator Cartridge Change Schedule

Respirators will be stored in clean containers (i.e., self-sealing bag) when not in use. If respirators are required to be worn based on the action levels established above, respirator cartridges will be replaced in accordance with the following change-out schedule.

Type of Cartridge	Cartridge Change-out Schedule
Particulate (i.e., High Efficiency Particulate Air)	At least weekly or whenever the employee detects an increase in breathing resistance. This will occur as the filter becomes loaded with particulate matter.
Sorbent (i.e., organic vapor)	Per the respirator manufacturer's change-out schedule or if cartridge breakthrough indicator is reached. The Project H&S Manager or the Project Manager must be consulted regarding gas/vapor cartridge change-out schedule. This will be determined per the ARCADIS Respiratory Protection standard – ARC HSGE017.

Personnel who wear APRs must be trained in their use, must have successfully passed a qualitative respiratory fit test within the last 12 months, and must have medical clearance for APR use.

With the exception of protection against particulates*, if the action plan outlined above calls for an upgrade to an air-purifying respirator (for protection against organic vapors and other gaseous chemicals), the following will apply:

- The respirator cartridge will be equipped with an end-of-service-life indicator (ESLI) certified by NIOSH for the contaminant; or

- If there is no ESLI appropriate for a contaminant, the project will implement a change schedule for cartridges to ensure that they are changed before the end of their service life.

**Note – A Cartridge Change Schedule is not necessary for cartridges used in the protection against particulates provided that the cartridges are changed out when there is a perceived resistance in breathing experienced by the user.*

9. Medical Surveillance

Medical surveillance requirements are outlined in the ARCADIS Medical Monitoring Program Standard ARCHSGE010. All medical surveillance requirements as indicated must be completed and Site personnel medically cleared before being permitted on the project Site.

10. General Site Access and Control

The SSO will coordinate access and control security at the work site. As the work dictates, the SSO will establish a work area perimeter. The size of the perimeter will be based on the daily task activities and will be discussed with all project personnel during the tailgate meeting and then documented on the tailgate meeting form. Control zones for Level C or above will be demarcated by either visual or physical devices and will be monitored for effectiveness by the SSO.

Only authorized personnel will be allowed beyond the perimeter. Other Site workers and visitors to the Site should be kept out of the work site. If visitors need access to the Site, the SSO will escort the visitor at all times. All visitors will log in and out with the SSO. The visitor log sheet is included in Appendix C.

ARCADIS will obtain access and acknowledgement agreements for all properties where work tasks will be conducted. Due to the nature and residential surroundings where some of the projects work tasks will be conducted, additional safety concerns are present. ARCADIS will instruct all associates to use SWA if any dangerous or illegal activity is observed. If SWA is used in relation to dangerous or illegal activity, ARCADIS will proceed directly to the project meeting point or office and will contact project management. If warranted, project management may decide to contact the local authorities to manage the situation.

10.1 Sanitation at Temporary Workplaces

10.1.1 Potable Water

An adequate supply of potable water must be provided on the Site. Portable containers used to dispense drinking water shall be capable of being tightly closed, and equipped with a tap. Water shall not be dipped from containers. Any container used to distribute drinking water shall be clearly marked as to the nature of its contents and not used for any other purpose. Where single service cups (to be used but once) are supplied, both a sanitary container for the unused cups and a receptacle for disposing of the used cups shall be provided.

10.1.2 Toilet Facilities

Under temporary field conditions, the SSO will make provisions so that no less than one toilet facility is available. Use of a nearby toilet facility is an acceptable arrangement for mobile crews having transportation readily available.

11. Decontamination Control Zones and Procedures

The decontamination procedures outlined in the Field H&S Handbook are provided for typical Level D and Level C ensembles.

The zones for Level C and above will be designated by traffic cones, barricades, signs, caution tape, or other means effective in identifying the different areas. The SSO will establish control boundaries for the exclusion zone, contamination reduction zone, and the support zone. The zones will be identified by the SSO during tailgate meetings and documented on the meeting form. Entrance and exit to the exclusion zone will only be through controlled access points established for each work area.

Level B or Level A decontamination procedures are detailed in the below table:

Table 4. Level A/B Decontamination Steps

Level A Decontamination Steps		Level B Decontamination Steps	
EZ-1	Segregated Equipment Drop	EZ-1	Segregated Equipment Drop
EZ-2	Boot Cover and Glove Wash	EZ-2	Boot Cover and Glove Wash
EZ-3	Boot Cover and Glove Rinse	EZ-3	Boot Cover and Glove Rinse
EZ-4	Tape Removal	EZ-4	Tape Removal
EZ-5	Boot Cover Removal	EZ-5	Boot Cover Removal
EZ-6	Outer Glove Removal	EZ-6	Outer Glove Removal
CRZ-7	Suit/Safety Boot Wash	CRZ-7	Outer Glove Removal
CRZ-8	Suit/Safety Boot Rinse	CRZ-8	Suit/SCBA/Boot/Glove Rinse
CRZ-9	Encapsulated Suit Partial Removal/Tank Change	CRZ-9	Tank Change
CRZ-9a	Redress-return to EZ	CRZ-9a	Redress-return to EZ
CRZ-10	Safety Boot Removal	CRZ-10	Safety Boot Removal
CRZ-11	Encapsulated Suit Removal	CRZ-11	SCBA Removal

Level A Decontamination Steps		**Level B Decontamination Steps**	
CRZ-12	SCBA Removal	CRZ-12	Splash Suit Removal
CRZ-13	Inner Glove Wash	CRZ-13	Inner Glove Wash
CRZ-14	Inner Glove Rinse	CRZ-14	Inner Glove Rinse
CRZ-15	Face-piece Removal	CRZ-15	Face-piece Removal
CRZ-16	Inner Glove Removal	CRZ-16	Inner Glove Removal
CRZ-17	Inner Clothing Removal	CRZ-17	Inner Clothing Removal
SZ-18	Field Wash	SZ-18	Field Wash
SZ-19	Redress	SZ-19	Redress

EZ-Exclusion Zone CRZ-Contamination Reduction Zone SZ-Support Zone

12. Emergency Action Plan (EAP)

In the event that an injury, over-exposure or spill has occurred, an EAP will be implemented. All employees working on this project must be shown the location and proper use of all emergency equipment prior to beginning work on the project.

13. Client-Specific Health and Safety Requirements

ARCADIS project personnel must comply with the client's specific H&S requirements at all times. Client-specific H&S requirements are as follows:

- Conform to Ashland Incorporated Procedure No. EHS-PR07 for confined spaces. (Copies of the Ashland and ARCADIS procedures are included in Appendix H.)

14. Ground or Air Shipments of Hazardous Materials (HazMat)

All samples, electronic equipment with batteries, powders, gases, liquids, magnetized materials or radioactive materials being shipped by air or ground transport will be evaluated using the ARCADIS Shipping Determination process to determine if the material or equipment being shipped is hazardous for transport. All materials identified as HazMat will be shipped according to applicable Department of Transportation (DOT) and International Air Transport Association (IATA) regulations and requirements as prescribed by the ARCADIS DOT Program.

All employees collecting samples, preparing HazMat packages, or offering HazMat to a 3rd party carrier such as FedEx will have current HazMat training as prescribed by the **ARCADIS DOT Program.**

14.1 Department of Transportation Dangerous Goods Shipping Requirements

ARCADIS has policies in place for transporting small quantities of hazardous materials and for offering for shipping via ground or air. These policies are designed to meet the applicable requirements. As such, only ARCADIS staff that have been trained in the proper methods to prepare and ship hazardous materials are authorized to do so. Tasks associated with the packaging, labeling, marking, and preparation of hazardous materials for shipping or transport must have all appropriate and applicable training.

14.2 Materials of Trade (MOT)

DOT allows for a small amount of hazardous materials that are used in or an inherent part of our work to be transported in company vehicles. This includes things like gasoline, paint, small compressed gas cylinders, calibration gas, etc. To transport these:

- Staff will complete MOT training.

- Vehicles used in transportation to and from off-site work locations will be in conformance with ARCADIS vehicle safety procedures.

Hazardous materials will be transported as described above as a result of the activities covered in this HASP. Site personnel who transport materials mentioned above will complete the Hazardous Materials Transportation Form included in Appendix E.

14.3 Department of Transportation

Staff who collect, prepare, package, mark, label, complete shipping declarations, offer shipments to a transporter, directly transport or are engaged in other activities associated with the transportation of Hazardous Materials (referred to as Dangerous Goods in Canada and by the IATA) will have appropriate and applicable training. DOT requires all individuals who participate in hazmat shipping including activities such as completing the paperwork (but not signing it), filling a container with a hazardous material (including filling a drum with drill cuttings or purge water), marking, labeling, and packaging the hazardous material, etc., have awareness level training on the DOT requirements. DOT requires additional job function training for those who conduct specific activities including:

- Staff who have to sign shipping papers or manifests, are listed as the 24-hour emergency contacts on shipping and have the responsibility for identifying, classifying, packaging, marking, and labeling HazMat packages, and/or are directing or overseeing others who do these tasks will become certified through the completion of additional training.

- The above training allows the offering employee to ship only by ground. If the shipment is to be offered for air transport, additional training is required.

Shipments as described above will be made as a result of the activities covered in this HASP. Site personnel shipping hazardous materials will complete the Hazardous Materials Shipment Form included in Appendix E.

15. Loss Prevention System™ and Loss Prevention Observations (LPOs)

As part of any project, no matter how simple or complex, LPOs should be conducted when practical and when able to integrate into normal business activities. LPOs should be scheduled based on the risk of the tasks being performed, and should be conducted for different tasks and at different times. Completion of LPOs should be documented on the tailgate meeting form.

The following table outlines the LPO plan for the project:

Identified Task for LPO	Schedule Date	Observer Name	Observee Name	Feedback Supervisor Name
TBD				

16. Subcontractors

A copy of this HASP is to be provided to all subcontractors prior to the start of work so that the subcontractor is informed of the hazards at the Site. While the ARCADIS HASP will be the minimum health and safety requirements for the work completed by ARCADIS and its subcontractors, each subcontractor, in coordination with ARCADIS health and safety personnel, is expected to perform its operations in accordance with its own HASP, policies and procedures unique to the subcontractor's work to ensure that hazards associated with the performance of the work activities are properly controlled. Copies of any required safety documentation for a subcontractor's work activities will be provided to ARCADIS for review prior to the start of on-site activities.

In the event that the subcontractor's procedures/requirements conflict with requirements specified in this HASP, the more stringent guidance will be adopted after discussion and agreement between the subcontractor and ARCADIS project health and safety personnel. Hazards not listed in this HASP, but known to the subcontractor or known to be associated with the subcontractor's services, must be identified and addressed to the ARCADIS project or task manager and SSO prior to beginning work operations.

If the subcontractor prefers to adopt this HASP, the **"Subcontractor Acknowledgement Memo" must be signed and dated by the subcontractor's management and placed in the project file.** Once the signed memo is received by the project manager, an electronic version of our HASP can be submitted to the subcontractor to use as their own. Subcontractors working at the Site will need to have this plan with them, and will also need to sign the Subcontractor HASP receipt signature page of the ARCADIS HASP (Appendix C). Subcontractors are responsible for the H&S of their employees at all times, and have the authority to halt work if unsafe conditions arise.

The Project/Task Manager and SSO (or authorized representative) has the authority to halt the subcontractor's operations and to remove the subcontractor or subcontractor's employee(s) from the Site for failure to comply with established health and safety procedures or for operating in an unsafe manner.

17. Project Personnel HASP Certification

All Site project personnel will sign the certification signature page provided in Appendix C of this HASP.

18. Roadway Work Zone Safety

All project work performed in a public (ARC DOT-301) or private (ARC DOT-302) roadway, regardless of work duration, will require a either a written Traffic Control Plan (TCP) or a Site Traffic Awareness and Response (STAR) Plan. Projects having work activities on both public and private roadways will operate under a TCP approved by an employee designated with Engineering Judgment.

Appendix A

HASP Addendum Pages and Log Table

ARCADIS

Addendum Page

This form should be completed for new tasks associated with the project. The project manager and/or task manager should revise the Project Hazard Analysis Worksheet with the new task information and attach to this addendum sheet. JLAs should be developed for any new tasks and attached as well.

Review the addendum with all Site staff, including subcontractors, during the daily tailgate briefing, and complete the tailgate briefing form as required. Attach a copy of the addendum to all copies of the HASP including the Site copy, and log in the Addendum Log Table A-1 on the next page.

Addendum Number: ____________________ Project Number: __________________________

Date of Changed Conditions: ____________________ Date of Addendum: __________________________

Description of Change that Results in Modifications to HASP:

Signed: ___________________________________ Project Manager

Signed: ___________________________________ Site Safety Officer

Signed: ___________________________________ H&S Plan Writer

Signed: ___________________________________ H&S Plan Reviewer

Addendum Log Table

Addendums are to be added to every copy of the HASP, and logged on Table A-1 to verify that all copies of the HASP are current:

Table A-1 Addendum Log Table

Addendum Number	Date of Addendum	Reason for Addendum	Person Completing Addendum
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Make additional copies of this form as necessary.

Appendix B

JLAs

Job Loss Analysis

General

Client Name	Hercules
JSA ID	
Job Name	Environmental-Soil sampling/well installation - drill rig
Task Description	Soil sampling using DPT drill rig
Project Number	
Project Name	Hercules
PIC Name	
Project Manager	
Status	
Creation Date	7/11/2011 12:00:00 AM
Auto Closed	

User Roles

Role	Employee	Due Date	Completed	Approve	Supervisor	Active
Created By	Riley, Joel					

Job Steps

Job Step	Job Step Description		Potential Hazard	Critical Action	HSP Reference
1	Load equipment and supplies into vehicle	1	Lifting hazards/back stain. Pinch points. Breaking glass in coolers. Spilling decon chemicals.	Use proper lifting technique, do not twist while lifting, use buddy system, lift with legs not back. Request assistance when lifting heavy equipment. Use dolly to transport coolers, as necessary. Load coolers and decon materials so they will not shift during transport.	
2	Mobilization - Driving to the Site.	1	Vehicle collision. Loss of equipment/supplies from moving vehicle.	Follow safe driving procedures (inspect vehicle prior to driving, safe following distances, headlights, safety belts, etc.). Do not use cell phones while driving. Properly secure all equipment and supplies before operating vehicle. DO NOT operate a cell phone or GPS while driving.	Smith Driving System Training
3	Working outdoors	1	Temperature-related illnesses (cold/heat stress). Weather. Biological hazards (animals, vegetation, etc.)	Drink plenty of fluids, take breaks as needed to avoid heat stress and dress appropriately for weather conditions. Postpone work if lightning is observed or expected. Watch for signs of heat stress or exhaustion in fellow co-workers. Use sunscreen. Scan for biological hazards when lifting objects.	
4	Tailgate safety meetings	1	Injury or property damage due to unknown or known hazards.	Discuss work to be performed and associated hazards. Open communication. All team members sign safety meeting form and JLA. Review utility drawings and sampling locations. Discuss routes of egress, rally points, and location specific hazards.	

5	Clear drilling locations	1	Traffic hazards, overhead and underground installations,product releases, and property damage	Have a minimium of three lines of evidence before conducting intrusive activities. Review proposed locations against known utilities. Mark out proposed boring locations. Call Utility locate company or have plant engineering conduct thorough utility locates before work commences. Hand clear borings with hand auger to 5ft.bgs using a hand probe to clear every ft.	Utility Location Policy/Procedure
6	Set up work/decon area	1	Slips from uneven terrain, wet ground, wet plastic sheeting. Pinched fingers from moving drums and augers. Strains and sprains. Custs from metal edges/knife.	Secure staging/decon area. Use spotter while moving in staging area. Scan ground ahead for obstacles. Use alternate routes if needed. Avoid placing hands between adjacent objects and between objects and ground (pinch points). Use two people to load/unload truck. Cut away from hands and body. Make sure to use proper ppe (work or nitrile gloves)	
7	Set up DPT rig	1	Electric shock from overhead power lines. Pinches from moving hydraulics. Contact with hydraulic fluid from busted hose. Uneven ground that could cause rig to turn over. Damage caused by rig while accessing setup location.	Minimum distance 15ft from overhead power lines. Inspect hoses for signs of wear/deterioration. Keep hands, feet, clothing at least 2 ft from moving parts. Use parking brake, chock wheels, level rig. Identify/avoid areas where rig could get stuck. Place cones or tape off work zone if in a busy area of the plant or near roadways.	
8	Commence DPT drilling	1	Cross-contamination from previous borehole. Back strain, heat/cold stress, eye injury, noise, exposure to chemicals, hitting underground utility, slip/trip/fall, and equipment failure.	Decontaminate drill equipment after each borehole. Use proper lifting technique. Use proper PPE and air monitoring equipment. Stay safe distance from drill rig. Watch for pinch points when handling augers. Keep hands, body parts and clothing away from moving parts of the rig. Good housekeeping. Maintain spill kit and fire extingusiher near rig. Keep in constant communication: voice, hand signals and eye contact.	
9	Soil logging and screening	1	Exposure to contaminants. Cross-contamination. Improper body positioning.	Use proper positioning and PPE. Use PID to screen air and borehole. Use nitrile gloves and change gloves between samples.	
10	Packaging samples for lab	1	Bottle breakage, back strain, sample cross-contamination, mislabeling	Keep samples stored in proper containers, on ice, and away from work area. Pack coolers to minimize sample jar movement. Use proper lifting technique. Label samples immediately upon sample collection.	
11	Demobilization	1	Lifting hazards and back strain. Vehicle collision. Loss of equipment/supplies from moving vehicle.	Leave Site clean of refuse and debris. Use proper lifting technique. Secure all equipment and supplies before operating vehicle. Follow safe driving procedures. Do not use cell phones while driving.	

Personal Protective Equipment

Type	Personal Protective Equipment	Description	Required
Dermal Protection	long sleeve shirt/pants		Required

Eye Protection	safety glasses		Required
Foot Protection	steel-toe boots		Required
Hand Protection	chemical resistant gloves (specify type)		Required
Hand Protection	work gloves (specify type)	Leather	Recommended
Head Protection	hard hat		Required
Hearing Protection	ear plugs		Required

Supplies

Type	Supply	Description	Required
Communication Devices	mobile phone		Required
Decontamination	Decon supplies (specify type)		Required
Miscellaneous	fire extinguisher		Required
Miscellaneous	first aid kit		Required
Miscellaneous	flashlight		Recommended
Personal	eye wash (specify type)		Required
Personal	insect repellant		Recommended
Personal	sunscreen		Recommended

Job Loss Analysis

General

Client Name	Hercules
JSA ID	
Job Name	Environmental-Surface water sampling
Task Description	Surface Water and Sediment Sampling
Project Number	
Project Name	
PIC Name	
Project Manager	
Status	
Creation Date	
Auto Closed	

User Roles

Role	Employee	Due Date	Completed	Approve	Supervisor	Active
Created By	Joel Riley					
Developer (Primary Contact)						
HASP Reviewer						
Quality Reviewer						
Reviewer						

Reviewer Comments

Role	Employee	Approval Status	Completed Date	Comments

Job Steps

Job Step	Job Step Description		Potential Hazard	Critical Action	HSP Reference
1	Approaching sample location near river	1	Slip, trips, and falls. Biological hazards.	Approach sample location with a free hand, and wearing the required PPE, sans boots or waders. Inspect the path before walking to make sure the least steep path has been taken. Scan for biological hazards, wear sname chaps if working in heavy vegetation. Use the buddy systems at all times.	
2	Surface Water Sampling from shoreline or wading	1	Fall/Drown Hazard	Don PPE. Don Personal Floatation Device (PFD) within 20 ft of the River's edgeg 5 ft of steam edge. withi. Personnel working within 5 ft of the river edge must don harness, and attach to a lifeline. Additional personnel must provide oversight as sampler enters the River to retrieve sampler, if necessary. If working only near small streams, PFD and buddy system is adequate. Ensure footing and equipment is stable at all times. Sample using the buddy system. Utlize sampling metods that allow shoreline sampling if possible. Ring bouy should be staged adjacent to shorline near support personnel at all times. Stay in constabt communication (verbal, eye contact, hand signals).	Field Guide: V.G.Water Operations Work/Working near or on Water/Ice

		2	muscle strains from carrying equipment to sampling locations	Make multiple trips if necessary. Use the buddy system to lift heavy or akward objects. Take water breaks. Plan routes prior to carrying loads. Coolers with samples will get heavier as job progresses. Use smaller coolers to keep loads light. Do not overfill backpacks.	Field Guide: V.G.Water Operations Work/Working near or on Water/Ice
		3	slips from walking on wet surfaces near shoreline	wear boots with good tread and avoid heavily muddied areas.	Field Guide: V.G.Water Operations Work/Working near or on Water/Ice
		4	Fall Hazard	Workers must wear U.S. Coast Guard approved (Type I or II) PFD (e.g. life jacket) when: working close to fast-flowing water or water that is deeper than 4 feet, where the work could results in slipping or falling into the water (circumstances may require the use of lifelines).	Field Guide: V.G.Water Operations Work/Working near or on Water/Ice
		5	Water entering boots can increase the chance for blisters and other skin issues with feet/ankles	Wear rubber outerboots when appropriate. Waders should be worn when wading into deeper water.	Field Guide: V.G.Water Operations Work/Working near or on Water/Ice
		6	falling into water can cause injury/drowning	Wear PFD if falling into water deeper than waist high is a hazard, or if working proximal to turbulent/fast moving water. TRACK water conditions every day as rain/snow thaw can cause water conditions to worsen. Person walking through water should minimize what they are carrying so they can maintain balance.	Field Guide: V.G.Water Operations Work/Working near or on Water/Ice
3	Soil sampling (auger or trowel advancement)	1	muscle straings from carrying equipment to sampling locations	make multiple trips if necessary. Coolers with samples will get heavier as job progresses. Use smaller coolers to keep loads light. Do not overfill backpacks.	
		2	Slips from walking on wet surfaces near shoreline	wear rubber outerboots when appropriate. Waders should be worn when wading into deeper water.	
		3	Water entering boots can increase the change for blisters and other skin issues with feet/ankles	wear rubber outerboots when appropriate. Waders should be worn when wading into deeper water.	
		4	falling into water can cause injury/drowning	wear PFD if falling into water deeper than waist high is a hazard, or if working proximal to turbulent/fast moving water. TRACK water coinditions every day as rain can cause water conditions to worsen. Person walking through water should minimize what they are carrying so they can maintain balance.	

		5	Muscle strains or falling	Rotate personnel advancing the auger to limit fatigue. Identify a non-slippery, flat area for advancement. The auger can be advanced easier in a more vegetated area (traction) than in the soft, muddy, sandy, shoreline areas. Properly collect and containerize all samples.	
4	Leaving sample location with equipment	1	Muscle fatigue and footing	Limit weight of coolers and sampling equipment by packing smart and mutiple people carrying the load to the vehicle. This will free up an arm in case of a fall or to keep balance.	

Personal Protective Equipment

Type	Personal Protective Equipment	Description	Required
Eye Protection	safety glasses		Required
Foot Protection	boots		Required
Foot Protection	rubber boots		Required
Hand Protection	chemical resistant gloves (specify type)	nitrile	Required
Miscellaneous PPE	other	Waders or overboots	Required
Miscellaneous PPE	personal flotation device		Required
Miscellaneous PPE	traffic vest--Class II or III		Required

Supplies

Type	Supply	Description	Required
Communication Devices	mobile phone		Required
Decontamination	Decon supplies (specify type)		Required
Miscellaneous	fire extinguisher		Required
Miscellaneous	first aid kit		Required
Miscellaneous	Other	Life line	Recommended
Personal	eye wash (specify type)		Required

ARCADIS

Appendix C

HASP Forms

ARCADIS

Document Control Number:TGM - ______________________________
TGM + *project number plus date as follows: xxxxxxxx.xxxx.xxxxx - dd/mm/year*

TAILGATE HEALTH & SAFETY MEETING FORM

This form documents the tailgate meeting conducted in accordance with the Project HASP. Personnel who perform work operations on-site during the day are required to attend this meeting and to acknowledge their attendance, at least daily.

Project Name:			**Project Location:**
Date:	**Time:**	**Conducted by:**	**Signature/Title:**
Client:		**Client Contact:**	**Subcontractor companies:**

TRACKing the Tailgate Meeting

Think through the Tasks (list the tasks for the day):

1 ______________________ 3 ______________________ 5 ______________________
2 ______________________ 4 ______________________ 6 ______________________

Other Hazardous Activities - Check the box if there are any other ARCADIS, Client or other party activities that may pose hazards to ARCADIS operations ☐

If there are none, write "None" here: __________

If yes, describe them here: ______________________________

How will they be controlled? ______________________________

Prework Authorization - check activities to be conducted that require permit issuance or completion of a checklist or similar before work begins:

	Doc #		Doc #		Doc #
☐ Not applicable		☐ Working at Height	______	☐ Confined Space	______
☐ Energy Isolation (LOTO)	______	☐ Excavation/Trenching	______	☐ Hot Work	______
☐ Mechanical Lifting Ops	______	☐ Overhead & Buried Utilities	______	☐ Other permit	______

Discuss following questions (for some review previous day's post activities). **Check if yes :**

☐ Incidents from day before to review?
☐ Any corrective actions from yesterday?
☐ JLAs or procedures are available?
☐ Staff has appropriate PPE?
☐ Lessons learned from the day before?
☐ Will any work deviate from plan?
☐ Field teams to "dirty" JLAs, as needed?
☐ Staff knows Emergency Plan (EAP)?
☐ Topics from Corp H&S to cover?
☐ Any Stop Work Interventions yesterday?
☐ If deviations, notify PM & client
☐ All equipment checked & OK?
☐ Staff knows gathering points?

Comments: ______________________________

Recognize the hazards (check all those that are discussed) (Examples are provided) and **Assess** the Risks (Low, Medium, High - circle risk level) - Provide an overall assessment of hazards to be encountered today and briefly list them under the hazard category.

☐ Gravity (i.e., ladder, scaffold, trips) (L M H)	☐ Motion (i.e., traffic, moving water) (L M H)	☐ Mechanical (i.e., augers, motors) (L M H)
☐ Electrical (i.e., utilities, lightning) (L M H)	☐ Pressure (i.e., gas cylinders, wells) (L M H)	☐ Environment (i.e., heat, cold, ice) (L M H)
☐ Chemical (i.e., fuel, acid, paint) (L M H)	☐ Biological (i.e., ticks, poison ivy) (L M H)	☐ Radiation (i.e., alpha, sun, laser) (L M H)
☐ Sound (i.e., machinery, generators) (L M H)	☐ Personal (i.e. alone, night, not fit) (L M H)	☐ Driving (i.e. car, ATV, boat, dozer) (L M H)

Continue TRACK Process on Page 2

TAILGATE HEALTH & SAFETY MEETING FORM - Pg. 2

Control the hazards (Check all and discuss those methods to control the hazards that will be implemented for the day): Review the HASP, applicable JLAs, and other control processes. Discuss and document any additional control processes.

☒ **STOP WORK AUTHORITY** (Must be addressed in every Tailgate meeting - (*See statements below*)

☐ Elimination
☐ Engineering controls
☐ General PPE Usage
☐ Personal Hygiene
☐ Emergency Action Plan (EAP)
☐ JLA to be developed/used ***(specify)***
☐
☐

☐ Substitution
☐ Administrative controls
☐ Hearing Conservation
☐ Exposure Guidelines
☐ Fall Protection
☐ LPO conducted ***(specify job/JLA)***
☐
☐

☐ Isolation
☐ Monitoring
☐ Respiratory Protection
☐ Decon Procedures
☐ Work Zones/Site Control
☐ Traffic Control
☐ Other ***(specify)***
☐

Signature and Certification Section - Site Staff and Visitors

Name/Company/Signature	Initial & Sign in Time	Initial & Sign out Time	I have read and understand the HASP

Important Information and Numbers

All site staff should arrive fit for work. If not, they should report to the supervisor any restrictions or concerns.

In the event of an injury, employees will call WorkCare at 1.800.455.6155 and then notify the field supervisor who will, in turn, notify Corp H&S at 1.720.344.3844.

In the event of a motor vehicle accident, employees will notify the field supervisor who will then notify Corp H&S at 1.720.344.3844 and then Corp Legal at 1.720.344.3756.

In the event of a utility strike or other damage to property of a client or 3rd party, employees will immediately notify the field supervisor, who will then immediately notify Corp Legal at 1.678.373.9556 and Corp H&S at 1.720.344.3500

Visitor Name/Co - not involved in work

In Out

In Out

In Out

In Out

I will STOP the job any time anyone is concerned or uncertain about health & safety or if anyone identifies a hazard or additional mitigation not recorded in the site, project, job or task hazard assessment.

I will be alert to any changes in personnel, conditions at the work site or hazards not covered by the original hazard assessments.

If it is necessary to **STOP THE JOB,** I will perform **TRACK**; and then amend the hazard assessments or the HASP as needed.

I will not assist a subcontractor or other party with their work unless it is absolutely necessary and then only after I have done TRACK and I have thoroughly controlled the hazard.

Post Daily Activities Review - Review at end of day or before next day's work (Check those applicable and explain:)

☐ Lessons learned and best practices learned today:
☐ Incidents that occurred today:
☐ Any Stop Work interventions today?
☐ Corrective/Preventive Actions needed for future work:
☐ Any other H&S issues:

Keep H&S 1st in all things

WorkCare - 1.800.455.6155
Near Loss Hotline - 1.866.242.4304

Real Time Exposure Monitoring Data Collection Form

Document all air monitoring conducted on the Site below. Keep this form with the project file.

Site Name: ______________________________ Date: ______________

Instrument: ______________ Model: ______________ Serial #: ______________

Calibration Method: (Material used settings, etc.)	
Calibration Results:	
Calibrated By:	

Activity Being Monitored	Compounds/Hazards Monitored	Time	Reading	Action Required? Y/N

Describe Any Actions Taken as a Result of this Air Monitoring and Why (does it match Table 5-1):

____

____

Employee Signature Form

I certify that I have read, understand, and will abide by the safety requirements outlined in this HASP.

Printed Name	Signature	Date

Subcontractor Acknowledgement: Receipt of HASP Signature Form

ARCADIS claims no responsibility for the use of this HASP by others although subcontractors working at the site may use this HASP as a guidance document. In any event, ARCADIS does not guarantee the health and/or safety of any person entering this site. Strict adherence to the health and safety guidelines provided herein will reduce, but not eliminate, the potential for injury at this site. To this end, health and safety becomes the inherent responsibility of personnel working at the site.

Printed Name	Company	Signature	Date

Visitor Acknowledgement and Acceptance of HASP Signature Form

By signing below, I waive, release and discharge the owner of the site and ARCADIS and their employees from any future claims for bodily and personal injuries which may result from my presence at, entering, or leaving the site and in any way arising from or related to any and all known and unknown conditions on the site.

Name	Company	Reason for Visit	Date/Time On Site	Date/Time Off Site

Hazardous Materials Transportation Form

	Vehicle (place X in box)	Type (pick-up, car, box truck, etc.)
Personal		
Rental		
ARCADIS owned/leased		
Government owned		
Trailer		

Materials Transported	Quantity	Storage/Transport Container

List Trained Drivers:

____

____

Hazardous Materials Shipment Form

Material Description and Proper Shipping Name (per DOT or IATA)	Shipment Quantity	DOT Hazard Classification	Shipment Method (air/ground)

List Shipper (i.e., who we are offering the shipment to):

____

____

List Trained Employee(s):

____

____

ARCADIS

Appendix D

PPE Equipment List

ARCADIS

PPE CHECKLIST

R = Equipment required to be present on the site. **O** = Optional equipment. Subcontractors must have the same equipment listed here as a minimum.

Description **(Put Specific Material or Type in Box)**	**Level Of Protection**		
	D	**C**	**B**
Body			
Coveralls	O	O	O
Chemical Protective Suit	O	R	R
Splash Apron	O	O	O
Rain Suit	O	O	O
Traffic Safety Vest (reflective)	R (near roadways)	R (near roadways)	R (near roadways)
Head			
Hard Hat (if does not create other hazard)	R	R	R
Head Warmer (depends on temperature and	O	O	O
Eyes & Face			
Safety Glasses (incorporate sun protection as	R	R	R
Goggles (based on hazard)	O	R	R
Splash Guard (based on hazard)	O	O	O
Ears			
Ear Plugs	R (near noisy operations)	R (near noisy operations)	R (near noisy operations)
Ear Muffs	O	O	O
Hands and Arms			
Outer Chemical Resistant Gloves	O	R	R
Inner Chemical Resistant Gloves	R (when sampling)	R	R
Insulated Gloves	O	O	O
Work Gloves*	R	O	O
Foot			
Safety Boots (steel toe and shank)	R	R	R
Rubber, Chemical Resistant Boots	O	R	R
Rubber Boots	O	N/A	N/A
Disposable Boot Covers	O	R	R
Respiratory Protection			
1/2 Mask APR	O	O	N/A
Full Face APR	O	R	R
Dust Protection	O	N/A	N/A
Powered APR	O	O	O
SCBA	N/A	N/A	O
Air Line	N/A	N/A	O

Appendix E

MSDSs (To be determined
prior to mobilization)

Appendix F

TCP/STAR Plan Template

Site Traffic Awareness and Response (STAR) Plan for Private Roadways and Parking Areas

1.0 GENERAL

Project Name	Hercules Incorporated
Project Number	LA002999.0004
STAR Plan Developer Name	Joel Riley
Reviewed By:	
Duration of Work (hours or days)	
Time restrictions (state times, describe in Section 2.0)	
Posted Speed Limits for Roadway	
Number of Lanes for Roadway (each direction)	

2.0 WORK DESCRIPTION

Provide a brief description of work activities in the roadway or parking area.

ARCADIS will be conducting groundwater sampling and maintenance activities at Hercules facility in Hattiesburg, Mississippi.

3.0 TRAFFIC TYPE

Check all that apply:

☒ Automobiles

☒ Straight Trucks

☒ Semi Trucks

☒ Construction Equipment

☒ Forklifts

☒ Bicycles

☒ Pedestrian

☒ Other – Specify: Train

4.0 TRAFFIC CONTROL LAYOUT

For roadway and parking area work, check all that apply and click link to print layout and attach. Manually revise to address specific requirement.

Roadway Work:

☒ Work Beyond the Shoulder (DOT Facts-301i)

☒ Work on the Shoulder (DOT Facts-301j)

☒ Short Duration Work or Mobile Operations Work on the Shoulder (DOT Facts-301k)

☐ Shoulder Closure with Minor Encroachment (DOT Facts-301m)

☐ Lane Closure on 2 Lane Road with Flagger (DOT Facts-301n)

☐ Lane Closure on 2 Lane Road with Low Traffic Flow (DOT Facts-301o)

☐ Temporary Road Closure (DOT Facts-301p)

☐ Haul Road Crossing (DOT Facts-301q)

☐ Work in the Center of Low Volume Traffic Road (DOT Facts-301r)

☐ Atypical Roadway Layout or Work in Congested Facilities (Attach Drawing) (DOT Facts-301u)

Parking Area Work:

DOT Fact Sheets for parking areas have numbered scenarios. Select applicable scenario(s) and work duration (S-Short, I – Intermediate, L – Long)

☒ Short Duration (<1 Hour) Retail Gas Station or Small Single Business (DOT Facts-302a) 1 2 3 4 5

☐ Intermediate Duration (1-8 Hours) Retail Gas Station or Small Single Business (DOT Facts-302b) 1 2 3 4

☐ Long Duration (>8 Hours) Retail Gas Station or Small Single Business (DOT Facts-302c) 1 2 3

☐ Multi Business Parking Lot (Malls, Strip Malls, etc) (DOT Facts-302e) 1 2 3 4 5 6 7 8 9 S I L

☐ Facility Parking Area (DOT Facts-302e) 1 2 3 4 5 6 7 8 9 S I L

☐ Parking Garage (develop drawing for controls)

☐ Other:

5.0 REQUIRED TRAFFIC CONTROL DEVICES

Need Sign Help? DOT Facts-301d
Need Channelizing Device Help? DOT Facts-302d (see also DOT Facts-301e)
Need Flagger Help? DOT Facts-301f
Review Flagger training and certification requirements by state: DOT Facts-301w.

Device	Number Required	Wording or Pictogram	Comments
Warning Signs			
Warning Signs			
Stop/Slow Paddle		▨	
Red Flag		▨	
Channelizing Cones 10 lb		▨	
Channelizing Cones 30 lb		▨	
Cones	4	▨	Place around vehicle and site workers
Drums[1]		▨	
Tubular Markers		▨	
Vertical Panels[1]		▨	
Barricade[1] (Type I)		▨	
Barricade[1] (Type II)		▨	
Barricade[1] (Type III)		▨	
Arrow Panels			

Other: Emergency flashers	1		Activate emergency flashers on vehicle
Other: High reflective Safety vest	3		One per person
Other:			

Notes:

1) Provide with warning lights if night work or traffic control use is required at night.

All vehicles used in the roadways or parking areas should be equipped with functioning high intensity rotating, flashing, oscillating, or strobe lights. If the vehicle is not equipped with supplemental lighting devices use vehicle flashers (be aware of battery drain when using any of the lighting devices).

Personal protective equipment required for this work is listed in the applicable project Job Loss analysis (JLA) or project specific HASP. A Class II (minimum) high visibility vest is required.

6.0 WORK SEQUENCE FOR ROADWAY WORK (PHASING)

Describe the sequence for placement, working and removal of traffic control devices:

ARCADIS will park the vehicle in front of any monitoring wells located adjacent to roadways. Before exiting, ARCADIS will activate the vehicles emergency flashers and will apply the parking brake. ACADIS will don high reflective safety vests and will then exit the vehicle to place safety cones on the border between the work zone and the roadway. ARCADIS will conduct sampling activate, remove the cones, get in the vehicle, remove the safety vest, de-activate the emergency flashers and parking brake.

7.0 APPROVALS

STAR Plan Developer	
Designated HASP Reviewer[1]	

1) An individual with Engineering Judgment may also approve this STAR Plan, even if not a designated HASP Reviewer

8.0 REVIEWED BY:

To be signed by each employee working on the project affected by this STAR Plan:

Name Printed	**Signature**

Appendix G

Shipping Determination Form Template

ARCADIS

SHIPPING/TRANSPORTATION DETERMINATION

(Rev.4, 8/10)

General Information (*Need Help?*)

Revision Number	
Project Name	
Project Number	
City of Shipment	
City of Destination	
Analytical/MSDS/Hazard Information Attached?	

Description of Material to be Shipped/Transported

Determination

	Not Restricted/Regulated
	Hazardous Material

Complete for Hazardous Materials (Refer to 49 CFR 172.101 or IATA DGR section 4.2)

Proper Shipping Name	
UN or ID Number	
Hazard Class	
Packing Group	

"X"	*How Do You Want to Ship/Transport This Material?*	*24/7 Emergency Number Required? (FedEx criteria)*	*Packing Instruction / Shipping Guide / Support Package*
	Materials of Trade Exception	No	
	Excepted Quantity	No	
	Limited Quantity (Ltd Qty)	Ground –Yes Air - No	
	Special Permit/49 CFR 173.13	Ltd Qty Ground –Yes Ltd Qty Air – No Non-Ltd Qty- Yes	
	UN Specification Ground, Non-Bulk	Yes	
	UN Specification Ground, Bulk	Yes	
	UN Specification Air, Passenger or Cargo Aircraft	Yes	
	UN Specification Air, Cargo Aircraft Only	Yes	
	Other:	Yes/No	
	Batteries (Excepted)	No	ARCADIS Guide US050
	Compressed Gases (Non-flammable)	Yes	ARCADIS Guide US020
	Dry Ice	No	ARCADIS Guide US015
	Radioactive Material, Excepted Package, Limited Quantity of Material	No	ARCADIS Guide US016
	Sample Coolers (Print Guide and provide to field staff)	NA	ARCADIS Guide US001

Other Determinations

	This material is a Hazardous Waste (being offered under a Hazardous Waste Manifest)
	This material is a Hazardous Substance (49 CFR 172.101 appendix A)
	This material is a Marine Pollutant or Severe Marine Pollutant (49 CFR 172.101 appendix B)

Method of Shipment/Transportation

	FedEx Freight		Ground (FedEx)		Air (FedEx)		Lab Courier
	FedEx Custom Critical		Ground (UPS)		Air (UPS)		Rail
	Freight Other		ARCADIS Transport		Non DOT Spec.		Other
Comments:							

Special Instructions

-

Rationale for Determination

Regulatory Reference/Interpretation

Determination Performed By

Name Printed	Signature	Date

QA/QC Check Performed By

Name Printed	Signature	Date

Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Field Equipment Cleaning and Decontamination**

Effective Date: November 1, 2007

Number: SESDPROC-205-R1

Authors

Name: Donald Hunter
Title: Environmental Scientist, Regional Expert
Signature:
Date: 11/02/07

Name: Doug Jager
Title: Environmental Scientist
Signature:
Date: 11/02/07

Approvals

Name: Antonio Quinones
Title: Chief, Enforcement and Investigations Branch
Signature:
Date: 11/02/07

Name: Bill Cosgrove
Title: Chief, Ecological Assessment Branch
Signature:
Date: 11/2/07

Name: Laura Ackerman
Title: Field Quality Manager, Science and Ecosystem Support Division
Signature: Laura Acke
Date: 11/02/07

Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Field Quality Manager.

History	Effective Date
SESDPROC-205-R1, *Field Equipment Cleaning and Decontamination,* replaces SESDPROC-205-R0. **General** Corrected any typographical, grammatical and/or editorial errors. **Title Page** Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch. Changed Bill Cosgrove's title from Acting Chief to Chief. **Section 1.3** Updated information to reflect that the procedure is located on the H: drive of the LAN. Clarified Field Quality Manager (FQM) responsibilities. **Section 1.5** Alphabetized and revised the referencing style for consistency. **Section 1.6.1** Corrected the title of the Safety, Health, and Environmental Management Program Procedures and Policy Manual.	November 1, 2007
SESDPROC-205-R0, *Field Equipment Cleaning and Decontamination,* Original Issue	February 05, 2007

TABLE OF CONTENTS

Contents

1 General Information

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed when cleaning and decontaminating sampling equipment during the course of field investigations.

1.2 Scope/Application

The procedures contained in this document are to be followed when field cleaning sampling equipment, for both re-use in the field, as well as used equipment being returned to the Field Equipment Center (FEC). On the occasion that SESD field investigators determine that any of the procedures described in this section are either inappropriate, inadequate or impractical and that other procedures must be used to clean or decontaminate sampling equipment at a particular site, the variant procedure will be documented in the field log book, along with a description of the circumstances requiring its use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and have been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the H: drive of the SESD local area network. The Field Quality Manager (FQM) is responsible for ensuring the most recent version of the procedure is placed on the H: drive and for maintaining records of review conducted prior to its issuance.

1.4 Definitions

Decontamination: The process of cleaning dirty sampling equipment to the degree to which it can be re-used, with appropriate QA/QC, in the field.

Field Cleaning: The process of cleaning dirty sampling equipment such that it can be returned to the FEC in a condition that will minimize the risk of transfer of contaminants from a site.

De-ionized water: Tap water that has been treated by passing through a standard de-ionizing resin column. At a minimum, the finished water should contain no detectable heavy metals or other inorganic compounds (i.e., at or above analytical detection limits) as defined by a standard inductively coupled Argon Plasma Spectrophotometer (ICP) (or equivalent) scan. De-ionized water obtained by other methods is acceptable, as long as it meets the above analytical criteria. Organic-free water may be substituted for de-ionized water.

Organic-free water: Tap water that has been treated with activated carbon and de-ionizing units. At a minimum, the finished water must meet the analytical criteria of de-ionized water and it should contain no detectable pesticides, herbicides, or extractable organic compounds, and no volatile organic compounds above minimum detectable levels as determined by the Region 4 laboratory for a given set of analyses. Organic-free water obtained by other methods is acceptable, as long as it meets the above analytical criteria.

Soap: A standard brand of phosphate-free laboratory detergent, such as Luminox®.

Tap water: Water from any potable water supply. De-ionized water or organic-free water may be substituted for tap water.

Drilling Equipment: All power equipment used to collect surface and sub-surface soil samples or install wells. For purposes of this procedure, direct push is also included in this definition.

1.5 References

SESD Operating Procedure for Management of Investigation Derived Waste, SESDPROC-202, Most Recent Version

SESD Operating Procedure for Equipment Cleaning and Decontamination at the FEC, SESDPROC-206, Most Recent Version

United States Environmental Protection Agency (US EPA). 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division (SESD), Athens, GA

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

1.6 General Precautions

1.6.1 Safety

Proper safety precautions must be observed when field cleaning or decontaminating dirty sampling equipment. Refer to the SESD Safety, Health and Environmental Management Program (SHEMP) Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASPs) for guidelines on safety precautions. These guidelines, however, should only be used to complement the judgment of an experienced professional. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate. At a minimum, the following precautions should be taken in the field during these cleaning operations:

- When conducting field cleaning or decontamination using laboratory detergent, safety glasses with splash shields or goggles, and latex gloves will be worn.

- No eating, smoking, drinking, chewing, or any hand to mouth contact should be permitted during cleaning operations.

1.6.2 Procedural Precaution

Prior to mobilization to a site, the expected types of contamination should be evaluated to determine if the field cleaning and decontamination activities will generate rinsates and other waste waters that might be considered RCRA hazardous waste or may require special handling.

2 Introduction to Field Equipment Cleaning and Decontamination

2.1 General

The procedures outlined in this document are intended for use by field investigators for cleaning and decontaminating sampling and other equipment in the field. These procedures should be followed in order that equipment is returned to the FEC in a condition that will minimize the risk of transfer of contaminants from a site.

Sampling and field equipment cleaned in accordance with these procedures must meet the minimum requirements for the Data Quality Objectives (DQOs) of the study or investigation. Site-specific alterations to these procedures should be documented in the study plan. Deviations from these procedures should be documented in the field records.

Cleaning procedures for use at the Field Equipment Center (FEC) are found in SESD Operating Procedure for Equipment Cleaning and Decontamination at the FEC (SESDPROC-206).

2.2 Handling and Containers for Cleaning Solutions

Improperly handled cleaning solutions may easily become contaminated. Storage and application containers must be constructed of the proper materials to ensure their integrity. Following are acceptable materials used for containing the specified cleaning solutions:

- <u>Soap</u> must be kept in clean plastic, metal, or glass containers until used. It should be poured directly from the container during use.

- <u>Tap water</u> may be kept in tanks, hand pressure sprayers, squeeze bottles, or applied directly from a hose.

- <u>De-ionized water</u> must be stored in clean, glass or plastic containers that can be closed prior to use. It can be applied from plastic squeeze bottles.

- <u>Organic-free water</u> must be stored in clean glass or Teflon® containers prior to use. It may be applied using Teflon® squeeze bottles, or with the portable system.

2.3 Disposal of Cleaning Solutions

Procedures for the safe handling and disposition of investigation derived waste (IDW); including used wash water and rinse water are in SESD Operating Procedure for Management of Investigation Derived Waste (SESDPROC-202).

2.4 Sample Collection Equipment Contaminated with Concentrated Materials

Equipment used to collect samples of concentrated materials from investigation sites must be field cleaned before returning from the study. At a minimum, this should consist of washing with soap and rinsing with tap water. When the above procedure cannot be followed, the following options are acceptable:

1. Leave with facility for proper disposal;
2. If possible, containerize, seal and secure the equipment and leave on-site for later disposal;
3. Containerize, bag or seal the equipment so that no odor is detected and return to the SESD.

It is the project leader’s responsibility to evaluate the nature of the sampled material and determine the most appropriate cleaning procedures for the equipment used to sample that material.

2.5 Sample Collection Equipment Contaminated with Environmental Media

Equipment used to collect samples of environmental media from investigation sites should be field cleaned before returning from the study. Based on the condition of the sampling equipment, one or more of the following options must be used for field cleaning:

1. Wipe the equipment clean;
2. Water-rinse the equipment;
3. Wash the equipment in detergent and water followed by a tap water rinse.
4. For grossly contaminated equipment, the procedures set forth in Section 2.4 must be followed.

Under extenuating circumstances such as facility limitations, regulatory limitations, or during residential sampling investigations where field cleaning operations are not feasible, equipment can be containerized, bagged or sealed so that no odor is detected and returned to the FEC without being field cleaned. If possible, FEC personnel should be notified that equipment will be returned without being field cleaned. It is the project leader's responsibility to evaluate the nature of the sampled material and determine the most appropriate cleaning procedures for the equipment used to sample that material.

2.6 Handling of Decontaminated Equipment

After decontamination, equipment should be handled only by personnel wearing clean gloves to prevent re-contamination. In addition, the equipment should be moved away (preferably upwind) from the decontamination area to prevent re-contamination. If the equipment is not to be immediately re-used it should be covered with plastic sheeting or wrapped in aluminum foil to prevent re-contamination. The area where the equipment is kept prior to re-use must be free of contaminants.

3 Field Equipment Decontamination Procedures

3.1 General

Sufficient equipment should be transported to the field so that an entire study can be conducted without the need for decontamination. When equipment must be decontaminated in the field, the following procedures are to be utilized.

3.2 Specifications for Decontamination Pads

Decontamination pads constructed for field cleaning of sampling and drilling equipment should meet the following minimum specifications:

- The pad should be constructed in an area known or believed to be free of surface contamination.

- The pad should not leak.

- If possible, the pad should be constructed on a level, paved surface and should facilitate the removal of wastewater. This may be accomplished by either constructing the pad with one corner lower than the rest, or by creating a sump or pit in one corner or along one side. Any sump or pit should also be lined.

- Sawhorses or racks constructed to hold equipment while being cleaned should be high enough above ground to prevent equipment from being splashed.

- Water should be removed from the decontamination pad frequently.

- A temporary pad should be lined with a water impermeable material with no seams within the pad. This material should be either easily replaced (disposable) or repairable.

At the completion of site activities, the decontamination pad should be deactivated. The pit or sump should be backfilled with the appropriate material designated by the site project leader, but only after all waste/rinse water has been pumped into containers for disposal. See SESD Operating Procedure for Management of Investigation Derived Waste (SESDPROC-202) for proper handling and disposal of these materials. If the decontamination pad has leaked excessively, soil sampling may be required.

3.3 "Classical Parameter" Sampling Equipment

"Classical Parameters" are analyses such as oxygen demand, nutrients, certain inorganics, sulfide, flow measurements, etc. For routine operations involving classical parameter analyses, water quality sampling equipment such as Kemmerers, buckets, dissolved oxygen dunkers, dredges, etc., may be cleaned with the sample water or tap water between sampling locations as appropriate.

Flow measuring equipment such as weirs, staff gages, velocity meters, and other stream gauging equipment may be cleaned with tap water between measuring locations, if necessary.

Note: The procedures described in Section 3.3 are not to be used for cleaning field equipment to be used for the collection of samples undergoing trace organic or inorganic constituent analyses.

3.4 Sampling Equipment used for the Collection of Trace Organic and Inorganic Compounds

For samples undergoing trace organic or inorganic constituent analyses, the following procedures are to be used for all sampling equipment or components of equipment that come in contact with the sample:

1. Clean with tap water and Luminox® soap using a brush, if necessary, to remove particulate matter and surface films. Equipment may be steam cleaned (Luminox® soap and high pressure hot water) as an alternative to brushing. Sampling equipment that is steam cleaned should be placed on racks or saw horses at least two feet above the floor of the decontamination pad. PVC or plastic items should not be steam cleaned.

2. Rinse thoroughly with tap water.

3. Rinse thoroughly with organic-free water and place on a clean foil-wrapped surface to air-dry.

4. All equipment must be wrapped with foil. If the equipment is to be stored overnight before it is wrapped in foil, it should be covered and secured with clean, unused plastic sheeting.

3.5 Well Sounders or Tapes

The following procedures are recommended for decontaminating well sounders (water level indicators) and tapes:

1. Wash with soap and tap water.
2. Rinse with tap water.
3. Rinse with de-ionized water.

3.6 Redi-Flo2® Pump

The Redi-Flo2® pump should be decontaminated prior to use and between each monitoring well. The following procedure is required:

CAUTION - Make sure the pump is not plugged in.

1. Using a brush, scrub the exterior of the pump, electrical cord and garden hose with soap and tap water. Do not wet the electrical plug.
2. Rinse with tap water.
3. Rinse with de-ionized water.
4. Place the equipment in a clean plastic bag.

To clean the Redi-Flo2® ball check valve:

1. Remove the ball check valve from the pump head. Check for wear and/or corrosion, and replace as needed.
2. Using a brush, scrub all components with soap and tap water.
3. Rinse with de-ionized water.
4. Replace the ball check valve to the Redi-Flo2® pump head.

3.7 Downhole Drilling Equipment

These procedures are to be used for drilling activities involving the collection of soil samples for trace organic and inorganic constituent analyses and for the construction of monitoring wells to be used for the collection of groundwater samples for trace organic and inorganic constituent analyses.

3.7.1 Introduction

Cleaning and decontamination of all equipment should occur at a designated area (decontamination pad) on the site. The decontamination pad should meet the specifications of Section 3.2 of this procedure.

Tap water brought on the site for drilling and cleaning purposes should be contained in a pre-cleaned tank.

A steam cleaner and/or high pressure hot water washer capable of generating a pressure of at least 2500 PSI and producing hot water and/or steam (200^{o} F plus), with a soap compartment, should be obtained.

3.7.2 Preliminary Cleaning and Inspection

Drilling equipment should be clean of any contaminants that may have been transported from off-site to minimize the potential for cross-contamination. The drilling equipment should not serve as a source of contaminants. Associated drilling and decontamination equipment, well construction materials, and equipment handling procedures should meet these minimum specified criteria:

- All downhole augering, drilling, and sampling equipment should be sandblasted before use if painted, and/or there is a buildup of rust, hard or caked matter, etc., that cannot be removed by steam cleaning (soap and high pressure hot water), or wire brushing. Sandblasting should be performed <u>prior to arrival</u> on site, or well away from the decontamination pad and areas to be sampled.

- Any portion of the drilling equipment that is over the borehole (kelly bar or mast, backhoe buckets, drilling platform, hoist or chain pulldowns, spindles, cathead, etc.) should be steam cleaned (soap and high pressure hot water) and wire brushed (as needed) to remove all rust, soil, and other material which may have come from other sites before being brought on site.

- Printing and/or writing on well casing, tremie tubing, etc., should be removed before use. Emery cloth or sand paper can be used to remove the printing and/or writing. Most well material suppliers can provide materials without the printing and/or writing if specified when ordered. Items that cannot be cleaned are not acceptable and should be discarded.

- Equipment associated with the drilling and sampling activities should be inspected to insure that all oils, greases, hydraulic fluids, etc., have been removed, and all seals and gaskets are intact with no fluid leaks.

3.7.3 Drill Rig Field Cleaning Procedure

Any portion of the drill rig, backhoe, etc., that is over the borehole (kelly bar or mast, backhoe buckets, drilling platform, hoist or chain pulldowns, spindles, cathead, etc.) should be steam cleaned (soap and high pressure hot water) between boreholes.

3.7.4 Field Decontamination Procedure for Drilling Equipment

The following is the standard procedure for field cleaning augers, drill stems, rods, tools, and associated equipment. This procedure does <u>not</u> apply to well casings, well screens, or split-spoon samplers used to obtain samples for chemical analyses, which should be decontaminated as outlined in Section 3.4 of this procedure.

1. Wash with tap water and soap, using a brush if necessary, to remove particulate matter and surface films. Steam cleaning (high pressure hot water with soap) may be necessary to remove matter that is difficult to remove with the brush. Drilling equipment that is steam cleaned should be placed on racks or saw horses at least two feet above the floor of the decontamination pad. Hollow-stem augers, drill rods, etc., that are hollow or have holes that transmit water or drilling fluids, should be cleaned on the inside with vigorous brushing.

2. Rinse thoroughly with tap water.

3. Remove from the decontamination pad and cover with clean, unused plastic. If stored overnight, the plastic should be secured to ensure that it stays in place.

ARCADIS
Infrastructure, environment, facilities

Imagine the result

Field Equipment Decontamination

Rev. #: 3

Rev Date: April 26, 2010

Approval Signatures

Prepared by: ______________________ Date: 4/26/2010
Keith Shepherd

Reviewed by: ______________________ Date: 4/26/2010
Richard Murphy (Technical Expert)

I. Scope and Application

Equipment decontamination is performed to ensure that sampling equipment that contacts a sample, or monitoring equipment that is brought into contact with environmental media to be sampled, is free from analytes of interest and/or constituents that would interfere with laboratory analysis for analytes of interest. Equipment must be cleaned prior to use for sampling or contact with environmental media to be sampled, and prior to shipment or storage. The effectiveness of the decontamination procedure should be verified by collecting and analyzing equipment blank samples.

The equipment cleaning procedures described herein includes pre-field, in the field, and post-field cleaning of sampling tools which will be conducted at an established equipment decontamination area (EDA) on site (as appropriate). Equipment that may require decontamination at a given site includes: soil sampling tools; groundwater, sediment, and surface-water sampling devices; water testing instruments; down-hole instruments; and other activity-specific sampling equipment. Non-disposable equipment will be cleaned before collecting each sample, between sampling events, and prior to leaving the site. Cleaning procedures for sampling equipment will be monitored by collecting equipment blank samples as specified in the applicable work plan or field sampling plan. Dedicated and/or disposable (not to be re-used) sampling equipment will not require decontamination.

II. Personnel Qualifications

ARCADIS field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, site supervisor training, and site-specific training, as needed. In addition, ARCADIS field sampling personnel will be versed in the relevant SOPs and possess the skills and experience necessary to successfully complete the desired fieldwork. The project HASP and other documents will identify any other training requirements such as site specific safety training or access control requirements.

III. Equipment List

- health and safety equipment, as required in the site Health and Safety Plan (HASP)
- distilled water

- Non-phosphate detergent such as Alconox or, if sampling for phosphorus phosphorus-containing compounds, Luminox (or equivalent).
- tap water
- rinsate collection plastic containers
- DOT-approved waste shipping container(s), as specified in the work plan or field sampling plan (if decontamination waste is to be shipped for disposal)
- brushes
- large heavy-duty garbage bags
- spray bottles
- (Optional) – Isoprophyl alcohol (free of ketones) or methanol
- Ziploc-type bags
- plastic sheeting

IV. Cautions

Rinse equipment thoroughly and allow the equipment to dry before re-use or storage to prevent introducing solvent into sample medium. If manual drying of equipment is required, use clean lint-free material to wipe the equipment dry.

Store decontaminated equipment in a clean, dry environment. Do not store near combustion engine exhausts.

If equipment is damaged to the extent that decontamination is uncertain due to cracks or dents, the equipment should not be used and should be discarded or submitted for repair prior to use for sample collection.

A proper shipping determination will be performed by a DOT-trained individual for cleaning materials shipped by ARCADIS.

V. Health and Safety Considerations

Review the material safety data sheets (MSDS) for the cleaning materials used in decontamination. If solvent is used during decontamination, work in a well-ventilated area and stand upwind while applying solvent to equipment. Apply solvent in a manner that minimizes potential for exposure to workers. Follow health and safety procedures outlined in the HASP.

VI. Procedure

A designated area will be established to clean sampling equipment in the field prior to sample collection. Equipment cleaning areas will be set up within or adjacent to the specific work area, but not at a location exposed to combustion engine exhaust. Detergent solutions will be prepared in clean containers for use in equipment decontamination.

Cleaning Sampling Equipment

1. Wash the equipment/pump with potable water.
2. Wash with detergent solution (Alconox, Liquinox or equivalent) to remove all visible particulate matter and any residual oils or grease.
3. If equipment is very dirty, precleaning with a brush and tap water may be necessary.
4. (Optional) – Flush with isopropyl alcohol (free of ketones) or with methanol. This step is optional but should be considered when sampling in highly impacted media such as non-aqueous phase liquids or if equipment blanks from previous sampling events showed the potential for cross contamination of organics.
5. Rinse with distilled/deionized water.

Decontaminating Submersible Pumps

Submersible pumps may be used during well development, groundwater sampling, or other investigative activities. The pumps will be cleaned and flushed before and between uses. This cleaning process will consist of an external detergent solution wash and tap water rinse, a flush of detergent solution through the pump, followed by a flush of potable water through the pump. Flushing will be accomplished by using an appropriate container filled with detergent solution and another contained filled with potable water. The pump will run long enough to effectively flush the pump housing and hose (unless new, disposable hose is used). Caution should be exercised to avoid contact with the pump casing and water in the container while the pump is running (do not use metal drums or garbage cans) to avoid electric shock. Disconnect the pump from the power source before handling. The pump and hose should be placed on or in clean polyethylene sheeting to avoid contact with the ground surface.

VII. Waste Management

Equipment decontamination rinsate will be managed in conjunction with all other waste produced during the field sampling effort. Waste management procedures are outlined in the work plan or Waste Management Plan (WMP).

VIII. Data Recording and Management

Equipment cleaning and decontamination will be noted in the field notebook. Information will include the type of equipment cleaned, the decontamination location and any deviations from this SOP. Specific factors that should be noted include solvent used (if any), and source of water.

Any unusual field conditions should be noted if there is potential to impact the efficiency of the decontamination or subsequent sample collection.

An inventory of the solvents brought on site and used and removed from the site will be maintained in the files. Records will be maintained for any solvents used in decontamination, including lot number and expiration date.

Containers with decontamination fluids will be labeled.

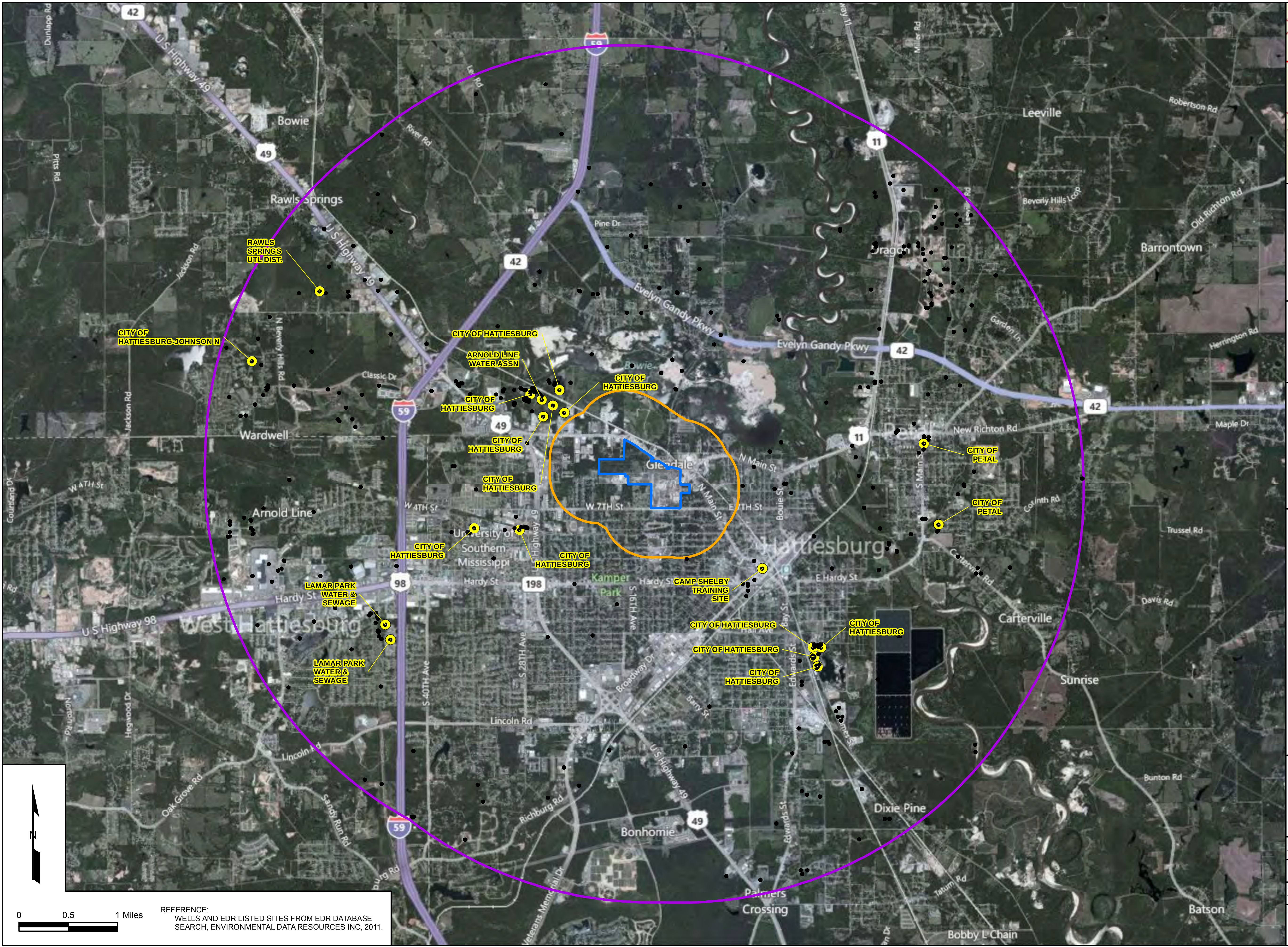
IX. Quality Assurance

Equipment blanks should be collected to verify that the decontamination procedures are effective in minimizing potential for cross contamination. The equipment blank is prepared by pouring deionized water over the clean and dry tools and collecting the deionized water into appropriate sample containers. Equipment blanks should be analyzed for the same set of parameters that are performed on the field samples collected with the equipment that was cleaned. Equipment blanks are collected per equipment set, which represents all of the tools needed to collect a specific sample.

X. References

USEPA Region 9, Field Sampling Guidance #1230, Sampling Equipment Decontamination.

USEPA Region 1, Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells.



REFERENCE:
WELLS AND EDR LISTED SITES FROM EDR DATABASE SEARCH, ENVIRONMENTAL DATA RESOURCES INC, 2011.

EDR IDENTIFIED PUBLIC SUPPLY WELLS

Phase I Sampling and Analysis Work Plan

HERCULES INCORPORATED
613 W. 7th Street
Hattiesburg, Mississippi

ARCADIS
10352 PLAZA AMERICANA DRIVE
BATON ROUGE, LA 70816
TEL: 225-292-1004
FAX: 225-218-9677
WWW.ARCADIS-US.COM

Legend

- ● EDR Identified Wells
- ○ Public Supply Well
- ▭ Approximate Hercules Property
- ▭ Half Mile Radius
- ▭ Four Mile Radius

No public supply wells within 1/2 mile of site.
17 public supply wells within 4 miles of site.

PROJECT MANAGER: JE	CHECKED BY: CD
DRAWING FILE:	GIS FILE:
DRAWING BY: JEC	DATE: 06/28/2011
PROJECT NUMBER: LA002999.0004	FIGURE NUMBER: **Appendix F**

Date Saved: 9/14/2011 12:36:47 PM

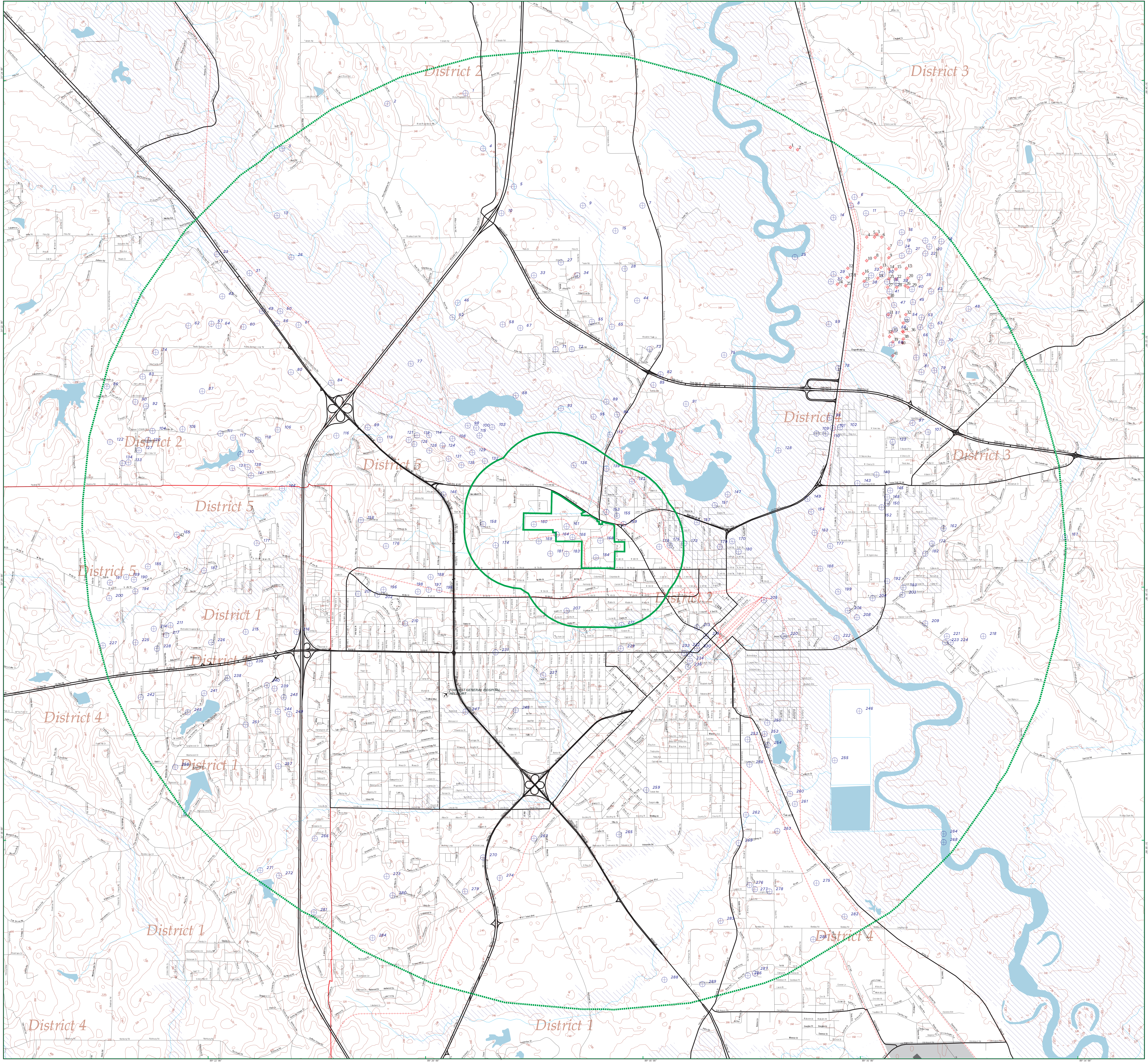
Path: U:\projects\ashland\LA002999\ArcMap\LA002999-04\LA002999-04-01-AppF.mxd

U:\projects\ashland\LA002999\output\LA002999-04\LA002999-04-01-5.pdf

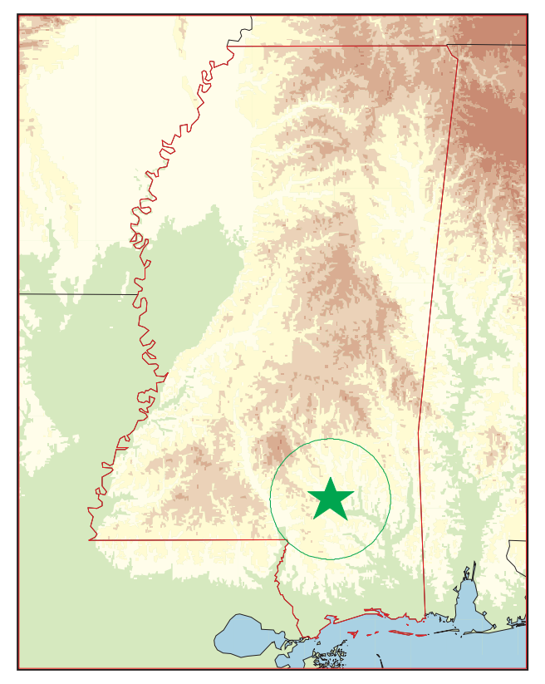
EDR DataMap®
Well Search

Hercules, Inc.

- ⊕ Listed Water Wells
- ✧ Oil & Gas Wells
- Study Boundary
- Roads
- Major Roads
- Waterways
- Railroads
- Contour Lines
- Fault Lines
- 🟦 Water
- ▨ Superfund Sites
- ▨ 100-Yr Flood Zones



N



Hattiesburg, MS

0 1/2 1

Scale in Miles

EDR® Environmental Data Resources Inc

3078218.1w - 02 Jun 11

EDR Database Findings

Regulatory agency database information was obtained from the EDR Radius Map Report, which maps and lists properties in U.S. government and Mississippi state environmental databases with existing conditions or status that may have the potential to impact the site. A description of the databases searched and the information obtained is summarized below.

Type of Database	Description of Database/Effective Date	Radius Searched	Number of Sites Identified in 0.5-Mile Radius	Number of Sites Identified in 4-Mile Radius
NPL	The National Priorities List identifies uncontrolled or abandoned hazardous waste sites. To appear on the NPL, sites must have met or surpassed a predetermined hazard ranking system score, been chosen as a state's top priority site, pose a significant health or environmental threat, or be a site where the EPA has determined that remedial action is more cost-effective than removal action.	4 miles	0	0
CORRACTS	Listing of RCRA facilities that are undergoing corrective action. Corrective actions may be required beyond the facility's boundary and can be required regardless of when the release occurred, even if it predates RCRA.	4 miles	0	0
CERCLIS	The Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) database identifies hazardous waste sites that require investigation and possible remedial action to mitigate potential negative impacts on human health or the environment.	4 miles	1 (including Hercules)	3 (including Hercules)

Type of Database	Description of Database/Effective Date	Radius Searched	Number of Sites Identified in 0.5-Mile Radius	Number of Sites Identified in 4-Mile Radius
CERC-NFRAP	CERCLIS-No Further Remedial Action Planned (CERCLIS-NFRAP) contains data on sites where, following an initial investigation, no contamination was found, contamination was removed quickly without the need for the site to be placed on the NPL, or the contamination was not serious enough to require Federal Superfund action or NPL consideration. Source: USEPA/National Technical Information Service (NTIS).	4 miles	0	2
RCRA-NonGen	RCRAInfo database of sites that do not presently generate hazardous waste.	4 miles	1	17
RCRA Generators	RCRA-regulated hazardous waste generator notifiers list (includes small quantity, large quantity, and conditionally exempt small quantity generators).	4 miles 4 miles 4 miles	SQG – 2 LQG – 1 (including Hercules) CESQG - 4	SQG – 14 LQG – 1 (including Hercules) CESQG - 44
ERNS and state spills list	EPA's Emergency Response Notification System (ERNS) list contains reported spill records of oil and hazardous substances.	4 mile	2	43
HMIRS	The Hazardous Materials Incident Report System contains hazardous material spill incidents reported to the Department of Transportation.	4 mile	0	83
US CDL	US Department of Justice listing of clandestine drug lab locations.	4 mile	0	2
US Brownfields	The EPA's listing of Brownfields properties addressed by Cooperative Agreement Recipients and Brownfields properties addressed by Targeted Brownfields Assessments	4 mile	3	18

Type of Database	Description of Database/Effective Date	Radius Searched	Number of Sites Identified in 0.5-Mile Radius	Number of Sites Identified in 4-Mile Radius
FUDS	Formerly Used Defense Sites where USACOE will take necessary cleanup actions	4 mile	0	1
MINES	Department of Labor, Mine Safety and Health Administration – mine site index	4 mile	0	2
TRIS	The Toxic Chemical Release Inventory System identifies facilities that release toxic chemicals to the air, water, and land in reportable quantities under SARA Title III, Section 313. The source of this database is the U.S. EPA	4 mile	1 (including Hercules)	6 (including Hercules)
TSCA	The Toxic Substances Control Act identifies manufacturers and importers of chemical substances included on the TSCA Chemical Substance Inventory list. It includes data on the production volume of these substances by plant site.	4 mile	1 (including Hercules)	7 (including Hercules)
FTTS	FIFRA/TSCA/EPCRA – tracks administrative cases and pesticide enforcement and compliance activities	4 mile	1 (including Hercules)	13 (including Hercules)
SSTS	Federal Insecticide, Fungicide, and Rodenticide Act – registered pesticide-producing establishment	4 mile	1	3
ICIS	Integrated Compliance Information System – supports the information needs of the national enforcement compliance program as well as the NPDES program	4 mile	2 (including Hercules)	5 (including Hercules)
PADS	PCB Activity Database – identified generators, transporters, commercial storers and/or brokers and disposers of PCBs	4 mile	1 (including Hercules)	2 (including Hercules)
FINDS	Facility Index System – US EPA/NTIS database that contains both facility information and “pointers” to other sources of information including RCRIS, PCS, AIRS, FATES, FTTS, CERCLIS, DOCKET, FURS, FRDS, SIA, TSCA, CICS, PADS, RCRA-J, TRIS, TSCA	4 mile	17 (including Hercules)	190 (including Hercules)

Type of Database	Description of Database/Effective Date	Radius Searched	Number of Sites Identified in 0.5-Mile Radius	Number of Sites Identified in 4-Mile Radius
SHWS	The State Hazardous Waste Sites records are the states' equivalent to CERCLIS. These sites may or may not already be listed on the federal CERCLIS list. Priority sites planned for cleanup using state funds (state equivalent of Superfund) are identified along with sites where cleanup will be paid for by potentially responsible parties. The data come from the Department of Environmental Quality's Uncontrolled Site Project Tracking System.	4 mile	5 (including Hercules)	28 (including Hercules)
SWF/LF	State inventory of solid waste disposal and landfill sites.	4 miles	0	2
LUST	List of information pertaining to all reported leaking underground storage tanks.	4 miles	3	46
UST/AST	State registered underground and above-ground storage tank sites listing.	4 miles	UST – 17 AST – 0	UST – 203 AST – 2
PERMITS	Environmental Site Information System Listing – NPDES Program, Air Title V, Construction & Operating Programs, Solid/Hazardous Waste Programs	4 miles	2 (including Hercules)	14 (including Hercules)
INST CONTROLS	Sites included on the CERCLA/Uncontrolled Sites File List that have institutional and/or engineering controls	4 miles	2	4
MS NPDES	Mississippi Industrial and Municipal NPDES facilities.	4 mile	1 (including Hercules)	14 (including Hercules)
VCP	Voluntary Evaluation Program Sites	4 mile	1	5
DRYCLEANERS	Listing of drycleaner facilities	4 mile	0	1

Type of Database	Description of Database/Effective Date	Radius Searched	Number of Sites Identified in 0.5-Mile Radius	Number of Sites Identified in 4-Mile Radius
ASBESTOS	Listing of Air Division Asbestos Branch Projects	4 mile	0	4
MGP	Manufactured Gas Plants – records of coal gas plants.	4 mile	0	1

ARCADIS
Infrastructure · Water · Environment · Buildings

ARCADIS U.S., Inc.
10352 Plaza Americana Drive
Baton Rouge
Louisiana 70816
Tel 225 292 1004
Fax 225 218 9677
www.arcadis-us.com

«Property_Owner»
«Contact_Address»
«CityStateZip»

Subject:
Hattiesburg Water-Well Survey – Hercules Incorporated
Hattiesburg Facility
Hattiesburg, Forrest County, Mississippi

ENVIRONMENT

Your Property:
«Parcel_ID»; «Property_Address»

Date:
xx xxxx 2011

Contact:
Craig Derouen

Extension:
238

Email:
craig.derouen@arcadis-us.com

Our ref:
LA002933.0003.00001
2933.3/C/2/jk

Dear Property Owner or Occupant:

ARCADIS U.S., Inc. (ARCADIS) is conducting an investigation on behalf of Hercules Incorporated (Hercules) and with the support of the Mobile Bouie Neighborhood Association, the North Main Historic Neighborhood Association and the City of Hattiesburg. The U. S. Environmental Protection Agency requested Hercules to find all wells within a half-mile radius of the Hercules facility, whether currently in use or not. This includes wells used for drinking water, irrigation, industrial supply, heat pumps or some other use.

ARCADIS is sending this letter to you because we believe your property is located within the half-mile radius of the former Hercules plant. To enable us to complete an accurate list, please respond to the questions and return the postcard within 10 days. By returning this survey with as much detail as you can provide, you are helping an important project to benefit your community. If you have any questions regarding this survey, please contact me by telephone at 1/800-XXX-XXXX.

Sincerely,

ARCADIS U.S., Inc.

Craig A. Derouen, P.E.
Task Manager

CD:jk

Your Property:
«Parcel_ID»; «Property_Address»

ARCADIS

Please answer the following questions by placing an "X" in Yes or No box.

1. Is a water well installed on your property for drinking, irrigation or other purposes? Yes ☐ No ☐

   Well Type: Irrigation ☐ Drinking Water (Domestic) ☐ Industrial Water Supply ☐ Agricultural ☐ Public Supply ☐ Other ________________________

   Well Details: Year Installed: ________ Diameter: ________ Depth: ________ Pump Type: ________

2. If YES to #1: Is the water well still in use? If not, please explain. Yes ☐ No ☐

   ____

3. Are you obtaining your drinking water from a municipal or private source (i.e., from the city or village)? Yes ☐ No ☐

4. Are you aware of any water wells in the area other than any that may be on your property? If yes, please explain. Yes ☐ No ☐ Comments: ____

   ____

5. Are you aware of any environmental issues that may be on your property? If yes, please explain. Yes ☐ No ☐ Comments: ____

   ____

Signature of property owner/occupant: ________________________________ Date: ____________

Please Print Name: ____

Hercules Incorporated
Hattiesburg, MS
Community Well Questionnaire and Summarized Community Responses

No.	Date Received	Date Postcard Signed	Parcel No.	Landowner's Name	Question 1 Is a Water Well Present on Property? (Y / N)	Questions 1 Comments	Question 2 If "Yes" to Q#1, is the Water Well Still in Use? (Y / N / NA)	Question 3 Drinking Water Obtained from Private or Municipal Source? (Y / N)	Question 4 Aware of Other Water Wells in Area Not on Your Property? (Y / N)	Questions 4 Comments	Question 5 Aware of Environmental Issues on Your Property? (Y / N)	Questions 5 Comments
1	8/4/11	8/2/11	2-024P-32-015.00	[redacted]	N		NA	Y	N		Y	ZEON Chemicals and Hercules has probably contaminated my land.
2	8/4/11	8/2/2011	2-028H-05015.00	[redacted]	N		NA	Y	N		N	
3	8/4/11	8/2/2011	2-028H-05014.00	[redacted]	N		NA	Y	N		N	
4	8/4/11	8/2/2011	2-029C-04-159.00	[redacted]	N		NA	Y	N		N	
5	8/4/11	8/2/2011	2-024P-32-007.00	[redacted]	N		NA	Y	N		N	
6	8/4/11	8/2/2011	2-024P-32-008.00	[redacted]	N		NA	Y	N		N	
7	8/4/11	8/2/2011	2-029E-04-140.00	[redacted]	N		NA	Y	N		Y	Tree's that won't produce fruits or nuts. Spardioc episodes of dirty drinking water kitchen/bath.
8	8/4/11	8/2/2011	2-029E-04-162.00	[redacted]	N		NA	Y	Y	Several W/I the fence of the Hercules property.	Blank	
9	8/4/11	8/2/2011	2-028B-05-028.00	[redacted]	N		NA	Y	N		N	
10	8/4/11	8/2/2011	2-028B-05-025.00	[redacted]	N		NA	Y	N		N	
11	8/4/11	8/2/2011	2-028B-05-030.00	[redacted]	N		NA	Y	N		N	
12	8/4/11	blank	2-028B-05-029.00	[redacted]	Blank		Blank	Blank	Blank		Blank	
13	8/4/11	8/2/2011	2-029D-04-027.00	[redacted]	N		NA	Y	N		N	
14	8/5/11	8/3/2011	2-029K-09-187.00	[redacted]	N		NA	Y	N		N	
15	8/5/11	8/2/2011	2-029C-04-114.00	[redacted]	N		N	Y	N		Blank	
16	8/5/11	8/2/2011	2-029E-04-065.00	[redacted]	N		NA	Y	N		N	
17	8/5/11	8/3/2011	2-029F-04-093.00	[redacted]	N		NA	Y	N		N	
18	8/5/11	BLANK	2-028A-05-050.00	[redacted]	Y	Industrial water supply, 1960's, 4" galvanized pipe, 40', above ground pump	No property not inhabited	None	N		Y	
19	8/5/11	8/2/2011	2-029F-04-160.00	[redacted]	N		NA	Y	N		N	
20	8/5/11	8/3/2011	2-029G-03-438.00	[redacted]	N		NA	Y	Y	There was a pump for drinking water at 1009 (or 4??) Allen Street Formerly	Y	Sewer Leak - 222 JD Randolph Street
21	8/5/11	8/3/2011	2-029F-04-197.00	[redacted]	N		NA	Y	N		N	
22	8/5/11	8/3/2011	2-029C-04-101.00	[redacted]	N		NA	Y	N		N	
23	8/5/11	8/3/2011	2-028H-05-139.00	[redacted]	N		NA	Y	N		N	
24	8/5/11	8/3/2011	2-029F-04-271.00	[redacted]	N		NA	Y	N		Y	BLANK
25	8/5/11	8/3/2011	2-028A-05-098.00	[redacted]	N		NA	Y	N		N	
26	8/5/11	8/3/2011	2-028H-05-259.00	[redacted]	N		NA	Y	N		N	
27	8/5/11	8/3/2011	2-029C-04-071.00	[redacted]	N		NA	Y	N		N	
28	8/5/11	8/3/2011	2-029C-04-017.00	[redacted]	N		NA	Y	N		N	
29	8/5/11	8/2/2011	2-029L-09-116.00	[redacted]	N		NA	Y	N		N	
30	8/5/11	8/2/2011	2-029K-09-101.00	[redacted]	N		NA	Y	N		N	
31	8/5/11	8/2/2011	2-028I-08-074.00	[redacted]	N		NA	Y	Blank	I think a natural spring may be near under ground spring at 410 Dixie Ave.	N	
32	8/5/11	8/4/2011	2-028H-05-158.00	[redacted]	N		NA	Y	N		N	
33	8/5/11	8/2/2011	2-029L-09-068.00	[redacted]	N		NA	Y	N		N	
34	8/5/11	8/3/2011	2-028B-05-010.00	[redacted]	N		NA	Y	N		N	

Hercules Incorporated
Hattiesburg, MS
Community Well Questionnaire and Summarized Community Responses

No.	Date Received	Date Postcard Signed	Parcel No.	Landowner's Name	Question 1 Is a Water Well Present on Property? (Y / N)	Questions 1 Comments	Question 2 If "Yes" to Q#1, is the Water Well Still in Use? (Y / N / NA)	Question 3 Drinking Water Obtained from Private or Municipal Source? (Y / N)	Question 4 Aware of Other Water Wells in Area Not on Your Property? (Y / N)	Questions 4 Comments	Question 5 Aware of Environmental Issues on Your Property? (Y / N)	Questions 5 Comments
35	8/5/11	8/3/2011	2-029B-03-130.00	[redacted]	N		NA	Y	N		Y	Chemical that came from Hercules not sure.
36	8/5/11	8/1/2011	2-028H-05-146.00	[redacted]	N		NA	Y	N		Blank	Not sure.
37	8/5/11	8/2/2011	2-029F-04-078.00	[redacted]	N		NA	Y	N		N	
38	8/5/11	8/3/2011	2-029C-04-060.00	[redacted]	N		NA	N	N		N	Estate of Thomas E. Cranford.
39	8/5/11	8/3/2011	2-028H-05-157.00	[redacted]	N		NA	Y	N		N	I find it hard to grow plants & flowers in my garden. I was thanking if I should have my soil tested.
40	8/5/11	8/2/2011	2-029F-04-291.00	[redacted]	N		NA	Y	N		N	
41	8/5/11	8/2/2011	2-023M-33-004.00	[redacted]	Y	Irrigation, Drinking Water, Agricultural. Installed 1993, Diameter 4", 200 ft deep, Submergable pump.	Y	Y	Y	Neighbor: Glenda Casico	Y	Creek coming by property comes from Hercules, ditch runs thru property from Hercules.
42	8/5/11	8/3/2011	2-029C-04-158.01	[redacted]	Y	Industrial water supply. Installed 2009	Y	Y	N	2688 Old Richton Rd.	N	
43	8/5/11	8/2/2011	2-029D-04-012.00	[redacted]	Y	Irrigation, Drinking Water, Agricultural. Installed 1993, Diameter 4", 200 ft deep, Submergable pump.	Y	Y	Y	Neighbor: Glenda Casico	Y	1841 Lakeview (our house) creek from Hercules running by property: 190 Lakeview ditch from across by Hercules runs thru yard.
44	8/5/11	8/2/2011	2-029D-04-013.00	[redacted]	Y	Irrigation, Drinking Water, Agricultural. Installed 1993, Diameter 4", 200 ft deep, Submergable pump.	Y	Y	Y	Neighbor: Glenda Casico	Y	Creek running by (from Hercules and ditch thru yard coming from Hercules.
45	8/5/11	8/2/2011	2-023M-33-003.00	[redacted]	Y	Irrigation, Drinking Water, Agricultural. Installed 1993, Diameter 4", 200 ft deep, Submergable pump.	Y	Y	Y	Neighbor: Glenda Casico	Y	Creek running by property from Hercules ditch runs thru property (comes from Hercules.
46	8/5/11	8/3/2011	2-029F-04-033.00	[redacted]	Y	Drinking Water. Details: Not sure well has been capped.	N	NA	Y	N	Y	Mold and mildew smell of air. I've lived here 23 yrs. Never had Bronchitis after a few years here.
47	8/5/11	8/2/2011	2-024P-32-018.00	[redacted]	Y	Drinking Water. Details: Installed 1935	No covered it up for safety of grandchildren and dogs.	Y	N		N	
48	8/5/11	8/3/2011	2-029G-03-302.00	[redacted]	Y	Drinking Water	Y	N	N		N	
49	8/5/11		2-029L-09-119.00	[redacted]								To my knowledge we do not have any wells in that area. (Stafford Construction Co., Inc 601-264-0878.
50	8/5/11		2-029E-04-024.00	[redacted]								To my knowledge we do not have any wells in that area. (Stafford Construction Co., Inc 601-264-0878.
51	8/5/11	8/2/2011	2-029K-09-195.00	[redacted]	N		NA	Y	N		N	
52	8/5/11	8/2/2011	2-029D-04-029.00	[redacted]	N		NA	Y	N		N	
53	8/5/11	8/3/2011	2-029K-09-010.00	[redacted]	N		NA	Y	N		N	
54	8/5/11	8/2/2011	2-029F-04-022.00	[redacted]	N		NA	Y	N		N	
55	8/5/11	8/3/2011	2-028G-05-003.00	[redacted]	N		NA	Y	Blank		Blank	
56	8/5/11	8/2/2011	2-029F-04-268.00	[redacted]	N		NA	Y	N		N	
57	8/5/11	7/20/2011	2-028A-05-069.00	[redacted]	N		NA	Y	N		N	
58	8/5/11	8/3/2011	2-028G-05-009.00	[redacted]	N		NA	Y	Blank		Blank	
59	8/5/11	8/4/2011	2-029F-04-269.00	[redacted]	N		NA	Y	N		N	

Hercules Incorporated
Hattiesburg, MS
Community Well Questionnaire and Summarized Community Responses

No.	Date Received	Date Postcard Signed	Parcel No.	Landowner's Name	Question 1 Is a Water Well Present on Property? (Y / N)	Questions 1 Comments	Question 2 If "Yes" to Q#1, is the Water Well Still in Use? (Y / N / NA)	Question 3 Drinking Water Obtained from Private or Municipal Source? (Y / N)	Question 4 Aware of Other Water Wells in Area Not on Your Property? (Y / N)	Questions 4 Comments	Question 5 Aware of Environmental Issues on Your Property? (Y / N)	Questions 5 Comments
60	8/5/11	8/3/2011	2-029F-04-296.00	[redacted]	N		NA	Y	N		N	
61	8/5/11	8/1/2011	2-029F-04-305.00	[redacted]	N		NA	Y	N		N	
62	8/5/11	8/2/2011	2-028A-05-109.00	[redacted]	N		NA	Y	N		N	
63	8/5/11	8/2/2011	2-029L-09-084.00	[redacted]	N		NA	Y	N		Blank	
64	8/5/11	8/3/2011	2-028G-05-004.01	[redacted]	N		NA	Y	Blank		Blank	
65	8/5/11	8/3/2011	2-028G-05-007.00	[redacted]	N		NA	Y	Blank		Blank	
66	8/5/11	8/3/2011	2-028G-05-006.00	[redacted]	N		NA	Y	Blank		Blank	
67	8/5/11	8/2/2011	2-028H-05-042.00	[redacted]	N		NA	Y	N		N	
68	8/5/11	8/2/2011	2-029K-09-055.00	[redacted]	N		NA	Y	N		N	
69	8/5/11	8/2/2011	2-028H-05-125.00	[redacted]	N		NA	Y	N		N	
70	8/5/11	8/3/2011	2-029F-04-284.00	[redacted]	N		NA	Y	N		N	
71	8/5/11	8/2/2011	2-029L-09-025.00	[redacted]	N		NA	Y	N		N	
72	8/5/11	Blank	2-028H-05-242.00	[redacted]	N		NA	Y	N		N	
73	8/5/11	8/3/2011	2-029F-04-315.00	[redacted]	N		NA	Y	N		N	
74	8/5/11	8/2/2011	2-029C-04-118.00	[redacted]	N		NA	Y	N		Blank	
75	8/5/11	8/2/2011	2-029F-04-195.00	[redacted]	N		NA	Blank	N		N	
76	8/5/11	Blank	2-029B-03-142.00	[redacted]	N		NA	Y	N		N	
77	8/5/11	8/3/2011	2-028B-05-011.00	[redacted]	N		NA	Y	N		N	
78	8/5/11	8/3/2011	2-023N-33.007.00	[redacted]	N		NA	N	N		N	Estate of Thomas E. Cranford.
79	8/5/11	8/3/2011	2-023M-33-015.00	[redacted]	N		NA	N	N		N	Estate of Thomas E. Cranford.
80	8/5/11	8/3/2011	2-023N-33-005.00	[redacted]	N		NA	N	N		N	Estate of Thomas E. Cranford.
81	8/5/11	8/2/2011	2-028A-05-072.00	[redacted]	N		NA	Y	N		N	
82	8/5/11	8/1/2011	2-029L-09-107.00	[redacted]	N		NA	Y	N		N	
83	8/5/11	Blank	2-028A-05-049.00	[redacted]	Blank		Blank	Blank	Blank		Blank	Not aware of any other wells on property.
84	8/5/11	8/3/2011	2-023N-33-006.00	[redacted]	N		N	N	N		N	Estate of Thomas E. Cranford.
85	8/5/11	8/2/2011	2-028A-05-002.00	[redacted]	N		NA	Y	N		N	
86	8/5/11	8/3/2011	2-028B-05-148.00	[redacted]	N		NA	Y	N		N	
87	8/5/11	8/2/2011	2-029C-04-113.00	[redacted]	N		NA	Y	N		N	
88	8/5/11	7/3/2011	2-029C-04-180.00	[redacted]	N		NA	Y	N		N	
89	8/5/11	8/1/2011	2-028B-05-118.00	[redacted]	N		NA	Y	N		N	
90	8/5/11	8/3/2011	2-028G-05-002.00	[redacted]	N		NA	Y	Blank		Blank	
91	8/5/11	8/3/2011	2-029L-09-049.00	[redacted]	N		NA	Y	N		N	
92	8/5/11	8/3/2011	2-029C-04-135.00	[redacted]	N		NA	Y	N		N	
93	8/5/11	8/3/2011	2-029C-04-136.00	[redacted]	N		NA	Y	N		N	
94	8/5/11	8/3/2011	2-029C-04-137.00	[redacted]	N		NA	Y	N		N	
95	8/5/11	8/2/2011	2-028A-05-091.00	[redacted]	N		NA	Y	N		N	
96	8/5/11	8/2/2011	2-029B-03-079.00	[redacted]	N		NA	Y	N		N	
97	8/5/11	8/2/2011	2-029L-09-041.00	[redacted]	Blank		Blank	Y	Blank		Blank	
98	8/5/11	8/2/2011	2-028H-05-004.00	[redacted]	N		NA	Y	N		N	
99	8/5/11	8/2/2011	2-028H-05-006.00	[redacted]	N		NA	Y	N		N	
100	8/5/11	8/3/2011	2-029B-03-148.00	[redacted]	N		NA	Y	N		Blank	Not really sure haven't been tested yet.
101	8/5/11	8/2/2011	2-029B-03-081.00	[redacted]	N		NA	Y	N		N	

Hercules Incorporated
Hattiesburg, MS
Community Well Questionnaire and Summarized Community Responses

No.	Date Received	Date Postcard Signed	Parcel No.	Landowner's Name	Question 1 Is a Water Well Present on Property? (Y / N)	Questions 1 Comments	Question 2 If "Yes" to Q#1, is the Water Well Still in Use? (Y / N / NA)	Question 3 Drinking Water Obtained from Private or Municipal Source? (Y / N)	Question 4 Aware of Other Water Wells in Area Not on Your Property? (Y / N)	Questions 4 Comments	Question 5 Aware of Environmental Issues on Your Property? (Y / N)	Questions 5 Comments
102	8/5/11	8/2/2011	2-029K-09-064.00	[redacted]	N		NA	Y	N		N	
103	8/5/11	8/3/2011	2-029A-05-090.00	[redacted]	N		NA	Y	N		N	
104	8/5/11	8/3/2011	2-029C-04-031.00	[redacted]	N		NA	Y	N		N	
105	8/8/11	8/2/2011	2-029E-04-025.00	[redacted]	N		NA	Y	N		N	
106	8/8/11	8/5/2011	2-028H-05-123.00	[redacted]	N		NA	Y	N		N	
107	8/8/11	8/5/2011	2-029K-09-032.00	[redacted]	N		NA	Y	N		N	
108	8/8/11	8/5/2011	2-029F-04-222.00	[redacted]	N		NA	Y	N		Y	I am aware of rumors.
109	8/8/11	7/6/2011	2-029F-04-172.00	[redacted]	N		NA	Y	Y	Water is discolored when coming out of faucet.	N	
110	8/8/11	8/5/2011	2-028H-05-058.00	[redacted]	N		NA	Y	N		N	My father worked at Hercules.
111	8/8/11	8/4/2011	2-029E-04-063.00	[redacted]	N		NA	Y	N		N	
112	8/8/11	8/2/2011	2-029K-09-061.00	[redacted]	N		NA	Y	N		Y	Water plants grass.
113	8/8/11	8/4/2011	2-028H-05-018.00	[redacted]	N		NA	Y	N		Blank	Back yard smells like raw sewage.
114	8/8/11	8/4/2011	2-028H-05-020.00	[redacted]	N		NA	Y	N		Y	City ownes ditch that runs thru my property they do not keep up.
115	8/8/11	7/5/2011	2-029C-04-208.00	[redacted]	N		NA	Y	Y	There is a big water tower on the company property next door.	N	Some people in the community have died form lung problems.
116	8/8/11	8/3/2011	2-028H-05-096.00	[redacted]	N		NA	Y	N		N	There have always been questions about the water system from Hercules Inc.
117	8/8/11	8/4/2011	2-028A-05-095.00	[redacted]	N		NA	Y	N		Y	Erodsion
118	8/8/11	8/4/2011	2-029B-03-151.00	[redacted]	N		NA	Y	N		Y	Hercules Plant water in runn in my back year foms.
119	8/8/11	8/2/2011	2-029F-04-003.00	[redacted]	N		NA	Y	N		Y	City sewer station pump, water turn off value from a mell train tracks.
120	8/8/11	8/3/2011	2-029K-09-007.00	[redacted]	N		NA	Y	N		Y	I believe chemical in the soil have prevented growth of my fruit trees and garden due to Hercules contamination.
121	8/8/11	8/3/2011	2-029K-09-001.00	[redacted]	N		NA	Y	N		Y	I believe chemical in the soil have prevented growth of my fruit trees and garden due to Hercules contamination.
122	8/8/11	8/4/2011	2-029B-03-140.00	[redacted]	N		NA	Y	N		N	Possible contamination from ditch drainage running thru property.
123	8/8/11	8/2/2011	2-028G-05-005.00	[redacted]	N		NA	Blank	N	Property described is a vacant lot.	N	
124	8/8/11	8/3/2011	2-028A-05-106.00	[redacted]	N		NA	Y	N		Blank	No sure, there is a stream behind my house. Water stands there.
125	8/8/11	8/5/2011	2-029E-04-082.00	[redacted]	N		NA	Y	N		Blank	Lived close to Hercules for most of my life. Not certain of anything though.
126	8/8/11	8/3/2011	2-029G-03-611.00	[redacted]	N		NA	Y	N		N	I believe chemical in the soil have prevented growth of my fruit trees and garden due to Hercules contamination.

Hercules Incorporated
Hattiesburg, MS
Community Well Questionnaire and Summarized Community Responses

No.	Date Received	Date Postcard Signed	Parcel No.	Landowner's Name	Question 1 Is a Water Well Present on Property? (Y / N)	Questions 1 Comments	Question 2 If "Yes" to Q#1, is the Water Well Still in Use? (Y / N / NA)	Question 3 Drinking Water Obtained from Private or Municipal Source? (Y / N)	Question 4 Aware of Other Water Wells in Area Not on Your Property? (Y / N)	Questions 4 Comments	Question 5 Aware of Environmental Issues on Your Property? (Y / N)	Questions 5 Comments
127	8/8/11	8/3/2011	2-029F-04-058.00	[redacted]	N		NA	Y	N		N	I believe chemical in the soil have prevented growth of my fruit trees and garden due to Hercules contamination.
128	8/8/11	8/3/2011	2-029K-09.002.00	[redacted]	N		NA	Y	N		N	I believe chemical in the soil have prevented growth of my fruit trees and garden due to Hercules contamination.
129	8/8/11	8/4/2011	2-029B-03-139.00	[redacted]	N		NA	Y	N		Y	Possible contamination from ditch drainage running thru property.
130	8/8/11	8/4/2011	2-029G-03-311.00	[redacted]	N		NA	Y	Y	Wells on property on two sides of us. One has recently been tore down (3 wells total).	N	
131	8/8/11	8/5/2011	2-028A-05-012.00	[redacted]	Y	Drinking Water. Installed in 1940	No. Once city water came through we got city water.	Y	Y	All property had wells.	N	Smell.
132	8/8/11	8/5/2011	2-028A-05-028.00	[redacted]	Y	Drinking Water. Installed in 1938	No. City was put in.	Y	N		N	Smell.
133	8/8/11	8/5/2011	2-028A-05-027.00	[redacted]	Y	Drinking Water. Installed in 1940	No. Once city came through we replace it to city.	Y	N		N	Smell.
134	8/8/11	8/3/2011	2-028H-05-013.01	[redacted]	Y	2 wells on site Drinking Water. Well 1 installed in 1988; 8" in diameter; 610 ft deep; submerge 30 HP. Well 2 installed in 1990 9" in diameter; 602 ft deep; submerge 30 HP.	Y	Y	N		N	Not aware of any outstanding environmental issues related to Hercules Zeon Chemicals Plant activities.
135	8/8/11	8/5/2011	2-029L-09-054.00	[redacted]	N		NA	Y	N		Y	My frith trac will not grow tomato plants. Will no make anything.
136	8/8/11	8/5/2011	2-029L-09-050.00	[redacted]	N		NA	Y	N		Y	I am aware of rumors.
137	8/8/11	8/4/2011	2-029K-09-186.00	[redacted]	N		NA	Y	N		Y	Occasionally my water comes out an orange, rusty color it until it clears we can't bathe or drink the water.
138	8/8/11	8/3/2011	2-029F-04-176.00	[redacted]	N		NA	Y	N		N	Sometimes water appears dirty or brownish looking.
139	8/8/11	8/3/2011	2-029F-04-175.00	[redacted]	N		NA	Y	N		N	Sometimes water appears dirty or brownish looking.
140	8/8/11	8/4/2011	2-028H-05-253.00	[redacted]	N	Other. Dish in the back yard the city cover up.	NA	Y	N		N	We have a garden.
141	8/8/11	8/4/2011	2-029E-04-049.00	[redacted]	N	Not as I know of.	NA	Blank	N	Use city water.	N	
142	8/8/11	8/6/2011	2-029K-09-049.00	[redacted]	N		NA	Y	N		Y	Air polution from Hercules adolus the chemicals under ground.
143	8/8/11	8/4/2011	2-029K-09-103.00	[redacted]	N		NA	Y	N		Y	When it rain, the ditch appears to have a greasy apperance.
144	8/8/11	8/3/2011	2-029F-04-174.00	[redacted]	N		NA	Y	N		N	Sometimes water appears dirty/brownish looking.
145	8/8/11	8/4/2011	2-029K-09-046.00	[redacted]	N		NA	Y	N		Y	Water plants grass.

Hercules Incorporated
Hattiesburg, MS
Community Well Questionnaire and Summarized Community Responses

No.	Date Received	Date Postcard Signed	Parcel No.	Landowner's Name	Question 1 Is a Water Well Present on Property? (Y / N)	Questions 1 Comments	Question 2 If "Yes" to Q#1, is the Water Well Still in Use? (Y / N / NA)	Question 3 Drinking Water Obtained from Private or Municipal Source? (Y / N)	Question 4 Aware of Other Water Wells in Area Not on Your Property? (Y / N)	Questions 4 Comments	Question 5 Aware of Environmental Issues on Your Property? (Y / N)	Questions 5 Comments
146	8/8/11	8/4/2011	2-029K-09-062.00	[redacted]	N		NA	Y	N		Y	Water plants grass.
147	8/8/11	8/5/2011	2-028H-05-258.00	[redacted]	N		NA	Y	N		N	
148	8/8/11	8/6/2011	2-029C-04-027.00	[redacted]	N		NA	Y	N		N	
149	8/8/11	8/6/2011	2-029D-04-019.00	[redacted]	N		NA	Y	N		N	
150	8/8/11	8/4/2011	2-029K-09-170.00	[redacted]	N		NA	Y	N		N	
151	8/8/11	Blank	2-028H-05-007.00	[redacted]	N		NA	Y	N		N	
152	8/8/11	8/4/2011	2-029F-04-094.00	[redacted]	N		NA	Y	N		N	
153	8/8/11	8/3/2011	2-029K-09-189.00	[redacted]	N		NA	Y	N		N	
154	8/8/11	8/4/2011	2-028B-05-113.00	[redacted]	N		NA	Y	N		N	
155	8/8/11	Blank	2-028B-05-122.00	[redacted]	N		NA	Y	Blank		Blank	
156	8/8/11	8/2/2011	2-028H-05-069.00	[redacted]	N		NA	Y	N		N	
157	8/8/11	8/3/2011	2-029K-09-044.00	[redacted]	N		NA	Y	N		N	
158	8/8/11	8/5/2011	2-029L-122.00	[redacted]	N		NA	Y	N		N	
159	8/8/11	Blank	2-029F-04-113.00	[redacted]	N		NA	Y	N		N	
160	8/8/11	8/5/2011	2-028H-05-283.00	[redacted]	N		NA	Y	N		N	
161	8/8/11	8/4/2011	2-028H-05-079.00	[redacted]	N		NA	Y	N		N	
162	8/8/11	8/4/2011	2-028B-05-117.00	[redacted]	N		NA	Y	Blank		N	
163	8/8/11	8/4/2011	2-029E-04-034.00	[redacted]	N		NA	Y	N		N	
164	8/8/11	8/4/2011	2-029E-04-042.00	[redacted]	N		NA	Y	N		N	
165	8/8/11	8/4/2011	2-028H-05-108.00	[redacted]	N		NA	Y	N		N	
166	8/8/11	8/4/2011	2-028H-05-263.00	[redacted]	N		NA	Y	N		N	
167	8/8/11	8/3/2011	2-029C-04-008.00	[redacted]	N		NA	Y	N		N	
168	8/8/11	8/5/2011	2-028H-05-112.00	[redacted]	N		NA	Y	N		N	
169	8/8/11	8/4/2011	2-029E-04-089.00	[redacted]	N		NA	Y	N		N	
170	8/8/11	8/5/2011	2-028H-05-110.00	[redacted]	N		NA	Y	N		N	
171	8/8/11	8/4/2011	2-029E-04-057.00	[redacted]	N		NA	Y	N		N	
172	8/8/11	8/3/2011	2-028B-05-139.00	[redacted]	N		NA	Y	N		N	
173	8/8/11	Blank	2-028H-05-026.00	[redacted]	N		NA	Y	N		Blank	
174	8/8/11	8/3/2011	2-029E-04-111.00	[redacted]	Blank		NA	Y	Blank		N	
175	8/8/11	8/3/2011	2-029E-04-109.00	[redacted]	Blank		NA	Y	N		Blank	
176	8/8/11	8/5/2011	2-029F-04-133.00	[redacted]	N		NA	Y	N		N	
177	8/8/11	8/5/2011	2-029C-04-015.00	[redacted]	N		NA	Y	N		N	
178	8/8/11	8/2/2011	2-029E-04-059.00	[redacted]	N		NA	Y	N		N	
179	8/8/11	8/4/2011	2-029F-04-086.00	[redacted]	N		NA	Y	N		N	
180	8/8/11	8/2/2011	2-028B-05-014.00	[redacted]	N		NA	Y	N		N	
181	8/8/11	8/4/2011	2-028A-05-006.00	[redacted]	N		NA	Y	N		N	
182	8/8/11	8/4/2011	2-028A-05-011.00	[redacted]	N		NA	Y	N		N	
183	8/8/11	8/4/2011	2-028A-05-007.00	[redacted]	N		NA	Y	N		N	
184	8/8/11	7/31/2011	2-029C-04-201.00	[redacted]	N		NA	Y	N		N	
185	8/8/11	8/3/2011	2-029K-09-037.00	[redacted]	N		NA	Y	N		N	
186	8/8/11	8/2/2011	2-029E-04-073.00	[redacted]	N		NA	Y	N		N	
187	8/8/11	8/4/2011	2-029K-09-129.00	[redacted]	Y	Drinking Water, Industrial Water Supply	Y	Y	N		N	
188	8/8/11	8/3/2011	2-029L-09-092.00	[redacted]	N		NA	Y	N		N	
189	8/8/11	8/4/2011	2-029D-04-005.00	[redacted]	N		NA	Y	N		N	
190	8/8/11	8/4/2011	2-029C-04-125.00	[redacted]	N		NA	Y	N		N	
191	8/8/11	8/3/2011	2-029F-04-289.00	[redacted]	N		NA	Blank	N		N	
192	8/8/11	8/3/2011	2-028H-05-161.00	[redacted]	N		NA	Y	N		N	
193	8/8/11	8/3/2011	2-029D-04-009.00	[redacted]	N		NA	Y	N		N	

Hercules Incorporated
Hattiesburg, MS
Community Well Questionnaire and Summarized Community Responses

No.	Date Received	Date Postcard Signed	Parcel No.	Landowner's Name	Question 1 Is a Water Well Present on Property? (Y / N)	Questions 1 Comments	Question 2 If "Yes" to Q#1, is the Water Well Still in Use? (Y / N / NA)	Question 3 Drinking Water Obtained from Private or Municipal Source? (Y / N)	Question 4 Aware of Other Water Wells in Area Not on Your Property? (Y / N)	Questions 4 Comments	Question 5 Aware of Environmental Issues on Your Property? (Y / N)	Questions 5 Comments
194	8/8/11	8/2/2011	2-029C-04-148.00	[redacted]	N		NA	Y	N		N	
195	8/8/11	8/2/2011	2-028B-05-132.00	[redacted]	N		NA	Y	N		N	
196	8/8/11	8/4/2011	2-029D-04-011.00	[redacted]	N		NA	Y	N		N	
197	8/8/11	Blank	2-029D-04-008.00	[redacted]	N		NA	Y	N		N	
198	8/8/11	8/4/2011	2-029C-04-102.00	[redacted]	N		NA	Y	N		N	
199	8/8/11	8/4/2011	2-029D-04-007.00	[redacted]	N		NA	Y	N		N	
200	8/8/11	8/5/2011	2-029K-09-022.00	[redacted]	N		NA	Y	N		N	
201	8/8/11	8/2/2011	2-029E-04-087.00	[redacted]	N		NA	Y	N		N	
202	8/8/11	8/3/2011	2-029D-04-039.00	[redacted]	N		NA	Y	N		N	
203	8/8/11	8/3/2011	2-029K-09-012.00	[redacted]	Not Sure		NA	Y	N		N	
204	8/8/11	8/4/2011	2-029B-03-077.00	[redacted]	N		NA	Y	N		N	
205	8/8/11	8/2/2011	2-029F-04-316.00	[redacted]	N		NA	Y	N		N	
206	8/8/11	8/3/2011	2-028B-05-104.00	[redacted]	N		NA	Y	N		N	
207	8/8/11	8/5/2011	2-029B-03-099.00	[redacted]	N		NA	Blank	N		Blank	Don't know.
208	8/8/11	8/3/2011	2-029L-09-047.00	[redacted]	N		NA	Y	N		N	
209	8/8/11	7/31/2011	2-029C-04-205.00	[redacted]	N		NA	Y	Blank		N	
210	8/8/11	8/4/2011	2-028A-05-079.00	[redacted]	Blank		Blank	Blank	Blank		Blank	
211	8/8/11	8/3/2011	2-028A-05-005.00	[redacted]	N		NA	Y	N		N	
212	8/10/11	8/3/2011	2-029F-04-307.00	[redacted]	N		NA	Y	N		Y	There is sometime water comes from under the house and water in sink is brown color.
213	8/10/11	8/2/2011	2-029F-04-170.00	[redacted]	N		NA	Y	N	My neighbor across the street from me says she has one behind her house.	Y	The smell is terrible. Also I was diagnosed with multiple slerosis about 3 yrs ago. I think it has everything to do with my environment. We need water drain to get rid of this water that's left in our yard after it rains.
214	8/10/11	8/8/2011	2-029K-09-169.00	[redacted]	N		NA	Y	N		Y	Water comes out dirty looking at times, cloudy with particules in it.
215	8/10/11	8/2/2011	2-029F-04-128.00	[redacted]	N (could be)		NA	Y	Y	I moved on this property after the use of well, there could be one there. I don't use it.	Blank	There may be because water use to stand on this property. I had to bring in three load of dirt in the front yard alone.
216	8/10/11	7/29/2011	2-024P-32-013.00	[redacted]	Y	Irrigation	Y City Water	Y	N		N	
217	8/10/11	8/7/2011	2-029F-04-274.00	[redacted]	N		NA	Y	N		N	
218	8/10/11	8/7/2011	2-029F-04-281.00	[redacted]	N		NA	Y	N		N	
219	8/10/11	8/8/2011	2-029C-04-134.00	[redacted]	N		NA	Y	N		N	
220	8/10/11	8/8/2011	2-029C-04-132.00	[redacted]	N		NA	Y	N		N	
221	8/10/11	8/8/2011	2-029C-04-131.00	[redacted]	N		NA	Y	N		N	
222	8/10/11	8/8/2011	2-028A-05-061.00	[redacted]	N		NA	Y	N		N	
223	8/10/11	8/6/2011	2-029F-04-240.00	[redacted]	N		NA	Y	N		N	
224	8/10/11	8/2/2011	2-029F-04-300.00	[redacted]	N		NA	Y	N		N	
225	8/10/11	8/6/2011	2-029K-09-027.00	[redacted]	N		NA	Y	N		N	

Hercules Incorporated
Hattiesburg, MS
Community Well Questionnaire and Summarized Community Responses

No.	Date Received	Date Postcard Signed	Parcel No.	Landowner's Name	Question 1 Is a Water Well Present on Property? (Y / N)	Questions 1 Comments	Question 2 If "Yes" to Q#1, is the Water Well Still in Use? (Y / N / NA)	Question 3 Drinking Water Obtained from Private or Municipal Source? (Y / N)	Question 4 Aware of Other Water Wells in Area Not on Your Property? (Y / N)	Questions 4 Comments	Question 5 Aware of Environmental Issues on Your Property? (Y / N)	Questions 5 Comments
226	8/10/11	8/8/2011	2-029C-04-119.00	[redacted]	N		NA	Y	N		N	
227	8/10/11	Blank	2-028H-05-027.00	[redacted]	I don't know		I don't know	Blank	N	I will sale	N	
228	8/10/11	8/5/2011	2-028I-08-008.00	[redacted]	N		NA	Y	N		N	
229	8/10/11	8/4/2011	2-029F-04-169.00	[redacted]	N		NA	Y	N		Blank	unknown
230	8/10/11	8/6/2011	2-029K-09-041.00	[redacted]	N		NA	Y	N		N	
231	8/10/11	8/7/2011	2-028H-05-094.00	[redacted]	N		NA	Y	N		N	
232	8/10/11	8/6/2011	2-028A-05-029.00	[redacted]	N		NA	Y	N		N	
233	8/10/11	8/6/2011	2-029K-09-026.00	[redacted]	N		NA	Y	N		N	
234	8/10/11	8/3/2011	2-029E-04-052.00	[redacted]	N		NA	Y	N		N	
235	8/10/11	8/8/2011	2-028H-05-164.00	[redacted]	N		NA	Y	N		N	
236	8/10/11	8/8/2011	2-028A-05-033.00	[redacted]	N		NA	Y	N		N	
237	8/10/11	8/3/2011	2-029C-04-165.00	[redacted]	N		NA	Y	N	Have not seen any evidence of wells.	N	
238	8/10/11	8/2/2011	2-029F-04-266.00	[redacted]	N		NA	Blank	N		Blank	
239	8/10/11	8/5/2011	2-029E-04-131.00	[redacted]	N		NA	Blank	N		N	
240	8/10/11	8/6/2011	2-029K-09-120.00	[redacted]	N		NA	Y	N		N	
241	8/10/11	8/4/2011	2-028G-05-035.00	[redacted]	N		NA	Y	N		N	
242	8/10/11	8/8/2011	2-029C-04-129.00	[redacted]	N		NA	Y	N		N	
243	8/10/11	8/8/2011	2-029K-09-025.00	[redacted]	N		NA	Y	N		N	
244	8/10/11	8/8/2011	2-029K-09-132.00	[redacted]	N		NA	Y	N		N	
245	8/10/11	8/3/2011	2-029K-09-184.00	[redacted]	N		NA	Y	N		N	
246	8/10/11	8/7/2011	2-028B-05-012.00	[redacted]	N		NA	Y	N		N	
247	8/10/11	8/7/2011	2-029L-09-109.00	[redacted]	N		NA	Y	N		N	
248	8/10/11	8/8/2011	2-029C-04-130.00	[redacted]	N		NA	Y	N		N	
249	8/10/11	8/8/2011	2-029C-04-122.00	[redacted]	N		NA	Y	N		N	
250	8/10/11	8/3/2011	2-029C-04-166.00	[redacted]	N		NA	Y	N	Have not seen any evidence of wells.	N	
251	8/10/11	8/7/2011	2-028B-05-013.00	[redacted]	N		NA	Y	N		N	
252	8/10/11	8/5/2011	2-028A-05-115.00	[redacted]	N		NA	Y	N		N	
253	8/10/11	8/8/2011	2-028H-05-041.00	[redacted]	N		NA	Y	N		N	
254	8/10/11	8/4/2011	2-028H-05-154.00	[redacted]	N		NA	Y	N		N	
255	8/11/11	8/9/2011	2-023M-33-013.00	[redacted]	N		NA	Y	N		Blank	Unaware at this time.
256	8/11/11	8/9/2011	2-028A-05-024.00	[redacted]	Y	Drinking Water, Pump Type: don't know	N	Y	N		N	
257	8/11/11	8/9/2011	2-029B-03-101.00	[redacted]	N		NA	Y	N		N	
258	8/11/11	8/8/2011	2-029B-03-102.00	[redacted]	N		NA	Y	N		N	
259	8/11/11	8/8/2011	2-029B-03-146.00	[redacted]	N		NA	Y	N		N	
260	8/11/11	8/9/2011	2-028B-05-138.00	[redacted]	N		NA	Y	Blank		N	
261	8/11/11	8/8/2011	2-029C-04-152.00	[redacted]	N		NA	N	N		N	Lost sale to potential buyer because buyers lendor wanted a soil survey and buyer wouldn't pay for it.
262	8/11/11	8/9/2011	2-029C-04-153.00	[redacted]	N		NA	Y	N		N	
263	8/11/11	8/4/2011	2-029E-04-013.00	[redacted]	N		NA	Y	N		Blank	
264	8/11/11	8/4/2011	2-029E-04-026.00	[redacted]	N		NA	Y	N		N	
265	8/11/11	8/8/2011	2-029E-04-114.00	[redacted]	N		NA	Y	N		N	

Hercules Incorporated
Hattiesburg, MS
Community Well Questionnaire and Summarized Community Responses

No.	Date Received	Date Postcard Signed	Parcel No.	Landowner's Name	Question 1 Is a Water Well Present on Property? (Y / N)	Questions 1 Comments	Question 2 If "Yes" to Q#1, is the Water Well Still in Use? (Y / N / NA)	Question 3 Drinking Water Obtained from Private or Municipal Source? (Y / N)	Question 4 Aware of Other Water Wells in Area Not on Your Property? (Y / N)	Questions 4 Comments	Question 5 Aware of Environmental Issues on Your Property? (Y / N)	Questions 5 Comments
266	8/11/11	8/8/2011	2-029E-04-115.00	[redacted]	N		NA	Y	N		N	
267	8/11/11	8/8/2011	2-029E-04-116.00	[redacted]	N		NA	Y	N		N	
268	8/11/11	8/8/2011	2-029E-04-117.00	[redacted]	N		NA	Y	N		N	
269	8/11/11	8/9/2011	2-029F-04-031.00	[redacted]	N		NA	Y	N		Y	Water taste funny and different color.
270	8/11/11	8/9/2011	2-029F-04-032.00	[redacted]	N		NA	Y	N		Y	Water taste funny and different color.
271	8/11/11	8/8/2011	2-029F-04-144.00	[redacted]	N		NA	Y	N		N	
272	8/11/11	7/31/2011	2-029F-04-212.00	[redacted]	N		NA	Y	N		Blank	The report on T.V. about living near Hercules.
273	8/11/11	8/8/2011	2-029F-04-264.00	[redacted]	N		NA	Y	N		Y	Grass stay brown and nald spots in the yard. I got fertlize and seeds to help more soil dirt. I been sick since I move there with breathing problems.
274	8/11/11	8/7/2011	2-029F-04-303.00	[redacted]	N		NA	Y	N		N	
275	8/11/11	8/8/2011	2-028G-05-028.00	[redacted]	N		NA	Y	N		N	
276	8/11/11	8/8/2011	2-028G-05-031.00	[redacted]	N		NA	Y	N		N	
277	8/11/11	8/2/2011	2-028H-05-019.00	[redacted]	N		NA	Y	N		N	
278	8/11/11	8/8/2011	2-028H-05-080.00	[redacted]	N		NA	Y	N		N	
279	8/11/11	8/2/2011	2-028H-05-140.00	[redacted]	N		NA	Y	N		Y	Frequent smell of natural gas.
280	8/11/11	8/2/2011	2-028H-05-207.00	[redacted]	N		NA	Y	N		N	
281	8/11/11	8/4/2011	2-029K-09-0240.00	[redacted]	?		?	Y	?	I am interested in learning of any potential risks to my property.	Blank	I recently purched property at 406 Broad St. I am unaware of any potential hazards or environmental issues.
282	8/11/11	8/9/2011	2-029K-09-047.00	[redacted]	N		NA	Y	N		Y	Water taste funny and different color.
283	8/11/11	8/8/2011	2-029K-098.00	[redacted]	N		NA	Y	N		N	
284	8/11/11	8/8/2011	2-029L-09-021.00	[redacted]	N		NA	Y	N		N	
285	8/11/11	8/8/2011	2-029L-09-023.00	[redacted]	N		NA	Y	N		N	
286	8/12/11	8/10/2011	2-029B-03-153.00	[redacted]	N	Ditch with Hercule Chemicals	There's standing water in the ditch.	Y	Blank	Just the ditcht that is behind my home running from Hercules.	Y	The contamination that is running from Hercules into the ditch behind my home.
287	8/12/11	8/3/2011	2-029F-04-219.00	[redacted]	N		NA	Y	N		N	I would like for someone to come out and check.
288	8/12/11	8/11/2011	2-029B-03-125.00	[redacted]	N		NA	Y	N		N	
289	8/12/11	Blank	2-029L-09-070.00	[redacted]	N		NA	Y	N		N	
290	8/12/11	8/10/2011	2-028I-08-120.00	[redacted]	N		NA	Y	N		N	
291	8/12/11	8/7/2011	2-028H-05-032.00	[redacted]	N		NA	Y	N		Y	Can not get grass to grow.
292	8/12/11	8/8/2011	2-029C-04-133.00	[redacted]	N		NA	Y	N		N	

Hercules Incorporated
Hattiesburg, MS
Community Well Questionnaire and Summarized Community Responses

No.	Date Received	Date Postcard Signed	Parcel No.	Landowner's Name	Question 1 Is a Water Well Present on Property? (Y / N)	Questions 1 Comments	Question 2 If "Yes" to Q#1, is the Water Well Still in Use? (Y / N / NA)	Question 3 Drinking Water Obtained from Private or Municipal Source? (Y / N)	Question 4 Aware of Other Water Wells in Area Not on Your Property? (Y / N)	Questions 4 Comments	Question 5 Aware of Environmental Issues on Your Property? (Y / N)	Questions 5 Comments
293	8/15/11	8/11/2011	2-029F-04-049.00	[redacted]	Y	Well has been filled in for several years. Unsure of Pump Type	N Filled in	Y	N		Y	The old Hercules run off ditch runs across our property.
294	8/15/11	8/6/2011	2-029G-03-313.00	[redacted]	Y	Irrigation, Drinking Water, Installed ?, 8" in diameter, 135 ft deep	N Well in place & tank of premises property not in use.	N	Y	Next parcel to the east old federal compess property.	N	Phase II study recently completed.
295	8/15/11	8/12/2011	2-028A-05-008.00	[redacted]	N		NA	Y	N		Y	Drinking water from faucets turns brown @ every 2-3 wks & lasts @ 1/2 of a day.
296	8/15/11	8/2/2011	2-029F-04-171.00	[redacted]	N		NA	Y	N		N	
297	8/15/11	8/11/2011	2-029L-09-061.00	[redacted]	N		NA	Y	N		N	
298	8/15/11	Blank	2-029C-04-203.00	[redacted]	N		NA	N	N		N	
299	8/15/11	8/8/2011	2-028H-05-049.00	[redacted]	N		NA	Blank	N		N	
300	8/15/11	8/12/2011	2-028B-05-120.00	[redacted]	N		NA	Y	N		N	
301	8/15/11	8/2/2011	2-029K-09-234.00	[redacted]	N		NA	Y	Blank		N	
302	8/15/11	8/10/2011	2-028A-05-034.00	[redacted]	N	Don't know of a well.	NA	Y	N		N	
303	8/15/11	8/11/2011	2-029F-04-054.00	[redacted]	Not Sure		NA	Y	Blank	Don't know.	Blank	Don't know.
304	8/15/11	8/11/2011	2-028B-05-007.00	[redacted]	N		NA	N	N		N	
305	8/15/11	8/11/2011	2-029L-09-031.00	[redacted]	N		NA	Y	N		N	
306	8/15/11	8/2/2011	2-029L-09-114.00	[redacted]	N		NA	Y	N		N	
307	8/15/11	8/11/2011	2-029L-09-059.00	[redacted]	N		NA	Y	N		N	
308	8/15/11	8/11/2011	2-028H-05-099.00	[redacted]	N		NA	Y	N		N	
309	8/15/11	8/8/2011	2-028H-05-044.00	[redacted]	N		NA	Y	N		N	
310	8/15/11	8/11/2011	2-029F-04-002.00	[redacted]	N		NA	Y	N		N	
311	8/15/11	8/9/2011	2-028G-05-030.00	[redacted]	N		NA	Y	N		N	
312	8/15/11	8/2/2011	2-029F-04-013.00	[redacted]	N		NA	Y	N		N	
313	8/15/11	8/2/2011	2-029K-09-233.00	[redacted]	N		NA	Y	Blank		N	
314	8/15/11	8/2/2011	2-029F-04-012.00	[redacted]	N		NA	Y	Blank		N	
315	8/15/11	8/6/2011	2-028B-05-146.00	[redacted]	N		NA	Y	N		N	
316	8/15/11	8/2/2011	2-029F-04-014.00	[redacted]	N		NA	Y	N		N	
317	8/15/11	8/10/2011	2-029L-09-015.00	[redacted]	N		NA	Y	N		N	
318	8/15/11	8/10/2011	2-029F-04-261.00	[redacted]	N		NA	Y	N		N	
319	8/15/11	8/11/2010	2-028G-05-027.00	[redacted]	N		NA	Y	N		N	
320	8/15/11	8/2/2011	2-029E-04-031.00	[redacted]	N		NA	Y	N	The property is a rental I am uncertain.	N	
321	8/15/11	8/11/2011	2-028A-05-017.00	[redacted]	N		NA	Y	N		N	
322	8/15/11	8/10/2011	2-029D-04-022.00	[redacted]	N		NA	Y	N		N	
323	8/15/11	8/11/2011	2-029B-03-122.00	[redacted]	N		NA	Y	N		N	
324	8/15/11	8/11/2011	2-029B-03-121.00	[redacted]	N		NA	Y	N		N	
325	8/15/11	8/11/2011	2-029F-04-103.00	[redacted]	N		NA	N	N		N	
326	8/15/11	8/11/2011	2-029B-03-120.00	[redacted]	N		NA	Y	N		N	
327	8/15/11	8/11/2011	2-029B-03-123.00	[redacted]	N		NA	Y	N		N	
328	8/15/11	8/11/2011	2-029B-03-124.00	[redacted]	N		NA	Y	N		N	
329	8/16/11	9/10/2011	2-028A-05-118.00	[redacted]	N		NA	Y	N		N	
330	8/16/11	8/8/2011	2-028H-05-025.00	[redacted]	N	No Well	NA	Blank	N		Blank	
331	8/17/11	8/9/2011	2-029B-03-195.00	[redacted]	N		NA	Y	N		N	
332	8/17/11	8/9/2011	2-029B-03-189.00	[redacted]	N		NA	Y	N		N	

Hercules Incorporated
Hattiesburg, MS
Community Well Questionnaire and Summarized Community Responses

No.	Date Received	Date Postcard Signed	Parcel No.	Landowner's Name	Question 1 Is a Water Well Present on Property? (Y / N)	Questions 1 Comments	Question 2 If "Yes" to Q#1, is the Water Well Still in Use? (Y / N / NA)	Question 3 Drinking Water Obtained from Private or Municipal Source? (Y / N)	Question 4 Aware of Other Water Wells in Area Not on Your Property? (Y / N)	Questions 4 Comments	Question 5 Aware of Environmental Issues on Your Property? (Y / N)	Questions 5 Comments
333	8/17/11	8/14/2011	2-028A-05-114.00	[redacted]	N		NA	Y	N		Y	Grass wunt grown in certain spots since 2002.
334	8/17/11	8/15/2011	2-028B-05-123.00	[redacted]	N		NA	Y	N		N	
335	8/17/11	8/15/2011	2-023M-33-011.00	[redacted]	N		NA	Y	Blank		N	
336	8/17/11	8/14/2011	2-029B-03-126.00	[redacted]	N		NA	N	N		N	
337	8/17/11	8/9/2011	2-029B-03-187.00	[redacted]	N		NA	Y	N		N	
338	8/17/11	8/14/2011	2-029B-03-128.00	[redacted]	N		NA	N	N		N	
339	8/18/11	8/13/2011	2-029F-04-286.00	[redacted]	N		NA	Y	N		Blank	
340	8/18/11	Blank	2-029D-04-054.00	[redacted]	N		NA	Y	N		Blank	
341	8/18/11	8/12/2011	2-023M-33-012.00	[redacted]	N		NA	Y	N		N	
342	8/19/11	8/3/2011	2-029F-04-114.00	[redacted]	N		NA	Y	N		N	
343	8/19/11	8/16/2011	2-029F-04-076.00	[redacted]	N		NA	Y	N		N	
344	8/22/11	8/2/2011	2-028B-05-003.00	[redacted]	Y	Drinking Water, Installed 1940	N	Y	N		N	
345	8/22/11	8/1/2011	2-029B-03-196.00	[redacted]	Y		Y	Y	N		Blank	Don't know.
346	8/22/11	8/19/2011	2-029E-04-160.00	[redacted]	N		NA	Y	N		N	
347	8/22/11	8/18/2011	2-029D-04-124.00	[redacted]	Y	Drinking Water, Installed 1990	Y	Blank	N		N	
348	8/22/11	8/17/2011	2-029L-09-089.00	[redacted]	N		NA	Y	N		N	
349	8/22/11	8/17/2011	2-029B-03-186.00	[redacted]	N		NA	Y	N		N	
350	8/22/11	8/18/2011	2-029C-04-174.00	[redacted]	N		NA	Y	N		N	
351	8/22/11	8/17/2011	2-029B-03-185.00	[redacted]	N		NA	Y	N		N	
352	8/22/11	8/17/2011	2-029B-03-184.00	[redacted]	N		NA	Y	N		N	
353	8/22/11	8/18/2011	2-029C-04-200.00	[redacted]	N		NA	Y	N		N	
354	8/22/11	8/17/2011	2-029B-03-183.00	[redacted]	N		NA	Y	N		N	
355	8/22/11	8/18/2011	2-029C-04-169.00	[redacted]	N		NA	Y	N		N	
356	8/22/11	8/3/2011	2-028H-05-113.00	[redacted]	N		NA	Y	N		N	
357	8/22/11	8/18/2011	2-029C-04-199.00	[redacted]	N		NA	Y	N		N	
358	8/22/11	8/11/2011	2-029K-09-188.00	[redacted]	N		City Water	Y	N		Y	Possible soil contamination and water contamination.
359	8/25/11	8/22/2011	2-024P-32-021.00	[redacted]	N	Installed in 1940, depth 40	N replaced with city water	N	N	All property owners had pump well back in the 1940.	N	
360	8/25/11	8/13/2011	2-029L-09-100.00	[redacted]	N		NA	Y	N		Y	Underground water lines.
361	8/25/11	Blank	2-028H-05-221.00	[redacted]	N		NA	Blank	N		N	As far as I know, this property is undeveloped.
362	8/25/11	8/5/2011	2-029K-09-230.00	[redacted]	N		NA	Y	N		N	
363	8/25/11	Blank	2-028H-05-043.00	[redacted]	N		NA	Blank	N		N	
364	8/25/11	8/22/2011	2-029F-04-294.00	[redacted]	Y	Drinking Water	Y	N	N		N	
365	8/26/11	Blank	2-028A-05-039.00	[redacted]	N		NA	Y	N		Blank	Cannont get plants or flowers to do good in garden.
366	8/26/11	8/22/2011	2-029L-09-012.00	[redacted]	N		NA	Y	N		N	
367	8/29/11	8/8/2011	2-028B-05-106.00	[redacted]	N		NA	Y	N		N	
368	8/29/11	8/10/2011	2-028H-05-211.00	[redacted]	N		NA	Y	N		Y	Black soot on screens and window sills all my childhood years every morning. Awful smells.
369	8/29/11	Blank	2-028A-05-058.00	[redacted]	N		NA	Y	N		N	
370	8/29/11	8/5/2011	2-028H-05-278.00	[redacted]	N		NA	Y	N		Y	Mosquito infestation on street behind Delks Tire.
371	8/29/11	7/31/2011	2-029B-03-194.00	[redacted]	N		NA	N	N		N	

Hercules Incorporated
Hattiesburg, MS
Community Well Questionnaire and Summarized Community Responses

No.	Date Received	Date Postcard Signed	Parcel No.	Landowner's Name	Question 1 Is a Water Well Present on Property? (Y / N)	Questions 1 Comments	Question 2 If "Yes" to Q#1, is the Water Well Still in Use? (Y / N / NA)	Question 3 Drinking Water Obtained from Private or Municipal Source? (Y / N)	Question 4 Aware of Other Water Wells in Area Not on Your Property? (Y / N)	Questions 4 Comments	Question 5 Aware of Environmental Issues on Your Property? (Y / N)	Questions 5 Comments
372	8/29/11	8/12/2011	2-029F-04-105.00	[redacted]	N		NA	Y	N		N	
373	8/29/11	8/2/2011	2-029G-03-331.00	[redacted]	N		NA	Y	N		N	
374	8/29/11	8/23/2011	2-028H-05-269.00	[redacted]	N		NA	Y	N		Blank	
375	8/29/11	8/16/2011	2-028H-05-117.00	[redacted]	N		NA	Y	N		N	
376	8/30/11	8/2/2011	2-028A-05-088.00	[redacted]	Blank		Blank	Y	N	Uncertain about wells.	N	Uncertain about any issues.
377	8/30/11	8/28/2011	2-028I-08-077.00	[redacted]	N		NA	Y	N		N	Not sure about that.
378	9/1/11	8/28/2011	2-029F-04-034.00	[redacted]	N		NA	Y	N		N	
379	9/1/11	8/28/2011	2-029F-04-026.00	[redacted]	N		NA	Y	N		N	
380	9/1/11	Blank	2-029F-04-027.00	[redacted]	N		NA	Y	N		N	
381	9/7/11	Blank	2-029E-04-081.00	[redacted]	N		NA	Y	N		N	
382	9/7/11	8/26/2011	2-28H-05-274.00	[redacted]	N		NA	Y	N		N	
383	9/8/11	9/2/2011	2-028G-05-012.00	[redacted]	N		NA	Y	N		N	
384	9/9/11	Blank	2-028H-05-256.00	[redacted]	N	No well located on property to the best of my knowledge.	NA	Y	N		Blank	
385	9/9/11	8/11/2011	2-028A-05-107.00	[redacted]	N		NA	N	N		N	
386	9/9/11	9/7/2011	2-029C-04-041.00	[redacted]	N		NA	Y	N		N	
387	9/9/11	Blank	2-029F-04-186.00	[redacted]	N		NA	Y	N		N	
388	9/9/11	8/5/2011	2-029C-04-163.00	[redacted]	N		NA	Y	N		Blank	
389	9/12/11	9/5/2011	2-029K-09-236.00	[redacted]	N		NA	Y	N		N	

Water Well Survey
Hercules Facility
USEPA RCRA 3013(a) Administrative Order
Hattiesburg, Mississippi

Well Survey: Project Overview
An initial evaluation of public records has already been performed as described above to identify public and private drinking water wells within the search radii specified in the Order. Site records indicated that historical well surveys including the 1993 B&V Waste Science and Technology Corporation report (B&V 1993) have also been performed and five municipal suppliers of potable water having wells within 4 miles of the Site existed at that time.

Initial response actions performed by Hercules shortly after receiving the AO included performing a public records search of registered wells that exist within a 4-mile radius of the Site. This initial well inventory identified a total of 806 well records within the search radius. The well inventory search radius was refined to show only the registered wells that exist on or within a 0.5 mile radius of the Site and 20 wells exist were identified within a 0.5-mile radius of the Site. However, there may be other wells within this radius that are not listed in public records. Further investigation into the existence of wells in the area will be performed and information collected from individual well owners will be recorded on the attached survey form.

Hercules will perform a neighborhood survey of residents and businesses located within a 0.5-mile radius of the Site by distributing a questionnaire to collect information on the presence and use of public and private wells. The survey will be further supported by performing a windshield survey of properties within the 0.5-mile radius to look for signs typically associated with private water well use (staining on structures and sidewalks, small enclosures or well houses, etc.). Well verification may be performed using a door-to-door follow-up survey to further support either a questionable windshield survey observation or a response from the questionnaire that requires clarification.

Hercules will pursue access to properties where wells exist within the 0.5-mile radius and where sampling is advised to conform to requirements of the Administrative Order. Access agreements will be presented to each well owner for review and approval. The sampling event will be scheduled with the well owner once the access agreement is signed.

The sampling team will perform a short interview with the owner during the sampling event to ascertain information regarding the well and water use at the property. Interviews will be conducted with the owners (or their current tenants) using the attached form to record specific information on the well and each form will be added to the data record for the investigation.

Hercules Facility Water Well Survey

This information is being collected for research purposes and to evaluate if testing of groundwater samples from an identified well is recommended. The results of this survey will be reported only in anonymous summary form, and individual surveys will not become part of public record. Thank you for taking time to help us compile this important information.

We realize you may not have the information available to answer all of these questions.
Please answer whatever questions you can.
If you have your well records, these will be helpful for answering the questions below

PLEASE CHECK (•) OR PROVIDE YOUR MOST APPROPRIATE RESPONSE
FOR EACH QUESTION YOU CAN ANSWER.

A survey technician will collect information from you during a brief visit to gain information on the well constructed on your property. If you choose to complete this survey and mail it to the address provided at the close of the questionnaire, please return your survey using the enclosed pre-addressed, stamped envelope, ***by October 21, 2011.***

Last Name: ______________________ **First Name:**______________________________
(optional) *(optional)*
Street Address ____

Town: __________________________ **Tax map & Parcel Number:** ________________

Phone: __________________________ **e-mail address:**_____________________

Number of Wells at this Address ______ **Lot size** _____ **acres**
Number of Full-Time Residents ______

Please provide descriptive information (if known) for each well on your property, in the space provided below:

		Well #1	Well #2	Well #3
Use of Well *(check all that apply)*	Residential..	●	●	●
	Commercial/Industrial..................................	●	●	●
	Shared Water Supply....................................	●	●	●
	Agricultural...	●	●	●
	Irrigation (lawn & garden)..............................	●	●	●
	Irrigation (commercial/farm)............................	●	●	●
	Out of service *(Why?)*..................................	●	●	●
	Other *(Describe)* ______________________________	●	●	●
Type of Well Construction	Drilled in Bedrock......................................	●	●	●
	Drilled in sand/Gravel..................................	●	●	●
	Driven Point..	●	●	●
	Dug...	●	●	●
	Other *(Describe)*______________________________	●	●	●
Total Depth of Well (in feet)				
Depth to Bedrock (in feet)				
Length of Casing Installed in Well (in feet)				
Length of Screened Section or open hole in Well (in feet)				
Well Casing extends above ground (inches)				
Well Yield (in gallons per minute)				
Date the well was drilled (or approximate age of well in years)				
Date well was abandoned (if known)				
Abandonment method (if known)				

What type of residence occupies your property?

• Single family house • <2000 ft^2 • 2000 -4000 ft^2 • >4000 ft^2	• "Attached house" (shared walls between units) (e.g. Condominium or townhouse)	• Mobile home • Apartment

What are the primary activities if the property is non-residential?

• Commercial (type of business): ____________________________ • Industrial (type of business): ____________________________	• Farm (describe) __________________________ • Nursery • Livestock • OTHER (describe) _______________________

WATER QUANTITY ISSUES:

How have you been affected by droughts during the past 10 years?

	Well #1	**Well #2**	**Well #3**
No problem ……………………………………………………..…..	●	●	●
Had to limit household use………...	●	●	●
Not enough water to irrigate as much as I wanted….………….....	●	●	●
Couldn't irrigate at all……………………………………..…....	●	●	●
Well(s) went completely dry………………………………..…	●	●	●

Have you run out of water during the past five years for reasons other than mechanical pump failure?

Never………………………………………………….………	●	●	●
Once *(state which year and month)*______________________________	●	●	●
More than once *(state how often)*______________________________	●	●	●
Regularly……………………………………………………....	●	●	●

WATER QUALITY ISSUES:

Do you have a point-of –entry water treatment system in your home or business?

• Yes	• No

Do you have any of the following color stains in your water fixtures (toilet bowl, etc.)

• Green • Rust/brown/orange	• Black • Blue	• Other (describe)

Are you aware of any seasonal variations in your water quality?

	Well #1	**Well #2**	**Well #3**
No seasonal variations ….……………………………………..	●	●	●
Yes, there have been seasonal variations…………………….....	●	●	●

Have you tested your water for quality, and were any problems identified?

	Well #1	**Well #2**	**Well #3**
Never tested …………………………………………………..	●	●	●
Yes, I have tested it ………………………………………...	●	●	●
Describe any water quality problems identified:			

Are you concerned about the following contaminants affecting your well/s?

● MTBE (gasoline) ● Road salt	● Bacteria ● Arsenic	● Nitrates ● Radon	● Fluoride

Would you be willing to have your water tested at no cost to you (and be willing to share the results)?

● Yes	● No

Please provide any other comments or questions that you may have regarding the well in the space provided on this form below.

Thank you! Your participation in this survey is greatly appreciated!

Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Surface Water Sampling**

Effective Date: November 1, 2007 | **Number:** SESDPROC-201-R1

Authors

Name: Joe Compton
Title: Life Scientist
Signature: Joe Compton Date: 11/7/07

Name: Laura Ackerman
Title: Environmental Engineer
Signature: Laura Acker Date: 11/02/07

Approvals

Name: Antonio Quinones
Title: Chief, Enforcement and Investigations Branch
Signature: Date: 11/02/07

Name: Bill Cosgrove
Title: Chief, Ecological Assessment Branch
Signature: Date: 11/2/07

Name: Laura Ackerman
Title: Field Quality Manager, Science and Ecosystem Support Division
Signature: Laura Acker Date: 11/02/07

Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Field Quality Manager.

History	Effective Date
SESDPROC-201-R1, *Surface Water Sampling*, replaces SESDPROC-201-R0. **General** Corrected any typographical, grammatical and/or editorial errors. **Title Page** Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch. Changed Bill Cosgrove's title from Acting Chief to Chief. **Section 1.3** Updated information to reflect that the procedure is located on the H: drive of the LAN. Clarified Field Quality Manager (FQM) responsibilities. **Section 1.4** Updated referenced operating procedures due to changes in title names. Alphabetized and revised the referencing style for consistency. Added two references (49 CFR and SESDPROC-206). **Section 1.5.1** Corrected the title of the Safety, Health, and Environmental Management Program Procedures and Policy Manual. **Section 1.5.2, 4th bullet** Added references to the CFR and IATA's Dangerous Goods Regulations. **Section 2.2, 5th bullet** Added reference to SESDPROC-206. **Section 2.5** Updated referenced operating procedures due to changes in title names.	November 1, 2007
SESDPROC-201-R0, *Surface Water Sampling*, Original Issue	February 05, 2007

TABLE OF CONTENTS

Contents

1 General Information

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed when collecting surface water samples for field screening or laboratory analysis.

1.2 Scope/Application

The procedures contained in this document are to be used by field personnel when collecting and handling surface water samples in the field. On the occasion that SESD field personnel determine that any of the procedures described in this section are either inappropriate, inadequate or impractical and that another procedure must be used to obtain a surface water sample, the variant procedure will be documented in the field log book, along with a description of the circumstances requiring its use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and have been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the H: drive of the SESD local area network. The Field Quality Manager (FQM) is responsible for ensuring the most recent version of the procedure is placed on the H: drive and for maintaining records of review conducted prior to its issuance.

1.4 References

International Air Transport Authority (IATA). Dangerous Goods Regulations, Most Recent Version

SESD Operating Procedure for Control of Records, SESDPROC-002, Most Recent Version

SESD Operating Procedure for Sample and Evidence Management, SESDPROC-005, Most Recent Version

SESD Operating Procedure for Logbooks, SESDPROC-010, Most Recent Version

SESD Operating Procedure for Field Sampling Quality Control, SESDPROC-011, Most Recent Version

SESD Operating Procedure for Field pH Measurement, SESDPROC-100, Most Recent Version

SESD Operating Procedure for Field Specific Conductance Measurement, SESDPROC-101, Most Recent Version

SESD Operating Procedure for Field Turbidity Measurement, SESDPROC-103, Most Recent Version

SESD Operating Procedure for Equipment Inventory and Management, SESDPROC-108, Most Recent Version

SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, Most Recent Version

SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC, SESDPROC-206, Most Recent Version

SESD Operating Procedure for Packaging, Marking, Labeling and Shipping of Environmental and Waste Samples, SESDPROC-209, Most Recent Version

Title 49 Code of Federal Regulations, Pts. 171 to 179, Most Recent Version

United States Environmental Protection Agency (US EPA). 1981. "Final Regulation Package for Compliance with DOT Regulations in the Shipment of Environmental Laboratory Samples," Memo from David Weitzman, Work Group Chairman, Office of Occupational Health and Safety (PM-273), April 13, 1981.

US EPA. 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division (SESD), Athens, GA

US EPA. Analytical Support Branch Laboratory Operations and Quality Assurance Manual. Region 4 SESD, Athens, GA, Most Recent Version

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when collecting surface water samples. Refer to the SESD Safety, Health and Environmental Management Program (SHEMP) Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASP) for guidelines on safety precautions. These guidelines should be used to complement the judgment of an experienced professional. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate.

1.5.2 Procedural Precautions

The following precautions should be considered when collecting surface water samples.

- Special care must be taken not to contaminate samples. This includes storing samples in a secure location to preclude conditions which could alter the properties of the sample. Samples shall be custody sealed during long-term storage or shipment.
- Collected samples are in the custody of the sampler or sample custodian until the samples are relinquished to another party.
- If samples are transported by the sampler, they will remain under his/her custody or be secured until they are relinquished.
- Shipped samples shall conform to all U.S. Department of Transportation (DOT) rules of shipment found in Title 49 of the Code of Federal Regulations (49 CFR parts 171 to 179), and/or International Air Transportation Association (IATA) hazardous materials shipping requirements found in the current edition of IATA's Dangerous Goods Regulations.
- Documentation of field sampling is done in a bound logbook.
- Chain-of-custody documents shall be filled out and remain with the samples until custody is relinquished.
- All shipping documents, such as air bills, bills of lading, etc., shall be retained by the project leader and stored in a secure place.

2 Special Sampling Considerations

2.1 Volatile Organic Compounds (VOC) Analysis

Surface water samples for VOC analysis must be collected in 40 ml glass vials with Teflon® septa. The vial may be either preserved with concentrated hydrochloric acid or they may be unpreserved. Preserved samples have a two week holding time, whereas, unpreserved samples have only a seven day holding time. In the great majority of cases, the preserved vials are used to take advantage of the extended holding time. In some situations, however, it may be necessary to use the unpreserved vials. For example, if the surface water sample contains a high concentration of dissolved calcium carbonate, there may be an effervescent reaction between the hydrochloric acid and the water, producing large numbers of fine bubbles. This will render the sample unacceptable. In this case, unpreserved vials should be used and arrangements must be confirmed with the laboratory to ensure that they can accept the unpreserved vials and meet the shorter sample holding times.

The samples should be collected with as little agitation or disturbance as possible. The vial should be filled so that there is a reverse or convex meniscus at the top of the vial and absolutely no bubbles or headspace should be present in the vial after it is capped. After the cap is securely tightened, the vial should be inverted and tapped on the palm of one hand to see if any undetected bubbles are dislodged. If a bubble or bubbles are present, the vial should be topped off using a minimal amount of sample to re-establish the meniscus. Care should be taken not to flush any preservative out of the vial during topping off. If, after topping off and capping the vial, bubbles are still present, a new vial should be obtained and the sample re-collected.

Samples for VOC analysis must be collected using either stainless steel or Teflon® equipment.

2.2 Special Precautions for Trace Contaminant Surface Water Sampling

- A clean pair of new, non-powdered, disposable gloves will be worn each time a different location is sampled and the gloves should be donned immediately prior to sampling. The gloves should not come in contact with the media being sampled and should be changed any time during sample collection when their cleanliness is compromised.
- Sample containers for samples suspected of containing high concentrations of contaminants shall be stored separately.
- All background or control samples shall be collected and placed in separate ice chests or shipping containers. Sample collection activities shall proceed progressively from the least suspected contaminated area to the most suspected contaminated area. Samples of waste or highly contaminated media must not be placed in the same ice chest as

environmental (i.e., containing low contaminant levels) or background samples.

- If possible, one member of the field sampling team should take all the notes and photographs, fill out tags, etc., while the other members collect the samples.
- Samplers must use new, verified and certified-clean disposable or non-disposable equipment cleaned according to procedures contained in SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, or SESD Operating Procedure for Field Cleaning and Decontamination at the FEC, SESDPROC-206, for collection of samples for trace metals or organic compound analyses.

2.3 Sample Handling and Preservation Requirements

1. Surface water samples will typically be collected either by directly filling the container from the surface water body being sampled or by decanting the water from a collection device such as a stainless steel scoop or other device.
2. During sample collection, if transferring the sample from a collection device, make sure that the device does not come in contact with the sample containers.
3. Place the sample into appropriate, labeled containers. Samples collected for VOC analysis must not have any headspace (see Section 2.1, Volatile Organic Compound Analysis). All other sample containers must be filled with an allowance for ullage.
4. All samples requiring preservation must be preserved as soon as practically possible, ideally immediately at the time of sample collection. If preserved VOC vials are used, these will be preserved with concentrated hydrochloric acid by ASB personnel prior to departure for the field investigation. All other chemical preservatives required for the remaining suite of analytes will be supplied by ASB personnel and will be added to the samples by SESD field personnel or other authorized persons. The adequacy of sample preservation will be checked after the addition of the preservative for all samples, except for the samples collected for VOC analysis. If it is determined that a sample is not adequately preserved, additional preservative should be added to achieve adequate preservation. Preservation requirements for surface water samples are found in the USEPA Region 4 Analytical Support Branch Laboratory Operations and Quality Assurance Manual (ASBLOQAM), Most Recent Version.
5. All samples preserved using a pH adjustment (except VOCs) must be checked, using pH strips, to ensure that they were adequately preserved. This is done by pouring a small volume of sample over the strip. Do not place the strip in the sample. Samples requiring reduced temperature storage should be placed on ice immediately.

2.4 Quality Control

If possible, a control sample should be collected from a location not affected by the possible contaminants of concern and submitted with the other samples. In streams or other bodies of moving water, the control sample should be collected upstream of the sampled area. For impounded bodies of water, particularly small lakes or ponds, it may be difficult or inappropriate to obtain an unbiased control from the same body of water from which the samples are collected. In these cases, it may be appropriate to collect a background sample from a similar impoundment located near the sampled body of water if there is a reasonable certainty that the background location has not been impacted. Equipment blanks should be collected if equipment is field cleaned and re-used on-site or if necessary to document that low-level contaminants were not introduced by pumps, bailers or other sampling equipment.

2.5 Records

Information generated or obtained by SESD personnel will be organized and accounted for in accordance with SESD records management procedures found in SESD Operating Procedure for Control of Records, SESDPROC-002. Field notes, recorded in a bound field logbook, will be generated, as well as chain-of-custody documentation in accordance with SESD Operating Procedure for Logbooks, SESDPROC-010 and SESD Operating Procedure for Sample and Evidence Management, SESDPROC-005.

3 General Considerations

3.1 General

The surface water sampling techniques and equipment described in the following Sections 4, 5 and 6 of this procedure document are designed to minimize effects on the chemical and physical integrity of the sample. If the procedures in this section are followed, a representative sample of the surface water should be obtained.

3.2 Equipment Selection Considerations

The physical location of the investigator when collecting a sample may dictate the equipment to be used. If surface water samples are required, direct dipping of the sample container into the stream is desirable. Collecting samples in this manner is possible when sampling from accessible locations such as stream banks or by wading or from low platforms, such as small boats or piers. Wading or streamside sampling from banks, however, may cause the re-suspension of bottom deposits and bias the sample. Wading is acceptable if the stream has a noticeable current (is not impounded), and the samples are collected while facing upstream. If the stream is too deep to wade, or if the sample must be collected from more than one water depth, or if the sample must be collected from an elevated platform (bridge, pier, etc.), supplemental sampling equipment must be used.

To collect a surface water sample from a water body or other surface water conveyance, a variety of methods can be used:

- Dipping Using Sample Container
- Scoops
- Peristaltic Pumps
- Submersible Pumps
- Discrete Depth Samplers
- Bailers
- Buckets

Regardless of the method used, precautions should be taken to insure that the sample collected is representative of the water body or conveyance. These methods are discussed in the following sections.

4 Dipping Using Sample Container

A sample may be collected directly into the sample container when the surface water source is accessible by wading or other means. The sampler should face upstream if there is a current and collect the sample without disturbing the bottom sediment. The surface water sample should always be collected prior to the collection of a sediment sample at the same location. The sampler should be careful not to displace the preservative from a pre-preserved sample container, such as the 40-ml VOC vial.

5 Scoops

Stainless steel scoops provide a means of collecting surface water samples from surface water bodies that are too deep to access by wading. They have a limited reach of about eight feet and if samples from distances too far to access using this method are needed, a mobile platform, such as a boat may be required.

Stainless steel scoops are useful for reaching out into a body of water to collect a surface water sample. The scoop may be used directly to collect and transfer a surface water sample to the sample container, or it may be attached to an extension in order to access the selected sampling location.

6 Peristaltic Pumps

Another device that can be effectively used to sample a water column, such as a shallow pond or stream, is the peristaltic pump/vacuum jug system. The peristaltic pump can be used to collect a water sample from any depth if the pump is located at or near the surface water elevation. There is no suction limit for these applications. The use of a metal conduit to which the tubing is attached, allows for the collection of a vertical sample (to about a 25 foot depth) which is representative of the water column. The tubing intake is positioned in the water column at the desired depth by means of the conduit. Using this method, discrete samples may be collected by positioning the tubing intake at one depth or a vertical composite may be collected by moving the tubing intake at a constant rate vertically up and down the water column over the interval to be composited.

Samples for VOC analysis cannot be collected directly from the peristaltic pump discharge or from the vacuum jug. If a peristaltic pump is used for sample collection and VOC analysis is required, the VOC sample must be collected using one of the "soda straw" variations. Ideally, the tubing intake will be placed at the depth from which the sample is to be collected and the pump will be ran for several minutes to fill the tubing with water representative of that interval. After several minutes, the pump is turned off and the tubing string is retrieved. The pump speed is then reduced to a slow pumping rate and the pump direction is reversed. After turning the pump back on, the sample stream is collected into the VOC vials as it is pushed from the tubing by the pump. Care must be taken to prevent any water that was in contact with the silastic pump head tubing from being incorporated into the sample.

7 Discrete Depth Samplers

When discrete samples are desired from a specific depth, and the parameters to be measured do not require a Teflon®-coated sampler, a standard Kemmerer or Van Dorn sampler may be used. The Kemmerer sampler is a brass cylinder with rubber stoppers that leave the ends of the sampler open while being lowered in a vertical position, thus allowing free passage of water through the cylinder. The Van Dorn sampler is plastic and is lowered in a horizontal position. In each case, a messenger is sent down a rope when the sampler is at the designated depth, to cause the stoppers to close the cylinder, which is then raised. Water is removed through a valve to fill respective sample containers. With a rubber tube attached to the valve, dissolved oxygen sample bottles can be properly filled by allowing an overflow of the water being collected. With multiple depth samples, care should be taken not to disturb the bottom sediment, thus biasing the sample.

When metals and organic compounds parameters are of concern, then a double-check valve, stainless steel bailer or Kemmerer sampler should be used to collect the sample.

8 Bailers

Teflon® bailers may also be used for surface water sampling if the study objectives do not necessitate a sample from a discrete interval in the water column. A closed-top bailer with a bottom check-valve is sufficient for many studies. As the bailer is lowered through the water column, water is continually displaced through the bailer until the desired depth is reached, at which point the bailer is retrieved. This technique may not be successful where strong currents are found.

9 Buckets

A plastic bucket can be used to collect samples for measurement of water quality parameters such as pH, temperature, and conductivity. Samples collected for analysis of classical water quality parameters including but not limited to ammonia, nitrate-nitrite, phosphorus, and total organic carbon may also be collected with a bucket. Typically, a bucket is used to collect a sample when the water depth is too great for wading, it is not possible to deploy a boat, or access is not possible (excessive vegetation or steep embankments) and the water column is well mixed. The water body is usually accessed from a bridge. The bucket is normally lowered by rope over the side of the bridge. Upon retrieval, the water is poured into the appropriate sample containers

Caution should be exercised whenever working from a bridge. Appropriate measures should be taken to insure the safety of sampling personnel from traffic hazards.

10 Submersible Pumps

Submersible pumps can be used to collect surface water samples directly into a sample container. The constituents of interest should be taken into consideration when choosing the type of submersible pump and tubing to be used. If trace contaminant sampling of extractable organic compounds and/or inorganic analytes will be conducted, the submersible pump and all of its components should be constructed of inert materials such as stainless steel and Teflon®. The tubing should also be constructed of Teflon®. If re-using the same pump between sample locations, the pump should be decontaminated using SESD Operating Procedure for Field Equipment Cleaning and Decontamination, (SESDPROC-205). New tubing should be used at each sample location.

If the samples will be analyzed for classical parameters such as ammonia, nitrate-nitrite, phosphorus, or total organic carbon, the pump and tubing may be constructed of components other than stainless steel and Teflon®. The same pump and tubing may be re-used at each sampling station after rinsing with deionized water and then purging several volumes of sample water through the pump and tubing prior to filling the sample containers.

Either a grab or composite sample can be collected using a submersible pump. A composite sample can be collected by raising and lowering the pump throughout the water column. If a composite sample is collected, it may be necessary to pump the sample into a compositing vessel for mixing prior to dispensing into the sample containers. If a compositing vessel is required, it should be constructed of materials compatible with the constituents of concern and decontaminated between sample stations according to appropriate procedures, again depending on the constituents of concern.

11 Automatic Samplers

Where unattended sampling is required (e.g., storm-event sampling, time-of-travel studies) an automatic sampler may be used. The automatic sampling device may be used to collect grab samples based on time, in-stream flow or water level or used to collect composite samples as dictated by the study data needs. The automatic sampling device should be calibrated prior to deployment to insure the proper volume is collected. The manufacturer's instruction manual should be consulted for automatic sampler operation.

12 Trace-Level Mercury Sampling

In order to prevent contamination during sample collection, Region 4 has developed this sampling procedure for trace-level mercury analysis (< 1 part per trillion). This procedure is based on EPA Method 1669.

A vacuum chamber assembly is utilized to collect surface water samples for trace-level mercury analyses. The vacuum chamber assembly consists of the following: 1) an airtight acrylic, cylindrical chamber with an o-ring sealed lid to hold the sample bottle, 2) a Teflon® sample tubing that connects to a centered Teflon® compression fitting on top of the chamber. The other end of the tubing passes through a rigid Teflon® pole for stability and has a modified magnetic screen holder at the intake, and a hand vacuum pump. The chamber is designed to hold a 2-liter sample bottle; however, smaller sample containers may be utilized with a spacer inserted into the chamber. A two inch square of 100 μm Nitex® screen is used on the magnetic screen holder at the intake to prevent large pieces of debris from entering the sample. The screen does not prevent the passage of particulate organic matter which is often prevalent in surface water. The vacuum chamber has a second off-center compression fitting with a 4 inch piece of Teflon® tubing inserted in the fitting. A piece of clear Tygon® tubing approximately 18-24 inches long is placed over the small piece of Teflon®. The Teflon® adds stability to the tubing and keeps it from crimping. The Tygon® is attached to the hand pump and the chamber with electrical tape. The Nitex® screen intake is inserted into the water to be sampled and a vacuum is pulled on the chamber by means of the hand vacuum pump, thus drawing a water sample into a sample container placed directly beneath the intake tubing within the chamber.

Teflon® bottles or 300-Series glass bottles with single use Teflon®-lined caps may be used for sample collection. All sample containers used for collection of trace-level mercury water samples must be pre-cleaned in a laboratory as described in EPA Method 1631. Teflon® containers should also be etched on the outside of the bottle with a unique identification number for QA purposes. All bottles for trace-level sampling must be double bagged in re-sealable bags. Water samples collected for total, inorganic, methyl or ethyl mercury analyses are pumped into appropriately cleaned bottles. Preservation should be done in a clean room laboratory that has been specifically prepared for the preparation of trace level samples (positive pressure ventilation, sticky floor mats, etc.). Preservation must occur within 48 hours of sample collection, sooner if possible. Region 4 utilizes laboratory preservation of trace-level mercury samples in order to minimize the potential for contamination, and if split samples are required, they must be split in a trace-level clean room laboratory.

The following quality assurance/quality control (QA/QC) samples are collected in conjunction with low-level mercury samples:

- bottle blanks
- equipment blanks

- air deposition blanks
- trip blanks
- duplicates, and
- splits

A bottle blank is prepared in the lab with reagent-grade water to insure the cleanliness of the bottles prior to use in the field. After decontamination of the Teflon® tubing by pumping and discarding several sample container volumes of reagent-grade water through the tubing, (using the same amount of water used for sample collection in the field) an equipment blank sample is collected into an appropriately pre-cleaned sample container. Equipment blanks are collected at the beginning of each field trip and at the end of each day. The bottle blank and the equipment blank do not go out into the field and are preserved at the end of the day with the regular field samples.

Air deposition blanks are collected to determine if airborne mercury is present at the time of sample collection. The air deposition blanks consist of a pre-cleaned mercury sample container, filled with reagent-grade water by the laboratory that prepared the containers, and is shipped with the containers to the field. The air deposition blank is uncapped using “clean hands”/ “dirty hands” procedures (see below) and set near the sampling location throughout the duration of the mercury sample collection for that particular station. Once the mercury sample is collected, the air deposition blank is recapped and handled and processed with the other mercury samples. One air deposition blank is collected each day by each field crew unless atmospheric conditions or site conditions warrant additional blanks.

Trip blanks are utilized to determine if any contaminants of interest to the study are potentially introduced to the samples during storage and transport to the laboratory. Trip blanks are prepared by the laboratory which supplies the mercury sample containers. The trip blanks consist of cleaned bottles which are filled with reagent-grade water by the laboratory and shipped with the other clean sample containers. A dark plastic bag is placed in each cooler that will hold the trace-level water samples. One trip blank is placed in each trace-level cooler of samples and returned to the laboratory with the ambient trace-level water samples. All trace-level samples should be kept in the dark until they are preserved. The trip blanks are never opened in the field. Trip blanks are preserved in the clean room.

Duplicate samples are discrete samples collected at the same site and time to measure variability of collected samples and to assess sample collection consistency. Sample splits are aliquots of a minimum 500 ml poured from a single ambient sample. They must be split in a trace-level clean room laboratory.

In order to prevent cross contamination in samples analyzed for trace-level mercury in ambient surface waters, clean sampling protocols must be employed throughout the sampling effort. For each sampling event, one sampling team member is designated as “clean hands” and one as “dirty hands” (see below). All operations involving contact with the sample bottle and transfer of the sample from the sample collection device to the sample bottle are handled by the individual designated as “clean hands”. “Dirty hands” is responsible for preparation of the sampling device (except the sample container) and for all other activities that do not involve direct contact with the sample.

Prior to sample collection with the vacuum chamber assembly, the Teflon® line is cleaned at each station by rinsing with ambient water as follows: A 2-liter poly bottle is placed into the chamber and filled half full with ambient water. The bottle is swirled to rinse it and the water is discarded downstream of sampling area. The same 2-liter poly bottle can be used at each station. Additional cleaning measures are not recommended as long as the chamber assembly is only used to collect ambient surface water samples. Detergent washes and acid rinses are not conducted due to potential mercury contamination from these solutions. If applicable, samples for other analyses can be collected in a poly bottle with the vacuum chamber assembly but should be collected before the trace-level sample as an additional means of flushing the sampling line prior to collection of the trace-level samples. It is not necessary to implement the “clean hands”/ “dirty hands” method for collection of non-mercury samples, but latex or vinyl gloves should be worn when any samples are collected.

Following are procedures for cleaning the vacuum chamber tubing and collection of ancillary water quality samples, if applicable:

1. Carefully approach the sampling station from downstream and downwind if possible.

2. While wearing latex or vinyl gloves, place an uncapped 2-liter poly bottle into the chamber and secure the chamber lid by attaching the spring-loaded clamps.

3. Place a new square of 100 µm Nitex® screen in the magnetic screen holder. Place the intake beneath the surface of the water (mid-depth or six inches, which ever is less) and hold firmly in place. Care should be taken not to disturb sediment particles in very shallow waters (< 4 inches deep).

4. Squeeze the hand pump until liquid starts to fill the bottle in the chamber. When the bottle is approximately half full, release the vacuum on the chamber, remove the bottle, swirl the contents and discard the water downstream. Repeat this rinse. If ancillary water quality samples are to be collected, return the 2-liter poly bottle to the chamber and pump the required volume of water to fill the appropriate ancillary sample containers. Remove the 2-liter bottle from the chamber and cap. Fill the ancillary sample bottles upon completion of the mercury sample collection.

Water samples for trace level mercury analyses should be collected immediately after the ancillary water samples have been collected according to the following procedures:

1. “Clean hands” should put on a pair of latex or vinyl gloves, then a pair of shoulder length polyethylene gloves.

2. “Dirty hands” should put on a pair of latex or vinyl gloves, retrieve the double bagged trace level sample bottle from the cooler, and open the outer bag. “Clean hands” should open the inner bag and remove the pre-cleaned Teflon® or glass bottle.

3. “Dirty hands” should open the lid on the chamber. “Clean hands” should place the sample bottle in the chamber, remove the bottle top and place it inside the chamber with the bottle.

4. “Dirty hands” should close and secure the chamber lid and using the hand pump, fill the container. The sample container should be filled to overflowing. “Dirty hands” should then release the vacuum and open the lid on the chamber.

5. “Clean hands” should place the top on the sample bottle, remove it from the chamber and place it in the inner bag and seal the bag. “Dirty hands” should seal the outer bag and place the sample in the black bag in the dark cooler. Only coolers dedicated to storage and transport of trace-level mercury samples should be used.

ARCADIS

Atlanta Environmental Practice

SHALLOW SURFACE WATER SAMPLING PROCEDURES

Site-Wide Policy No. FSP-4.2

Revision No. 0
Revision Date: August 16, 2004

1.0 OVERVIEW

This policy provides guidance on the proper procedures associated with shallow (less than 3 ft deep) surface water sample collection.

2.0 HEALTH AND SAFETY

The following health and safety policies are applicable to this policy:

- SWP HSP-1.3, “Hazard Communication;”
- SWP HSP-1.11, “Field Readiness Assessment Process;”
- SWP-HSP-2.2, “Lifting and Materials Handling;”
- SWP HSP-3.4, “Personal Protective Equipment;” and
- **SWP HSP-3.13, “Groundwater and Surface Water Sampling.”**

The policy in **BOLD** contains specific safety information related to procedures described in this policy.

3.0 PROCEDURE/POLICY

3.1 General Requirements

The following requirements are applicable to the collection of shallow surface water samples:

- Wear personal protective equipment required by the task/project Task Hazard Analysis.
- Sampling equipment and supplies to be used for surface water sampling will be determined during the task/project Field Readiness Assessment.
- All sampling equipment will be decontaminated in accordance with SWP FSP-7.5, “Decontamination Procedures.”
- All sampling devices will be constructed from glass, Teflon®, or stainless steel materials.
- Once collected, all surface water samples will be prepared, packaged and shipped in accordance with SWP FSP-3.5, “Preparation of Water Samples for Environmental Analysis.”
- All equipment and procedures used to collect surface water samples will be documented in accordance with SWP FSP-7.1, “Field Documentation.” Physical parameters and field analysis results should be recorded on the Water Sampling Log (Exhibit 1).

3.2 Shallow Surface Water Sampling Procedure

The following general procedure is applicable to collection of shallow surface water samples:

1. Prepare sample containers and mobilize to the sample location. If wading to the location, approach the sample location from the downstream direction.
2. Facing the upstream direction, open the sample container and gently place the container in the water at a slight angle with the mouth of the container in the elevated position. As good sampling practice, collect the sample in the following order:
    - Volatile organic compounds;
    - Total organic carbon;
    - Extractable organics;
    - Total metals (see note below);
    - Dissolved metals;
    - Cyanide;
    - Sulfate and chloride;
    - Turbidity; and
    - Nitrate and ammonia.
3. Allow the container to fill by letting water flow down the inner wall of the container.
4. Fill container to approximately 90% capacity. For volatile organic compounds (VOCs) fill the vial nearly full and remove from the water. Use the cap of the vial to retrieve additional water and gently pour the water into the vial until the meniscus forms. For all containers containing preservatives, avoid overfilling the container and losing preservative.
5. Promptly cap the container(s), collect additional sample for field test kit analysis in an unpreserved sample bottle or other suitable container.
6. Collect physical parameters in accordance with task/project data quality objectives.

Note: When surface water and sediment samples are being collected at the same location, always collect the surface water samples first.

If the surface water location has good flow but is so shallow that the sample container can not be filled without creating a lot of sediment disturbance, use the following procedures:

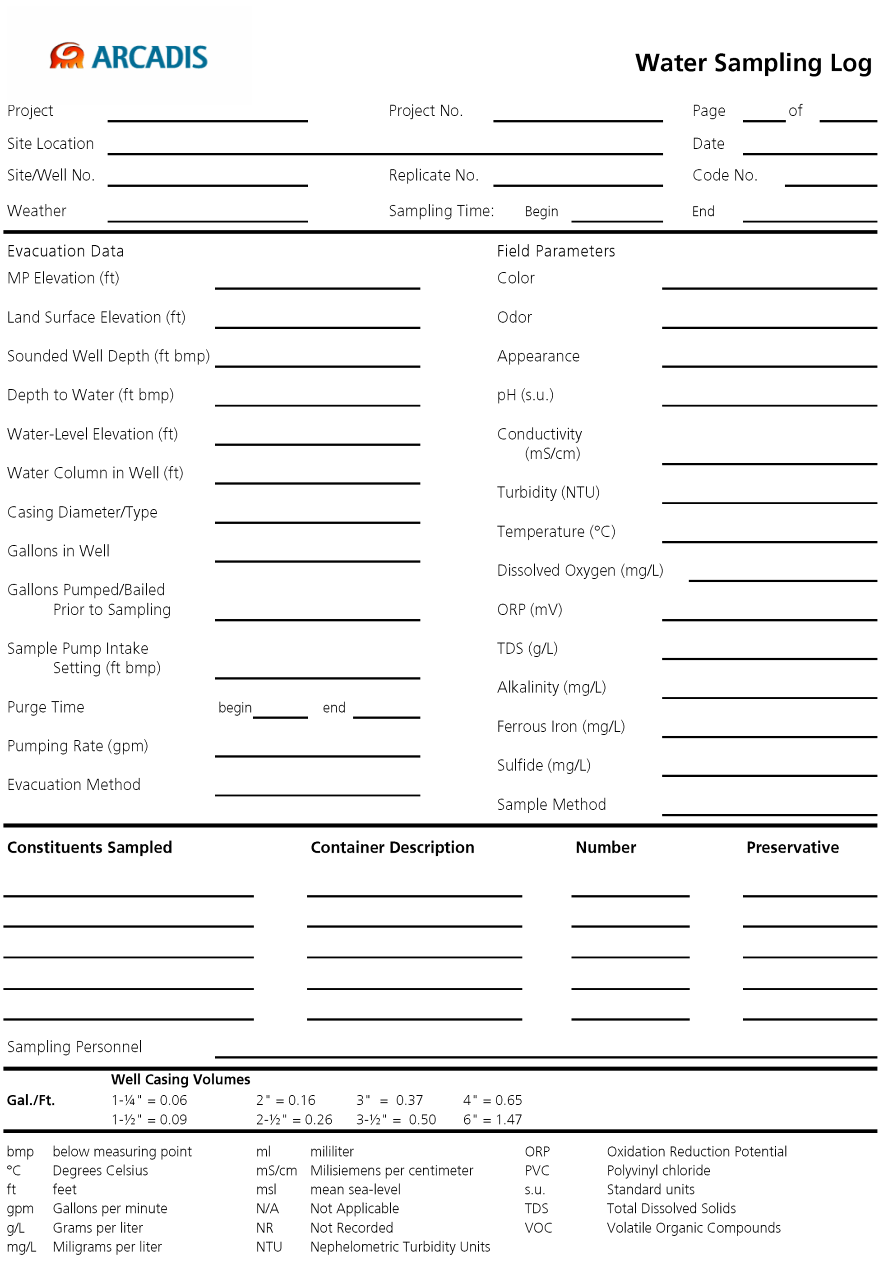
1. Using a decontaminated stainless steel spoon/scoop/shovel and dig out a hole in the bottom of the surface water sampling location of sufficient size to allow the container to be safely dipped into the water.
2. Wait a minimum of 24 hours for the area to return to equilibrium before sampling using the procedure above.
3. If rock prevents digging out a location to sample by dipping, use a stainless steel ladle to collect and transfer the sample appropriate container. The sample order should follow the sampling sequence described above.

4.0 REFERENCES AND GUIDANCE

United States Army Corps of Engineers. 2001. Requirements for the Preparation of Sampling and Analysis Plans. EM 200-1-3. February 1, 2001.

United States Environmental Protection Agency. 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. United States Environmental Protection Agency Region IV. November, 2001.

Exhibit 1. Example Water Sampling Log



ARCADIS

Water Sampling Log

Project ____________ Project No. ____________ Page ____ of ____
Site Location ________________________ Date ____________
Site/Well No. ____________ Replicate No. ____________ Code No. ____________
Weather ____________ Sampling Time: Begin ____________ End ____________

Evacuation Data		Field Parameters	
MP Elevation (ft)		Color	
Land Surface Elevation (ft)		Odor	
Sounded Well Depth (ft bmp)		Appearance	
Depth to Water (ft bmp)		pH (s.u.)	
Water-Level Elevation (ft)		Conductivity (mS/cm)	
Water Column in Well (ft)		Turbidity (NTU)	
Casing Diameter/Type		Temperature (°C)	
Gallons in Well		Dissolved Oxygen (mg/L)	
Gallons Pumped/Bailed Prior to Sampling		ORP (mV)	
Sample Pump Intake Setting (ft bmp)		TDS (g/L)	
Purge Time	begin ______ end ______	Alkalinity (mg/L)	
Pumping Rate (gpm)		Ferrous Iron (mg/L)	
Evacuation Method		Sulfide (mg/L)	
		Sample Method	

Constituents Sampled	**Container Description**	**Number**	**Preservative**

Sampling Personnel ________________________

	Well Casing Volumes			
Gal./Ft.	1-¼" = 0.06	2" = 0.16	3" = 0.37	4" = 0.65
	1-½" = 0.09	2-½" = 0.26	3-½" = 0.50	6" = 1.47

bmp	below measuring point	ml	mililiter	ORP	Oxidation Reduction Potential
°C	Degrees Celsius	mS/cm	Milisiemens per centimeter	PVC	Polyvinyl chloride
ft	feet	msl	mean sea-level	s.u.	Standard units
gpm	Gallons per minute	N/A	Not Applicable	TDS	Total Dissolved Solids
g/L	Grams per liter	NR	Not Recorded	VOC	Volatile Organic Compounds
mg/L	Miligrams per liter	NTU	Nephelometric Turbidity Units		

Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Sediment Sampling**

Effective Date: September 8, 2010

Number: SESDPROC-200-R2

Authors

Name: Kevin Simmons
Title: Environmental Scientist, Regional Expert
Signature:
Date: 9/2/10

Approvals

Name: Archie Lee
Title: Chief, Enforcement and Investigations Branch
Signature: Archie Lee
Date: 9/7/2010

Name: Bill Cosgrove
Title: Chief, Ecological Assessment Branch
Signature: John C Deatrick for
Date: 9/7/10

Name: Liza Montalvo
Title: Field Quality Manager, Science and Ecosystem Support Division
Signature:
Date: 9/7/10

Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Document Control Coordinator.

History	Effective Date
SESDPROC-200-R2, *Sediment Sampling,* replaces SESDPROC-200-R1. **Cover Page:** The Enforcement and Investigations Branch Chief was changed from Antonio Quinones to Archie Lee. The FQM was changed from Laura Ackerman to Liza Montalvo. **Revision History:** Changed Field Quality Manager to Document Control Coordinator. **Section 1.2:** Added the following statement: "Mention of trade names or commercial products does not constitute endorsement or recommendation for use." **Section 1.3:** Omitted reference to the H: drive of the LAN. Changed Field Quality Manager to Document Control Coordinator.	September 8, 2010
SESDPROC-200-R1, *Sediment Sampling,* replaces SESDPROC-200-R0. **General** Corrected any typographical, grammatical and/or editorial errors. **Title Page** Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch. Changed Bill Cosgrove's title from Acting Chief to Chief. **Section 1.3** Updated information to reflect that the procedure is located on the H: drive of the LAN. Clarified Field Quality Manager (FQM) responsibilities. **Section 1.4** Updated referenced operating procedures due to changes in title names. Alphabetized and revised the referencing style for consistency. **Section 1.5.1** Corrected the title of the Safety, Health, and Environmental Management Program Procedures and Policy Manual.	November 1, 2007

Section 1.5.2, 4th bullet Added references to the CFR and IATA's Dangerous Goods Regulations. **Section 2.6** Updated referenced operating procedures due to changes in title names.	
SESDPROC-200-R0, *Sediment Sampling*, Original Issue	February 05, 2007

TABLE OF CONTENTS

Contents

1 General Information

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed when collecting sediment samples for field screening or laboratory analysis.

1.2 Scope/Application

The procedures contained in this document are to be used by field investigators when collecting and handling sediment samples in the field. On the occasion that SESD field investigators determine that any of the procedures described in this section are inappropriate, inadequate or impractical and that another procedure must be used to obtain a sediment sample, the variant procedure will be documented in the field log book, along with a description of the circumstances requiring its use. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and has been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the SESD local area network (LAN). The Document Control Coordinator (DCC) is responsible for ensuring the most recent version of the procedure is placed on the LAN and for maintaining records of review conducted prior to its issuance.

1.4 References

International Air Transport Authority (IATA). Dangerous Goods Regulations, Most Recent Version

SESD Operating Procedure for Control of Records, SESDPROC-004, Most Recent Version

SESD Operating Procedure for Sample and Evidence Management, SESDPROC-005, Most Recent Version

SESD Operating Procedure for Logbooks, SESDPROC-010, Most Recent Version

SESD Operating Procedure for Field Sampling Quality Control, SESDPROC-011, Most Recent Version

SESD Operating Procedure for Equipment Inventory and Management, SESDPROC-104, Most Recent Version

SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, Most Recent Version

SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC, SESDPROC-206, Most Recent Version

SESD Operating Procedure for Packaging, Marking, Labeling and Shipping of Environmental and Waste Samples, SESDPROC-209, Most Recent Version

Title 49 Code of Federal Regulations, Pts. 171 to 179, Most Recent Version

United States Environmental Protection Agency (US EPA). 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division (SESD), Athens, GA

US EPA. Analytical Support Branch Laboratory Operations and Quality Assurance Manual. Region 4 SESD, Athens, GA, Most Recent Version

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

United States Office of Occupational Health and Safety (US OSHA). 1981. Final Regulation Package for Compliance with DOT Regulations in the Shipment of Environmental Laboratory Samples (PM-273), Memo from David Weitzman, Work Group Chairman, US EPA. April 13, 1981.

1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when collecting sediment samples. Refer to the SESD Safety, Health and Environmental Management Program (SHEMP) Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASPs) for guidelines on safety precautions. These guidelines should be used to complement the judgment of an experienced professional. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate.

1.5.2 Procedural Precautions

The following precautions should be considered when collecting sediment samples.

- Special care must be taken not to contaminate samples. This includes storing samples in a secure location to preclude conditions which could alter the properties of the sample. Samples shall be custody sealed during long-term storage or shipment.
- Collected samples are in the custody of the sampler or sample custodian until the samples are relinquished to another party.
- If samples are transported by the sampler, they will remain under his/her custody or be secured until they are relinquished.
- Shipped samples shall conform to all U.S. Department of Transportation (DOT) rules of shipment found in Title 49 of the Code of Federal Regulations (49 CFR parts 171 to 179), and/or International Air Transportation Association (IATA) hazardous materials shipping requirements found in the current edition of IATA's Dangerous Goods Regulations.
- Documentation of field sampling is done in a bound logbook.
- Chain-of-custody documents shall be filled out and remain with the samples until custody is relinquished.
- All shipping documents, such as air bills, bills of lading, etc., shall be retained by the project leader and stored in a secure place.

2 Special Sampling Considerations

2.1 Sediment Samples for Volatile Organic Compounds Analysis

If samples are to be analyzed for volatile organic compounds (VOCs), they should be collected in a manner that minimizes disturbance of the sample. The sample for VOC analysis should be collected directly from the sample device, if possible, before it is emptied into the pan. It may not be possible to do this with certain types of sediment sampling equipment, such as the Ponar dredge. In cases such as these, the VOC aliquots should be collected from the dredge contents immediately after they have been deposited in the pan and prior to any mixing. The sample shall be placed in the appropriate container (En Core® Sampler or other Method 5035 compatible container) with no headspace. ***Samples for VOC analysis are not homogenized.*** Preservatives may be required for some samples with certain variations of Method 5035. Consult the method description below in Section 2.2, Sediment Sampling (Method 5035) or the principal analytical chemist to determine if preservatives are necessary.

In some cases, the sediment may be soft and not lend itself to collection by plunging En Core® Samplers or syringe samplers into the sample matrix. In these cases, it is appropriate to open the sample device, i.e., the En Core® Sampler barrel or syringe, prior to sample collection, and to carefully place the sediment in the device, filling it fully with the required volume of sample.

2.2 Sediment Sampling (Method 5035)

The following sampling protocol is recommended for site investigators assessing the extent of VOCs in sediments at a project site. Because of the large number of options available, careful coordination between field and laboratory personnel is needed. The specific sampling containers and sampling tools required will depend upon the detection levels and intended data use. Once this information has been established, selection of the appropriate sampling procedure and preservation method best applicable to the investigation can be made.

2.2.1 Equipment

Sediment for VOC analyses may be retrieved using any of the SESD sediment sampling methods described in Sections 3 through 6 of this procedure. Once the sediment has been obtained, the En Core® Sampler, syringes, stainless steel spatula, standard 2-oz. sediment VOC container, or pre-prepared 40 ml vials may be used/required for sub-sampling. The specific sample containers and the sampling tools required will depend upon the data quality objectives established for the site or sampling investigation. The various sub-sampling methods are described below.

2.2.2 *Sampling Methodology - Low Concentrations*

When the total VOC concentration in the sediment is expected to be less than 200 µg/kg, the samples may be collected directly with the En Core® Sampler or syringe. If using the syringes, the sample must be placed in the sample container (40 ml pre-prepared vial) immediately to reduce volatilization losses. The 40 ml vials should contain 10 ml of organic-free water for an un-preserved sample or approximately 10 ml of organic-free water and a preservative. It is recommended that the 40 ml vials be prepared and weighed by the laboratory (commercial sources are available which supply preserved and tared vials). When sampling directly with the En Core® Sampler, the vial must be immediately capped and locked.

A sediment sample for VOC analysis may also be collected with conventional sampling equipment. A sample collected in this fashion must either be placed in the final sample container (En Core® Sampler or 40 ml pre-prepared vial) immediately or the sample may be immediately placed into an intermediate sample container with no head space. If an intermediate container (usually 2-oz. sediment jar) is used, the sample must be transferred to the final sample container (En Core® Sampler or 40 ml pre-prepared vial) as soon as possible, not to exceed 30 minutes.

NOTE: After collection of the sample into either the En Core® Sampler or other container, the sample must immediately be stored in an ice chest and cooled.

Sediment samples may be prepared for shipping and analysis as follows:

En Core® Sampler - the sample shall be capped, locked, and secured in a plastic bag.

Syringe - Add about 3.7 cc (approximately 5 grams) of sample material to 40-ml pre-prepared containers. Secure the containers in a plastic bag. Do not use a custody seal on the container; place the custody seal on the plastic bag. Note: When using the syringes, it is important that no air is allowed to become trapped behind the sample prior to extrusion, as this will adversely affect the sample.

Stainless Steel Laboratory Spatulas - Add between 4.5 and 5.5 grams (approximate) of sample material to 40 ml containers. Secure the containers in a plastic bag. Do not use a custody seal on the container; place the custody seal on the plastic bag.

2.2.3 *Sampling Methodology - High Concentrations*

Based upon the data quality objectives and the detection level requirements, this high level method may also be used. Specifically, the sample may be packed into a single 2-oz. glass container with a screw cap and septum seal. The sample container must be filled quickly and completely to eliminate head space. Sediments containing high total VOC concentrations may also be collected as described in Section 2.2.2, Sampling Methodology - Low Concentrations, and preserved using 10 ml methanol.

2.2.4 Special Techniques and Considerations for Method 5035

Effervescence

If low concentration samples effervesce from contact with the acid preservative, then either a test for effervescence must be performed prior to sampling, or the investigators must be prepared to collect each sample both preserved or un-preserved as needed, or all samples must be collected unpreserved.

To check for effervescence, collect a test sample and add to a pre-preserved vial. If preservation (acidification) of the sample results in effervescence (rapid formation of bubbles) then preservation by acidification is not acceptable, and the sample must be collected un-preserved.

If effervescence occurs and only pre-preserved sample vials are available, the preservative solution may placed into an appropriate hazardous waste container and the vials triple rinsed with organic-free water. An appropriate amount of organic-free water, equal to the amount of preservative solution, should be placed into the vial. The sample may then be collected as an un-preserved sample. Note that the amount of organic free water placed into the vials will have to be accurately measured.

Sample Size

While this method is an improvement over earlier ones, field investigators must be aware of an inherent limitation. Because of the extremely small sample size, sample representativeness for VOCs may be reduced compared to samples with larger volumes collected for other constituents. The sampling design and objectives of the investigation should take this into consideration.

Holding Times

Sample holding times are specified in the USEPA Region 4 Analytical Support Branch Laboratory Operations and Quality Assurance Manual (ASBLOQAM), Most Recent Version. Field investigators should note that the holding time for an un-preserved VOC sediment sample is 48 hours. Arrangements should be made to ship the sediment VOC samples to the laboratory by overnight delivery the day they are collected so the laboratory may preserve and/or analyze the sample within 48 hours of collection.

Percent Moisture

Samplers must ensure that the laboratory has sufficient material to determine percent moisture in the VOC sediment sample to correct the analytical results to dry weight. If other analyses requiring percent moisture determination are being performed upon the sample, these results may be used. If not, a separate sample (minimum of 2 oz.) for percent moisture determination will be required.

Safety

Methanol is a toxic and flammable liquid. Therefore, methanol must be handled with all required safety precautions related to toxic and flammable liquids. Inhalation of methanol vapors must be avoided. Vials should be opened and closed quickly during the sample preservation procedure. Methanol must be handled in a ventilated area. Use protective gloves when handling the methanol vials. Store methanol away from sources of ignition such as extreme heat or open flames. The vials of methanol should be stored in a cooler with ice at all times.

Shipping

Methanol and sodium bisulfate are considered dangerous goods, therefore shipment of samples preserved with these materials by common carrier is regulated by the U.S. Department of Transportation and the International Air Transport Association (IATA). The rules of shipment found in Title 49 of the Code of Federal Regulations (49 CFR parts 171 to 179) and the current edition of the IATA Dangerous Goods Regulations must be followed when shipping methanol and sodium bisulfate. Consult the above documents or the carrier for additional information. Shipment of the quantities of methanol and sodium bisulfate used for sample preservation falls under the exemption for small quantities. A summary of the requirements for shipping samples follows. Refer to the code for a complete review of the requirements.

1. The maximum volume of methanol or sodium bisulfate in a sample container is limited to thirty (30) ml.

2. The sample container must not be full of methanol.

3. The sample container must be stored upright and have the lid held securely in place. Note that the mechanism used to hold the cap in place must be able to be completely removed so weight is not added to the sample container, as specified in Method 5035.

4. Sample containers must be packed in an absorbent material capable of absorbing spills from leaks or breakage of the sample containers.

5. The maximum sample shuttle weight must not exceed 64 pounds.

6 The maximum volume of methanol or sodium bisulfate per shipping container is 500 ml.

7 The shipper must mark the sample shuttle in accordance with shipping dangerous goods in acceptable quantities.

8. The package must not be opened or altered until no longer in commerce.

The following summary table lists the options available for compliance with SW846 Method 5035. The advantages and disadvantages are noted for each option. SESD's goal is to minimize the use of hazardous material (methanol and sodium bisulfate) and minimize the generation of hazardous waste during sample collection.

OPTION	PROCEDURE	ADVANTAGES	DISADVANTAGES
1	Collect 2 – 40 ml vials with ~5 grams of sample and 1 – 2 oz. glass w/septum lid for screening and % moisture	Screening conducted by lab	Presently a 48 hour holding time for unpreserved samples
2	Collect 3 EnCore® Samplers and 1 – 2oz. glass w/septum lid for screening and % moisture	Lab conducts all preservation/preparation procedures	Presently a 48 hour holding time for preparation of samples
3	Collect 2 – 40 ml vials with 5 grams of sample and preserve w/methanol or sodium bisulfate, and 1 – 2 oz. glass w/septum lid for screening and % moisture	High level VOC samples may be composited Longer holding time	Hazardous materials used in field
4	Collect 1 – 2 oz. glass w/septum lid for analysis and % moisture	Lab conducts all preservation/preparation procedures	May have significant VOC loss

2.3 Special Precautions for Trace Contaminant Sediment Sampling

- A clean pair of new, non-powdered, disposable gloves will be worn each time a different location is sampled and the gloves should be donned immediately prior to sampling. The gloves should not come in contact with the media being sampled and should be changed any time during sample collection when their cleanliness is compromised.
- Sample containers for samples suspected of containing high concentrations of contaminants shall be stored separately. All background

samples shall be collected and placed in separate ice chests or shipping containers. Sample collection activities shall proceed progressively from the least suspected contaminated area to the most suspected contaminated area if sampling devices are to be reused. Samples of waste or highly contaminated media must not be placed in the same ice chest as environmental (i.e., containing low contaminant levels) or background samples.

- If possible, one member of the field sampling team should take all the notes and photographs, fill out tags, etc., while the other members collect the samples.
- Samplers must use new, verified and certified-clean disposable or non-disposable equipment cleaned according to procedures contained in SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, or SESD Operating Procedure for Field Cleaning and Decontamination at the FEC, SESDPROC-206, for collection of samples for trace metals or organic compound analyses.

2.4 Sample Homogenization

1. If sub-sampling of the primary sample is to be performed in the laboratory, transfer the entire primary sample directly into an appropriate, labeled sample container(s). Proceed to step 5

2. If sub-sampling the primary sample in the field or compositing multiple primary samples in the field, place the sample into a glass or stainless steel homogenization container and mix thoroughly. Each aliquot of a composite sample should be of the same volume.

3. All sediment samples must be thoroughly mixed to ensure that the sample is as representative as possible of the sample media. ***Samples for VOC analysis are not homogenized.*** The most common method of mixing is referred to as quartering. The quartering procedure should be performed as follows:

    - The material in the sample pan should be divided into quarters and each quarter should be mixed individually.
    - Two quarters should then be mixed to form halves.
    - The two halves should be mixed to form a homogenous matrix.

   This procedure should be repeated several times until the sample is adequately mixed. If round bowls are used for sample mixing, adequate mixing is achieved by stirring the material in a circular fashion, reversing direction, and occasionally turning the material over.

3. Place the sample into an appropriate, labeled container(s) using the alternate shoveling method and secure the cap(s) tightly. Threads on the container and lid should be cleaned to ensure a tight seal when closed.
4. Return any unused sample material back to the location from which the sample was collected.

2.5 Quality Control

If possible, a control sample should be collected from an area not affected by the possible contaminants of concern and submitted with the other samples. The control sample should be collected at an upstream location in the same stream or conveyance from which the primary samples area collected. Equipment blanks should be collected if equipment is field cleaned and re-used on-site or if necessary to document that low-level contaminants were not introduced by sampling tools.

2.6 Records

Information generated or obtained by SESD personnel will be organized and accounted for in accordance with SESD records management procedures found in SESD Operating Procedure for Control of Records, SESDPROC-004. Field notes, recorded in a bound field logbook, will be generated, as well as chain-of-custody documentation in accordance with SESD Operating Procedure for Logbooks, SESDPROC-010 and SESD Procedure for Sample and Evidence Management, SESDPROC-005.

3 General Considerations

3.1 General

The sediment sampling techniques and equipment described in the following Sections 4, 5 and 6 of this procedure document are designed to minimize effects on the chemical and physical integrity of the sample. If the procedures in this section are followed, a representative sample of the sediment should be obtained.

3.2 Equipment Selection Considerations

The physical location of the investigator when collecting a sample may dictate the equipment to be used. Wading is the preferred method for reaching the sampling location, particularly if the stream has a noticeable current (is not impounded). However, wading may disrupt bottom sediments causing biased results; therefore, the samples should be collected facing upstream. If the stream is too deep to wade, the sediment sample may be collected from a platform such as a boat or a bridge.

To collect a sediment sample from a water body or other surface water conveyance, a variety of methods can be used:

- Scoops and spoons
- Dredges (Ponar, Young)
- Coring Devices (tubes, Shelby tubes, Ogeechee Sand Pounders®, and augers)
- Vibracore® (Electronic Vibratory Core Tube Driver)

Regardless of the method used, precautions should be taken to insure that the sample collected is representative of the water body or conveyance. These methods are discussed in the following paragraphs.

4 Stainless Steel Scoops and Spoons

4.1 Wading

If the conveyance is dry or is a wadeable surface water body, the easiest way to collect a sediment sample is by using a stainless steel scoop or spoon. If the conveyance is dry, the sediment is accessed directly and is collected using either the stainless steel scoop or spoon. If the conveyance is a wadeable stream or other water body, the method is accomplished by wading into the surface water body and while facing upstream (into the current), scooping the sample along the bottom of the surface water body in the upstream direction. Excess water may be removed/drained from the scoop or spoon. However, this may result in the loss of some fine-grained particle size material associated with the substrate being sampled. Care should be taken to minimize the loss of this fine-grained material. Aliquots of the sample thus collected are then placed in a glass pan and homogenized according to the quartering method described in Section 2.4.

4.2 Bank/Platform Sampling

In surface water bodies that are too deep to wade, but less than eight feet deep, a stainless steel scoop or spoon attached to a piece of conduit can be used either from the banks, if the surface water body is narrow, or from a boat. Again, care should be taken to minimize the loss of the fine particle sizes. The sediment is placed into a glass pan and mixed according to the quartering method described in Section 2.4.

5 Dredges

5.1 General Considerations

Dredges provide a means of collecting sediment from surface water bodies that are too deep to access with a scoop and conduit. They are most useful when collecting softer, finer-grained substrates comprised of silts and clays but can also be used to collect sediments comprised of sands and gravel, although sample recovery in these materials may be less than complete.

Free, vertical clearance is required to use any of the dredges. Dredges, attached to ropes, are lowered vertically from the sampling platform (boat, bridge, etc.) to the substrate being sampled beneath the deployment point.

5.2 Ponar Dredge

The Ponar dredge has side plates and a screen on the top of the sample compartment and samples a 0.05 m^2 surface area. The screen over the sample compartment permits water to pass through the sampler as it descends thus reducing turbulence around the dredge. The Ponar dredge is easily operated by one person and is one of the most effective samplers for general use on most types of substrates.

The Ponar dredge is deployed in its open configuration. It is lowered gently from the sampling platform to the substrate below the platform. After the dredge lands on the substrate, the rope is tugged upward, closing the dredge and capturing the sample. The dredge is then hauled to the surface, where it is opened to acquire the sample.

5.3 Mini-Ponar Dredge

The Mini-Ponar dredge is a smaller, much lighter version of the Ponar dredge and samples a 0.023 m^2 surface area. It is used to collect smaller sample volumes when working in industrial tanks, lagoons, ponds, and shallow water bodies. It is a good device to use when collecting sludge and sediment containing hazardous constituents because the size of the dredge makes it more amenable to field cleaning. Its use and operation are the same as described in Section 5.2, Ponar Dredge, above.

5.4 Young Grab

The Young grab sampler is a stainless steel clamshell-type grab sampler similar to a Ponar dredge. It is a clamshell-type sampler with a scissors closing action typically used for marine and estuarine sediment sampling. The Young grab sampler is one of the most consistently performing grab sampling devices for sediment sampling in both offshore marine sediments, as well as estuarine sediments. The Young sampler comes in two sizes, 0.1 m^2 and 0.04 m^2. The 0.1 m^2 is typically used when a larger volume of sediment is needed for chemistry and particle size. The 0.04 m^2 is typically used for marine benthic macroinvertebrate sampling and has become the standard grab sampler used by NOAA, USGS and USEPA.

The Young sampler is lowered to the substrate to be sampled with a cable or rope that has a catch that is released when tension is taken off the cable or rope. When the sample device is pulled up, the scissors action of the arms close the clamshell and grabs the sample.

The major difference in the Young grab sampler and other grab samplers is a square or rectangular frame attached to the device which prevents it from penetrating too deeply into soft sediments. In harder substrates, weights may be added to the frame in order to hold the grab in place to prevent collection of a "shallow" sample. A tripod frame can also be attached to the frame surrounding the Young grab sampler. The wire or rope that the grab is raised and lowered with passes through an opening in the top of the tripod and prevents the device from landing sideways or at an angle when there are strong currents or there is lateral movement of the sampling vessel during grab sampling operations.

The draw back to the Young grab sampler is that due to the weight and size of the frame, a ship with an "A" frame or a boat with a davit is required in order to raise and lower the sampler.

6 Sediment Coring Devices

6.1 General

Core samplers are used to sample vertical columns of sediment. They are particularly useful when a historical picture of sediment deposition is desired since they preserve the sequential layering of the deposit. They are also particularly useful when it is desirable to minimize the loss of material at the sediment-water interface. Many types of coring devices have been developed, depending on the depth of water from which the sample is to be obtained, the nature of the bottom material and the length of core to be collected. They vary from hand-driven push tubes to electronic vibrational core tube drivers. These methods are described below in the following sections.

Coring devices are particularly useful in pollutant monitoring because turbulence created by descent through the water is minimal, thus the fines at the sediment-water interface are only minimally disturbed; the sample is withdrawn intact, permitting the removal of only those layers of interest; core liners manufactured of glass or Teflon® can be purchased, thus reducing possible sample interferences; and the samples are easily delivered to the lab for analysis in the tube in which they were collected.

The disadvantage of coring devices is that a relatively small surface area and sample size is obtained, often necessitating repetitive sampling in order to obtain the required amount of material for analysis. Because it is believed that this disadvantage is offset by the advantages, coring devices are recommended in sampling sediments for trace organic compounds or metals analyses.

6.2 Manually Deployed Push Tubes

In shallow, wadeable waters, or for diver-collected samples, the direct use of a core liner or tube manufactured of Teflon®, plastic, or glass is recommended for the collection of sediment samples. Plastic tubes are principally used for collection of samples for physical parameters such as particle size analysis and, in some instances, are acceptable when inorganic constituents are the only parameter of concern. Their use can also be extended to deep waters when SCUBA diving equipment is utilized. Teflon® or plastic is preferred to glass since they are unbreakable, reducing the possibility of sample loss or personal injury. Stainless steel push tubes are also acceptable and provide a better cutting edge and higher strength than Teflon®. The use of glass or Teflon® tubes eliminates any possible interference due to metals contamination from core barrels, cutting heads, and retainers. The tube should be approximately 12-inches in length if only recently deposited sediments (8 inches or less) are to be sampled. Longer tubes should be used when the depth of the substrate exceeds 8 inches. Soft or semi-consolidated sediments such as mud and clays have a greater adherence to the inside of the tube and thus can be sampled with larger diameter tubes. Because coarse or unconsolidated sediments, such as sands and gravel, tend to fall out of the tube, a smaller diameter push tube is normally required to obtain a sample. In extreme cases, where sample retention in the tube is problematic, core-catchers or end caps made of Teflon® should be employed. A tube about two-inches in diameter is usually the best size. The wall thickness of the tube should be about 1/3-inch for Teflon® plastic, or glass. The inside wall may be filed down at the bottom of the tube to provide a cutting edge to facilitate entry of the liner into the substrate.

Caution should be exercised not to disturb the bottom sediments when the sample is obtained by wading in shallow water (always work facing upstream and working from downstream up). The core tube is pushed into the substrate until four inches or less of the tube is above the sediment-water interface. When sampling hard or coarse substrates, a gentle rotation of the tube while it is being pushed will facilitate greater penetration and decrease core compaction. The top of the tube is then capped to provide suction and reduce the chance of losing the sample. A Teflon® plug or end cap, or a sheet of Teflon® held in place by a rubber stopper or cork may be used. After capping, the tube is slowly extracted with the suction and adherence of the sediment keeping the sample in the tube. Before pulling the bottom part of the tube and core above the water surface, it too should be capped. An alternative to the coring device is the Shelby tube. The Shelby tube has a gravity check valve at the top of the tube where an auger handle attaches. This check valve allows air and water to escape as the tube is advanced. Once the tube is to the desired depth, the check valve will close automatically forming suction on the tube; thus, holding the sample inside.

When extensive core sampling is required, such as a cross-sectional examination of a streambed with the objective of profiling both the physical and chemical contents of the sediment, complete cores are desirable. A strong coring tube such as one made from aluminum, steel or stainless steel is needed to penetrate the sediment and underlying clay or sands. To facilitate complete core collection and retention, it is recommended that the corer (like a Shelby tube) have a check valve built into the driving head which allows water and air to escape from the cutting core, thus creating a partial vacuum, helping to hold the sediment core in the tube. The corer is attached to a standard auger extension and handle, allowing it to be corkscrewed into the sediment from a boat or while wading. The coring tube is easily detached and the intact sediment core is removed with an extraction device.

Before extracting the sediment from the coring tubes, the clear supernatant above the sediment-water interface in the core should be decanted from the tube. This is accomplished by simply turning the core tube to its side, and gently pouring the liquid out until fine sediment particles appear in the waste liquid. The loss of some of the fine sediments usually occurs with this technique.

6.3 Ogeechee Sand Pounders® and Gravity Cores

In deeper, non-wadeable water bodies, sediment cores may be collected from a bridge or a boat using different coring devices such as Ogeechee Sand Pounders®, gravity cores and vibrating coring devices. All three devices utilize a core barrel with a core liner tube system. The core liner can be removed from the core barrel and replaced with a clean core liner, as needed, after each sample. Liners are made of stainless steel, Teflon® or plastic. The type of core liner and its composition should be based on the contaminants to be evaluated.

Ogeechee Sand Pounders® and gravity cores are hand-held devices that use a standard size 2-inch diameter core barrel. The core tube and liner are interchangeable between the two units. The Ogeechee® uses a slide-hammer mechanism attached to the core head that allows the sampler to pound the core tube into the sediment. The Ogeechee® is good for sandy, more consolidated sediments. The gravity core uses a guiding fin mechanism with a built-in gravity-type check valve. The gravity core is placed in the water and released at the surface to free fall to the bottom. The fin mechanism keeps the core tube upright and free from spinning in the water column as it descends. The core tube stabs the bottom, forcing the sediment into the tube. Both coring devices are equipped with removable nose pieces on the core barrel and disposable core catchers for the liner tubes. The core catchers are designed to cap the liner tube to avoid loss of the core when retrieved from the bottom. The gravity core can be modified to attach a slide hammer mechanism, similar to the Ogeechee®, to further pound the core into the sediment further if deemed necessary.

Sediment cores collected from most hand operated coring devices can suffer from either spreading or compaction when driven into the sediment, depending on the softness of the sediment. Spreading occurs when the sediment is pushed or moved to the side during the advancement of the core tube. Compaction occurs when the sediment is being pushed downward as the core tube is advanced. Both phenomena can affect the physical integrity of the core sample. For instance, the core tube may be advanced through the sediment to a depth of 36 inches, but upon examination of the recovered core, there is only 24 inches of sediment in the core tube.

6.4 Vibratory Core Tube Drivers (Vibracore®)

Vibratory Core Tube Drivers (Vibracore®) facilitate sampling of soft or loosely consolidated, saturated sediments, with minimal compaction or spreading, using lined or unlined core tubes. It is designed for use with core tubes having nominal diameters ranging from 2-inches to 4-inches OD. The Vibracore® uses an electric motor to create vibration ranges from approximately 6,000 RPM to 8,000 RPM (100 Hz to 133 Hz) depending on the resistance afforded by the sediment; the greater the resistance, the higher the frequency. The actual vibrational displacement of the Vibracore® is on the order of a few tens of thousandths of an inch, so essentially no mixing of the sediment within the tube occurs. The vibrational energy tends to re-orient the sediment particles at the lower end of the core tube, causing them to move out of the way of the advancing wall of the core tube and into a more efficient (i.e. denser) packing. This action advances the core tube with minimal compaction of the sediment.

7 Diving

7.1 General

Sediment samples can also be obtained from large streams and open water bodies such as ponds, lakes, estuarine bodies and open ocean environments by divers. Using a variety of the above mentioned methods, divers can directly access the substrate and collect sediment samples. Depending upon the sampling methods used and the required analyses, the samples may be collected directly into the containers from the substrate or they may be returned, in bulk, to the bank or other sampling platform for processing and sample container allocation.

ARCADIS Atlanta Environmental Practice	SEDIMENT SAMPLING PROCEDURES	
Site-Wide Policy No. FSP-4.1	Page 1 of 8	Revision No. 0 Revision Date: October 9, 2004

1.0 OVERVIEW

This policy provides guidance on proper sediment sampling procedures (shallow and deep sample collection).

2.0 PROCEDURE/POLICY

2.1 General Requirements

The following requirements are applicable to the collection of sediment samples:

- Wear personal protective equipment required by the task/project Task Hazard Analysis.
- Sampling equipment and supplies to be used for sediment sampling will be determined during the task/project Field Readiness Assessment.
- All sampling and mixing equipment will be decontaminated in accordance with SWP FSP-7.5, “Decontamination Procedures.”
- All sampling devices will be constructed from stainless steel materials. If liners are used for the collection of samples for environmental analysis, the liner will be new and sealed in factory supplied packaging upon arrival onto the site and will be composed of materials appropriate for task/project data quality objectives (DQOs) (generally Teflon® or stainless steel).
- Rope used to lower sediment collection devices in deep water will be new nylon or polyethylene rope with a minimum diameter of ½ inch. If the sediment sampling device is lowered on extension rods, the preferred rod material should be stainless steel.
- Once collected, all sediment samples will be prepared, packaged and shipped in accordance with SWP FSP-1.3, “Preparation of Soils for Environmental Analysis.” Liners used as sample containers will be subject to similar requirements as soil containers except that the ends will be capped with Teflon® lined caps and taped with electrical tape.
- All equipment and procedures used to collect sediment samples will be documented in accordance with SWP FSP-7.1, “Field Documentation.” An example Soil/Sediment Sampling Log is presented in Exhibit 1.

2.2 Scoop and Spoon Sampling Procedure

2.2.1 Shallow Water Sediment Collection

The following general procedure is applicable to sediment sampling with scoops and spoons:

1. Unwrap the spoon/scoop and sample collection bowl and mobilize to the sediment sample location. When wading to the location, approach the sampling point from the downstream direction. When sampling from the edge of the water body, use caution to avoid knocking soils from the bank into the water column.
2. Advance the spoon/scoop into the sediment, retrieve a sample and place into the collection bowl.
3. Repeat process until a sufficient volume of soil is collected.
4. Decant water from the collection bowl after sampling is complete.
5. Promptly return to the bank, scan the sample with the photoionization detector (PID) or other air monitoring device as applicable or required by the task/project DQOs.
6. Prepare the sediment sample for laboratory analysis (refer to SWP FSP-1.3, “Preparation of Soils for Environmental Analysis”).

2.2.2 Deep Water Sediment Collection

For waters that are too deep to wade and less than eight feet deep, spoons/scoops may be used if the following general procedure is followed:

1. Attach the handle of a spoon/scoop to a piece of conduit using stainless steel hose clamps.
2. Mobile to the sample location by watercraft; or by accessing the location from a bridge, dock, or by standing on the bank.
3. Unwrap the spoon/scoop and collection bowl; lower the spoon/scoop through the water column and into the sediment.
4. Gently retrieve the sample. Take care to avoid rapid movement through the water column as sediment may be lost during the retrieval.
5. Repeat process until a sufficient volume of soil is collected.
6. Decant water from the collection bowl after sampling is complete.

7. Scan the sample with the photoionization detector (PID) or other air monitoring device as applicable or required by the task/project DQOs.
8. Prepare the sediment sample for laboratory analysis (refer to SWP FSP-1.3, "Preparation of Soils for Environmental Analysis").

2.3 Sediment Core Sampling

An example of a sediment coring device is presented in Exhibit 2. The following general procedure is applicable to sediment sampling using a manual sediment core device:

1. Unwrap a sediment core tube and insert a liner (if required as part of task/project DQOs). If the sediment is anticipated to be uncohesive, install a stainless steel catcher in the nose of the core tube.
2. Attach the core tube to the "T" handle and appropriate length of extension rods.
3. Mobilize to the sample location. If wading, approach the location from the downstream direction.
4. Insert the sediment core tube through the water column and into the sediment for the full length of the tube. If the sediment has hard substrate or has a high gravel content, gently rotate the core tube as it is inserted.
5. Once filled, carefully extract the core tube and return the tube to the surface. Since the core tube is usually subjected to suction forces during extraction, assistance may be required to extract the tube. Use proper lifting techniques. If on a watercraft equipped with a hoist, use the hoist to retrieve the core tube.
6. Once at the surface, discharge the contents of the tube into the collection bowl or remove liner and cap the ends.
7. For sediment in the collection bowl, decant any water to the extent practical and scan with the photoionization detector (PID) or other air monitoring device as required by the task/project DQOs.
8. Prepare the sample for analysis (refer to SWP FSP-1.3, "Preparation of Soils for Environmental Analysis").

Note: Sediment core tubes can be used in deep water (greater than 15 ft deep) with soft sediments by attaching the core tube to nylon rope and allowing the tube to free fall through the water column and into the sediment.

2.4 Dredge Sampling

The following general procedure is applicable to sediment sample collection with dredges [Ponar® Dredge procedure presented here (Exhibits 2 and 3)]:

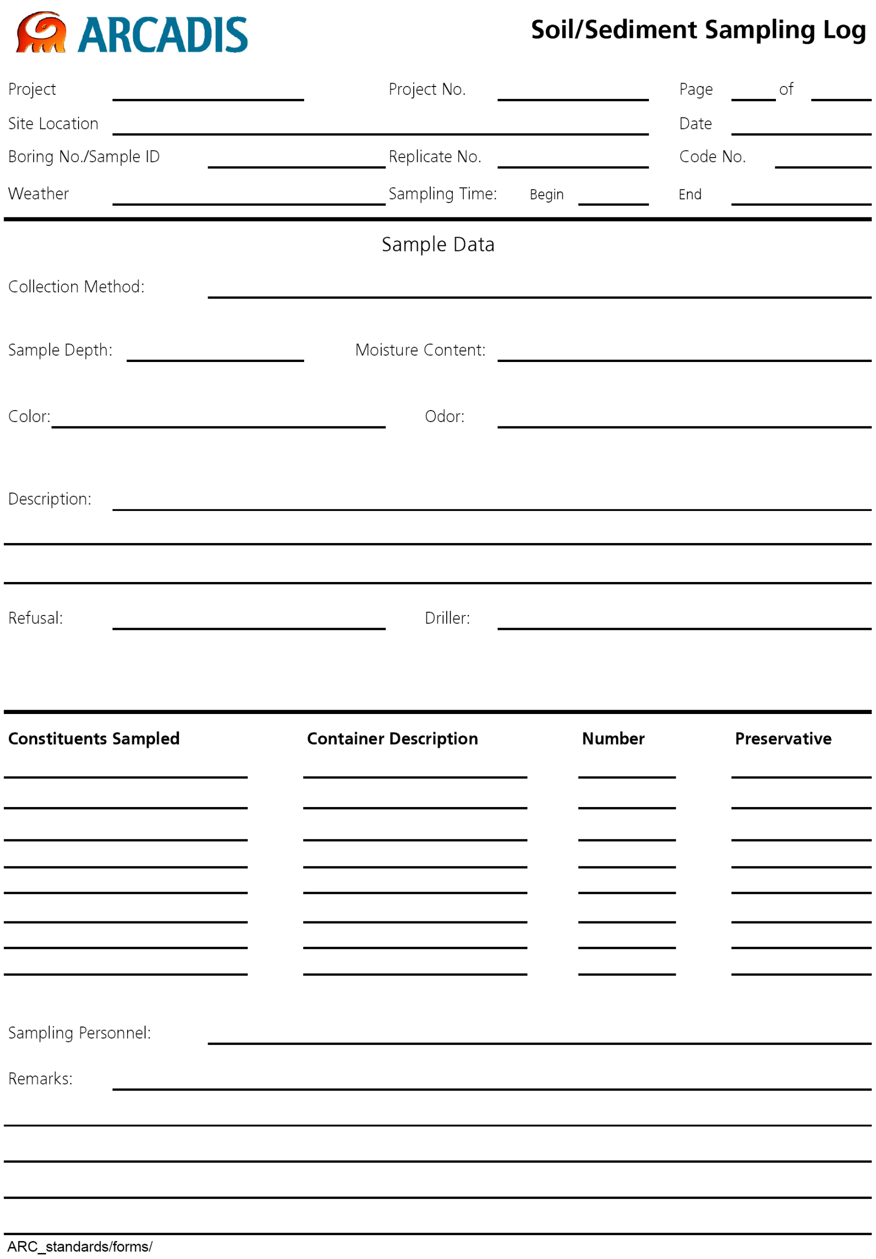
1. Unwrap the dredge and attach to new rope.
2. Remove the pin that secures the release pin on the dredge. Apply pressure on the release pin to hold it in place by pulling up in the top of the scissor mechanism where the rope connects to the dredge. **CAUTION:** If the pin releases, the dredge will quickly close because of the upward pressure be exerted. The scissor mechanism will pinch fingers if they are in the mechanism (Exhibit 3).
3. Carefully place the dredge, while maintaining pressure on the pin/scissor mechanism, over the edge of the watercraft/bridge/dock and lower through the water column and into the sediment.
4. When the dredge impacts the sediment, the pin releases. Pull up the dredge (which forces it to close) and bring up to the surface.
5. Carefully retrieve dredge, allow water to drain, and discharge contents into the collection bowl.
6. Repeat process until sufficient volume of sediment is collected.
7. Scan with the photoionization detector (PID) or other air monitoring device as required by the task/project DQOs.
8. Prepare the sample for analysis (refer to SWP FSP-1.3, “Preparation of Soils for Environmental Analysis”).

3.0 REFERENCES AND GUIDANCE

United States Army Corps of Engineers. 2001. Requirements for the Preparation of Sampling and Analysis Plans. EM 200-1-3. February 1, 2001.

United States Environmental Protection Agency. 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. United States Environmental Protection Agency Region IV. November, 2001.

Exhibit 1. Example Soil/Sediment Sampling Log



ARCADIS

Soil/Sediment Sampling Log

Project ____________ Project No. ____________ Page ____ of ____

Site Location ____________ Date ____________

Boring No./Sample ID ____________ Replicate No. ____________ Code No. ____________

Weather ____________ Sampling Time: Begin ________ End ________

Sample Data

Collection Method: ____________

Sample Depth: ____________ Moisture Content: ____________

Color: ____________ Odor: ____________

Description: ____________

Refusal: ____________ Driller: ____________

Constituents Sampled	**Container Description**	**Number**	**Preservative**

Sampling Personnel: ____________

Remarks: ____________

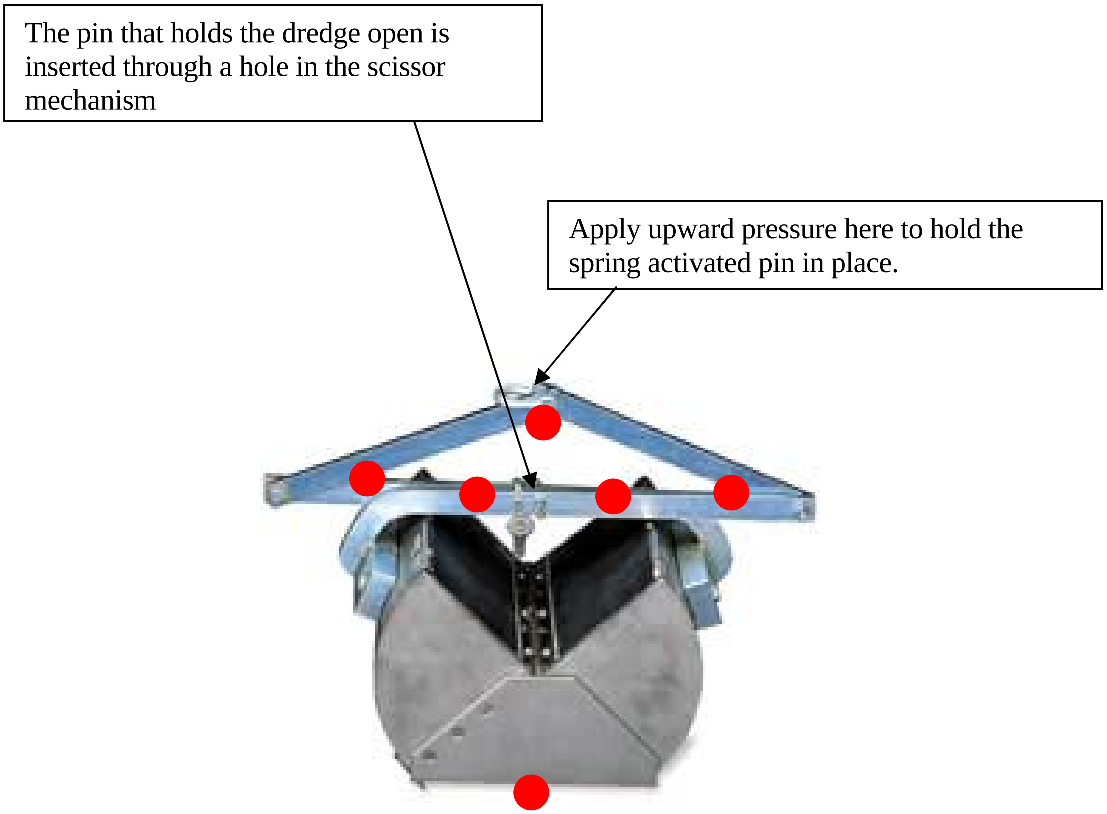
ARC_standards/forms/

Exhibit 2. Typical Sediment Sampling Devices

Hand Core Sediment Sampler	Ideal Use
	Good for collecting sediment and sludge samples at depth and obtaining an undisturbed sediment core

Dredges	Ideal Use
	**Heavyweight Deep Water Dredge** Good for collecting most types of surface sediment through deep water. *Weight 25 pounds*
	**Bottom Sampling Dredge** Lightweight and good for sampling silt and sand sediments. *Weight 4 pounds*

Exhibit 3. The Ponar® Dredge



The pin that holds the dredge open is inserted through a hole in the scissor mechanism

Apply upward pressure here to hold the spring activated pin in place.

● Pinch point location

Refer to SWP HSP-3.15, “Manual Soil, Sediment and Waste Sampling” for additional safety information.

Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Groundwater Sampling**

Effective Date: November 1, 2007
Number: SESDPROC-301-R1

Authors

Name: Donald Hunter
Title: Environmental Scientist, Regional Expert
Signature: Donald Hunter Date: 11/02/07

Approvals

Name: Antonio Quinones
Title: Chief, Enforcement and Investigations Branch
Signature: Date: 11/02/07

Name: Laura Ackerman
Title: Field Quality Manager, Science and Ecosystem Support Division
Signature: Laura Acker Date: 11/01/07

Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Field Quality Manager.

History	Effective Date
SESDPROC-301-R1, *Groundwater Sampling*, replaces SESDPROC-301-R0. **General** Corrected any typographical, grammatical and/or editorial errors. **Title Page** Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch **Section 1.3** Updated information to reflect that the procedure is located on the H: drive of the LAN. Clarified Field Quality Manager (FQM) responsibilities. **Section 1.4** Updated referenced operating procedures due to changes in title names. Alphabetized and revised the referencing style for consistency. **Section 1.5.1** Corrected the title of the Safety, Health, and Environmental Management Program Procedures and Policy Manual. **Section 1.5.2, 4th bullet** Added references to the CFR and IATA's Dangerous Goods Regulations. **Section 2.5** Updated referenced operating procedures due to changes in title names.	November 1, 2007
SESDPROC-301-R0, Groundwater Sampling, Original Issue	February 05, 2007

TABLE OF CONTENTS

Contents

1 General Information

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed when collecting groundwater samples for field screening or laboratory analysis.

1.2 Scope/Application

The procedures contained in this document are to be used by field personnel when collecting and handling groundwater samples in the field. On the occasion that SESD field personnel determine that any of the procedures described in this section are either inappropriate, inadequate or impractical and that another procedure must be used to obtain a groundwater sample, the variant procedure will be documented in the field log book, along with a description of the circumstances requiring its use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and have been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the H: drive of the SESD local area network. The Field Quality Manager (FQM) is responsible for ensuring the most recent version of the procedure is placed on the H: drive and for maintaining records of review conducted prior to its issuance.

1.4 References

International Air Transport Authority (IATA). Dangerous Goods Regulations, Most Recent Version

Puls, Robert W., and Michael J. Barcelona. 1989. Filtration of Ground Water Samples for Metals Analysis. Hazardous Waste and Hazardous Materials 6(4), pp.385-393.

Puls, Robert W., Don A. Clark, and Bert Bledsoe. 1992. Metals in Ground Water: Sampling Artifacts and Reproducibility. Hazardous Waste and Hazardous Materials 9(2), pp. 149-162.

SESD Guidance Document, Design and Installation of Monitoring Wells, SESDGUID-001, Most Recent Version

SESD Operating Procedure for Control of Records, SESDPROC-002, Most Recent Version

SESD Operating Procedure for Sample and Evidence Management, SESDPROC-005, Most Recent Version

SESD Operating Procedure for Logbooks, SESDPROC-010, Most Recent Version

SESD Operating Procedure for Field Sampling Quality Control, SESDPROC-011, Most Recent Version

SESD Operating Procedure for Field pH Measurement, SESDPROC-100, Most Recent Version

SESD Operating Procedure for Field Specific Conductance Measurement, SESDPROC-101, Most Recent Version

SESD Operating Procedure for Field Temperature Measurement, SESDPROC-102, Most Recent Version

SESD Operating Procedure for Field Turbidity Measurement, SESDPROC-103, Most Recent Version

SESD Operating Procedure for Groundwater Level and Well Depth Measurement, SESDPROC-105, Most Recent Version

SESD Operating Procedure for Management of Investigation Derived Waste, SESDROC-202, Most Recent Version

SESD Operating Procedure for Pump Operation, SESDPROC-203, Most Recent Version

SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, Most Recent Version

SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC, SESDPROC-206, Most Recent Version

SESD Operating Procedure for Potable Water Supply Sampling, SESDPROC-305, Most Recent Version

United States Environmental Protection Agency (US EPA). 1975. Handbook for Evaluating Water Bacteriological Laboratories. Office of Research and Development (ORD), Municipal Environmental Research Laboratory, Cincinnati, Ohio.

US EPA. 1977. Sampling for Organic Chemicals and Microorganisms in the Subsurface. EPA-600/2-77/176.

US EPA. 1978. Microbiological Methods for Monitoring the Environment, Water and Wastes. ORD, Municipal Environmental Research Laboratory, Cincinnati, Ohio.

US EPA. 1981. "Final Regulation Package for Compliance with DOT Regulations in the Shipment of Environmental Laboratory Samples," Memo from David Weitzman, Work Group Chairman, Office of Occupational Health and Safety (PM-273), April 13, 1981.

US EPA. 1995. Ground Water Sampling - A Workshop Summary. Proceedings from the Dallas, Texas November 30 – December 2, 1993 Workshop. ORD, Robert S. Kerr Environmental Research Laboratory. EPA/600/R-94/205, January 1995.

US EPA. 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division (SESD), Athens, GA

US EPA. Analytical Support Branch Laboratory Operations and Quality Assurance Manual. Region 4 SESD, Athens, GA, Most Recent Version

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when collecting groundwater samples. Refer to the SESD Safety, Health and Environmental Management Program (SHEMP) Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASP) for guidelines on safety precautions. These guidelines should be used to complement the judgment of an experienced professional. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate.

1.5.2 Procedural Precautions

The following precautions should be considered when collecting groundwater samples.

- Special care must be taken not to contaminate samples. This includes storing samples in a secure location to preclude conditions which could alter the properties of the sample. Samples shall be custody sealed during long-term storage or shipment.
- Always sample from the anticipated cleanest, i.e., least contaminated location, to the most contaminated location. This minimizes the opportunity for cross-contamination to occur during sampling.

- Collected samples must remain in the custody of the sampler or sample custodian until the samples are relinquished to another party.
- If samples are transported by the sampler, they will remain under his/her custody or be secured until they are relinquished.
- Shipped samples shall conform to all U.S. Department of Transportation (DOT) rules of shipment found in Title 49 of the Code of Federal Regulations (49 CFR parts 171 to 179), and/or International Air Transportation Association (IATA) hazardous materials shipping requirements found in the current edition of IATA's Dangerous Goods Regulations.
- Documentation of field sampling is done in a bound logbook.
- Chain-of-custody documents shall be filled out and remain with the samples until custody is relinquished.
- All shipping documents, such as air bills, bills of lading, etc., shall be retained by the project leader and placed in the project files.

2 Special Sampling Considerations

2.1 Volatile Organic Compounds (VOC) Analysis

Groundwater samples for VOC analysis must be collected in 40 ml glass vials with Teflon® septa. The vial may be either preserved with concentrated hydrochloric acid or they may be unpreserved. Preserved samples have a two week holding time, whereas unpreserved samples have only a seven day holding time. In the great majority of cases, the preserved vials are used to take advantage of the extended holding time. In some situations, however, it may be necessary to use the unpreserved vials. For example, if the groundwater has a high amount of dissolved limestone, i.e., is highly calcareous, there will most likely be an effervescent reaction between the hydrochloric acid and the water, producing large numbers of fine bubbles. This will render the sample unacceptable. In this case, unpreserved vials should be used and arrangements must be confirmed with the laboratory to ensure that they can accept the unpreserved vials and meet the shorter sample holding times.

The samples should be collected with as little agitation or disturbance as possible. The vial should be filled so that there is a meniscus at the top of the vial and absolutely no bubbles or headspace should be present in the vial after it is capped. After the cap is securely tightened, the vial should be inverted and tapped on the palm of one hand to see if any undetected bubbles are dislodged. If a bubble or bubbles are present, the vial should be topped off using a minimal amount of sample to re-establish the meniscus. Care should be taken not to flush any preservative out of the vial during topping off. If, after topping off and capping the vial, bubbles are still present, a new vial should be obtained and the sample re-collected.

Samples for VOC analysis must be collected using either stainless steel or Teflon® equipment, such as:

- Bailers must be constructed of stainless steel or Teflon®
- RediFlo2® submersible pumps used for sampling should be equipped with Teflon® sample delivery tubing
- Peristaltic pump/vacuum jug assemblies should be outfitted with Teflon® tubing from the water column to the transfer cap, which should also be constructed of Teflon®

2.2 Special Precautions for Trace Contaminant Groundwater Sampling

- A clean pair of new, non-powdered, disposable gloves will be worn each time a different location is sampled and the gloves should be donned immediately prior to sampling. The gloves should not come in contact with the media being sampled and should be changed any time during sample collection when their cleanliness is compromised.

- Sample containers for samples suspected of containing high concentrations of contaminants shall be stored separately.
- Sample collection activities shall proceed progressively from the least suspected contaminated area to the most suspected contaminated area if sampling devices are to be reused. Samples of waste or highly contaminated media must not be placed in the same ice chest as environmental (i.e., containing low contaminant levels) or background samples.
- If possible, one member of the field sampling team should take all the notes and photographs, fill out tags, etc., while the other members collect the samples.
- Clean plastic sheeting will be placed on the ground at each sample location to prevent or minimize contaminating sampling equipment by accidental contact with the ground surface.
- Samplers must use new, verified certified-clean disposable or non-disposable equipment cleaned according to procedures contained in SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205) or SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC (SESDPROC-206) for collection of samples for trace metals or organic compound analyses.

2.3 Sample Handling and Preservation Requirements

1. Groundwater samples will typically be collected from the discharge line of a pump or from a bailer, either from the pour stream of an up-turned bailer or from the stream from a bottom-emptying device. Efforts should be made to reduce the flow from either the pump discharge line or the bailer during sample collection to minimize sample agitation.

2. During sample collection, make sure that the pump discharge line or the bailer does not contact the sample container.

3. Place the sample into appropriate, labeled containers. Samples collected for VOC analysis must not have any headspace (see Section 2.1, Volatile Organic Compound Analysis). All other sample containers must be filled with an allowance for ullage.

4. All samples requiring preservation must be preserved as soon as practically possible, ideally immediately at the time of sample collection. If preserved VOC vials are used, these will be preserved with concentrated hydrochloric acid by ASB personnel prior to departure for the field investigation. All other chemical preservatives required for the remaining suite of analytes will be supplied by ASB personnel and will be added to the samples by SESD field personnel or other

authorized persons. The adequacy of sample preservation will be checked after the addition of the preservative for all samples except for the samples collected for VOC analysis. Additional preservative should be added to achieve adequate preservation. Preservation requirements for groundwater samples are found in the USEPA Region 4 Analytical Support Branch Laboratory Operations and Quality Assurance Manual (ASBLOQAM), Most Recent Version.

2.4 Quality Control

If possible, a control sample should be collected from location not affected by the possible contaminants of concern and submitted with the other samples. This control sample should be collected as close to the sampled area as possible and from the same water-bearing formation. Equipment blanks should be collected if equipment is field cleaned and re-used on-site or if necessary to document that low-level contaminants were not introduced by pumps, bailers or other sampling equipment.

2.5 Records

Information generated or obtained by SESD personnel will be organized and accounted for in accordance with SESD records management procedures found in SESD Operating Procedure for Control of Records, SESDPROC-002. Field notes, recorded in a bound field logbook, will be generated, as well as chain-of-custody documentation in accordance with SESD Operating Procedure for Logbooks, SESDPROC-010 and SESD Procedure for Sample and Evidence Management, SESDPROC-005.

3 Groundwater Sampling Methods - Purging

3.1 General

3.1.1 Purging and Purge Adequacy

Purging is the process of removing stagnant water from a well, immediately prior to sampling, causing its replacement by ground water from the adjacent formation that is representative of actual aquifer conditions. In order to determine when a well has been adequately purged, field investigators should monitor the pH, specific conductance, temperature, and turbidity of the ground water removed during purging and, in the case of permanent monitoring wells, observe and record the volume of water removed.

Prior to initiating the purge, the amount of water standing in the water column (water inside the well riser and screen) should be determined, if possible. To do this, the diameter of the well should be determined and the water level and total depth of the well should be measured and recorded. Specific methodology for obtaining these measurements is found in SESD Operating Procedure for Groundwater Level and Well Depth Measurement (SESDPROC-105). Once this information is obtained, the volume of water to be purged can be determined using one of several methods. One is the equation:

$$V = 0.041\ d^2h$$

Where: h = depth of water in feet
d = diameter of well in inches
V = volume of water in gallons

Alternatively, the volume may be determined using a casing volume per foot factor for the appropriate diameter well, similar to that in Table 3.1.1. The water level is subtracted from the total depth, providing the length of the water column. This length is multiplied by the factor in the Table 3.1.1 which corresponds to the appropriate well diameter, providing the amount of water, in gallons, contained in the well, i.e., one well or water column volume. Other acceptable methods include the use of nomographs or other equations or formulae.

With respect to volume, an adequate purge is normally achieved when three to five well volumes have been removed. The field notes should reflect the single well volume calculations or determinations, according to one of the above methods, and a reference to the appropriate multiplication of that volume, i.e., a minimum three well volumes, clearly identified as a purge volume goal.

With respect to the ground water chemistry, an adequate purge is achieved when the pH, specific conductance, and temperature of the ground water have stabilized

TABLE 3.1.1
WELL CASING DIAMETER vs. VOLUME

WELL CASING DIAMETER (INCHES) vs. VOLUME (GALS.)/FEET of WATER	
CASING	GALLONS/FT
1	0.041
2	0.163
3	0.367
4	0.653
5	1.02
6	1.469
7	1.999
8	2.611
9	3.305
10	4.08
11	4.934
12	5.875

and the turbidity has either stabilized or is below 10 Nephelometric Turbidity Units (NTUs) (twice the Primary Drinking Water Standard of 5 NTUs). Although 10 NTUs is normally considered the minimum goal for most ground water sampling objectives, lower turbidity has been shown to be easily achievable in most situations and reasonable attempts should be made to achieve these lower levels. Stabilization occurs when, for at least three consecutive measurements, the pH remains constant within 0.1 Standard Unit (SU), specific conductance varies no more than approximately 10 percent, and the temperature is constant. There are no set criteria for establishing how many total sets of measurements are adequate to document stability of parameters. If the calculated purge volume is small, the measurements should be taken frequently enough to provide a sufficient number of measurements to evaluate stability. If the purge volume is large, measurements taken every 15 minutes, for example, may be sufficient. See the SESD Operating Procedure for Field pH Measurement (SESDPROC-100), SESD Operating Procedure for Field Specific Conductance Measurement (SESDPROC-101), SESD Operating Procedure for Field Temperature Measurement (SESDPROC-102) and SESD Operating Procedure for Field Turbidity Measurement (SESDPROC-103) for procedures for conducting these purge adequacy measurements.

If, after three well volumes have been removed, the chemical parameters have not stabilized according to the above criteria, additional well volumes (up to five well volumes), should be removed. If the parameters have not stabilized within five volumes, it is at the discretion of the project leader whether or not to collect a sample or to continue purging. If, after five well volumes, pH and conductivity have stabilized and the turbidity is still decreasing and approaching an acceptable level, additional purging should be considered to obtain the best sample possible, with respect to turbidity. The conditions of sampling should be noted in the field log.

In some situations, even with slow purge rates, a well may be pumped or bailed dry (evacuated). In these situations, this generally constitutes an adequate purge and the well can be sampled following sufficient recovery (enough volume to allow filling of all sample containers). ***It is not necessary that the well be evacuated three times before it is sampled***. The pH, specific conductance, temperature, and turbidity should be measured and recorded, during collection of the sample from the recovered volume, as the measurements of record for the sampling event.

For wells with slow recovery, attempts should be made to avoid purging them to dryness. This can be accomplished, for example, by slowing the purge rate. If a well is purged to dryness, it may result in the sample being comprised partially of water contained in the sand pack, which may be reflective, at least in part, of initial, stagnant conditions. Additionally, as water enters a well that has been purged to dryness, it may cascade down the sand pack and/or the well screen, stripping volatile organic constituents that may be present and/or introducing soil fines into the water column.

It is particularly important that wells be sampled as soon as possible after purging. If adequate volume is available immediately upon completion of purging, the well must be sampled immediately. If not, sampling should occur as soon as adequate volume has recovered. Sampling of wells which have a slow recovery should be scheduled so that they can be purged and sampled in the same day, after adequate volume has recovered. Wells of this type should not be purged at the end of one day and sampled the following day.

3.1.2 Equipment Considerations for Purging

Monitoring well purging is preferably accomplished by using in-place plumbing and dedicated pumps or by using portable pumps/equipment when dedicated systems are not present. The equipment utilized by Branch personnel will usually consist of peristaltic pumps and variable speed electric submersible pumps, but may also include bladder pumps or inertial pumps. The pump of choice is usually a function of the well diameter, the depth to water, the depth of the well and the amount of water that is to be removed during purging. Whenever the head difference between the sampling location and the water level is less than the limit of suction and the volume to be removed is reasonably small, a peristaltic pump should be used for purging. For wells where the water level is below the limit of suction and/or there is a large volume of water to be purged, the variable speed electric submersible pump would be the pump of choice. SESD Operating Procedure for Pump Operation (SESDPROC-203) contains the use and operating instructions for all pumps commonly used during SESD ground water investigations.

Bailers may also be used for purging in appropriate situations, however, their use is discouraged. Bailers tend to disturb any sediment that may be present in the well, creating or increasing sample turbidity. If a bailer is used, it should be a closed-top Teflon® bailer.

3.2 Wells Without Plumbing or In-Place Pumps

For permanent monitoring wells, the depth to water (water level) and depth of the well (total depth) should be determined before purging. Caution should be exercised during this procedure to prevent cross-contamination between wells. This is a critical concern when samples for trace organic compounds or metals analyses are collected. See SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205**)** for cleaning procedures for well sounders. After cleaning, the well sounding device should be protected to keep it clean until its next use.

3.2.1 Purging with Pumps

3.2.1.1 Peristaltic Pumps

The following step-by-step procedures describe the process of purging with a peristaltic pump:

1. Cut a length of standard-cleaned (SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC (SESDPROC-206) Teflon® tubing, equal to the well depth plus an additional five to ten feet. Enough tubing is needed to run from the ground surface up to the top of the well casing and back down to the bottom of the well. This will allow for operation of the pump at all possible water level conditions in the well.

2. Place one end of the tubing into the vacuum side of the peristaltic pump head. Proper sizing of the Teflon® and Silastic® or Tygon® tubing should allow for a snug fit of the Teflon® tubing inside the flexible tubing mounted in the pump head.

3. Run a short section of tubing (does not have to be Teflon®) from the discharge side of the pump head to a graduated bucket.

4. Place the free end of the Teflon® tubing into the well until the end of the tubing is just below the surface of the water column.

5. Secure the Teflon® tubing to the well casing or other secure object using electrician's tape or other suitable means. This will prevent the tubing from being lost in the well should the tubing detach from the pump head.

6. Turn on the pump to produce a vacuum on the well side of the pump head and begin the purge. Observe pump direction to ensure that a vacuum is being applied to the purge line. If the purge line is being pressurized, either switch the tubing at the pump head or reverse the polarity of the cables on the pump or on the battery.

7. If the pumping rate exceeds the recovery rate of the well, continue to lower the tubing into the well, as needed, until the drawdown stabilizes or the well is evacuated to dryness. If the pump is a variable speed peristaltic pump, and the water level in the well is being drawn down, reduce the speed of the pump in an attempt to stabilize the drawdown. If the well can be purged without evacuating the well to dryness, a sample with greater integrity can be obtained.

8. For wells which are not evacuated to dryness, particularly those with recovery rates equal to or very nearly equal to the purge rate, there may not be a complete exchange and removal of stagnant water in that portion of the water column above the tubing intake. For this reason, it is important that the tubing intake be placed in the very uppermost portion of the water column while purging. Standard field measurements should frequently be taken during this process to verify adequacy of the purge and readiness for sampling, as described in Section 3.

3.2.1.2 Submersible Pumps

When a submersible pump is used for well purging, the pump itself is lowered into the water column. The pump must be cleaned as specified in SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205).

The pump/hose assembly used in purging should be lowered into the top of the standing water column and not deep into the column. This is done so that the purging will "pull" water from the formation into the screened area of the well and up through the casing so that the entire static volume can be removed. If the pump is placed deep into the water column, the water above the pump may not be removed, and the subsequent samples, particularly if collected with a bailer, may not be representative of the aquifer conditions. It is recommended that no more than three to five feet of hose be lowered into the water column. If the recovery rate of the well is faster than the pump rate and no observable draw down occurs, the pump should be raised until the intake is within one foot of the top of the water column for the duration of purging. If the pump rate exceeds the recovery rate of the well, the pump will have to be lowered, as needed, to accommodate the drawdown. After the pump is removed from the well, the hose and the pump should be cleaned as outlined in SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205).

3.2.2 Purging With Bailers

Standard-cleaned (SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205) or SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC (SESDPROC-206) closed-top Teflon® bailers with Teflon® coated stainless steel leaders and new nylon rope are lowered into the top of the water column, allowed to fill, and removed. It is critical that bailers be slowly and gently immersed into the top of the water column, particularly during final stages of purging, to minimize turbidity and disturbance of volatile organic constituents. The use of bailers for purging and sampling is discouraged because the correct technique is highly operator dependent and improper use may result in an unrepresentative sample.

3.2.3 Field Care of Purging Equipment

New plastic sheeting should be placed on the ground surface around the well casing to prevent contamination of the pumps, hoses, ropes, etc., in the event they accidentally come into contact with the ground surface or, for some reason, they need to be placed on the ground during the purging event. It is preferable that hoses used in purging that come into contact with the ground water be kept on a spool or contained in a large wash tub lined with plastic sheeting, both during transportation and during field use, to further minimize contamination by the transporting vehicle or the ground surface.

Careful consideration shall be given to using submersible pumps to purge wells which are excessively contaminated with oily compounds, because it may be difficult to adequately decontaminate severely contaminated pumps under field conditions. When wells of this type are encountered, alternative purging methods, such as bailers, should be considered.

3.2.4 General Low Flow/Low Stress Method Preference

The device with the lowest pump or water removal rate and the least tendency to stress the well during purging should be selected for use. For example, if a bailer and a peristaltic pump both work in a given situation, the pump should be selected because it will greatly minimize turbidity, providing a higher quality sample (Sec.

3.4.2, Purging When Water Level Is Within Limit of Suction**,** contains a description of low flow purging and sampling with a peristaltic pump used in a temporary well).

3.2.5 Low Flow/Low Volume Purging Techniques/Procedures

An alternative to the low flow/low stress purging method is the low flow/low volume method, commonly referred to as the "micro-purge" method. The low flow/low volume purging method is a procedure developed and used to minimize purge water volumes. The pump intake is placed within the screened interval at the zone of sampling, preferably, the zone with the highest flow rate. Low flow rate purging is conducted after hydraulic conditions within the well have re-stabilized, usually within 24 to 48 hours. Flow rates should not exceed the recharge rate of the aquifer. This is monitored by measuring the top of the water column with a properly cleaned water level indicator or similar device while pumping. This method is not considered to be a standard method by the Branch and is only acceptable under certain hydraulic conditions. It's use must be evaluated on a case-by-case basis.

3.3 Wells With In-Place Plumbing

Wells with in-place plumbing are commonly found at municipal water treatment plants, industrial water supplies, private residences, etc. Many permanent monitoring wells at active facilities are also equipped with dedicated, in-place pumps. The objective of purging wells with in-place pumps is the same as with monitoring wells without in-place pumps, i.e., to ultimately collect a ground water sample representative of aquifer conditions. Among the types of wells identified in this section, two different approaches are necessary.

A permanent monitoring well with an in-place pump should, in all respects, be treated like a monitoring well without a pump. One limitation is that in most cases the in-place pump is "hard" mounted, that is, the pump is suspended in the well at a pre-selected depth and cannot be moved up or down during purging and sampling. In these cases, well volumes are calculated, parameters are measured and the well is sampled from the pump discharge, after volume removal and parameter conditions have been met.

In the case of the other types of wells, i.e., municipal, industrial and residential supply wells, however, not enough is generally known about the construction aspects of the wells to apply the same criteria as used for monitoring wells, i.e., 3 to 5 well volumes. The volume to be purged in these situations, therefore, depends on several factors: whether the pumps are running continuously or intermittently and whether or not any storage/pressure tanks are located between the sampling point and the pump. The following considerations and procedures should be followed when purging wells with in-place plumbing under the conditions described.

3.3.1 Continuously Running Pumps

If the pump runs more or less continuously, no purge (other than opening a valve and allowing it to flush for a few minutes) is necessary. If a storage tank is present, a spigot, valve or other sampling point should be located between the pump and the storage tank. If not, locate the valve closest to the tank. Measurements of pH, specific conductance, temperature, and turbidity are recorded at the time of sampling.

3.3.2 Intermittently or Infrequently Running Pumps

If the pump runs intermittently or infrequently, best judgment should be utilized to remove enough water from the plumbing to flush standing water from the piping and any storage tanks that might be present. Generally, under these conditions, 15 to 30 minutes will be adequate. Measurements of pH, specific conductance, temperature and turbidity should be made and recorded at intervals during the purge and the final measurements made at the time of sampling should be considered the measurements of record for the event.

3.4 Temporary Monitoring Wells

3.4.1 General Considerations

Procedures used to purge temporary ground water monitoring wells differ from permanent wells because temporary wells are installed for immediate sample acquisition. Wells of this type may include standard well screen and riser placed in boreholes created by hand augering, power augering, or by drilling. They may also consist of a rigid rod and screen that is pushed, driven, or hammered into place to the desired sampling interval, such as a direct push Wellpoint®, a Geoprobe® Screen Point 15 sampler or a Hydropunch® sampler. As such, the efforts to remove several volumes of water to replace stagnant water do not necessarily apply because stagnant water is not present. It is important to note, however, that the longer a temporary well is in place and not sampled, the more stagnant the water column becomes and the more appropriate it becomes to apply, to the extent possible, standard permanent monitoring well purging criteria to it to re-achieve aquifer conditions.

In cases where the temporary well is to be sampled immediately after installation, purging is conducted primarily to mitigate the impacts of installation. In most cases, temporary well installation procedures disturb the existing aquifer conditions, resulting primarily in increased turbidity. Therefore, the goal of purging is to reduce the turbidity and remove the volume of water in the area directly impacted by the installation procedure. Low turbidity conditions in these types of wells that are completed within the limit of suction are typically and routinely achieved by the use of low-flow/low stress purging techniques using variable speed peristaltic pumps.

3.4.2 Purging When Water Level Is Within Limit of Suction

In situations where the elevation of the top of the water column is within the limit of suction (no greater than about 25 feet head difference between the pump and the water level), a variable speed peristaltic pump may be used to purge temporary wells. Enough tubing is deployed to reach the bottom of the temporary well screen. At the onset of purging, the tubing is slowly lowered to the bottom of the screen and is used to remove any formation material which may have entered the well screen during installation. This is critical to ensuring rapid achievement of low turbidity conditions. After the formation material is removed from the bottom of the screen, the tubing is slowly raised through the water column to near the top of the column. The tubing can be held at this level to determine if the pump rate is drawing down the water level in the well. If the water level remains the same, secure the tubing at the surface to maintain this pumping level.

If drawdown is observed on initiation of pumping, reduce the pump speed and attempt to match the drawdown of the well. Sustained pumping at these slow rates will usually result in a relatively clear, low turbidity sample. If the drawdown stabilizes, maintain that level, however, if it continues to lower, "chase" the water column until the well is evacuated. In this case, the recovered water column may be relatively free of turbidity and can be sampled. It may take several episodes of recovery to provide enough volume for a complete sample.

3.4.3 Purging When Water Level Is Greater Than Limit of Suction

In situations where the elevation of the water table is greater than the limit of suction, peristaltic pumps cannot be used to purge temporary wells. If the temporary well is a ScreenPoint15® sampler with small diameter probe rod riser, the only practical choices for water removal are a small diameter bailer, a small diameter bladder pump or an inertial pump. If the well is to be used strictly for VOC screening, it may be acceptable to use the bailer to bail as much sediment from the well as possible prior to sampling. If metals are the analytes of concern, the bladder pump is the best choice for lowering the turbidity of the water column prior to sampling, followed next by the inertial pump. For larger diameter temporary wells, two-inch diameter or greater, bailers and the Grundfos® RediFlo2 may be used although excessive silt or other "fines" may present problems with the operation of the pump.

3.4.4 Considerations for Direct Push Groundwater Sampling

With many of the direct push sampling techniques, purging is either not practical or possible, therefore, no purging is conducted. The sampling device is simply pushed or driven to the desired depth and opened and the sample is collected and retrieved. As a result, some samples collected in this way may not be satisfactory or acceptable for certain analyses, i.e., the subject procedure may yield a turbid sample that is not appropriate for metals analyses.

3.5 Investigation Derived Waste

Purging generates quantities of purge water or investigation derived waste (IDW), the disposition of which must be considered. See SESD Operating Procedure for Management of Investigation Derived Waste (SESDPROC-202) for guidance on management or disposal of this waste.

4 Groundwater Sampling Methods – Sampling

4.1 General

Sampling is the process of obtaining, containerizing, and preserving (if required) a ground water sample after the purging process is complete. Non-dedicated pumps for sample collection generally should not be used. Many pumps are made of materials such as brass, plastic, rubber, or other elastomer products which may cause chemical interferences with the sample. Their principle of operation may also render them unacceptable as a sample collection device. It is recognized that there are situations, such as industrial or municipal supply wells or private residential wells, where a well may be equipped with a dedicated pump from which a sample would not normally be collected. Discretion should always be used in obtaining a sample.

4.2 Sampling Wells With In-Place Plumbing

Samples should be collected following purging from a valve or cold water tap as near to the well as possible, preferably prior to any storage/pressure tanks or physical/chemical treatment system that might be present. Remove any hose that may be present before sample collection and reduce the flow to a low level to minimize sample disturbance, particularly with respect to volatile organic constituents. Samples should be collected directly into the appropriate containers as specified in the ASBLOQAM. It may be necessary to use a secondary container, such as a clean 8 oz. or similar size sample jar or a stainless steel scoop, to obtain and transfer samples from spigots with low ground clearance. Also, refer to the discussion in the SESD Operating Procedure for Potable Water Supply Sampling (SESDPROC-305), Sec. 4.2, Potable Water Samples Collected from Wells with In-Place Plumbing**.** Potable well measurements for pH, specific conductance, temperature, and turbidity should be recorded at the time of sample collection.

4.3 Sampling Wells without Plumbing, Within the Limit of Suction

4.3.1 Equipment Available

The pump of choice for sampling ground water within the limit of suction is the variable-speed peristaltic pump. Its use is described in the following sections. Other acceptable alternatives that may be used under these conditions are the RediFlo2® electric submersible pump (with Teflon® tubing) and a closed-top Teflon® bailer

4.3.1.1 Peristaltic Pump, Direct from Pump Head Tubing

Samples for some constituents, primarily inorganic analytes such as metals and cyanide, may be collected directly from the pump head tubing. This method is acceptable under the following conditions:

- The pump head tubing must be changed between sampling locations;
- The pump head tubing must be either be certified clean according to SESD's internal quality control program described in Section 3.2 of the SESD Operating Procedure for Field Sampling Quality Control (SESDPROC-011) or
- An equipment rinsate blank is collected by pumping de-ionized water through a piece of the tubing.

4.3.1.2 Peristaltic pump/vacuum jug

It is not acceptable to collect samples for organic compounds analyses through the flexible tubing used in the pump head. When collecting samples for organic compound analyses it is necessary to use a vacuum container, placed between the pump and the well for sample collection. The following step-by-step procedures describe the process of sampling with a peristaltic pump and vacuum jug (see note following these procedures for collection of VOC samples):

1. Disconnect the purge tubing from the pump. Make sure the tubing is securely attached to the protective casing or other secure object.

2. Insert the tubing into one of the ferrule nut fittings of a Teflon® vacuum container transfer cap assembly.

3. Place a suitable length of Teflon® tubing between the remaining transfer cap assembly ferrule nut fitting and the vacuum side of the flexible tubing in the peristaltic pump head. Securely hand-tighten both fittings.

4. Turn the pump on. Water should begin to collect in the transfer container (typically a 1-liter sample container) within a few minutes. If water does not begin to flow into the container within several minutes, check the transfer cap fittings and make sure the assembly is tightly attached to the container. It may be necessary to tighten the ferrule nuts with a wrench or pliers to achieve a vacuum in the system, particularly when approaching the maximum head difference between the pump and water table (limit of suction).

5. When the transfer container is nearly full, turn off the pump, remove the transfer cap assembly, and pour the sample into the appropriate containers. Because the 1-liter containers used by the Branch are rinsed with nitric acid during cleaning, they cannot be used for collecting samples to be analyzed for nitrogen sensitive parameters.

6. If additional sample volume is needed, replace the transfer cap assembly, turn the pump on, and collect additional volume. The use of Teflon® valves or ball check devices to retain the water column in the sample delivery tubing during the transfer phase, when large volumes of sample are required, is acceptable. These devices, however, must be constructed so that they may be completely disassembled and cleaned according to the procedures in SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205).

7. When sampling is completed, all Teflon® tubing should be discarded.

   NOTE: Samples for volatile organic compound analyses cannot be collected using this method. If samples for VOC analyses are required, they must be collected with a Teflon® or stainless steel bailer or by other approved methods, such as the “soda straw” method. The “soda straw” method involves allowing the tubing to fill, by either lowering it into the water column (A) or by filling it via suction applied by the pump head (B). If method (A) is used, the tubing is removed from the well after filling and the captured sample is allowed to drain into the sample vial. If method (B) is used, after running the pump and filling the tubing with sample, the pump speed is reduced and the direction reversed to push the sample out of the tubing into the vials. Avoid completely emptying the tubing when filling the sample vials when using method (B) to prevent introducing water that was in contact with the flexible pump head tubing. Either method is repeated, as necessary, until all vials are filled.

4.3.1.3 RediFlo2® Electric Submersible Pump (with Teflon® tubing)

After purging has been accomplished with RediFlo2® electric submersible pump, the sample may be obtained directly from the pump discharge, provided that Teflon® tubing was used for the sample delivery line. The discharge rate of the pump should be reduced during volatile organic compound sample collection to minimize sample disturbance. Note, if the RediFlo2® electric submersible pump is used for sampling, the water in the cooling chamber must be replaced with organic-free water between each well and the pump must undergo a full external and internal cleaning. In addition, pump rinsate blanks must be collected, at the appropriate frequency, to demonstrate that the pump has been adequately cleaned between wells.

4.3.1.4 Bailers

New bailer rope should be attached to the bailer via a Teflon® coated stainless steel wire. (If a bailer was used to purge the well, it may also be used to sample the well and new bailer rope is not required between purging and sampling). The bailer should be gently immersed in the top of the water column until just filled. At this point, the bailer should be slowly removed and the contents emptied into the appropriate sample containers.

4.4 Sampling Wells without Plumbing, Exceeding the Limit of Suction

All methods described previously in Section 4.3.2.1.3, RediFlo2® Electric Submersible Pumps, and Section 4.3.2.1.4, Bailers, are suitable sample methods where the water table is too deep to consider the use of a peristaltic pump for sampling.

4.5 Sample Preservation

After sample collection, all samples requiring preservation must be preserved as soon as practical. Consult the ASBLOQAM for the correct preservative for the particular analytes of interest. All samples preserved using a pH adjustment (except VOCs) must be checked, using pH strips, to ensure that they were adequately preserved. This is done by pouring a small volume of sample over the strip. Do not place the strip in the sample. Samples requiring reduced temperature storage should be placed on ice immediately.

4.6 Special Sample Collection Procedures

4.6.1 Trace Organic Compounds and Metals

Special sample handling procedures should be instituted when trace contaminant samples are being collected. All sampling equipment, including pumps, bailers, water level measurement equipment, etc., which comes into contact with the water in the well must be cleaned in accordance with the cleaning procedures described in the SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205 or SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC (SESDPROC-206). Pumps should not be used for sampling unless the interior and exterior portions of the pump and the discharge hoses are thoroughly cleaned. Blank samples should be collected to determine the adequacy of cleaning prior to collection of any sample using a pump other than a peristaltic pump.

4.6.2 Order of Sampling with Respect to Analytes

In many situations when sampling permanent or temporary monitoring wells, an adequate purge, with respect to turbidity, is often difficult to achieve. Removal and insertion of equipment after the purge and prior to actual sampling may negate the low turbidities achieved during purging and elevate turbidity back to unacceptable levels. For this reason, it is important that special efforts be used to minimize any disturbance of the water column after purging and to collect the aliquot for metals first. Therefore, the preferred order of sampling is metals first, followed by other inorganic analytes, extractable organic compounds and volatile organic compounds.

4.6.3 Filtering

As a standard practice, ground water samples will not be filtered for routine analysis. Filtering will usually only be performed to determine the fraction of major ions and trace metals passing the filter and used for flow system analysis and for the purpose of geochemical speciation modeling. Filtration is not allowed to correct for improperly designed or constructed monitoring wells, inappropriate sampling methods, or poor sampling technique.

When samples are collected for routine analyses and are filtered, both filtered and non-filtered samples will be submitted for analyses. Samples for organic compounds analysis should not be filtered. Prior to filtration of the ground water sample for any reason other than geochemical speciation modeling, the following criteria must be demonstrated to justify the use of filtered samples for inorganic analysis:

1. The monitoring wells, whether temporary or permanent, have been constructed and developed in accordance with the SESD Guidance Document, Design and Installation of Monitoring Wells (SESDGUID-001).

2. The ground water samples were collected using sampling techniques in accordance with this section, and the ground water samples were analyzed in accordance with USEPA approved methods.

3. Efforts have been undertaken to minimize any persistent sample turbidity problems. These efforts may consist of the following:

- Redevelopment or re-installation of permanent ground water monitoring wells.
- Implementation of low flow/low stress purging and sampling techniques.

4. Turbidity measurements should be taken during purging and sampling to demonstrate stabilization or lack thereof. These measurements should be documented in the field notes. If the ground water sample appears to have either a chemically-induced elevated turbidity, such as would occur with precipitate formation, or a naturally elevated colloid or fine, particulate-related turbidity, filtration will not be allowed.

If filtration is necessary for purposes of geochemical modeling or other **pre-approved** cases, the following procedures are suggested:

1. Accomplish in-line filtration through the use of disposable, high capacity filter cartridges (barrel-type) or membrane filters in an in-line filter apparatus. The high capacity, barrel-type filter is preferred due to the higher surface area associated with this configuration. If a membrane filter is utilized, a minimum diameter of 142 mm is suggested.

2. Use a 5 µm pore-size filter for the purpose of determining the colloidal constituent concentrations. A 0.1 µm pore-size filter should be used to remove most non-dissolved particles.

3. Rinse the cartridge or barrel-type filter with 500 milliliters of the solute (ground water to be sampled) prior to collection of sample. If a membrane filter is used, rinse with 100 milliliters of solute prior to sample collection.

Potential differences could result from variations in filtration procedures used to process water samples for the determination of trace element concentrations. A number of factors associated with filtration can substantially alter "dissolved" trace element concentrations; these include filter pore size, filter type, filter diameter, filtration method, volume of sample processed, suspended sediment concentration, suspended sediment grain-size distribution, concentration of colloids and colloidally-associated trace elements, and concentration of organic matter. Therefore, consistency is critical in the comparison of short-term and long-term results. Further guidance on filtration may be obtained from the following: 1) Metals in Ground Water: Sampling Artifacts and Reproducibility; 2) Filtration of Ground Water Samples for Metals Analysis; and 3) Ground Water Sampling - A Workshop Summary. See Section 1.4, References, for complete citation for these documents.

Bacterial Sampling

Whenever wells (normally potable wells) are sampled for bacteriological parameters, care must be taken to ensure the sterility of all sampling equipment and all other equipment entering the well. Further information regarding bacteriological sampling is available in the following: 1) Sampling for Organic Chemicals and Microorganisms in the Subsurface; 2) Handbook for Evaluating Water Bacteriological Laboratories; and 3) Microbiological Methods for Monitoring the Environment, Water and Wastes. See Section 1.4, References, for complete citation for these documents.

4.7 Specific Sampling Equipment Quality Assurance Techniques

All equipment used to collect ground water samples shall be cleaned as outlined in the SESD Operating Procedure for Field Equipment Cleaning and Decontamination

(SESDPROC-205) or SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC (SESDPROC-206) and repaired, if necessary, before being stored at the conclusion of field studies. Cleaning procedures utilized in the field or field repairs shall be thoroughly documented in field records.

4.8 Auxiliary Data Collection

During ground water sample collection, it is important to record a variety of ground water related data. Included in the category of auxiliary data are water levels measured according to the SESD Operating Procedure for Groundwater Level and Well Depth Measurement (SESDPROC-105), well volume determinations (Section 3.1.1, Purging and Purge Adequacy), pumping rates during purging (see below), and occasionally, drillers or boring logs. This information should be documented in the field records.

4.8.1 Well Pumping Rate - Bucket/Stop Watch Method

The pumping rate for a pump can be determined by collecting the discharge from the pump in a bucket of known volume and timing how long it takes to fill the bucket. The pumping rate should be in gallons per minute. This method shall be used primarily with pumps with a constant pump rate, such as gasoline-powered or electric submersible pumps. Care should be taken when using this method with some battery-powered pumps. As the batteries' charge decreases, the pump rate also decreases so that pumping rate calculations using initial, high pump rates may be erroneously high. If this method is used with battery-powered pumps, the rate should be re-checked frequently to ensure accuracy of the pumping rate calculations.

GROUNDWATER SAMPLE COLLECTION

Rev. #: 1

Rev Date: 7/8/11

Standard Operating Procedure: Groundwater Sample Collection

I. Introduction

Groundwater samples will be collected using the low-flow (minimal drawdown) technique (Puls and Barcelona 1996) for newly installed monitoring wells. The use of low-flow purging and sampling will minimize the stresses (pressure gradients, drawdown, heating, and turbulence) associated with more conventional purging techniques, reduce mixing of stagnant casing water with formation water, and facilitate the direct withdrawal of groundwater from the formation surrounding the well screen.

No monitoring wells will be sampled until well development has been performed, and sampling will be conducted no sooner than 24 hours following well development. Any synoptic water level measurement events will be completed under static groundwater conditions, prior to the initiation of purging and sampling activities. When one round of water levels is taken to generate water elevation data, the water levels will be taken prior to sampling or other activities.

II. Materials

The following materials, as required, shall be available during groundwater sampling:

- Peristaltic or bladder pump for purging and sampling;
- Sample tubing;
- Power source (i.e., generator);
- Photoionization detector (PID);
- Appropriate health and safety equipment as specified in the Health and Safety Plan (HASP);
- Plastic sheeting (for each sampling location);
- Five-gallon buckets for temporary containment of purge water;
- Dedicated or disposable bailers;
- Field filters (if necessary);
- New disposable polypropylene rope;
- Clear glass or plastic measuring cup graduated in milliliters;
- Buckets to measure purge water;
- Water level probe;

- Portable electronic meter(s) capable of measuring pH, conductivity, temperature, dissolved oxygen (DO), oxidation-reduction potential (ORP), salinity, and/or turbidity;
- Flow-through cell to be used in the measurement of field parameters;
- Appropriate water sample containers;
- Appropriate blanks (trip blank supplied by the laboratory);
- Appropriate transport containers (coolers) with ice and appropriate labeling, packing, and shipping materials;
- Groundwater sampling logs;
- Chain-of-custody forms;
- Indelible ink pens;
- Site map with well locations and groundwater contours maps; and
- Keys to wells.

III. Procedures

Monitoring well sampling procedures are as follows:

A. Ensure the appropriate equipment has been acquired.

B. Use safety equipment, as required in the HASP.

C. Prior to sampling any monitoring well, collect depth-to-water and PID headspace screening measurements from all Site monitoring wells as follows:

   1. Measure and record the background PID reading.

   2. Unlock and open the well cover while standing upwind of the well.

   3. Remove and replace rusted or broken well caps and locks as necessary.

   4. Obtain and record depth-to-water and total well depth measurements using an electronic water level indicator (sounder); depths will be measured and recorded to the nearest 0.01 foot.

   5. Clean the water level indicator after each use.

D. Determine a well sampling order, generally from historically least to historically most impacted, or if the wells are being sampled for the first time, use or distance from the source area to gauge the relative levels of impact at the various monitoring wells.

E. Begin purging and sampling activities. Identify the site and well being sampled in the field log, along with date, arrival time, and weather conditions. Identify the personnel and equipment utilized and other pertinent data.

F. Place the plastic sheeting adjacent to the well to use as a clean work area.

G. Set out on plastic sheeting the decontaminated and/or disposable sampling device and meters.

H. Label all sample containers with the following information (at a minimum):

   1. Site name;

   2. Sample location / ID;

   3. Date and time of sampling;

   4. Analyses requested;

   5. Type of preservative (if any); and

   6. Initials of sampling personnel.

I. Pump, safety cable, and tubing will be lowered slowly into the monitoring well to a depth corresponding to the center of the saturated screen section of the well. Any internal combustion power sources should be placed downwind of the monitoring well at a distance sufficient to prevent the migration of engine exhaust into the sampling area.

   Measure the water level again with the pump in the monitoring well before starting the pump. Start pumping the well at 200 to 500 milliliters per minute. Ideally, the pump rate should cause little or no water level drawdown in the well. Although a maximum acceptable drawdown of 0.3 foot is commonly used, the acceptable level of drawdown will be determined in the field on a Site-specific and well-specific basis. In general, for wells screened below the water table, drawdown will be acceptable as long as the water level can be stabilized at a constant pumping rate, at a level above the top of the well screen. For wells screened across the water table, drawdown will be acceptable if the water level can be stabilized at a constant pumping rate, at a level above the intake of the pump. The water level should be monitored every 3 to 5 minutes (or as appropriate) during pumping. Care should be taken not to cause pump suction to be broken or entrainment of air in the sample. Record pumping rate adjustments and depths to water. Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to minimize drawdown.

If minimal draw down cannot be maintained, water should be purged from the well at the minimum sustainable pumping rate. If the indicator parameters do not stabilize before the water level reaches the pump intake, then purging should be interrupted and the water level allowed to recover before groundwater samples are collected.

J. During monitoring well purging, monitor the field indicator parameters (turbidity, temperature, specific conductance, pH, DO, and ORP every 3 to 5 minutes (or as appropriate) using a portable electronic meter(s). The well is considered stabilized and ready for sample collection as soon as the indicator parameters meeting the following criteria for three consecutive readings (taken over a minimum period of 15 minutes):

1. pH measurements remain stable within 0.1 standard unit;

2. Specific conductivity varies by no more than 3 percent;

3. ORP remains stable within 10 millivolts;

4. DO varies no more than 10 percent; and

5. A constant non-turbid discharge (<10 nephelometric turbidity units) is achieved, or turbidity over three consecutive readings varies no more than 10 percent.

Measurements for DO and ORP must be obtained using a flow-through cell; however, other parameters may be taken in a clean container such as a glass beaker if individual meters are being used to obtain the field parameter measurements.

K. When conventional volumetric purging is used, an attempt should be made to purge at least three but no greater than five well volumes of water prior to sampling. Monitoring of field parameters should be conducted at a frequency of at least one measurement per well volume. If three well volumes cannot be removed before the water level reaches the pump intake, then the purging should be interrupted and the well water level allowed to recover (at least 75 percent) prior to sample collection. Sampling should be conducted as soon as possible (no longer than 24 hours) after cessation of purging.

L. After purging has been completed, obtain the groundwater sample needed for analysis directly from the sampling device in the appropriate container and tightly screw on the caps. If samples are to be field-filtered, connect field-filter sampling device. Allow approximately three sample volumes to flow through the filter before collecting the groundwater sample.

M. Make sure that all samples are labeled as indicated in the Field Sampling Plan. Secure the samples with packing material and store at 4 degrees Celsius on wet ice in an insulated transport container provided by the laboratory.

N. After all sampling containers have been filled, collect an additional, post-sampling set of field parameter measurements, and record these measurements along with the color, appearance, and odor of the sample on the field log.

O. Record the time sampling procedures were completed on the field logs.

P. Place all disposable sampling materials (plastic sheeting, disposable bailers, and health and safety equipment) in appropriately labeled containers. Go to the next well and repeat Step E through Step P until all wells are sampled.

Q. Complete the procedures for packaging, shipping, and handling with associated chain-of-custody forms.

IV. References

Puls, R.W., and M.J. Barcelona. 1996. Low-Flow (Minimal Drawdown) Ground-water Sampling Procedures, EPA/540/S-95/504.

Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

GUIDANCE

Title: **Design and Installation of Monitoring Wells**

Effective Date: February 18, 2008 **Number:** SESDGUID-101-R0

Authors

Name: Brian Striggow
Title: Environmental Engineer
Signature: Date: 2-13-08

Approvals

Name: Antonio Quinones
Title: Chief, Enforcement and Investigations Branch
Signature: Date: 2/13/08

Name: Laura Ackerman
Title: Field Quality Manager, Science and Ecosystem Support Division
Signature: Laura Ackerm Date: 02|13|08

Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Document Control Coordinator.

History	Effective Date
SESDGUID-101-R0, *Design and Installation of Monitoring Wells*, Original Issue	February 18, 2008

TABLE OF CONTENTS

1 General Information

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed when designing and installing permanent and temporary groundwater monitoring wells to be used for collection of groundwater samples.

1.2 Scope/Application

The procedures contained in this document are to be used by field personnel when designing, constructing and installing groundwater monitoring wells. On the occasion that SESD field personnel determine that any of the procedures described in this section are either inappropriate, inadequate or impractical and that another procedure must be used for any aspect of the design, construction and/or installation of a groundwater monitoring well, the variant procedure will be documented in the field log book, along with a description of the circumstances requiring it's use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and has been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the H: drive of the SESD local area network. The Document Control Coordinator is responsible for ensuring the most recent version of the procedure is placed on the H: drive and for maintaining records of review conducted prior to its issuance.

1.4 References

USEPA Region 4 Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), November 2001

USEPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Science and Ecosystem Support Division, Region 4, Athens, GA.

SESD Operating Procedure for Field Sampling Quality Control, SESDPROC-011-Most Recent Version

SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205- Most Recent Version

SESD Operating Procedure for Field Records and Documentation, SESDPROC-204-Most Recent Version

SESD Operating Procedure for Groundwater Sampling, SESDPROC-301- Most Recent Version

SESD Operating Procedure for Management of Investigation Derived Waste, SESDPROC-202- Most Recent Version

EPA/540/S-95/503, *Nonaqueous Phase Liquids Compatibility with Materials Used in Well Construction, Sampling, and Remediation*

ASTM standard D5092, *Design and Installation of Ground Water Monitoring Wells in Aquifers*

1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when constructing and installing groundwater monitoring wells. Refer to the SESD Safety, Health and Environmental Management Program Procedures and Policy (SHEMP) Manual and any pertinent site-specific Health and Safety Plans (HASPs) for guidelines on safety precautions. These guidelines should be used to complement the judgment of an experienced professional. When using this procedure, minimize exposure to potential health hazards through the use of protective clothing, eye wear and gloves. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate. Section 2.6, Safety Procedures for Drilling Activities, contains detailed and specific safety guidelines that must be followed by Branch personnel when conducting activities related to monitoring well construction and installation.

1.5.2 Procedural Precautions

The following precautions should be considered when constructing and installing groundwater monitoring wells.

- Special care must be taken to minimize or prevent inadvertent cross-contamination between borehole locations. Equipment, tools and well materials must be cleaned and/or decontaminated according to procedures found in SESD Operating Procedure for Field Equipment Cleaning and Decontamination, (SESDPROC-205).
- All field activities are documented in a bound logbook according to the procedures found in SESD Operating Procedure for Field Records and Documentation, (SESDPROC-204).

2 Permanent Monitoring Well Design Considerations

2.1 General

The design and installation of permanent monitoring wells involves drilling into various types of geologic formations that exhibit varying subsurface conditions. Designing and installing permanent monitoring wells in these geologic environments may require several different drilling methods and installation procedures. The selection of drilling methods and installation procedures should be based on field data collected during a hydrogeologic site investigation and/or a search of existing data. Each permanent monitoring well should be designed and installed to function properly throughout the duration of the monitoring program. When designing monitoring wells, the following should be considered:

- Short-and long-term objectives;
- Purpose of the well(s);
- Probable duration of the monitoring program;
- Contaminants likely to be monitored;
- Surface and subsurface geologic conditions;
- Properties of the aquifer(s) to be monitored;
- Well screen placement;
- General site conditions; and
- Potential site health and safety hazards.

In designing permanent monitoring wells, the most reliable, obtainable data should be utilized. Once the data have been assembled and the well design(s) completed, a drilling method(s) must be selected. The preferred drilling methods for installing monitoring wells are those that temporarily case the borehole during drilling and the construction of the well, e.g. hollow-stem augers and sonic methods. However, site conditions or project criteria may not allow using these methods. When this occurs, alternate methods should be selected that will achieve the project objectives. The following discussion of methods and procedures for designing and installing monitoring wells will cover the different aspects of selecting materials and methods, drilling boreholes, and installing monitoring devices.

2.2 Drilling Methods

The following drilling methods may be used to install environmental monitoring wells or collect samples under various subsurface conditions. In all cases the preferred methods are those that case the hole during drilling, i.e. Hollow Stem Augers (HSA) and sonic methods using an override system. Other methods may be used where specific subsurface or project criteria dictate.

2.2.1 Hollow Stem Auger (HSA)

This type of auger consists of a hollow, steel stem or shaft with a continuous, spiraled steel flight, welded onto the exterior. A hollow auger bit, generally with carbide teeth, disturbs soil material when rotated, whereupon the spiral flights transport the cuttings to the surface. This method is best suited in soils that have a tendency to collapse when disturbed. A monitoring well can be installed inside of hollow-stem augers with little or no concern for the caving potential of the soils. If caving sands exist during monitoring well installations, a drilling rig must be used that has enough power to extract the augers from the borehole without having to rotate them. A bottom plug, trap door, or pilot bit assembly can be used at the bottom of the augers to keep out most of the soils and/or water that have a tendency to enter the bottom of the augers during drilling. Potable water (analyzed for contaminants of concern) may be poured into the augers during drilling to equalize pressure so that the inflow of formation materials will be held to a minimum. Water-tight center bits are not acceptable because they create suction when extracted from the augers. This suction forces or pulls cuttings and formation materials into the augers, defeating the purpose of the center plug. Augering without a center plug or pilot bit assembly is permitted, provided that the soil plug, formed in the bottom of the augers, is removed before sampling or installing well casings. Removing the soil plug from the augers can be accomplished by drilling and washing out the plug using a rotary bit, or augering out the plug with a solid-stem auger bit sized to fit inside the hollow-stem auger. Bottom plugs can be used where no soil sampling is conducted during the drilling process. The bottom plug is wedged into the bottom of the auger bit and is knocked out at depth with drill pipe or the weight of the casing and screen assembly. The plug material should be compatible with the screen and casing materials. The use of wood bottom plugs is not acceptable. The type of bottom plug, trap door, or pilot bit assembly proposed for the drilling activity should be approved by a senior field geologist prior to drilling operations. Boreholes can be augered to depths of 150 feet or more (depending on the auger size), but generally boreholes are augered to depths less than 100 feet.

2.2.2 Solid Stem Auger

This type of auger consists of a sealed hollow or solid stem or shaft with a continuous spiraled steel flight welded on the outside of the stem. An auger bit connected to the bottom disturbs soil material when rotated and the helical flights transport cuttings to the surface. At the desired depth the entire auger string is removed to gain access to the bottom of the borehole. This auger method is used in cohesive and semi-cohesive soils that do not have a tendency to collapse when disturbed. Boreholes can be augered to depths of 200 feet or more (depending on the auger size), but generally boreholes are augered to depths less than 100 feet.

Both of the previously discussed auger methods can be used in unconsolidated soils and semi-consolidated (weathered rock) soils, but not in competent rock.

Each method can be employed without introducing foreign materials into the borehole such as water and drilling fluids, minimizing the potential for cross contamination. Minimizing the risk of cross contamination is one of the most important factors to consider when selecting the appropriate drilling method(s) for a project.

2.2.3 Sonic Methods

These methods generally alternately advance concentric hollow drill stems using rotation in conjunction with axial vibration of the drill stem. After each stage of drill stem advancement, the inner string is removed with a core of drill cuttings while the outer ‘override’ string remains to hold the borehole open. The cuttings can be removed nearly intact from the inner casing for examination of the stratigraphy prior to sampling or disposal. Because there are no auger flights to increase the borehole diameter, the quantity of cuttings removed from the hole is minimized as compared to hollow stem augering. With moderate rotation, smearing of the formation materials on the borehole walls is reduced as well. This drilling method is useful in a variety of materials, from flowing sands to heavily consolidated or indurated formations.

In flowing sands, the drill casings can be filled and/or pressurized with potable water to prevent excess entry of formation materials into the drill string. The same QA/QC requirements for sampling of material introduced to the borehole apply as in other drilling methods. Because the amount of water introduced into the borehole can be significant, an approximation of the water used in the drilling process should be logged for use in estimating appropriate well development withdrawal.

Sonic drilling allows a larger diameter temporary casing to be set into a confining layer while drilling proceeds into deeper aquifers. This temporary casing is then removed during the grouting operation. In many cases this will be acceptable technique. However, the level of contamination in the upper aquifer, the importance of the lower aquifers for drinking water uses, the permeability and continuity of the confining layer, and state regulations should be taken into account when specifying this practice as opposed to permanent outer casing placed into the confining unit. Note that when using the temporary casing practice, it is critical that grout be mixed and placed properly as specified elsewhere in this section.

Because the total borehole diameter in sonic drilling is only incrementally larger than the inner casing diameter, particular care should be taken that the well casing is placed in the center of the drill stem while placing the filter pack. Centralizers should be used in most cases to facilitate centering, particularly in the case of deep wells with PVC casing.

2.2.4 Rotary Methods

These methods consist of a drill pipe or drill stem coupled to a drilling bit that rotates and cuts through the soils. The cuttings produced from the rotation of the drilling bit are transported to the surface by drilling fluids which generally consist of water, drilling mud, or air. The water, drilling mud, or air are forced down through the drill pipe, and out through the bottom of the drilling bit. The cuttings are then lifted to the surface between the borehole wall and the drill pipe, (or within a concentric drill stem in reverse rotary). Except in the case of air rotary, the drilling fluid provides a hydrostatic pressure that reduces or prevents borehole collapse. When considering this method, it is important to evaluate the potential for contamination when fluids and/or air are introduced into the borehole.

Due to the introduction of the various circulating fluids, the use of rotary methods requires that the potential for contamination by these fluids be evaluated. Water and mud rotary methods present the possibility of trace contamination of halogenated compounds when municipal water supplies are used as a potable water source. Air rotary drilling can introduce contamination through the use of lubricants or entrained material in the air stream. Unless contaminated formations are cased off, the circulation of drilling fluids presents a danger of cross contamination between formations. In any of the rotary (or sonic) methods, care must be exercised in the selection and use of compounds to prevent galling of drill stem threads.

2.2.4.1 Water Rotary

When using water rotary, potable water (that has been analyzed for contaminants of concern) should be used. If potable water (or a higher quality water) is not available on-site, then potable water will have to be transported to the site or an alternative drilling method will have to be selected. Water does not clog the formation materials, but the suspended drilling fines can be carried into the formation, resulting in a very difficult to develop well. This method is most appropriate for setting isolation casing.

2.2.4.2 Air Rotary

Air rotary drilling uses air as a drilling fluid to entrain cuttings and carry them to the surface. High air velocities, and consequently large air volumes and compressor horsepower are required. “Down-the-hole” (DTH) percussion hammers driven by the air stream can be used with this method to rapidly penetrate bedrock materials. Where a casing through unconsolidated material is required to prevent borehole collapse, it can be driven in conjunction with advancement of the drill stem.

When using air rotary drilling in any zone of potential contamination, the cuttings exiting the borehole must be controlled. This can be done using the dual-tube reverse circulation method where cuttings are carried to the surface inside dual-wall drill pipe and separated with a cyclone separator. An air diverter with hose or pipe carrying cuttings to a waste container is also an acceptable alternative. Allowing cuttings to blow uncontrolled from the borehole is not acceptable.

When using air rotary, the issue of contaminants being introduced into the borehole by the air stream must be addressed. Screw compressor systems should have a coalescing filter system in good working order to capture excess entrained compressor oils. The lubricant to be used with DTH hammers as well as thread lubricants to be used on drill stem should be evaluated for their potential impact on analytical samples.

2.2.4.3 Mud Rotary

Mud rotary is an undesirable drilling method because contamination can be introduced into the borehole from the constituents in the drilling mud, cross contamination can occur along the borehole column, and it is difficult to remove the drilling mud from the borehole after drilling and during well development. The drilling mud can also carry contaminates from a contaminated zone to an uncontaminated zone thereby cross-contaminating the borehole. If mud rotary is selected, only potable water and pure (no additives) bentonite drilling muds should be used. All materials used should have adequate documentation as to manufacturer's recommendations and product constituents. QA/QC samples of drilling muds and potable water should be sampled at a point of discharge from the circulation system to assure that pumps and piping systems are not contributing cross-contamination from previous use.

2.2.5 Other Methods

Other methods such as the cable-tool method, jetting method, and boring (bucket auger) method are available. If these and/or other methods are selected for monitoring well installations, they should be approved by a senior field geologist before field work is initiated.

2.3 Borehole Construction

2.3.1 Annular Space

The borehole or hollow stem auger should be of sufficient diameter so that well construction can proceed without major difficulties. For open boreholes, the annular space should be approximately 2" to allow the uniform deposition of well materials around the screen and riser, and to allow the passage of tremie pipes and well materials without unduly disturbing the borehole wall. For example, a 2" nominal diameter (nom.) casing would require a 6" inside diameter (ID) borehole.

In hollow stem augers and sonic method drill casing, the ID should be of sufficient size to allow the passage of the tremie pipe to be used for well grout placement, as well as free passage of filter sands or bentonite pellets dropped through the auger or casing. In general, 4-1/4" ID should be the minimum size used for placement of 2" nom. casing and 8-1/4" ID for 4" nom. casing. Larger augers should be used where installation difficulties due to geologic conditions or greater depths are anticipated, e.g. larger augers might be required to place a bentonite pellet seal through a long water column.

2.3.2 Over-drilling the Borehole

Sometimes it is necessary to over-drill the borehole in anticipation of material entering the augers during center bit removal or knocking out of the bottom plug. Normally, 3 to 5 feet is sufficient for over-drilling. The borehole can also be over-drilled to allow for an extra space or a "sump" area below the well screen. This "sump" area provides a space to attach a 5 or 10 foot section of well casing to the bottom of the well screen. The extra space or "sump" below the well screen serves as a catch basin or storage area for sediment that flows into the well and drops out of suspension. These "sumps" are added to the well screens when the wells are screened in aquifers that are naturally turbid and will not yield clear formation water (free of visible sediment) even after extensive development. The sediment can then be periodically pumped out of the "sump" preventing the well screen from clogging or "silting up". If the borehole is inadvertently drilled deeper than desired, it can be backfilled to the design depth with bentonite pellets, chips, or the filter sand that is to be used for the filter pack.

2.3.3 Filter Pack Placement

When placing the filter pack into the borehole, a minimum of 6-inches of the filter pack material should be placed under the bottom of the well screen to provide a firm base. Also, the filter pack should extend a minimum of 2-feet above the top of the well screen to allow for settling and to isolate the screened interval from the grouting material. In open boreholes, the filter pack should be placed by the tremie or positive displacement method. Placing the filter pack by pouring the sand into an open drill stem is acceptable with the use hollow stem augers, and other methods where the borehole is temporarily cased down to the filter pack.

2.3.4 Filter Pack Seal – Bentonite Pellet Seal (Plug)

Bentonite pellets consist of ground, dried bentonite compacted into pellets available in several sizes. Bentonite pellets are compressed to a bulk density of 70-80 lbs/cu.ft. and hydrate to a 30% min. solids material. Where neat cement grouts are to be used, the placement of a bentonite pellet seal above the filter pack is mandatory to prevent the possibility of grout infiltration into the screened interval prior to setting. Bentonite chips or other sealing products should not be substituted in this application. Where bentonite grouts are to be used, the placement of a bentonite pellet seal is optional, but desirable.

Since bentonite pellets begin hydrating rapidly, they can be very difficult to place properly. They are generally placed by pouring slowly into open boreholes, hollow stem augers or sonic drill pipe. In some cases, pellets are placed by tremie pipe and flushed into place with potable water. A tamper can be used to ensure that the material is being placed properly and to rapidly break up any pellet bridging that occurs.

Pellet seals should be designed for a two-foot thickness of dry pellets above the filter pack. Hydration may extend the height of the seal. Where neat cement grouts are to be used, the pellets should be hydrated for eight hours, or the manufacturer's recommended hydration time, whichever is greater. Where the water table is temporarily below the pellet seal, potable (or higher quality) water should be added repeatedly to hydrate the pellets prior to grouting.

2.3.5 Grouting the Annular Space

The annular space between the casing and the borehole wall should be filled with either a 30% solids bentonite grout, a neat cement grout, or a cement/bentonite grout. Each type of grout selected should be evaluated as to its intended use and integrity. Bentonite grouts are preferred unless the application dictates the use of another material.

Bentonite grout shall be a 30% solids pure bentonite grout. Drilling muds are not acceptable for grouting. The grout should be placed into the borehole, by the tremie method, from the top of the bentonite seal to within 2-feet of the ground surface or below the frost line, whichever is the greater depth. The bentonite pellet seal or filter pack should not be disturbed during grout placement, either by the use of a side discharge port on the tremie tube, or by maintaining clearance between the bottom of the tremie tube and the bentonite seal or filter pack. The grout should be allowed to cure for a minimum of 24 hours before the concrete surface pad is installed. The preferred method of achieving proper solids content is by measurement of ingredients per the manufacturer's specifications during mixing with a final check by grout balance after mixing. Bentonite grouts should have a minimum density of 10 lbs/gal to ensure proper gelling and low permeability. The density of the first batch of grout should be measured while mixing to verify proper measurement of ingredients. In addition, the grouting operation should not cease until the bentonite grout flowing out of the borehole has a minimum density of 10 lbs/gal. Estimating the grout density is not acceptable.

Cement grouts are generally dictated where a high level of dissolved solids or a particular dissolved constituent would prevent proper gelling of a bentonite grout. Neat cement grouts (cement without additives) should be mixed using 6 gallons of water per 94-lb bag of Type 1 Portland cement to a density of 15lbs/gal. The addition of bentonite (5 to 10 percent) to the cement grout can be used to delay the "setting" time and may not be needed in all applications. The specific mixtures and other types of cement and/or grout proposed should be evaluated on a case by case basis by a senior field geologist.

2.3.6 Above Ground Riser Pipe and Outer Casing

The well casing, when installed and grouted, should extend above the ground surface a minimum of 2.5 feet. A vent hole should be drilled into the top of the well casing cap to permit pressure equalization, if applicable. An outer protective casing should be installed into the borehole after the annular grout has cured for at least 24 hours. The outer protective casing should be of steel construction with a hinged, locking cap. Generally, outer protective casings used over 2-inch well casings are 4 inches square by 5 feet long. Similarly, protective casings used over 4-inch well casings are 6 inches square and 5 feet long. Other types of protective casing including those constructed of pipe are also acceptable. All protective casings should have sufficient clearance around the inner well casings, so that the outer protective casings will not come into contact with the inner well casings after installation. The protective casings should have a weep hole to allow drainage of accumulated rain or spilled purge water. The weep hole should be approximately 1/4-inch in diameter and drilled into the protective casings just above the top of the concrete surface pad to prevent water from standing inside of the protective casings. Protective casings made of aluminum or other soft metals are normally not acceptable because they are not strong enough to resist tampering. Aluminum protective casing may be used in very corrosive environments such as coastal areas.

Prior to installing the protective casing, the bentonite grout in the borehole annulus is excavated to a depth of approximately two feet. The protective casing is installed by pouring concrete into the borehole on top of the grout. The protective casing is then pushed into the wet concrete and borehole a minimum of 2 feet. Extra concrete may be needed to fill the inside of the protective casing so that the level of the concrete inside of the protective casing is at or above the level of the surface pad. In areas where frost heave of the surface pad is possible, the protective casing should first be pressed into the top surface of the bentonite grout seal and concrete poured around the protective casing. A granular material such as sand or gravel can then be used to fill the space between the riser and protective casing. The use of granular material instead of concrete between the protective casing and riser will also facilitate the future conversion of the well to a flush-mount finish, if required. The protective casing should extend above the ground surface to a height so that the top of the inner well casing is exposed when the protective casing is opened. At each site, all locks on the outer protective casings should be keyed alike.

2.3.7 Concrete Surface Pad

A concrete surface pad should be installed around each well at the same time as the outer protective casing is being installed. The surface pad should be formed around the well casing. Concrete should be placed into the pad forms and into the borehole (on top of the grout) in one operation making a contiguous unit. The size of the concrete surface pad is dependent on the well casing size. If the well casing is 2 inches in diameter, the pad should be 3 feet x 3 feet x 4 inches. If the well casing is 4 inches in diameter, the pad should be 4 feet x 4 feet x 6 inches. Round concrete surface pads are also acceptable. The finished pad should be slightly sloped so that drainage will flow away from the protective casing and off of the pad. A minimum of one inch of the finished pad should be below grade to prevent washing and undermining by soil erosion.

2.3.8 Surface Protection – Bumper Guards

If the monitoring wells are located in a high traffic area, a minimum of three bumper guards consisting of steel pipes 3 to 4 inches in diameter and a minimum 5-foot length should be installed. These bumper guards should be installed to a minimum depth of 2 feet below the ground surface in a concrete footing and extend a minimum of 3 feet above ground surface. Concrete should also be placed into the steel pipe to provide additional strength. Substantial steel rails and/or other steel materials can be used in place of steel pipe. Welding bars between the bumper posts can provide additional strength and protection in high traffic areas, but the protective bumpers should not be connected to the protective casing.

2.4 Construction Techniques

2.4.1 Well Installation

The borehole should be bored, drilled, or augered as close to vertical as possible, and checked with a plumb bob or level. Deviation from plumb should be within 1° per 50ft of depth. Slanted boreholes are undesirable and should be noted in the boring logs and final construction logs. The depth and volume of the borehole, including the over-drilling if applicable, should have been calculated and the appropriate materials procured prior to drilling activities.

The well casings should be secured to the well screen by flush-jointed threads and placed into the borehole and plumbed by the use of centralizers and/or a plumb bob and level. Another method of placing the well screen and casings into the borehole and plumbing them at the same time is to suspend the string of well screen and casings in the borehole by means of a hoist on the drill rig. This wireline method is especially useful if the borehole is deep and a long string of well screen and casings have to be set and plumbed.

No lubricating oils or grease should be used on casing threads. No glue of any type should be used to secure casing joints. Teflon "O" rings can also be used to insure a tight fit and minimize leakage; however, "O" rings made of other materials are not acceptable if the well is going to be sampled for organic compound analyses.

Before the well screen and casings are placed on the bottom of the borehole, at least 6 inches of filter material should be placed at the bottom of the borehole to serve as a firm footing. The string of well screen and casings should then be placed into the borehole and plumbed. Centralizers can be used to plumb a well, but centralizers should be placed so that the placement of the filter pack, bentonite pellet seal, and annular grout will not be hindered. Centralizers placed in the wrong locations can cause bridging during material placement. Monitoring wells less than 50 feet deep generally do not need centralizers. If centralizers are used they should be placed below the well screen and above the bentonite pellet seal. The specific placement intervals should be decided based on site conditions.

When installing the well screen and casings through hollow-stem augers, the augers should be slowly extracted as the filter pack, bentonite pellet seal, and grout are tremied and/or poured into place. The gradual extraction of the augers will allow the materials being placed in the augers to flow out of the bottom of the augers into the borehole. If the augers are not gradually extracted, the materials (sand, pellets, etc.) will accumulate at the bottom of the augers causing potential bridging problems.

After the string of well screen and casing is plumb, the filter pack material should then be placed around the well screen to the designated depth. With cased drilling methods, the sand should be poured into the casing or augers until the lower portion is filled. The casing or augers are then withdrawn, allowing the sand to flow into the evacuated space. With hollow stem augers, sand should always fill the augers 6-12 inches, maintained by pouring the sand while checking the level with a weighted tag line. The filter pack sand in open boreholes should be installed by tremie methods, using water to wash the sand through the pipe to the point of placement.

After the filter pack has been installed, the bentonite pellet seal (if used) should be placed directly on top of the filter pack to an unhydrated thickness of two feet. When installing the seal for use with ~~neat~~ cement grouts, the bentonite pellet seal should be allowed to hydrate a minimum of eight hours or the manufacturer's recommended hydration time, whichever is longer.

After the pellet seal has hydrated for the specified time, the grout should then be pumped by the tremie method into the annular space around the casings. The grout should be allowed to set for a minimum of 24 hours before the surface pad and protective casing are installed.

After the surface pad and protective casing are installed, bumper guards should be installed (if needed). The bumper guards should be placed around the concrete surface pad in a configuration that provides maximum protection to the well. Each piece of steel pipe or approved material should be installed into an 8-to 10-inch diameter hole, to a minimum depth of 2 feet below ground surface, and filled with concrete. As previously stated, the bumper guard should extend above the ground surface a minimum of 3 feet. The total length of each bumper guard should be a minimum of 5 feet.

After the wells have been installed, the outer protective casing should be painted with a highly visible paint. The wells should be permanently marked with the well number, date installed, site name, elevation, etc., either on the cover or an appropriate place that will not be easily damaged and/or vandalized.

If the monitoring wells are installed in a high traffic area such as a parking lot, in a residential yard, or along the side of a road it may be desirable to finish the wells to the ground surface and install water-tight flush mounted traffic and/or man-hole covers. Flush mounted traffic and man-hole covers are designed to extend from the ground surface down into the concrete plug around the well casing. Although flush mounted covers may vary in design, they should have seals that make the unit water-tight when closed and secured. The flush mounted covers should be installed slightly above grade to minimize standing water and promote runoff. Permanent identification markings should be placed on the covers or in the concrete plug around the cover. Expansive sealing plugs should be used to cap the well riser to prevent infiltration of any water that might enter the flush cover.

2.4.2 Double-Cased Wells

Double-cased wells should be constructed when there is reason to believe that interconnection of two aquifers by well construction may cause cross-contamination or when flowing sands make it impossible to install a monitoring well using conventional methods. A highly contaminated surface soil zone may also be cased off so that drilling may continue below the casing with reduced danger of cross contamination. A pilot borehole should be bored through the overburden and/or the contaminated zone into the clay confining layer or bedrock. An outer casing (sometimes called surface or pilot casings) should then be placed into the borehole and sealed with grout. The borehole and outer casing should extend into tight clay a minimum of two feet and into competent bedrock a minimum of 1 foot. The total depths into the clay or bedrock will vary, depending on the plasticity of the clay and the extent of weathering and\or fracturing of the bedrock. The final depths should be approved by a senior field geologist. The size of the outer casing should be of sufficient inside diameter to contain the inner casing, and the 2-inch minimum annular space. In addition, the borehole should be of sufficient size to contain the outer casing and the 2-inch minimum outer annular space, if applicable.

The outer casing should be grouted by the tremie, displacement, grout shoe, or Halliburton method from the bottom to the ground surface. The grout should be pumped into the annular space between the outer casing and the borehole wall. A minimum of 24 hours should be allowed for the grout plug (seal) to cure before attempting to drill through it. The grout mixture used to seal the outer annular space should be either a neat cement, cement/bentonite, cement/sand, or a 30% solids bentonite grout. However, the seal or plug at the bottom of the borehole and outer casing should consist of a Type I portland cement/bentonite or cement/sand mixture. The use of a pure bentonite grout for a bottom plug or seal is not acceptable, because the bentonite grout cures to a gel-like material, and is not rigid enough to withstand the stresses of drilling. When drilling through the seal, care should be taken to avoid cracking, shattering, or washing out the seal. If caving conditions exist so that the outer casing cannot be sufficiently sealed by grouting, the outer casing should be driven into place and a grout seal placed in the bottom of the casing.

2.4.2.1 Bedrock Wells

The installation of monitoring wells into bedrock can be accomplished in two ways:

1. The first method is to drill or bore a pilot borehole through the soil overburden into the bedrock. An outer casing is then installed into the borehole by setting it into the bedrock, and grouting it into place as described in the previous section. After the grout has set, the borehole can then be advanced through the grout seal into the bedrock. The preferred method of advancing the borehole into the bedrock is rock coring. Rock coring makes a smooth, round hole through the seal and into the bedrock without cracking and/or shattering the seal. Roller cone bits are used in soft bedrock, but extreme caution should be taken when using a roller cone bit to advance through the grout seal in the bottom of the borehole because excessive water and "down" pressure can cause cracking, eroding (washing), and/or shattering of the seal. Low volume air hammers may be used to advance the borehole, but they have a tendency to shatter the seal because of the hammering action. If the structural integrity of the grout seal is in question, a pressure test can be utilized to check for leaks. A visual test can also be made by examining the cement/concrete core that is collected when the seal is cored with a diamond coring bit. If the seal leaks (detected by pressure testing) and/ or the core is cracked or shattered, or if no core is recovered because of washing, excessive down pressure, etc., the seal is not acceptable. The concern over the structural integrity of the grout seal applies to all double cased wells. Any proposed method of double casing and/or seal testing will be evaluated on its own merits, and will have to be approved by a senior field geologist before and during drilling activities, if

applicable. When the drilling is complete, the finished well will consist of an open borehole from the ground surface to the bottom of the well. There is no inner casing, and the outer surface casing, installed down into bedrock, extends above the ground surface, and also serves as the outer protective casing. If the protective casing becomes cracked or is sheared off at the ground surface, the well is open to direct contamination from the ground surface and will have to be repaired immediately or abandoned. Another limitation to the open rock well is that the entire bedrock interval serves as the monitoring zone. In this situation, it is very difficult or even impossible to monitor a specific zone, because the contaminants being monitored could be diluted to the extent of being non-detectable. The installation of open bedrock wells is generally not acceptable in the Superfund and RCRA programs, because of the uncontrolled monitoring intervals. However, some site conditions might exist, especially in cavernous limestone areas (karst topography) or in areas of highly fractured bedrock, where the installation of the filter pack and its structural integrity are questionable. Under these conditions the design of an open bedrock well may be warranted.

2. The second method of installing a monitoring well into bedrock is to install the outer surface casing and drill the borehole (by an approved method) into bedrock, and then install an inner casing and well screen with the filter pack, bentonite seal, and annular grout. The well is completed with a surface protective casing and concrete pad. This well installation method gives the flexibility of isolating the monitoring zone(s) and minimizing inter-aquifer flow. In addition, it gives structural integrity to the well, especially in unstable areas (steeply dipping shales, etc.) where the bedrock has a tendency to shift or move when disturbed. Omitting the filter pack around the well screen is a general practice in some open rock borehole installations, especially in drinking water and irrigation wells. However, without the filter pack to protect the screened interval, sediment particles from the well installation and/or from the monitoring zone could clog the well screen and/or fill the screened portion of the well rendering it inoperable. Also, the filter pack serves as a barrier between the bentonite seal and the screened interval. Rubber inflatable packers have been used to place the bentonite seal when the filter pack is omitted, but the packers have to remain in the well permanently and, over a period of time, will decompose and possibly contribute contaminants to the monitoring zone.

2.5 Well Construction Materials

2.5.1 Introduction

Well construction materials are chosen based on the goals and objectives of the proposed monitoring program and the geologic conditions at the site(s). In this section, the different types of available materials will be discussed.

2.5.2 Well Screen and Casing Materials

When selecting the materials for well construction, the prime concern should be to select materials that will not contribute foreign constituents, or remove contaminants of concern from the ground water. If the monitoring program is designed to analyze for organic compounds, stainless steel materials are the preferred choice. If the monitoring program calls for the analyses of only inorganic compounds or the contaminants or formation are highly corrosive, then rigid PVC materials meeting National Sanitary Foundation (NSF) Standard 14 type WC (Well Casing) are acceptable. PVC materials may be acceptable for monitoring identified organic compounds in a soluble aqueous phase where incompatibilities are known to not exist. EPA document EPA/540/S-95/503, *Nonaqueous Phase Liquids Compatibility with Materials Used in Well Construction, Sampling, and Remediation* (http://www.epa.gov/ada/-download/issue/napl.pdf) should be used for guidance in this area and in the use of PVC with non-aqueous phase liquids (NAPLs). Another concern is to select materials that will be rugged enough to endure the entire monitoring period. Site conditions will generally dictate the type of materials that can be used. A preliminary field investigation should be conducted to determine the geologic conditions, so that the most suitable materials can be selected. The best grade or highest quality material for that particular application should be selected. Each manufacturer can supply the qualitative data for each grade of material that is being considered. All materials selected for monitoring well installation should be evaluated and approved by a senior field geologist prior to field activities.

Well screen and casing materials generally used in monitoring well construction on RCRA and Superfund sites are listed in order of preference:

1. Stainless Steel (304 or 316)
2. Rigid PVC meeting NSF Standard 14 (type WC)
3. Other (where applicable)

There are other materials used for well screens and casings such as black iron, carbon steel, galvanized steel, and fiberglass, but these materials are not recommended for use in long term monitoring programs at hazardous waste sites, because of their low resistance to chemical attack and potential constituent contribution to the ground water. In cases where a driven casing is used, or a high strength outer casing is needed, carbon steel may be acceptable in non-corrosive aquifers. This outer casing should have threaded connections. Welding casing is not an acceptable practice unless all relevant safety issues have been adequately addressed.

The minimum nominal casing size for most permanent monitoring wells will be 2". Where a complete program of installation, monitoring, and abandonment is being designed, smaller wells may be installed if suitable purging and sampling equipment for the smaller diameter wells can be specified and obtained. The length of well screens in permanent monitoring wells should be long enough to effectively monitor the interval or zone of interest. However, well screens designed for long term monitoring purposes should normally not be less than 5 feet in length. Well screens less than 5 feet long are generally only used in temporary monitoring wells where ground water samples are collected for screening purposes.

2.5.3 Filter Pack Materials

The filter pack materials should consist of clean, rounded to well-rounded, hard, insoluble particles of siliceous composition. The required grain-size distribution or particle sizes of the filter pack materials should be selected based upon a sieve analysis conducted on the soil samples collected from the aquifer materials and/or the formation(s) to be monitored. Filter pack materials should not be accepted unless proper documentation can be furnished as to the composition, grain-size distribution, cleaning procedure, and chemical analysis. If a data search reveals that there is enough existing data to adequately design the well screen and filter pack, then it may not be necessary to conduct a sieve analysis on the formation materials to be monitored. However, all data and design proposals will be evaluated and approved by a senior staff geologist before field activities begin.

2.5.4 Filter Pack and Well Screen Design

The majority of monitoring wells are installed in shallow ground water aquifers that consist of silts, clays, and sands in various combinations. These shallow aquifers are not generally characteristic of aquifers used for drinking water. Therefore, modifications to the procedures used for the design of water well filter packs may be required. In cases where insufficient experience exists with local or similar materials, the filter pack and well screen design should be based on the results of a sieve analysis conducted on soil samples collected from the aquifer or the formation(s) that will be monitored.

In formations consisting primarily of fines (silts and clays), the procedures for water well screen design may result in requirements for filter packs and screen slot sizes that are not available. In those cases the selection of 0.010" screen slots with a 20-40 sand filter pack, or 0.005" screen slots with 100 sand filter pack for very fine formations, will be acceptable practice. Table 6.6.1 provides size specifications for the selection of sand packs for fine formation materials. ASTM standard D5092, *Design and Installation of Ground Water Monitoring Wells in*

Aquifers, may be consulted for further guidance on specifications for sand appropriate for these applications.

Table 6.6.1
Sand Pack Specifications

Screen Opening (in)	Sand Pack Mesh Name	1% Passing Size (d-1) (in)	10% Passing Size (d-10) (in)	30% Passing Size (d-30) (in)	Derived 60% Passing Size (d-60) (in)	Range for Uniformity Coefficient
0.005-0.006	100	.0035 - .0047	.0055 - .0067	.0067 - .0083	.0085 - .0134	1.3 - 2.0
0.010"	20-40	.0098 - .0138	.0157 - .0197	.0197 -.0236	.020 - .0315	1.1 - 1.6

The following procedure should be used in coarser grained formations:

The data from the sieve analysis are plotted on a grain-size distribution graph, and a grain-size distribution curve is generated. From this grain-size distribution curve, the uniformity coefficient (Cu) of the aquifer material is determined. The Cu is the ratio of the 60 percent finer material (d60) to the 10 percent finer material (d10)

$$Cu = (d60/d10)$$

The Cu ratio is a way of grading or rating the uniformity of grain size. For example, a Cu of unity means that the individual grain sizes of the material are nearly all the same, while a Cu with a large number indicates a large range of particle sizes. As a general rule, a Cu of 2.5 or less should be used in designing the filter pack and well screen.

Before designing the filter pack and well screen, the following factors should be considered:

1. Select the well screen slot openings that will retain 90 percent of the filter pack material.

2. The filter pack material should be of the size that minimizes head losses through the pack and also prevents excessive sediment (sand, silt, clay) movement into the well.

3. A filter material of varying grain sizes is not acceptable because the smaller particles fill the spaces between the larger particles thereby reducing the void spaces and increasing resistance to flow. Therefore, filter material of the same grain size and well rounded is preferred.

4. The filter pack design is based on the gradation of the finest aquifer materials being analyzed.

Steps to design a filter pack in aquifers:

1. Construct a grain-size distribution curve, on a grain-size distribution graph, from the sieve analysis of the aquifer materials. The filter pack design (as stated above) is based on the gradation of the finest aquifer materials.

2. Multiply the d30 size from the grain-size distribution graph by a factor of four to nine (Pack-Aquifer ratio). A factor of four is used if the formation is fine-grained and uniform (Cu is less than 3), six if it is coarse-grained and non-uniform, and up to nine if it is highly non-uniform and contains silt. Head losses through filter packs increase as the Pack-Aquifer (P-A) ratios decrease. In order to design a fairly stable filter pack with a minimum head loss, the d30 size should be multiplied by a factor of four.

3. Plot the point from step 2 on the d30 abscissa of a grain-size distribution graph and draw a smooth curve with a uniformity coefficient of approximately 2.5.

4. A curve for the permissible limits of the filter pack is drawn plus or minus 8 per cent of the desired curve with the Cu of 2.5.

5. Select the slot openings for the well screen that will retain 90 per cent or more of the filter pack material.

The specific steps and procedures for sieve analysis and filter pack design can be found in soil mechanics, ground water, and water well design books. The staff geologists and/or engineers should be responsible for the correct design of the monitoring wells and should be able to perform the design procedures.

2.6 Safety Procedures for Drilling Activities

A site health and safety plan should be developed and approved by the Branch Safety Officer or designee prior to any drilling activities, and should be followed during all drilling activities. The driller or designated safety person should be responsible for the safety of the drilling team performing the drilling activities. All personnel conducting drilling activities should be qualified in proper drilling and safety procedures. Before any drilling activity is initiated, utilities should be marked or cleared by the appropriate state or municipal utility protection organization. In developed areas, additional measures should be taken to locate utilities not covered by the utility protection program. Before operating the drill rig, a pilot hole should be dug (with hand equipment) to a depth of three feet to check for undetected utilities or buried objects. Proceed with caution until a safe depth is reached where utilities normally would not be buried. The following safety requirements should be adhered to while performing drilling activities:

1. All drilling personnel should wear safety hats, safety glasses, and steel toed boots. Ear plugs are required and will be provided by the safety officer or driller.

2. Work gloves (cotton, leather, etc.) should be worn when working around or while handling drilling equipment.

3. All personnel directly involved with the drilling rig(s) should know where the kill switch(s) is located in case of emergencies.

4. All personnel should stay clear of the drill rods or augers while in motion, and should not grab or attempt to attach a tool to the drill rods or augers until they have completely stopped rotating. Rod wipers, rather than gloves or bare hands should be used to remove mud, or other material, from drill stem as it is withdrawn from the borehole.

5. Do not hold drill rods or any part of the safety hammer assembly while taking standard penetration tests or while the hammer is being operated.

6. Do not lean against the drill rig or place hands on or near moving parts at the rear of the rig while it is operating.

7. Keep the drilling area clear of any excess debris, tools, or drilling equipment.

8. The driller will direct all drilling activities. No work on the rig or work on the drill site will be conducted outside of the driller's direction. Overall drill site activities will be in consultation with the site geologist or engineer, if present.

9. Each drill rig will have a first-aid kit and a fire extinguisher located on the rig in a location quickly accessible for emergencies. All drilling personnel will be familiarized with their location.

10. Work clothes will be firm fitting, but comfortable and free of straps, loose ends, strings etc., that might catch on some moving part of the drill rig.

11. Rings, watches, or other jewelry will not be worn while working around the drill rig.

12. The drill rig should not be operated within a minimum distance of 20 feet of overhead electrical power lines and/or buried utilities that might cause a safety hazard. In addition, the drill rig should not be operated while there is lightening in the area of the drilling site. If an electrical storm moves in during drilling activities, the area will be vacated until it is safe to return.

2.7 Well Development

A newly completed monitoring well should not be developed for at least 24 hours after the surface pad and outer protective casing are installed. This will allow sufficient time for the well materials to cure before development procedures are initiated. The main purpose of developing new monitoring wells is to remove the residual materials remaining in the wells after installation has been completed, and to try to re-establish the natural hydraulic flow conditions of the formations which may have been disturbed by well construction, around the immediate vicinity of each well. A new monitoring well should be developed until the column of water in the well is free of visible sediment, and the pH, temperature, turbidity, and specific conductivity have stabilized. In most cases the above requirements can be satisfied; however, in some cases the pH, temperature, and specific conductivity may stabilize but the water remains turbid. In this case the well may still contain well construction materials, such as drilling mud in the form of a mud cake and/or formation soils that have not been washed out of the borehole. Excessive or thick drilling mud can not be flushed out of a borehole with one or two well volumes of flushing. Continuous flushing over a period of several days may be necessary to complete the well development. If the well is pumped to dryness or near dryness, the water table should be allowed to sufficiently recover (to the static water level) before the next development period is initiated. Caution should be taken when using high rate pumps and/or large volume air compressors during well development because excessive high rate pumping and high air pressures can damage or destroy the well screen and filter pack. The onsite geologist should make the decision as to the development completion of each well. All field decisions should be documented in the field log book.

The following development procedures, listed in approximate increasing order of the energy applied to the formation materials, are generally used to develop wells:

1. Bailing
2. Pumping/overpumping
3. Surging
4. Backwashing ("rawhiding")
5. Jetting
6. Compressed air (with appropriate filtering): airlift pumping and air surging

These development procedures can be used, individually or in combination, in order to achieve the most effective well development. In most cases, over-pumping and surging will adequately develop the well without imparting undue forces on the formation or well materials. Except when compressed air is being used for well development, sampling can be initiated as soon as the ground water has re-equilibrated, is free of visible sediment, and the water quality parameters have stabilized. Since site conditions vary, even between wells, a general rule-of-thumb is to wait 24 hours after development to sample a new monitoring well. Wells developed with stressful measures may require as long as a 7-day interval before sampling. In particular, air surge developed wells require 48 hours or longer after development so that the formation can dispel the compressed air and restabilize to pre-well construction conditions. Because of the danger of introducing contaminants with the airstream, the possibility of entraining air in the aquifer, and the violent forces imparted to the formation, air surging is the least desired method of development and should only be used where there is a specific need for the procedure. Air-lift pumping is permissible where an eductor pipe is used and several well volumes of water are removed from the well by other by pumping means after air-lift pumping. The selected development method(s) should be approved by a senior field geologist before any well installation activities are initiated.

2.8 Well Decommisioning (Abandonment)

When a decision is made to decommission (abandon) a monitoring well, the borehole should be sealed in such a manner that the well can not act as a conduit for migration of contaminants from the ground surface to the water table or between aquifers. To properly decommission a well, the preferred method is to completely remove the well casing and screen from the borehole, clean out the borehole, and backfill with a cement or bentonite grout, neat cement, or concrete. In order to comply with state well decommissioning requirements, the appropriate state agency should be notified (if applicable) of monitoring well decommissioning. However, some state requirements are not explicit, so a technically sound well abandonment method should be designed based on the site geology, well casing materials, and general condition of the well(s).

2.8.1 Decommissioning Procedures

As previously stated the preferred method should be to completely remove the well casing and screen from the borehole. This may be accomplished by augering with a hollow-stem auger over the well casing down to the bottom of the borehole, thereby removing the grout and filter pack materials from the hole. The well casing should then be removed from the hole with the drill rig. The clean borehole can then be backfilled with the appropriate grout material. The backfill material should be placed into the borehole from the bottom to the top by pressure grouting with the positive displacement method (tremie method). This abandonment method can be accomplished on small diameter (1-inch to 4-inch) wells without too much difficulty. With wells having 6-inch or larger diameters, the use of hollow-stem augers for casing removal is very difficult or almost impossible. Instead of trying to ream the borehole with a hollow-stem auger, it is more practical to force a drill stem with a tapered wedge assembly or a solid-stem auger into the well casing and extract it out of the borehole. Wells with little or no grouted annular space and/or sound well casings can be removed in this manner. However, old wells with badly corroded casings and/or thickly grouted annular space have a tendency to twist and/or break-off in the borehole. When this occurs, the well will have to be grouted with the remaining casing left in the borehole. The preferred method in this case should be to pressure grout the borehole by placing the tremie tube to the bottom of the well casing, which will be the well screen or the bottom sump area below the well screen. The pressurized grout will be forced out through the well screen into the filter material and up the inside of the well casing sealing holes and breaks that are present.

A PVC well casing may be more difficult to remove from the borehole than a metal casing, because of its brittleness. If the PVC well casing breaks during removal, the borehole should be cleaned out by using a drag bit or roller cone bit with the wet rotary method to grind the casing into small cuttings that will be flushed out of the borehole by water or drilling mud. Another method is to use a solid-stem auger with a carbide tooth pilot bit to grind the PVC casing into small cuttings that will be brought to the surface on the rotating flights. After the casing materials have been removed from the borehole, the borehole should be cleaned out and pressure grouted with the approved grouting materials.

Where state regulations and conditions permit, it may be permissible to grout the casing in place. This decision should be based on confidence in the original well construction practice, protection of drinking water aquifers, and anticipated future property uses. The pad should be demolished and the area around the casing excavated. The casing should be sawn off at a depth of three feet below ground surface. The screen and riser should be tremie grouted with a 30% solids bentonite grout in the saturated zone. The remaining riser may be grouted with a cement grout for long term resistance to dessication.

3 Temporary Monitoring Well Installation

3.1 Introduction

Five types of temporary monitoring well installation techniques have been demonstrated as acceptable. The type selected for a particular site is dependent upon site conditions. The project leader and site geologist should be prepared to test temporary well installations on site and select the best solution. Temporary wells are cost effective, may be installed quickly, and provide a synoptic picture of ground water quality.

Temporary monitoring well locations are not permanently marked, nor are their elevations normally determined. Sand pack materials may or may not be used, but typically there is no bentonite seal, grout, surface completion, or extensive development (as it normally applies to permanent monitoring wells). Temporary wells are generally installed, purged, sampled, removed, and backfilled in a matter of hours.

Due to the nature of construction, turbidity levels may initially be high. However, these levels may be reduced by low flow purging and sampling techniques as described in Section 7.2.4.

Temporary wells may be left overnight, for sampling the following day, but the well must be secured, both against tampering and against the fall hazard of the open annulus. If the well is not sampled immediately after construction, the well should be purged prior to sampling as specified in SESD Operating Procedure for Groundwater Sampling, SESDPROC-301.

3.2 Data Limitation

Temporary wells described in this section are best used for delineation of contaminant plumes at a point in time, and for some site screening purposes. They are not intended to replace permanent monitoring wells. Temporary wells can be used in conjunction with a mobile laboratory, where quick analytical results can be used to delineate contaminant plumes.

3.3 Temporary Well Materials

Materials used in construction of temporary monitoring wells are the same standard materials used in the construction of permanent monitoring wells. Sand used for the filter pack (if any) should be as specified in Section 2.5.3, Filter Pack Materials. The well screen and casing should be stainless steel for ruggedness and suitability for steam cleaning and solvent rinsing. Other materials may be acceptable, on a case by case basis. Some commercially available temporary well materials, pre-packed riser, screen and filter pack assemblies are available commercially; however, these pre-assembled materials cannot be cleaned. Appropriate QA/QC must be performed to assure there will be no introduction of contamination.

3.4 Temporary Monitoring Well Borehole Construction

Borehole construction for temporary wells is as specified in Section 2.3, using a drill rig. Alternatively, boreholes may be constructed using hand augers or portable powered augers (generally limited to depths of ten feet or less). If a drill rig is used to advance the borehole, the augers must be pulled back the length of the well screen (or removed completely) prior to sampling. When hand augers are used, the borehole is advanced to the desired depth (or to the point where borehole collapse occurs). In situations where borehole collapse occurs, the auger bucket is typically left in the hole at the point of collapse while the temporary well is assembled. When the well is completely assembled, a final auger bucket of material is quickly removed and the well is immediately inserted into the borehole, pushing, as needed, to achieve maximum penetration into the saturated materials.

3.5 Temporary Monitoring Well Types

Five types of monitoring wells which have been shown to be acceptable are presented in the order of increasing difficulty to install and increasing cost:

3.5.1 No Filter Pack

This is the most common temporary well and is very effective in many situations. After the borehole is completed, the casing and screen are simply inserted. This is the least expensive and fastest well to install. This type of well is extremely sensitive to turbidity fluctuations because there is no filter pack. Care should be taken to not disturb the casing during purging and sampling.

3.5.2 Inner Filter Pack

This type differs from the "No Filter Pack" well in that a filter pack is placed inside the screen to a level approximately 6 inches above the well screen. This ensures that all water within the casing has passed through the filter pack. For this type well to function properly, the static water level must be at least 6-12 inches above the filter pack. The screen slots may plug in some clayey environments with this construction method and others that use sand only inside the well screen.

3.5.3 Traditional Filter Pack

For this type of well, the screen and casing are inserted into the borehole, and the sand is poured into the annular space surrounding the screen and casing. Occasionally, it may be difficult to effectively place a filter pack around shallow open boreholes, due to collapse. This method requires more sand than the "inner filter pack" well, increasing material costs. As the filter pack is placed, it mixes with the muddy water in the borehole, which may increase the amount of time needed to purge the well to an acceptable level of turbidity.

3.5.4 Double Filter Pack

The borehole is advanced to the desired depth. As with the "inner filter pack" the well screen is filled with filter pack material and the well screen and casing inserted until the top of the filter pack is at least 6 inches below the water table. Filter pack material is poured into the annular space around the well screen. This type temporary well construction can be effective in aquifers where fine silts or clays predominate. This construction technique takes longer to implement and uses more filter pack material than others previously discussed.

3.5.5 Well-in-a-Well

The borehole is advanced to the desired depth. At this point, a 1-inch well screen and sufficient riser is inserted into a 2-inch well screen with sufficient riser, and centered. Filter pack material is then placed into the annular space surrounding the 1-inch well screen, to approximately 6 inches above the screen. The well is then inserted into the borehole.

This system requires twice as much well screen and riser, with attendant increases in assembly and installation time. The increased amount of well construction materials results in a corresponding increase in decontamination time and costs. The use of pre-packed well screens in this application will require rinse blanks of each batch of screens. Pre-pack Screen assemblies can not be decontaminated for reuse.

3.6 Decommissioning

Temporary well boreholes must be decommissioned after sampling and removal of the screen and riser. Backfilling the holes with cuttings may be acceptable practice for shallow holes in uniform materials with expected low contamination levels. Use of cuttings would not be an acceptable practice if waste materials were encountered or a confining layer was breached. Likewise, where the borehole is adjacent to, or downgradient of contaminated areas, the loose backfilled material could create a highly permeable conduit for contaminant migration. If the borehole will not be backfilled with the soil cuttings for this or other reasons, then SESD Operating Procedure for Management of Investigation Derived Waste, SESDPROC-202, should be referenced regarding disposal of the cuttings as IDW.

4 Temporary Monitoring Well Installation Using the Geoprobe® Screen Point 15/16 Groundwater Sampler

4.1 Introduction

The Geoprobe® Screen Point 15/16 Groundwater Sampler is a discrete interval ground water sampling device that can be pushed to pre-selected sampling depths in saturated, unconsolidated materials. Once the target depth has been reached, the screen is opened and groundwater can be sampled as a temporary monitoring well, which yields a representative, uncompromised sample from that depth. Using knock-out plugs, this method also allows for grouting of the push hole during sample tool retrieval.

The Screen Point® 15 sampler consist of four parts (drive point, screen, sampler sheath and drive head), with an assembled length of 52 inches (1321 mm) and a maximum OD of 1.5 inches (38 mm). When opened, it has an exposed screen length of 41 inches (1041 mm). It is typically pushed using 1.25-inch probe rod. The Screen Point® 16 consists of the same parts and works in the same fashion, the only differences being larger diameter and its use with 1.5” rods.

4.1.1 Assembly of Screen Point® 15/16 Groundwater Sampler

1. Install O-ring on expendable point and firmly seat in the angled end of the sampler sheath.

2. Place a grout plug in the lower end of the screen section. Grout plug material should be chosen with consideration for site specific Data Quality Objectives (DQOs).

3. When using stainless steel screen, place another O-ring* in the groove on the upper end of the screen and slide it into the sampler sheath.

4. Place an O-ring* on the bottom of the drive head and thread into the top of the sampler sheath.

5. The Screen Point® 15/16 Groundwater Sampler is now assembled and ready to push for sample collection.

   * It should be noted that O-ring use in steps 3 and 4 are optional.

4.1.2 Installation of Screen Point® 15/16 Groundwater Sampler

1. Attach drive cap to top of sampler and slowly drive it into the ground. Raise the hammer assembly, remove the drive cap and place an O-ring* in the top groove of the drive head. Add a probe rod and continue to push the rod string.

2. Continue to add probe rods until the desired sampling depth is reached.

3. When the desired sampling depth is reached, re-position the probe derrick and position either the casing puller assembly or the rod grip puller over the top of the top probe rod.

4. Thread a screen push adapter on an extension rod and attach sufficient additional extension rods to reach the top of the Screen Point® 15/16 sampler. Add an extension handle to the top of the string of extension rods and run this into the probe rod, resting the screen push adapter on top of the sampler.

5. To expose the screened portion of the sampler, exert downward pressure on the sampler, using the extension rod and push adapter, while pulling the probe rod upward. To expose the entire open portion of the screen, pull the probe rod upward approximately 41 inches.

6. At this point, the Screen Point® 15/16 Groundwater Sampler has been installed as a temporary well and may be sampled using appropriate ground water sampling methodology. If waters levels are less than approximately 25 feet, EIB personnel typically use a peristaltic pump, utilizing low-flow methods, to collect ground water samples from these installations. If water levels are greater than 25 feet, a manual bladder pump, a micro bailer, or other method may have to be utilized to collect the sample (SESD Operating Procedure for Groundwater Sampling, SESDPROC-301-R0) provides detailed descriptions of these techniques and methods).

4.1.3 Special Considerations for Screen Point® 15/16 Installations

<u>Decommissioning (Abandonment)</u>

In many applications, it may be appropriate to grout the abandoned probe hole where a Screen Point® 15/16 sampler was installed. This probe hole decommissioning can be accomplished through two methods which are determined by location and contamination risk. In certain non-critical areas, boreholes may be decommissioned by filling the saturated zone with bentonite pellets and grouting the vadose zone with neat cement poured from the surface or Bentonite pellets properly hydrated in place. Probe holes in areas where poor borehole sealing could present a risk of contaminant migration should be decommissioned by pressure grouting through the probe rod during sampler retrieval. To accomplish this, the grout plug is knocked out of the bottom of the screen using a grout plug push adapter and a grout nozzle is fed through the probe rod, extending just below the bottom of the screen. As the probe rod and sampler are pulled, grout is injected in the open hole below the screen at a rate that just fills the open hole created by the pull. Alternatively, the screen can generally be pulled and the hole re-probed with a tool string to be used for through-the-rod grouting.

Screen Material Selection

Screen selection is also a consideration in sampling with the Screen Point® 15/16 sampler. The screens are available in two materials, stainless steel and PVC. Because of stainless steel's durability, ability to be cleaned and re-used, and overall inertness and compatibility with most contaminants, it is the material typically used during EIB investigations.

MONITOR WELL INSTALLATION PROCEDURES

Rev. #: 1

Rev Date: 7/8/11

Pre-packed Screen Monitoring Well Installation Procedures

Prior to commencing work, all underground utilities will be located by the Mississippi One Call Center, by field personnel with appropriate devices, and/or by a private utility locator. Also, consistent with ARCADIS subsurface drilling policies, soil probing will be attempted to feet below ground surface at or adjacent to the intended locations where drilling/soil borings will take place.

Direct-push drilling is the preferred technique for subsurface sampling because it minimizes the generation of soil cuttings and the introduction of foreign fluids into the probehole. Direct-push techniques are also known to cause less disturbance to the natural formations. A pre-packed screen is an assembly consisting of an inner slotted screen surrounded by a wire mesh sleeve that acts as a support for filter media. Because the filter media is placed around the screen at the surface, pre-packed screens allow more control over the filter pack grain size and eliminate bridging of the filter media. Use of pre-packed screens may make it possible to use finer grained filter pack sand than is used for conventional well filter pack, providing less turbid samples.

I. Temporary Monitoring Well Installation using Pre-Packed Screens

The prepacked screens are constructed in 3- to 5-foot length sections, which have an outside diameter of about 1.5 to 2.0 inches and an inside diameter of 0.75 to 1.0 inch. The screen length will be determined in the field, but will not exceed 10 feet in length. The inner component of the prepacked screens consists of a flush-threaded, 0.5-inch Schedule 40 polyvinyl chloride (PVC) with 0.01-inch slots. The outer component of the screen is stainless steel wire mesh with a pore size of 0.011 inch. The space between the inner slotted pipe and outer wire mesh is filled with 20/40 silica sand.

The specific procedure for installing direct-push pre-packed screen monitoring wells is as follows. Equivalent pre-packed screen materials can also be used.

§ The installation begins by advancing a 2.25-inch outside diameter probe rods to depth with a direct-push machine.

§ Pre-packed screens are then assembled and installed through the 1.5-inch inside diameter of the probe rods using corresponding 0.75-inch Schedule 40 PVC riser.

§ The pre-pack tool string is attached to an expendable anchor point with a locking connector that is threaded to the bottom of the leading screen. Once the connector is locked onto the anchor point, the rod string is slowly retracted until the lower end of the rods is approximately 3 feet above the top prepack. A threaded bottom plug with an expendable point is another way to set the well.

- A minimum 2-foot sand barrier will be installed above the top prepack to avoid contaminating the well screens with bentonite or cement during installation (if the wells are converted to permanent wells). If the formation is stable and does not collapse around the riser as the rod string is retracted, environmental grade 20/40 mesh sand may be installed through the probe rods to provide the minimum 2-foot barrier.

Groundwater samples can be collected with a check valve assembly (with 3/8-inch outside diameter poly tubing), a stainless steel mini-bailer assembly, or a peristaltic pump when appropriate. Groundwater samples collected using pre-packed screens should be considered screening-level data, suitable for obtaining a general understanding of groundwater quality.

II. Conversion of Temporary to Permanent Monitoring Wells

The following steps may be followed to convert a temporary well to a permanent well:

- Granular bentonite or bentonite slurry will be installed in the annulus to form a well seal. A high-pressure grout pump may be used as a tremie cement/bentonite slurry to fill the well annulus.

- The grout mixture should be installed with a tremie tube from the bottom up to accomplish a tight seal without voids.

- These wells will be allowed to equilibrate overnight and groundwater measurements will be collected to determine groundwater flow direction.

Wells will be completed with a flush-mount (curb box) cover when installed in areas exposed to vehicle access or in residential areas. In areas not exposed to vehicle access, a vented protective steel casing will be located over the riser casing extending at least 1.5 feet below grade and 2 to 3 feet above grade secured by a neat concrete seal. The concrete seal will be flush with the ground surface and will extend approximately 1.5 feet below grade and laterally at least 1 foot in all directions from the protective casing and will slope gently to drain water away from the well. Monitoring wells will be labeled with the appropriate designation both on the inner and outer well casings.

The supervising geologist will specify the monitoring well designs to the drilling contractor before installation.

The supervising geologist is responsible for recording the exact construction details as relayed by the drilling contractor and actual measurements. Both the supervising geologist and drilling contractor are responsible for tabulating all materials used, such as casing footage and screen or bags of bentonite, cement, and sand.

III. Conversion of Temporary to Double-Cased Permanent Monitoring Wells

Double-cased monitoring wells will be installed to assess groundwater where the borings penetrate soil and/or groundwater zones potentially containing elevated levels of constituents of interest. An outer casing will be used to minimize the potential for the drilling process to draw or carry contamination down. Hollow-stem auger drilling methods or a direct push drill rig with the ability to advance a longer isolation casing will be used to install the wells.

The specific procedure for installing double-cased direct push monitoring wells is as follows. Equivalent direct-push techniques can also be used.

- The borehole for the outer casing will be advanced with a large-diameter hollow-stem auger or direct-push device to the required depth. Soil will be continuously sampled using a 2-inch diameter split-spoon sampler and visually classified by the supervising scientist.

- Then, a large-diameter PVC outer casing will be installed through the hollow-stem augers or direct-push device. To complete the installation, the outer casing will be hydraulically pushed approximately 1 foot beyond the bottom of the boring. The annular space of the borehole will then be filled with a cement/bentonite grout mixture using a tremie pipe installed to the bottom of the borehole.

- The cement/bentonite grout in the annulus will be allowed to cure for at least 24 hours before the boring is advanced.

- After the grout has cured for a minimum of 24 hours, the boring will be advanced through the outer casing using a smaller-diameter hollow-stem auger or direct-push device to the required depth.

- During advancement of the boring, soil will be continuously sampled with a 2-inch diameter split-spoon sampler, or 4-foot Macrocore sampler, and will be visually classified by the supervising scientist.

The direct-push well will be installed in accordance with the procedures described in Section I.

Wells will be completed with a flush-mount (curb box) cover when installed in areas exposed to vehicle access or in residential areas. In areas not exposed to vehicle access, a vented protective steel casing will be located over the riser casing extending at least 1.5 feet below grade and 2 to 3 feet above grade secured by a neat concrete seal. The concrete seal will be flush with the ground surface and will extend approximately 1.5 feet below grade and laterally at least 1 foot in all directions from the protective casing and will slope gently to drain water away from the well. Monitoring wells will be labeled with the appropriate designation on the outer well casing.

The supervising geologist will specify the monitoring well designs to the drilling contractor before installation.

The supervising geologist is responsible for recording the exact construction details as relayed by the drilling contractor and actual measurements. Both the supervising geologist and drilling contractor are responsible for tabulating all materials used, such as casing footage and screen or bags of bentonite, cement, and sand.

IV. Development

Development will not be performed within 24 hours of the monitoring well installation. Development will be accomplished by surging and evacuating water by slow pumping. As an alternative to surging and pumping, shallow overburden wells may be developed by using a new, disposable hand bailer to entrain the water and fine-grained solids in and around the well screen and remove these materials. Each well will be developed until turbidity is reduced to 10 nephelometric turbidity units (NTUs) or less. In the event that the wells cannot be developed to 10 NTUs, development will proceed until three consecutive measurements of pH, conductivity, and temperature (taken at 5-minute intervals) agree within 10 percent.

Materials for well development include:

- Appropriate health and safety equipment;
- Appropriate cleaning equipment;
- Bottom-loading bailer;
- Polypropylene rope;
- Plastic sheeting;
- pH, conductivity, and temperature meters;
- Nephelometric turbidity meter;

- Graduated buckets;
- Disposable gloves;
- Drums to collect purge fluids;
- Pump/tubing/foot valve/surge block; and
- Generator.

The procedure for developing a well using the pumping method is outlined below:

When developing a well using the pumping method, new cleaned polypropylene tubing equipped with a foot valve and surge block will be extended to the screened portion of the well. The diameter of the surge block will be within 0.5 inch of the well diameter. The tubing will be connected to a hydrolift-type pumping system that allows up and down movement of the surge block. The tubing will also be manually lifted and lowered within the screened interval. The pumping rate will be about two times the anticipated well purging rate. Surging will be repeated as many times as necessary within the well screen interval until the groundwater is relatively clear. Any tubing will be disposed of between wells; clean, new tubing will be used at each well.

Detailed procedures for groundwater well development are as follows:

1. Use appropriate safety equipment.
2. All equipment entering each monitoring well will be cleaned as specified in Attachment 10.
3. Attach appropriate pump and lower tubing into well.
4. Turn on pump. If well runs dry, shut off pump and allow to recover.
5. Surging by raising and lowering the tubing in the well will be performed several times to pull in fine-grained materials.
6. Steps 4 and 5 will be repeated until groundwater is relatively silt free.
7. Step 6 will be repeated until entire well screen has been developed.

V. Survey

A field survey control program will be conducted using standard instrument survey techniques to document the well location, as well as the ground, inner casing, and outer casing elevations, to the North American Vertical Datum of 1988.

VI. Equipment Cleaning

Downhole equipment will be cleaned with high-pressure steam cleaning equipment using a tap water source. Downhole equipment will be cleaned prior to use on the Site, between each monitoring well location, and at the completion of the drilling prior to leaving the Site as discussed in Attachment 12.

Traditional Groundwater Monitoring Well Installation and Development Procedures

Prior to commencing work, all underground utilities will be located by the Mississippi One Call Center, by field personnel with appropriate devices, and/or by a private utility locator. Also, consistent with best management practices, soil probing will be attempted to 5 feet below ground surface at or adjacent to the intended locations where drilling/soil borings will take place.

I. Monitoring Wells in Overburden

Monitoring wells will be installed by placing the screen and casing assembly with bottom cap into the auger string once the screen interval has been selected. At that time, a washed silica sand pack will be placed in the annular space opposite the screen to 1 to 2 feet above the top of the screen. A graded filter sand pack appropriate to the size of the screened soil interval will be used. The upper 0.5 foot of the sand pack will consist of #00 morie sand to impede bentonite infiltrating into the sand pack. Hydrated bentonite will be added to the annulus between the casing and the borehole wall for at least 2 feet. A cement/bentonite grout will then be added above the bentonite during the extraction of the augers to ground surface. For each 94-pound bag of cement, 6 to 7 gallons of water and approximately 7 pounds of granular or powdered bentonite will be added to make the grout mixture. During placement of sand and bentonite, frequent measurements will be made to check the height of the sand pack and thickness of bentonite by a weighted tape measure.

Monitoring wells will be constructed of 2-inch polyvinyl chloride well screen and riser. The well screen will be installed from approximately 2 feet above the water table to just above the anticipated aquitard depth with a maximum screen length of 15 feet. During advancement of the boring, soil will be continuously sampled with a 2-inch diameter split-spoon sampler, or 4-foot Macrocore sampler, and will be visually classified by the supervising scientist.

Wells will be completed with a flush-mount (curb box) cover when installed in areas exposed to vehicle access or in residential areas. In areas not exposed to vehicle access, a vented protective steel casing will be located over the riser casing extending at least 1.5 feet below grade and 2 to 3 feet above grade secured by a neat concrete seal. The concrete seal will be flush with the ground surface and will extend approximately 1.5 feet below grade and laterally at least 1 foot in all directions from the protective casing and will slope gently to drain water away from the well. Monitoring wells will be labeled with the appropriate designation both on the inner and outer well casings. A typical overburden monitoring well detail is shown on Figures 5-1 and 5-2.

The supervising geologist will specify the monitoring well designs to the drilling contractor before installation.

The supervising geologist is responsible for recording the exact construction details as relayed by the drilling contractor and actual measurements. Both the supervising geologist and drilling contractor are responsible for tabulating all materials used, such as casing footage and screen or bags of bentonite, cement, and sand.

II. Development

All monitoring wells will be developed of fine-grained materials that may have collected in the sand filter pack placed around the screen during installation. Development will not be performed within 24 hours of the monitoring well installation of protective casing and concrete pad. Development will be accomplished by surging and evacuating water by slow pumping. As an alternative to surging and pumping, shallow overburden wells may be developed by using a new, disposable hand bailer to entrain the water and fine-grained solids in and around the well screen and remove these materials. Each well will be developed until turbidity is reduced to 10 nephelometric turbidity units (NTUs) or less. In the event that the wells cannot be developed to 10 NTUs, development will proceed until three consecutive measurements of pH, conductivity, and temperature (taken at 5-minute intervals) agree within 10 percent.

Materials for well development include:

- Appropriate health and safety equipment;
- Appropriate cleaning equipment;
- Bottom-loading bailer;
- Polypropylene rope;
- Plastic sheeting;
- pH, conductivity, and temperature meters;
- Nephelometric turbidity meter;
- Graduated buckets;
- Disposable gloves;
- Drums to collect purge fluids;
- Pump/tubing/foot valve/surge block; and
- Generator.

The procedure for developing a well using the pumping method is outlined below:

When developing a well using the pumping method, new cleaned polypropylene tubing equipped with a foot valve and surge block will be extended to the screened portion of the well. The diameter of the surge block will be within 0.5 inch of the well diameter. The tubing will be connected to a hydrolift-type pumping system that allows up and down movement of the surge block. The tubing will also be manually lifted and lowered within the screened interval. The pumping rate will be about two times the anticipated well purging rate. Surging will be repeated as many times as necessary within the well screen interval until the groundwater is relatively clear. Any tubing will be disposed of between wells; clean, new tubing will be used at each well.

Detailed procedures for groundwater well development are as follows:

1. Use appropriate safety equipment.

2. All equipment entering each monitoring well will be cleaned as specified in Attachment 12.

3. Attach appropriate pump and lower tubing into well.

4. Turn on pump. If well runs dry, shut off pump and allow to recover.

5. Surging by raising and lowering the tubing in the well will be performed several times to pull in fine-grained materials.

6. Steps 4 and 5 will be repeated until groundwater is relatively silt free.

7. Step 6 will be repeated until entire well screen has been developed.

Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Soil Sampling**

Effective Date: November 1, 2007 **Number:** SESDPROC-300-R1

Authors

Name: Fred Sloan
Title: Environmental Engineer, Regional Expert
Signature: Date: 11/2/07

Approvals

Name: Antonio Quinones
Title: Chief, Enforcement and Investigations Branch
Signature: Date: 11/02/07

Name: Laura Ackerman
Title: Field Quality Manager, Science and Ecosystem Support Division
Signature: Laura Acker Date: 11/01/07

Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Field Quality Manager.

History	Effective Date
SESDPROC-300-R1, *Soil Sampling*, replaces SESDPROC-300-R0. **General** Corrected any typographical, grammatical and/or editorial errors. **Title Page** Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch. **Section 1.3** Updated information to reflect that the procedure is located on the H: drive of the LAN. Clarified Field Quality Manager (FQM) responsibilities. **Section 1.4** Updated referenced operating procedures due to changes in title names. Alphabetized and revised the referencing style for consistency. **Section 1.5.1** Corrected the title of the Safety, Health, and Environmental Management Program Procedures and Policy Manual. **Section 1.5.2, 4th bullet** Added references to the CFR and IATA's Dangerous Goods Regulations. **Section 2.7** Updated referenced operating procedures due to changes in title names.	November 1, 2007
SESDPROC-300-R0, Soil Sampling, Original Issue	February 05, 2007

TABLE OF CONTENTS

TABLES

Contents

1 General Information

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed when collecting soil samples for field screening or laboratory analysis.

1.2 Scope/Application

The procedures contained in this document are to be used by field personnel when collecting and handling soil samples in the field. On the occasion that SESD field personnel determine that any of the procedures described in this section are either inappropriate, inadequate or impractical and that another procedure must be used to obtain a soil sample, the variant procedure will be documented in the field log book and subsequent investigation report, along with a description of the circumstances requiring its use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and have been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the H: drive of the SESD local area network. The Field Quality Manager (FQM) is responsible for ensuring the most recent version of the procedure is placed on the H: drive and for maintaining records of review conducted prior to its issuance.

1.4 References

International Air Transport Authority (IATA). Dangerous Goods Regulations, Most Recent Version

SESD Operating Procedure for Sample and Evidence Management, SESDPROC-005, Most Recent Version

SESD Operating Procedure for Logbooks, SESDPROC-010, Most Recent Version

SESD Operating Procedure for Field Sampling Quality Control, SESDPROC-011, Most Recent Version

SESD Operating Procedure for Field X-Ray Fluorescence (XRF) Measurement, SESDPROC-107, Most Recent Version

SESD Operating Procedure for Equipment Inventory and Management, SESDPROC-108, Most Recent Version

SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, Most Recent Version

SESD Operating Procedure for Packaging, Marking, Labeling and Shipping of Environmental and Waste Samples, SESDPROC-209, Most Recent Version

Title 49 Code of Federal Regulations, Pts. 171 to 179, Most Recent Version

United States Environmental Protection Agency (US EPA). 1981. "Final Regulation Package for Compliance with DOT Regulations in the Shipment of Environmental Laboratory Samples," Memo from David Weitzman, Work Group Chairman, Office of Occupational Health and Safety (PM-273), April 13, 1981.

US EPA. 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division (SESD), Athens, GA

US EPA. Analytical Support Branch Laboratory Operations and Quality Assurance Manual. Region 4 SESD, Athens, GA, Most Recent Version

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when collecting soil samples. Refer to the SESD Safety, Health and Environmental Management Program (SHEMP) Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASP) for guidelines on safety precautions. These guidelines, however, should only be used to complement the judgment of an experienced professional. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate.

1.5.2 Procedural Precautions

The following precautions should be considered when collecting soil samples.

- Special care must be taken not to contaminate samples. This includes storing samples in a secure location to preclude conditions which could alter the properties of the sample. Samples shall be custody sealed during long-term storage or shipment.

- Collected samples are in the custody of the sampler or sample custodian until the samples are relinquished to another party.
- If samples are transported by the sampler, they will remain under his/her custody or be secured until they are relinquished.
- Shipped samples shall conform to all U.S. Department of Transportation (DOT) rules of shipment found in Title 49 of the Code of Federal Regulations (49 CFR parts 171 to 179), and/or International Air Transportation Association (IATA) hazardous materials shipping requirements found in the current edition of IATA's Dangerous Goods Regulations.
- Documentation of field sampling is done in a bound logbook.
- Chain-of-custody documents shall be filled out and remain with the samples until custody is relinquished.
- All shipping documents, such as air bills, bills of lading, etc., shall be retained by the project leader in the project files.

2 Special Sampling Considerations

2.1 Soil Samples for Volatile Organic Compounds (VOC) Analysis

If samples are to be analyzed for volatile organic compounds, they should be collected in a manner that minimizes disturbance of the sample. For example, when sampling with a bucket auger, the sample for VOC analysis should be collected directly from the auger bucket (preferred) or from minimally disturbed material immediately after an auger bucket is emptied into the pan. The sample shall be containerized by filling an En Core® Sampler or other Method 5035 compatible container. ***Samples for VOC analysis are not homogenized.*** Preservatives may be required for some samples with certain variations of Method 5035. Consult the method or the principal analytical chemist to determine if preservatives are necessary.

2.2 Soil Sampling (Method 5035)

The following sampling protocol is recommended for site investigators assessing the extent of volatile organic compounds (VOC's) in soils at a project site. Because of the large number of options available, careful coordination between field and laboratory personnel is needed. The specific sampling containers and sampling tools required will depend upon the detection levels and intended data use. Once this information has been established, selection of the appropriate sampling procedure and preservation method best applicable to the investigation can be made.

2.2.1 Equipment

Soil for VOC analyses may be retrieved using any of the SESD soil sampling methods described in Sections 3 through 8 of this procedure. Once the soil has been obtained, the En Core® Sampler, syringes, stainless steel spatula, standard 2-oz. soil VOC container, or pre-prepared 40 ml vials may be used/required for sub-sampling. The specific sample containers and the sampling tools required will depend upon the data quality objectives established for the site or sampling investigation. The various sub-sampling methods are described below.

2.2.2 Sampling Methodology - Low Concentrations (<200 ug/kg)

When the total VOC concentration in the soil is expected to be less than 200 µg/kg, the samples may be collected directly with the En Core® Sampler or syringe. If using the syringes, the sample must be placed in the sample container (40 ml pre-prepared vial) immediately to reduce volatilization losses. The 40 ml vials should contain 10 ml of organic-free water for an un-preserved sample or approximately 10 ml of organic-free water and a preservative. It is recommended that the 40 ml vials be prepared and weighed by the laboratory (commercial sources are available which supply preserved and tared vials). When sampling directly with the En Core® Sampler, the vial must be immediately capped and locked

A soil sample for VOC analysis may also be collected with conventional sampling equipment. A sample collected in this fashion must either be placed in the final sample container (En Core® Sampler or 40 ml pre-prepared vial) immediately or the sample may be immediately placed into an intermediate sample container with no head space. If an intermediate container (usually 2-oz. soil jar) is used, the sample must be transferred to the final sample container (En Core® Sampler or 40 ml pre-prepared vial) as soon as possible, not to exceed 30 minutes.

NOTE: After collection of the sample into either the En Core® Sampler or other container, the sample must immediately be stored in an ice chest and cooled.

Soil samples may be prepared for shipping and analysis as follows:

En Core® Sampler - the sample shall be capped, locked, and secured in a plastic bag.

Syringe - Add about 3.7 cc (approximately 5 grams) of sample material to 40-ml pre-prepared containers. Secure the containers in a plastic bag. Do not use a custody seal on the container; place the custody seal on the plastic bag. Note: When using the syringes, it is important that no air is allowed to become trapped behind the sample prior to extrusion, as this will adversely affect the sample.

Stainless Steel Laboratory Spatulas - Add between 4.5 and 5.5 grams (approximate) of sample material to 40 ml containers. Secure the containers in a plastic bag. Do not use a custody seal on the container; place the custody seal on the plastic bag.

2.2.3 Sampling Methodology - High Concentrations (>200 ug/kg)

Based upon the data quality objectives and the detection level requirements, this high level method may also be used. Specifically, the sample may be packed into a single 2-oz. glass container with a screw cap and septum seal. The sample container must be filled quickly and completely to eliminate head space. Soils\sediments containing high total VOC concentrations may also be collected as described in Section 2.2.2, Sampling Methodology - Low Concentrations, and preserved using 10 ml methanol.

2.2.4 *Special Techniques and Considerations for Method 5035*

Effervescence

If low concentration samples effervesce from contact with the acid preservative, then either a test for effervescence must be performed prior to sampling, or the investigators must be prepared to collect each sample both preserved or un-preserved as needed, or all samples must be collected unpreserved.

To check for effervescence, collect a test sample and add to a pre-preserved vial. If preservation (acidification) of the sample results in effervescence (rapid formation of bubbles) then preservation by acidification is not acceptable, and the sample must be collected un-preserved.

If effervescence occurs and only pre-preserved sample vials are available, the preservative solution may be placed into an appropriate hazardous waste container and the vials triple rinsed with organic free water. An appropriate amount of organic free water, equal to the amount of preservative solution, should be placed into the vial. The sample may then be collected as an un-preserved sample. Note that the amount of organic free water placed into the vials will have to be accurately measured.

Sample Size

While this method is an improvement over earlier ones, field investigators must be aware of an inherent limitation. Because of the extremely small sample size and the lack of sample mixing, sample representativeness for VOC’s may be reduced compared to samples with larger volumes collected for other constituents. The sampling design and objectives of the investigation should take this into consideration.

Holding Times

Sample holding times are specified in the Analytical Support Branch *Laboratory Operations and Quality Assurance Manual* (ASBLOQAM), Most Recent Version. Field investigators should note that the holding time for an un-preserved VOC soil/sediment sample is 48 hours. Arrangements should be made to ship the soil/sediment VOC samples to the laboratory by overnight delivery the day they are collected so the laboratory may preserve and/or analyze the sample within 48 hours of collection.

Percent Moisture

Samplers must ensure that the laboratory has sufficient material to determine percent moisture in the VOC soil/sediment sample to correct the analytical results to dry weight. If other analyses requiring percent moisture determination are being performed upon the sample, these results may be used. If not, a separate sample (minimum of 2 oz.) for percent moisture determination will be required. The sample collected for Percent Moisture may also be used by the laboratory to check for preservative compatibility.

Safety

Methanol is a toxic and flammable liquid. Therefore, methanol must be handled with all required safety precautions related to toxic and flammable liquids. Inhalation of methanol vapors must be avoided. Vials should be opened and closed quickly during the sample preservation procedure. Methanol must be handled in a ventilated area. Use protective gloves when handling the methanol vials. Store methanol away from sources of ignition such as extreme heat or open flames. The vials of methanol should be stored in a cooler with ice at all times.

Shipping

Methanol and sodium bisulfate are considered dangerous goods, therefore shipment of samples preserved with these materials by common carrier is regulated by the U.S. Department of Transportation and the International Air Transport Association (IATA). The rules of shipment found in Title 49 of the Code of Federal Regulations (49 CFR parts 171 to 179) and the current edition of the IATA Dangerous Goods Regulations must be followed when shipping methanol and sodium bisulfate. Consult the above documents or the carrier for additional information. Shipment of the quantities of methanol and sodium bisulfate used for sample preservation falls under the exemption for small quantities.

The summary table on the following page lists the options available for compliance with SW846 Method 5035. The advantages and disadvantages are noted for each option. SESD's goal is to minimize the use of hazardous material (methanol and sodium bisulfate) and minimize the generation of hazardous waste during sample collection.

2.3 Dressing Soil Surfaces

Any time a vertical or near vertical surface is sampled, such as achieved when shovels or similar devices are used for subsurface sampling, the surface should be dressed (scraped) to remove smeared soil. This is necessary to minimize the effects of contaminant migration interferences due to smearing of material from other levels.

Table 1: Method 5035 Summary

OPTION	PROCEDURE	ADVANTAGES	DISADVANTAGES
1	Collect 2 - 40 mL vials with ~5 grams of sample and 1 - 2 oz., glass w/septum lid for screening, % moisture and preservative compatibility	Screening conducted by lab	Presently a 48 hour holding time for unpreserved samples Sample containers must be tared
2	Collect 3 En Core® Samplers; and 1- 2 oz., glass w/septum lid for screening, % moisture and preservative compatibility	Lab conducts all preservation/preparation procedures	Presently a 48 hour holding time for preparation of samples
3	Collect 2 - 40 ml vials with 5 grams of sample and preserve w/methanol or sodium bisulfate and 1 - 2-oz., glass w/septum lid for screening, % moisture and preservative compatibility	High level VOC samples may be composited Longer holding time	Hazardous materials used in field Sample containers must be tared
4	Collect 1 - 2-oz., glass w/septum lid for analysis, % moisture and preservative compatibility	Lab conducts all preservation/preparation procedures	May have significant VOC loss

2.4 Special Precautions for Trace Contaminant Soil Sampling

- A clean pair of new, non-powdered, disposable gloves will be worn each time a different sample is collected and the gloves should be donned immediately prior to sampling. The gloves should not come in contact with the media being sampled and should be changed any time during sample collection when their cleanliness is compromised.
- Sample containers for samples suspected of containing high concentrations of contaminants shall be collected, handled and stored separately.
- All background samples shall be segregated from obvious high concentration or waste samples. Sample collection activities shall proceed progressively from the least suspected contaminated area to the most suspected contaminated area if sampling devices are to be reused. Samples of waste or highly contaminated media must not be placed in the same ice chest as environmental (i.e., containing low contaminant levels) or background samples.

- If possible, one member of the field sampling team should take all the notes and photographs, fill out tags, etc., while the other members collect the samples.
- Samplers must use new, verified certified-clean disposable or non-disposable equipment cleaned according to procedures contained in SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205), for collection of samples for trace metals or organic compound analyses.

2.5 Sample Homogenization

1. If sub-sampling of the primary sample is to be performed in the laboratory, transfer the entire primary sample directly into an appropriate, labeled sample container(s). Proceed to step 5.

2. If sub-sampling the primary sample in the field or compositing multiple primary samples in the field, place the sample into a glass or stainless steel homogenization container and mix thoroughly. Each aliquot of a composite sample should be of the same approximate volume.

3. All soil samples must be thoroughly mixed to ensure that the sample is as representative as possible of the sample media. ***Samples for VOC analysis are not homogenized.*** The most common method of mixing is referred to as quartering. The quartering procedure should be performed as follows:

    - The material in the sample pan should be divided into quarters and each quarter should be mixed individually.
    - Two quarters should then be mixed to form halves.
    - The two halves should be mixed to form a homogenous matrix.

    This procedure should be repeated several times until the sample is adequately mixed. If round bowls are used for sample mixing, adequate mixing is achieved by stirring the material in a circular fashion, reversing direction, and occasionally turning the material over.

4. Place the sample into an appropriate, labeled container(s) by using the alternate shoveling method and secure the cap(s) tightly. The alternate shoveling method involves placing a spoonful of soil in each container in sequence and repeating until the containers are full or the sample volume has been exhausted. Threads on the container and lid should be cleaned to ensure a tight seal when closed.

5. Return any unused sample material back to the auger, drill or push hole from which the sample was collected.

2.6 Quality Control

If possible, a control sample should be collected from an area not affected by the possible contaminants of concern and submitted with the other samples. This control sample should be collected as close to the sampled area as possible and from the same soil type. Equipment blanks should be collected if equipment is field cleaned and re-used on-site or if necessary to document that low-level contaminants were not introduced by sampling tools. SESD Operating Procedure for Field Sampling Quality Control (SESDPROC-011) contains other procedures that may be applicable to soil sampling investigations.

2.7 Records

Field notes, recorded in a bound field logbook, will be generated, as well as chain-of-custody documentation, as described in the SESD Operating Procedure for Logbooks (SESDPROC-010) and the SESD Operating Procedure for Sample and Evidence Management (SESDPROC-005).

3 Manual Soil Sampling Methods

3.1 General

These methods are used primarily to collect surface and shallow subsurface soil samples. Surface soils are generally classified as soils between the ground surface and 6 to 12 inches below ground surface. The most common interval is 0 to 6 inches, however the data quality objectives of the investigation may dictate another interval, such as 0 to 3 inches for risk assessment purposes. The shallow subsurface interval may be considered to extend from approximately 12-inches below ground surface to a site-specific depth at which sample collection using manual collection methods becomes impractical.

3.2 Spoons

Stainless steel spoons may be used for surface soil sampling to depths of approximately 6-inches below ground surface where conditions are generally soft and non-indurated and there is no problematic vegetative layer to penetrate.

3.2.1 Special Considerations When Using Spoons

- When using stainless steel spoons, consideration must be given to the procedure used to collect the volatile organic compound sample. If the soil being sampled is cohesive and holds its in situ texture in the spoon, the En Core® Sampler or syringe used to collect the sub-sample for Method 5035 should be plugged directly from the spoon. If, however, the soil is not cohesive and crumbles when removed from the ground surface for sampling, consideration should be given to plugging the sample for Method 5035 directly from the ground surface at a depth appropriate for the investigation Data Quality Objectives.
- When compositing, make sure that each composite location (aliquot) consist of equal volumes, i.e., same number of equal spoonfuls.
- If a thick, matted root zone is present at or near the surface, it should be removed before the sample is collected

3.3 Hand Augers

Hand augers may be used to advance boreholes and collect soil samples in the surface and shallow subsurface intervals. Typically, 4-inch stainless steel auger buckets with cutting heads are used. The bucket is advanced by simultaneously pushing and turning using an attached handle.

3.3.1 Surface Soil Sampling

When conducting surface soil sampling with hand augers, the auger buckets may be used with a handle alone or with a handle and extensions. The bucket is advanced to the appropriate depth and the contents are transferred to the homogenization container for processing. Observe precautions for volatile organic compound sample collection found in Section 2.2.4, Special Techniques and Considerations for Method 5035.

3.3.2 Subsurface Soil Sampling

Hand augers are the most common equipment used to collect shallow subsurface soil samples. Auger holes are advanced one bucket at a time until the sample depth is achieved. When the sample depth is reached, the bucket used to advance the hole is removed and a clean bucket is attached. The clean auger bucket is then placed in the hole and filled with soil to make up the sample and removed.

The practical depth of investigation using a hand auger depends upon the soil properties and depth of investigation. In sand, augering is usually easily performed, but the depth of collection is limited to the depth at which the sand begins to flow or collapse. Hand augers may also be of limited use in tight clays or cemented sands. In these soil types, the greater the depth attempted, the more difficult it is to recover a sample due to increased friction and torqueing of the hand auger extensions. At some point these problems become so severe that power equipment must be used.

3.3.3 Special Considerations for Soil Sampling with the Hand Auger

- Because of the tendency for the auger bucket to scrape material from the sides of the auger hole while being extracted, the top several inches of soil in the auger bucket should be discarded prior to placing the bucket contents in the homogenization container for processing.
- Observe precautions for volatile organic compound sample collection found in Section 2.2.4, Special Techniques and Considerations for Method 5035. Collect the VOC sample directly from the auger bucket, if possible.
- Power augers, such as the Little Beaver®, and drill rigs may be used to advance boreholes to depths for subsurface soil sampling with the hand auger. They may not be used for sample collection. When power augers are used to advance a borehole to depth for sampling, care must be taken that exhaust fumes, gasoline and/or oil do not contaminate the borehole or area in the immediate vicinity of sampling.
- When a new borehole is advanced, the entire hand auger assembly must be replaced with a properly decontaminated hand auger assembly.

4 Direct Push Soil Sampling Methods

4.1 General

These methods are used primarily to collect shallow and deep subsurface soil samples. Three methods are available for use with either the Geoprobe® or the drill rig adapted with a hydraulic hammer. All methods involve the collection and retrieval of the soil sample within a thin-walled liner. The following sections describe each of the specific sampling methods that can be accomplished using direct push techniques, along with details specific to each method.

4.2 Large Bore® Soil Sampler

The Large Bore® (LB) sampler is a solid barrel direct push sampler equipped with a piston-rod point assembly used primarily for collection of depth-discrete subsurface soil samples. The sample barrel is approximately 30-inches (762 mm) long and has a 1.5-inch (38 mm) outside diameter. The LB® sampler is capable of recovering a discrete sample core 22 inches x 1.0 inch (559 mm x 25 mm) contained inside a removable liner. The resultant sample volume is a maximum of 283 ml.

After the LB® sample barrel is equipped with the cutting shoe and liner, the piston-rod point assembly is inserted, along with the drive head and piston stop assembly. The assembled sampler is driven to the desired sampling depth, at which time the piston stop pin is removed, freeing the push point. The LB® sampler is then pushed into the soil a distance equal to the length of the LB® sample barrel. The probe rod string, with the LB® sampler attached, is then removed from the subsurface. After retrieval, the LB® sampler is then removed from the probe rod string. The drive head is then removed to allow removal of the liner and soil sample.

4.3 Macro-Core® Soil Sampler

The Macro-Core® (MC) sampler is a solid barrel direct push sampler equipped with a piston-rod point assembly used primarily for collection of either continuous or depth-discrete subsurface soil samples. Although other lengths are available, the standard MC® sampler has an assembled length of approximately 52 inches (1321 mm) with an outside diameter of 2.2 inches (56 mm). The MC® sampler is capable of recovering a discrete sample core 45 inches x 1.5 inches (1143 mm x 38 mm) contained inside a removable liner. The resultant sample volume is a maximum of 1300 ml. The MC® sampler may be used in either an open-tube or closed-point configuration. Samples collected for chemical analyses must be collected with the closed-point configuration. If used for collection of soil for stratigraphic descriptions, the open-tubed configuration is acceptable.

4.4 Dual Tube Soil Sampling System

The Dual Tube 21 soil sampling system is a direct push system for collecting continuous core samples of unconsolidated materials from within a sealed outer casing of 2.125-inch (54 mm) OD probe rod. The samples are collected within a liner that is threaded onto the leading end of a string of 1.0-inch diameter probe rod. Collected samples have a volume of up to 800 ml in the form of a 1.125-inch x 48-inch (29 mm x 1219 mm) core. Use of this method allows for collection of continuous core inside a cased hole, minimizing or preventing cross-contamination between different intervals during sample collection. The outer casing is advanced, one core length at a time, with only the inner probe rod and core being removed and replaced between samples. If the sampling zone of interest begins at some depth below ground surface, a solid drive tip must be used to drive the dual tube assembly and core to its initial sample depth.

4.5 Special Considerations When Using Direct Push Sampling Methods

- *Liner Use and Material Selection* – Due to the mode of operation, the samples must be collected with a liner. Liners are available in the following materials: stainless steel, brass, cellulose acetate butyrate (CAB), PETG, polyvinyl chloride (PVC) and Teflon®. For the majority of environmental investigations conducted by EIB, either CAB or Teflon® liners are used. If samples are collected for organic compound analyses, Teflon® liners are required. CAB or PVC liners may be used if metals or other inorganic constituents are the object of the investigation.
- *Sample Orientation* – When the liners and associated sample are removed from the sample tubes, it is important to maintain the proper orientation of the sample. This is particularly important when multiple sample depths are collected from the same push. It is also important to maintain proper orientation to define precisely the depth at which an aliquot was collected. Maintaining proper orientation is typically accomplished using vinyl end caps. Convention is to place red caps on the top of the liner and black caps on the bottom to maintain proper sample orientation. Orientation can also be indicated by marking on the exterior of the liner with a permanent marker.
- *Core Catchers* – Occasionally the material being sampled lacks cohesiveness and is subject to crumbling and falling out of the sample liner. In cases such as these, the use of core catchers on the leading end of the sampler may help retain the sample until it is retrieved to the surface. Materials of construction for core catchers must be consistent with the type of liner used, i.e., if stainless steel liners are required, stainless steel core catchers must be used.
- *VOC Sample Collection* - Observe precautions for volatile organic compound sample collection found in Section 2.2.4, Special Techniques and Considerations for Method 5035.

5 Split Spoon/Drill Rig Methods

5.1 General

Split spoon sampling methods are used primarily to collect shallow and deep subsurface soil samples. All split spoon samplers, regardless of size, are basically split cylindrical barrels that are threaded on each end. The leading end is held together with a beveled threaded collar that functions as a cutting shoe. The other end is held together with a threaded collar that serves as the sub used to attach the spoon to the string of drill rod. Two basic methods are available for use, including the smaller diameter standard split spoon, driven with the drill rig safety hammer, and the larger diameter continuous split spoon, advanced inside and slightly ahead of the lead auger during hollow stem auger drilling. The following sections describe each of the specific sampling methods, along with details specific to each method.

5.2 Standard Split Spoon

A drill rig is used to advance a borehole to the target depth. The drill string is then removed and a standard split spoon is attached to a string of drill rod. Split spoons used for soil sampling must be constructed of stainless steel and are typically 2.0-inches OD (1.5-inches ID) and 18-inches to 24-inches in length. Other diameters and lengths are common and may be used if constructed of the proper material. After the spoon is attached to the string of drill rod it is lowered into the borehole. The drill rig safety hammer is then used to drive the split spoon into the soil at the bottom of the borehole. After the split spoon has been driven into the soil, filling the spoon, it is retrieved to the surface, where it is removed from the drill rod string and opened for sample acquisition.

5.3 Continuous Split Spoon

The continuous split spoon is a large diameter split spoon that is advanced into the soil column inside a hollow stem auger. Continuous split spoons are typically 3-inches to 5-inches in diameter and either 5-feet or 10-feet in length, although the 5-foot long samplers are most common. After the auger string has been advanced into the soil column a distance equal to the length of the sampler being used it is returned to the surface. The sampler is removed from inside the hollow stem auger and the threaded collars are removed. The split spoon is then opened for sampling.

5.4 Special Considerations When Using Split Spoon Sampling Methods

- Always discard the top several inches of material in the spoon before removing any portion for sampling. This material normally consists of borehole wall material that has sloughed off of the borehole wall after removal of the drill string prior to and during inserting the split spoon.
- Observe precautions for volatile organic compound sample collection found in Section 2.2.4, Special Techniques and Considerations for Method 5035.

6 Shelby Tube/Thin-Walled Sampling Methods

6.1 General

Shelby tubes, also referred to generically as thin-walled push tubes or Acker thin-walled samplers, are used to collect subsurface soil samples in cohesive soils and clays during drilling activities. In addition to samples for chemical analyses, Shelby tubes are also used to collect relatively undisturbed soil samples for geotechnical analyses, such as hydraulic conductivity and permeability, to support hydrogeologic characterizations at hazardous waste and other sites.

6.2 Shelby Tube Sampling Method

A typical Shelby tube is 30-inches in length and has a 3.0-inch OD (2.875 ID) and may be constructed of steel, stainless steel, galvanized steel, or brass. They also typically are attached to push heads that are constructed with a ball-check to aid in holding the contained sample during retrieval. If used for collecting samples for chemical analyses, it must be constructed of stainless steel. If used for collecting samples for standard geotechnical parameters, any material is acceptable.

To collect a sample, the tube is attached to a string of drill rod and is lowered into the borehole, where the sampler is then pressed into the undisturbed clay or silts by hydraulic force. After retrieval to the surface, the tube containing the sample is then removed from the sampler head. If samples for chemical analyses are needed, the soil contained inside the tube is then removed for sample acquisition. If the sample is collected for geotechnical parameters, the tube is typically capped, maintaining the sample in its relatively undisturbed state, and shipped to the appropriate geotechnical laboratory.

6.3 Special Considerations When Using Split Spoon Sampling Methods

Observe precautions for volatile organic compound sample collection found in Section 2.2.4, Special Techniques and Considerations for Method 5035.

7 Backhoe Sampling Method

7.1 General

Backhoes may be used in the collection of surface and shallow subsurface soil samples. The trenches created by excavation with a backhoe offer the capability of collecting samples from very specific intervals and allow visual correlation with vertically and horizontally adjacent material. If possible, the sample should be collected without entering the trench. Samples may be obtained from the trench wall or they may be obtained directly from the bucket at the surface. The following sections describe various techniques for safely collecting representative soil samples with the aid of a backhoe.

7.2 Scoop and Bracket Method

If a sample interval is targeted from the surface, it can be sampled using a stainless steel scoop and bracket. First a scoop and bracket are affixed to a length of conduit and is lowered into the backhoe pit. The first step is to take the scoop and scrape away the soil comprising the surface of the excavated wall. This material likely represents soil that has been smeared by the backhoe bucket from adjacent material. After the smeared material has been scraped off, the original stainless steel scoop is removed and a clean stainless steel scoop is placed on the bracket. The clean scoop can then be used to remove sufficient volume of soil from the excavation wall to make up the required sample volume.

7.3 Direct-From-Bucket Method

It is also possible to collect soil samples directly from the backhoe bucket at the surface. Some precision with respect to actual depth or location may be lost with this method but if the soil to be sampled is uniquely distinguishable from the adjacent or nearby soils, it may be possible to characterize the material as to location and depth. In order to ensure representativeness, it is also advisable to dress the surface to be sampled by scraping off any smeared material that may cross-contaminate the sample.

7.4 Special Considerations When Sampling with a Backhoe

- Do not physically enter backhoe excavations to collect a sample. Use either procedure 7.2, Scoop and Bracket Method, or procedure 7.3, Direct-From-Bucket Method to obtain soil for sampling.
- Smearing is an important issue when sampling with a backhoe. Measures must be taken, such as dressing the surfaces to be sampled (see Section 2.3), to mitigate problems with smearing.

- Paint, grease and rust must be removed and the bucket decontaminated prior to sample collection.
- Observe precautions for volatile organic compound sample collection found in Section 2.2.4, Special Techniques and Considerations for Method 5035.

ARCADIS

FIELD INSTRUMENT CALIBRATION LOG

Date: ______________________

ARCADIS Project Name: ______________________ Project Number: ______________________

Field Calibration by: ______________________ Instrument Source ______________________

Type of Instrument	Manufacturer	Model Number	Time	Standard Concentration	Calibrated Reading	Remarks
pH Meter				4.00 s.u.		
				7.00 s.u.		
				10.00 s.u.		
				4.00 s.u.		
				7.00 s.u.		
				10.00 s.u.		
				4.00 s.u.		
				7.00 s.u.		
				10.00 s.u.		
Conductivity Meter				3,000 µmhos/cm		
				5,000 µmhos/cm		
				30,000 µmhos/cm		
				3,000 µmhos/cm		
				5,000 umhos/cm		
				30,000 µmhos/cm		
				3,000 µmhos/cm		
				5,000 µmhos/cm		
				30,000 µmhos/cm		
Dissolved Oxygen Calibrate to Water-Saturated Air				mm Hg		
				mm Hg		
				mm Hg		
Turbidimeter				NTU		
				NTU		
				NTU		
ORP				150 MV		
				150 MV		
				150 MV		

H:/Excel Files/CALIBRATIONFORM.xls/Field Instr/ibk

ARCADIS

FIELD PARAMETER FORM

Well Identification Number:

Job Name/Number: ____________________ Date: ____________

Water Level (TOC): ____________________ Total Depth: ____________

OVM Reading: ____________________ 3 Well Volumes: ____________

Start Time: ____________________ Total Volumes Removed: ____________

Time	Water Level (ft gmp)	Temp (°F)	Spc. Cond. (µmhos/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH (s.u.)	REDOX/ORP (mv)

Observations/Comments:

Ferrous Iron: ____________ Sulfide: ____________

ARCADIS

SOIL/SEDIMENT SAMPLING LOG

PROJECT NAME:

PROJECT NUMBER: DATE:

SITE LOCATION:

SAMPLE ID NUMBER: CODED/REPLICATE NO.: NA

TIME SAMPLING BEGAN: ENDING:

WEATHER:

SITE DESCRIPTION:

SAMPLING DATA

COLLECTION METHOD:

DEPTH: MOISTURE CONTENT:

COLOR: ODOR:

DESCRIPTION:

ANALYSES REQUIRED

CONTAINER DESCRIPTION

FROM LAB: X OR ARCADIS:

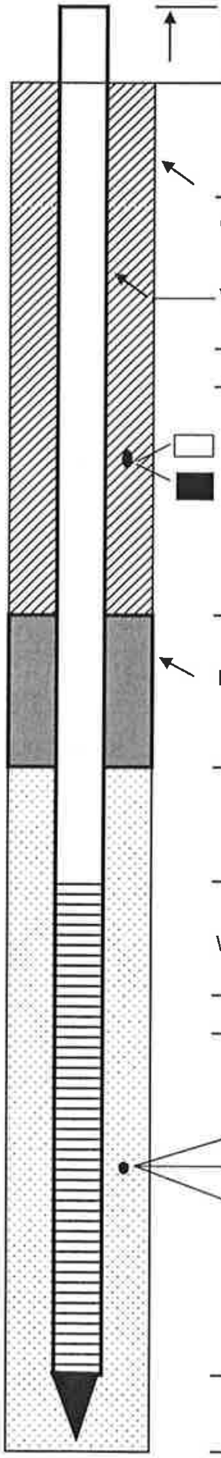
SAMPLING MONITORING (TIP, OVA, HNU, etc.)

REMARKS:

SAMPLING PERSONNEL:

ARCADIS

WELL CONSTRUCTION LOG



_____ ft

Land Surface

_____ inch diameter drilled hole

Well casing, _____ inch diameter, PVC

☐ Backfill

■ Grout cement

_____ ft*

Bentonite ☐ slurry ■ pellets

_____ ft*

_____ ft*

Well Screen, _____ inch diameter PVC, 0.010 slot

☐ Gravel Pack

■ Sand Pack

☐ Formation Collapse

_____ ft*

_____ ft*

Measuring Point is Top of Well Casing Unless Otherwise Noted.

* Depth Below Land Surface

Project _____ Well _____

Town/City _____

County/Parish _____ State _____

Permit Number _____

Land-Surface Elevation and Datum _____ feet X Surveyed Estimated

_____

Installation Date(s) _____

Drilling Method _____

Drilling Contractor _____

Drilling Fluid _____

_____

Development Technique(s) and Date(s)

_____

Fluid Loss During Drilling _____ gallons

Water Removed During Development _____ gallons

Static Depth to Water _____ feet below M.P.

Pumping Depth to Water _____ feet below M.P.

Pumping Duration _____ hours

Yield _____ gpm Date _____

Specific Capacity _____ gpm/ft

Well Purpose Monitor Well

Remarks _____

Prepared by _____

ARCADIS U.S., Inc.
10352 Plaza Americana Drive
Baton Rouge, LA 70816

SAMPLE / CORE LOG

Boring/Well: ______ **Project No.:** ______ **Page 1 of 1**

Site Location: ______ **Drilling Started:** ______ **Drilling Completed:** ______

Land-Surface Elev.: ______ **Surveyed:** ______ **Estimated:** ______ **Datum:** ______

Drilling Fluid: ______ **Drilling Method Used:** ______

Drilling Contractor: ______ **Driller:** ______ **Helper:** ______

Prepared By: ______ **Hammer Weight:** ______ **Hammer Drop (inches):** ______

▨ Fill	▨ Silty Clay	▥ Silt	▨ Sandy Silt	▨ Silty Sand	◧ Acetate Sleeve	▽ Water First Encountered
▨ Clay	▨ Sandy Clay	▥ Clayey Silt	▨ Sand	▨ Clayey Sand	▩ Split Spoon	▼ Water Level After 10 Minutes

SAMPLE DEPTH (ft)	SAMPLE TYPE	RECOVERY (ft)	SYMBOL	VISUAL DESCRIPTION	USCS (LL/PL/PI)	PP H	PP V	OVA (wo/F) (ppm)	OVA (w/F) (ppm)	REMARKS
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										

ARCADIS

WATER SAMPLING LOG

Project Project No.

Site Location Date:

Site/Well No. Replicate No. Code No.

Weather Sampling Time: Begin End

Evacuation Data

Measuring Point

MP Elevation (ft)

Land Surface Elevation (ft)

Sounded Well Depth (ft bmp)

Depth To Water (ft bmp)

Water Level Elevation (ft)

Water Column In Well (ft)

Casing Diameter/Type

Gallons In Well

Gallons Pumped/Bailed Prior To Sampling

Sample Pump Intake Setting (ft bmp)

Purge Time Begin: End

Pumping Rate (gpm)

Evacuation Method

Field Parameters

Color

Odor

Appearance

pH (s.u.)

Conductivity (mS/cm)

Conductivity (µmhos/cm)

Turbidity (NTU)

Temperature (°C/ °F)

Dissolved Oxygen

REDOX

Sampling Method

Remarks

Constituents Sampled	Container Description	Number	Preservative

Sampling Personnel

Well Casing Volumes

Gal./Ft.

1" = 0.04	1 - 1/2" = 0.09	2 - 1/2" = 0.26	3 - 1/2" = 0.50	6" = 1.47
1 - 1/4" = 0.06	2" = 0.16	3" = 0.37	4" = 0.65	

---

bmp	Below measuring point	ml	Milliliter	NTU	Nephelometric Turbidity Units
°C/°F	Degrees Celsius/Fahrenheit	mS/cm	Millisiemens per centimeter	PVC	Polyvinyl chloride
ft	Feet	msl	Mean sea level	s.u.	Standard units
gpm	Gallons per minute	NA	Not Applicable	µmhos/cm	Micromhos per centimeter
mg/L	Milligrams per liter	NR	Not Recorded	VOC	Volatile Organic Compounds
ppt	Parts per thousand	CS	Carbon steel	SS	Stainless steel

ARCADIS

Project Name / Number:

Sample ID:

Matrix:

Collection:

Preservative:

Date:

Analysis:

Time:

Sampler(s):

ARCADIS
Infrastructure · Water · Environment · Buildings

ID#:

CHAIN OF CUSTODY & LABORATORY ANALYSIS REQUEST FORM

Page ___ of ___

Lab Work Order #

Send Results to:

Contact & Company Name:
Telephone:
Address:
Fax:
City State Zip
E-mail Address:
Project Name/Location (City, State):
Project #:
Sampler's Printed Name:
Sampler's Signature:

Preservative							
Filtered (✓)							
# of Containers							
Container Information							

PARAMETER ANALYSIS & METHOD

Keys

Preservation Key:	**Container Information Key:**
A. H_2SO_4	1. 40 ml Vial
B. HCL	2. 1 L Amber
C. HNO_3	3. 250 ml Plastic
D. NaOH	4. 500 ml Plastic
E. None	5. Encore
F. Other: ________	6. 2 oz. Glass
	7. 4 oz. Glass
G. Other: ________	8. 8 oz. Glass
H. Other: ________	9. Other: ________
	10. Other: ________

Matrix Key:

SO - Soil	SE - Sediment	NL - NAPL/Oil
W - Water	SL - Sludge	SW - Sample Wipe
T - Tissue	A - Air	Other: ________

Sample ID	**Collection**		**Type (✓)**		**Matrix**								**REMARKS**
	Date	Time	Comp	Grab									

Special Instructions/Comments:

☐ **Special QA/QC Instructions(✓):**

Laboratory Information and Receipt		**Relinquished By**	**Received By**	**Relinquished By**	**Laboratory Received By**
Lab Name:	Cooler Custody Seal (✓)	Printed Name:	Printed Name:	Printed Name:	Printed Name:
☐ Cooler packed with ice (✓)	☐ Intact ☐ Not Intact	Signature:	Signature:	Signature:	Signature:
Specify Turnaround Requirements:	Sample Receipt:	Firm:	Firm/Courier:	Firm/Courier:	Firm:
Shipping Tracking #:	Condition/Cooler Temp: ________	Date/Time:	Date/Time:	Date/Time:	Date/Time:

Distribution: **WHITE – Laboratory returns with results** **YELLOW – Lab copy** **PINK – Retained by ARCADIS**

CHAIN-OF-CUSTODY SEAL • CHAIN-OF-CUSTODY SEAL

ARCADIS

____

CHAIN-OF-CUSTODY SEAL • CHAIN-OF-CUSTODY SEAL

Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Soil Gas Sampling**

Effective Date: September 8, 2010	**Number:** SESDPROC-307-R2

Authors

Name: Tim Slagle
Title: Environmental Scientist, Regional Expert
Signature: Date: 9/2/2010

Approvals

Name: Archie Lee
Title: Chief, Enforcement and Investigations Branch
Signature: Archie Lee Date: 9/7/2010

Name: Liza Montalvo
Title: Field Quality Manager, Science and Ecosystem Support Division
Signature: Date: 9/7/10

Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Document Control Coordinator.

History	Effective Date
SESDPROC-307-R2, *Soil Gas Sampling*, replaces SESDPROC-307-R1 **Title Page:** Changed Enforcement and Investigations Branch Chief from Antonio Quinones to Archie Lee. **Revision History:** Changed Field Quality Manager to Document Control Coordinator. **Section 1.2:** Added the following statement: "Mention of trade names or commercial products does not constitute endorsement or recommendation for use." **Section 1.3:** Omitted reference to the H: drive. Changed the Field Quality Manager to the Document Control Coordinator. **Section 1.4:** Updated references. **Section 2.2**: Two bullets added to bullet list **Section 2.4:** Quality Control section re-written with four bulleted definitions. **Sections 3, 4 and 5:** Sections re-written to reflect separate installation procedures (Sections 3 and 4) and sampling procedures (Section 5). **Section 3**: PRT installation procedures re-written. Decommissioning procedures added. **Section 4:** Permanent Soil Gas Implant procedures re-written. Decommissioning procedures added. **Section 5:** Sampling PRT and Permanent Soil Gas Installations added as separate sampling procedures section. Sampling procedures revised.	September 8, 2010
SESDPROC-307-R1, *Soil Gas Sampling*, replaces SESDPROC-307-R0 **General** Updated referenced operating procedures due to	November 1, 2007

changes in title names and/or to reflect most recent version. **Title Page** Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch **Section 1.3** Updated information to reflect that the procedure is located on the H: drive of the LAN. Clarified Field Quality Manager (FQM) responsibilities. **Section 1.4** Alphabetized and revised the referencing style for consistency. **Section 1.5.1** Corrected the title of the Safety, Health, and Environmental Management Program Procedures and Policy Manual.	
SESDPROC-307-R0, Soil Gas Sampling, Original Issue	February 05, 2007

TABLE OF CONTENTS

1 General Information

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed when collecting soil gas samples for field screening or laboratory analysis.

1.2 Scope/Application

The procedures contained in this document are to be used by field personnel when collecting and handling soil gas samples in the field. On the occasion that SESD field personnel determine that any of the procedures described in this section are either inappropriate, inadequate or impractical and that another procedure must be used to obtain a soil gas sample, the variant procedure will be documented in the field log book, along with a description of the circumstances requiring its use. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and has been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the SESD Local Area Network (LAN). The Document Control Coordinator (DCC) is responsible for ensuring the most recent version of the procedure is placed on LAN and for maintaining records of review conducted prior to its issuance.

1.4 References

Geoprobe® Systems Tools and Equipment Catalog, Kejr Engineering, Inc., Salinas, Kansas, 1997.

International Air Transport Authority (IATA). Dangerous Goods Regulations, Most Recent Version

SESD Operating Procedure for Control of Records, SESDPROC-002, Most Recent Version

SESD Operating Procedure for Equipment Inventory and Management (SESDPROC-104, Most Recent Version)

SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, Most Recent Version

SESD Operating Procedure for Field Sampling Quality Control, SESDPROC-011, Most Recent Version

SESD Operating Procedure for Logbooks, SESDPROC-010, Most Recent Version

SESD Operating Procedure for Packaging, Marking, Labeling and Shipping of Environmental and Waste Samples, SESDPROC-209, Most Recent Version

SESD Operating Procedure for Sample and Evidence Management, SESDPROC-005, Most Recent Version

The Yellow Field Book©, Kejr Engineering, Inc., Salinas, Kansas, 2000.

US EPA. 1999. Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, Compendium Method TO-15, Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS); Center for Environmental Research Information, Office of Research and Development, Cincinnati, OH; EPA/625/R-96/010b

US EPA. Analytical Support Branch Laboratory Operations and Quality Assurance Manual. Region 4 SESD, Athens, GA, Most Recent Version

US EPA. April 13, 1981. Final Regulation Package for Compliance with DOT Regulations in the Shipment of Environmental Laboratory Samples. Memo from David Weitzman, Work Group Chairman, Office of Occupational Health and Safety (PM-273)

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

Geoprobe Systems, Direct Push Installation of Devices for Active Soil Gas Sampling & Monitoring, Technical Bulletin No. MK3098, Prepared May, 2006.

1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when collecting soil gas samples. Refer to the SESD Safety, Health and Environmental Management Program (SHEMP) Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASP) for guidelines on safety precautions. These guidelines should be used to complement the judgment of an experienced professional. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate.

1.5.2 Procedural Precautions

The following precautions should be considered when collecting soil gas samples.

- Special care must be taken not to contaminate samples. This includes storing samples in a secure location to preclude conditions which could alter the properties of the sample. Samples shall be custody sealed during long-term storage or shipment.
- Collected samples are in the custody of the sampler or sample custodian until the samples are relinquished to another party.
- If samples are transported by the sampler, they will remain under his/her custody or be secured until they are relinquished.
- Shipped samples shall conform to all U.S. Department of Transportation (DOT) and/or International Air Transportation Association (IATA) hazardous materials shipping requirements.
- Documentation of field sampling is done in a bound logbook.
- Chain-of-custody documents shall be filled out and remain with the samples until custody is relinquished.
- All shipping documents, such as air bills, bills of lading, etc., shall be retained by the project leader and stored in a secure place.

2 Special Sampling Considerations

2.1 Special Considerations for Sampling

The tubing used as part of either of the described sampling systems should be Teflon® or stainless steel. As most soil gas sampling will be conducted to investigate the presence or extent of organic compounds, Teflon® tubing is required to ensure the integrity of the sample.

2.2 Special Precautions for Soil Gas Sampling

- A clean pair of new, non-powdered, disposable gloves will be worn each time a different location is sampled and the gloves should be donned immediately prior to sampling. The gloves should be changed any time during sample collection when their cleanliness is compromised.
- If possible, one member of the field sampling team should take all the notes and photographs, fill out tags, etc., while the other members collect the samples.
- Use O-rings on all tooling, adapters and probe rods to ensure that the entire sampling train is air-tight. This is necessary to prevent soil ingress during installation and to maintain sample integrity by ensuring that no ambient air is introduced into the sample during collection.
- When using the Post-Run Tubing (PRT) sampling system, excavate a small depression around the rods after driving the distance of the intended open interval. Fill the depression with bentonite crumbles (not pellets) and hydrate with tap water to ensure sealing at the ground surface. Special care should be taken to keep the rod string aligned with the push axis of the probe machine.

2.3 Sample Handling Requirements

1. Soil gas samples will typically be collected by directly filling evacuated, specially-prepared stainless steel canisters (SUMMA or SilcoSteel® canisters), after sample delivery line purging.

2. The canister will be labeled and identified according to SESD Operating Procedure for Packaging, Marking, Labeling and Shipping of Environmental and Waste Samples (SESDPROC-209).

2.4 Quality Control

Quality control sampling for soil gas sampling investigations will consist of collection of the following types of samples, as appropriate.

- Control Sample: If applicable to the study or investigation, a control sample should be collected from a location not affected by the possible contaminants of concern and submitted with the other samples.
- Field Blank: A canister field blank, prepared prior to the investigation by ASB personnel, should also be submitted with the sample set during the investigation.
- Equipment rinsate blank: Equipment rinsate blanks should be collected if equipment, such as PRT adapters, probe rod or other sampling equipment is field cleaned and re-used to document that low-level contaminants were not introduced into the sample by the decontaminated equipment.
- Field Split: Field split samples, at a minimum frequency of one for every twenty samples, should be collected. Split samples are collected by attaching the center leg of a Swagelok® "T" to the end of the sample tubing. The remaining legs of the "T" are connected to two sample containers which are opened and filled simultaneously.

2.5 Records

Information generated or obtained by SESD personnel will be organized and accounted for in accordance with SESD records management procedures found in the SESD Operating Procedure for Control of Records (SESDPROC-002). Field notes, recorded in a bound field logbook, will be generated, as well as chain-of-custody documentation according to the procedures found in SESD Operating Procedure Logbooks (SESDPROC-010) and SESD Operating Procedure for Sample and Evidence Management (SESDPROC-005).

3 Geoprobe® PRT System Installation

3.1 General

Single event or grab sampling may be conducted using the Post-Run Tubing System (PRT). Using this system, soil gas samples can be collected quickly and with a high degree of assurance that the samples are representative of the targeted depth, i.e., using this method, there is no leakage at probe rod joints that will compromise the integrity of the sample.

The downhole components of the PRT system include:

- Sample delivery tubing
- Probe rods
- PRT Adapter
- Expendable point holder
- Expendable point

O-ring seals are used on the PRT Adapter, the expendable point holder and at all rod joints. The O-rings prevent soil ingress which can prevent air-tight docking of the PRT adapter.

3.2 PRT System Installation Procedures

The following procedures are used to collect soil gas samples using the Geoprobe® PRT system. The PRT system is available for 1.0-inch, 1.25-inch and 1.5-inch diameter probe rod. In SESD practice, 1.25-inch rods are used. All parts or accessories used in the PRT system must be selected with the appropriate diameter probe rod in mind to ensure compatibility of all components.

1. Place O-ring on PRT expendable point holder and attach to initial section of probe rod.

2. Place O-ring on expendable point and press into expendable point holder.

3. Add drive cap to probe rod and push PRT system into ground the distance of the intended open-interval. Take special care to assure that the rods are in line with the push axis of the probe machine. Dig a small depression around the rod string. Fill the depression with bentonite crumbles (not pellets) and hydrate with tap water.

4. At the desired sampling depth, attach a point popper to an extension rod and insert extension rod string into rods so that the point popper rests on the expendable point. Using the rod puller, and taking special care to maintain probe alignment with the rods, begin pulling the rods while maintaining pressure on the extension

rods. The extension rods should drop when the pull is started, indicating that the expendable point has been ejected. The rods can then be pulled to expose the desired open sampling interval.

5. Using a properly decontaminated water level sounder, check, if conditions warrant, to make sure groundwater is not present prior to proceeding with Step 6.

6. Secure the PRT adapter to a length of tubing sufficient to reach from the sampling interval to the surface, with several feet of excess tubing extending beyond the top of the probe rod to facilitate sampling. The adapter is secured tightly to the tubing using electrical tape. This will not compromise the integrity of the sample to be collected, as the sample is pulled directly through the adapter and is never exposed to the tape.

7. Run the tubing and adapter into the probe rod and, using steady downward pressure, turn the tubing counter-clockwise to dock the adapter into the top of the expendable point holder. Tug gently on the tubing to ensure that the adapter engaged with the expendable point holder. Continue rotating tubing until the adapter is firmly seated. Failure to dock could indicate that soil intruded during the push or that the expendable point was lost during the push.

8. At this point, the PRT system has been installed and is ready for sampling. If the sample can not be collected immediately, the end of the tubing should be capped with a stainless steel Swagelok® cap. Sampling is conducted using one of the procedures described in Section 5, Sampling PRT and Permanent Soil Gas Installations

3.3 Decommissioning PRT Sample Locations

Because it is impractical to pump grout through the PRT adapter on the lead probe rod, the entire string of rod must be removed before decommissioning can commence. The following methods are available, depending on conditions related to sample depth and post-removal probe hole wall stability:

1. **Direct Placement of Pellets or Grout** - If the sampling depth was fairly shallow, on the order of ten feet or less, grouting/sealing the open hole can be accomplished by directly placing bentonite pellets, hydrated in lifts, or pouring a 30% solids bentonite grout mixture from the surface. The acceptable maximum depth for this option is somewhat dependent on the stability of the hole and these methods may be used at slightly greater depths if the holes do not collapse after removal of the rod.

2. **Re-entry Grouting** - For locations where sampling was conducted at somewhat greater depths or where the surficial formations tend to collapse, the only viable option for grout placement may be to re-probe the entire depth with an expendable point. After reaching the original sample depth, the expendable point

is ejected and the hole is grouted by directly injecting grout through the inside of the rod string, as it is removed. Use of this option is dependent on the relative degree of hole stability.

4 Geoprobe® Permanent Soil Gas Implant Installation

4.1 General

Long-term soil gas sampling may be conducted using permanent soil gas sampling implants installed with the Geoprobe®. Stainless steel implants may be installed at any depth achievable by the Geoprobe® and may be installed using 1.0-inch, 1.25-inch or 1.5-inch diameter probe rod. In SESD practice, 1.25-inch probe rods are used. The implants may be installed in custom lengths, configured using a wide assortment of available implant lengths and connections. The implant screens are double-woven stainless steel mesh with 0.0057-inch (0.15 mm) pore openings.

Permanent soil gas sampling implants may also be installed using 2.125-inch diameter rods utilizing an advancing thin-walled corer to facilitate placement of the implant (see Geoprobe Systems, Direct Push Installation of Devices for Active Soil Gas Sampling & Monitoring, Technical Bulletin No. MK3098 for details of this application).

4.2 Installation of Permanent Soil Gas Sampling Implants (Typical)

The following procedures are used by to install a permanent soil gas sampling implant using the Geoprobe®. These are the general procedures which are used with 1.25-inch diameter probe rod.

1. Attach O-ring to implant point anchor.

2. Press implant point anchor into point holder and attach to first section of probe rod.

3. Push implant point anchor to the desired depth for implant installation. Using O-rings on all rod joints will prevent soil intrusion.

4. When the desired depth has been reached, attach the implant to the sample delivery tubing. This is accomplished by loosening or removing the Swagelok® fitting and pressing the tubing into the implant. When the end of the tubing is sufficiently engaged in the end of the implant, the Swagelok® fitting is tightened to secure the tubing in the implant. The Swagelok® tightening recommendation is 1 and ¼ turns after finger-tightening. It is critical that the tubing be securely attached to the implant so that it does not pull off during subsequent steps of the installation.

5. Feed the tubing into the probe rod until the implant reaches the implant point anchor. At this point, cut the tubing to allow enough tubing to remain for sampling, usually three to four feet.

6. Rotate the tubing and implant counter-clockwise, threading the implant into the anchor. If there was any soil intrusion during the push, the implant may not dock. If the implant does not dock, it is possible to salvage the installation by removing the implant and sealing the small hole on the bottom of the implant, if present, with foil or with a small sheet metal screw, then returning the implant to the hole.

7. After the implant has been docked, use a pull cap and pull the probe rod approximately one foot, exposing the implant. Observe the tubing to make sure that anchor remained in place and is not being pulled with the rod.

8. If the implant remained in place, slowly pour a measured amount of 60-100 mesh glass beads down the inside of the probe rod. The glass beads are used as a filter pack around the implant. The implant should be covered with beads to approximately six inches above the top of the implant. The volume of beads should be calculated based on the length of implant used. While pouring the beads, it is advisable to gently shake the tubing to prevent the beads from bridging inside the probe rod.

9. After placing the beads, the implant is sealed using a flowable mixture of the glass beads and fine-powdered bentonite. To accomplish this, two to three feet of rod is pulled and the mixture is slowly poured into the rod above the bead-packed implant. As with the bead placement, similar care should be taken to avoid bridging of this mixture. After placement of the bead/bentonite seal, hydrate by pouring one gallon of de-ionized water above the seal.

10. After placement and hydration of the seal, the rod string is removed and the resultant annular space is grouted using one of the following procedures, which are dependent on the depth and stability of the open hole.

    a. If the resultant open hole is shallow (ten feet or less) and the hole walls are stable, the hole may either be filled with bentonite pellets, hydrated in lifts, or grouted using a 30% solids bentonite grout, poured from the surface.

    b. If the hole is deeper than ten to fifteen feet, better results may be obtained by using a tremie pipe to place a pumpable grout. ½-inch PVC tremie pipe or Geoprobe nylon grout tubing is threaded down the annulus to the top of the bead/bentonite seal. The tremie is pulled off the bottom to prevent jetting out the seal and grout is pumped until the annulus is filled. Procedures are similar to those for well annular seals described in SESDGUID-101, Section 2.3.5.

11. For permanent or long-term installations the tubing should be protected by an appropriate surface completion, such as a flush vault or well protective casing, similar to well protective casings, as described in SESDGUID-101. The finish should be performed after 24 hours of grout curing.

12. After installation is complete the soil gas implant is sampled using one of the methods described in Section 5, Sampling PRT and Permanent Soil Gas Installations.

5 Sampling PRT and Permanent Soil Gas Installations

Soil gas samples may be collected from PRT and permanent soil gas implant installations using one of several methods, listed below. Canister sampling is the most common method utilized by SESD.

- Canister Sampling for Laboratory Analysis – After installation is complete and immediately prior to sampling, a flow-limiting device, consisting of a sintered stainless steel filter and a critical orifice, is attached at the sampling end of the tubing. After the device is connected to the Teflon® tubing, it is necessary to remove all stagnant or ambient air from the sample string. This volume, equal to approximately three times the volume of the sample string, should be estimated or calculated and attention must be given to not over-purging the estimated or calculated volume of the tubing and sample interval prior to sampling. Line purging can be accomplished using a low-flow pump, such as a personal air sampling pump, or a TVA1000.

  After all stagnant/ambient air has been removed, the purging pump is removed and an evacuated canister is attached using a Swagelok® or other suitable secure connection. After connection, the valve on the canister is opened, pulling soil gas from the implant into the canister. Typically the sample is collected over a one-hour period, at which time the canister valve is closed and the canister tagged with pertinent sampling information. Alternatively, in some situations a mass-flow controller will be required to collect a sample over a specified, longer period of time period. This type of sampler is typically out-fitted with a gauge that will display the canister vacuum during the sampling period. When using this type of device, it is advisable to check the canister vacuum throughout the sampling period to verify filling Gauge pressure/vacuum reading should be recorded in the project logbook.

- Real-time Field Analytical Methods – Real-time analytical measurements may be obtained from PRT or soil gas implant installations using appropriate instrumentation. The soil gas to be analyzed may be drawn directly into the instrument by the instrument pump or the instrument may be placed in line and the sample drawn into the instrument using a suitable pump connected to the discharge side of the instrument. Results may be qualitative, such as those obtained with flame ionization or photoionization detectors, or they may be quantitative, for instruments which can be calibrated to specific compounds.

Region 4
U. S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Ambient Air Sampling**

Effective Date: January 5, 2011

Number: SESDPROC-303-R4

Authors

Name: Richard Guillot
Title: Environmental Scientist
Signature: Richard Guillot Date: 1/4/2011

Approvals

Name: Archie Lee
Title: Chief, Enforcement and Investigations Branch
Signature: Date: 1/4/11

Name: Liza Montalvo
Title: Field Quality Manager, Science and Ecosystem Support Division
Signature: Date: 1/4/11

Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Document Control Coordinator.

History	Effective Date
SESDPROC-303-R4, *Ambient Air Sampling*, replaces SESDPROC-303-R3. **Table of Contents:** Edited to reflect changes below. **Section 1.7:** Deleted references to the Tekran Model 2505 Mercury Vapour Calibration Unit User Manual and the Tekran Vapour Analyzer 2537A User Manual. **Section 3.5:** Deleted this Section. **Section 3.6:** Renumbered to Section 3.5.	January 5, 2011
SESDPROC-303-R3, *Ambient Air Sampling*, replaces SESDPROC-303-R2. **Title Page:** Under Approvals, changed Field Quality Manager from Laura Ackerman to Liza Montalvo. **Section 1.2:** Sentence added to indicate that mention of trade names or commercial products does not constitute endorsement or recommendation for use. **Section 2.5:** Bullet #7 edited to include the daily monitoring and recording of the refrigerator temperature.	October 15, 2010
SESDPROC-303-R2, *Ambient Air Sampling*, replaces SESDPROC-303-R1. **General** Corrected any typographical, grammatical and/or editorial errors. **Title Page** Under Author changed Danny France to Richard Guillot Under Approvals changed Branch Chief from Antonio Quinones to Archie Lee. **History:** Changed Field Quality Manager to Document Control Coordinator. **Section 1.3:** Omitted reference to the H: drive. Changed the Field Quality Manager to the Document Control Coordinator.	October 30, 2009

Section 2 All previous sections were deleted. New sections were added. **Section 3** Section 3.1 was rewritten. **Section 3.8** Removed to separate guidance document. **Section 3.9** Removed to separate guidance document.	
SESDPROC-303-R1, *Ambient Air Sampling*, replaces SESDPROC-303-R0. **General** Corrected any typographical, grammatical and/or editorial errors. **Title Page** Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch. **Section 1.3** Updated information to reflect that the procedure is located on the H: drive of the LAN. Clarified Field Quality Manager (FQM) responsibilities. **Section 1.5** Updated referenced operating procedures due to changes in title names. **Section 1.6.1** Corrected the title of the Safety, Health, and Environmental Management Program Procedures and Policy Manual. **Section 1.6.2, 4th bullet** Added references to the CFR and IATA's Dangerous Goods Regulations. **Section 1.7** Updated referenced operating procedures due to changes in title names. Alphabetized and revised the referencing style for consistency. Added two references (IATA and 49 CFR).	November 1, 2007
SESDPROC-303-R0, *Ambient Air Sampling*, Original Issue	February 05, 2007

TABLE OF CONTENTS

1 GENERAL INFORMATION

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed when collecting ambient air samples for field screening or laboratory analysis. Air toxics, as used in this procedure, means air pollutants for which National Ambient Air Quality Standards have not been established. Criteria pollutants mean air pollutants for which National Ambient Air Quality Standards have been established.

1.2 Scope/Application

The procedures contained in this document are to be used by field personnel when collecting and handling ambient air samples in the field. On the occasion that SESD field personnel determine that any of the procedures described in this section are inappropriate, inadequate or impractical and that another procedure must be used to obtain an ambient air sample, the variant procedure will be documented in the field log book, along with a description of the circumstances requiring its use. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and have been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the SESD local area network (LAN). The Document control Coordinator (DCC) is responsible for ensuring the most recent version of the procedure is placed on the LAN and for maintaining records of review conducted prior to its issuance.

1.4 Quality Control

Quality control for sampling associated with ambient air monitoring is method specific. The sampling methods described in the sections that follow contain the quality control procedures appropriate for each method.

1.5 Records

Information generated or obtained by SESD personnel will be organized and accounted for in accordance with SESD records management procedures found in SESD Operating Procedure for Control of Records, SESDPROC-002. Field notes, recorded in a bound field logbook, will be generated, as well as chain-of-custody documentation in accordance with SESD Operating Procedure for Logbooks, SESDPROC-010 and SESD Operating Procedure for Sample and Evidence Management, SESDPROC-005.

1.6 General Precautions

1.6.1 Safety

Proper safety precautions must be observed when collecting ambient air monitoring samples. Refer to the SESD Safety, Health and Environmental Management Program (SHEMP) Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASPs) for guidelines on safety precautions. These guidelines, however, should only be used to complement the judgment of an experienced professional. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate.

1.6.2 Procedural Precautions

The following precautions should be considered when collecting ambient air monitoring samples.

- Special care must be taken not to contaminate samples. This includes storing samples in a secure location to preclude conditions which could alter the properties of the sample. Samples shall be custody sealed during long-term storage or shipment.

- Collected samples are in the custody of the sampler or sample custodian until the samples are relinquished to another party.

- If samples are transported by the sampler, they will remain under his/her custody or be secured until they are relinquished.

- Shipped samples shall conform to all U.S. Department of Transportation (DOT) rules of shipment found in Title 49 of the Code of Federal Regulations (49 CFR parts 171 to 179), and/or International Air Transportation Association (IATA) hazardous materials shipping requirements found in the current edition of IATA's Dangerous Goods Regulations.

- Documentation of field sampling is done in a bound logbook.

- Chain-of-custody documents shall be filled out and remain with the samples until custody is relinquished.

- All shipping documents, such as bills of lading, etc., shall be retained by the project leader and stored in a secure place.

1.7 References

Ambient Monitoring Technology Information Center (AMTIC) Internet Bulletin Board: $PM_{2.5}$ QA area (http://www.epa.gov/ttn/amtic/pmqa.html)

Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Method TO-4A (pesticides and PCBs) and TO-13A (polynuclear aromatic compounds)

Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Method TO-9A

Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Method TO-11A

Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Method TO-15A

International Air Transport Authority (IATA) Dangerous Goods Regulations, Most Recent Version

Neutronics Model RI-2002PA Portable Automotive Refrigerant Identifier Operation Instruction Manual

SESD Operating Procedure for Control of Records, SESDPROC-002, Most Recent Version

SESD Operating Procedure for Sample and Evidence Management, SESDPROC-005, Most Recent Version

SESD Operating Procedure for Logbooks, SESDPROC-010, Most Recent Version

SESD Operating Procedure for Field Sampling Quality Control, SESDPROC-011, Most Recent Version

SESD Operating Procedure for Equipment Inventory and Management, SESDPROC-108, Most Recent Version

SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, Most Recent Version

SESD Operating Procedure for Packaging, Marking, Labeling and Shipping of Environmental and Waste Samples, SESDPROC-209, Most Recent Version

Title 40 Code of Federal Regulations (CFR), Part 50, Appendix A - Reference Method for the Determination of Sulfur Dioxide in the Atmosphere (Pararosaniline Method), Most Recent Version

Title 40 CFR, Part 50, Appendix B - Reference Method for the Determination of Suspended Particulate Matter in the Atmosphere (High Volume Method), Most Recent Version

Title 40 CFR, Part 50, Appendix C - Measurement Principle and Calibration Procedure for the Measurement of Carbon Monoxide in the Atmosphere (Non-Dispersive Infrared Photometry), Most Recent Version.

Title 40 CFR, Part 50, Appendix D-Measurement Principle and Calibration Procedure for the Measurement of Ozone in the Atmosphere, Most Recent Version

Title 40 CFR, Part 50, Appendix F - Measurement Principle and Calibration Procedure for the Measurement of Nitrogen Dioxide in the Atmosphere (Gas Phase Chemiluminescence), Most Recent Version

Title 40 CFR, Part 50, Appendix G - Reference Method for the Determination of Lead in Suspended Particulate Matter Collected From Ambient Air, Most Recent Version

Title 40 CFR Part 50, Appendix J - Reference Method for the Determination of Particulate Matter as PM_{10} in the Atmosphere, Most Recent Version

Title 40 CFR Part 50, Appendix L - Reference Method for the Determination of Fine Particulate Matter as $PM_{2.5}$ in the Atmosphere, Most Recent Version

Title 40CFR Part 53 – Ambient Air Monitoring Reference and Equivalent Methods, Most Recent Version

Title 40 CFR, Part 58 – Ambient Air Quality Surveillance, Most Recent Version

Title 40 CFR, Part 58, Appendix A -Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS), Most Recent Version

Title 40 CFR, Part 58, Appendix C - Ambient Air Quality Monitoring Methodology, Most Recent Version

Title 40 CFR, Part 58, Appendix D - Network Design for State and Local Air Monitoring Stations (SLAMS), National Air Monitoring Stations (NAMS), and Photochemical Assessment Monitoring Stations (PAMS), Most Recent Version

Title 40 CFR, Part 58, Appendix E - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring, Most Recent Version

Title 49 CFR, Parts 171 to 179, Most Recent Version

US Environmental Protection Agency (US EPA) 1994. Quality Assurance Handbook for Air Pollution Measurement Systems, Volume I, Principles, EPA/600/R-94/038a, April1994.

US EPA. 1995. Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, (revised edition) EPA/600/R-94/038d, March, 1995.

US EPA. 1998. Quality Assurance Handbook for Air Pollution Measurement System, Volume II: Part 1, Ambient Air Quality Monitoring Program, Quality System Development, EPA-454/R-98-004, August 1998 (commonly referred to as the "Red Book.").

US EPA. 1998. EPA Quality Assurance Document: Method Compendium, $PM_{2.5}$ Mass Weighing Laboratory Standard Operating Procedures for the Performance Evaluation Program, United States Environmental Protection Agency Office of Air Quality Planning and Standards, October 1998.

US EPA. 2006. Standard Operating Procedure for Through-the-Probe Performance Evaluations of Ambient Air Quality Monitoring of Criteria Air Pollutants, January 2006.

US EPA. 1998. Quality Assurance handbook for Air Pollution Measurement Systems, Volume II, Ambient Air Specific Methods, Section 2.12, EPA/600/R-94/038b, November, 1998

US EPA. 2002. EPA Quality Assurance Guidance Document: Method Compendium, Field Standard Operating Procedures for the $PM_{2.5}$ Performance Evaluation Program, United States Environmental Protection Agency Office of Air Quality Planning and Standards, Revision No. 2, March 2002.

US EPA. 2005. Standard Operating Procedures for Through-The-Probe (TTP) Performance Evaluations of Ambient Air Quality Monitoring of Criteria Air Pollutants, Office of Air Quality Planning and Standards, May 2005.

US EPA Quality Assurance Document: Quality Assurance Project Plan for the Performance Evaluation Program

US EPA Implementation Plan: $PM_{2.5}$ Federal Reference Method Performance Evaluation Program, EPA Quality Assurance Guidance Document 2.12

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

2 AUDITING OF OZONE AND CARBON MONOXIDE MONITORING SITES IN THE NATIONAL PERFORMANCE AUDIT PROGRAM (NPAP)

2.1 Auditing Ozone Analyzers

The following is a synopsis of procedures which should be strictly adhered to for the auditing of ozone at ambient monitoring sites.

- The photometer (audit instrument) will meet 40 CFR Part 50, Appendix D specifications for a Primary Standard Calibration Photometer. This instrument will be re-plumbed to act as an analyzer to measure test gas concentrations.

- The photometer will be verified quarterly against a National Institute of Standards and Technology (NIST) Standard Reference Photometer before use.

- The mobile laboratory will meet the specifications of monitor reference/ equivalent designation for temperature control which is between 20-30 degrees Celsius when the analyzer is in operation.

- The probe line must meet the requirements stated in 40 CFR Part 58 for materials and sample residence time.

- Flows will be calibrated annually, and all flow calibrations will be traceable to a primary standard. Flows will be corrected to EPA standard temperature and pressure (25^{o}C and 760 mm Hg).

- The ozone generator/calibrators flow and ozone generation output will be calibrated annually.

- The ozone generator and photometer will operate using zero air supplied by a zero air generator. The zero air scrubber components will be replaced annually or if anomalies in the zero measurement are observed. The desiccant will be regenerated when two thirds (2/3) of the blue indicating silica gel has turned pink.

- During the audit, stability of each audit point will be demonstrated for at least five minutes.

- All auditing will be performed at approximately ambient pressure (utilizing a vent for excess during the audit procedure). There should be excess air flow at the probe at all times.

- All audits will be conducted “through the probe” where the probe is safely accessible.

- Chain-of-custody must be maintained at all times (monitor will be locked in the mobile laboratory when the operator is not present to prevent tampering).

2.1.1 Audit Procedure

Auditing will be conducted using the procedures as summarized below, and in accordance with the EPA Standard Operating Procedure for Through-the-Probe Performance Evaluations of Ambient Air Quality Monitoring of Criteria Air Pollutants, and 40 CFR Part 50, APPENDIX A:

- Procedures detailed in the approved instrument manual will be used for installation, calibration, QA checks, maintenance, and repairs.

- The photometer will be verified quarterly against a National Institute of Standards and Technology (NIST) Standard Reference Photometer after major maintenance or when a quality assurance (QA) check shows an out-of-control condition exists.

- A data telemetry system, with electronic strip charting capability will be operated to record the audit progress and each audit activity will be annotated on the chart. This will serve as a permanent record and diagnostic tool.

- Prior to the audit, the audit equipment, including the photometer and calibrator, will be allowed a warm up period of at least 3 hours. During this time, the system should be conditioned with at least 200 ppb of ozone. The concentration of ozone used to condition the system must always be higher than the highest audit point that will be audited.

- The audit will consist of at least three consecutive levels where at least 80% of ozone measurements are expected to be at the monitoring site and a zero measurement. The prescribed audit levels are recorded in 40 CFR Part 58, Appendix A, 3.2.2.1.

- Audit data from the mobile laboratory and monitoring site will be recorded electronically on the NPAP Audit Worksheet. This worksheet, along with the electronic strip chart trace will be printed at the conclusion of each audit event. In addition, the NPAP Audit Worksheet will be copied and placed on the network drive for archival. A hard copy of the preliminary audit report and electronic strip chart will be provided to the site operator at the conclusion of the audit.

- After completion of the study, the mobile laboratory will be returned for inspection, maintenance, and repair. All field documentation will be retained by the Air Monitoring Staff.

2.2 Auditing Carbon Monoxide Analyzers

The following is a synopsis of procedures which should be strictly adhered to for the auditing of carbon monoxide in air.

- Calibration systems will meet 40 CFR Part 50, Appendix C specifications.

- The mobile laboratory will meet the specifications of monitor reference/ equivalent designation for temperature control which is between 20-30 degrees Celsius when the analyzer is in operation.

- The audit analyzer will be calibrated using certified concentrations of standard gases before and after use.

- The probe line must meet the requirements stated in 40 CFR Part 58 for materials and sample residence time.

- Calibrator flows will be calibrated annually, and all flow calibrations will be traceable to a primary standard. Flows will be corrected to EPA standard temperature and pressure (25^{o}C and 760 mm Hg).

- The gas calibrator will operate using zero air supplied by a zero air generator. The zero air scrubber components will be replaced annually or if anomalies in the zero measurement are observed. The desiccant will be regenerated when two thirds (2/3) of the blue indicating silica gel has turned pink.

- During the audit, stability of each audit point must be demonstrated for at least five minutes.

- All auditing will be performed at approximately ambient pressure (utilizing a vent for excess during the audit procedure). There should be excess air flow at the probe at all times.

- All audits will be conducted “through the probe” where the probe is safely accessible.

- Chain-of-custody must be maintained at all times (monitor will be located in a locked enclosure when the operator is not present to prevent tampering).

2.2.1 Audit Procedure

Auditing will be conducted using the procedures summarized below, and in accordance with the EPA Standard Operating Procedure for Through-the-Probe Performance Evaluations of Ambient Air Quality Monitoring of Criteria Air Pollutants, and 40 CFR Part 50, APPENDIX C:

- Procedures detailed in the approved instrument manual will be used for installation, calibration, QA checks, maintenance, and repairs.

- The carbon monoxide analyzer will be verified using G1 or G2 certified tank gases before and after each audit or when a quality assurance (QA) check shows an out-of-control condition exists.

- A data telemetry system, with electronic strip charting capability will be operated to record the audit progress and each audit activity will be annotated on the chart. This will serve as a permanent record and diagnostic tool.

- Prior to the audit, the audit equipment, including the carbon monoxide analyzer and calibrator, will be allowed a warm up period of at least 6 hours. During this time, the system should be conditioned with approximately 200 ppb of ozone.

- The audit will consist of at least three consecutive levels where at least 80% of carbon monoxide measurements are expected to be at the monitoring site and a zero measurement. The prescribed audit levels are recorded in 40 CFR Part 58, Appendix A, 3.2.2.1.

- Audit data from the mobile laboratory and monitoring site will be recorded electronically on the NPAP Audit Worksheet. This worksheet, along with the electronic strip chart trace will be printed at the conclusion of each audit event. In addition, the NPAP Audit Worksheet will be copied and placed on the network drive for archival. A hard copy of the preliminary audit report and electronic strip chart will be provided to the site operator at the conclusion of the audit.

- After completion of the study, the mobile laboratory and equipment will be returned for inspection, maintenance, and repair. All field documentation will be retained by the Air Monitoring Staff.

2.3 Sampling of Particulate Matter in Ambient Air as $PM_{2.5}$ in the $PM_{2.5}$ Performance Evaluation Program

The following is a synopsis of procedures which should be strictly adhered to for filter based sampling of PM2.5 in air. The procedures below are a summarized version of the procedure described in the September 2006 Revised Quality Assurance Guidance Document, Method Compendium "Field Standard Operating Procedures for the $PM_{2.5}$ Performance Evaluation Program” which should be referenced for all low volume $PM_{2.5}$ sampling:

- Field personnel will take the filters, field data sheets, and COC to the monitoring site and setup the portable samplers.

- Air flow rate, barometric pressure, and two temperature measuring devices will be verified prior to each sampling event. All flow, barometric pressure and temperature standard devices are annually calibrated and traceable to a primary standard.

- An external leak check will be performed.

- The sampler will be programmed to operate and the sampling unit will be locked to prevent tampering.

- Within 8 to 16 hours following the sampling event the exposed filters will be collected, and transported refrigerated (≤ 4°C) to the SESD Filter Weighing Laboratory.

- Field personnel will return the exposed filter, data downloads, field data sheets, and COC to SESD keeping a set of the data records in two separate locations.

- After sample collection, all filters will be stored in petri-slides, boxed, and archived for one (1) year at ≤ 4°C and at least two (2) years at ambient room temperature ≤ 25°C.

2.4 Sampling of Particulate Matter in Ambient Air as PM_{10}

The following is a synopsis of procedures which should be strictly adhered to for the sampling of particulate matter as PM_{10} in air.

- All filters used will be supplied by the EPA National Filter Distribution Program, and of the same quality as supplied to the State and Local Agency Air Monitoring Stations.

- Prior to use, all filters will be checked for pinholes, and desiccated at 15^oC - 30^oC ± 3^oC, and less than 50 ± 5 percent relative humidity, for at least 24 hours.

- Initial and final (exposed) filter weights will be determined by air monitoring personnel. One of ten filters will be re-weighed as a quality assurance check. For batches less than ten, one filter will be re-weighed. Weights of clean filters should be within 2.8mg of original values, and exposed filters should be within 5 mg.

- After sampling, filters will be desiccated as previously described.

- Chain-of-custody must be maintained for all samples (monitor will be locked when the operator is not present to prevent tampering).

2.4.1 Sample Collection Procedure

Particulate samples will be collected using the High Volume sampler as described, and operated in accordance with 40 CFR Part 50, Appendix J, and Red Book Sections 2.10, and 2.11.

- All flow calibration orifices will be traceable to a primary standard Rootsmeter. Flows will be corrected to EPA standard temperature and pressure (25^{o}C and 760 mm Hg).
- Volumetric flow controllers will be used on all PM_{10} samplers. Flows will be determined using a calibrated orifice and a digital manometer.

2.5 Laboratory Filter Analysis of Particulate Matter in Ambient Air as $PM_{2.5}$ in the $PM_{2.5}$ Performance Evaluation Program

The following is a synopsis of procedures which should be strictly adhered to for filter based sampling of $PM_{2.5}$ in air. The procedures below are a summarized version of the procedure described in the Quality Assurance Guidance Document, Method Compendium "$PM_{2.5}$ Mass Weighing Laboratory Standard Operating Procedures for the Performance Evaluation Program" which should be referenced for all low volume $PM_{2.5}$ filter analysis.

- EPA OAQPS National Filter Distribution Program will send filters to the SESD $PM_{2.5}$ Filter Weighing Laboratory
- Upon introduction into the weighing laboratory process, each individual batch of filters will go through lot stability testing to determine a minimum equilibration time period.
- Prior to use the filters will be checked for deformities, equilibrated at 20 - 23°C ± 2°C and 30 - 40 % ± 5 % relative humidity for a minimum of 24 hours, labeled, pre-weighed (auto-entry into database), loaded into cassettes, and prepared for packaging and shipping.
- During the pre-weighing session, the filter batch should pass 100µg and 200µg balance checks (+/- 3ug), two consecutive weightings demonstrating stability (+/- 5 ug), and provide an initial laboratory blank weighing.
- The SESD Filter Weighing Laboratory will ship the pre-weighed filters and chain-of- custody (COC) forms to the field personnel.
- Filters and COC forms for Region 4 are passed directly to the field scientists.

- After sampling, filters will be transported to the SESD Filter Weighing Laboratory, logged into the database, refrigerated until a batch is completed, moved to the laboratory, unloaded from the cassettes, equilibrated for at least 24 hours, and post-weighed. The filter refrigerator temperature will be monitored and recorded on a daily basis.

- During the post-weighing session, the filter batch should pass 100mg and 200mg balance checks (+/- 3ug), post batch stability check (+/- 15ug), and laboratory blank check (+/- 15ug).

- SESD will calculate the tare weight from the laboratory analyses and will calculate a concentration from the field data. All field data and laboratory data will be archived and backup data will be kept on the network.

Chain-of-custody and all accompanying field data must be maintained for all samples.

3 NON-CRITERIA POLLUTANT MONITORING FOR AIR POLLUTANTS FOR WHICH NATIONAL AMBIENT AIR QUALITY STANDARDS HAVE NOT BEEN ESTABLISHED.

3.1 Formaldehyde Sampling With Dinitrophenylhydrazine Cartridges Using Method TO-11A

The following is a synopsis of procedures which should be strictly adhered to for the handling and field use of dinitrophenylhydrazine (DNPH) cartridges for formaldehyde sampling. The following generic procedures should be adhered to at all times.

Summary of Sampling Method:

A glass cartridge using dinitrophenylhydrazine (DNPH) is placed in a special sampler and is equipped with pumps that withdraw a calibrated air volume for a specified time to capture formaldehyde and other carbonyl compounds. The cartridges are collected and shipped to the laboratory under controlled temperature.

- Quality Control requirements will be based on the method’s DQO.

- A minimum of one trip blank shall be transported per one to ten samples collected. Instrument blanks, duplicated samples or co-located samples will be based on laboratory request.

- Chain of Custody shall be maintained for all samples.

- Polyethylene or latex gloves must be worn whenever handling any of the DNPH cartridges (in the extraction laboratory, during preparation for shipment, during field set-up, in the field during preparation for return shipment, and in the laboratory during preparation for analysis and during analysis).

- All padding material shall be either clean tissue paper or polyethylene-air bubble padding. Never use polyurethane foam, cardboard, or newspaper as padding material. DNPH cartridges which have been properly prepared for shipment should be shipped in coolers with eutectic salt packs (Blue Ice).

Due to shelf life limitations, only the number of DNPH cartridges needed for a maximum of 180 days (including trip blanks and extra DNPH cartridges for breakage) should be ordered at any one time.

- On the date of shipment or when loading out for a study, the Air Monitoring Staff will remove the capped DNPH cartridges from the refrigerator in the Air Laboratory.

- An appropriate amount of packing material shall be placed in the shipping container to prevent breakage of the glass DNPH tubes. The DNPH tubes should be shipped in coolers containing eutectic salt packs (e.g., Blue Ice) to maintain a temperature of approximately 4^{o}C. The DNPH cartridges shall be shipped the same day they are packed.

- At each sampling location the cooler will be opened and one plugged DNPH cartridge will be removed (wearing clean polyethylene or latex gloves) and the two end plugs will be removed from each end of the DNPH cartridge which will be immediately placed on the sampling train. (If it is the SKC brand, the glass ends of the tubes must be broken off. A trip blank will be placed in a sampler enclosure at one of the sites for the duration of the sampling event.

- The sampler will be manually turned on and allowed to run for five minutes. An initial flowrate should be recorded on the sample data sheet. The timer should be set to turn the sampler on and off at the desired times.

- The operator should retrieve and secure the sample as soon as possible after the sampling period ends. The sampler should manually be turned on and allowed to run for five minutes and a final flowrate and the elapsed time from the time meter should be recorded on the sample data sheet. The exposed DNPH cartridge will then be removed from the sampling train (wearing clean polyethylene, latex or nylon gloves). The two end caps will be placed on the ends of the DNPH cartridge. The DNPH cartridge will be placed back into the cooler. The same procedure is to be followed at each sampling site.

- At the end of each day on which the samples are collected, the exposed DNPH cartridges shall be either placed in a refrigerator for storage overnight or stored in the cooler. The cooler will be used to transport the samples to the laboratory. The duration of the non-refrigerated period shall be kept to a minimum but absolutely not more than two days (including the sampling event).

- Upon arrival of the DNPH cartridges at the laboratory, the samples shall be stored in a refrigerator until extraction.

- Chain-of-custody and all accompanying field data must be maintained for all samples.

3.2 Volatile Organic Compounds (VOC) Sampling with SUMMA® Electropolished Stainless Steel Canisters or Silcosteel® Canisters Using Method TO-15A

The following is a synopsis of procedures which should be strictly adhered to for the cleanup and use of Summa® canisters for sampling air for Volatile Organic Compounds (VOC) analysis.

The following procedures must be followed in the preparation and use of Summa® canisters for collecting samples for VOC analysis:

- All new Summa®/Silcosteel® canisters must be individually checked for contamination by the laboratory before use. One of each batch of 10 Summa® canisters that are subsequently cleaned must be analyzed to check for contamination.

- All sampler tubing, fittings, and wetted parts of valves must be solvent washed in hexane and heated to >100° C. These parts should then be assembled and flushed with nitrogen[1] for at least 8 hours prior to use in the sample train or in the canister cleanup apparatus.

- Each canister's valve and fitting will be inspected for damage before cleaning. Any damaged valve will be replaced with a previously cleaned (see procedure above) valve. After replacing any valve, the canister will be cleaned and analyzed to verify that it is free of contamination.

- If any canister is used to sample a high concentration source, it must be cleaned and analyzed to verify it is free of contamination before it can be used again.

- Chain-of-custody must be maintained for all samples.

1. The nitrogen should be certified 99.999% pure by the manufacturer. A scrubber should be attached to the nitrogen line after the regulator to remove any trace impurities.

3.2.1 Sample Collection Procedure

Two types of VOC samples can be collected with Summa®/ Silcosteel® canisters. The canister can be opened and allowed to fill rapidly to obtain a grab sample or filled slowly by using a flow controller to collect a time integrated sample. With either type of sample, the following general procedures should be followed:

- A Chain-Of-Custody Record should be completed detailing time of sampling, sampling interval, and signed by the person collecting the sample.

- After the sample has been collected, the Summa®/Silcosteel® canister should be capped, an EPA pre-numbered tag should be completed and attached to the canister, and the canister should be placed in a shipping container with a copy of the Chain-Of-Custody Record and sealed with EPA sample custody tape.

3.2.2 Grab Sample Collection Procedure

Before a grab sample is collected for VOC analysis in a Summa®/Silcosteel® canister, the canister inlet valve should be fitted with a pre-cleaned stainless steel particulate filter. At the sample collection location, the main valve should be opened and the canister allowed to fill. After about one minute (when no audible sound of rushing gas can be heard), the main valve of the Summa® canister should be closed and capped.

3.2.3 Time Integrated Sample Collection Procedure

This sample collection method involves the use of a flow controller or a sampler containing a flow controller to slowly meter the flow of air entering a Summa®/Silcosteel® canister. With this method, a sample is collected over a longer period of time than with a grab sample. If a constant flowrate was maintained, the resulting sample will have a VOC content that is the average of the VOC concentrations during the sampling interval. The following procedures should be followed to collect time integrated samples:

- <u>Cleaning and Adjustment</u>
  All sampler systems should be checked for contamination prior to use or after any major repair. This is accomplished by metering humidified zero air to the inlet of the sampler. Excess zero air should be vented with a Swagelok® tee from the sampler inlet to atmosphere. The evacuated canister should then be filled at the normal sampling rate with the zero gas and verified by the laboratory to be free from contamination.

- <u>Sample Collection</u>
  Prior to sampling the flow controller will be calibrated a mass flow meter. The flowrate should be adjusted so that at the end of the sampling interval the ending pressure of the canister is approximately 0.9 atm. The final canister vacuum should be between 5 inches and 1 inch of Hg. The final flowrate should be at least 1 scc/min.

After sample collection, all canisters should be tagged with an EPA pre-numbered tag with all of the information filled out. Place the canister in a shipping container and seal the container with EPA sample custody tape.

3.3 Sampling for Semi-Volatile Organic Compounds (SVOC) Analysis with High Volume PUF Samplers Using Methods TO-4A & TO-13A

The following is a synopsis of procedures which should be strictly adhered to for use of the High Volume Polyurethane Foam (PUF) sampling method for collecting samples for semi-volatile organic compound (SVOC) analysis including pesticides and polychlorinated biphenyls.

The following procedures must be followed during preparation of PUF sampling media when using the High Volume PUF method for collecting samples for SVOC analysis:

- All PUF sampling media should be pre-cleaned, loaded into High Volume PUF sample cartridges, and sealed in solvent washed cans by the extraction laboratory prior to use.

- Chain-of-custody shall be maintained for all samples.

3.3.1 PUF Cleaning Procedure

- The Air Monitoring Staff has responsibility for buying the PUF media and cutting the PUF plugs. PUF media should be specified as <u>not</u> containing any fire retardants. It should be stored in the dark to prevent photo-oxidation. It should be less than two years old, and should be stored in a pesticide-free environment.

- Care should be exercised in cutting the PUF. It should be thoroughly wet with tap water prior to cutting. A drill press and stainless steel PUF cutting die should be used. The drill press area should be free of oil and a polyethylene cutting block should be used to stop the die at the bottom of the drill press stroke (do not use wood). Water should be sprayed on the die to help prevent snagging as the PUF is cut. After the plugs are cut, they should be rinsed with tap water and followed by a rinse with analyte-free water. Finally, the excess water should be squeezed out.

- The PUF/XAD cartridges are assembled using a modified glass sleeve containing an extra-extra coarse frit to retain the XAD resin in the following manner. A 3/4-inch layer of XAD resin is poured on top of the frit followed by a 1½-inch PUF plug to retain the XAD resin.

- The assembled PUF/XAD cartridges are delivered to the extraction laboratory for cleaning and checking. The extraction laboratory will be given a minimum of three weeks notice for cleaning and checking the PUF/XAD cartridges. The cleaned PUF/XAD cartridges should be wrapped in aluminum foil and packed in pre cleaned metal cans or glass jars cushioned by new polyethylene bubble wrap to prevent breakage during shipment. Prepared PUF/XAD sample cartridges that are pre-packed in solvent washed metal cans will be obtained from the extraction laboratory prior to sampling. The cans should be packed inside coolers frozen eutectic salt packs (Blue Ice) to maintain a temperature of less than 15°C.

3.3.2 Sample Collection Procedure

The following procedure will be followed for all High Volume PUF/XAD sampling.

- Powder-free latex gloves will be used when handling all PUF/XAD cartridges and quartz particulate pre-filters. Assure that the red silicon upper and lower gaskets, located in the cartridge housing, are in place. Then remove the PUF/XAD cartridge from the shipping container, remove from the foil and insert the cartridge into the High Volume sampler's chamber. The pre-filter should be installed in the filter holder using caution not to over tighten the fittings. The foil should be placed back in the shipping container. The container should be labeled with site ID, operator's name, and sample date, and placed in the High Volume sampler enclosure until the sample is collected.

- The High Volume sampler should be turned on and allowed to run for two minutes. An initial flowrate should be recorded on the sample data sheet. The timer should be set to turn the sampler on and off at the desired times.

- The operator should retrieve and secure the sample as soon as possible after the sampling period ends. The sampler should then be manually turned on and allowed to run for two minutes. A final flowrate should be recorded on the sample data sheet. The final flowrate should be at least 150 liters per minute. The PUF/XAD cartridge should be removed, and the quartz pre-filter folded and placed in the top of the PUF/XAD cartridge. The PUF/XAD cartridge and pre-filter should be re-wrapped in the original aluminum foil and placed back in the shipping container. The container should then be tightly sealed. Complete the sample data sheet and Chain-Of-Custody Record and seal the shipping container with a sample custody seal. Finally, the shipping container containing the sample should be placed in a cooler containing frozen eutectic salt packs (at a nominal temperature of ~ 15^{o} C). When all samples are collected from all sites, the cooler should be sealed with sample custody tape for transport back to the laboratory.

- Upon arrival of the metal container at the laboratory, the samples shall be stored in the metal container in a refrigerator until submitted for extraction.

3.4 Collecting Samples for Metals Analysis Using the High Volume Sampler

The following is a synopsis of procedures which should be strictly adhered to for the collection of samples for metals analysis in air using the High Volume sampler:

- All quartz filters used will be supplied by the EPA National Filter Distribution Program, and of the same quality as supplied to the State and Local Agency Air Monitoring Stations.

- Prior to use, all filters will be checked for pinholes, and desiccated at 15^{o}C - 30^{o}C, ± 3^{o}C, and less than 50 percent relative humidity, ± 5 percent, for at least 24 hours.

- A filter field blank will be taken to the field, but not exposed. Filter field blanks will be analyzed by the laboratory to determine the concentration of metals contained in the filter matrix. The number of filter blanks will be determined based on a minimum of one blank for each ten samples collected.

- Chain-of-custody must be maintained for all samples.

3.4.1 Sample Collection Procedure

Samples will be collected using the High Volume sampler as described, and operated in accordance with 40 CFR, PART 50, APPENDIX B:

- All flow calibration orifices will be traceable to a Primary Standard Rootsmeter. Flows will be corrected to EPA standard temperature and pressure (25^{o}C and 760 mm Hg).

- Digital manometers used to determine flow rates will calibrated by the factory annually.

- Air Monitoring Staff personnel will remove a 2-inch strip of the exposed filter from one end and discard it. Two 1-inch strips will be cut from the same end and transported to the laboratory for analysis.

3.4.2 Integrated Sample Collection Procedure

The following procedure should be followed to collect time integrated samples:

- Initial and final flow rates will be determined with a calibrated orifice and a digital manometer.

- After the sample has been collected, the filter will be folded lengthwise and placed in a filter holder. The filter holder is then placed in an envelope and the envelope sealed.

- A Chain-Of-Custody Record should be completed which contains the time of sampling, the sampling interval, and the signature of the person taking the sample.

After sample collection, all sample envelopes will be placed in an appropriate container. An EPA custody seal will be placed on the container. Filters will be cut by the Air Monitoring Staff and transported to the laboratory for analysis.

3.5 Sampling for Dioxin and Dibenzofuran Analyses with High Volume PUF Samplers Using Method TO-9A

3.5.1 General Information

The following is a synopsis of procedures which should be strictly adhered to for use of the High Volume Polyurethane Foam (PUF) sampling method for collecting samples for polychlorinated dibenzo-p-dioxins and dibenzofurans analyses.

Since this method requires High-Resolution Mass Spectrometry which the Region 4 laboratory does not have, all sample media preparation and analysis will have to be contracted. At least one month's notice prior to sampling should be given to obtain a contract laboratory for any dioxin and dibenzofuran analysis. It is important that the contract specify a number of details to assure accurate results:

- All of the PUF media and a representative number of each batch of quartz pre-filters should be checked by the contract laboratory to assure that there is no contamination. Each PUF plug should be pre-spiked by the contract laboratory with dioxin and dibenzofuran surrogates as a check of the accuracy of the method.

- Each set of PUF plugs and quartz filters should be securely packed in sealed containers and in coolers to prevent damage during shipment. The sampling media should be shipped air freight to minimize the time between cleanup and sampling.

- Chain-of-custody shall be maintained for all samples.

3.5.2 Sample Collection Procedure

The following procedure will be followed for the collection of all High Volume PUF samples for dioxins and dibenzofurans analyses.

Latex gloves will be used when handling all PUF cartridges and quartz particulate pre-filters. Assure that the red silicon upper and lower gaskets are in place in the PUF cartridge housing. Remove the PUF cartridge from the shipping can. Unwrap and insert the PUF cartridge into the High Volume (Hi-Vol) PUF sampler's chamber. Install the pre-filter in the filter holder using caution not to over-tighten the fittings. The removed aluminum foil should be placed in the shipping container which then should be resealed. The container should be labeled with the site ID, the operator's name, and the sample date, and placed in the Hi-Vol PUF sampler enclosure until the sample is collected. The Hi-Vol PUF sampler should be turned on and allowed to run for two minutes. An initial flowrate should be recorded on the sample data sheet. The timer should be set to turn the sampler on and off at the desired times.

The operator should retrieve and secure the sample as soon as possible after the sampling period ends. The sampler should then be manually turned on and allowed to run for two minutes and a final flowrate recorded on the sample data sheet. The final flowrate should be at least 150 liters/minute. The PUF cartridge should be removed, and the quartz pre-filter folded and placed in the top of the PUF cartridge. The PUF cartridge and pre-filter should be re-wrapped in the original aluminum foil and placed back in the shipping container and the container should be tightly sealed. Complete the sample data and sample custody sheets. Each shipping container should have a sample custody seal. Finally, the shipping container containing the sample should be placed in a cooler containing frozen eutectic salt packs (at a nominal temperature of ~ 4^{o}C). When all samples are collected from all sites, the cooler should be sealed with sample custody tape for shipment to the contract laboratory.

Upon arrival of the metal container at the contract laboratory, the samples shall be stored in the metal container in a refrigerator until submitted for extraction.

Imagine the result

Soil Gas Sampling Using Single or Nested Ports

SOP #428199

Rev. #: 4

Rev Date: July 9, 2010

Approval Signatures

Prepared by: Mitch Wacksman Date: 07/09/2010
Mitch Wacksman and Andrew Guther

Approved by: Christopher C Lutes Date: 07/09/2010
Christopher Lutes and Nadine Weinberg

I. Scope and Application

This document describes the procedures for installing semi-permanent or permanent single or nested soil-gas ports and collecting soil-gas samples. Nested soil-gas ports allow for the generation of discrete data as a function of depth and time. Samples are collected for the analysis of volatile organic compounds (VOCs) by United States Environmental Protection Agency (USEPA) Method TO-15 (TO-15). Method TO-15 uses a 1-liter, 3-liter or 6-liter SUMMA® passivated stainless steel canister. An evacuated SUMMA canister (less than 28 inches of mercury ("Hg")) will provide a recoverable whole-gas sample of approximately 5 liters when allowed to fill to a vacuum of 6 inches of Hg. The whole-air sample is then analyzed for VOCs using a quadrupole or ion-trap gas chromatograph/mass spectrometer (GS/MS) system to provide compound detection limits of 0.5 parts per billion volume (ppbv). Optionally, the whole air sample can also be analyzed for permanent gasses such as oxygen and carbon dioxide.

The following sections list the necessary equipment and provide detailed instructions for the installation of semi-permanent or permanent single or nested soil-gas ports (using direct-push technology or a hollow stem auger) and the collection of soil-gas samples for VOC analysis.

II. Personnel Qualifications

ARCADIS field sampling personnel will have current health and safety training, including 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training. Site supervisor training, site-specific training, first-aid, and cardiopulmonary resuscitation (CPR), may be appropriate at some sites. ARCADIS field sampling personnel will be well versed in the relevant standard operating procedures (SOPs) and possess the required skills and experience necessary to successfully complete the desired field work. ARCADIS personnel responsible for leading soil-gas sample collection activities must have previous soil-gas sampling experience.

III. Health and Safety Considerations

All sampling personnel should review the appropriate health and safety plan (HASP) and job loss analysis (JLA) prior to beginning work to be aware of all potential hazards associated with the job site and the specific installation. Field sampling equipment must be carefully handled to minimize the potential for injury and the spread of hazardous substances. For vapor port installation, drilling with a direct-push drilling rig or hollow stem auger rig should be done only by personnel with prior experience using such of equipment.

IV. Equipment List

The equipment required to install single or nested soil vapor ports is presented below:

- Appropriate personal protective equipment (PPE; as required by the HASP and JLA).
- Appropriate drill rig to reach necessary sample depth (hollow stem auger, direct-push rig, etc)
    - Hollow stem auger rig with interconnecting augers. The inner diameter of typical augers ranges from 2.25-inches to 7.75-inches; the auger size should be chosen should be large enough to accommodate the number of nested ports that will be installed inside the boring.
    - Direct-push rig (e.g., -Geoprobe) equipped with interconnecting 4-foot lengths of steel drive rods (2.25-inch-diameter, or 3.25-inch diameter depending on the number of ports to be installed).
- 1/4-inch outside diameter (OD) x 1/8-inch inside diameter (ID) tubing (Teflon, Teflon lined, or nylon). Note that Nylaflow tubing has a somewhat higher background level of BTEX and much poorer recovery of trichlorobenzene and naphthalene then Teflon, so it should not be used on site where these compounds are a concern (Hayes, 2006)
- Stainless steel sample screens with sacrificial point (one per sample depth to weight sample screen, available from Geoprobe). Typically 6" long for sized for 1/4-inch OD tubing.
- Stainless steel, or Teflon ball valve or needle valve (one per sample depth to match sample tubing) for sample line termination.
- Commercially available clean sand filter pack or glass beads having a grain size larger than 0.0057-inch (pore diameter of screen)

- Granular and powdered bentonite (Benseal®, Volclay® Crumbles, or equivalent)

- Down hole measuring device

- Distilled or Deionized water for hydration of bentonite

- Plastic or aluminum tags for permanently labeling port with sample depth, and port identification number. It is no recommended to write on or affix adhesive tape to tubing as these methods fail over time.

- Well cover for permanent installation, This should be a traffic rated road box for exterior installations or an appropriate clean-out cover for interior installations.

- Photoionization Detector (PID) (with a lamp of 11.7 eV).

The equipment required for soil-gas sample collection from single or nested ports is presented below:

- 1,3, or 6 -liter stainless steel SUMMA® canisters (order at least one extra, if feasible) (batch certified canisters or individual certified canisters as required by the project)

- Flow controllers with in-line particulate filters and vacuum gauges. Flow controllers are pre-calibrated to specified sample duration (e.g., 30 minutes, 8 hours, 24 hours) or flow rate (e.g., 200 milliliters per minute [mL/min]). confirm with the laboratory that the flow controller comes with an in-line particulate filter and pressure gauge (order at least one extra, if feasible). Flow rate should be selected based on expected soil type (see below)

- Decontaminated stainless steel1/4-inch Swagelok (or equivalent) fittings (e.g., nuts, ferrules and backers)

- Decontaminated stainless steel Swagelok or comparable "T" fitting and needle valve for isolation of purge pump.

- Stainless steel or brass "T" fitting (if collecting duplicate (i.e., split) samples). Swage-lok or comparable

- Portable vacuum pump capable of producing very low flow rates (e.g., 100 to 200 mL/min) with vacuum gauge. Purging flow rate should also be selected based on expected soil type (see below).

- Rotameter or an electric flow sensor if vacuum pump does not have an accurate flow gauge (Bios DryCal or equivalent).

- Tracer gas testing supplies if applicable (refer to tracer SOP)

- Photoionization Detector (PID) (with a lamp of 11.7 eV)

- Appropriate-sized open-end wrench (typically 9/16-inch, 1/2-inch, and 3/4-inch)

- Down hole measuring device (e.g., water level probe, tape measure)

- Portable weather meter, if appropriate

- Chain-of-custody (COC) forms

- Sample collection logs (attached)

- Field Book

V. Cautions

The following cautions and field tips should be reviewed and considered prior to installing or collecting a single or nested soil-gas sample.

- When drilling to install sampling ports , be mindful of utilities that may be in the area. Follow ARCADIS utility location procedure. If the driller is concerned about a particular location, consult the project manager about moving it to another location. Do not hesitate to use Stop Work Authority if something doesn't seem right stop and remedy the situation.

- Sampling personnel should not handle hazardous substances (such as gasoline), permanent marking pens (sharpies), wear/apply fragrances, or smoke cigarettes/cigars before and/or during the sampling event.

- Ensure that the flow controller is pre-calibrated to the proper sample collection duration (confirm with laboratory). Sample integrity can be compromised if sample collection is extended to the point that the canister reaches atmospheric pressure. Sample integrity is maintained if sample collection is terminated prior to the target duration and a measurable vacuum (e.g., 3-7 inches Hg) remains in the canister when sample collection is terminated. Do not let sample canister reach atmospheric pressure (e.g., 0-inches Hg).

- Care should be taken to ensure that nested ports are installed at the target sample depths within the sand filer pack.. Sampling personnel should work closely with the driller to accomplish this.

- When introducing granular bentonite to the boring, the material should be introduced slowly and hydrated properly. Consult the bentonite manufacturer's instructions on the bag to determine the proper amount of to be used. When hydrated properly bentonite forms a thick clay mass that remains moist. The hydration step is crucial in the installation process and if not done properly the integrity of the bentonite seal can be compromised.

- Using prehydrated bentonite is best and should be discussed with drilling subcontractor.

- The purge flow rate of 100 ml/min should be suitable for a variety of silt and sand conditions but will not be achievable in some clays without excessive vacuum. Thus lower flow rates may be necessary in clay. A low vacuum (≤10" of mercury) should be maintained. Record the measured flow rate and vacuum pressure during sample collection.

  The cutoff value for vacuum differs in the literature from 10" of water column (ITRC 2007) to 136" of water column or 10" of mercury (http://www.dtsc.ca.gov/lawsregspolicies/policies/SiteCleanup/upload/SMBR_ADV_activesoilgasinvst.pdf). A detailed discussion of the achievable flow rates in various permeability materials can be found in Nicholson 2007. Related issues of contaminant partitioning are summarized in ASTM D5314-92. Passive sampling approaches can be considered as an alternative for clay soils although most passive methods for soil gas do not yield a quantitative concentration in soil gas.

- It is important to record the canister pressure, start and stop times and ID on a proper field sampling form. You should observe and record the time/pressure at a mid-point in the sample duration. It is a good practice to lightly tap the pressure gauge with your finger before reading it to make sure it isn't stuck.

- Ensure that there is still measureable vacuum in the SUMMA® after sampling. Sometimes the gauges sent from labs have offset errors, or they stick.

- When sampling carefully consider elevation. If your site is over 2,000' above sea level or the difference in elevation between your site and your lab is more than 2,000', then pressure effects will be significant. If you take your samples at a high elevation they will contain less air for a given ending pressure reading. High elevation samples analyzed at low elevation will result in more dilution at the lab, which could affect reporting limits. Conversely low elevation samples when received at high elevation may appear to not have much vacuum left in them. http://www.uigi.com/Atmos_pressure.html.

- If possible, have equipment shipped a two or three days before the sampling date so that all materials can be checked. Order replacements if needed.

- Requesting extra canisters from the laboratory should also be considered to ensure that you have enough equipment on site in case of an equipment failure.

- Soil-gas sampling should not proceed within 5 days following a significant rain event (1/2-inch of rainfall or more). Exceptions to this requirement may be appropriate depending on site climatic conditions, soil gas point depth and soil drainage characteristics. However since this requirement is frequently contained in regulatory documents, any exception to this requirement must be discussed with client and/or regulatory representatives. ITRC (2007) discussed the conditions when this requirement may not be necessary: “*Infiltration from rainfall can potentially impact soil gas concentrations by displacing the soil gas, dissolving VOCs, and by creating a “cap” above the soil gas. In many settings, infiltration from large storms penetrates into only the uppermost vadose zone. In general, soil gas samples collected at depths greater than about 3–5 feet bgs or under foundations or areas with surface cover are unlikely to be significantly affected. Soil gas samples collected closer to the surface (<3 feet) with no surface cover may be affected. If the moisture has penetrated to the* *sampling zone, it typically can be recognized by difficulty in collecting soil gas samples. "*

VI. Procedure

Single or Nested Soil-Gas Monitoring Point Installation

The procedure used to install semi-permanent or permanent single or nested soil-gas ports will vary based upon the method of boring installation. In most situations a temporary well casing well need to be installed to keep the down hole formation from collapsing during port installation. The following steps will detail installing nested soil-gas ports through a temporary well casing.

If the nested ports will be installed at shallow depths, or the formation is thought to be stable enough to not collapse, a temporary well casing may not be necessary to facilitate the installation of the sample ports. Either way, the steps for installing the sample ports are nearly identical. These following steps should be discussed with the drilling subcontractor and altered based on the methods chosen for a given project.

1. Advance boring to bottom of deepest sampling interval and install a temporary well casing. Care should be taken to ensure that the terminal depth of the boring does not reach groundwater or the capillary fringe. Soil-gas probes should not be installed in groundwater or the capillary fringe. Moisture conditions and/or other observations (such as depth to water in nearby monitoring wells) should be recorded on the soil-gas collection log, as indicated.

2. Cut a length of 1/4-inch tubing slightly longer (e.g., 4 to 5 feet) than the collection depth. Attach a stainless steel sample screen and sacrificial point to the tubing and lower the screen and attached tubing through the boring.

3. Assure that the sample screen has reached the bottom of the boring and record this depth.

4. Begin simultaneously filling in the area around the sample screen with sand filter pack and retracting the temporary well casing. The casing should be lowered back down onto the sand every few inches to compact the sand around the screen. Sand should be introduced 3-inches below the screen, to cover the 6-inch sample screen and extend 3-inches inches above the screen for a total of 12 inches of sand. Closely monitor the amount of sand added to the borehole with a tape measure or water level probe.

5. With the proper sand pack in place begin slowly introducing 6-inches of dry granular bentonite into the boring. This dry Bentonite will prevent water from entering the sand filter pack during hydration.

6. A slurry of hydrated bentonite should be placed above the dry granular bentonite to the next sample depth (for nested ports) or to the ground surface (for single ports).

7. Properly label the sample tubing with a permanent label to designate the sample number and screen depth.

8. Affix a Swagelok fitting and valve to the end of the tubing.

9. Add an inch or two of dry granular Bentonite over the bentonite slurry prior to installing the subsequent sand filter pack and screen.

10. Repeat steps 2-8 until all the sample depths are installed.

11. With all semi-permanent or permanent single or nested ports installed and labeled, a well cover may be installed.

    a. For permanent installations, the well cover should be rated for whatever type of traffic it may encounter in the future. For interior installations a brass clean-out cover available from a plumbing supply store may provide adequate protection. For exterior installations in high traffic areas a heavy duty groundwater well cover may be appropriate.

    b. For a semi-permanent installation, a well cover is generally not necessary as the tubing will be removed within several days.

12. All soil-gas points should be allowed to sit and equilibrate for a minimum of 24-hours before proceeding to soil-gas sample collection.

Soil-Gas Sample Collection

The following steps should be used to collect a soil-gas sample from each of the single or nested probes installed using the above procedure.

1. Record the following information on the sample log, if appropriate (contact the local airport or other suitable information source (e.g., site-specific measurements, weatherunderground.com) to obtain the information):

    a. wind speed and direction;

    b. ambient temperature;

    c. barometric pressure; and

    d. relative humidity.

2. Assemble the sample train by removing the cap from the SUMMA canister and connecting the Swagelok T-fitting to the can using a short length of 1/4-inch OD Teflon tubing. The flow controller with in-line particulate filter and vacuum gauge is then attached to the T-fitting. The Swagelok (or similar) two-way valve is connected to the free end of the T-fitting using a short length of ¼-inch OD Teflon tubing (precleaned stainless steel tubing could also be used)..

3. When collecting duplicate or other quality assurance/quality control (QA/QC) samples as required by applicable regulations and guidance, couple two SUMMA canisters using stainless steel Swagelok duplicate sample T-fitting supplied by the laboratory. Attach flow controller with in-line particulate filter and vacuum gauge to duplicate sample T-fitting provided by the laboratory.

4. Attach Teflon sample tubing to the flow controller using Swagelok fittings.

5. Remove the flush Swagelok cap from the sample port and install a Swagelok nut, ferrules, and sample tubing into the sub-slab port.

6. Connect the two-way valve and the portable purge pump using a length of Teflon sample tubing.

7. Record on the sample log and COC form the flow controller number with the appropriate SUMMA® canister number.

    a. Perform a leak-down-test by replacing the nut which secures sample tubing with the cap from the canister or closing the valve on the sample port. This will create a closed system. Open the canister valve and quickly close it; the vacuum should increase approaching 30" Hg. If there are no leaks in the system this vacuum should be held. If vacuum holds proceed with sample collection; if not attempt to rectify the situation by tightening fittings.

8. The seal around the soil-gas sampling port and the numerous connections comprising the sampling train will be evaluated for leaks using helium as a tracer gas. The helium tracer gas will be administered according to the methods established in the appropriate guidance documents and SOP: Administering Tracer Gas.

9. Open the two-way valve and purge the soil-gas sampling port and tubing with the portable sampling pump. Purge approximately three volumes of air from the soil-gas sampling port and sampling line using a flow rate of 200 mL/min. Purge volume is calculated by the following equation: purge volume = 3 × Pi × inner radius of tubing^2 × length of tubing. Purge air should be vented away from personnel and sampling equipment, a length of tubing or Tedlar bag can be used for this purpose. Measure organic vapor levels and tracer gas within the Tedlar bag, as appropriate.

10. Close the two-way valve to isolate the purge pump.

11. Open the SUMMA® canister valve to initiate sample collection. Record on the sample log (attached) the time sampling began and the canister pressure.

If the initial vacuum pressure registers less than -25 inches of Hg, then the SUMMA® canister is not appropriate for use and another canister should be used.

12. Take a photograph of the SUMMA® canister and surrounding area unless prohibited by the property owner.

13. Check the SUMMA canister pressure approximately halfway through the sample duration and note progress on sample logs.

14. Steps 2-10 should be repeated for each of the nested soil-gas ports; samples can be collected concurrently.

Termination of Sample Collection

1. Arrive at the SUMMA® canister location at least 1-2 hours prior to the end of the required sampling interval (e.g., 8, 24-hours)..

2. Record the final vacuum pressure. Stop collecting the sample by closing the SUMMA® canister valves. The canister should have a minimum amount of vacuum (approximately 6 inches of Hg or slightly greater).

3. Record the date and time of valve closing on the sample log and COC form.

4. Close the valve on the nested soil-gas sample tubing or replace Swagelok cap.

5. Once all the nested samples have been collected, be sure the well cover (if applicable) is properly re-installed and secured.

6. Remove the particulate filters and flow controllers from the SUMMA® canisters, re-install the brass plugs on the canister fittings, and tighten with the appropriate wrench.

7. Package the canisters and flow controllers in the shipping container supplied by the laboratory for return shipment to the laboratory. The SUMMA® canisters should not be preserved with ice or refrigeration during shipment.

8. Complete the appropriate forms and sample labels as directed by the laboratory (e.g., affix card with a string).

9. Complete the COC form and place the requisite copies in a shipping container. Close the shipping container and affix a custody seal to the container closure. Ship the container to the laboratory via overnight carrier (e.g., Federal Express) for analysis.

VII. Soil-Gas Monitoring Point Abandonment

If the single or nested soil-gas ports were installed in a semi-permanent manner, and the soil-gas samples have been collected, the soil-gas monitoring points will be abandoned by pulling up the sample tubing. Since the boring is filled with bentonite and sand, no additional abandonment steps are necessary. Ensure that the boring location and surrounding area are returned to as close to their original appearance as possible.

VIII. Waste Management

The waste materials generated by these activities should be minimal. Personal protective equipment, such as gloves and other disposable equipment (i.e., tubing) should be collected by field personnel for proper disposal. Any soils brought up from the borehole should be disposed of in a manner consistent with the project workplan.

IX. Data Recording and Management

Measurements will be recorded on the sample log at the time of measurement with notations of the project name, sample date, sample start and finish time, sample location (e.g., GPS coordinates, distance from permanent structure), canister serial number, flow controller serial number, initial vacuum reading, and final pressure reading. Field sampling logs and COC records will be transmitted to the Project Manager.

X. Quality Assurance

Duplicate samples should be collected in the field as a quality assurance step. Generally, duplicates are taken of 10% of samples, but project specific requirements should take precedence.

Soil-gas sample analysis will generally be performed using USEPA TO-15 methodology or a project specific constituent list. Method TO-15 uses a quadrupole or ion-trap GC/MS with a capillary column to provide optimum detection limits (typically 0.5-ppbv for most VOCs). A trip blank sample will accompany each shipment of soil-gas samples to the laboratory for analysis. Trip blanks assess potential sample contamination resulting from the transportation and storing of samples.

Duplicate soil gas samples should be collected via a split sample train, allowing the primary and duplicate sample to be collected from the soil-gas probe simultaneously.

XI. References

ASTM – "Standard Guide for Soil Gas Monitoring in the Vadose Zone", D5314-92.

ITRC "Vapor Intrusion Pathway: A Practical Guide", January 2007, Appendix F: "Regulators Checklist for Reviewing Soil Gas Data".

New York State Department of Health (NYSDOH). 2005. DRAFT “Guidance for Evaluating Soil Vapor Intrusion in the State of New York” February 23, 2005.

Nicholson, P, D. Bertrand and T. McAlary. “Soil Gas Sampling in Low-Permeability Materials” Presented at AWMA Specialty Conference on Vapor Intrusion, Providence RI, Sept 200

Hayes, H. C., D. J. Benton and N. Khan “Impact of Sampling Media on Soil Gas Measurements” Presented with short paper at AWMA Vapor Intrusion Conference, January2006, Philadelphia, PA.

ARCADIS

Sub-slab Soil Vapor Sample Collection Log

		Sample ID:	
Client:		**Boring Equipment:**	
Project:		**Sealant:**	
Location:		**Tubing Information:**	
Project #:		**Miscellaneous Equipment:**	
Samplers:		**Subcontractor:**	
`		**Equipment:**	
Sampling Depth:		**Moisture Content of Sampling Zone):**	
Time and Date of Installation:		**Approximate Purge Volume:**	

Instrument Readings:

Date	Time	Canister Vacuum (a) (inches of Hg)	Temperature (°F)	Relative Humidity (%)	Air Speed (mph)	Barometric Pressure (inches of Hg)	PID (ppb)

(a) Record canister information at a minimum at the beginning and end of sampling

SUMMA Canister Information:

Size (circle one):	**1 L** **6 L**
Canister ID:	
Flow Controller ID:	
Notes:	

Tracer Test Information (if applicable):

Initial Helium Shroud:	
Final Helium Shroud:	
Tracer Test Passed:	**Yes** **No**
Notes:	

General Observations/Notes:

Approximating One-Well Volume (for purging):

When using 1□-inch "Dummy Point" and a 6-inch sampling interval, the sampling space will have a volume of approximately 150 mL. Each foot of □-inch tubing will have a volume of approximately 10 mL.

ARCADIS
Infrastructure · Water · Environment · Buildings

Imagine the result

HERCULES

Project Management Plan

USEPA RCRA 3013(a)
Administrative Order
EPA ID No. MSD 008 182 081
Docket No. RCRA-04-2011-4251
MDEQ AI No. 2022

16 September 2011

Project Management Plan

USEPA RCRA 3013(a)
Administrative Order
Hattiesburg, Mississippi

John Ellis

John Ellis, P.G.
Principal Scientist/Hydrogeologist

James Reid

James L. Reid
Principal in Charge

Prepared for:
Hercules Incorporated

Prepared by:
ARCADIS U.S., Inc.
10352 Plaza Americana Drive
Baton Rouge
Louisiana 70816
Tel 225 292 1004
Fax 225 218 9677

Our Ref.:
LA002999.0004.00700

Date:
16 September 2011

Appendix

1. Project Organization and Responsibilities

This Project Management Plan (PMP) has been prepared to support the Phase 1 Sampling and Analysis Work Plan (Work Plan) by documenting mechanisms that will be implemented to ensure the investigation undertaken by Hercules Incorporated (Hercules), in Hattiesburg, Mississippi, pursuant to the May 9, 2011, Administrative Order (AO) issued by Region 4 of the U.S. Environmental Protection Agency (USEPA) pursuant to Section 3013(a) of the Resource Conservation and Recovery Act (RCRA), 42 United States Code (USC) §6934(a), is performed in accordance with the requirements of the AO.

Hercules will review this PMP periodically to ensure its continued applicability. Laboratory control limits will be updated annually or as re-calculated by the analytical laboratory. The Project Manager (PM) will be responsible for initiating the review and update. If the review indicates additions or changes are required, the PMP will be updated by preparing changes to specific sections.

The information presented in this PMP covers general procedures for implementing applicable USEPA guidance and Mississippi Department of Environmental Quality (MDEQ) requirements to ensure that data of verifiable quality are generated. This is necessary to ensure the validity of the results of the investigation. Hercules' Subcontractors will also be contracted to perform activities in accordance with this PMP. The analytical laboratory will perform analyses in accordance with USEPA-approved methods and as further defined by the laboratory standard operating procedures, as well as the project's Quality Assurance Project Plan (QAPP) and the Work Plan requirements.

This PMP addresses the general activities that may be performed in accordance with the AO to achieve the project objectives. The investigation is being performed under the direction of the USEPA to assess the presence, magnitude, extent, direction, and rate of movement of any of the constituents to be monitored under the AO (the "Constituents").

An environmental contractor will be selected to perform and oversee the field operations as well as compile and submit the final report on behalf of Hercules. Accredited contract laboratories will be selected to provide analytical support. Geotechnical work will be performed by a water well driller licensed in the state of Mississippi.

The PM and Field Operations Manager are primarily responsible for the implementation of the PMP and quality assurance and quality control (QA/QC) programs on the project. The specific QA responsibilities of the key project personnel are described in the QAPP. The organizational chart for the project is provided as Attachment A.

1.1 Project Manager

The selected contractor will identify a PM for the project. The PM will oversee the implementation of all schedules and budgets. He will establish and interpret all contract policies and procedures and access appropriate resources in order to maintain technical quality. The PM will work with the Field Operations Manager and QA Manager to resolve any QA/QC issues during the implementation of the site activities.

The PM is responsible for all field activities. The PM will also be responsible for reviewing any new work not currently defined to determine whether the PMP will require amendments or modifications. In addition, the PM is responsible for distributing all site-specific plans and related documents to the Field Operations Manager and the Laboratory PM, who in turn distribute it to the appropriate technical staff. Specific PM responsibilities include:

- Overseeing day-to-day task performance including all technical and administrative operations;
- Coordinating with the Hercules PM;
- Tracking schedules and budgets and management of mobilization and contract closeout activities;
- Performing assessment and oversight duties as described in the Work Plan;
- Selecting and monitoring technical staff;
- Reviewing and approving all final reports and other work products; and
- Distributing the QA/QC Plan and the site Health and Safety Plan to the technical staff and subcontractors.

1.2 Field Coordinator/Field Operations Manager

The contractor will provide a Field Coordinator/Field Operations Manager for the project. As Field Coordinator, the selected individual will interface between the PM and subcontractors to ensure that all personnel, supplies, and equipment necessary for completion of field activities are available. In the role of Field Operations Manager, the selected individual will coordinate and be present during all sampling activities and will ensure the availability and maintenance of all sampling materials/equipment. The Field Operations Manager will be responsible for the completion of all sampling and chain-of-custody documentation and the overall quality of work performed during the investigation at the site as it relates to the following specific responsibilities:

- Implementation of the field activities in accordance with the Work Plan;
- Management of field staff during the investigation, including health and safety procedures; and
- Coordination of site work including subcontractor access to and work at the site.

1.3 QA Manager

The Project QA Manager will be responsible for oversight of all site QA/QC activities. The QA Manager will remain independent of day-to-day direct project involvement, but will have the responsibility for ensuring that all project and task-specific QA/QC requirements are met. The QA Manager’s specific duties include:

- Reviewing and approving the QA/QC Plan;
- Reviewing and approving substantive changes to the QA/QC Plan;
- Reviewing any new work orders with the PM to determine if the QA/QC Plan requires modification;
- Providing external review of field and analytical activities by performance of assessment and oversight duties; and
- Conducting field audits and keeping written records of those audits.

1.4 Project Health & Safety Manager and Site Safety Officer

The Project Health and Safety Manager (PHSM), or designee, is responsible for overseeing all aspects of the site safety program and preparing any site-specific health and safety guidance documents or addenda to this plan. The PHSM does not report to the PM and is separately accountable to the contractor's senior management for site health and safety.

1.5 Task Manager and Technical Staff

The Task Manager and technical staff for this program will be specified in advance by the contractor. The technical staff will implement project and site tasks, analyze data, and prepare reports/support materials as directed by the Task Manager. All personnel assigned will be experienced professionals who possess the degree of specialization and technical competence required to perform the required work effectively and efficiently. Project personnel will hold current certifications documenting appropriate training for assigned tasks, as required.

1.6 Analytical Laboratory

The analytical laboratories providing analytical services will be chosen as appropriate for the project requirements. The analytical laboratory shall be accredited for the analytical parameters required for the project and covered under the scope of the certification programs. The laboratory QA programs will be reviewed by the QA Manager. The laboratory must provide an experienced PM to coordinate between the QA Manager and the laboratory. The laboratory staff shall include a QA Officer/Coordinator who is independent of the day-to-day operations of the laboratory. The specific duties of each Laboratory PM and Laboratory QA Officer on the project include:

- Reviewing the QA/QC Plan to verify that analytical operations will meet project requirements;
- Documenting and implementing site-specific QA/QC requirements in the laboratory and reviewing analytical data to verify the requirements were met;
- Reviewing receipt of all sample shipments and notifying the Field Operations Manager of any discrepancies in a timely fashion;

- Conducting internal laboratory audits to assess implementation of the QA/QC Plan and providing written records of those audits;

- Providing rapid notification to the contractor’s PM regarding laboratory nonconformance with the QA/QC Plan or analytical QA/QC problems affecting samples; and

- Coordinating with the project and laboratory management to implement corrective actions as required by the QA/QC Plan or laboratory Quality Assurance Manual.

1.7 Other Subcontractors

The drilling, probing, surveying, and/or other subcontractors are responsible for implementing the subcontracts and applicable portions of this PMP as provided in the subcontract package. Subcontractors are responsible for rapidly notifying the Field Operations Manager regarding nonconformance with the PMP or QAPP problems affecting the project. Subcontractors must coordinate with the Field Operations Manager to implement corrective actions required by the contractor.

ARCADIS

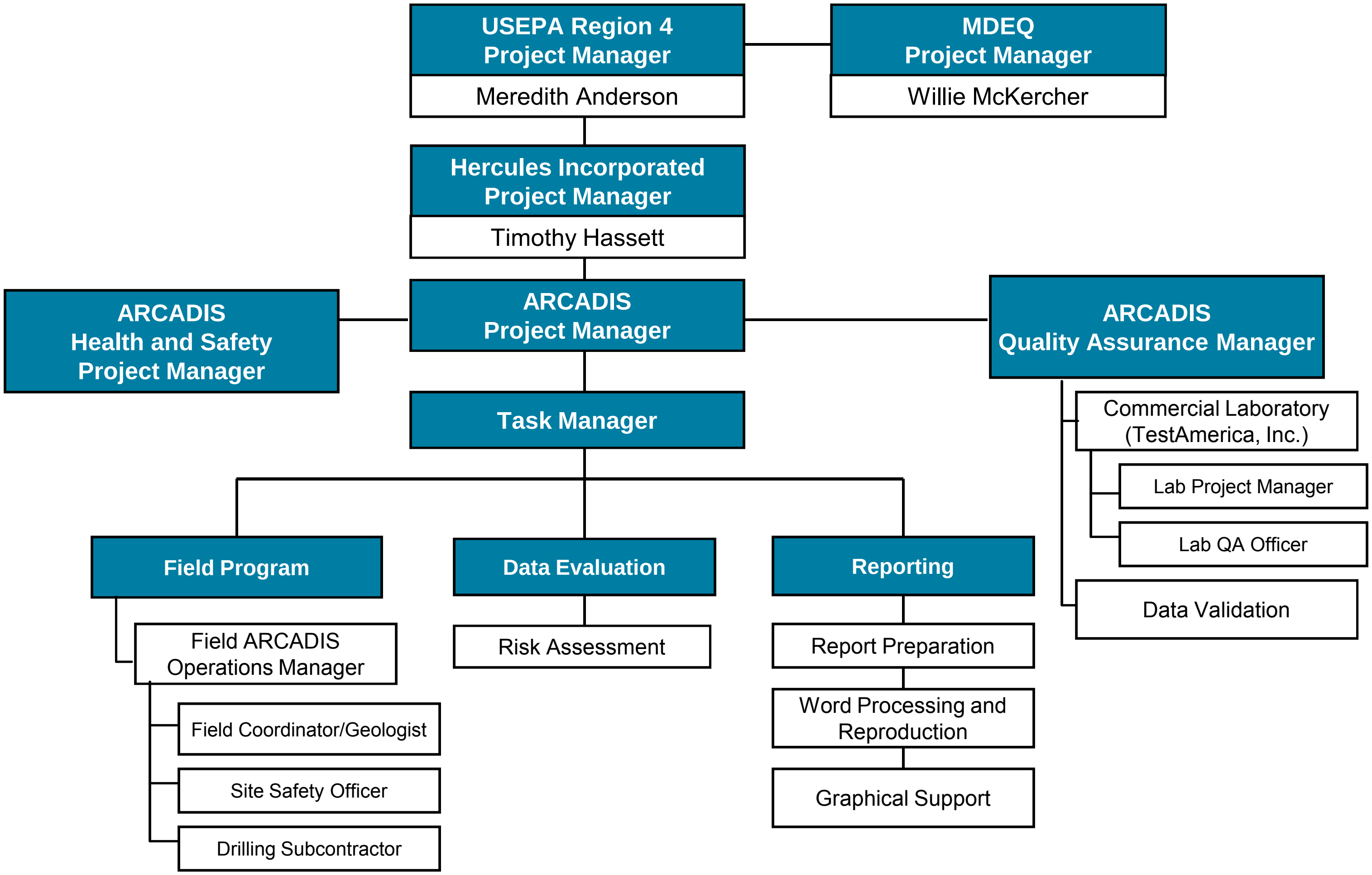
Attachment A

Organizational Chart

ARCADIS

Organizational Chart

Phase I Sampling and Analysis Work Plan



USEPA Region 4 Project Manager
Meredith Anderson

MDEQ Project Manager
Willie McKercher

Hercules Incorporated Project Manager
Timothy Hassett

ARCADIS Health and Safety Project Manager

ARCADIS Project Manager

ARCADIS Quality Assurance Manager
- Commercial Laboratory (TestAmerica, Inc.)
  - Lab Project Manager
  - Lab QA Officer
- Data Validation

Task Manager

Field Program
- Field ARCADIS Operations Manager
  - Field Coordinator/Geologist
  - Site Safety Officer
  - Drilling Subcontractor

Data Evaluation
- Risk Assessment

Reporting
- Report Preparation
- Word Processing and Reproduction
- Graphical Support